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Research Article

Management Implications for Releasing Orphaned, Captive-Reared Bears Back to the Wild

JOHN J. BEECHAM,[1] *Idaho Department of Fish and Game, 600 S. Walnut Street, Boise, ID 83707, USA and 7252 N. Pierce Park Lane, Boise, ID 83703, USA*

MIGUEL DE GABRIEL HERNANDO, *C/ Carnicer, í, as 3, 2°I, León 24003, Spain*

ALEXANDROS A. KARAMANLIDIS, *ARCTUROS, Civil Society for the Protection and Management of Wildlife and the Natural Environment, Florina 53075, Greece and Department of Ecology and Natural Resource Management, Norwegian University of Life Sciences, Ås 1432, Norway*

RICHARD A. BEAUSOLEIL, *Washington Department of Fish and Wildlife, 3515 State Highway 97A, Wenatchee, WA 98801, USA*

KELCEY BURGUESS, *New Jersey Division of Fish and Wildlife, 141 Van Syckels Road, Hampton, NJ 08827, USA*

DONG-HYUK JEONG, *Species Restoration Technology Institute of Korea National Park Service, 53-1, Hwangjeon-ri, Masan-myeon, Gurye, Jeonnam Province, South Korea*

MATHEW BINKS, *Laurentian University, Sudbury, Ontario, Canada and 104 David Street, Sudbury, ON P3E 1T1, Canada*

LEONARDO BERECZKY, *Association for Conserving Natural Values, 1st December Street Number 22, Balan 535200, Romania*

N. V. K. ASHRAF, *Wildlife Trust of India, F13, Sector 8, Noida, Uttar Pradesh 201301, India*

KIRA SKRIPOVA, *Vladivostok Branch of Russian Customs Academy 16v, Strelkovaya Street, Vladivostok 690034, Russia*

LISA RHODIN, *Montana Wildlife Center at Montana Wild, Post Office Box 200701, Helena, Montana 59601, USA*

JANENE AUGER, *1110 Monte L. Bean Museum, Brigham Young University, Provo, UT 84602, USA*

BAE-KEUN LEE, *Species Restoration Technology Institute of Korea National Park Service, 53-1, Hwangjeon-ri, Masan-myeon, Gurye, Jeonnam Province, South Korea*

ABSTRACT Orphaned bears have been captive-reared and released back to the wild for more than 3 decades, often without a clear understanding of their fates because post-release monitoring is not a common practice. As a result, management agencies lack efficacy data on post-release success rates and are often reluctant to encourage increased use of this technique. We evaluated the potential management and conservation implications of releasing captive-reared bears by documenting post-release survival, cause-specific mortality, human conflict activity, movements, and reproduction for 550 American black, brown and Asiatic black bears reared in 12 captive-rearing programs around the world. Survival rates in these programs ranged from 0.50 to 1.00 and were similar among the 3 species. The primary causes of mortality were sport hunting and road kills for American black bears, intra-specific predation and illegal kills for brown bears, and natural mortalities and illegal kills for Asiatic black bears. Although American and Asiatic black bears were involved in conflicts post-release, the majority of released bears (94%) were not documented in conflict situations. Movement patterns of captive-reared American black and brown bears showed no homing tendencies toward their rearing facility. Twenty captive-reared bears produced 21 litters. Our analyses reduce many of the uncertainties surrounding the fate of bears released as yearlings and provide evidence that releasing captive-reared bears is a defensible management alternative.

KEY WORDS captive-reared, conflict, mortality, orphaned, rehabilitation, reintroduction, reproduction, survival, *Ursus*.

Raising orphaned wildlife in captive-rearing facilities for release back to the wild is expanding globally (Kelly et al. 2010), and this trend will likely increase in the future as a consequence of increasing interactions between humans and wildlife because of competition for resources and the availability of human food attractants. Such efforts are regularly carried out for birds (Golightly et al. 2002), marine mammals (Moore et al. 2007), and primates (Agoramoorthy and Hsu 1999), but with large carnivores such as bears, there are concerns that habituation (Herrero et al. 2005) can result from captive-rearing efforts and lead to human conflict, which can affect public acceptance for agency management programs.

For more than 30 years, wildlife biologists have rescued orphaned American black bear (*Ursus americanus*) cubs,

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[1]*E-mail: john.beecham@gmail.com*

placed them in captive-rearing facilities and released them as cubs or yearlings back into occupied bear habitat (Clarke et al. 1980, Alt and Beecham 1984, Carney and Vaughan 1987). The technique has more recently been applied to orphaned brown bears (*U. arctos ssp.*), Andean bears (*Tremarctos ornatus*), sun bears (*Helarctos malayanus*), and Asiatic black bears (*U. thibetanus*; Huber et al. 1994, Fredriksson 2001, Castellanos 2005, Han and Jung 2006, Pop et al. 2012). Although there is published research demonstrating success in reintroducing orphan American black bear cubs of the year to radio collared, lactating females (Clarke et al. 1980, Alt and Beecham 1984, Carney and Vaughan 1987, Clark 1999), into artificial dens (Jonkel et al. 1980), or as translocated family units (Eastridge and Clark 2001, Clark et al. 2002*a*), the fate of these cubs as yearlings has not been well documented (Clarke et al. 1980, Jonkel et al. 1980, Alt and Beecham 1984, Clark et al. 2002*b*). Moreover, samples sizes are limited and management agencies may be reluctant to encourage increased use of these techniques. The purpose of this assessment is to provide new data documenting post-release survival, cause-specific mortality, human-bear conflict activity, movements, and reproduction of orphaned, captive-reared bears released as yearlings to evaluate the potential management and conservation implications of this practice.

STUDY AREA

We evaluated data from 12 captive-rearing programs of orphaned bears around the world involving 3 species: 7 programs for American black bears (USA and Canada), 3 programs for brown bears (Canada, Romania, and Greece), and 2 programs for Asiatic black bears (South Korea and India). Government entities responsible for managing wildlife in each jurisdiction approved the selection of all release sites. All bears were released in areas with suitable habitat components; including adequate natural food availability, cover, and low probability of encountering humans. In New Jersey, the lack of relatively remote areas necessitated that bears be released in relatively urban areas with a history of increased risk for human-bear conflicts.

METHODS

All orphaned bears were accepted into captive-rearing facilities during their first year of life. The cubs were kept in captivity for 2–14 months using a variety of accepted captive animal protocols (International Fund for Animal Welfare [IFAW] 2007) that primarily involved minimizing post-weaning human contact during their captivity. Orphaned bears were housed in different kinds and sizes of enclosures depending on their age, size, health and/or temperament. Location, funding and the availability of building materials dictated the number of enclosures and type of construction. Cubs older than 12 weeks of age were housed in large outdoor enclosures (1.2–2.0 ha) with protection from weather extremes and given an opportunity to socialize with other orphaned cubs, when possible. Bears were fed natural foods (fruits, berries, nuts, road killed ungulates), supplemented with dry dog food and other anthropogenic foods after weaning (Beecham 2006). Asiatic black bears released in the Republic of Korea were orphaned and captive-reared in Russia before being transported to South Korea for release or were born in zoos and captive-reared in South Korea.

Captive-reared bears considered suitable for reintroduction into the wild were released as yearlings (11–23 months) into habitat occupied by the species. Release sites ranged from rural to remote areas with no exceptional levels of protection for released bears. Releases of American black bears took place during the first winter (Nov–Mar) or the second year during spring or summer (Apr–Jul), with a few exceptions (7%) that were kept in captivity until the second year fall (Sep–Oct) when they were considered releasable. Brown bear releases took place during the first winter or second year spring up to September. Both species were released using hard-release methods, defined as those without an acclimatization period (Clark 2009). Bears released in winter were placed into natural or artificial dens or released directly to choose a natural den site. Asiatic black bears were released during the second year spring, summer, or fall using a hard-release; however, in India this method led to high predation so an assisted-release technique was used that involved a gradual process where bears were taken for daily walks and returned to a protective enclosure for the night until they refused to return. This process occurred over several months.

All released bears were ear-tagged and/or equipped with very high frequency (VHF) or global positioning system (GPS) telemetry collars for post-release monitoring. Monitoring frequency and duration varied among projects because of logistical constraints and funding limitations. Collared bears were monitored until the collar dropped or malfunctioned and provided data on survival, cause-specific mortality, and movements. Ear-tagged bears provided opportunistic data on longevity, movements, and conflict activity.

Post-Release Survival and Cause-Specific Mortality

We estimated survival parameters using the Kaplan–Meier staggered entry design (Pollock et al. 1989) by entering the status of bears into the model at weekly intervals (Koehler and Pierce 2005). We included all American black bears, brown bears, and Asiatic black bears that were monitored using telemetry collars for a minimum of 20 days after release. Any animal that lost its collar or dispersed beyond telemetry detection was censored for that week (Sorensen and Powell 1998). Collared individuals that were known to have died after being censored were not included in the sample beyond the initial censoring date.

To test for differences in survival, by sex and species and between different study areas, we compared the survival rates generated through a Kaplan–Meier model using a log-rank test performed within the Survival package (Therneau 2014) for R software, version 3.0.1 (R Core Team 2013). We determined annual survival rates for each study area ($\hat{S}_i$)

using the number of recorded deaths (D_{ij}) and the number of individuals at risk (R_{ij}) for the study area i during the j week of the year (Hovey and McLellan 1996):

$$\hat{S}_i = \prod_{j=1}^{n=52} \left[1 - \left(\frac{D_{ij}}{R_{ij}}\right)\right]$$

Collared bears that died during the monitoring period provided data on cause-specific mortality via necropsies or hunter harvest reports with the assumption that hunter harvest was not biased by the presence of telemetry collars. We used logistic regressions to test the effect of age at orphaning, time in captivity, and release weight on mortality for American black bears in North America monitored through VHF transmitters during their first year in the wild as 1 to 2-year-olds by pooling data from Idaho, Montana, and Washington, 3 states with similar survival rates ($\chi^2_2 = 1.6$, $P = 0.441$). We compared all possible model combinations of the 3 predictor variables, their 2-way and 3-way interactions, and the null model, and chose the model with lowest Akaike's Information Criterion (AIC) value as the top model. Ear-tagged bears that were recaptured or found dead during the study provided opportunistic data on longevity.

Human-Bear Conflicts

We assumed that all released bears found in conflict situations with humans were identified by ear-tag or collar. We calculated the percentage of bears involved in conflicts for each species by dividing the number of bears found in conflict situations by the total number of bears released for that species.

We used the Pearson's χ^2 test to test the hypothesis that captive-reared American black bears found involved in post-release conflicts with humans were more likely to come from mothers with a known history of conflict activity. We also used logistic regression to test the influence of age at orphaning, time in captivity and release weight on probability that an American black bear was in a human conflict after release and selected the model with the lowest AIC value.

Post-Release Movements

We examined post-release movements using American black bear hunter-kill records in Idaho, USA to estimate post-release dispersal distances, which were calculated as the total straight-line distance between the release site and the kill site for each captive-reared bear. We used linear regression to examine the relationship between distances dispersed and the time between date of release and harvest. We used 1-way analysis of variance (ANOVA) to compare the log-transformed dispersal distance for males and females, and for bears harvested during the first year post-release as 1 to 2-year-olds with those harvested after their first year in the wild.

We used movement data of captive-reared brown bears fitted with GPS-GSM (global system for mobile communications) transmitters (Vectronics GmbH®, Berlin, Germany) in Romania and Greece to ascertain the extent of movements adjacent to roads and human settlements within their individual home ranges. All bears were released as yearlings during spring and summer months and monitored until they entered their first den as 2-year-olds. For each bear, we randomly selected 200 GPS locations (R software v. 3.0.1) and compared the number of locations within a 500-m distance to roads and human settlements to 200 random points within each bear's minimum convex polygon (MCP) home range (Manly et al. 2002) using a geographic information system (ArcGIS v.10.1, Environmental Systems Research Institute, Inc., Redlands, CA). We compared observed and expected patterns using techniques described by Neu et al. (1974) and tested statistical differences using Bonferroni confidence intervals at $\alpha = 0.05$ (Byers et al. 1984). We used the same data to detect homing patterns by calculating the minimum recorded post-release distance to the captive-rearing facility for each individual, and to calculate dispersal distances between release site and first den location.

Reproduction

We investigated reproductive success of captive-reared female American black bears in New Jersey, USA and Asiatic black bears in South Korea by monitoring radio-collared bears until they reached reproductive age. Incidental observations of ear-tagged captive-reared bears with cubs provided additional information on reproduction for brown bears. We summarized mean litter sizes and age at first birth of each species.

All facilities involved in this study were permitted and complied with required animal welfare and care protocols in each jurisdiction.

RESULTS

Five hundred and fifty captive-reared yearling bears were released back to the wild between 1991 and 2012: American black bears ($n = 424$; 245 M, 179 F), brown bears ($n = 64$; 37 M, 27 F), and Asiatic black bears ($n = 62$; 31 M, 31 F). Approximately 30% of all released bears were not observed post-release and were categorized as of unknown fate, 31% were known to have died, and 39% were alive when last observed.

Post-Release Survival and Cause-Specific Mortality

A log rank test did not indicate statistical differences in survival between sex classes for the 3 species (American black bears $\chi^2 = 3.5$, $P = 0.062$; brown bears $\chi^2 = 0.9$, $P = 0.356$; Asiatic black bears $\chi^2 = 0.5$, $P = 0.458$). Mean annual survival rates across sex and programs for captive-reared American black (0.734), brown (0.749), and Asiatic black bears (0.867) were similar ($\chi^2_2 = 3.7$, $P = 0.159$; Table 1).

Survival rates of American black bears varied considerably among states and provinces, ranging from 0.502 ± 0.027 in Washington ($n = 39$) to 0.897 ± 0.010 in Utah ($n = 14$). A log-rank test indicated that bears released in the 3 northwestern states, with unlimited or controlled entry spring hunting and unlimited fall hunting opportunities (ID, MT, and WA; $n = 96$), showed lower survival (Table 1) than states and provinces with controlled entry or no spring hunting and unlimited fall hunting opportunities (NJ, NM,

Table 1. Annual survival rates for captive-reared orphan bears released back to the wild as yearlings by species and sex, 1991–2012.

	Total			Males			Females		
Species/population	***n***	**Survival**	**SE**	***n***	**Survival**	**SE**	***n***	**Survival**	**SE**
American blackbear	209	0.734	0.010	116	0.692	0.014	93	0.777	0.009
Idaho (ID)	44	0.613	0.026	27	0.693	0.025	17	0.500	0.039
Montana (MT)	13	0.629	0.038	7	0.429	0.087	6	0.833	0.023
New Jersey (NJ)	14	0.868	0.009	3	0.889	0.011	11	0.862	0.010
New Mexico (NM)	26	0.751	0.026	14	0.795	0.026	12	0.700	0.039
Ontario (ON)	59	0.704	0.018	32	0.680	0.021	27	0.722	0.020
Utah (UT)	14	0.897	0.010	9	0.750	0.026	5	1.000	0.000
Washington (WA)	39	0.502	0.027	24	0.503	0.028	15	0.457	0.056
Brown bear	61	0.749	0.018	34	0.699	0.022	27	0.811	0.016
Romania (RO)	51	0.727	0.021	26	0.666	0.027	25	0.795	0.018
British Columbia (BC)	8	0.900	0.014	6	0.857	0.020	2	1.000	0.000
Greece (GR)	2	1.000	0.000	2	1.000	0.000			
Asiatic black bear	51	0.867	0.005	24	0.889	0.007	27	0.847	0.008
India (IN)	19	0.720	0.022	9	0.875	0.020	10	0.583	0.039
South Korea (SK)	32	0.889	0.005	15	0.893	0.006	17	0.884	0.006

ON, and UT; $n = 113$; $\chi^2_1 = 9.0$, $P = 0.003$). We did not detect differences in survival ($\chi^2 = 3.5$, $P = 0.060$) when we compared winter released bears <12 months of age ($n = 54$) with spring and summer releases of yearlings ($n = 155$), or when comparing den releases ($n = 36$) with other hard-release methods ($n = 173$) for this species ($\chi^2 = 2.3$, $P = 0.128$).

Hunters were the main cause of mortality (53%) for American black bears (Table 2). Of 141 known mortalities, 54% occurred during the first year after release when bears were 1 to 2-year old and at least 2 bears lived for more than 10 years in the wild. The best fitting logistic regression model indicated that age at orphaning ($Z = -2.35$, $P = 0.018$), release weight ($Z = -2.26$, $P = 0.024$), and the interaction between the 2 ($Z = 2.33$, $P = 0.020$) were the variables that best explained first-year mortality in Idaho, Montana, and Washington. Mortality was lower for bears orphaned at <8 months when they were released at heavier weights (Fig. 1). However, increasing release weight had a negative effect on survival for bears orphaned at ≥8 months.

Brown bears released in Romania showed the lowest survival rates (0.727 ± 0.021) of the 3 study areas, although sample sizes for Canada and Greece were too low for statistical comparison. We detected no difference in survival between brown bears released in spring (Apr–Jun; $n = 31$) and those released during summer (Jul–Sep; $n = 26$; $\chi^2 = 1.6$, $P = 0.205$). Intraspecific predation was the main cause of mortality for brown bears (37%). Illegal kills (25%) were the only documented cause of mortality for males in Romania and Canada. Eighty-five percent of documented brown bear mortalities ($n = 13$) occurred in the first year after release; 1 bear was legally harvested in Romania 4 years after release.

We observed similar survival rates ($\chi^2 = 2.0$, $P = 0.157$) for Asiatic black bears from South Korea (0.889 ± 0.005) and India (0.720 ± 0.022). Bears released during spring and summer ($n = 23$) survived at similar rates to those released in the fall ($n = 28$; $\chi^2 = 0.1$, $P = 0.709$). We found no difference in the survival rates between captive-born (0.913 ± 0.005) ($n = 16$) and wild-born (0.869 ± 0.007; $n = 18$) bears ($\chi^2 = 0.5$, $P = 0.469$) released in South Korea. Natural mortalities (37%) represented the majority of deaths for Asiatic black bears, although removals due to human conflicts were also a major cause of death for males (29%); illegal kills accounted for 26% of total mortalities. Fifty-three percent of documented mortalities ($n = 19$) occurred within the first year in the wild and 5 individuals were alive more than 8 years after release.

Human-Bear Conflicts

Whereas post-release conflict with humans was documented for American (6.1%) and Asiatic black bears (9.7%), the

Table 2. Causes of mortality for 91 captive-reared bears released back to the wild as yearlings by species and sex in the United States, Canada, Romania, Greece, India, and South Korea, 1991–2012.

Species/sex	***n***	**Mortalities**	**Natural mortalities (%)**	**Predator kills (%)**	**Road kills (%)**	**Illegal kills (%)**	**Hunter kills (%)**	**Conflict removals (%)**
American black bear	209	60	1 (1.7)	2 (3.3)	8 (13.3)		32 (53.3)	17 (28.3)
Males	116	34		1 (2.9)	4 (11.8)		20 (58.8)	9 (26.5)
Females	93	26	1 (3.8)	1 (3.8)	4 (15.4)		12 (46.2)	8 (30.8)
Brown bear	61	12		8 (66.7)	1 (8.3)	3 (25.0)		
Males	34	8		5 (62.5)		3 (37.5)		
Females	27	4		3 (75.0)	1 (25.0)			
Asiatic black bear	51	19	7 (36.8)	1 (5.3)		5 (26.3)		6 (31.6)
Males	24	7	2 (28.6)			2 (28.6)		2 (28.6)
Females	27	12	5 (41.7)	1 (8.3)		3 (25.0)		3 (25.0)

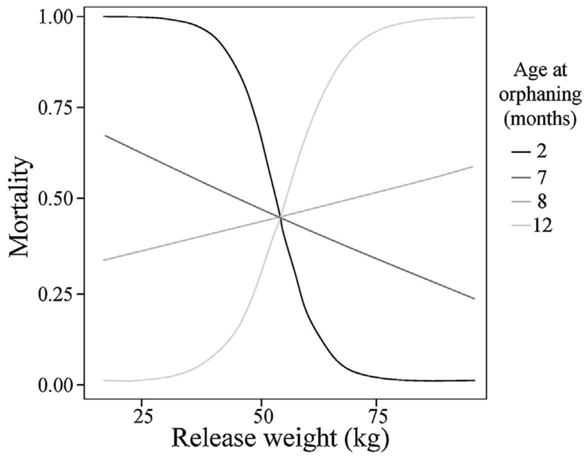

Figure 1. Relationship based on best-fitting logistic regression model between first-year mortality, release weight, and age at orphaning for captive-reared American black bears released in Idaho, Montana, and Washington.

majority of released black bears (94.2%) and all brown bears were not documented to be involved in conflicts (Table 3). The main causes of conflict removals in order of importance for both black bear species were persistent attempts to access unsecured human food resources, livestock damages, and habituated behavior that led to bears approaching humans in search of food; no agonistic behaviors towards humans were reported for any captive-reared bears. Most conflicts, 96.1% for American black and 66.7% for Asiatic black bears, were documented during the first year after release.

The sex of bears involved in conflicts did not differ from parity for American black bears ($\chi^2 = 1.5$, $P = 0.215$). Spring and fall release period ($\chi^2 = 0.3$, $P = 0.585$) and hard versus soft release method ($\chi^2 = 0.8$, $P = 0.373$) had no apparent effect on the probability of bears being involved in conflicts. We documented no difference in the probability of bears being involved in a conflict ($\chi^2 = 0.1$, $P = 0.752$) between captive-reared American black bears born to mothers with a known history of conflict behavior (2 of 37; 5%) and those born to mothers with no known history of conflict behavior (3 of 42; 7%). The probability of a bear being involved in a conflict increased with the length of time in captivity ($Z = 2.35$, $P = 0.018$) and decreased with heavier release weight ($Z = -2.08$, $P = 0.038$). Increasing release weight had a larger effect in reducing conflict probability for bears held in captivity for longer periods of time (i.e., >6 months) but was less important when bears were in captivity for shorter periods (Fig. 2).

Although sample sizes were limited for Asiatic black bears, we observed no differences in post-release conflict behavior (9.7%) between the sexes ($\chi^2 = 0.0$, $P = 1.000$) or by release period ($\chi^2 = 1.9$, $P = 0.170$). Captive-born ($n = 16$) and wild-born ($n = 18$) Asiatic black bears in South Korea showed a similar frequency of being involved in human conflict ($\chi^2 = 0.2$, $P = 0.683$).

Post-Release Movements

We observed post-release movements of 1 to 251 km from release location to harvest location for American black bears in Idaho ($\bar{x} = 42.8 \pm 49.2$ km). Linear regression analysis showed that length of time from release to harvest date did not affect total distance between the release site and harvest location ($F_{1,\ 45} = 0.841$, $P = 0.492$, $r^2 = -0.01$). We found no difference in average post-release dispersal distance between bears harvested the first year post-release ($\bar{x} = 45.8 \pm 54.6$km) and those surviving >1 year ($\bar{x} = 38.4 \pm 40.9$ km; $F_{1,\ 45} = 0.02$, $P = 0.884$). Average dispersal distance appeared to be slightly shorter for American black bear males ($\bar{x} = 38.8 \pm 39.1$km, $n = 28$) than for females ($\bar{x} = 48.8 \pm 61.9$km, $n = 19$), although we did not detect statistical differences ($F_{1,\ 45} = 1.34$, $P = 0.252$). Ten male and 5 female (31.9%, $n = 47$) American black bears were harvested within 10 km of their release site.

Examination of movements of captive-reared brown bears in Greece ($n = 2$) and Romania ($n = 8$) provided limited information about movements from the release site towards the captive facility (Table 4). The minimum recorded distance bears were located from captive facilities exceeded

Table 3. Number of orphaned captive-reared bears involved in conflict activity after being released back to the wild as yearlings by species, location, and sex, 1991–2012.

	Total		Males		Females	
Species/population	***n***	**Conflict removals (%)**	***n***	**Conflict removals (%)**	***n***	**Conflict removals (%)**
American black bear	424	26 (6.1)	245	12 (4.9)	179	14 (7.8)
Idaho (ID)	124	7 (5.6)	74	4 (5.4)	50	3 (6.0)
Montana (MT)	77	2 (2.6)	47	1 (2.1)	30	1 (3.3)
New Jersey (NJ)	58	5 (8.6)	30	1 (3.3)	28	4 (14.3)
New Mexico (NM)	31	4 (12.9)	17	2 (11.8)	14	2 (14.3)
Ontario (ON)	60	5 (8.3)	32	2 (6.3)	28	3 (10.7)
Utah (UT)	14	0	9	0	5	0
Washington (WA)	60	3 (5.0)	36	2 (5.6)	24	1 (4.2)
Brown bear	64	0	37	0	27	0
Romania (RO)	54	0	29	0	25	0
British Columbia (BC)	8	0	6	0	2	0
Greece (GR)	2	0	2	0		
Asiatic black bear	62	6 (9.7)	31	3 (9.7)	31	3 (9.7)
India (IN)	28	2 (7.1)	15	0	13	2 (15.4)
South Korea (SK)	34	4 (11.8)	16	3 (18.8)	18	1 (5.6)
Total combined	550	32 (5.8)	313	15 (4.8)	237	17 (7.2)

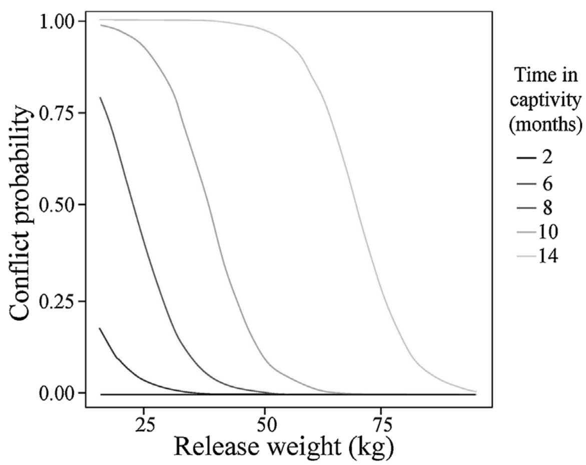

Figure 2. Relationship based on best-fitting logistic regression model between conflict probability, release weight, and time held in captivity for captive-reared American black bears released in Idaho, Montana, and Washington.

10 km, with the exception of 1 male bear in Romania and the 2 Greek males that were released less than 5 km from their captive rearing facility and spent 2 months nearby before dispersing 46 km to the south. First-year dens were all located >16 km from the release site ($\bar{x} = 52.8 \pm 35.2$ km, $n = 10$). All GPS collared bears avoided areas closer than 500 m to human settlement boundaries. Overall, captive-reared brown bears showed no attraction toward roads or settlements (Table 4). However, in Romania, males showed similar occurrence to expected values <500 m of roads.

No data were available to illustrate potential post-release movements in the vicinity of roads or human settlements for Asiatic black bears. No released Asiatic black bears were known to have returned to the vicinity of their captive rearing facility.

Reproduction

Eight of 10 captive-reared bears in New Jersey that were monitored until reproductive age gave birth to 28 cubs in 11 litters ($\bar{x} = 2.5$). Age at first breeding was 2.5 for 5 females and the offspring of 1 captive-reared female released in 2003 produced a cub in 2009. No brown bear captive-rearing programs included long-term post-release monitoring for reproduction. However, 4 ear-tagged, captive-reared female brown bears in Romania were observed with cubs after their release. Six of 10 captive-reared Asiatic black bears from South Korea gave birth to cubs while being monitored; all gave birth for the first time at 4.5 years old and produced 10 cubs in 7 litters ($\bar{x} = 1.4$).

DISCUSSION

In our attempt to evaluate the feasibility and efficacy of releasing orphaned bears back to the wild, we examined a large disparate dataset for 3 species of bears occupying vastly different habitats on 3 continents. The release of orphaned American black bears is relatively common and less controversial than it is for other species, but concerns still exist regarding post-release survival and the potential for captive-reared bears to cause conflicts that threaten humans and their property. We defined post-release success in 2 hierarchical levels: the primary level of success was achieved when captive-reared bears were able to survive in the wild and avoided negative interactions with humans; the secondary level of success was defined as bears demonstrating life-history traits similar to wild bears, including post-release movements and reproduction. We also provided information on movement data and reproduction by captive-reared bears.

Primary Success: Survival and Avoidance of Human Conflicts

We focused our analysis on 2 areas of primary concern for managers responsible for deciding the fates of orphaned bear cubs, survival and conflict activity. Our data show that captive-reared orphaned bears survived in the wild at similar rates to wild bears in the same populations and mortality causes were consistent with those reported in literature. The ability of orphaned bears to survive in the wild is an important concern facing wildlife managers deciding whether to release captive-reared bears back to the wild (Huber 2010). There are anecdotal reports of American black bears and brown bears surviving when left in the wild at 5–7 months of age (Erickson 1959, Palomero et al. 1997, Swenson et al. 1998), but no quantitative data exists for cubs released at <12 months of age. Reports on the survival of older (>12 months of age), captive-reared American black bears (Alt and Beecham 1984, Carney and Vaughan 1987, Clark 1999) and Asiatic black bears (Skripova 2013) released back to the wild are available, but little peer-reviewed information is available for brown bears (Huber 2010).

Survival rates of captive-reared American black bears appeared to reflect the amount of hunting pressure to which

Table 4. Post-release movements for captive-reared brown bears released from rearing facilities to the wild in Romania and Greece from 2007 to 2011. O = observed; E = expected (based on random locations); RS = release site. *indicates significant differences at $\alpha = 0.05$ based on Bonferroni confidence intervals.

Population/sex	n	Mean (range) distance from RS to den (km)	Range of recorded distances to facility (km)	Proportion of locations <500 m to roads O vs. E	Proportion of locations <500 m to villages O vs. E
Romania	8	50.6 (16.7–135.9)	3.6–140.7	0.078 < 0.124 (*)	0.046 < 0.108 (*)
Males	5	63.6 (16.7–135.9)	3.6–l38.5	0.102 = 0.123	0.033 < 0.110 (*)
Females	3	28.9 (20.6–38.2)	12.5–140.7	0.038 < 0.127 (*)	0.068 < 0.105 (*)
Greece/males	2	61.6 (61.3–61.9)	1.5–77.4	0.178 < 0.354 (*)	0.053 < 0.144 (*)
Combined	10	52.8 (16.7–135.9)	1.5–140.7	0.098 < 0.179 (*)	0.048 < 0.117 (*)

they were exposed. States with the lowest survival rates offered unlimited or controlled entry spring hunting and unlimited fall hunting opportunities, whereas those states and provinces with the highest survival rates offered limited entry controlled and harvest quota hunts or no spring hunting season. Survival rates reported for wild, subadult black bears (0.48–0.93) in North America (Garshelis 1994, Clark et al. 2002*b*) were similar to the rates we observed for orphaned captive-reared American black bears in their yearling and subadult age-classes. Research on wild bears in New Mexico (USA) and Ontario (Canada), 2 areas included in this study with harvest limits or fall only hunting opportunities, reported survival rates similar to those we found for captive-reared bears in those areas, ranging from 0.75 to 0.97 for yearlings and 0.86 to 0.89 for subadults (Costello et al. 2001), and 0.77 to 0.86 for yearlings and 0.57 to 0.77 for subadults (Obbard and Howe 2008), respectively. Jonkel and Cowan (1971) reported that wild bears in Montana, a state with greater hunting opportunities, showed survival rates of 0.38 for yearlings and 0.48 for subadults, which were similar to the values we observed for captive-reared males released in this state and slightly lower than survival rates we observed in populations with similar hunting seasons in Idaho and Washington.

Differences in sport hunting regulations, age at orphaning, and release weights appeared to be important factors influencing post-release mortality in American black bears. Hunter harvest was the primary cause of mortality for captive-reared American black bears as described for wild bears in nearby hunted populations (Koehler and Pierce 2005, Czetwertynski et al. 2007). Release weight and age at orphaning positively affected first-year survival. The significant interaction between weight and age at orphaning indicated higher first-year survival for bears orphaned at younger ages (i.e., <8 months) with increasing release weight, suggesting that heavier weights might compensate for the lack of previous experience in the wild. However, increased mortality for heavier bears orphaned at ≥ 8 months might be explained by the hunter preferences for larger bears in the 3 analyzed populations.

In Montana, wild brown bears showed survival rates of 0.682 for yearlings and 0.852 for subadults (Mace et al. 2012), which was similar to the overall survival rates we observed in captive-reared brown bears. Intraspecific predation was a notable cause of mortality for younger (<18 months) brown bears in Romania. Intraspecific predation was also a source of mortality in Sweden for young (<4 years) brown bears (Swenson et al. 1997, 2001). Illegal kills were the second highest cause of mortality for captive-reared brown bears in Romania. Researchers in Europe speculated that increasing encounters with brown bears in recolonized areas resulted in increasing numbers of illegal kills by local residents (Karamanlidis et al. 2011, Rigg et al. 2011, Zedrosser et al. 2011).

Other than Japan and Russia, Asiatic black bears are a protected species (i.e., not hunted for sport) throughout their range and this likely influenced survival rates for captive-reared Asiatic black bears which, in general, exceeded those of American black and brown bears. Conflict removals and illegal kills were major causes of human-caused mortality for Asiatic black bears in India and South Korea. The majority of illegal kills in South Korea were associated with illegal trapping efforts for wild boar (*Sus scrofa*). Black bears released in South Korea likely benefitted from the level of protection they received from being released in a national park, as part of a restoration effort, but high survival rates may also be related to the absence of adult bears in the release area. The lack of difference in survival rates between hand-reared Asiatic black bears born in the wild and those born in zoos suggests that captive-born bears may be suitable for release in augmentation or reintroduction programs when they are removed from zoo environments early in life and raised in rehabilitation facilities using recognized protocols for captive-rearing bears (IFAW 2007).

Wildlife managers have expressed concern about the involvement of captive-reared bears in conflict activity (Stiver et al. 1997, Clark et al. 2002*c*), especially cubs from sows with a prior history of conflict activity. We were not able to demonstrate that captive-reared American black bears from mothers with a known history of conflict behavior were more prone to become involved in conflict behavior than bears from mothers with no known history of conflict behavior. We agree with the conclusions of Breck et al. (2008) that the development of conflict behavior in bears is complex and strongly influenced by a variety of environmental and social factors. Breck et al. (2008) found little evidence of a genetic influence on conflict behavior and concluded that food-conditioned behavior was likely learned through asocial mechanisms (manner in which innovative behaviors are learned). They concluded that food conditioning was a behavioral adaptation to temporal food shortages (McCarthy and Seavoy 1994, Baruch-Mordo et al. 2011), availability of anthropogenic food resources, and intraspecific bear interactions (Beckmann and Berger 2003, Galef 2004).

Reported conflicts with humans are increasing for many bear species in much of the world (Baruch-Mordo et al. 2011, Can et al. 2014). The relationship between the numbers of reported conflicts and numbers of bears is unclear. However, increasing conflicts for wild American black bears are closely related to increasing human and bear numbers, the increasing availability of anthropogenic foods and agricultural crops adjacent to occupied bear habitats (Garshelis and Hristienko 2006, Spencer et al. 2007), and increasing frequency of failure in natural food production in xeric landscapes (Baruch-Mordo et al. 2011). Despite increasing trends in human-bear conflicts across bear habitats included in this study, there were relatively few cases (5.8%) of captive-reared bears becoming involved in conflict situations from the programs we report. Although we view the number of captive-reared bears involved in conflicts as a minimum because of potential loss of ear tags and/or radio collars (Diefenbach and Alt 1998), the authors of this study observed minimal ear-tag losses, so we have no reason to believe that the actual number is significantly higher than we observed.

Low release weight and longer periods of captivity increased the probability of post-release conflicts, suggesting that keeping bears in captivity for longer periods to increase their weight prior to release, which results in higher survival, may be an acceptable risk if the probability of conflict with humans is low in the release area. Otherwise, it appears advisable to maximize growth rates and reduce the length of time they are in captivity to increase survival rates and reduce the potential for human-bear conflicts in the first year post-release.

Secondary Success: Post-Release Movements and Reproduction

Post-release movements are one of the main concerns for managers when discussing potential release locations because of the dispersal ability of bears, their potential for homing behavior, and attraction toward human infrastructures. Captive-reared American black and brown bears in this study exhibited a wide range of post-release dispersal distances but showed no significant movements toward captive-rearing facilities. Binks (2008) also reported that captive-reared American black bears in Ontario demonstrated no tendency to move toward captive-rearing facilities and that post-release movements away from release sites were random in direction.

The lack of correlation between distance from the release site and length of time from release to harvest date in American black bears from Idaho, together with the similar dispersal distances found for bears harvested during the first year and those surviving >1 year, indicate that most dispersal occurred during the first active season after release (i.e., second year of life), which is consistent with other studies (Schwartz and Franzmann 1992, Lee and Vaughan 2003, Costello 2010). These results suggest that post-release dispersal patterns of captive-reared bears are not different from subadult wild bears, and that other considerations such as land use issues, potential conflict sources, habitat quality, competition, and cultural acceptance should take precedence over concerns about homing behavior or post-release dispersal from release sites when considering the suitability of potential release sites.

The despotic distribution hypothesis (Elfström et al. 2013) suggests that captive-reared brown bears should select for habitats adjacent to roads and human settlements because of the high risk of intraspecific predation or direct competition with dominant conspecifics in habitats away from roads and settlements (Rode et al. 2006*a*,*b*, Breck et al. 2008, Schwartz et al. 2010, Baruch-Mordo et al. 2011). Contrary to these findings, we found that 1 to 2-year-old captive-reared brown bears avoided habitats near both roads and settlements. We were not able to confirm the presence or absence of dominant bears using habitats near roads and settlements in our study, so we can only speculate that it is possible that the prior experience of captive-reared bears with humans influenced them in a negative way and they were actually avoiding contact with humans by selecting for habitats away from roads and settlements. Although intraspecific predation was an important mortality factor for brown bears <18 months of age in Romania, we observed no predation on older captive-reared bears or evidence that competition with dominant bears forced released bears to use marginal habitats.

Age at first reproduction and litter sizes observed for captive-reared American and Asiatic black bears were consistent with those reported for wild bears (Garshelis 1994, Yamanaka et al. 2011). Garshelis (1994) reported mean litter size for American black bears varied from 1.4 to 3.0 with a mean of 2.2 in 28 studies. Mean litter size for 244 litters of wild American black bears in New Jersey was 2.8 (K. Burguess, New Jersey Division of Wildlife, unpublished data); 11 litters from captive-reared bears averaged 2.5. The similarity between low age of first breeding and relatively large litter sizes of primiparous captive-reared and wild bears in New Jersey indicates that captive-reared females were not excluded from high quality habitats as a result of social interactions with wild bears. The difference we observed in litter size between captive-reared bears and wild bears in New Jersey likely resulted from the large proportion of first litters we observed for captive-reared bears. The relatively low mean litter size for bears in South Korea (1.4) in our study was consistent with data collected for captive and wild Asiatic black bears (1.6; Kong et al. 1998, Yamanaka et al. 2011, Lin 2013).

MANAGEMENT IMPLICATIONS

We examined the fates of 550 captive-reared bears raised in 12 geographically disparate areas across 3 continents under a variety of management regimes in an attempt to evaluate the efficacy of raising orphaned bear cubs for release back to the wild. Our analyses reduce many uncertainties surrounding the fate of captive-reared bears and provide evidence that releasing orphaned bears back to the wild is a defensible management alternative. Captive-reared bears released to the wild met our primary and secondary definitions of success; survival rates, human conflict levels, and reproduction by captive-reared and released bears in this study were comparable to those reported for wild bears. The obvious options managers face when presented with an orphaning include 1) leave them in the wild and let nature take its course; 2) put them in permanent captivity; 3) euthanize them; and 4) place them in a captive-rearing facility for release back to the wild at a future date. While acknowledging the need to reduce the orphaning of wild cubs, developing programs for the release of captive-reared bears can have direct and indirect conservation implications that extend beyond obvious welfare benefits, such as increasing public support and participation in conservation programs (Seddon et al. 2012), maintaining genetic diversity in small, isolated populations (Jamieson et al. 2006), and restoring bears to previously occupied habitat (Eastridge and Clark 2001, Clark et al. 2002*a*).

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LITERATURE CITED

Agoramoorthy, G., and M. J. Hsu. 1999. Rehabilitation and releases of chimpanzees on a natural island - methods hold promise for other as well. Journal of Wildlife Rehabilitation 22:3–7.

Alt, G. L., and J. J. Beecham. 1984. Reintroduction of orphaned black bear cubs into the wild. Wildlife Society Bulletin 12:169–174.

Baruch-Mordo, S., S. W. Breck, K. R. Wilson, and J. Broderick. 2011. The carrot or the stick? Evaluation of education and enforcement as management tools for human-wildlife conflicts. PLoS ONE 6:e15681.

Beckmann, J. P., and J. Berger. 2003. Using black bears to test ideal-free distribution models experimentally. Journal of Mammalogy 84:594–606.

Beecham, J. J. 2006. Orphan bear cubs: rehabilitation and release guidelines. World Society for the Protection of Animals, London, United Kingdom.

Binks, M. 2008. Survival and behaviour of orphaned and rehabilitated black bears incentral Ontario. Cambrian College, Sudbury, Ontario, Canada.

Breck, S. W., C. L. Williams, J. P. Beckmann, S. M. Matthews, C. W. Lackey, and J. J. Beecham. 2008. Using genetic relatedness to investigate the development of conflict behavior in black bears. Journal of Mammalogy 89:428–434.

Byers, C. R., R. K. Steinhorst, and P. R. Krausman. 1984. Clarification of a technique for analysis of utilization availability data. Journal of Wildlife Management 48:1050–1053.

Can, O. E., N. D. Cruze, D. L. Garshelis, J. J. Beecham, and D. W. Macdonald. 2014. Resolving human-bear conflict: a global survey of countries, experts and key factors. Conservation Letters 7:501–513.

Carney, D. W., and M. R. Vaughan. 1987. Survival of introduced black bear cubs in Shenandoah National Park, Virginia. International Conference on Bear Research and Management 7:83–85.

Castellanos, A. X. 2005. Reinforcement of Andean bear populations in the Alto Choco Reserve and neighbouring areas, northern Ecuador. Re-introduction News 24:12–13.

Clark, J. E. 1999. Survival of orphaned black bears released in the Smoky Mountains. University of Tennessee, Knoxville, USA.

Clark, J. D. 2009. Aspects and implications of bear reintroduction. Pages 126–145 *in* M. W. Hayward, and M. J. Somers, editors. Reintroduction of top-order predators. Blackwell Publishing, Hoboken, New Jersey, USA.

Clark, J. D., D. Huber, and C. Servheen. 2002*a*. Bear reintroductions: lessons and challenges. Ursus 13:335–345.

Clark, J. E., M. R. Pelton, B. J. Wear, and D. R. Ratajczak. 2002*b*. Survival of orphaned black bears released in the Smoky Mountains. Ursus 13:269–273.

Clark, J. E., F. T. van Manen, and M. R. Pelton. 2002*c*. Correlates of success for on-site releases of nuisance black bears in Great Smoky Mountains National Park. Wildlife Society Bulletin 30:104–111.

Clarke, S. H., J. O'Pezio, and C. Hackford. 1980. Fostering black bear cubs in the wild. International Conference on Bear Research and Management 4:163–166.

Costello, C. M. 2010. Estimates of dispersal and home-range fidelity in American black bears. Journal of Mammology 91:116–121.

Costello, C. M., D. E. Jones, K. A. Green Hammond, R. M. Inman, K. H. Inman, B. C. Thompson, R. A. Deitner, and H. B. Quigley. 2001. A study of black bear ecology in New Mexico with models for population dynamics and habitat suitability. New Mexico Game and Fish, Sante Fe, New Mexico, USA.

Czetwertynski, S. M., M. Boyce, and F. K. A. Schmiegelow. 2007. Effects of hunting on demographic parameters of American black bears. Ursus 18:1–18.

Diefenbach, D. R., and G. L. Alt. 1998. Modeling and evaluation of ear tag loss in black bears. Journal of Wildlife Management 62:1292–1300.

Eastridge, R., and J. D. Clark. 2001. Evaluation of 2 soft-release techniques to reintroduce black bears. Wildlife Society Bulletin 29:1163–1174.

Elfström, M., A. Zedrosser, O. G. Stoen, and J. E. Swenson. 2013. Ultimate and proximate mechanisms underlying the occurrence of bears close to human settlements: review and management implications. Mammal Review 44:1–14.

Erickson, A. W. 1959. The age of self-sufficiency in the black bear. Journal of Wildlife Management 23:401–405.

Fredriksson, G. M. 2001. Conservation threats facing sun bears, *Helarctos malayanus*, and experiences with sun bear reintroductions in East Kalimantan, Indonesia. Ouwehands Zoo, Rhenen, Netherlands.

Galef, B. G. J. 2004. Approaches to the study of traditional behaviors of free-living animals. Learning Behavior 32:53–61.

Garshelis, D. L. 1994. Density-dependent population regulation of black bears. Pages 3–14 *in* M. Taylor, editor. Density-dependent population regulation of black, brown and polar bears. International Conference on Bear Research and Management. Monograph Series, Missoula, Montana, USA.

Garshelis, D. L., and H. Hristienko. 2006. State and provincial estimates of American black bear numbers versus assessments of population trend. Ursus 17:1–7.

Golightly, R. T., S. H. Newman, E. N. Craig, H. R. Carter, and J. A. K. Maxzet. 2002. Survival and behavior of western gulls following exposure to oil and rehabilitation. Wildlife Society Bulletin 30:539–546.

Han, S., and D. H. Jung. 2006. Asiatic black bear restoration on Mt. Jiri, South Korea. Re-introduction News 25:35–37.

Herrero, S., T. Smith, T. D. DeBruyn, K. Gunther, and C. A. Matt. 2005. From the field: brown bear habituation to people - safety, risks, and benefits. Wildlife Society Bulletin 33:362–373.

Hovey, F. W., and B. L. McLellan. 1996. Estimating population growth of grizzly bears from the Flathead River drainage using computer simulations of reproduction and survival rates. Canadian Journal of Zoology 74:1409–1416.

Huber, D. 2010. Rehabilitation and reintroduction of captive-reared bears: feasibility and methodology for European brown bears *Ursus arctos*. International Zoo Yearbook 44:47–54.

Huber, D., V. Dabanovic, J. Kusak, and A. Frkovic. 1994. Reintroduction of hand-reared brown bears into the wild: experiences, problems, chances. REPRO, Utrecht University, May 31–5 June 1994 Utrecht, Netherlands.

International Fund for Animal Welfare[IFAW]. 2007. Proceedings 2007 International Workshop on the Rehabilitation, Release and Monitoring of Orphan Bear Cubs. International Fund for Animal Welfare, Yarmouth Port, Massachuetts, USA.

Jamieson, I. G., G. P. Wallis, and J. V. Briskie. 2006. Inbreeding and endangered species management: is New Zealand out of step with the rest of the world? Conservation Biology 20:38–47.

Jonkel, C. J., and I. M. Cowan. 1971. The black bear in the spruce-fir forest. Wildlife Monographs 27:3–57.

Jonkel, C. J., P. Husby, R. Russell, and J. Beecham. 1980. The reintroduction of orphaned grizzly bear cubs in the wild. International Conference on Bear Research and Management 4:369–372.

Karamanlidis, A. A., A. Sanopoulos, L. Georgiadis, and A. Zedrosser. 2011. Structural and economic aspects of human-bear conflicts in Greece. Ursus 22:141–151.

Kelly, A., R. Scrivens, and A. Grogan. 2010. Post-release survival of orphaned wild-born polecats *Mustela putorius* reared in captivity at a wildlife rehabilitation centre in England. Endangered Species Research 12:107–115.

Koehler, G. M., and D. J. Pierce. 2005. Survival, cause-specific mortality, sex, and ages of American black bears in Washington state, USA. Ursus 16:157–166.

Kong, L., M. Lan, S. Yang, and Y. Deng. 1998. Studies on reproductive behavior of domestic black bears. Acta Theriologica Sinica 18:150–151.

Lee, D. J., and M. R. Vaughan. 2003. Dispersal movements by subadult American black bears in Virginia. Ursus 14:162–170.

Lin, R. 2013. Population viability analysis of Formosan black bears. National Pingtung University of Science & Technology, Neipu, Taiwan.

Mace, R. D., D. W. Carney, T. Chilton-Radandt, S. A. Courville, M. A. Haroldson, R. B. Harris, J. Jonkel, B. Mclellan, M. Madel, T. L. Manley, C. C. Schwartz, C. Servheen, G. Stenhouse, J. S. Waller, and E. Wenum. 2012. Grizzly bear population vital rates and trend in the

Northern Continental Divide Ecosystem, Montana. Journal of Wildlife Management 76:119–128.
Manly, B. F. J., L. L. McDonald, and D. L. Thomas. 2002. Resource selection by animals: statistical design and analysis for field studies. Kluwer Academic, Boston, Massachusetts, USA.
McCarthy, T. M., and R. J. Seavoy. 1994. Reducing nonsport losses attributable to food conditioning: Human and bear behavior modification in an urban environment. International Conference on Bear Research and Management 9:75–84.
Moore, M., G. Early, K. Touhey, S. Barco, F. Gulland, and R. Wells. 2007. Rehabilitation and release of marine mammals in the United States: risks and benefits. Marine Mammal Science 23:731–750.
Obbard, M. E., and J. E. Howe. 2008. Demography of black bears in hunted and unhunted areas of the boreal forest of Ontario. Journal of Wildlife Management 72:869–880.
Palomero, G., J. C. Blanco, P. Garcia, and G. Palomero. 1997. Ecology and behavior of 3 wild orphaned brown bear cubs in Spain. International Conference on Bear Research and Management 9:85–90.
Pollock, K. H., S. R. Winterstein, C. M. Bunck, and P. D. Curtis. 1989. Survival analysis in telemetry studies: the staggered entry design. Journal of Wildlife Management 53:7–15.
Pop, I. M., A. Sallay, L. Bereczky, and S. Chiriac. 2012. Land use and behavioral patterns of brown bears in the South Eastern Romanian Carpathian Mountains: a case study of relocated and rehabilitated individuals. Procedia Environmental Sciences 14:111–122.
R Core Team. 2013. R Foundation for Statistical Computing, Vienna, Austria.
Rigg, R., S. Findo, M. Wechselberger, M. L. Gorman, C. Sillero-Zubiri, and D. W. Macdonald. 2011. Mitigating carnivore-livestock conflict in Europe: lessons from Slovakia. Oryx 45:272–280.
Rode, K. D., S. D. Farley, and C. T. Robbins. 2006*a*. Behavioral responses of brown bears mediate nutritional effects of experimentally introduced tourism. Biological Conservation 133:70–80.
Rode, K. D., S. D. Farley, and C. T. Robbins. 2006*b*. Sexual dimorphism, reproductive strategy, and human activities determine resource use by brown bears. Ecology 87:2636–2646.
Schwartz, C. C., S. L. Cain, S. Podruzny, S. Cherry, and L. Frattaroli. 2010. Contrasting activity patterns of sympatric and allopatric black and grizzly bears. Journal of Wildlife Management 74:1628–1638.
Schwartz, C. C., and A. W. Franzmann. 1992. Dispersal and survival of subadult black bears from the Kenai Peninsula, Alaska. Journal of Wildlife Management 56:426–431.
Seddon, P. J., W. M. Strauss, and J. Innes. 2012. Animal translocations: what are they and why do we do them? Pages 23–32 *in* J. G. Ewen, D. P. Armstrong, K. A. Parker, and P. J. Seddon, editors. Reintroduction biology: integrating science and management. Wiley-Blackwell Publishing, Oxford, United Kingdom.
Skripova, K. V. 2013. The behavior of Asiatic black bear cubs (*Ursus (Selenarctos) thibetanus* G. Guvier, 1823) in the process of adaptation to the natural environment. Contemporary Problems of Ecology 6:113–120.
Sorensen, V. A., and R. A. Powell. 1998. Estimating survival rates of black bears. Canadian Journal of Zoology 76:1335–1343.
Spencer, R. D., R. A. Beausoleil, and D. A. Martorello. 2007. How agencies respond to human - black bear conflicts: a survey of wildlife agencies in North America. Ursus 18:217–229.
Stiver, W. H., M. R. Pelton, and C. D. Scott. 1997. Use of pen-reared black bears for augmentation or reintroductions. International Conference on Bear Research and Management 9:145–150.
Swenson, J. E., B. Dahle, and F. Sandegren. 2001. Intraspecific predation in Scandinavian brown bears older than cubs-of-the-year. Ursus 12:81–92.
Swenson, J. E., R. Franzen, P. Segerstrom, and F. Sandegren. 1998. On the age of self-sufficiency in Scandinavian brown bears. Acta Theriologica 43:213–218.
Swenson, J. E., F. Sandegren, A. Soderberg, A. Bjärvall, R. Franzen, and P. Wabakken. 1997. Infanticide caused by hunting of male bears. Nature 386:450–451.
Therneau, T. 2014. A package for survival analysis in S. R package version 2. 37-7. http://CRAN.R-project.org/package=survival Accessed 28 May 2014.
Yamanaka, A., K. Yamauchi, T. Tsujimoto, T. Mizoguchi, T. Oi, S. Sawada, M. Shimozuru, and T. Tsubota. 2011. Estimating the success rate of ovulation and early litter loss rate in the Japanese black bear (*Ursus thibetanus japonicus*) by examining the ovaries and uteri. Japanese Journal of Veterinary Research 59:31–39.
Zedrosser, A., S. M. J. G. Steyaert, H. Gossow, and J. E. Swenson. 2011. Brown bear conservation and the ghost of persecution past. Biological Conservation 144:2163–2170.

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