Diet and feeding habits of Asiatic black bears in the Northern Japanese Alps

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Abstract: Habitat loss and bear–human conflicts are reported throughout Asiatic black bear (*Ursus thibetanus*) range. Sound understanding of Asiatic black bear food habits and ecology is needed to develop effective conservation policies to protect or restore Asiatic black bear habitat and to reduce bear–human conflicts. We documented food habits and aspects of the feeding ecology of Asiatic black bears with access to an alpine zone in the Northern Japanese Alps from 408 scats, 220 bear feeding platforms in trees, 469 radiolocations obtained from 21 bears, and field observations between September 1995 and November 1999. Bears ate oak (*Quercus* spp.) acorns from the previous fall and dwarf bamboo (*Sasa* spp.) leaves and shoots in spring; succulent plants and soft mast, especially Japanese cluster cherry (*Prunus grayana*), in summer; and hard mast, especially oak acorns, in fall. Bears ate insects in all seasons, with a peak in summer, and also ate Japanese serow (*Naemorhedus crispus*) on at least 6 occasions. In summer, bears that moved to alpine elevations relied on succulent plants; bears that remained at lower elevations relied on soft mast. In fall, all bears moved to hard-mast producing areas in broad-leaved forests at lower elevations in the montane zone. Montane broad-leaved forests seem important for Asiatic black bear survival in the Northern Japanese Alps. It may be important to give these forests more protection than they currently receive.

Key words: alpine zone, Asiatic black bear, bear diet, bear movements, broadleaf forest, elevational shifts, food habits, Japan, Northern Japanese Alps, *Ursus thibetanus*

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The Asiatic black bear is listed by the International Union for the Conservation of Nature (IUCN) as vulnerable over most of its range and as critically endangered in Iran and Pakistan (Servheen et al. 1999). Habitat loss is cited as a major concern for Asiatic black bears in China, Japan, India, Russia, and Vietnam, and conflicts between humans and Asiatic black bears are reported in China, India, Iran, Japan, Russia, and Taiwan. Reported conflicts involve predation on crops, orchards, apiaries, fish farms, and livestock; debarking of trees; and mauling, killing, and even consuming humans.

Increasing rates of Asiatic black bear–human conflict have been attributed to shrinkage and degradation of Asiatic black bear habitat (Azuma and Torii 1980; Furubayashi et al. 1980; Watanabe 1981; Hazumi 1994, 1999; Sathyakumar 1999). To help prevent further conflicts, it is important to protect and restore habitats critical for the survival of Asiatic black bears. Habitat conservation policies meant to benefit Asiatic black bears and to reduce bear–human conflicts will not succeed unless the feeding habits and ecology of these bears are well understood throughout the variety of environments in which they occur. The food habits of Asiatic black bears in Japan are well documented, except at high elevations (e.g. Takada 1979, Nozaki et al. 1983, Torii 1989, Naganawa and Koyama 1994) and were

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Fig. 1. Study area in Japan's Nagano prefecture (in gray) for a 1995–99 study of food habits of Asiatic black bears with access to an alpine zone.

summarized by Hashimoto and Takatsuki (1997). Asiatic black bear have been reported to use alpine habitats (Novikov 1956, Hazumi 1994), but the food habits of such bears have not been described. We report on the food habits of Asiatic black bears with access to an alpine zone in the Northern Japanese Alps of central Japan.

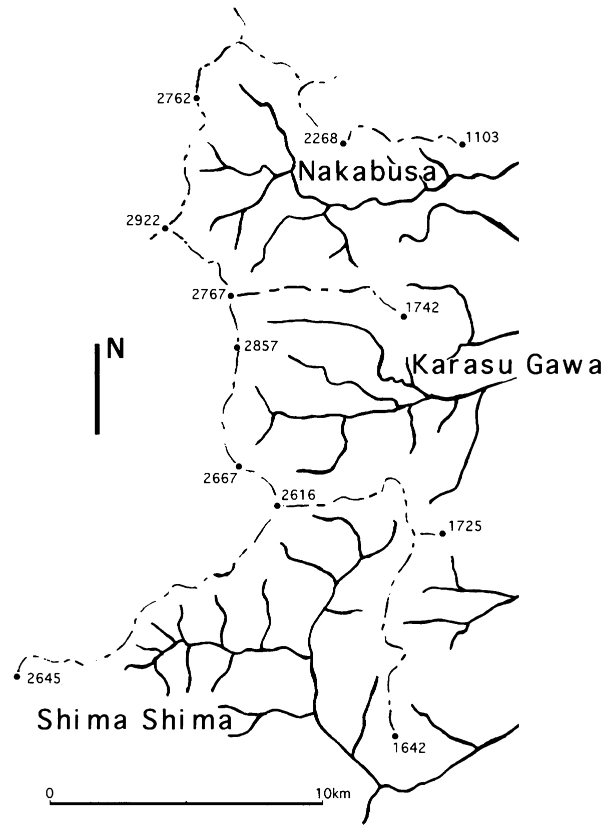

Fig. 2. The 3 major drainages of the study area in Nagano prefecture, Japan. The central drainage, the Karasu Gawa, has the least rugged topography and had been logged more. The elevation of peaks is included (meters).

Study area

The approximately 259-km^2 study area (36°22′N, 137°45′E) was located in Nagano Prefecture, in the center of Honshu, Japan's largest island (Fig. 1). The study area encompassed 3 major drainages (Fig. 2), straddling the southeastern edge of the Chubu Sangaku National Park in the Northern Japanese Alps, and was bordered by the Matsumoto Plain on the east. Elevations ranged from approximately 600 m on the east to 2,922 m on the west. Gravel and paved roads, hotels and hot spring resorts, vacation homes, mountain lodges, 2 golf courses, erosion-control dams, retaining walls, and mini hydroelectric dams occurred in the study area.

Yearly precipitation and snow fall averaged 967 mm and 100 cm, respectively, in Hotaka Town, at an elevation of 540 m in the plains just east of the study area. Although precipitation data were unavailable in the study area itself, precipitation there was probably higher. Rains were concentrated during the monsoon-like rainy season from 20 June to 20 July and during the typhoon season from 20 August 20 to 20 September. Snow started to accumulate at the higher elevations as early as October. Snow fields usually did not disappear until late July but could last into September in cooler years or in years with above average snow precipitation. Most trees leafed out in May and early June, and the first signs of fall were evident in late August in alpine meadows and by mid-September at lower elevations.

Three distinct vegetational zones occurred in the study area: the montane zone from approximately 800 m to about 1,500 m; the subalpine zone, between 1,500 and 2,500 m; and the alpine zone above 2,500 m.

The montane zone was characterized by numerous species of broad leaf deciduous trees. Mongolian oak (*Quercus crispula*), Japanese white oak (*Q. serrata*), Japanese chestnut (*Castanea crenata*), several species of cherries (*Prunus* spp.), 2 species of dogwood (*Cornus* spp.), walnut (*Juglans mandshurica*), beech (*Fagus crenata*), and *Sorbus alnifolia* were potential bear foods. Mesic sites, rocky ridges, and steep slopes were characterized by other plant communities that included conifers. Forests dominated by Japanese red pine (*Pinus densiflora*) also occurred at lower elevations, usually as an early successional species maintained by periodic cutting of competing deciduous trees. The shrub layer was diverse and included species of *Viburnum*, *Hydrangea*, *Euonymus*, *Ilex*, and *Rhus*. The shrub layer was further characterized by widespread thickets of dwarf bamboo (*Sasa* spp.) up to 2 m high and thick enough to be serious obstacles to both natural and artificial regeneration. These dwarf bamboo thickets, combined with the steep terrain and the lack of trails, also denied practical foot access for research to large parts of the study area.

The subalpine zone was dominated by *Abies veitchii* and *A. mariesii*, although *Picea jezoensis* var. *hondoensis* was also common. Ridges and steep dry slopes were often covered by *Tsuga diversifolia* in conjunction with *Pinus parviflora*, *P. parviflora* var. *pentaphylla*, Korean stone pine (*P. koraiensis*), *Thuja standishii*, and sometimes hinoki cypress (*Chamaecyparis obtusa*). Birch (*Betula ermanii*) was conspicuous in the subalpine zone and regularly formed pure stands at the boundary with the alpine zone. Broad-leaved deciduous forests comprised primarily of *Salix* spp. and *Alnus* spp. occurred along riversides. The shrub layer was often poorly developed, although *Viburnum furcatum* and several species of *Sorbus* were common.

The alpine zone was characterized by alpine scrub, snowfield grasslands, and alpine deserts. Impenetrable thickets of Japanese stone pine (*P. pumila*), a creeping pine, was often the climax vegetation in this zone. Alpine heaths, grasslands, and deserts occurred either as edaphic or topographic climaxes induced by exposure to wind, late thawing snow, the presence of serpentine soil, or as pioneer communities on landslips and scree. In concave depressions, Japanese stone pines occurred with broad-leaved deciduous shrubs such as *Alnus maximowiczii*, *Sorbus* spp., *Acer tschonoskii*, and others. Bog and meadow vegetation typically developed on slopes below late-melting snowfields. Numata (1974) and Wada (1985) provide further detail on the vegetation of Nagano Prefecture.

Selective cutting of trees had taken place on many of the steeper slopes within the study area, whereas the gentler slopes had usually been clearcut and converted to plantations of larch (*Larix kaempferi*), Japanese red pine, hinoki cypress, and Japanese red cedar (*Cryptomeria japonica*). The central drainage of the study area had the least rugged topography and consequently had experienced the most cutting. This encouraged the propagation of early successional species, some of which were good bear-food producers in the summer (such as *Prunus* spp., *Cornus* spp., and *Vitus* spp.). In contrast, the northern and southern drainages of the study area had steeper topography, had been logged less, and were characterized by later successional species, among which hard mast producing trees such as Mongolian oak and Japanese chestnut were important bear-food producers in the fall.

Japanese macaque (*Macaca fuscata*), Japanese serow, red fox (*Vulpes vulpes*), raccoon dog (*Nyctereutes procyonoides*), Eurasian badger (*Meles meles*), 2 species of weasels (*Mustela sibirica* and *M. erminea*), and Japanese martens (*Martes melampus*) were the most common mammals of the study area.

Methods

Scat analysis

From September 1995 to November 1999 we collected scats opportunistically as we captured and radiolocated bears. From early May to early November 1999, we also searched for scats in specific areas, mostly of the montane and alpine zones, by walking along animal trails, ridges, and any other land or vegetation features we thought might attract bears (2–3 searches per week). We did not collect scats that contained obvious anthropogenic foods (near orchards or mountain lodge garbage disposal sites). In 1999 we collected scats from bears caught in barrel traps.

We recorded the drainage, vegetation type, and other relevant information for each scat. We used 1:25,000 scale topographic maps to estimate elevation, and a Mann-Whitney U-test to test for differences in soft mast of diets of bears feeding at low and high elevations in summer. We included old scats (>2 months) in the analysis only when we were able to identify their contents, usually seeds or pits that also allowed us to assign an approximate date to the scat. In fall 1999 we left approximately half of an estimated 100 scats (containing mostly acorn but also walnut) deposited during about 1.5 months in a 0.25-km^2 area. Otherwise, we collected all the scats we found, including all scats found in clusters and near day beds. We visually estimated the freshness of each scat and assigned it to the month (i.e., days 1–10, 11–20, 21–31) we believed it had been deposited. For example, we assigned a scat found on 22

July and estimated to be 3–4 weeks old to the last third of June. We used scats that were easy to age to acquire the experience necessary to age other scats. For example, a scat found in early August and containing pits of a cherry that had ripened in early July was most likely about 4 weeks old, giving us an indication as to what other 4 week-old scats looked like. Up to summer 1998 we froze scats for storage and thawed them before analysis. Beginning in summer 1998, we analyzed unfrozen scats within 1 week of finding them. We softened all scats in water and washed them through 3 sieves (apertures of 4, 2.36, and 0.5 mm) to separate individual food items. All items were identified to the finest taxonomic resolution possible. We visually estimated the relative volume of each food item and either assigned it to 1 of 6 volume categories: trace, 1–25%, 25–50%, 50–75%, 75–100%, and 100% (Maehr and Brady 1984), or, when possible, assigned an exact volume (for food items in scats that were composed of equal volumes of 2–3 food items). Items found in trace amounts were given an arbitrary volume of 1%, but we excluded bear hairs, stones, and wood particles. We calculated percent frequency of occurrence (FO) and percent volume (PV) of items as follows:

Frequency of item = number of scats containing same item

Percent frequency of occurrence (FO) = (frequency of item/total number of scats) × 100

Percent volume (PV) = total percent volume of item/ total number of scats

For PV calculations, we used the midpoint of each volume category (we gave an item in the 1–25% volume category a value of 12.5)(Dahle et al. 1998); we used exact amounts when we estimated the exact volume.

Kuma dana

We collected additional information on bear foraging behavior from direct observation of bears and field signs. Asiatic black bears break branches in treetops to reach hard and soft mast throughout their range (Bromlei 1965, Schaller 1969, Reid et al. 1991, Hazumi 1999, Hwang et al. 2002). This feeding behavior results in conspicuous crude feeding platforms in treetops, called *kuma dana* (bear shelf) or *enza* (round seat) in Japanese. We walked roads in the study area in late fall and early winter of 1995, after deciduous leaves had fallen, and scanned the slopes with binoculars to count *kuma dana*. Where possible, we walked to these *kuma dana* to identify tree species.

Telemetry

We captured bears with barrel traps set in the montane zone in 2 drainages of the study area and near 2 lodges in the Alpine zone. We attempted to triangulate radiocollared bears twice a week from the ground with 2 or 3-element Yagi antennas from August 1996 to October 1997. In most cases a minimum of 3 azimuths obtained within 30 minutes were transcribed onto 1:25,000 topographic maps and used for each location. Less than 3 azimuths were used for some locations where the lay of the land either made it difficult to get more or gave us reasonable assurance that 2 or 1 were sufficient. The extremely complex topography, by allowing us to quickly move behind land features where the signal should dim or die if the location was reasonably correct, also often allowed us to verify our radiolocations. We estimated the elevation of radiolocations from 1:25,000 topographic maps.

Results

Scat analysis

We found a total of 408 scats (56, 53, and 299 in spring, summer, and fall, respectively) between September 1995 and November 1999. Of these, we found 215 opportunistically from fall 1995 to fall 1998 (12 and 203 in summer and fall, respectively), and 193 during systematic searches in 1999 (56, 41, and 96 in spring, summer, and fall, respectively).

This sample allowed us to identify 3 main bear food seasons (Table 1). During spring (den emergence–30 Jun) bears fed on oak acorns from the previous fall as long as they were available. They complemented this with dwarf bamboo leaves during early spring (PV = 5.95 before 20 May and 1.84 after) and with dwarf bamboo shoots during late spring (PV = 0 before 20 May and 20.6 after).

During summer (1 Jul–31 Aug), bears fed on succulent plants and consumed soft mast when available. However, scats found at higher elevations contained less soft mast ($\bar{x}$ = 9.2%, SE = 4.1) than scats found at lower elevations ($\bar{x}$ = 59.7%, SE = 8.5; U = 149.5, $P < 0.001$, Table 2). The mean elevation of scats found at higher elevations ($n = 28$) was 2,496 m (SE = 13), whereas the mean elevation of scats found at lower elevations ($n = 23$) was 1,082 m (SE = 38). We found no scats at the lower elevations from 10 to 31 July and no scats between the elevations of 1,760 and 2,450 m during the study.

Bears fed on oak acorns and walnuts as early as 21 August, but soft mast comprised the bulk of the diet until

Table 1. Percent frequency of occurrence (FO) and percent fecal volume (PV) of food items in 408 Asiatic black bear scats in the Northern Japanese Alps, 1995–99.

	Spring[a] (*n* = 56)		Summer[b] (*n* = 53)		Fall[c] (*n* = 317)	
Food item	**FO**	**PV**	**FO**	**PV**	**FO**	**PV**
Hard mast						
Quercus spp.	80	63	6	5	78	73
Castanea crenata			2	0.7	8	6
Juglans mandshurica			15	5	11	3
Pinus koraiensis			4	0.04	6	5
Pinus pumila			8	0.5		
Soft mast						
Prunus grayana			25	23		
Rubus vernus			9	3		
Cornus controversa			6	2		
Vitis coignetiae			4	1		
Diospyros kaki					3	2
Sorbus commixta					2	2
Lindera umbellata					2	1
Other			43	4	13	4
Graminoids						
Sasa spp. shoots	29	21	4	3		
Sasa spp. leaves	32	8	4	2		
Other, leaves			11	6	11	6
Forbs						
Rubus pseudojaponicus			8	5		
Elatostema japonicum	4	4				
Angelica spp.			17	10		
Cardiocrinum spp.			6	4		
Petasites spp.			6	4		
Cirsium spp.			8	3		
Other plant material	54	4	30	15	16	2
Insects						
Formicidae	9	0.1	38	4	1	0.3
Vespidae	2	0.02	6	0.5	3	0.1
Bibionidae					7	0.5
Mammals						
Naemorhedus crispus	11	2			1	0.4
Other	13	0.1	19	2	23	1

[a]From den emergence until 30 Jun.
[b]From 1 Jul until 31 Aug.
[c]From 1 Sep until den entrance.

Table 2. Percent frequency of occurrence (FO) and percent fecal volume (PV) of food items found in Asiatic black bear scats collected during summer at low elevations (925–1,760 m) and high elevations (2,450–2,650 m) in the Northern Japanese Alps, 1995–99.

	Summer[a]			
	low (*n* = 25)		high (*n* = 28)	
Food item	**FO**	**PV**	**FO**	**PV**
Hard mast				
Quercus spp.	12	11		
Castanea crenata	4	1.5		
Juglans mandshurica	32	9.6		
Pinus koraiensis	8	0.1		
Pinus pumila			14	1
Soft mast				
Prunus grayana	52	48		
Prunus maximowiczii	4	1.5		
Cornus controversa	12	3.5		
Vitis coignetiae	8	3		
Acanthopanax spinosus	4	1.5		
Rubus vernus			18	6
Rubus pseudojaponicus			7	2
Other	36	2.2	36	2
Graminoids				
Sasa spp. shoots	8	6		
Sasa spp. leaves			7	3
Other			21	11
Forbs (stems & leaves)				
Angelica spp.			32	19
Rubus pseudojaponicus			14	9
Cardiocrinum spp.			11	8
Petasites spp.			11	7
Cirsium spp.			14	6
Urtica spp.			4	2
Other plant material	28	5.2	32	23
Insects				
Formicidae	40	5.6	36	3
Vespidae	8	0.5	4	0.5
Other	4	0.5		

[a]From 1 Jul until 30 Aug.

31 August (Table 1). During fall (1 Sep–den entrance), forbs and berries almost disappeared from the diet and were replaced by walnuts, Korean stone pine seeds, chestnuts, and especially Mongolian oak and Japanese white oak acorns. Bears ate small quantities of ants, ant eggs (Formicidae); and bees and wasps (Vespidae) in all seasons, but peaking during summer. Hair and meat in scats also indicated bears ate serows on at least 6 occasions (3 in spring, and 3 in fall; total of 9 scats).

We found only 19 scats (4.7%) in the subalpine zone, of which 16 were of Korean stone pine seeds, 2 were of dwarf bamboo shoots, and 1, from a bear captured in a barrel trap set in the subalpine zone, consisted of stems, leaves, ants, and *Actinidia arguta* fruits. We spent comparatively less time searching for scats in the subalpine zone, as radio telemetry results indicated bears spent little time there (Huygens 1998, Carr et al. 2002).

Table 3. Species of trees containing *kuma dana* (bear feeding platforms) observed in the Northern Japanese Alps, fall 1995.

Scientific name	Occurrence	%
Quercus crispula	112	51.9
Quercus serrata	37	17.1
Quercus spp.[a]	13	6.0
Castanea crenata	34	15.7
Lindera obtusiloba	10	4.6
Diospyros kaki[b]	5	2.3
Juglans mandshurica	3	1.4
Cornus macrophylla	2	0.9
Total	216	100.00

[a]*Q. crispula* or *Q. serrata*.
[b]From planted but abandoned trees in an area near a village where the forest had reclaimed farm land on a steep slope.

We found only 7 scats (1.7%) in tree plantations, even though such plantations made up 19.7% of the study area. Telemetry locations (Huygens 1998) indicated bears occasionally used tree plantations, either in the spring when they presumably fed on dwarf bamboo leaves or shoots, or in the fall when *kuma dana* in either Japanese chestnut trees or Mongolian oaks, which occur sporadically in larch plantations, indicated bears had been feeding in them.

We found scats on hiking trails only in the alpine zone. Especially during spring and summer, there was a preponderance of scats along small, steep ridge-like formations formed when a steep slope meanders back and forth. This may have been because these steep mini-ridges were easier for us to search. However, 19 of the 25 day beds we found were located on these ridge-like formations, often on the flatter area immediately above a large tree, further suggesting that bears used them frequently. Bears may like such vantage points because they allow surveillance of the surroundings, offer easy escape routes, are breezier and therefore cooler, and possibly also offer an occasional chance to prey upon unsuspecting approaching ungulates using such ridges as travel routes. Predation by Asiatic black bears in our study was suggested when we saw a young, radio-collared male drag the carcass of a serow across a creek on 1 November 1995. Upon inspection the next day the serow was judged to have been healthy, with no obvious leg injuries, and with clean hooves, a good dentition; it was 10–15 years old, as determined by ring counts on its horns.

Kuma dana

We found 264 *kuma dana* in the study area during fall 1995, of which we accessed 216 (81.8%) for species determination. Of these, 162 (75%) were in either Mongolian or Japanese white oak. Over 92% of the *kuma dana* were in trees that produce hard mast in the fall (Table 3). We found 2 *kuma dana* in trees that had obviously broken while the bears where in them, causing the bears to fall to the ground, one from a height >10 m.

Telemetry

We radiocollared 21 bears (11 adult and 3 juvenile males; 5 adult and 2 juvenile females) between August 1995 and October 1997 and obtained 469 usable radiolocations on them by December 1997 (Huygens 1998). It was difficult to obtain bear locations in some roadless areas, but this could often be circumvented by hiking up to trails on the high ridges. Even so, we were unable to obtain radiolocations of bears in some areas, especially of the subalpine zone.

During summer, 5 bears (4 males, 1 female) remained at lower elevations (<1,500 m) and 10 bears (6 males, 4 females) either stayed above 2,300 m or moved back and forth between these high elevations and elevations <1,500 m. Up to 3 unknown adult bears fed concurrently in the same meadow above timberline in summer. After August, all radiocollared bears moved to the montane zone at elevations <1,500 m to feed on hard mast, especially oak acorns.

Two bears (1 male, 1 female) remained in the central drainage (which had experienced more timber cutting) throughout the year, but 5 bears (4 males, 1 female) left that drainage for the more pristine drainages in the fall. The fact that of 299 fall scats only 41 (13.7%) were from the central, more heavily cut drainage, probably also reflects this exodus. No radiocollared bear moved to the more disturbed drainage in the fall (Hugyens 1998).

Field signs, direct observation of bears, and depredation reports indicated bears fed on other foods besides those revealed in scats. Although we never found beechnuts or beech buds in scats, we found beeches with numerous older claw marks leading up their trunks, suggesting that in previous years bears either had fed on beech buds in the spring or on beechnuts in the fall. In spring 1999 we occasionally found evergreen trees (e.g. hinoki cypress and Japanese red pine) with peeled bark, indicating bears had fed on the cambium. On 19 May 1996, we saw an adult bear feed on the budding leaves of a *Salix sachalinensis*. A minimum of 13 bears were killed on the southeastern edge of the study area where they were raiding orchards and apiaries, indicating that the diet of some bears in the study area included these anthropogenic foods. We observed a bear feed on the nest of the wasp *Vespula lewisi* located in the hollow branch of a windblown tree. Another bear dug up a nest of *V. flaviceps* (a ground dwelling wasp), and another unsuccessfully attempted to enlarge the entrance of a nest of wild honey bees (*Apis mellifera*) in a hollow tree. Bears in the study area peeled acorns and chestnuts before eating them, and we found numerous acorn peels below *kuma dana* in oak trees and no peels, or only traces, in scats.

We found 3 day-beds of interwoven, uncut dwarf bamboo stems and leaves in dwarf bamboo thickets (2 in early spring on relatively flat areas and 1 in late autumn on a steep slope). These somewhat oval-shaped beds formed a springy mattress approximately 90 cm long and 30 to 40 cm high.

Discussion

Except for their use of the alpine zone, the behavior and food habits of Asiatic black bears in the Northern Japanese Alps were consistent with those reported in the literature throughout Asiatic black bear range (e.g. Bromlei 1965, Schaller 1969, Reid et al. 1991, Hashimoto and Takatsuki 1997, Hwang et al. 2002). Virtually all Asiatic black bear diet studies report shifts from succulent forbs and grasses in spring, to soft mast in summer, and hard mast, either oak acorns, Korean stone pine seeds, or walnuts, in fall. When available, Asiatic black bears ate hard mast from the previous fall in spring (Bromlei 1965, Yudin 1993, Hashimoto and Takatsuki 1997, Goto 2000). Eating dwarf bamboo in spring has been reported in Japan (Takada 1979, Naganawa and Koyama 1994) and China (Wu 1983, Wang 1988, Schaller et al. 1989, Reid et al. 1991). Asiatic black bears in other studies also moved to seasonal feeding areas and made little use of the subalpine zone (Wu 1983, Hazumi and Maruyama 1987, Reid et al. 1991, Yudin 1993, Hwang et al. 2002). The paucity of Asiatic black bear scats found on trails, the peeling of acorns, the eating of the cambium of evergreen trees, beech buds, and beechnuts, and the possible ambushing of ungulates have also been previously reported (Furubayashi et al 1980, Watanabe 1980, Nozaki et al. 1983, Schaller et al. 1989, Hwang et al. 2002). Finally, American black bears (*U. americanus*) were also reported to have different concurrent diets at low and high elevations (Graber and White 1983, Raine and Kansas 1990).

We observed a partial exodus of bears from the central drainage, which had been logged more intensely, toward the 2 more pristine drainages during autumn. We hypothesize that differences among drainages in forage availability, related in turn to successional stage, caused this movement. Early successional species (e.g. *Prunus* spp., *Cornus* spp., *Vitus* spp.), which were more common in the central drainage, appeared to be adequate producers of soft mast during summer and thus of interest to the bears. However, we hypothesize that late successional species (particularly Mongolian oak, which was more common and mature in the pristine drainages), were better producers of hard mast during fall, thus attracting bears.

Asiatic black bears peeled acorns and chestnuts and scats consequently lacked these peels. This made it difficult to differentiate between acorn and chestnut scats, especially when they were older. Although we observed *kuma dana* in chestnut trees throughout the study, we noticed chestnuts in scats only in 1999, the only year the oak acorn crop was poor. We may have missed chestnuts in scats in previous years due to a lack of experience.

Hwang et al. (2002) also found ground nests intricately built with live vegetation in Taiwan, and these nests resulted in a bowl-like structure in which a bear might hide. The nests we found resembled an insulating springy cushion on which a bear might more likely rest than hide, possibly during cold periods.

Personal observations indicated that Japanese stone pines, which are abundant in the alpine zone of the study area, produced poor seed crops during the 3 summers of 1997 to 1999. Throughout the world, bears depend on the seeds of stone pines wherever bears and stone pines are sympatric (Mattson and Jonkel 1990). The seeds of Japanese stone pines are much smaller than the seeds of Korean stone pines and may consequently be of less interest to bears. It is possible, however, that in good crop years bears in our study area feed on the seeds of Japanese stone pines more extensively than reported here, especially because these seeds ripen in mid-summer (Hayashida 1994) when other hard mast is not yet available.

Oak acorns dominated in the scats each fall, even in 1999, the only year when the acorn crop was relatively poor (personal observations). This suggests a longer-term study would not greatly affect our fall results, except in years of total acorn crop failure. Our spring and summer results are based mostly on 1999 scats, a period too short to adequately document bear diet. Mattson et al. (1991) suggested that long-term studies are necessary to adequately document bear food habits because they noted substantial among-year differences in grizzly bears (*U. arctos*) scat content in Yellowstone National Park, USA, and that estimates of average scat composition took 4–6 years to stabilize. Further studies are needed in our study area to document bear diet in years of total acorn crop failure and to complete our understanding of bear diet in spring and summer.

Several factors affected the number of scats we found each season. Bears did not congregate during spring and summer because food items were scattered, and scat visibility was lowest during summer due to the luxurious plant development which covered the ground and hid scats. Consequently, scats were most difficult to find in summer, followed by spring and fall. Bears also possibly increased their ingestion and defecation rates during late summer and fall, as has been reported for brown bears (Roth 1980, Mattson et al. 1991), possibly further explaining our larger fall sample.

We could not search for scats in thick dwarf bamboo stands or on extremely steep slopes, even though telemetry data indicated bears used these areas. We possibly biased the sample further by collecting all scats regardless of cluster size, mainly because scats in a cluster often contained different food items. The senior author found all but 33 (8.1%) of the 408 scats we found, possibly further biasing the sample because his searches were based on subjective criteria or were often concentrated on areas where he found scats in previous years. However, searches were also oriented toward areas where radiotelemetry data indicated bear presence. Additionally, we did not reach some *kuma dana* for identification because of a combination of deep snow, steep slopes, dense vegetation, and distance, biasing our sample.

Scat analysis may bias estimates of food habits because of differential disappearance of foods due to chewing and digestion. This bias can be reduced with correction factors that relate the amount of residue in feces to the amount of a diet item ingested (Hewitt and Robbins 1996). We did not use digestibility correction factors because we lacked appropriate equations for many of the food items we encountered. Therefore, we probably underestimated the importance of highly digestible or easily fragmented foods and overestimated the importance of less digestible items relative to their actual proportion in the diet (Hewitt and Robbins 1996).

Management implications

During late summer and fall, Asiatic black bears in the Northern Japanese Alps concentrated in the montane zone where they fed on soft, and especially, hard mast. Hard mast is high in fat (Landers et al. 1979, Eagle and Pelton 1983, Kasbohm et al. 1995, Hashimoto and Takatsuki 1997, Kirkpatrick and Pekins 2002), and its consumption in the fall allows bears to rapidly gain weight before the crucial hibernation period. Bear reproductive success and levels of bear–human conflicts are directly and indirectly related to food availability during summer and especially fall (e.g. Jonkel and Cowan 1971, Bunnell and Tait 1981, Rogers 1987, Eiler et al. 1989, Elowe and Dodge 1989, Mattson et al. 1992). Thus, degradation of the montane zone, where soft and hard mast producing plants are concentrated, is likely to reduce bear reproductive fitness and increase levels of bear–human conflicts in the Northern Japanese Alps. General habitat degradation continues to occur throughout Japan (Hazumi 1994, 1999) and occurred in the montane zone of the study area during this study in the form of evergreen plantations and construction of golf courses, roads, dams, hotels, and second homes. Chubu Sangaku National Park covers mostly scenic but biologically less diverse areas in the subalpine and alpine zones of the study area and includes little of the more biologically diverse montane zone where bear fall foods are concentrated. Strategies aimed at reducing levels of bear–human conflict in Japan should include protection of remaining broadleaf forests and conversion of evergreen tree plantations to broadleaf forests. Our recommendations are similar to those of Takada (1979), Hazumi and Maruyama (1987), and Hazumi (1999) in Japan, of Yudin (1993) and Chestin and Yudin (1999) in the Russian Far East, of Reid et al. (1991) in China, and of Sathyakumar (1999) in India.

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