Denning ecology of brown bears and Asiatic black bears in the Russian Far East

Ivan V. Seryodkin[1], Alexei V. Kostyria[2], John M. Goodrich[3,5], Dale G. Miquelle[3], Evgeny N. Smirnov[4], Linda L. Kerley[3], Howard B. Quigley[3], and Maurice G. Hornocker[3]

[1]*Pacific Geographical Institute, Russian Academy of Sciences, Radio Street 7, Vladivostok, Primorski Krai, Russia, 690041*
[2]*Biology and Soil Sciences, Russian Academy of Sciences,159 Stoletiya Street, Vladivostok, Russia, 690022*
[3]*Hornocker Wildlife Institute and Wildlife Conservation Society, 2023 Stadium Drive, Suite 1a, Bozeman, MT 59719, USA*
[4]*Sikhote-Alin State Biosphere Zapovednik, Terney, Primorski Krai, Russia, 692150*

Abstract: We observed differences in den types, den site characteristics, and chronology of denning between radiocollared brown bears (*Ursus arctos*) and Asiatic black bears (*U. thibetanus*) on and near the Sikhote-Alin Biosphere Zapovednik in the Russian Far East during 1993–2002. Of 27 Asiatic black bear dens, 17 (63%) were in hollow trees, 6 (22%) in ground nests, 3 (11%) in caves or under rocks, and 1 (4%) was in an old excavated brown bear den. Of 12 brown bear dens, 9 were burrows excavated into hillsides, 2 under rock outcroppings, and 1 was a ground nest. We compared elevation, percent slope, aspect, and location on slope of 20 brown and 31 Asiatic black bear dens between species, sexes, and with 100 random coordinates, used to represent availability. Brown bears denned at higher elevations and on steeper slopes than Asiatic black bears and selected higher elevations and steeper slopes than were generally available. Black bears selected flat areas more often than available. Female black bears emerged from dens later than did males, and female black bears with cubs emerged later than barren females. One brown and 1 Asiatic black bear abandoned dens in response to investigator disturbance. While in dens, 1 Asiatic black bear was killed by a tiger (*Panthera tigris*) and 2 other Asiatic black bears survived predation attempts, one by a tiger and one by a brown bear. Tree dens may be important for Asiatic black bears for protection against predators. To increase survival and reproduction, we recommend protecting potential den trees from logging and adjusting hunting seasons and practices to reduce mortality of adult females.

Key words: Asiatic black bear, brown bear, denning, Russian Far East, Sikhote-Alin Zapovednik, *Ursus arctos*, *Ursus thibetanus*

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Denning ecology is important to bear survival and reproduction, hence its documentation is essential to conservation planning for bears. American black bears (*U. americanus*) often select specific den types, presumably to reduce energy expenditure and increase cub survival (Johnson and Pelton 1979, 1981; Lentz et al. 1983; Alt 1984). Specific den types also may be important for predator avoidance, especially for females with cubs (Lindzey and Meslow 1976, Rogers and Mech 1981, Ross et al. 1988, Pikunov et al. 1991). Human disturbance at dens may reduce reproductive success through cub abandonment and increased overwinter weight loss (Tietje and Ruff 1980, LeCount 1983, Goodrich and Berger 1994). Denning chronology often differs among sex and age classes, and adjusting hunting seasons to these differences provides a mechanism for regulating harvest (Bromlei 1965, Lindzey and Meslow 1976, Johnson and Pelton 1979).

Very little information exists on the denning ecology of Asiatic black bears, particularly in Russia. Further, although brown bear denning ecology has been well studied in Eurasia and North America, it has received little attention in the Russian Far East (Bromlei 1965,

[5]email: tiger372@yahoo.com

Hazumi and Maruyama 1986, Pikunov et al. 1991, Reid et al. 1991, Yudin 1993, Xu et al. 1994). Asiatic black bears are considered ecologically equivalent to North American black bears (Schaller et al. 1989, Reid et al. 1991) and probably exhibit similar regional variation in denning ecology (review in Hayes and Pelton 1994). Brown bear denning habits also vary throughout their range (Stroganov 1962, Vroom et al. 1980). Therefore, it is difficult to draw inferences from data from other populations, and regional data is needed to characterize population-specific denning ecology (Vroom et al. 1980, Weaver and Pelton 1994).

We examined denning ecology of both bear species on and near the Sikhote-Alin Biosphere Zapovednik (strictly protected area) in the Russian Far East to establish a baseline database which can assist much needed conservation planning. Here, Asiatic black bears are near the northern extent of their range. They are listed under CITES Appendix I (Wilson and Reeder 1993) and, until recently (1997), were listed as an endangered species in the Russian Red Data Book (Borodin et al. 1984). Both species can be legally harvested in dens and, with the opening of Russia's borders in 1992, increased access to international markets has lead to intensive legal and illegal harvest to satisfy the demand for bear derivatives (Seryodkin and Pikunov 2002). Logging may influence den ecology due to habitat loss and alterations, cutting of cavity trees, and increased density of roads, increasing access for poachers and hunters (Bromlei 1965, Abramov 1972, Kostoglod 1981, Kerley et al. 2002, Seryodkin and Pikunov 2002). Additionally, Kucherenko (1974) argued that destruction of denning trees by hunters is a potential limiting factor for Asiatic black bears in the Russian Far East.

Study area

We studied bears on and near the Sikhote-Alin State Biosphere Zapovednik (4,000 km^2) near the village of Terney, Primorye Krai, in the Russian Far East (44°46′N, 135°48′E), during 1993–2002 (Fig. 1). Sikhote-Alin Zapovednik is closed to the public; this restricted access provides ideal conditions for collecting baseline data in undisturbed habitats. Sikhote-Alin Zapovednik is bordered by the Sea of Japan to the east and bisected by the Sikhote-Alin Mountains, which parallel the coastline and are characterized by low rolling hills near the coast and steep slopes and braided creek and river valleys farther inland. The western macroslope is wide and gentle, but the eastern macroslope is short and steep. Mean elevation of mountain peaks is 800 m. The highest peak within the Zapovednik is 1,598 m.

Sikhote-Alin Zapovednik is in the coastal region of the Far Eastern Temperate climate zone and has a monsoon climate characterized by seasonal changes in prevailing winds. Strong western and northwestern winds prevail in winter on the eastern macroslope, but winter winds are calm on the western macroslope. Shielded by the mountains, the western macroslope has a continental climate with greater extremes of temperature; the eastern macroslope is moderated by the sea, and has high humidity and milder temperatures. Mean temperature in January was –12.4° C near the coast in Terney and –22.6° C on western slopes.

Snow depth and distribution is uneven in the Sikhote-Alin region. Mean January snow depth in Terney for 1992–2002 was 24.2 cm, but in the mountains and on sites protected from winds snow cover usually was >70 cm. Ground freezes 1.5–2 m deep occur on both macroslopes. All weather data were from Sikhote-Alin Zapovednik and Terney Weather Station records.

Forest covered >90% of the Zapovednik and dominant forest types on eastern slopes included oak (*Quercus mongolica*) forests near the coast and mixed conifer–deciduous forest inland and at higher elevations, dominated by Korean pine (*Pinus koraiensis*), larch (*Larix cajanderi*), and birch (*Betula* spp.). Western slopes were dominated by spruce–fir (*Picea–Abies* spp.) taiga.

Methods

We captured bears on the east side of the Sikhote-Alin Mountains with Aldrich foot snares set on trails and near tiger and bear mark trees, tiger kills, or bait (Goodrich et al. 2001). During 1993–97, bears were incidentally captured in snares set for tigers, but we trapped specifically for bears during 1998–2002. We anesthetized all bears with a mixture of ketamine hydrochloride (Aveco, Fort Dodge, Iowa, USA and Wildlife Pharmaceuticals, Fort Collins, Colorado, USA) and xylazine hydrochloride (Mobay, Shawnee, Kansas, USA; dosage: 4.4 mg/kg ketamine and 2.2 mg/kg xylazine for Asiatic black bears; 7.2 mg/kg ketamine and 3.6 mg/kg xylazine for brown bears), or Telazol® (intended dose the same as for ketamine; Fort Dodge Animal Health, Fort Dodge, Iowa, USA) (Kreeger 1996).

All bears were weighed and ear-tagged and tattooed with an identification number. Standard morphological measurements were taken, blood was collected, and a first premolar tooth was extracted for cementum annuli aging (Stoneberg and Jonkel 1966). All females and most adult males were fitted with radiocollars (MOD-400 or MOD-500, Telonics, Mesa, Arizona, USA). For our analysis, we also included 2 years of den data from an orphaned bear cub that was captive for 6 months before being radiocollared and released in April 1997.

We collected den data from winter 1993–94 through winter 2001–02, but most data were collected during 3 winters (1999–2002). We monitored radiocollared bears from the ground, on foot and from vehicles, and from the air using an Antonov-2 biplane, MI-2 helicopter, or a MI-8 helicopter. Ground locations were collected by triangulation with 2- or 3-element Yagi antennas, by approaching to 100–400 m and partially circling the bear, by visual observation, and by locating tracks in an area where we detected a bear's radio signal. We calculated den entry dates based on the median date between the first location at the den site and the previous location for weekly locations. Emergence dates were calculated as the median date between the last location at the den site and the subsequent location.

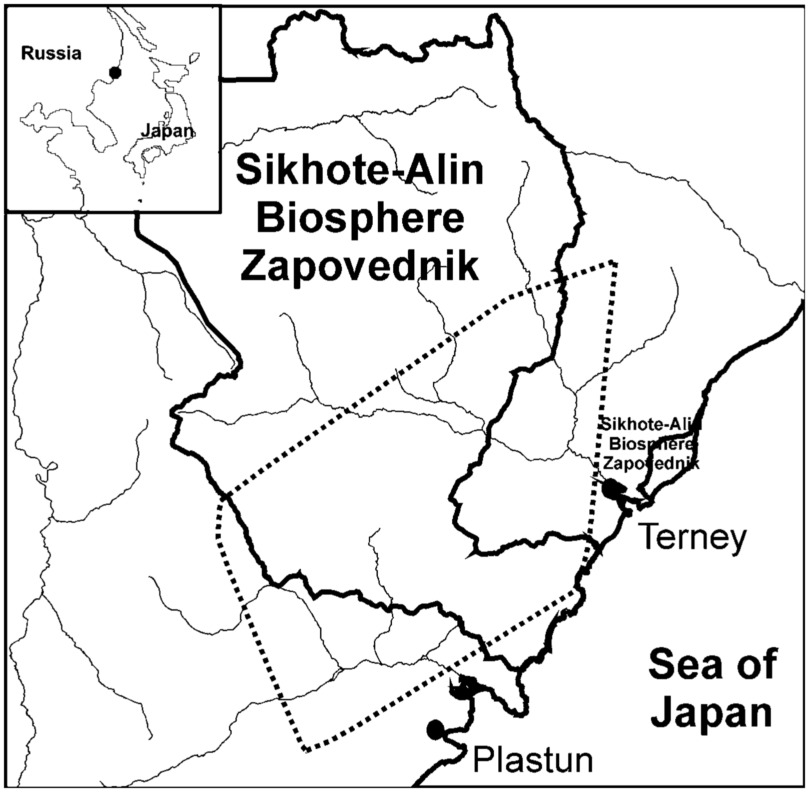

Fig. 1. Study area (dotted lines) for investigation of den ecology of Asiatic black bears and brown bears, Russian Far East, 1993–2002.

Because den abandonment due to investigator disturbance is common (e.g., Manville 1983, Goodrich and Berger 1994), we avoided approaching occupied dens closely. Rather, to locate dens, we waited until a bear's movements were localized for at least two weeks and then approached quietly on foot from downwind to approximately 100 m and partially circled the den. We searched that area for a den after the bear emerged in spring. In some cases we were unable to locate the den or the den was too remote to access, but repeated aerial and ground locations were sufficiently accurate (within 200 m) to define an approximate den site. We included these locations with observed dens in our analysis of environmental parameters. For comparing differences in den entry and emergence dates between pregnant and barren females, we defined a female as pregnant if we detected <1-year-old cubs with the female following den emergence. We may have failed to detect litters that died shortly after emergence.

We estimated elevation, percent slope, aspect of slope, and position on slope (lower, middle, or upper third) for den sites from 1:25,000-scale topographic maps with 5-m contour intervals. We measured percent slope by counting the number of contour lines 50 m above and 50 m below the den site. If 1:25,000-scale maps were not available, we estimated all parameters, except percent slope, from 1:100,000-scale maps. We could not measure percent slope from 1:100,000 maps because contour intervals were too great for accurate measurements. Aspect of slope was divided into 4 categories: north (316–45°), east (46–135°), south (136–225°), and west (226–315°).

We compared elevation, aspect, percent slope, whether dens occurred on level areas, and position on slope of den sites between species, sexes, and with 100 random locations in our study area to determine if bears selected environmental parameters. We defined our study area as a minimum convex polygon (Hayne 1949) containing 90% of the telemetry locations from all bears combined (2,957 km^2). We used 100 random locations because we believed this would sufficiently estimate availability of the variables measured within the study area. We classified a component as "selected" or "preferred" when use was greater ($P < 0.05$) than availability (Mann-Whitney U-test or log-likelihood ratio [G]; Zar 1984).

We treated data collected on the same individual in different years as independent random events and pooled them. This may increase the true type I error above the stated alpha (Machlis et al. 1985), so conclusions must be treated with caution. However, large samples from different individuals were logistically impossible to collect because bears on our study area were secretive and occurred at low densities, and our study area was remote with limited access.

Results

Den types

We observed 27 Asiatic black bear dens (9 inhabited by females and 18 by males) belonging to 15 different bears (4 females and 11 males): 17 (63%) were in hollow trees, 6 (22%) in nests on the ground, 3 (11%) in caves or under rocks, and 1 (4%) in an old excavated brown bear den. Most tree dens (14) were cottonwood (*Populus maximowiczii* and *P. koreana*), but 2 were in oak (*Quercus mongolica*) and 1 in a Korean pine (*Pinus koraiensis*). Entrances were above ground level in 63% of the tree dens and at ground level in the rest. Ground nests were shallow (≈70 cm deep), circular depressions approximately 90 cm in diameter and usually lined with, and sometimes covered with, conifer boughs.

We observed 12 brown bear dens (6 inhabited by females and 6 by males) belonging to 10 different bears (5 females and 5 males). Brown bears denned predominantly in burrows, which they excavated horizontally into hillsides beneath tree roots (9 dens), but 2 adult female bears denned under rock outcroppings and 1 adult male denned in a ground nest similar to those described for Asiatic black bears. The ground nest was used by a bear after it abandoned its excavated den on our approach. None of the dens were used more than once by a radiocollared bear of either species during the study.

Den site characteristics

We measured den site characteristics for 31 Asiatic black bear dens (21 dens inhabited by 12 different males and 10 dens inhabited by 4 females) and 20 brown bear dens (11 dens inhabited by 7 males and 9 dens inhabited by 7 females; Table 1). Brown bears denned at higher elevations than did Asiatic black bears ($U = 151$, $P = 0.002$; Table 1). Male brown bears denned at higher elevations than did female brown bears ($U = 17.5$, $P = 0.012$) and selected areas with higher elevations compared with random locations ($U = 205$, $P = 0.001$; Table 1). Female Asiatic black bears denned at lower elevations than did males ($U = 53$, $P = 0.030$) and tended to select sites at elevations lower than those associated with random locations ($U = 298$, $P = 0.067$; Table 1).

Brown bears always denned on slopes, whereas Asiatic black bears selected for flat areas in creek or river bottoms ($G = 10.2$, 2 df, $P = 0.006$; Table 2). Brown bears used steeper slopes than did Asiatic black bears ($U = 94$, $P < 0.001$), and males of both species selected for steeper slopes compared with random locations ($U = 701$, $P = 0.035$ for black bears and $U = 166$, $P = 0.006$ for brown bears; Table 1). Male brown bears denned on steeper slopes than did females ($U = 12$, $P = 0.036$). Brown bears selected den sites on the upper third of slopes ($G = 12.3$, 2 df, $P = 0.002$), whereas black bears that denned on slopes were not selective for position on slope ($G = 0.3$, 2 df, $P = 0.846$). Neither brown nor black bears selected aspect (Table 2).

Denning chronology

We failed to detect interspecific differences in den entry or emergence dates or intraspecific differences in den entry dates (Table 3). Female black bears emerged from dens later than did males ($U = 25$, $P = 0.026$), and female black bears with cubs emerged later than barren females ($U = 0$, $P = 0.034$; Table 3). Most bears entered dens prior to the first winter snow, but some bears stayed active well into winter: 3 adult male brown bears did not den until late December and one adult female black bear did not enter her den until 6 January.

Human disturbance, predation, and mortality

We accidentally disturbed 2 bears in their dens by approaching too closely on 3 occasions. In the first case, we approached within 3 m of a solitary adult female black bear denned in the base of an oak tree. She abandoned her den shortly after we left and established a new den in the base of an oak tree approximately 3 km away. We approached that den to approximately 60 m and she charged to within 20 m before running away, abandoning her second den. We did not locate her third den. In the second instance, an adult male brown bear in an excavated den ran away when we approached. He established a second den in a ground nest.

We detected 2 predation attempts and 1 instance of successful predation on denned bears. In February 1998, an adult male brown bear attempted to prey on an adult male Asiatic black bear denned in the base of a cottonwood tree with a ground-level entrance. Tracks

Table 1. Characteristics of den sites used by Asiatic black bears and brown bears on and near the Sikhote-Alin Biosphere Zapovednik, Russian Far East, 1993–2002.

Species cohort	Elevation (m)			Slope (%)		
	mean[a]	SD	*n*	mean	SD	*n*
Asiatic						
all	585*a*	181	31	31*a*	9	31
male	629*b*	197	21	37*b*	4	21
female	491*b*	97	10	25	10	10
Brown						
all	775*a*	229	20	37*a*	5	16
male	872*c,d*	170	11	39*c,d*	3	8
female	655*d*	244	9	34*d*	5	8
Random	610*c*	253	100	28*b,c*	14	100

[a]Like letters in italics within columns indicate a significant difference (Mann-Whitney U, $P < 0.05$).

in the snow and marks on the tree indicated that the brown bear tore open the den entrance, but the black bear apparently escaped predation by climbing the inside of the hollow tree. This Asiatic black bear subsequently abandoned that den and relocated in a tree with a ground-level entrance about 500 m away. Tracks in the snow and marks on the tree indicated that a brown bear also attempted to prey on this black bear in its second den, but despite the threat the black bear did not abandon this den.

In 2 cases tigers attempted to prey on denned bears, once successfully and once unsuccessfully. A radio-collared adult male tiger killed and ate a radiocollared adult male Asiatic black bear on 5 December 1998. The bear's movements had been localized for 14 days, suggesting it had denned, but we were unable to locate a den site because light snow had covered most of the tiger and bear tracks. Blood and claw marks indicated that the tiger climbed and extracted the bear from 2 different trees, one of which was a cottonwood large enough to contain a bear den. However, it is very unlikely that a tiger could extract a bear from a tree cavity, and we believe the bear either denned on the ground or was not in its den when the tiger attacked it. In the unsuccessful attempt, several tiger beds were located near an Asiatic black bear den we located in late May, 19 days after the bear, a female with new cubs, had left the den. The entrance to the den, located beneath a rock outcropping, was too small for the tiger to gain access, but tiger hair around the outside and just on the inside of the den indicated that it had attempted to do so. The number of tiger bed sites indicated that the tiger had been in the area for at least a day.

Table 2. Slope aspect of bear dens used by Asiatic black bears and brown bears on and near the Sikhote-Alin Biosphere Zapovednik, Russian Far East, 1993–2002.

Aspect	Number of dens	
	brown bear	black bear
N (316–45°)	6	7
E (46–135°)	8	3
S (136–225°)	4	3
W (226–135°)	2	5
Flat		
River bottom	0	10
Ridge top	0	3

One adult female black bear, denned in a ground nest with ≥1 yearling, died of unknown causes in her den. We discovered the carcass in the den in early May and little fleshy material remained. Tracks of her offspring, tooth marks on her remains, and lack of tracks or other evidence of predators suggest that she was eaten by her yearling offspring.

Discussion

Pooling data from individuals may have biased our results if individuals tend to select for den types or site characteristics. Our sample sizes were too small to test for differences among individuals, but use of non-parametric statistics should have made our tests conservative. If a bias exists, it may be most pronounced in our analysis of den site characteristics because individuals often denned in the same area within their home range.

Den types

Asiatic black bears used a greater variety of den types than did brown bears. This result is consistent with existing information from the region (Bromlei 1965, Abramov et al. 1977), and use of trees, rock outcroppings, and ground nests has been observed elsewhere

Table 3. Den entry and emergence dates for Asiatic black bears and brown bears on and near the Sikhote-Alin Biosphere Zapovednik, Russian Far East, 1993–2002.

Species cohort	Enter date (mm/dd)				Emerge date (mm/dd)				Den period (days)
	median[a]	SD	range	*n*	median	SD	range	*n*	
Asiatic									
all	11/23	21	10/31–01/09	19	04/11	18	03/15–05/29	22	140
male	11/23	21	10/31–12/26	11	04/07*a*	14	03/15–05/03	15	136
female	11/22	19	11/12–01/09	8	04/*a*	19	04/07–05/29	7	153
pregnant female	12/02	11	11/16–12/07	3	05/11*b*	11	05/10–05/29	3	169
barren female	11/19	24	11/12–01/09	5	04/12*b*	10	04/07–04/30	4	138
Brown									
all	11/21	20	11/01–12/23	11	04/09	16	03/26–05/19	14	146
male	12/20	21	11/01–12/23	6	04/04	12	03/26–04/23	7	126
female	11/03	10	10/30–11/24	5	04/12	16	04/10–05/19	7	169
pregnant female	11/13	19	11/03–11/24	2	05/12	12	04/25–05/19	3	176
barren female	11/03	0	11/03–11/03	2	04/10	0	04/10–04/10	2	158

[a]Like letters in italics within columns indicate a significant difference (*t*-test, $P < 0.05$). Comparisons between species were made only for both sexes combined.

(Hazumi and Maruyama 1986, Reid et al. 1991). However, we detected a greater diversity of den types used by Asiatic black bears than other researchers (Sysoev 1960, Kucherenko 1974, Pikunov et al. 1991). Radiotelemetry provides a less biased sample than either snowtracking (a traditional study technique in Russia), which is biased toward cohorts that are more active during snow months, or monitoring specific dens, which is biased toward den types such as hollow trees that are more easily located. Asiatic black bears most often denned in cavity trees. Tree dens likely provide greater thermal protection, particularly in areas where snow is less likely to provide insulating cover, and they may provide greater protection from predation (Johnson and Pelton 1981). Predation on Asiatic black bears by brown bears and tigers is common (Bromlei 1965, Yudakov and Nikolaev 1987, Khramtsov 1993), but neither tigers nor brown bears are proficient tree climbers. Our observation that one Asiatic black bear survived 2 predation attempts by brown bears in 2 different tree dens suggests that tree dens provide protection against predation.

Use of ground dens by Asiatic black bears has been documented in many areas (Abramov 1972, Reid et al. 1991, this study), and some authors have argued that ground nests are used by Asiatic black bears only when cavity trees are not available (Abramov 1972, Pikunov et al. 1991). Although we did not measure availability of cavity trees suitable for denning, it is unlikely that suitable tree den sites were limiting on our study area, much of which has never been logged, or was selectively logged ≥45 years ago. We argue that use of ground nests for denning, although infrequent, is characteristic of Asiatic black bears (Yudin 1993). Although use of ground dens may increase predation risk from brown bears and tigers, it probably decreases predation risk from people because hunters in Russia often monitor potential den trees for bears (Abramov 1972).

Brown bear dens were similar to those described for many other regions in Eurasia and North America (Stroganov 1962, Bromlei 1965, Servheen and Klaver 1983, Judd et al. 1986, Pazhetnov 1990). The lower variability in den types used by brown bears may be related to the ability of brown bears to dig and hence create their own dens.

Den site characteristics

Brown bears were more selective for den site characteristics than were Asiatic black bears and denned at high elevations, on steep slopes, and on the upper third of slopes. Similar den site characteristics have been reported for brown bears elsewhere (Vroom et al. 1980, Servheen and Klaver 1983, Judd et al. 1986). Most authors have concluded that these conditions tend to trap snow in the den entrance, providing insulation, whereas dens on lesser slopes would have a shallow roof that would provide less thermal protection and would be more likely to collapse (Vroom et al. 1980, Servheen and Klaver 1983, Judd et al. 1986).

In contrast to brown bears, Asiatic black bears avoided slopes and preferred river bottoms at lower elevations, where the probability of finding potential tree dens likely was greater. Large cavity trees (63% of Asiatic black bear dens), especially cottonwoods, occur almost exclusively in creek and river bottoms, and are therefore more closely associated with flat areas and lower elevations.

Denning chronology

Contrary to previous studies of denning chronology of Asiatic black bears in Russia, we failed to detect a difference in den entry dates between sexes (Bromlei 1965, Khramtsov 1990). Female American black bears in many populations enter dens earlier than males (O'Pezio et al. 1983, Hellgren and Vaughan 1989, Smith et al. 1994), although in Idaho, Beecham et al. (1983) found that pregnant females entered dens before males and barren females entered dens later. We failed to detect a difference in den entry dates between pregnant and barren females and between pregnant females and males. However, our sample size of pregnant females was small ($n = 3$) and all 3 gave birth during the same year, so our results must be interpreted with caution. Brown bear females entered dens earlier than males in our study, a general pattern reported previously in the Russian Far East and elsewhere (Bromlei 1965, Judd et al. 1986, Yudin 1993).

Female Asiatic black bears emerged from dens later than males, and females with cubs emerged last. Brown bears followed a similar pattern, but differences were not significant, likely because of small sample sizes. This pattern has been reported previously for both species in the Russian Far East and for brown bears elsewhere, as well as for American black bears (Bromlei 1965, O'Pezio et al. 1983, Judd et al. 1986). Female Asiatic black bears with cubs emerged later when compared with emergence dates reported for female brown and American black bears with cubs (emergence dates >1 May are rarely reported) even at latitudes much further north and areas with more severe winters (Tietje and Ruff 1980, Miller 1990, Smith et al. 1994). Whether this is a characteristic of the species or a response to regional variables, such as abundant predators, is unclear.

Human disturbance, predation, and mortality

Bears on our study area were sensitive to approach of humans and abandoned dens in 3 instances when we approached too closely. Abandonment due to human disturbance is common in North American black bears (e.g., Manville 1983, Kolenosky and Strathearn 1987, Hellgren and Vaughan 1989) and may result in increased winter activity, greater overwinter weight loss, and cub abandonment (Tietje and Ruff 1980, Goodrich and Berger 1994). Brown bears also are sensitive to human disturbance and may select den sites in areas where human disturbance is low (Craighead and Craighead 1972, Elgmork 1978).

Denned Asiatic black bears were subject to predation by both tigers and brown bears. Although tigers prey on adult brown bears (Kaplanov 1948; J. Goodrich, unpublished data), we did not detect predation by tigers on denned brown bears. Brown bear selection of den site and den type may reduce risk of predation by tigers because tigers infrequently used such high elevations (J. Goodrich, Wildlife Conservation Society, unpublished data) and brown bears could likely defend the narrow tunnel at the entrance of an excavated den. Denned North American black bears have reportedly been preyed upon by grizzly bears, wolves (*Canis lupus*), and other black bears, but such reports are rare (Ross et al. 1988).

Management implications

Our data suggest that tree dens may be important to overwinter survival of Asiatic black bears and to increase survival, potential den trees, especially cottonwoods, should be protected from logging and destruction by hunters, who often destroy den trees while extracting bears from dens (Bromlei 1965, Abramov 1972, Kostoglod 1981, Seryodkin and Pikunov 2002). Cottonwoods are not highly valuable for timber extraction in the Russian Far East, particularly because larger trees usually are decayed. However, to protect den trees, logging companies could be made aware of the importance of cottonwoods to Asiatic black bears in planning road construction and access (skidder trails). Repair of den trees destroyed by hunters has been suggested as well (Kostoglod 1981), but we strongly recommend against this in the Russian Far East until legislation is in place and enforced to protect denned bears from illegal harvest. Repairing these trees may encourage bears to den in trees known to and monitored by hunters and poachers, resulting in even greater harvest of denned bears.

Reproductive females and their cubs can be better protected by prohibiting hunting bears in dens. Currently, such hunting is legal in Russia and results in large numbers of orphaned cubs (J. Goodrich, Wildlife Conservation Society, unpublished data). Hunting seasons may be adjusted to further protect reproductive females, as for American black bears (Lindzey and Meslow 1976, Johnson and Pelton 1979, O'Pezio et al. 1983). For example, for brown bears in this study area, a season beginning on 1 December and ending about 15 April would protect most adult females while allowing hunters to take adult males, if hunting denned bears were prohibited. For Asiatic black bears, the season could start later.

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