# East Kootenay Badger Project Summary: June 1996 – June 2006

**18 July 2006**

**Prepared for:**

Columbia Basin Fish and Wildlife
Compensation Program
Nelson, BC

Parks Canada
Radium Hot Springs, BC

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## Introduction

Southern British Columbia is the northwestern range limit of the American badger (*Taxidea taxus*), and supports the nationally endangered subspecies *T. t. jeffersonii*. The East Kootenay Badger Project is a multi-faceted, interagency project that began in 1996. The project has integrated ecological research, population augmentation, and community outreach and extension in an effort to understand and conserve badger populations. The following summarizes major findings and accomplishments to June, 2006, and provides key recommendations for management.

## Ecological Research

We conducted radiotelemetry-based research to gain an understanding of space-use, diet and demography. Research began in the north then gradually shifted southward, so that the study area extended from about Brisco to the Montana boundary (Figure 1). Animal captures were primarily in the Rocky Mountain Trench, but monitoring extended outward to the Rocky and Purcell mountains to follow animal movements. We monitored 14 males (3 adults in north, 7 adults in south, and 4 juveniles in south) and 16 females (3 adults in north, 6 adults in south, and 7 juveniles in south). Although demographic trends were more negative in the north than south, the offset in timing of research between the 2 areas initially made it unclear whether trends were related to timing (i.e. trends were poor for both areas at the start of the study) or location (the north was no longer capable of supporting badgers). Subsequent research suggested that, while the north may have a lower total carrying capacity for badgers, the results we observed were largely related to the difference in timing between northern and southern portions of the study area.
Results of the research, and analyses stemming from it, are listed below.

<u>Demographics</u>

- Age of adults at capture ranged from 1 to 12 years, with mean and median ages of 4.7 and 3 years overall. Mean and median ages in the north were 5.0 and 3 years, and in the south were 4.6 and 4 years. The oldest animal at the time of death was a 13.6 year old female struck by a car.
- In the north, 0 kits were observed in 10 animal-years (n = 4 adult females). In the south, 19 kits were observed from 12 litters in 15 animal-years (n = 7 adult females). Two of 3 southern females observed at age 1 had successful litters.
- Annual Kaplan-Meier survivorship of juveniles (all from the south) was 51%. Mortality causes of juveniles included train kill, probable starvation, cougar or bobcat predation, and unknown. Starvation was likely due to this juvenile being in captivity for 5 weeks while her mother recovered from a broken pelvis from a vehicle hit.

- Annual survivorship of adults was 81.8% (Kaplan-Meier method); south = 90.2% (K-M method); north = 68.1 (Mayfield method). Mortality causes included roadkill, probable cougar predation, probable bobcat predation, probable old age, and unknown.
- Survivorship was greater later in the study for both northern and southern animals.

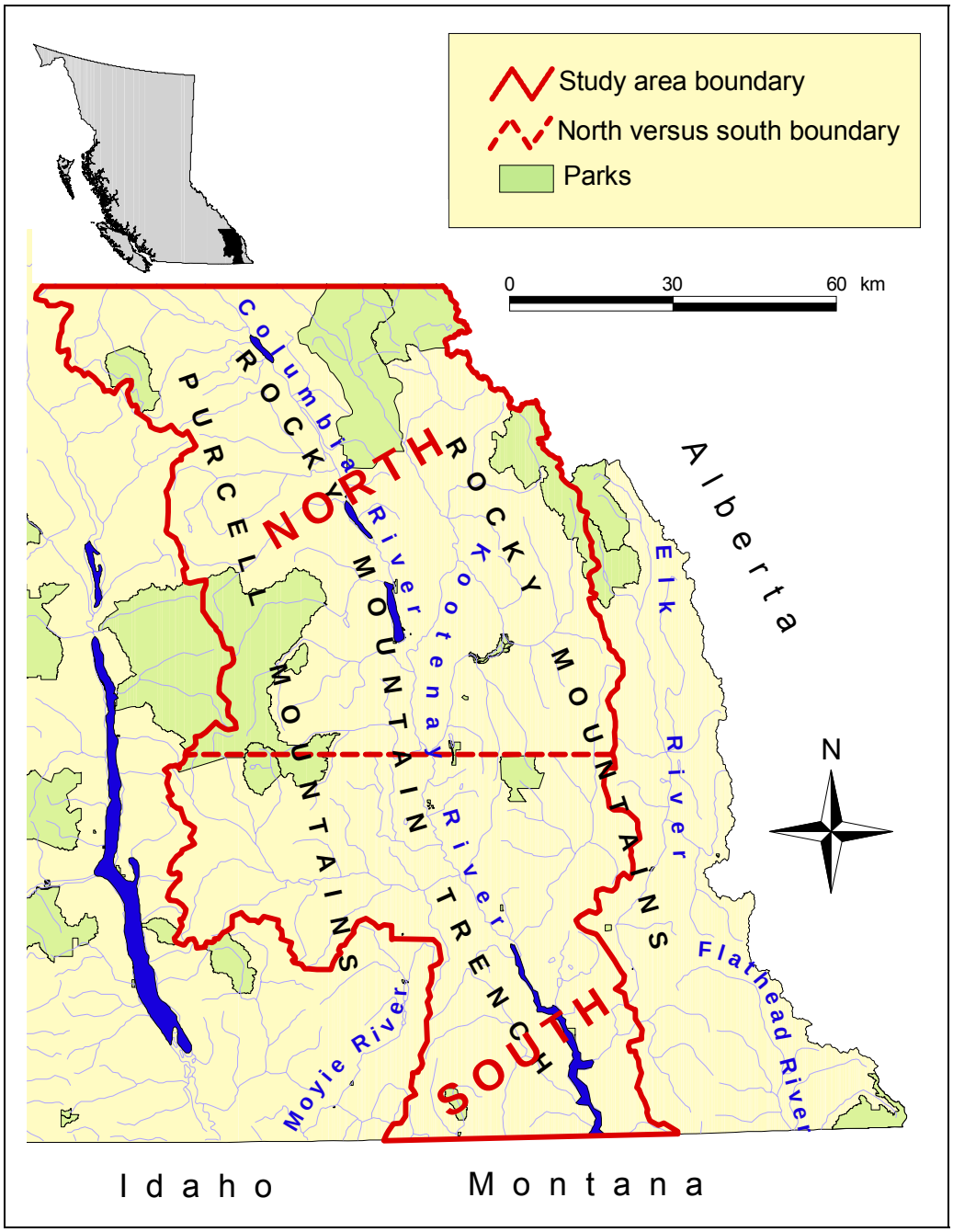


Figure 1. Radiotelemetry research study area for the East Kootenay Badger Project. All but 1 capture and most telemetry occurred within the Rocky Mountain Trench.

Space-Use

- Average home ranges were larger than had been reported for studies in Idaho, Wyoming, Colorado and Illinois. In the East Kootenay, average home ranges (SE) for males were 301 $km^2$ (98) using 100% minimum convex polygon (MCP) methods or 64 $km^2$ (21) using 95% fixed kernel (FK) methods. Average home ranges for females were 35 $km^2$ (12) using 100% MCP or 18 $km^2$ (10) using 95% FK. Home ranges were much larger in the north than the south, particularly for male MCPs.
- Compared to females, resident male kits made initial dispersal movements later (325 vs 106 days), made maximum dispersals later (495 vs 176 days), and had greater maximum dispersal distances (26.1 vs 11.0 km).
- Projected population growth rate for the north was $\lambda = 0.7$ (30% annual decline), for the south was $\lambda = 1.2$ (20% annual growth), and combined 1.0 (stable).
- Periods of winter inactivity (December-April) were highly variable, ranging from apparently continuous activity to 105 days. Our monitoring interval may not have been sufficiently sensitive to detect short bouts of inactivity.
- Movements may be significantly altered during the breeding season. On 1 day in August, 3 radiotagged male badgers were located within 350 of each other despite having MCP home ranges of 12 - 83 $km^2$.

Prey

- The dominant prey was Columbian ground squirrels, but other rodents, birds, amphibians and insects were regularly consumed. Diets were similar throughout the study area.
- Of 201 randomly located plots within the Interior Douglas-fir (IDF) zone between Brisco and Wasa, only 5% had any ground squirrel burrows within a 0.8-ha sampling area. Despite this, ground squirrel burrows occurred 81% of the time (n = 397) on at least 1 of 4 50-m x 4-m transects radiating out from occupied badger burrows.

Microhabitat

- Burrows were frequently near a change in cover; 82% (n=515) were within 50 m and half of those were within 10 m.
- Burrows occurred on a variety of terrain, but typically were on gentle slopes with 53% on slopes ≤ 10% and only 2% on slopes ≥ 80% (n=521).
- Badgers used existing burrows 1.8 as many times as they dug new ones (n = 393). Many burrows appeared to be used year after year, and in 2 cases, 2 apparently unrelated badgers used the same burrow at different times.
- Badgers do sometimes use culverts under roads. For example, a radiotagged female with a maternal den in the highway right-of-way was documented using a nearby culvert to access a field on the other side of the highway and also to use another culvert 1.3 km distant on the same day.

Broad-Scale Habitat Use

- Badgers used all biogeoclimatic zones in the East Kootenay, with most telemetry and sightings records from the Interior Douglas-fir and Ponderosa Pine zones (PP), but regular use of disturbed areas within the Montane Spruce (MS), Engelmann Spruce-Subalpine Fir (ESSF) and Interior Cedar-Hemlock (ICH) zones, and occasional use of the Interior Mountain-heather Alpine (IMA) zone.
- Similarly, while radiotagged badgers occurred largely in and near ecosections where they were captured (East Kootenay Trench, Eastern Purcell Mountains, Southern Park Ranges and McGillivray Range), sightings included all ecosections including also the Border Ranges, Southern Columbia Mountains, Central Columbia Mountains and Big Bend Trench.
- Rapid movement over long distances and across elevations sometimes occurs. Two males were documented traveling from the IDF to IMA, in 1 case several times, covering elevations from 800 m to 2200-2400 m.
- Median elevations for both radiotagged badgers (n = 1008 based on a database thinned to have less bias toward animals with many radiolocations) and those sighted by the public (n = 1008) were about 900 m, although they extended from the valley floor to nearly 2400 m (tagged animals) or nearly 2600 m (sightings).
- Over half of both radiolocations and sightings were on private land, with most of the remaining ones on provincial Crown land. Indian reserves supported about 7% of telemetry locations and 2% of sightings, while fewer than 2% of either telemetry or sightings records were in parks.
- Based on 1:50,000-scale mapping, both radiotagged badgers and those reported by the public occurred predominantly in silty through gravelly soils where surface materials were > 10 cm deep. However, soil characteristics were not recorded in the field so fine-scale results may differ considerably.
- The most common land-use classes used by badgers (both from sightings and radiolocations) were agriculture, young forest, logged, rangeland, and selectively logged. Sightings also commonly occurred in the urban class, while telemetry locations were often also in the burn and urban classes.
- About 40-45% of both sightings and telemetry records were in areas designated as productive forest, mostly of Douglas-fir and lodgepole pine (though not always with mature forest cover).
- The most common ecosystem units used by badgers (both from sightings and radiolocations) were grassland, forest with pinegrass understory, forested grassland, forest with soopolallie understory, and urban. Ecosystem units reflect the expected climax conditions and those listed are based on groupings of units identified through Predictive Ecosystem Mapping (PEM).

Habitat Model

A habitat model was developed (led by Clayton Apps, Aspen Wildlife Research) for the northern portion of the study area, part way through the research. Based on the data available then, the following results were observed.

- At a broad landscape scale (23.8 $km^2$), badgers were positively associated with glaciolacustrine and glaciofluvial and negative with colluvial soil parent materials. There was also a positive relationship with fine sandy-loam texture. Associations were negative with forested habitats and positive with open range, agricultural habitats and linear disturbances. Associations were negative with elevation, slope, terrain ruggedness and both vegetation productivity and moisture.
- At a fine landscape scale (14.5 ha), associations were positive with glaciofluvial, fine sandy-loam textured, and well-drained soils. Associations were negative with colluvial soils, forest cover, vegetation moisture, elevation and ruggedness. Associations with open range and southern aspects were positive.
- Private land represented 9% of the study area, but 35% of probable habitat.
- Although sites with a wide range of crown closures are used by badgers, data used in an earlier draft of the habitat model indicated that badger burrows (n = 780) occurred more commonly than expected by chance in areas with the surrounding 200-m radius having ≤25% crown closure, and especially with ≤15% crown closure.

Roads

- From field sampling of 514 burrows 50% were within 200 m of a gravel road and 37% were within 200 m of a paved road. Of the 514, 6% were within 10 m of a gravel road and 3% were within 10 m of a paved road.
- Based on 1:20,000 mapping in relation to 1008 telemetry locations, 81% were within 200 m of a dirt, gravel or paved road.
- Habitat modeling showed a positive relationship with linear disturbances at the broad scale, but not at the fine scale.

Genetics

Tissue samples for radiotagged and roadkilled badgers from the East Kootenay were compared by Chris Kyle, University of Alberta, to those from Alberta and Montana.

- Genetic variation of badgers within the East Kootenay was nearly as high as 2 sampled populations of *Taxidea taxus taxus*, suggesting that demographic declines may have been relatively recent and that the level of genetic variation has yet to diminish.
- Gene flow did not appear to be impaired between sampled regions of northwestern Montana (*T. t. jeffersonii*) and the East Kootenay, nor was there any indication of substructure within these regions.

## Population Augmentation

We translocated badgers from northwestern Montana into the northern part of the study area for 2 reasons. We wished to determine whether the apparent decline or extirpation of badgers from that area reflected a permanent loss of its capacity

to support badgers or just the variability in population size that would be expected at this range limit. In addition, the translocations were intended to initiate recovery (which would be possible only if the recent decline had been due to chance or other temporary effects. We translocated 16 badgers from 2002 through 2004 including 8 adult males, 4 adult females, 2 juvenile males, and 2 juvenile females.

- We documented 10 kits from 5 successful litters across 8 animal-years of monitoring.
- We radiotagged 6 juveniles (4 females, 2 males) that were the offspring of either translocated females or their kits.
- Of the 4 animals translocated as juveniles, all were lost from radio contact prior to their first birthday. Of the 6 radiotagged from the re-established population, 4 survived to their first birthday and 2 were lost from radio contact. Thus, Kaplan-Meier annual juvenile survivorship was 100%.
- Kaplan-Meier annual adult survivorship was 77%. Mortality causes included roadkills, probable predation, and probable roadkill.
- The dominant prey was Columbian ground squirrels, but other rodents and fish were also consumed.
- Average home range size (SE) for males were 702 $km^2$ (185) using 100% MCP and 194 $km^2$ (72) using 95% FK. Average home ranges for females were 34 $km^2$ (14) using 100% MCP and 9 $km^2$ (3) using 95% FK.
- No differences were detected between males and females in age of dispersal or maximum dispersal distance. First dispersals occurred at a mean age of 102 days, with maximum dispersal at 255 days and mean distance of 32 km.
- Translocated animals and their offspring had a projected population growth of $\lambda = 1.3$ (30% annual increase).

## Other Conservation Initiatives

In addition to population augmentation, we took several other conservation actions.

- *Badger Hotline*: The hotline serves a dual purpose of collecting important distribution and trend data from sightings reported by the public, and as a valuable opportunity for researchers to convey ecological and conservation messages to callers. From 1996 to 15 June 2006, 1059 recent and historic sightings have been recorded within the East Kootenay and Creston valley. The hotline is on-going. Many of the sightings have arrived via the provincial badger website, in response to a notice in the provincial hunting regulations, from direct contact with landowners, resource managers and attendees at talks, and (earlier in the project) from posters or notices in newspapers.
- *Roadkill Reduction*: From June to September in 2004, 2005 and 2006, badger crossing signs were temporarily installed near Brisco to alert drivers to badgers in the area. The signs also serve as a valuable awareness tool for community members reinforcing the idea that badgers are in the area, that they are rare, and that they are vulnerable to roadkill. In addition, the Ministry

of Transportation installed a badger culvert near Elko in September, 2004. The culvert was monitored by the Nature Conservancy of Canada in summer 2005 and regular use by Columbian ground squirrels but not badgers was documented. Monitoring is continuing in 2006.

- *Rehabilitation*: We brought a radiotagged female into captivity to heal a pelvis broken from a car collision in June, 2000. She was held for about 6 weeks and released to her original home range. She successfully bred and produced a litter of 2 kits in 2001. We also held her female offspring with her for approximately 5 weeks, but it died of apparent starvation in September, 2000. We are also providing advice on an apparently orphaned East Kootenay badger kit taken in by the BC Wildlife Park in Kamloops.
- *Landowner Signs*: We developed two signs, "Badgers Dig it Here" and "Badgers: Nature's Gopher Getters", and installed them at gates of about 20 cooperating landowners.
- *Private Stewardship*: The most powerful private stewardship tool was the sense of ownership of individual badgers that landowners developed when badgers were captured and radiotagged on their property. We often found that landowners became strongly committed to badger conservation through the process of handling immobilized badgers and subsequently learning where these badgers traveled to and what fates they met.
- *Burrow ID Card:* We developed a card designed to assist field technicians and private landowners to differentiate between badger, ground squirrel and coyote burrows
- *Brochures and Postcards*: We designed a brochure and helped Parks Canada to design a post card describing badger ecology and preliminary results. These were distributed to landowners and at public events.
- *Displays*: A portable display and detachable display posters were created for conferences, workshops, and for display in local visitor centers, in cooperation with Parks Canada. A permanent Parks Canada display focusing on the use of fire as a tool for eco-restoration (including badgers), has been installed at the Radium Hot Springs Visitor Centre.
- *Media*: Education efforts were made through various media including newspapers, magazines, radio, and television. Highlights a *Champions of the Wild* documentary, which has received international distribution, has been re-broadcast many times, and was also shown regularly at Science World in Vancouver in 2005/06.
- *Websites*: There are several active websites that provide information about the EKBP, including:
  - Columbia Basin Fish and Wildlife Compensation Program www.cbfishwildlife.org
  - Parks Canada www.pc.gc.ca/pn-np/bc/kootenay/natcul/natcul30a_e.asp
  - jeffersonii Badger Recovery Team www.badgers.bc.ca
  - Science World British Columbia www.scienceworld.ca/whats_on/science_theatre/now_playing/badgers.htm

  - Nature Conservancy of Canada
    www.natureconservancy.ca/pdf/ark_fall05_english.pdf
    http://www.natureconservancy.ca/pdf/NCC_AR_EN_Final.pdf
  - Denise Withers (producer of Champions of the Wild badger documentary)
    http://homepage.mac.com/denisewithers/iblog/StorySharing/C376604327/
- *Golf Course Stewardship:* An initiative to promote conservation of ground squirrels and badgers on golf courses was developed in cooperation with the Kimberley Golf Course. The course agreed to leave ground squirrels to live in the rough and to live-trap only animals digging on the fairway. An interpretive sign explaining the ecological benefits of ground squirrels to soils and predators, including badgers was installed at the pro shop. This initiative received national coverage through *Greenmaster* magazine.
- *Cooperation with NGOs:* Information regarding important badger habitats has been provided to The Land Conservancy of BC and the Nature Conservancy of Canada. We have also cooperated with TLC's "Adopt-a-Badger" program, a fund-raising program to purchase properties in the Wycliffe area.
- *First Nation Involvement:* Both the Shuswap Band and Akisqnuk First Nation cooperated with the EKBP by allowing access to their lands for research purposes. The Akisqnuk First Nation was also involved in translocating 3 badgers onto reserve lands. A presentation on badger ecology was made at the "Species at Risk in K'tunaxa Traditional Territory" workshop in 2006.
- *Input into Land Use Planning:* We have initiated and continue to provide input regarding badger habitat requirements and locations into planning for ecosystem restoration (Ministry of Forests and Range, Ministry of Environment) and rural land-use planning (Regional District of East Kootenay). Under separate funding from the Ministry of Forests, we continue to help guide the selection of wildlife habitat areas (WHAs) for badgers, and are monitoring their effectiveness.
- *Participation in jeffersonii Badger Recovery Team:* This subspecies of badgers is nationally endangered but, within Canada, occurs only in British Columbia. The EKBP project biologists sits on the national (provincial) recovery team, which was formed in the winter of 2001. The most recent recovery strategy was completed in March 2005. It has been submitted to the BC Ministry of Environment, but has not yet been approved. In order to be submitted federally, the strategy requires revisions to make it SARA compliant.

## Products Available

Annual Reports, Surveys and Journal Articles

Annual reports were prepared from 1996 to 2006. The most recent one is:

Newhouse, N. J., and T. A., Kinley. 2006. East Kootenay Badger Project 2005-2006 progress report: ecology, translocation, communication, sightings and habitat Use. Prepared for Columbia Basin Fish and Wildlife

Compensation Program, Nelson, BC, and Parks Canada, Radium Hot Springs, BC.

Three survey reports have been produced.

Kinley, T. A., and N. J. Newhouse. 2005. Survey for burrows of American badgers and Columbian ground squirrels on the Columbia National Wildlife Area, British Columbia. Prepared for Parks Canada Agency, Radium Hot Springs, BC.

Kinley, T. A., and N. J. Newhouse. 2005. Survey for burrows of American badgers and Columbian ground squirrels on the Shuswap Indian Reserve, British Columbia. Prepared for Parks Canada Agency, Radium Hot Springs, BC.

Newhouse, N.J. 1999. Badger habitat and ground squirrel survey summary report. Prepared for Columbia Basin Trust, Nakusp, BC, Columbia Basin Fish and Wildlife Compensation Program, Nelson, BC, and Canadian Parks Service, Radium Hot Springs, BC.

Articles have been published in the proceedings of the two British Columbia Species at Risk conferences.

Newhouse, N. J., and T. A. Kinley. 2000. Biology and conservation challenges of badgers in the East Kootenay region of British Columbia. Pp. 685-690 in: L. M. Darling (ed.). Proceedings of a conference on the biology and management of species and habitats at risk. University College of the Cariboo, Kamloops, BC, February 15-19, 1999. The University College of the Cariboo, Kamloops, BC, and Ministry of Environment, Lands and Parks, Victoria, BC.

Newhouse, N. J., T. A. Kinley, G. T. McAllister, and R. W. Klafki. 2006. Translocation as a promising tool to aid recovery of badger populations. T. D. Hooper (ed.). Proceedings of the Species at Risk 2004 Pathways to Recovery Conference, March 2-6, 2004, Victoria, BC. 2004 Pathways to Recovery Conference Organizing Committee, Victoria, BC. (available electronically only)

Two journal articles have been published and one is being submitted for publication.

Apps, C. D., N. J. Newhouse, and T. A. Kinley. 2002. Habitat associations of American badgers in southeast British Columbia. Canadian Journal of Zoology 80:1228-1239.

Kyle, C. J., R. D. Weir, N. J. Newhouse, H. Davis, and C. Strobeck. 2004. Genetic structure of sensitive and endangered northwestern badger populations (*Taxidea taxus taxus and T.t. jeffersonii*). Journal of Mammology 85:633-639.

Kinley, T. A., and N. J. Newhouse. in prep. Ecology of an endangered range-limit badger population and use of translocation of aid recovery.

A draft recovery plan (not written directly under the auspices of the EKBP, but with input from the project biologist) has been developed.

*jeffersonii* Badger Recovery Team. 2004. National recovery strategy for American badger, *jeffersonii* subspecies (*Taxidea taxus jeffersonii*). Recovery of Nationally Endangered Wildlife, Ottawa, ON.

Databases

All databases are stored at the CBFWCP office, Nelson.

- Excel file with all resident and translocated badger radiolocations to January 19, 2006. Updated periodically.
- Excel file with all sightings for the East Kootenay and Creston area to January 19, 2006. Updated periodically.
- Excel file with starting and maximum dispersal for all resident juveniles.
- Excel file with starting and maximum dispersal for juveniles born to translocated females.
- Excel file with univariate GIS-based habitat attributes for radiolocations. This is a compilation of individual files for each forest district derived by CBFWCP staff. It includes land ownership, biogeoclimatic zonation, elevation, forest cover, baseline thematic mapping, PEM mapping, soils and terrain mapping, road density and distance to nearest road. The file includes data for all radiolocations and also for the "thinned" version of the database that limited the period between sequential locations to ≥4 days and ≤30 total locations per animal. Radiolocations current to January 19, 2006.
- Excel file with univariate GIS-based habitat attributes for sightings reported by the public. Contents as above, but contains attributes for all sightings. Radiolocations current to January 19, 2006.

Other Products

- Habitat suitability map (as published in Apps et al. 2002) from $49^0$30'N to $50^0$50'N
- Telemetry, home range and dispersal map for resident badgers, current to January 19, 2006
- Telemetry, home range and dispersal map for translocated badgers and their descendents, current to January 19, 2006, portrayed on habitat suitability layer
- Burrow ID card

## Key Recommendations and Conclusions

1. Based on evidence from translocated and resident animals, we conclude that the extirpation of the northern population was largely related to fluctuations over time in environmental and human-related conditions or the effect of random events expected at range limits. It did not appear to have been primarily due to any permanent loss of the northern area's capacity to support badgers. While concerns remain about several factors that have or may have contributed to mortality and previous population declines in the north, that area had an apparently growing population of badgers 3.5 years after starting translocations.

2. Our results point to the value of long-term monitoring of populations of badgers or other species at range limits, or endangered populations generally. If trends relating to persistence vary dramatically over time, then short-term observations indicating that certain areas may have lost their ability to support a species may be misleading.

3. The loss of a species-at-risk from a locale should not necessarily be taken as evidence that the area can no longer support that species. Fluctuations in any population's size are more likely to cause extirpation when numbers are low, so the simple addition of more animals, along with potentially modest improvements in ecological conditions, may be sufficient to initiate recovery or at least improve stability. Where there is a nearby source population having no at-risk status, translocation provides a low-risk experiment and potentially speeds recovery. This observation may have applicability for other species and ecosystems, both locally (e.g. sharp-tailed grouse, mountain caribou) and beyond.

4. Part of the initial success may have been due to translocations occurring shortly after the loss of the original resident population. Burrows in which badgers are found are more often re-used than freshly dug, so translocating animals prior to those burrows deteriorating was likely beneficial. From a social perspective, having a collective public memory and recognition of badgers as part of the ecosystem probably improves the likelihood of support for both translocation and the necessary management actions (such as habitat restoration, protection of prey, and improving the public's perception of the value of badgers). In fact, rather than viewing translocation as being appropriate only when land and resource management actions have already been taken to maximize the likelihood of success, we argue that the re-introduction of an endangered species through translocation in itself acts as a catalyst for appropriate management activities.

5. For translocated badgers, the slightly lower survivorship among males, due largely to roadkills which in turn were likely due to more extensive movements, indicates that a preponderance of males might be desirable.

This imbalance should help ensure pregnancy among translocated females and therefore increase the number of litters, given the polygamous mating pattern. In addition, it would decrease the likelihood of females competing with other females for food in the initial period after translocation, likely furthering site fidelity and kit production. Our translocation of more males than females was a simple function of more males being trapped, but future efforts may wish to achieve this intentionally. These considerations may hold for other carnivores with similar space-use patterns.

6. Preliminary indications are that the translocation of kits (family groups) had no significant benefit over translocating the adults alone. We had initially expected that juveniles might be less attached than adults to their point of origin, making them less likely to "go home". However, preliminary indications are that translocated kits did not remain near release sites or mothers and in fact were rapidly lost from radio contact, whereas females and offspring born in future years showed site fidelity. While means of improving the fidelity of translocated juveniles to their release sites may be found, conservation goals might ultimately be best served by leaving independent juveniles in the source area. This would facilitate their establishing home ranges in areas vacated by captured animals, thus improving the status of the source population and allowing future removal of animals for translocation.

7. The translocation program has shown initial signs of success but numbers of badgers in the northern portion of the study area, particularly in the Columbia valley, remain too low to ensure population stability in the light of random events and fluctuations that typically affect small populations. Most of the suitable habitat remains unoccupied or occupied at very low densities. Recovery would be furthered by continuing translocation until it is clear that a population that is more-or-less self-sustaining is established. A proposal to translocate up to 25 more badgers into the upper Columbia valley and the portion of the Kootenay River immediately to the south was written in 2005 but has not been funded.

8. The badger habitat model published in 2002 was based on data only from Cranbrook north, and from a limited number of badgers. Land-use and habitat-restoration planning would be facilitated by having a model covering the entire East Kootenay, or at least the East Kootenay Trench ecosection. A provincial conservation assessment now underway (Artemis Wildlife Consultants) may provide a broad-level habitat model for the province or regions within it. If or when this is completed for the East Kootenay, its utility for detailed planning should be assessed. If more detail is required, an empirical habitat model similar to the existing one, should be created for the entire Trench.

9. Private land contributes significantly to badger habitat in the East Kootenay. Strong efforts should be made to maintain private land parcels as functioning badger habitat through purchase, covenant, or stewardship agreements. Considerable badger habitat also occurs on Indian reserves, so cooperative habitat management with First Nations has potential to benefit badgers.

10. We expect badger habitat quality within the Rocky Mountain Trench is lower than would be occur under natural disturbance as a result of forest in-growth. Therefore, ecosystem restoration efforts in areas of potential badger habitat should be supported. Monitoring is required to determine what habitats and treatments provide the best response for badgers and ground squirrels.

11. Given that ground squirrels tend to settle near existing colonies, rather than in vacant habitat, we expect that habitat restoration would be most beneficial when conducted on areas adjacent to currently suitable habitat.

12. Badgers occasionally used stands with high crown closures, but the selection evident for closure of less than about 25% indicates that restoration activities should aim to achieve values lower than that.

13. Badgers frequently re-use existing burrows, so effort should be made to avoid destruction of burrows during restoration or harvesting. Old burrows should be maintained through land-use planning exercises even if they are currently unoccupied as they provide habitat for dispersing or translocated individuals and presumably reduce the energy requirements of badgers using them.

14. Roadkill poses a significant risk to badger populations. Highway mitigation options, including culverts, signage and openings in concrete barriers, should be supported. However, roadkills are likely not randomly or uniformly distributed, selection by badgers relative to culvert type and placement is not clear, and mitigation may be costly. Therefore, priorities for locations and types of mitigation should be developed based on:
    a. records of roadkill locations (both in the East Kootenay and elsewhere);
    b. characteristics of culverts type and placement where use has occurred;
    c. sand-tracking at a selection of culvert mouths to investigate use; and
    d. if possible, use of GPS transmitters to more accurately gauge patterns of cross-highway movements by badgers. GPS transmitters as small as 35 g are apparently now available, so glue-on transmitters or other temporary deployment systems could be used to get high-frequency, short-duration data from badgers occurring near highways.

15. Land-use planning will be an essential tool to conserve badgers in the East Kootenay. Input should be made into the East Kootenay Regional District's Official Community Plans to ensure zoning and development decisions incorporate badger habitat and population requirements.

16. Badgers are susceptible to being illegally killed. In addition, their primary prey, Columbian ground squirrels, can be legally killed on private property. Therefore, it is crucial that positive approaches to conservation be taken whenever possible so that it is in the landowners' best interest to maintain badger habitat and badgers on their property.

17. Education efforts should continue to focus on badger and ground squirrel conservation and ecology, and the value of land-use planning and private land stewardship.

18. The *jeffersonii* Badger Recovery Team should continue to focus on provincial-level conservation and research initiatives and on completing the recovery strategy. WHAs, while not the primary tool for badger conservation, provide benefits and should continue to be designated and monitored. Techniques for effectiveness monitoring of WHAs should be considered for other monitoring initiatives relating to badgers, particularly ecosystem restoration.

## Acknowledgements

Funding and in-kind support for this research was provided by the Columbia Basin Fish and Wildlife Compensation Program, Columbia Basin Trust, Environment Canada, Forest Investment Account, Forest Renewal BC, Invermere Veterinary Hospital, Ministry of Water, Land and Air Protection, Montana Fish, Wildlife and Parks, Parks Canada Species at Risk program, Tembec Industries Inc. and Wildsight. We thank M. Badry, M. Belcher, S. Crowley, A. Dibb, R. Forbes, K. Fort, L. Ingham, J. Krebs, A. Levesque, J. Nicholas, M. Panian, Dr. H. Schwantje, I. Teske, T. Their, R. Washtak, J. Williams and E. Wenum for administrative and logistical support; I. Adams, A. Candy, S. Coulter, A. Davidson, R. DeGraff, R. Franken, C. Holschuh, M. Kaneen, R. Klafki, D. Lewis, K. Martell, T. McAllister, H. Page and D. Wallace for trapping and field work; S. Crockford and G. Frederick for identifying prey remains; Drs. M. Zehnder and C. Esch for implanting radiotransmitters, Dr. S. McDonald for inspection of badgers at the border, and the pilots at Babin Air for telemetry flights. We particularly wish to acknowledge contributions spanning the entire 10-year project, namely the logistical and financial support of L. Ingham of the Columbia Basin Fish and Wildlife Compensation Program and A. Dibb of Parks Canada, the dedicated field work of T. McAllister, and land access provided by landowners, Akisqnuk First Nation and Shuswap Indian Band. J. Krebs of the Columbia Basin Fish and Wildlife Compensation Program provided helpful comments on an earlier draft of this and other reports.