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CRYPTIC BEHAVIOR OF BLACK BEARS (*URSUS AMERICANUS*) IN ROCKY MOUNTAIN NATIONAL PARK, COLORADO

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Abstract: Black bear (*Ursus americanus*) in many U.S. and Canadian national parks become habituated to humans. They are often bold, frequent human use areas and are generally a nuisance. At Rocky Mountain National Park, Colorado, the antithesis of this behavior has been observed in the black bear population. A 4-year study using radio-telemetry and observation indicates that although many bears have home ranges in high human use areas, they are secretive and avoid humans and developed areas. The behavior of 2 of the park's radio-collared bears is documented and discussed.

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Most U.S. and Canadian national parks with populations of American black bears (*Ursus americanus*) have reported problems with this species. In part because they are protected in parks, bears have become habituated to humans, human activity, and development. They have tended to depend on human foods and refuse, and they have caused human injury and property damage because of these unwanted habits. Black bears in most parks are highly visible and are commonly observed by the public along roads, trails, and in campgrounds. Many parks have historically experienced high numbers of bear incidents and depredations (Barnes 1967, Bray 1967, Marsh 1972, Pelton et al. 1976, Zardus and Parsons 1980, Harms 1979 and 1980, Singer and Bratton 1980, Graber 1981, Keay and VanWagtendonk 1983, Herrero 1985).

Because of bear depredations and human injury, most national parks have developed programs, costly in funding and manpower, to mitigate or reduce black bear problems (Marsh 1972, Pelton 1972, Pelton et al. 1976, Harms 1979 and 1980, Zardus and Parsons 1980, Singer and Bratton 1980, Keay and VanWagtendonk 1983). These include: educational programs to teach park visitors and employees proper behavior and food handling techniques in regard to bears; establishment and vigorous enforcement of rules and regulations relating to food handling and disposal and feeding bears, and capture and transplant or removal of problem bears from the population. Expensive schemes to handle human refuse have been devised, such as installation of many bear-proof food containers and garbage cans; closing open pit dumps; scheduling daily garbage pickups, and hauling refuse long distances out of the parks. These measures have significantly reduced the numbers of bear incidents and bear-related human injuries over the past 15 years. However, many parks still have many bear incidents and depredations.

The black bear situation at Rocky Mountain National Park, Colorado contrasts with that of the other parks. The park has a small black bear population and although the

area is predominately forested and receives 2.5 million visitors during most years, depredations or incidents have been few to non-existent. There has seldom been a need to destroy or transplant a bear. Further, black bears are rarely observed by park visitors or employees. The park has never had to implement a major bear management program or install bear-proof garbage cans because of bears.

In 1984 a research program was initiated on the black bears in the park to determine their population dynamics, status, and behavior. The bears here were generally found to be shy and secretive. Their behavior is similar to that of European brown bears (*Ursus arctos*) (Roth 1976 and 1977, Roben 1980, Huber and Roth 1986, Elgmork 1976 and 1987) rather than that of black bears in North American national parks (Marsh 1972, Pelton 1972, Pelton et al. 1976, Zardus and Parsons 1980, Harms 1980, Graber 1981, Herrero 1985, Hastings et al. 1986). This paper describes and documents the behavior of the bears at Rocky Mountain National Park.

STUDY AREA

Rocky Mountain National Park, located in north central Colorado, is 106,700 ha in size. The park, established in 1915, lies along the Continental Divide. Situated about 65 km northwest of Denver, a major metropolitan area, the park preserves one of the most rugged and spectacular reaches of the Colorado Front Range. The elevations are high, ranging from 2,329 m to 4,345 m. There are over 100 mountain peaks exceeding an elevation of 3,000 m. Most of the area is mountainous with steep cliffs and rugged U-shaped valleys formed by glaciers during the Pleistocene epoch. The climate is continental with a mean annual temperature of 6 C and a mean annual precipitation of 41 cm at the lower elevations. Mean annual temperatures decrease and precipitation increases with an increase in elevation (Stevens 1980). The highest precipitation occurs in the spring in the form of heavy,

wet snow. In the summer, afternoon thunderstorms also bring precipitation.

About two-thirds of the park is forested. At the lower elevations, from 2,300 m to 2,700 m, is a mosaic of forests and grasslands with meadows and riparian types along the floodplains and river bottoms. The forests contain stands of ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), aspen (*Populus tremuloides*), and lodgepole pine (*Pinus contorta*). On the more open slopes there are stands of big sage (*Artemisia tridentata*) and bitterbrush (*Purshia tridentata*) as well as grassland containing mountain muhly (*Muhlenbergia montana*), needle-and-thread (*Stipa comata*) and sedges (*Carex* spp.). Wet meadows contain timothy (*Phleum pratense*), tufted hairgrass (*Deschampsia caespitosa*) and Kentucky bluegrass (*Poa pratensis*). Along the rivers are stands of willow (*Salix* spp.), narrowleaf cottonwood (*Populus angustifolia*) and birch (*Betula glandulosa*).

At mid-elevations, from 2,700 m to 3,500 m, are subalpine associations with stands of Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) with an understory of whortleberry (*Vaccinium* spp.). Lodgepole pine is present on areas of shallow soil and in old burns. Limber pine (*Pinus flexilis*) and aspen stands are also present in some sites.

The upper elevations, above 3,500 m, contain alpine tundra. Tundra is fairly extensive in the park covering about one-third of the area. Vegetation consists of tufted hairgrass, sedges, Mt. Washington dryad (*Dryas octopetala*), cliff sedge (*Carex scopulorum*), Parry primrose (*Primula parryi*), kobresia (*Kobresia myosuroides*) and golden avens (*Geum rossii*).

The area had a long history of land use before its establishment as a national park. Settlers began to arrive in the 1860's. Many areas in the park were farmed, mined, logged, and burned. Large ranches were established and there was heavy grazing by domestic livestock. Because of its scenic beauty, the area was also recognized for its recreational opportunities, which led to the early development of dude ranches and resorts. In the early days the area was noted for its good hunting. Large ungulates, including elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*) and bighorn sheep (*Ovis canadensis*) were extremely abundant (Stevens 1980). Wolves (*Canis lupus*), grizzly bears (*Ursus arctos*), and black bears were present, but not as common as ungulates (Armstrong 1975). Loss of habitat, local hunting, and market hunters from Denver reduced the ungulate herds so that by the turn of the century the elk had been extirpated (Sprague 1925, Stevens 1980). The bighorn

populations persisted but declined drastically possibly from scabies and loss of winter range in the 1930's (Wright et al. 1932). The wolf became extinct in the early 1900's and the grizzly by the late 1920's (Wright et al. 1932, Armstrong 1975). The black bear survived these human impacts but in low numbers (Wright et al. 1932). In 1915, after 15 years of effort by conservationists, the area was established as a national park.

Since then, a major effort in managing the park has been aimed at restoring the area to natural conditions from past land uses. Farms, ranches, homes, and resorts within the park boundary were purchased and razed. Disturbed areas were revegetated or allowed to revegetate naturally. Critical ungulate winter range was purchased and restored. Elk and bighorn sheep were reintroduced and have shown impressive increases (Stevens 1980, Stevens and Hanson 1986).

The presence of the park now dominates the local economy. Tourism has become the major business. Tourism and development, particularly along the eastern boundary, has increased to the point that it threatens the integrity of the park. The gateway town of Estes Park to the east has expanded to the park boundary. Dude ranches, condominiums, conference centers, and private homes are increasing in numbers every year. Fortunately the areas adjacent to the north, west, and south park boundaries are primarily public lands where human development and use is controlled. Hunting for bears and other wildlife species occurs outside the park boundary. Regionally, urbanization is occurring at a rapid pace along the Front Range lowlands north of Denver and east of the park.

Rocky Mountain is one of the most heavily used U.S. national parks with 2.6 million visits in 1987, down from 3 million in 1978 (Rocky Mountain National Park Fact Sheet, Oct. 1988). The park receives more visitation than Yellowstone, yet is only one-eighth the size. Day use predominates; however, there are over 300,000 camper nights annually at the 5 campgrounds (Statement for Management, 1982, Rocky Mountain National Park). Use is highly seasonal with the bulk occurring during June, July, and August. Over 75% of the visitor use is concentrated on the east side of the Continental Divide in the park (Master Plan, 1976, Rocky Mountain National Park). There are 250 backcountry camp sites with an annual use of about 35,000 user nights, down from a peak of 62,000 in 1977 (Statement for Management, 1982, Rocky Mountain National Park). Day hiker use is also high, estimated at about 600,000 per year on the 300 miles of park trails (Statement for Management, 1982, Rocky

Mountain National Park). Commercial horse rides are estimated at 40,000 to 50,000 per year originating from 2 liverys in the park and 24 outside. Automobile traffic is heavy on the park's 100 miles of roads during peak days of visitor use. Trail Ridge Road, which traverses from the east side to the west side of the park, can receive more than 1,000 cars per hour use during peak periods (McCutchen unpubl. data). To alleviate traffic congestion to Bear Lake, another favored area, a shuttle bus system is in operation during the summer.

Black bears are present in the park but have never been considered common (Armstrong 1975). Current research indicates that the population in the park is 30 to 35 bears with about 1 bear per 30 km² (McCutchen unpubl. data). The bear population in the park is viewed as a "high elevation" subpopulation contiguous with a larger population of "low elevation" bears surrounding the park. Because the bears are secretive, they are seldom observed by the many visitors using the roads and trails. Bear scat and feeding sign is seldom seen in or near visitor use areas. Although bears have access to garbage cans and dumpsters (which are not bear-proofed), as well as campgrounds, picnic grounds, and backcountry campsites, there is seldom an incident of a bear raiding them (McCutchen unpubl. data).

A review of the historic records suggests that bear incidents are somewhat periodic in the park (McCutchen unpubl. data). Bear incidents were low in the late 1950's and early 1960's. During the 1960's there were 2 high years, 1963 and 1967, with 45 and 27 incidents, respectively. From 1959 to 1967 there were about 2 control actions per year with bears (14 transplanted and 2 killed) in the park. From 1968 to 1983 there were only 17 bear incidents for a rate of 1 per year. Three bears were captured and transplanted in control actions. The reasons for the 2 years of high incident rates in the 1960's as compared to the 1970's and early 1980's is not known. Visitation in 1962 was 1.7 million increasing to 2.5 million in 1972, then staying fairly constant (National Park Service 1976). Thus, visitation and bear incidents do not seem to be correlated. The reduction of incidents after the 1960's may be related to the purchase and razing of a number of private guest ranches within the park, which had open pit dumps used by bears, and bear control in the park at that time (D. Stevens 1989, Rocky Mountain National Park, pers. commun.). In 1984, after a 17-year hiatus, another exceptional year occurred when a bear began to raid backcountry campsites. That year there were about 90 incidents. The offending bear, a subadult male, was captured and removed from the area. In subsequent years bear incidents were again low.

MATERIALS AND METHODS

Between 1984 and 1988, we captured 23 black bears in the park with culvert traps or with Aldrich foot snares. We immobilized them with a combination of Ketamine and Rompun. They were marked with numbered aluminum ear tags, weighed, and measured. The first premolar was pulled for cementum aging. Seventeen of the bears were radio-collared (Telonics, Mesa, AZ). Radio-telemetry was conducted on foot, by automobile, by fixed-wing aircraft, and by helicopter. An attempt was made to obtain at least one accurate location on each bear each week. The usual procedure was to obtain a general location on a bear by vehicle then move in on foot to obtain a more accurate fix through a series of triangulations. It was extremely difficult to approach to within about 100 m of the bears without disturbing them and chasing them away. Because of this, researchers would often stay back about 400 m or more to obtain fixes. We estimated that radio-fixes obtained at 100 m or less were accurate to about ± 25 m. Radio-fixes 500 m to 1 km were accurate to about ± 150 m. Radio-locations were only obtained diurnally as nighttime locations were too difficult to obtain in the rugged terrain.

After the bear research began, the park staff developed a bear information network. All bear sightings reported by park personnel (75 permanent and 300 seasonals) and park visitors were channeled into a central dispatch office, recorded, then passed on to the research team. Because bears were rare, park visitors often stopped at the entrance stations or visitor centers and reported their bear sightings. Backcountry rangers reported bear sightings or signs. Garbage handlers reported bear or other animal raids on garbage cans along their route.

For this report the 2-year composite home ranges and radio-locations of 2 female bears for the years 1985 and 1986 are examined. These are bears No. 2 with 47 radio-locations, and No. 3 with 52 radio-locations. Bear No. 2 was estimated to be 14-years-old in 1985. She had no cubs in 1985 and lost her cubs in the spring of 1986. Bear No. 3 was estimated to be 4-years-old in 1985. She had no cubs either year. These bears were selected because they had home ranges in the portion of the park with the greatest human use.

During these time periods, no other bears were known to be permanent residents in these bears' home ranges; however, different bears, believed to have been transients, were sighted in the area. Snare lines were set to determine if other bears were present. None were captured except the known females.

The relocation data were lumped for 1985 and 1986 to increase the sample sizes for statistical analyses and to

show the radio-locations and home ranges on a single map. The 2 bears were captured in the summer of 1985, so that year's data were only for a part of the summer and fall. The 1986 radio-location data are for the entire year. The resultant 2-year composite home ranges and sizes for the 2 bears are similar to those obtained through more limited radio-tracking in 1987 and 1988 (McCutchen unpubl. data).

To provide a measurement of each bear's avoidance behavior in relation to human use, radio-location data were plotted on a base map. The distance of each location to the closest set of human use features was then measured to the nearest 0.1 km. Human use features I believed to be of importance included trails, trailheads, paved roads, dirt roads, human residences, picnic areas, major campgrounds, backcountry campgrounds, the park boundary, and miscellaneous developments (ski area, major pullouts, parking lots, visitor centers, stables). Home ranges were delimited by the minimum polygon method (Mohr 1947).

RESULTS AND DISCUSSION

Figure 1 depicts the 2-year composite home ranges of bears No. 2 and 3. The home ranges overlapped only slightly. Adult females in the park appeared to have nearly exclusive home ranges (McCutchen unpubl. data), and may be territorial, similar to the black bears reported by Young and Ruff (1982) and Rogers (1987).

Bear No. 2 had a home range (70.8 km²) that was roughly bounded by Trail Ridge Road to the north, the main park road to the east, the Bear Lake Road to the south, and timberline to the west (Fig. 1). Within her home range were approximately 17 km of roads, 59 km of trails, 11 backcountry sites, 9 trailheads, 2 major picnic grounds, a major campground, a major overlook, 2 major parking lots, and 1 small residential area. Along the roads were about 10 small pullouts and picnic tables with attendant garbage cans.

Bear No. 2 occasionally crossed the roads to the north and south but was never known to cross the roads to the east. The greater portion of her home range was in the backcountry, accessible only by trails. She frequently used the northwestern section of her home range containing Forest Canyon, a nearly impassable rugged area, of dense spruce/fir forest and dead fall containing no trails. Her home range was away from areas of major human development, particularly the area to the east of her. This area includes the Town of Estes Park outside the park and an intensive zone of development in the park containing 2 major campgrounds, a network of major roads, park

headquarters, several residential areas, and a visitor center. Although campgrounds are an attractant to bears in many national parks (Martinka 1974, Pelton et al. 1976, Harms 1979 and 1980, Graber 1981, Herrero 1985), bear No. 2 was never known to visit the campgrounds.

The distance of bear No. 2's radio-locations to visitor use areas (Fig. 2a) indicates that although she stayed away from these areas, the average distance was quite variable depending upon the area type. Much of her home range was dissected by trails; thus, she was located closer to trails (0.8 km) and trailheads (1.9 km) on the average than other areas of use. Based on locations in her home range (Fig. 1) she seemed to be electing to be near trails in the southern part, apparently for 2 reasons. First, trails in this area are near creeks and wet areas, which, from my experience, appear to be favored bear habitat. Second, there is some research bias here as her signal was more easily picked up along trails than in "dead spots" away from trails. Bear No. 2 was seldom located in or near areas of major development where human use and residence was on a 24-hour basis or was year-round, e.g., the major campgrounds, and the park boundary area (Fig. 2a).

Bear No. 3 had a smaller home range of 35.1 km² (Fig. 1), which was dissected by 2 major roads, Trail Ridge Road to the south and Fall River Road through the valley in the center. Both of these roads received heavy human use in the summer. Bear No. 3's home range contained 24 km of roads, 9 km of trails, a ski area, a major overlook, 6 large pullouts, 3 trailheads, and a small residential area. In addition, a major picnic ground was located almost in the geographic center of her home range. At the pullouts and other use areas were numerous garbage cans for the visitors' convenience.

Bear No. 3's home range overlapped only slightly with bear No. 2's. Bear No. 3 tended to utilize the rugged, steep, mountain slopes north and south of Fall River, particularly the north-facing slope with its denser vegetation. Figure 2b indicates that she also was radio-located away from areas of human use. She was located closer to the paved roads than other features but still maintained an average distance of 1.1 km from them. She maintained the farthest distance away from the nearest major campground (6.0 km) and the park boundary (6.5 km) to the east, on the average (Fig. 2b). She was never known to visit the picnic ground in the center of her home range even though it had dumpsters and garbage cans. In addition to the radio-telemetry, indirect evidence of avoidance was determined from the lack of any reported bear-raiding of the refuse containers in this area during that time period.

Figures 2a and 2b provide a rough index of the

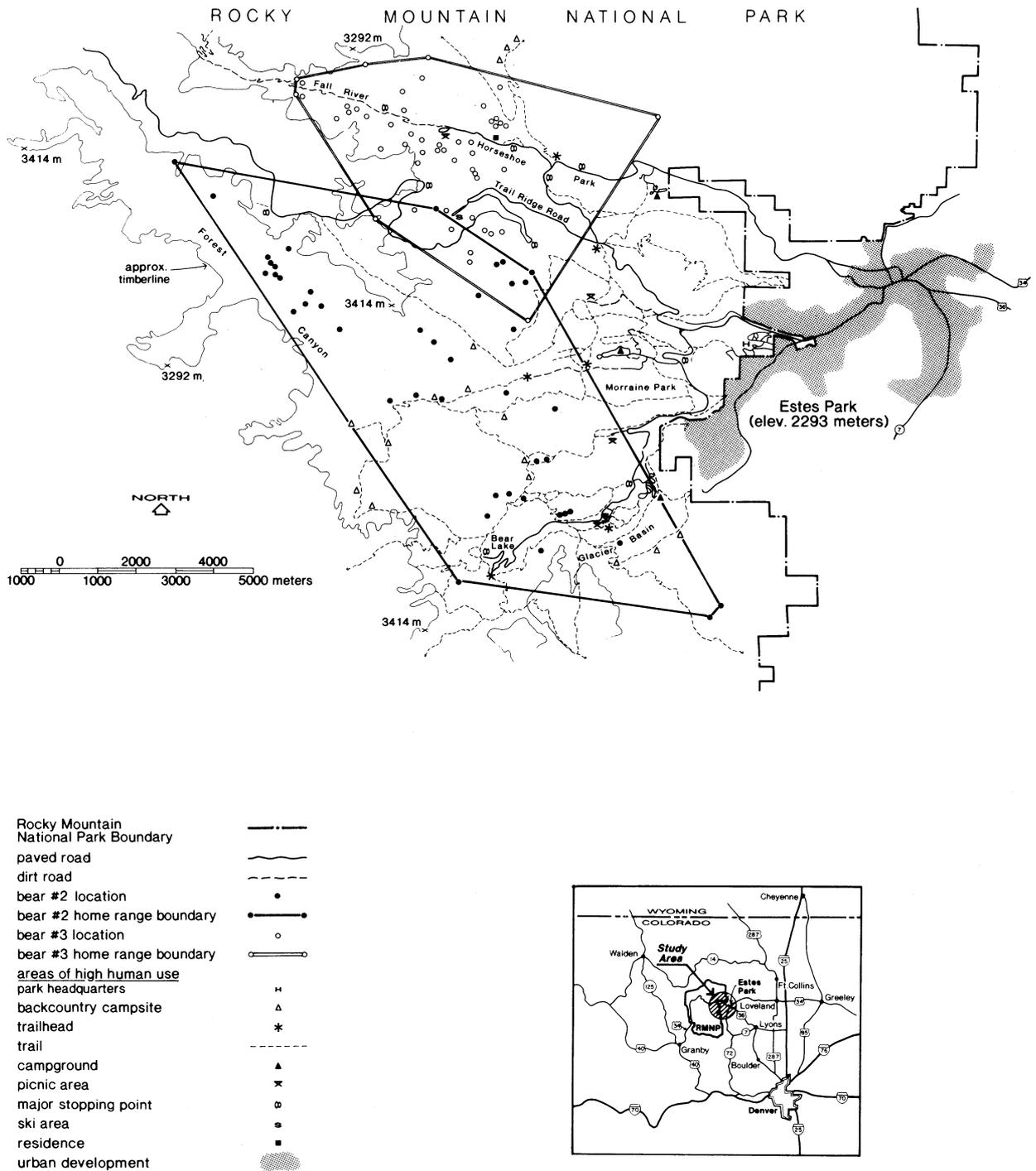
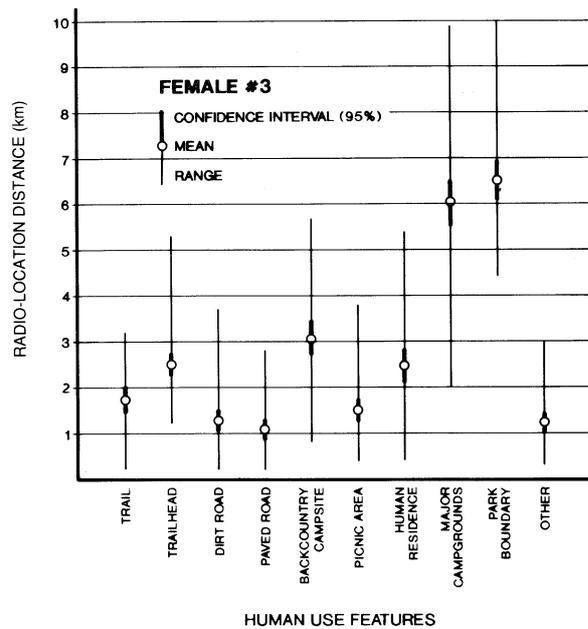
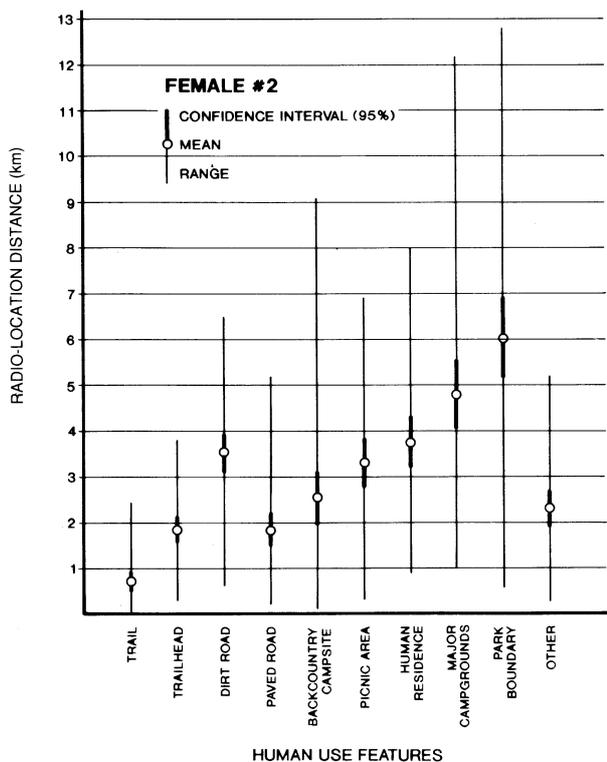


Fig. 1. Two-year composite home ranges of black bears No. 2 and No. 3 (1985-1986) in relation to human use areas, Rocky Mountain National Park, Colorado.



Figs. 2a and 2b. Radio-location distances of black bears No. 2 ($N=47$) and No. 3 ($N=52$) from human use features (1985-1986), Rocky Mountain National Park, Colorado.

tolerance of both bears to various park recreational developments. The various linear transportation corridors (trails and roads) were more tolerated than structures and facilities. Bear No. 2 was located closer to trails than to any other type of area probably because there were so many in her home range. Bear No. 3 was located closer to paved roads. Although paved roads tended to receive much greater use than dirt roads, both bears seemed to tolerate paved roads slightly better than the dirt roads.

The bears tended to keep about 1.5 to 4 km on the average from trailheads, human residences, and picnic grounds. They stayed the farthest, over 4 km on the average, from the major campgrounds. These average distances (Figs. 2a and 2b) illustrate a few general trends. Avoidance behavior of the bears is shown by the minimum distance the bears were located from human use areas (Figs. 2a and 2b). From the minimum distance statistics, other than the instance of bear No. 3 being located along a trail, both bears were always located away from areas of human use. I hypothesize that similar data developed for a bear habituated to a campground or roadside would show a closer mean distance and a minimum distance of zero as compared to a non-habituated bear showing a farther mean distance and minimum distance greater than zero.

Black bears have been known to stay away from

human use areas during the day and visit them at night (Ayres et al. 1986) to obtain food. There was no evidence that bears No. 2 and 3 did this.

That the bears did not use visitor use areas at night can be inferred in several ways: they were not observed at night along roads and trails nor in the frontcountry or backcountry campsites by the numerous park visitors or by rangers on patrol; bear scat was rarely observed on trails by the bear research team or backcountry rangers; and the numerous garbage cans placed along the roads and in picnic grounds and campgrounds were not raided at night.

The cryptic behavior of the bears in the park can also be shown by the small number of sightings and incidents during 1985 and 1986 (Table 1). An incident was recorded when a bear was observed in a visitor use area foraging for human food or when a garbage can was raided by a bear. In 1985 there were 16 bear sightings and 1 incident parkwide. Of these, 7 were sightings in bear No. 2's home range and 1 was a sighting in bear No. 3's. Most of these sightings within the home ranges were of the radio-collared bears; however, a large, different bear was sighted once in bear No. 2's home range, during the breeding season. It was most likely a male because bear No. 2 had cubs the following season.

In 1986 (Table 1), there were 13 sightings and 4

incidents parkwide. There were 2 sightings and 1 incident in bear No. 2's home range and 2 sightings and no incidents in bear No. 3's. Again through radio-tracking follow-up, the sightings were most likely of the radio-collared bears. The 1 incident, however, was caused by a transient bear. Considering that the bulk of the visitor use in the park is in bear No. 2 and bear No. 3's home ranges, including the estimated 600,000 hiker-days of trail use, the number of sightings is small.

The most graphic demonstration of the level of avoidance of these females to human use areas occurred in 1985-1986. In the summer of 1985, bears No. 2 and No. 3 were captured. Bear No. 2 weighed 49 kg and bear No. 3, captured in late summer, weighed 35 kg. In the winter of 1985-1986 they were reweighed at the dens. Bear No. 2, who had 2 cubs, still weighed 49 kg, and bear No. 3 weighed only 25 kg. In the summer of 1986 bear No. 2 was recaptured and weighed 71 kg. I suspect that these weight losses during the winter of 1985-1986 were attributed to a poor food year in 1985. Bear No. 2 lost her cubs and I suspect that she was in such poor condition at a weight of 49 kg that she could not provide adequate nutrition for them. Also for that winter, bear No. 3 lost about 26% of her summer weight. Neither of these bears raided readily available garbage cans along roads and in picnic areas or human food in backcountry campsites before or after this apparently difficult denning period. The study team could only ask "Why would these bears risk starvation in the den rather than forage on readily available, high energy, human foods in their home ranges?"

The data presented above suggest that black bears in this park exhibit a "model" behavior that many other parks are striving for. Yet, this "model" behavior exacts a cost from the bears although they are persisting in an area of high human use. In the park there is a network of human use travel corridors and centers of high human use with readily available high protein garbage. There are even human use areas in what we perceive as quality bear habitat (riparian areas, aspen stands), yet the bears avoid

these areas and utilize the interstices within the human use web.

Researchers of black bears and grizzlies in some parks have noted 2 types of behavior in the same population, depending upon whether or not they visited human use areas for food. For grizzlies in Yellowstone, Mattson et al. (1987) labeled these types "wary" and "habituated". Ayres et al. (1986) separated the black bears in Sequoia National Park into "natural" and "campground bears". At Rocky Mountain National Park the black bears, with rare exception, would be classified as "wary" or "natural". There is no evidence of "habituation" (McArthur 1983) at the present time.

Parks with a history of artificial feeding of bears, such as Yellowstone, Sequoia and Kings Canyon, Yosemite, and the Great Smoky Mountains, have persisting problems with habituated bears, even with intensive bear management programs in place over the past 15 years. At Rocky Mountain bears were never allowed to feed on human foods (Wright et al. 1932). From the time the park was established in 1915, bears that developed the habit of feeding on human foods were removed from the park. Martinka (1972) notes that this was the case in Glacier National Park. Yet, Glacier regularly has problems if food is unsecured. Black bears commonly enter campgrounds, picnic areas and other developed areas, and occasionally obtain unsecured food.

Elgmork (1976, 1987) suggested that the cryptic behavior of brown bears in Norway may have been the result of historic overhunting and "gun selection". He hypothesized that this trait could be passed on via heredity and learning to new generations. Perhaps heredity and learning have influenced Rocky Mountain National Park's black bears because they were heavily hunted prior to the park's establishment. Also, the park is so small that nearly every bear may be exposed to hunting adjacent to the park boundary during its lifetime, even though they are protected in the park. Two of the bears radio-collared in the park (subadult males) have been killed by hunters outside the park. An additional factor may be the selective pressure of the removal of problem bears that has been maintained on the small population of Rocky Mountain bears since the park was established in 1915.

At the present time the reason or reasons for the cryptic behavior of the black bears at Rocky Mountain National Park will continue to be investigated. Following the bears for several generations may provide some insight into the behavior; however, this phenomenon may never be easily explained. The behavior may be the result of genetics, learning, or a combination of these. Other interrelated factors might include a history of hunting prior to park

Table 1. Black bear sightings and incidents, 1985 and 1986, Rocky Mountain National Park, Colorado.

	Sightings		Incidents	
	1985	1986	1985	1986
Home ranges				
bear No. 2	7	2	0	1
bear No. 3	1	2	0	0
Other areas	8	9	1	3
Total	16	13	1	4

establishment; National Park Service control actions; a lack of widespread historical artificial feeding; low population densities with an inability to fill available vacant habitat; low rates of reproduction; loss of habitat; and poor quality, interspersed, and juxtaposition of resources. Whatever the reasons, these bears apparently give up valuable habitat to the more dominant species, man, within their own home ranges.

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