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Does Diversionary Feeding Create Nuisance Bears and Jeopardize Public Safety?

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ABSTRACT Diversionary feeding of black bears (*Ursus americanus*) around campgrounds and residential areas has received little study because of concerns it might create nuisance bears and jeopardize public safety. To evaluate those concerns and assess its effectiveness in mitigating human-bear conflict, we studied diversionary feeding at a U. S. Forest Service campground/residential complex where 6 bears had been removed as nuisances in the previous 3 years (1981-1983). During 8 years of diversionary feeding tests (1984-1991), the only bear removed was a transient sub-adult male that had not yet found the diversionary feeding site. Nuisance problems were greatly reduced throughout the study despite the fact that garbage continued to be available and study bears were intentionally habituated and food-conditioned. The study included 1985—the year with the lowest bear food index recorded for Minnesota. In this study and other examples of diversionary feeding across North America, nuisance complaints, house break-ins, attacks, and bear removals were fewer, often drastically fewer, than elsewhere, and residents became more willing to coexist with bears. The study showed that hunger, not habituation or food-conditioning, is the primary factor creating bear-human conflict in urbanized areas. Habituated, food-conditioned bears did not become nuisances, did not jeopardize public safety, and did not behave in accordance with the stereotypes assigned to them. There is a need to reevaluate policies toward these bears in this light. Further study is needed to determine the situations in which long-term or short-term diversionary feeding can be most effective in mitigating human-bear conflict during periods of food shortage.

KEY WORDS black bear attacks, campgrounds, diversionary feeding, food-conditioning, habituation, house break-ins, natural bear food, nuisance complaints, problem bears, supplemental feeding, *Ursus americanus.*

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As human residences spread into bear habitat, the potential for human-bear conflict increases (Conover 2002). Black bears (*Ursus americanus*) have a high tolerance for anthropogenic activities and readily adapt to artificial food sources (Spencer et al. 2007). It is well known that garbage, sunflower seeds, and other human foods can lure bears into campgrounds and residential areas (McCullough 1982, Garshelis 1989, Beckman and Berger 2003), but there has been little study of how food can be used to lure bears away from problem situations (Rogers 1989, Stringham 1989, Craighead et al. 1995). One reason for this lack of study is a concern that habituated, food-conditioned bears might become nuisances or jeopardize public safety. However, in Slovenia, bear damage in diversionary feeding areas was only a third that in non-

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feeding areas despite bear populations up to 6 times greater (Klenzendorf 1997). Diversionary feeding has proven effective in reducing damage to trees by black bears in the Pacific Northwest (Ziegltrum 2004, 2008) and in reducing crop damage by ducks, white-tailed deer (*Odocoileus virginianus*), and rats (*Rattus* sp.) (Conover 2002).

To evaluate diversionary feeding for mitigating human-bear conflict and to evaluate concerns about habituation and food-conditioning, we conducted diversionary feeding tests at a U. S. Forest Service campground and residential complex near Ely, Minnesota, USA, in 1984-1991. We compared conflicts in that area before and during the study, and we compared behavior of bears in the study area with that of bears in an adjacent 25-year study without diversionary feeding.

Habituation, as used in this paper, is the waning of bears' responses to humans. Food-conditioning refers to bears learning that certain locations, situations, or humans are likely to provide food. We intentionally used food-conditioning to facilitate habituation at the diversionary feeding site in order to test whether habituated, food-conditioned bears were more likely than other bears to become nuisances and jeopardize public safety.

STUDY AREAS

The diversionary study area was a 4.4 km stretch of residences and campsites along the south shore of the Kawishiwi River in the Superior National Forest, 18 km southeast of Ely, Minnesota. This was an area of perennial bear problems. We placed the diversionary feeding site near the middle of this area at the U. S. Forest Service (USFS) Kawishiwi Field Laboratory (47 degrees 49'N, 91 degrees 44'W). Problem areas were the following distances from the feeding site:

1) 0.25 km to the northeast was a roadside rest area and non-bearproof dumpster beside Minnesota State Highway 1,
2) 0.5 km to the northeast was a USFS swimming beach and picnic area with a non-bearproof dumpster and 2 non-bearproof garbage cans,
3) 0.5 to 1.0 km to the northeast was a 31-site USFS campground with a non-bearproof dumpster and 3 non-bearproof garbage cans,
4) 1.2 to 3.4 km to the southwest were 26 residences on leased USFS lots with food attractants including a non-bearproof dumpster and numerous garbage cans, bird feeders, barbecues, and fish-cleaning areas.

The diversionary study area was adjacent to a study area in which bears were not intentionally given diversionary food and were studied for 25 years (Rogers 1987). For comparative purposes, bears were monitored in both study areas and beyond. The entire region was within the Canadian Shield ecological complex. Vegetation was mixed coniferous/deciduous forest with little oak (*Quercus* spp.) and no beech (*Fagus grandifolia*) or hickory (*Carya* spp.). Soils are shallow and non-calcareous with low fertility (Rogers 1987). Preferred foods included ant brood, hornet larvae, hazelnuts (*Corylus cornuta*), and berries, all of which varied in abundance from year to year due to weather, insect outbreaks, and other factors (Rogers 1987).

METHODS AND MATERIALS

The diversionary feeding site was a box of food placed on a pad of tracking sand 8 meters from an overlooking 35-foot-wide window and flood lights. The building included living quarters for USFS observers and volunteer observers day and night. Beef fat was the primary diversionary food with the exception of 50 kg of grapes added during 6-21 July 1984. We replenished beef fat in unlimited amounts during 1984-1985 and in limited amounts during 1986-1991.

We identified bears by ear-tag number and placement, radio-collar frequency, sex, coat color, muzzle color, chest blaze, eyebrow patches, and scars. In the few instances when observers were not present at night, track characteristics were used for identification.

During 15 July to 30 September 1984, we weighed the box of food before and after each bear fed from it. The scale was a Toledo On nights when observers were not present, we weighed the box in the evening and morning and pro-rated amounts eaten among the 0-3 bears we identified by tracks.

Bears first observed as dependent young were of known age. We determined ages of other bears from cementum annuli in a first upper premolar or by a combination of head shape, baculum length, testicle size, nipple characteristics, weight, body length, width of a forepaw, and distance from gum to the cementum-enamel interface on an upper canine tooth (Brooks et al. 1998, McMillin et al. 1976, McRoberts et al. 1998).

To avoid confounding results, we did not reduce attractants in the study area. Dumpsters and garbage cans remained non-bear-proof and were often over-flowing. Campers were not warned about bears. Residents continued to feed birds. In addition, we intentionally food-conditioned bears at the diversionary feeding site by hand-feeding and stroking tolerant individuals.

We monitored bears by telemetry, ear tag returns, and direct observations. Observers included residents, USFS campground employees, hunters, and researchers. Nearly 200 volunteers and researchers accompanied certain habituated bears up to 48 hours at a time beginning in September 1985 (Rogers 1987; Rogers and Wilker 1990). To the extent possible, we monitored study bears until their deaths to determine the extent to which their behaviors and fates were altered by diversionary feeding, habituation, and food-conditioning. For comparisons, we used DNR statewide bear nuisance summaries and kill records (Garshelis and Noyce 2007), reports from District Wildlife Managers throughout the region, newspaper accounts, and data from the long-term ecological study we conducted simultaneously (Rogers 1987).

RESULTS

1981-1983

Nuisance activity in the study area in the 3 years before diversionary feeding began.— In the 3 years (1981-1983) before diversionary feeding began, officials removed 2 bears from the study area each year. Bears that were attracted to open dumpsters, garbage cans, and bird feeders in the campground/residential area also approached people for food.

1984

Nuisance activity during the first year of diversionary feeding.— In 1984, the first year of diversionary feeding, no bear was considered a problem in the campground/residential area

and no bear approached people for food despite the fact that the bears became habituated and food-conditioned at the diversionary feeding site. Bears present in the study area included female 812 that had been a nuisance in the campground the year before. At the end of 1984, USFS campground manager Joseph Lekatz wrote "diversionary feeding seems to be working well in the Kawishiwi Campground vicinity."

Nuisance activity elsewhere in Minnesota.— The Minnesota Department of Natural Resources (DNR) registered a moderate number (927) of bear complaints statewide in 1984 (Garshelis 2002).

Natural food abundance.— Natural bear food in northeastern Minnesota was moderately abundant in 1984 (Garshelis and Noyce 2007). Spring foods included emerging greens and ant pupae. Summer foods included hazelnuts, blueberries (*Vaccinium* spp.) and wild sarsaparilla (*Aralia nudicaulis*) berries.

Visits to the feeding site.— Eight bears visited the feeding site from the time observations began on 1 June until the last bear visit of 1984 on 30 September. Visitors included 2 adult females (each with 2 yearlings), a 2-year-old male (405), and a 5-year-old male (430) that walked through on 21 June (mating season) without stopping to eat.

One of the mothers, 6-year-old radio-collared female 403, held a territory to the south that included the 26 residences on USFS land. She brought her 2 yearlings (females 401 and 429) to the feeding site 8 times during 1-13 June, separated from them the evening of 13 June, and left for 5 days of the mating season (14-18 June). She returned on 19 June and visited the feeding station briefly on 12 of the 56 days from then to 13 August. Her longest absences were 13 and 16 days with no visits after 13 August. After family break-up on 13 June, the only visit by either of her daughters was by female 401 on 18 June.

The other mother, 10-year-old female 812, held a territory to the east that included 16 private residences, the highway rest area, and the USFS picnic area, swimming beach, and campground. She had been a nuisance in the campground in 1983. She brought her 2 yearlings (a black male and a brown male) to the feeding site on 10 June 1984 and separated from them by the end of that day. She left for 4 days of the mating season (11-14 June) and returned on 15 June to visit the feeding site briefly on 26 of the 46 days from then to 31 July. Her longest absence was 8 days with no visits after 31 July. By that time, blueberries and sarsaparilla berries were at peak ripeness, and hazelnuts were beginning to ripen.

812's two sons visited the feeding site after family break-up. Her black son was twice seen passing by the campground headed toward the feeding site, but he did not approach people or attempt to obtain food from the campground. He visited the feeding site briefly 4 times between 21 June and 18 July with no visits after that. However, 812's brown son visited on 74 of 112 days between family break-up (10 June) and 30 September and was the only visitor after 13 August. His longest absence was 5 days (17-21 August) during the peak of the hazelnut season. He became the most habituated, food-conditioned visitor at the feeding site. Nevertheless, the one time he was seen passing by the campground heading toward the feeding site he did not approach people or attempt to obtain food from the campground. As his activity decreased in September in preparation for hibernation, he became increasingly timid, nocturnal, and selective of what he ate, preferring omental fat to subcutaneous fat. On 14 September, he rejected fat and grazed on clover (*Trifolium repens*) at the feeding site. He ate nothing on his

final 3 visits 28-30 September, shortly before hibernation. He grew from an estimated 20 kg on 10 June to 77 kg on 28 September.

Male 405, a 2-year-old immigrant, was first seen in the study area on 10 July when he passed through a yard in the USFS residential area and fed from an open dumpster. Two days later, he found the feeding site and was not seen in a problem area again. He visited the feeding site on 10 of 18 days during 12-29 July with no visits the remainder of the year.

We recorded amounts eaten at the feeding site during 15 July to 30 September. Consumption per bear visit averaged 0.92 kg/visit, with 4 bears eating a total of 127 kg of beef fat and 17 kg of grapes. Most of that food (93 kg of fat and 13 kg of grapes) was eaten by the brown yearling male. Of the remainder, female 403 ate 12.8 kg of fat and 0.3 kg of grapes, and female 812 and male 405 shared 21.2 kg of fat and 3.7 kg of grapes.

Although beef fat is not a highly preferred food, it obviously was preferred over garbage and campground food. By mid-summer, most bears abandoned the beef fat and the feeding site when preferred berries and hazelnuts became available in the forest.

General behavior of the habituated, food-conditioned bears.— Bears that were habituated and food-conditioned at the feeding site avoided campers and residents elsewhere. None was killed by hunters in the September-October hunting season. Seven of the 8 bears that visited the feeding site did so only briefly and occasionally, especially after berries and hazelnuts ripened. A radio-collared female (403) that was habituated and food-conditioned held a territory similar in size to those in the adjacent study area without diversionary food (Rogers 1987). Behavior at the feeding site varied from trusting to timid and nervous but was not threatening.

1985

Natural food abundance in the region.— 1985 had the lowest statewide bear food index the DNR recorded in 23 years of surveys (Garshelis and Noyce 2007). In the region around the study area, rainfall in May and June was 48% higher than the 32-year average (Doran 2009). It hampered ant reproduction and flooded swamps where wild calla (*Calla palustris*) and blue joint grass (*Calamagrostis canadensis*) normally would be available. On June 3, a record low temperature (-8C recorded at nearby Embarrass, MN) killed many of the berry and hazelnut blossoms and reduced summer mast production. The food shortage extended hundreds of kilometers north on the Canadian Shield.

Bear complaints and killings in the region.— Statewide, bear complaints more than tripled to 2,859—the highest number recorded by the DNR in 22 years of such record-keeping (Garshelis and Noyce 2007). The scarcity of preferred foods forced bears to travel farther and eat less preferred foods, including human foods. Bears in Canada and northeastern Minnesota migrated south to Lake Superior and into cities along the shoreline, following migration routes similar to those reported in past years of extreme food shortage (Schorger 1946, 1949; Rogers 1987). Landowners and officials shot hundreds of nuisance bears around residences, including 70 in Thunder Bay and 90 in Duluth (Rogers 1987).

Three bears killed from the long-term study area were killed in Duluth 90, 107, and 107 km outside their usual home ranges. Female 664's trip to Duluth was the first known trip the 24-year-old made outside her territory in 11 years of radio-tracking. Bears from the long-term study area were killed in larger numbers and farther from their usual ranges than in any other year of that study (Rogers 1987). Of 11 marked bears killed, 7 were 20-107 km outside their usual

ranges. They included a disproportionate number over 14 years of age (Rogers 1987). Some bears traveled south around the tip of Lake Superior into the oak forests of Wisconsin and east central Minnesota (Rogers 1987).

Unusual numbers of bears were attracted to garbage dumps in summer and to hunters' baits in the September-October bear-hunting season. Compared with 180 bears killed by hunters in northeastern Minnesota in 1984, hunters killed 424 in 1985 (Joselyn and Lake 1987), in addition to hundreds killed as nuisances before hunting began. Hunter success rose from 20% in 1984 to 52% in 1985 (Joselyn and Lake 1987).

Natural mortality.— Starvation among cubs and yearlings in 1985 was the highest observed in the 25-year study. Of 10 cubs observed with mothers that did not visit the feeding site, only 4 cubs survived through August. Of 7 yearlings that emerged from dens in spring 1985, only 1 survived. Food shortage and increased travel caused the greatest annual weight loss among adults observed during the 25-year study. Two females 11 and 13 years old that emerged with yearlings in March 1985 weighing an average of 63 kg (65.5 and 61.4 kg) would normally have gained weight in 1985, produced cubs in January 1986, lactated for 2 months, and still weigh up to 33% more in March 1986 than they did in March 1985. Instead, they failed to produce cubs, and weighed 19 percent less by March 1986. A 20-year-old female that weighed 70.5 kg when she emerged with yearlings in March 1985 did produce 3 cubs in 1986 but lost 30 percent of her bodyweight by March 1986. Her undersized cubs weighed only 1.0 kg each in March 1986, and 2 of them died.

Visits to the feeding site.— Natural food shortage and rampant nuisance activity across the region provided an unusual opportunity to study diversionary feeding. Beef fat was made available at the feeding site throughout the period of bear activity from early April until late October. Seven of the 8 bears that had visited the feeding site in 1984 returned in 1985. Female 429, a 2-year-old, arrived shortly after emergence on 17 April even though she did not visit after family break-up in 1984. Her female sibling (401) arrived 11 May. On 23 May, 11-year-old female 812 arrived with 3 cubs (1 male, 2 females). 3-year-old male 405 arrived 25 May. 812's 2-year-old black son came briefly on 3 and 4 June and then presumably dispersed as would be expected of a male his age. 6-year-old radio-collared female 403 and her 2 cubs (females Patch and Terri) did not arrive until 12 June even though their den was only a kilometer away. 6-year-old male 430 was the last returnee to arrive (on 20 June). Surprisingly, the most frequent visitor of 1984—812's brown son—did not return in 1985 and presumably dispersed.

No new females (excluding cubs) visited in 1985. Five new young males arrived on 27 May (Morris), 30 May (4-year-old 428), 12 June (Schnoz), 12 June (Jimmy), and 23 June (Donald).

Each day a bear visited the feeding site was considered a visitor-day no matter how brief the visit or how many times it visited on that day. A visit by a mother with cubs was considered 1 visitor-day. We recorded 7 visitor-days by a 2-year-old female during 17-30 April, 52 visitor-days by 6 bears in May, 138 visitor-days by 12 bears in June, and 64 visitor-days by 9 bears during 1-25 July. During 202 visitor-days from 1 June to 25 July, 12 bears (plus the 5 cubs) ate 228 kg of beef fat.

Visits declined during July despite the regional food shortage. All 6 of the immigrant males, including returnee 405, made their last visits by July 25 and never returned. The 5

resident bears (812 and cubs, 403 and cubs, 2-year-old females 401 and 429, and 6-year-old male 430) made only 3 visits between 25 July and 8 September. We monitored radio-collared female 401 and radio-collared female 403 and her cubs and found that they were feeding on natural foods, apparently preferring wild greens, ant pupae, and scarce berries and hazelnuts over beef fat. Berries and hazelnuts essentially disappeared in early September. Female 403 and her 2 cubs resumed visits to the feeding site on 8 September and denned about 23 September. Female 401 returned on 12 September and denned on 8 October.

Nuisance activity in the study area.— Despite the large number of nuisance complaints across the region, residents and campground workers reported no problem in the study area. Isolated incidents that did not rise to the level of nuisance behavior included an unknown bear feeding once from an open dumpster on 29 June and Schnoz passing through the campground without causing a problem on 13 July. None of the 5 resident bears was killed by a hunter in 1985.

Nuisance activity in other areas with diversionary food.— Although nuisance activity was rampant throughout the region in 1985, 3 areas in addition to the study area had few or no bear problems, and all 3 had diversionary food.

One area was a 10-km radius around the Colville dump near Grand Marais, MN. Although a record 44 bears were seen feeding in the dump at once (Rogers 1989), DNR Wildlife Manager William Peterson reported that the only problem in the surrounding area was a bear sleeping in a yard (Wm. Peterson, pers. comm. 1985).

The second area was around Armstrong Lake in Eagles Nest Township where resident Ed Orazem had been feeding bears for 2 decades. On 26 August 1985, the Ely Echo Newspaper stated "*There have been a lot of problems with bears in and around Ely this year, tipping over garbage cans and getting into gardens, but south of town, on Armstrong Lake, the bears just aren't interested in causing problems. The main reason is that the bears are being served at an outdoor restaurant, owned and operated by Ed Orazem"* (Wognum 1985). Orazem and a mature bear are shown sitting next to each other. The article said Orazem began feeding bears in the mid-1960's to divert a bear from his neighbor's garbage. The feeding worked, and Orazem and others continued it.

The third area was the neighborhood of Mrs. Toini Salminen who began feeding a mother and 3 cubs that spring after they mother repeatedly tried to break into her house. The bear stopped trying to break in, and the two developed a trusting relationship that lasted 12 years. The mother had a withered right front leg and walked on 3 legs, making her identifiable. Neighbors visited Mrs. Salminen, met the bear, and developed protective attitudes. The bear caused no problem in the neighborhood and survived far beyond the average age of 3 years at which female bears are killed by hunters in Minnesota. The bear was between 16 and 20 when it finally succumbed to a hunter's bait several miles from Mrs. Salminen's house.

1986-1991

During these 6 years of follow-up studies, we provided limited food at the feeding site and continued to monitor nuisance activities, diets, travels, and fates of the resident bears.

Natural food abundance.— DNR surveys showed bear foods to be generally normal in northeastern Minnesota throughout this period (Garshelis and Noyce 2007). However, rainfall in

the study area in August 1991 was only 20 percent of normal (2.3 cm vs.11.2 cm) (Doran 1009), creating a severe berry shortage in late summer.

Nuisance activities in the study area.— With 2 exceptions, reduced amounts of diversionary food apparently were enough to divert bears from becoming problems in the study area when natural foods were of average abundance. One exception was a captive-raised female (Gerri) released into the study area in 1989 at the request of the Michigan and Minnesota Departments of Natural Resources. She ate mainly natural foods but visited the campground and residences enough in 1990 and 1991 that we returned her to captivity in spring 1992. Her antics are excluded from all statements in this paper. Another exception was a sub-adult male immigrant that had not yet found the diversionary feeding site and attempted to break into an occupied house 3.0 km away from the feeding site on 9 September 1991. We captured and translocated him the next day. On 7 July 1991, we translocated another young male from Outward Bound School, also 3.0 km away from the feeding site but outside the study area. The fact that both bears were 3 km from the feeding site may give an indication of the effective radius of the minimal amounts of diversionary food we provided in 1991.

Intensive habituation and food-conditioning.— By the end of 1985, we had learned the benign meanings of ferocious-looking displays and began to realize that behaviors we had earlier interpreted as threats or aggression were harmless expressions of nervousness. By that time, radio-collared Female 401 had become trusting enough that researchers could walk with her as described by Rogers and Wilker (1989). Four other bears and their cubs provided similar opportunities over the next 6 years, allowing us to walk with them for 24-48 hours at a time. These included the 2 daughters of Female 403 born in 1985 (Patch and Terri) and Terri's 2 adopted daughters (Gerri and Mary) born in 1989. Observations of these bears revealed how habituated, food-conditioned bears with access to supplemental food spend their time in the forest.

In 1989, USFS officials walked with the bears and assessed public safety. The officials included Deputy Chief George Leonard (30 July 1989), North Central Forest Experiment Station Director Ronald Lindmark (16 July 1989), and Superior National Forest Biologist Edward Lindquist (5 June 1989). Finding no problem, the USFS then enlisted nearly 200 volunteers to walk with the bears and expand research coverage. To protect the bears and observers, the DNR closed the bears' territories to hunting —an area of 50 square kilometers. The volunteers were interested members of the general public, including grandmothers, secretaries, hunters, teachers, etc., who lacked experience with bears. When a volunteer joined a bear, he or she gave the bear a handful of food containing a marker and began recording data when the bear went back to foraging on wild foods. Volunteers collected scats to determine passage rates of markers. The volunteers spent hundreds of hours alone with the bears. The bears roamed wild with uncontrolled access to the public. No one was harmed and none of the bears (with the exception of the captive-raised bear) were nuisances.

The habituated, food-conditioned bears maintained territories, daily activity cycles, travel patterns, and diets similar to those described for bears in the 25-year study without diversionary food (Rogers 1987, Rogers and Wilker 1989). In that study, 40 percent of the females and 67 percent of the males made forays more than 7 km outside their usual areas. Bears in the diversionary feeding study made similar forays. For example, on 30 July 1991, 6-year-old Terri and her 2 cubs began traveling 66 km to an unusually productive hazelnut stand

where they foraged for the remainder of August before returning to their territory. At the same time, 3 of 6 radio-collared bears from the 25-year study moved similar distances to the same area of hazelnut abundance. In another example, 7-year-old male 430 was killed by a hunter 173 km outside his usual area on 6 September 1986.

Reproduction.— Availability of diversionary food throughout the 8 years of study did not increase litter size. Average litter size for fed bears was 2.3 cubs (n=7 litters), compared with 2.38 cubs (n=52 litters) for non-fed bears in the adjacent study area (Rogers 1987). However, the diversionary food apparently enabled females to begin reproducing at earlier ages. Average age at first reproduction for 3 females that were fed since they were cubs was 3.3 years, compared with 6.3 years for 17 non-fed females in the adjacent study area (Rogers 1987). Although the sample size of fed females was small, the difference in age at first reproduction was significant (Kruskal-Wallis test, chi-square = 6.21, df = 1, P = 0.013).

Fates of study bears.— None of the resident bears (excluding captive-raised Gerri) became nuisances. None jeopardized public safety. Of the 8 resident bears studied during 1984-1991, 5 were killed by hunters at ages averaging over twice the ages of bears killed by hunters in the general population. The average age of bears killed by hunters in Minnesota is 2 for males and 3 for females (Garshelis and Noyce 2007), but male 430 was killed at 7 and 4 females were killed at the average age of 7. In addition to the 5 hunter-killed bears, 4-year-old female 401 was killed by 13-year-old female 812 in a territorial dispute on 10 June 1987. The fates of a 2-year-old female (429) and a 9-year-old female (403) are unknown. None were removed as nuisances.

Ending diversionary feeding.— Although there was a surge in bear complaints following the closure of the Yellowstone National Park dumps (Craighead et al. 1995), we did not find that when feeding ended in this study. The only resident bear living when this study ended in late 1991 was Mary. Mary was thoroughly habituated and food-conditioned. Over 100 people had walked with her and hand-fed her from the time she was a cub in 1989. People anticipated that she would show up in the campground or residential area in her territory, but years passed without a sighting. 1995 was the second worst food year in DNR records (Garshelis and Noyce 2007), but the summer passed without a sighting. Finally, on 4 September 1995, 6-year-old Mary succumbed to a hunter's bait 58 km southeast of her territory. She was recognized by her radio-collar. Presumably, she traveled outside her territory in that year of scarce food as bears commonly do.

Changes in bear density.— Density temporarily increased in 1985 when 5 young males immigrated in spring, but all 5 (plus male 405 that immigrated in 1984) left the study area by 25 July 1985. The resident population did not grow during the remaining 6 years of limited diversionary feeding. Dispersals, natural mortalities, and hunting mortalities balanced reproduction. Hunting pressure in Minnesota more than doubled during the study. The number of hunters increased from an estimated total of 3100 in 1984 to 7200 in 1991 with a resultant rise in the kill from 919 in 1984 to 2,381 in 1990 (Garshelis 2002). Hunters distributed hundreds of tons of bait across Minnesota during mid-August to mid-October each year, as has also been reported in Virginia (Gray et al. 2004). The bait provided another source of diversionary food that is especially effective in attracting bears in years of scarce natural food (Garshelis and Noyce 2007). In addition to the dispersals and mortalities reducing the bear population in the study area, 6 cubs of mothers killed by hunters far outside the study area were not seen in the

study area again, and 2 cubs that had not reached the age of independence when their mother (401) was killed by a bear on 10 June 1987 were not seen again.

DISCUSSION

Fed bears that become habituated and food-conditioned are often stereotyped in several ways as discussed below.

Did fed bears become nuisances?— Bears that visited the diversionary feeding site continued to forage for natural foods and did not become nuisances despite unabated availability of garbage and bird feeders in the study area. The lack of nuisance activity contrasted sharply with the frequent bear problems before the study began and with bear problems in other areas during the study—especially in 1985 when natural food was at a record low. The fed bears did not become nuisances despite being habituated and food-conditioned. The data indicate that hunger—not habituation or food-conditioning—is the driving force behind nuisance behavior.

Did fed bears become lazy and dependent?—Study bears did not become "hooked" on easy handouts and did not become lazy and dependent. They demonstrated a strong preference for natural foods as has been found for other fed bears in Minnesota (Rogers 1989), Virginia (Gray et al. 2004), and Washington (Ziegltrum 2008). They sought a variety of natural foods where possible and settled for less preferred foods (including beef fat at the feeding site) where necessary. Habituation and food-conditioning did not change their food preferences. Where natural foods are very scarce, bears spend more time feeding on human foods (Rogers 1989). Overgeneralizations based on behavior where natural foods are very scarce can lead to erroneous conclusions.

Did fed bears spread disease at the feeding site?—The fed bears showed no evidence of illness. A literature search revealed no reports of black bears spreading diseases at garbage dumps, salmon streams, or oak stands where black bears gather (Rogers and Rogers 1976, Rogers 1983).

Did the aggregation of fed bears lead to males killing cubs?— No.

Did fed bears change their travel patterns?—The feeding site did little to change bears' travel patterns. Young males dispersed from their mothers' territories and from the study area despite the availability of diversionary food. Resident bears abandoned the feeding site to feed on preferred natural foods when they became available. Territories of the 2 radio-collared females did not differ in size from those of females in the adjacent study area (Rogers 1987). Female 403 shifted her territory away from the feeding site when her territory became crowded with maturing daughters as has been reported outside the diversionary feeding area in the 25-year study area (Rogers 1987). Fersterer et al. (2001) reported that home ranges of bears that ate diversionary food in Washington did not differ from those of bears in other areas. Perhaps most striking of all was the absence of females whose territories were not adjacent to the feeding site, as was also reported for females that visited garbage dumps in the 25-year study area (Rogers 1987).

Did fed bears become increasingly aggressive in trying to obtain food from people?—Habituated, food-conditioned bears in this study did not become increasingly aggressive. They were non-aggressive to the point that nearly 200 untrained volunteers felt comfortable accompanying them and their cubs day and night for up to 48 hours at a time and did so without harm.

Does habituation and food-conditioning of black bears jeopardize public safety?— Despite common concerns that habituated, food-conditioned bears might be more dangerous than other bears, data from this study and from across North America suggest otherwise

- Of 60 killings by wild black bears across America during 1900-2007, none were by bears known to have been hand-fed or petted. Forty-seven of the killings were in remote areas of Canada and Alaska where people and bears had little contact. Only 3 were in eastern states (2 in Tennessee, 1 in New York) where encounters were frequent. None were in New Jersey and Pennsylvania where human-bear encounters were particularly frequent.
- In Michigan, Terry DeBruyn spent 4 summers walking with wild habituated, food-conditioned black bears, including mothers with cubs, and was not attacked (DeBruyn 1999).
- In Pennsylvania, Gary Alt studied an 18-square-kilometer community called Hemlock Farms where 7,000 people coexisted with 21 bears—a higher bear density than exists in any national park or national forest. People hand-fed bears and provided supplemental food in troughs, and no one was attacked (G. Alt, Biologist, Pennsylvania Game Commission, personal communication 2004).
- In Smoky Mountains National Park, raucous tourists crowded around roadside bears to hand-feed them, pour beer over their heads, lure them into cars, and have them lick honey from children's faces (Tate 1983). The more accustomed the bears became to people the less likely they were to react defensively (J. Tate, personal communication, 2008).
- Near Grand Marais, Minnesota, Jack Becklund and his family and friends formed close relationships with 10 bears at a rural residence in 1990-1995. They hand-fed the bears, sat with them, and mingled with them without being attacked. (Becklund 1999).
- At garbage dumps across America, people observed and interacted with black bears for decades (Rogers 1989, Stringham 1989). In 1989, I asked over 200 attendees at an International Bear Conference if they knew of anyone being attacked at a garbage dump. No one did.
- In Yellowstone National Park, habituated grizzly bears (*Ursus arctos*) foraged beside roads in front of onlookers. According to Herrero (2005), these bears did not injure any bear-viewers and were "less likely to attack hikers or bear viewers on a per-encounter basis."
- At McNeil River Sanctuary in Alaska, people have closely observed grizzly/brown bears ever since the area became a sanctuary in 1967. Habituated bears fought, mated, and nursed cubs within a few meters of observers with no fences. In over 60,000 encounters, no one has been hurt (Herrero et al. 2005).
- Elsewhere in Alaska, Stephen Stringham observed over 10,000 encounters between people and habituated grizzly bears and wrote, "There is little risk of being mauled by fully acclimated bruins (Stringham 2009)."

- Also in Alaska, Timothy Treadwell spent 13 summers camping among grizzly bears, walking among them, wading with them as they fished, and occasionally touching them—all without injury. He and his companion were fatally attacked only when they challenged one in camp and hit it with a frypan during a period of natural food scarcity.

Part of the common belief that habituated, food-conditioned bears jeopardize public safety may stem from misinterpretations of bear behavior. Nervous bears commonly perform ritualized blustery displays with no intention of attacking. Misinterpreting this harmless nervous bluster as aggression leads to the erroneous conclusion that such bears are a danger to public safety. Similarly, trustful, day-active bears that enter campgrounds or residential are often misinterpreted as bold when they are exhibiting normal circadian activity patterns.

Habituation to humans is a normal response where bears see a lot of people. Habituation is to be expected as more and more people move into bear habitat.

Limitations of habituation.—Both habituation and food-conditioning were specific to location and situation. Any broadening of tolerance beyond the feeding site required additional habituation. For example, a mature male that calmly accepted petting and hand-feeding in a specific location feared people who appeared in unexpected locations or behaved in unexpected ways. While being petted and hand-fed by 6 people, he noticed someone approaching over 100 m away on a driveway and bolted from the area. Even where habituated bears expected to see people, they continued to assess the behavior of people as they would assess other bears. Habituated bears were calm and trusting when people behaved in expected, non-threatening ways but fled when people behaved aggressively or approached too quickly. Each new situation and location required additional habituation.

Some bears were calmer and more easily habituated than others. Some bears eventually became sufficiently habituated to tolerate close observation away from the feeding site. During observation, bears foraged calmly and seldom looked at observers that were close enough for easy identification. However, they were disturbed by observers that fell behind, requiring the observers to re-identify themselves by speaking. Habituated bears eluded researchers who attempted to approach quietly without voice identification.

While accompanied by observers, habituated bears eluded people they encountered in unexpected locations. For example, on 20 July 1989, 4-year-old Terri and her cub Mary were accompanied by 2 observers when Terri detected people talking quietly 100-200 meters away. Terri stood up, listened, and led Mary over 200 meters away before they resumed foraging. Terri and Mary gradually became habituated to any observer that behaved according to expectations. During September 1989 to September 1991, they were accompanied by nearly 200 volunteers.

The importance of human knowledge and attitude.—A problem that bears and bear managers faced in the study area before diversionary feeding was that residents would not coexist with animals they feared. The residents had been exposed to the usual ferocious media images, unnatural snarls on taxidermy mounts, and excessive warnings written by government attorneys concerned about liability. The feeding site enabled residents to meet the bears and develop a true understanding of bear behavior. Residents saw firsthand the timid wariness that typifies black bears, the harmless bluster of nervous bears, and the calm trust of others. They learned firsthand that mothers with cubs are not likely to attack. They shared their experiences

with neighbors and friends who then became more willing to coexist with bears. Mere sightings were no longer reasons to register bear complaints with the DNR.

MANAGEMENT CONSIDERATIONS

Many people feel it is wrong to feed wildlife of any kind for any reason. Nevertheless, few bears eat only natural foods in their increasingly urbanized environment. Farms and residential areas prevent bears from feeding in areas once available to them.

Efforts to reduce nuisance behavior have typically focused on removing attractants and using aversive conditioning. These methods are somewhat effective where bears can turn to natural foods but largely fail where severe drought and frost make natural foods very scarce. Removing attractants where natural food is very scarce removes buffers against house break-ins, often leading to multiple house break-ins where diversionary food is not provided.

In this 8-year study diversionary feeding immediately reduced the number and severity of nuisance incidents despite the facts that the bears were intentionally habituated and food-conditioned and garbage continued to be available in potential problem areas. Bears that visited feeding sites were not involved in house break-ins, and none had to be removed from the study area. In years of natural food failure, managers must balance the ethics of diversionary feeding against killing bears that engage in nuisance behavior, including house break-ins. Many of the killings in such years are by landowners who intentionally wound unwelcome bears so they die elsewhere—up to 4 months later (Rogers 1983). Managers must balance the ethics of diversionary feeding against subjecting bears to slow, inhumane deaths.

Food supply determines reproductive rate (Rogers 1976, 1987) whether that food is natural, garbage, bird seed, diversionary food, or hunter baits. Diversionary feeding on a long-term basis can result in reproductive rates comparable to black bears in the best habitat. Feeding may have least affect on reproduction in good habitat but could make a noticeable difference where natural foods are scarce. Temporary diversionary feeding during short periods of extreme food shortage presumably would have less effect on reproduction. Managers must balance the ethics of temporarily providing diversionary food in periods of unusual food shortage against artificially reducing the population by killing hungry bears.

There has been little scientific study of the bear-human interface, including effects of diversionary feeding. The void has been filled with assumptions, supposition, anecdotes, and overgeneralizations, many of which form the underpinnings of bear management, education, and stereotypes of habituated, food-conditioned bears. Those stereotypes did not fit the bears in this study. They were not prone to nuisance behavior and did not jeopardize public safety. There is a need for decision-makers to reevaluate policies toward habituated, food-conditioned bears in this light, recognizing that habituation is a normal response wherever bears encounter numerous people. There is also a need for more study of true bear behavior. As the ferocious image of black bears is replaced by data, officials will have a better scientific basis for sparing bears that once were killed in the name of public safety and preventing liability problems for government agencies. In this study, diversionary feeding let residents meet bears and learn the true nature of bears. This reduced the fearful public attitudes, misconceptions, and intolerance that hinder bear management. There is a need for further study to determine the long-term and short-term situations where diversionary feeding can be most effective in mitigating human-bear conflict.

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