Translocation as a Promising Tool to Aid Recovery of Badger Populations

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Abstract: The subspecies of American badger[1] that occurs in British Columbia (*Taxidea taxus jeffersonii*) is on the provincial Red List, and is listed federally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered. Within the East Kootenay Trench, the badger population in the Kootenay River valley appears to be stable to possibly increasing slightly, but that of the upper Columbia River valley has approached extirpation. It is not clear whether trends in the upper Columbia are a product of a long-term loss in the area's ability to support badgers, suggesting that recovery would be unlikely, or simply the result of random events in a low-density population, indicating that recovery is possible under appropriate conditions. As a means of fast-tracking population recovery while testing the area's ability to support a recovering population, we translocated badgers into the upper Columbia valley. During the summers of 2002 and 2003, we radiotagged and translocated 15 badgers from the Kalispell, Montana area that were of the same subspecies and were genetically similar to those in the East Kootenay. These included seven adult males, four adult females, two juvenile males, and two juvenile females. As of December 2003, at least three of the seven badgers released in 2002 were alive, one had died of unknown causes, and three could no longer be radiolocated. One of the live animals was a female, and she weaned one kit in 2003. Of the eight badgers released in 2003, three were known to be alive, and five (four of which were juveniles) were at least temporarily lost from radio-telemetry contact. Early indications are that (1) survivorship among known-fate translocated adults is at least as high as for East Kootenay resident badgers, (2) 7 of 11 adults and 0 of 4 juveniles remained in radio-telemetry contact, (3) all released adults known to be alive remained entirely or partially within the release area, and (4) kit production has occurred. Thus, preliminary indications are that the upper Columbia River valley remains capable of supporting a badger population, and translocation has so far been an effective means of enabling or speeding recovery.

Key Words: badger, American badger, British Columbia, recovery, *Taxidea taxus*, *Taxidea taxus jeffersonii*, translocation

[1]NatureServe Explorer (version 4.0, July 2004) lists *Taxidea taxus* and *T. t. jeffersonii* as the American badger. The BC Species and Ecosystems Explorer (September 2004) lists the common name for *T. taxus* as 'badger'.

Introduction

American badgers (*Taxidea taxus*) occur throughout much of the conterminous United States and south central to southwestern Canada (Newhouse and Kinley 2000). There are four subspecies of the American badger (Long 1972; Newhouse and Kinley 2000); that which occurs in the western mountains is classified as *T. t. jeffersonii*. In Canada, this subspecies occurs only in British Columbia. It is considered nationally Endangered (COSEWIC 2003) and is red-listed provincially (Cannings et al. 1999). Ecological research on badgers in British Columbia began in 1996 with the East Kootenay Badger Project. Within the East Kootenay study area, the northern portion (upper Columbia River drainage) represents a northern range limit for the species. In the upper Columbia, the badger population declined from an already low level (likely less than five animals) at the onset of the research to as little as one animal by 2000. It appears that historically, badgers were relatively common at low elevations within the upper Columbia. Reasons for the decline are not clear but possibilities include shooting of perceived problem animals, control of badger prey (primarily Columbian ground squirrels [*Spermophilus columbianus*]), habitat alteration through fire suppression and real estate development, increasing numbers of roadkills as road density and traffic volume have risen, increasing barriers to movement caused by rapid urban development, or simply the effect of random events on a small population. In contrast, within the southern portion of the East Kootenay study area (the Kootenay River drainage upstream of the British Columbia-Montana boundary), the badger population appears to be small but recently stable, and possibly increasing over the short term (Newhouse and Kinley 2003). Despite the apparent potential for the Kootenay River drainage to act as a source population, the chances of rapid natural recolonization of the upper Columbia drainage appear slight given the relatively small source population in the Kootenay drainage (probably < 60 breeding adults) (N. Newhouse, unpublished data), the potentially ephemeral nature of conditions supporting increases within the Kootenay, the degradation of burrows over time (with reference to the importance of existing burrows to badgers [Newhouse and Kinley 2001]), the partial barriers (primarily human developments) to moving northward from the Kootenay to the Columbia, and the lack of connections to potential source populations in Alberta, as implied by subspecific differences.

The draft national recovery strategy for badgers (The *jeffersonii* Badger Recovery Team 2003), identified translocation as a possible method of augmenting populations and initiating recovery. Subpopulation delimitations (Newhouse and Kinley 2000) suggest that the part of Montana west of the Continental Divide supports the same subspecies of badger as British Columbia. The results of genetic research are consistent with this, as similarities between badgers in western Montana and those of the East Kootenay are greater than similarities between either of those two populations and badgers in eastern Montana or Alberta (Kyle et al. 2004). Thus, we began discussions with representatives of Montana Fish, Wildlife and Parks (FWP) in 2001 regarding possibilities for obtaining source animals for a translocation from the northwestern portion of that state. In Montana, badgers are classified as nongame wildlife with commercial value (Montana Fish, Wildlife and Parks 2002), so are subject to trapping and shooting without bag limits or seasons and (on private land) can be legally poisoned. The population status of *T. t. jeffersonii* in Montana has not been determined, although anecdotal observations suggest that badgers are considerably more abundant in northwestern Montana than in the East Kootenay. Thus, Montana officials were willing to permit the removal of badgers for translocation. We developed a plan to move 15 animals from Montana to the upper Columbia based on the following rationale:

- the population status within the upper Columbia River portion of the East Kootenay was extremely poor;
- natural recolonization was likely to be slow to nonexistent;
- a suitable source population for translocations was available;
- there was an opportunity to gain experience with translocation techniques;
- results of translocation might indicate whether the previous population decline was the result of ephemeral versus permanent factors; and
- translocation was included as an option within the national recovery strategy.

One initial concern about using translocation as a recovery tool might be the apparent poor prognosis for badgers released into an area where the original population had become extirpated or nearly so; however, we felt that several factors had recently changed in the upper Columbia valley. These included a general increase in public awareness and interest in badgers (Newhouse 2003) and the assumed reduction in intentional killing of badgers, the protection of Columbian ground squirrels on Crown land since 1992 and anecdotal evidence of increases in the ground squirrel population, and the ongoing efforts to address tree encroachment into former open forests and grasslands (Machmer et al. 2001). These changes suggested an increased likelihood of translocations being successful. In addition, population fluctuations can be due to random or other nonmechanistic factors. If this were the case for badgers in the upper Columbia, there would be further reason to expect that translocations could be successful. Ultimately, there appeared to be little chance of local recovery without translocations but some chance with them, so translocation appeared warranted.

Study Area

The East Kootenay region of southeastern British Columbia includes the portion of the Rocky Mountains west of the Continental Divide and south of about 52º N, the Purcell Mountains east of their height-of-land, and the Rocky Mountain Trench, a major northwest-southeast-trending valley between the two mountain ranges. Within this region, the Columbia River originates at Columbia Lake in the Trench and flows northward, while the Kootenay River originates in the Rockies before flowing into the Trench immediately south of Columbia Lake, and then travels southward. The Rocky Mountain Trench is narrower within the upper Columbia River drainage (3–16 km) than in the Kootenay River drainage (4–30 km).

Within the East Kootenay, biogeoclimatic zones generally follow an elevational sequence from the Ponderosa Pine (PP) at the lowest elevations in the warmest, driest areas, through the Interior Douglas-fir (IDF) above the PP and elsewhere on valley bottoms, followed by the Montane Spruce (MS), Engelmann Spruce–Subalpine Fir (ESSF), and Alpine Tundra (AT) zones. In some tributaries of the Trench that receive higher precipitation, the Interior Cedar–Hemlock (ICH) zone occurs in place of the MS (Braumandl and Curran 1992). The PP and IDF zones were historically dominated by open forests of ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*), respectively, on zonal sites, grasslands or grass-shrublands on more xeric sites, and extensive marsh and forested riparian habitat along rivers; however, human settlement within the IDF and PP has resulted in residential, recreational, road, and agricultural development along the valley bottoms, along with tree ingrowth and encroachment into former open forest and grassland due to fire suppression (Gayton 1996). Climax forests in the MS are closed-canopy stands of hybrid white spruce (*Picea glauca* x *engelmannii*) while those in the ICH are composed of western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*), and those in the ESSF are composed of Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*). However, the MS, ICH, and ESSF in the study area have had an extensive history of fire and timber harvesting so also include roads, cutblocks, burns, and forest stands of varying ages with a high proportion of lodgepole pine (*Pinus contorta*)[2] and other tree species. The AT is nonforested.

Resident badgers that were radiotagged for the East Kootenay Badger Project have been trapped in the PP, IDF, and MS zones, but radiotagged and untagged badgers reported by the public (Newhouse 2003) have also used the ICH, ESSF, and AT, and their locations have extended from 800 to 2700 m elevation, and from the Montana boundary at 49º N to about 51º N.

The badgers that were used for translocation were trapped at the southern end of the Salish Mountains, 30–50 km west of Kalispell, Montana, or in one case, within Kalispell. Kalispell is the approximate southern limit of the Rocky Mountain Trench. The trapping area is classified as IDF (Demarchi et al. 2000), although vegetation there appeared more typical of the PP zone in the East Kootenay.

Methods

Translocation and Monitoring

The general location for trapping source animals was selected by FWP biologists based on high-density badger populations. The one animal captured at Kalispell was targeted due to

[2]The BC Species and Ecosystems Explorer (September 2004) lists the taxonomic name for the lodgepole pine as *Pinus contorta* var. *latifolia*

complaints about it digging burrows under a helipad. We set and checked traps in cooperation with a contract trapper from Montana and a FWP biologist, and followed methods outlined in Apps et al. (2002). There were 935 trap-nights over 65 days between May and August 2002 and in July 2003 in the regular trapping area, plus 2 nights at the Kalispell helipad in August 2002. After capture, we transported badgers to Kalispell for veterinary examination and implantation of radio transmitters. In 2002, a variety of brands, models, and specifications of transmitters that were surplus from other research projects were implanted due to a temporary inability to license new radio transmitters. Transmitters used in 2003 were manufactured by Advanced Telemetry Systems (Isanti, MN) and were rated at > 3 years battery life. All badgers were dewormed and had topical flea ointment applied. We then transported them to the border for Canadian Food Inspection Agency (CFIA) veterinarian examination. Seven of the translocated badgers were released the day after capture, while six were released after two days and two were released after three days due to the temporary unavailability of veterinarian services or inspection personnel.

We selected release sites based on the following criteria:

- the site was located within or immediately adjacent to the upper Columbia River drainage;
- high habitat quality extended over a large area, as indicated by recent habitat suitability modeling (Apps et al. 2002) and subjective assessments that incorporated recent or imminent changes to habitat conditions;
- there was evidence of abundant ground squirrel populations;
- there was evidence of recent use by badgers;
- there was low risk of vehicle collisions (few roads and/or roads with little traffic); and
- there were relatively low levels of human settlement.

We released badgers at existing but currently unoccupied badger burrows within active Columbian ground squirrel colonies. Several frozen ground squirrels were provided to each released badger to ensure it had food immediately and an opportunity to develop familiarity with the release site. We monitored badgers aerially using standard radio-telemetry techniques (Samuel and Fuller 1996). The monitoring schedule varied by season, weather, aircraft availability, and budget. Flights occurred approximately three times monthly from release through October 2002, then monthly from November 2002 through March 2003, then twice monthly from April through June 2003, and then weekly through 13 August 2003. Flights were interrupted from 14 August (19 days after the release of the last badger) through 10 September 2003 because the telemetry aircraft was being used for spotting wildfires. Flights occurred about three times monthly in September and October 2003, then monthly during November and December 2003. In searching for badgers that were not readily located, we periodically extended monitoring flights in the Rocky Mountain Trench from 80 km northwest of the northernmost release site southward to the trapping locations and up to 15 km into both the Purcell and Rocky

Mountains, an area of about 10,000 km^2. This report summarizes results through December 2003.

We used the following procedures and obtained the following permits to conduct the translocations:

- The British Columbia Ministry of Water, Land and Air Protection (WLAP) provincially approved an 'Application for Permit to Conduct Badger Translocation' by The *jeffersonii* Badger Recovery Team.
- WLAP provincially issued a permit to import, transport, and release badgers.
- WLAP regionally issued a scientific permit for collecting samples, radiotagging, and tracking.
- A scientific collecting permit was issued by FWP.
- For each badger, a U.S. Fish and Wildlife Service 'Declaration for Importation or Exportation of Fish or Wildlife' (Form 3-177) was completed.
- Each badger was inspected by a veterinarian in Montana and issued a Health Certificate titled 'Official Certificate of Interstate Movement'.
- Each badger was checked at the border by a CFIA veterinarian.

Analyses

We employed the modified Kaplan-Meier method to chart survivorship following the staggered-entry technique described by Pollock et al. (1989). The survivorship function for each week was calculated using the formula

$$S(t) = \prod (1-d_j/r_j)$$

where $S(t)$ = survivorship at time t
$\prod$ = product
d_j = deaths in the week
r_j = number of animals at risk in the week (i.e., total number tagged minus number having previously died or for which telemetry contact was lost)

This provided weekly cumulative survivorship data for plotting. Confidence intervals for weekly Kaplan-Meier survivorship estimates were determined following Pollock et al. (1989):

$$95\%\ CI = S(t) +/- 1.96\{[S(t)]^2[1-S(t)]/r(t)\}^{1/2}$$

Following this, S_{annual} was extrapolated by taking the n^{th} root of the cumulative survivorship, where n is the number of years. The date of death or censoring (due to telemetry contact being lost) was assumed to be the midway point between the last live telemetry date and either the date on which the animal was found dead or the first date on which it could no longer be located.

We conducted a chi-square test using Statistix 8 (Analytical Software, Tallahassee, FL) to compare the proportion of juveniles vs. adults lost from radio contact. We used Calhome (Kie et al. 1994) to calculate 100% minimum convex polygons (MCP) enclosing post-release radiolocations of translocated badgers to provide preliminary indications of movement. Kernel estimators of home range were not calculated due to currently low relocation samples. We assumed the center of MCPs to be the midpoint of each badger's extreme post-release east and west coordinates and north and south coordinates.

Results

Fifteen badgers were translocated, almost half of which were adult males (Table 1). In addition, three juvenile females were released immediately after capture due to their small size, and two adult males were also immediately released due to the preponderance of males captured (Table 1). There were seven release sites (< 0.5 km^2 each) across 75 lineal km of the upper Columbia portion of the Trench or immediately adjacent to it (Fig. 1). We used four sites for the release of one adult male each; three males were released in 2002, and one was released in 2003. We used the fifth site for the release of an adult female and adult male in 2002 and an adult male in 2003; the sixth site for the release of an adult female and adult male in 2002 and an adult female with a kit of each sex in 2003; and the seventh site for the release of an adult female with a female kit and an unrelated male kit in 2003.

Table 1. Badgers translocated from the Kalispell, Montana area to the upper Columbia River portion of the East Kootenay region, British Columbia, 2002 and 2003.

Year	*Badgers translocated*				
	adult male	*adult female*	*juvenile male*	*juvenile female*	*total*
2002	5[a]	2	0	0[b]	7
2003	2	2	2	2	8
Total	7[a]	4	2	2[b]	15

[a]Two more were released upon capture due to preponderance of adult males trapped in 2002.
[b]Three more were released upon capture due to small size and young age.

Known movements of translocated badgers were within both the upper Columbia drainage and the adjacent Kootenay drainage (Fig. 1). While most activity was in the Rocky Mountain Trench within areas predicted to have medium to high habitat quality, several animals made use of sites farther into the Rocky or Purcell Mountains, including sites at high elevations. The sizes of MCPs enclosing known badger locations for badgers translocated in 2002 were highly variable, but within the limitations of the preliminary data, appeared similar between resident and translocated males but smaller for translocated females (Table 2).

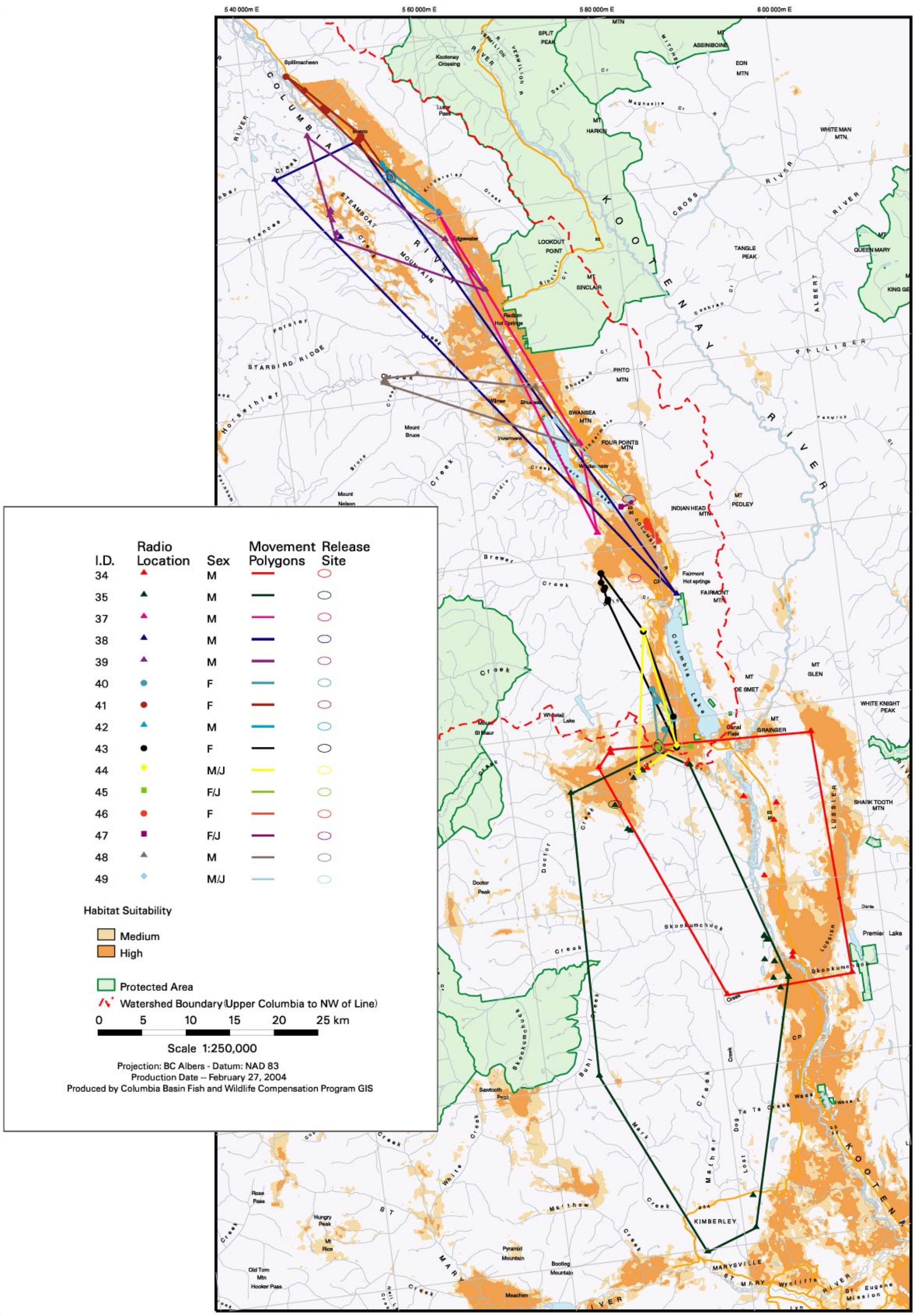

Figure 1. Release sites, radiolocations, and minimum convex polygons enclosing radiolocations for badgers translocated to the upper Columbia River portion of the East Kootenay region, British Columbia in 2002 and 2003.

Table 2. Area of minimum convex polygons (MCP)[a] enclosing movements of adult badgers translocated to the upper Columbia River portion of the East Kootenay region, British Columbia, 2002, compared to those of residents[b] in the upper Columbia, 1996–1999.

Badger	*Sex*	*Status*	*Months of data*	*No. of radiolocations[c]*	*Rate[d] (%)*	*MCP area (km^2)*
2	M	resident	23	57	87	513.0
4	M	resident	30	81	75	764.8
6	M	resident	17	39	75	776.4
1	F	resident	38	163	88	86.9
3	F	resident	36	142	83	84.4
5	F	resident	8	27	93	52.3
34	M	translocated 2002	19	36	92	560.7
35	M	translocated 2002	19	26	65	913.9
37	M	translocated 2002	13	14	54	55.3
38	M	translocated 2002	13	4	17	320.9
39	M	translocated 2002	12	11	100	107.6
40	F	translocated 2002	10	14	100	7.3
41	F	translocated 2002	16	28	88	9.6

[a]Due to small samples and the high proportion of unsuccessful relocations, these should be considered to be only preliminary indicators of areas used. No calculations were done for animals released in 2003.
[b]Calculated using N. Newhouse, unpublished data
[c]Excludes release locations for translocated badgers.
[d]Percentage of attempted radiolocations that were successful, including last successful radiolocation

As of December 2003, six of the translocated badgers were known to be alive and one (adult female) had died. The fates of the remaining eight are unknown, but they were presumed to either have experienced radio transmitter failure or to have dispersed beyond the range of monitoring (Table 3). This represents annual survivorship among known-fate adults of 88.9% (Fig. 2). We could not calculate survivorship for the translocated juveniles because all were lost from radio contact within a month of release, For animals translocated in 2003, a comparison among age groups was possible because identical radio transmitters were used in each animal. The proportion of badgers lost from radio-telemetry contact was higher among juveniles than adults (4/4 vs. 2/6; $\chi^2 = 4.44$, 1 DF, $P = 0.035$) in that year.

Table 3. Status and locations relative to release sites of badgers translocated to the upper Columbia River portion of the East Kootenay region, British Columbia, 2002 and 2003.

No.	*Sex*	*Age*	*Year*	*Status and latest radio-telemetry contact date*	*MCP[a] in upper Columbia?*	*Release site in MCP?*	*Maximum dispersal distance (km)*	*Distance from release site to center of MCP (km)*
34	M	adult	2002	alive Dec/03	part	yes	33.7	15.3
35	M	adult	2002	alive Dec/03	part	yes	51.7	23.7
37	M	adult	2002	unknown Aug/03	yes	no	47.1	26.9
38	M	adult	2002	unknown Sep/03[b]	yes	yes	57.2	24.0

Table 3. Status and locations relative to release sites of badgers translocated to the upper Columbia River portion of the East Kootenay region, British Columbia, 2002 and 2003 (cont'd).

No.	*Sex*	*Age*	*Year*	*Status and latest radio-telemetry contact date*	*MCP[a] in upper Columbia ?*	*Release site in MCP?*	*Maximum dispersal distance (km)*	*Distance from release site to center of MCP (km)*
39	M	adult	2002	unknown Feb/03	yes	no	16.9	4.0
40	F	adult	2002	dead Jun/03	yes	yes	7.0	3.7
41	F	adult	2002	alive Dec/03	yes	yes	16.6	8.4
42	M	adult	2003	unknown Sep/03	yes	yes	6.9	2.7
43	F	adult	2003	alive Dec/03	yes	yes	20.9	10.2
44	M	juv.	2003	unknown Jul/03	yes	yes	13.4	5.4
45	F	juv.	2003	unknown Jul/03	yes	yes	3.7	1.9
46	F	adult	2003	alive Dec/03	yes	no	5.6	4.3
47	F	juv.	2003	unknown Jul/03	yes	no	1.2	0.6
48	M	adult	2003	alive Dec/03	yes	no	24.5	13.1
49	M	juv.	2003	unknown Aug/03	yes	no	6.7	6.2

[a]100% minimum convex polygon enclosing post-release radio-telemetry locations
[b]Transmitter replaced in July 2003

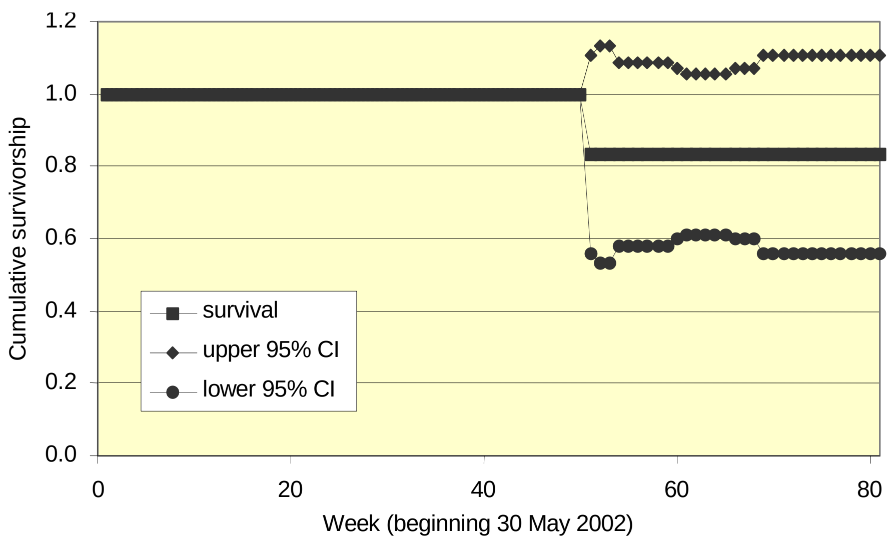

Figure 2. Kaplan-Meier survivorship curve for known-fate adult badgers that were translocated to the upper Columbia River portion of the East Kootenay region, British Columbia, May 2002–December 2003.

Of the two adult females present in the spring of 2003, one is known to have raised a single kit to the above-ground stage (first observed 12 June 2003). The fate of this kit is unknown as trapping attempts were not successful. We could not determine whether there were littermates that did not survive to the age at which they emerged from the natal burrow. The other adult female died between 10 and 30 May 2003. Although the last two radiolocations prior to death

(15 April and 10 May) had been estimated to be within 10 m of each other, suggestive of there being a maternal den, we had no direct evidence of the presence of kits.

Discussion

One difficulty in assessing the success of the translocation program is that the fate of 8 of the 15 translocated animals is unknown. It is likely that few if any of these animals died within the normal monitoring area as radio transmitters continue to function regardless of an animal’s death. In the past, dead resident animals with implanted transmitters have been readily detected from the air and ground when they were up to several meters underground, following a train collision, and after being struck by vehicles (N. Newhouse, unpublished data); thus, even if translocated animals had died, repeated attempts to locate them should have eventually been successful had the animals remained within the roughly 10,000-km^2 monitoring area. Several observations suggest that transmitter failure may have occurred in at least some of the animals. Failures have occurred for both resident and translocated animals in the past (N. Newhouse, unpublished data). This was particularly true for animals that were implanted in 2002 since surplus transmitters that were several years old were used. Thus, it is conceivable that the unknown status of badgers trapped in 2002 is partly or entirely due to transmitter failures. In fact, one of the badgers that was translocated in 2002 and subsequently retrapped in 2003 had a failed transmitter; its transmitter was replaced. However, there are also factors suggesting that dispersal was likely responsible for the unknown status of some animals. All transmitters implanted in 2003 were newly purchased and had an expected life > 3 years so having failures from 6 of the 10 transmitters in newly captured or recaptured animals would be surprising. The proportion of animals lost from radio-telemetry contact was higher among juveniles than adults, which is consistent with the expectation that juvenile badgers normally disperse (Messick and Hornocker 1981). This suggests that at least some of our observations may be due to long-distance dispersal by translocated badgers. Furthermore, several of the animals are known to have made movements well away from the release area, including some that were at high elevations and/or were near the edge of the monitoring area, and each of the translocated animals went undetected on at least one monitoring flight. These observations are consistent with some of the ‘lost’ animals having simply dispersed farther than those that remained in contact. The unavailability of the telemetry aircraft for much of the period shortly after release may have contributed to us losing contact with some animals before their general direction of travel could be established. Thus, while the fate of eight of the badgers will not be known unless they are found as dead animals, are retrapped, or return to the monitoring area, our best estimation is that (a) some portion, possibly the majority, of unknown fates represent animals that made long-distance dispersals, and (b) most of the remainder probably had transmitter failures. Permits are required for possession of badger carcasses in British Columbia, which provides an opportunity to inspect badgers that are picked up as roadkills or shot as nuisance animals. Full necropsies should be performed on all animals for which permits are requested, until at least 2010, to maximize the opportunity to learn the fate of translocated animals.

Despite the apparent dispersal of some or all of the translocated juveniles and the preliminary nature of our data, initial indications are that translocation has been relatively successful. Roughly half (likely more) of the translocated animals remained entirely or largely within the upper Columbia valley, with most continuing to make periodic to regular use of their release areas. There have been no other American badger translocation programs with which to compare results, but in two fisher (*Martes pennanti*) translocation programs in British Columbia, Weir (1995) found that 9–14 of the 15 collared animals established home ranges in the target area (mean < 42 km from release site), and Fontana et al. (1999) reported that 56% remained within the study area (mean < 26 km from release site) until losing radiocollars an average of five months post-release. Among grassland-dependent carnivores, dispersal data are available from the release of captive-reared and translocated wild-caught swift foxes (*Vulpes velox*) in Alberta and Saskatchewan, and captive-reared black-footed ferrets (*Mustela nigripes*) in Wyoming. In a year of apparent prey abundance, captive-reared foxes that survived from fall through spring had mean maximum dispersal distances of 9.3 km, with den sites averaging 4.5 km from release sites. In contrast, in a year of low food availability, 9 of 12 collared captive-reared foxes appeared to have dispersed beyond radio-telemetry contact within two weeks of release, while the remainder averaged 8 km dispersals in the same period (Herrero et al. 1991). Wild swift foxes captured in Wyoming and released in Alberta or Saskatchewan moved an average of 7.2 km from the release site within two days, 17.3 km after four days, and 27.2 km (adults) or 19.3 km (pups) during the multi-year monitoring period. In addition, daily movements were over twice as large for translocated than resident foxes during the first 50 days after release. Of the 29 foxes translocated in the fall, 11 survived within the target area to the following June (Moehrenschlager and Macdonald 2003). Many released ferrets were lost from radio-telemetry contact, but the locations of known-fate animals were within a rectangle of 1200 km^2 around the release site two months after release, and their maximum known dispersal distance was 26.5 km (Biggins et al. 2004). Within the constraints of having many animals of unknown fate, our results appear to be within the range of these five studies.

Additional evidence of success is that annual adult survivorship has been at least as good as that previously recorded for resident badgers (88.9% for translocated animals vs. 80.2% for residents of the East Kootenay as a whole [Newhouse and Kinley 2003]). Reproductive data are extremely limited, but the one female for which observations were possible had at least one kit that reached the above-ground stage in contrast to the previous complete absence of reproduction among tagged resident females in the upper Columbia (Newhouse and Kinley 2003). Thus, translocation appears to be a promising tool to 'kick-start' the recovery of extirpated or nearly extirpated badger populations. Our positive results also suggest that the original loss of the badger population in the upper Columbia valley may have been due to factors that were not permanent—

i.e., the decline prior to translocations does not necessarily indicate that the area has permanently lost its capability to support badgers.

Conducting translocations as soon as possible after a population declines is important for several reasons. Burrows in which badgers are found are more often reused than freshly dug (Newhouse and Kinley 2001). From a human social perspective, having a collective public memory and recognition of badgers as part of the ecosystem probably improves the likelihood of public support for both translocation and 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 presence of translocated badgers in itself acts as a catalyst for appropriate management activities. Without badgers present, it would probably be more difficult to convince government agencies and the public of the need to take other steps towards conservation of badgers. Thus, translocation of badgers into historic ranges from which they have been lost likely contributes to a positive feedback cycle that leads to further badger conservation actions. This may be appropriate for areas where badgers occur at low and potentially reduced densities elsewhere in British Columbia, such as parts of the Thompson-Okanagan region (Weir et al. 2003), or for badgers of the endangered *T. t. jacksoni* subspecies in southern Ontario (Newhouse and Kinley 2000).

Interpretation of translocated badger movements must be tempered by the fact that most animals were lost from radio contact. Additionally, some of the movements may have represented exploration so might not ultimately be included within a normal home range. These two factors have opposing implications as to whether or not the MCPs represented the true extent of home ranges; however, preliminary indications are that space use among translocated males was similar to residents. Adult female MCPs appeared to be much smaller for translocated than resident animals in the upper Columbia. The MCPs of the translocated females were similar to the mean value of 12.0 km^2 reported for resident adult females in the more southerly Kootenay River portion of the East Kootenay (Newhouse and Kinley 2003) and 10.5 km^2 for an adult female in the North Thompson River valley (Weir et al. 2003). More refined analyses of home ranges will be possible in future years as additional telemetry data from animals released in 2003 become available.

Two recommendations for future translocations relate to sex ratio and the use of juveniles. Even with the rejection of two males at the point of trapping, 64% of adults released in the upper Columbia were male. This sex ratio was skewed relative to the balanced population reported in other badger capture samples (Messick and Hornocker 1981; Newhouse and Kinley 2003). This imbalance will presumably help ensure pregnancy among translocated females, given the badger's polygamous mating pattern, but is obviously problematic from the perspective of maximizing the number of litters. The possibility of requiring additional effort and funding to acquire a more balanced sex ratio should be factored into the planning and budgets of future translocation programs. Unless our conclusions about juveniles having dispersed well out of the upper Columbia valley are wrong, preliminary indications are that the use of kits (family groups) had no significant benefit. We had initially expected that juveniles might be less attached than adults to their point of origin, potentially making them less likely to ‘go home’ and, therefore, perhaps more likely to remain in the vicinity of release sites. Among fishers translocated to the East Kootenay, family groups were found to be more likely than individuals to remain near the release site (Fontana et al. 1999). From our limited data, we cannot determine if the presence of kits improved fidelity to release sites among adult females, but preliminary indications are that the kits did not remain nearby. Site fidelity and family group cohesiveness among translocated kits and their mothers might be improved by forcing all members of family groups into the same burrow upon release. We released groups together but animals sometimes entered separate burrows, and we observed kits and mothers diverging from each other soon afterward. Using boards to funnel each member of a family group from the transport barrel into a single burrow would ensure that they did not immediately become separated. If translocations continue in future years or at other locations, monitoring the success of forcing family groups into a common burrow would be worthwhile. However, if future results indicate that translocated juveniles are not typically successful in establishing home ranges within target areas, and their presence does not improve site fidelity among their mothers, then conservation goals might ultimately be best served by leaving juveniles in the source area (assuming adult females were only removed late enough in the season that the kits would be independent or nearly so). This would facilitate juveniles establishing home ranges in areas vacated by captured animals, thus presumably increasing survivorship of the source population and allowing a higher future removal of animals for translocation.

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