BEAR–SHEEP INTERACTIONS, TARGHEE NATIONAL FOREST

CAROLE J. JORGENSEN,[1] University of Montana (Border Grizzly Project), Missoula, MT 59801

Abstract: Black bear (*Ursus americanus*), grizzly bear, (*U. arctos*), and domestic sheep interactions and competition were investigated using radiotelemetry on the Targhee National Forest in Idaho and Wyoming during 1976 and 1977. (Black and grizzly bear intra- and interspecific relationships are discussed in terms of habitat utilization.) Radio-monitored movements of 7 black bears and 1 grizzly were compared with movements of sheep herds on selected forest sheep allotments to investigate bear behavior near sheep herds and determine the extent of interspecific conflicts. Competition between bears and sheep occurred when they utilized the same plants (primarily grasses and forbs) that were limited by either abundance or seasonal availability. Additional conflict, resulting in losses of sheep to bear predation, occurred during concurrent habitat use by bears and sheep.

Int. Conf. Bear Res. and Manage. 5:191–200

Bear predation on livestock, although a minor problem nationwide, causes significant losses to some western livestock owners who use federal grazing lands. This study was undertaken to evaluate bear–sheep interactions, including predation on sheep. Support came from the Targhee National Forest of the U.S. Forest Service (USFS), the Border Grizzly Project, the Interagency Grizzly Bear Team, the state game agencies of Idaho and Wyoming, the U.S. Fish and Wildlife Service (USFWS), and the University of Montana. I also acknowledge the advice and assistance of C. Jonkel, B. O'Gara, L. Eddleman, S.J. Johnson, R. Knight, R. Hugie and J. Beecham.

STUDY AREA

The study area, on the Ashton Ranger District of the Targhee National Forest in southeast Idaho and northwest Wyoming, is bordered by Yellowstone National Park on the north and the Rockefeller Parkway and Grand Teton National Park on the east. The sheep allotments involved in the study are delineated in Fig. 1.

Elevations range from 1768 m at the west Targhee boundary to 2828 m at the southeast corner of the Grand Teton foothills. Annual precipitation averages 45.5 cm, occurring mostly as rainfall. Snow accumulation averages 381 cm at elevations above 2133 m. Killing frosts have occurred in every month, having a major impact on the vegetation.

Lodgepole pine (*Pinus contorta*) and aspen (*Populus tremuloides*) occur at the lower elevations, with snowberry (*Symphoricarpos albus, S. oreophilus*), hawthorn (*Crataegus* spp.), chokecherry (*Prunus virginiana*), and serviceberry (*Amelanchier alnifolia*) occurring as common co-dominants. Douglas fir (*Pseudotsuga menziesii*) and subalpine fir (*Abies lasiocarpa*), present on north slopes throughout the higher elevation allotments, generally occur with huckleberry (*Vaccinium* spp.) and pinegrass (*Calamagrostis rubescens*) as co-dominants. Dry meadows are characterized by fescues (*Festuca* spp.), wheatgrasses (*Agropyron* spp.), and timothy (*Phleum* spp.). Bluegrass (*Poa* spp.), sedges (*Carex* spp.), and reedgrasses (*Juncus* spp.) typically dominate the numerous glacial lakes and intermittently wet marshes. Riparian areas are flanked with willows (*Salix* spp.), alder (*Alnus* spp.), or dogwood (*Cornus stolonifera*). Forested habitat types are described in detail by D. Steele et al. (unpubl. rep., U.S. Dep. Agric., Intermountain For. and Range Exp. Stn., Missoula, Mont., 1977). Dry rocky sagebrush (*Artemesia* spp.) flats cover a small part of the study area.

METHODS AND MATERIALS

Black bears were captured in footsnares (Jonkel 1967*a*) or a hinged-door culvert trap (Piekielek and Burton 1975) from June through August 1976 and May through July 1977. Traps were located on livestock allotments where bear depredations had reportedly occurred and were checked every 12 hours as required by the Idaho Fish and Game Department.

Captured bears were anesthetized with a 6.4 mg/kg phencyclidine hydrochloride (Sernylan, Parke-Davis & Co.) or 11.0 mg/kg ketamine hydrochloride (Ketaset, Bristol Laboratories). Acepromazine at 2.2 mg/kg was injected if bears showed indications of convulsions.

[1] Present address: Bureau of Land Management, P.O. Box 670, Rawlins, WY 82301.

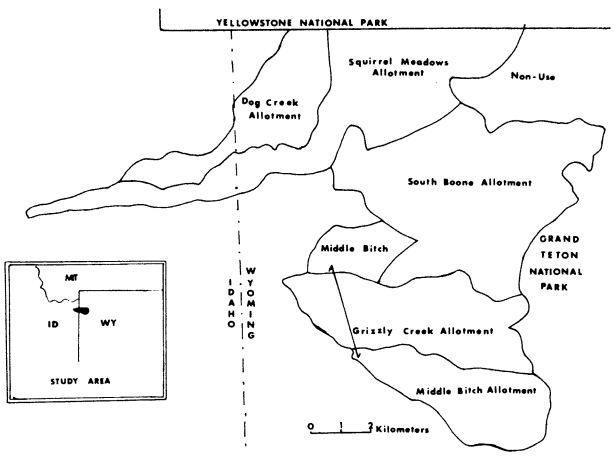

Fig. 1. Sheep allotments in the study area, Ashton Ranger District, Targhee National Forest.

Captured bears were ear-tagged with metal cattle tags and tattooed on one or both upper lips. Sex, measurements, and general condition were recorded. Weight was taken with a 91-kg (200-lb) spring scale or estimated with a cattle-hog girth/weight tape using Jonkel's (1967*b*) correlation value. Age classes were estimated by tooth wear and body size. A lower 1st premolar was sometimes removed for cementum annuli age determination (Stoneberg and Jonkel 1966). All bears but one were radio-collared with 164-MHz transmitters. Bears were released where captured and relocated from the ground, daily if possible, using a portable receiver and a hand-held Yagi-type antenna, or were located by the Interagency Grizzly Bear Team (IGBT) from the air.

Grizzly bears were captured by the IGBT and a USFWS predator control agent. Grizzly radio locations were obtained from IGBT's flight reports.

I calculated home ranges by both the minimum area method (Mohr 1947) and the modified minimum area method (Harvey and Barbour 1965). Data on scats, sightings, reported bear predation, and other bear sign were collected throughout the study area. A list of predominant trees, shrubs, and forbs, and the percentage crown cover of each plant, was compiled at each location. Habitats were classified according to the criteria of Steele et al. (unpubl. rep., U.S. Dep. Agric., Intermountain For. and Range Exp. Stn., Missoula, Mont., 1977). I attempted to verify all reported bear mortality and to collect skulls and stomach contents.

Each scat was given an estimated deposition date based upon the degree of decay, type of contents, and recent weather conditions. Rough qualitative analysis was performed in the field. Scats were air-dried and re-examined in the laboratory. I compared each component of a scat with identified reference collections. Using a circular screen, quartered to act as a grid, I separated the scat into components and estimated what percent volume of the scat each component comprised.

The estimated percentage volume of each component was tabulated into one of 5 categories: I (1–5%), II (6–25%), III (26–50%), IV (51–75%), V (76–100%). The combined percentage volume of all components in a scat approximated 100%. The frequency of occurrence of each component was adjusted by the percentage volume per scat, and grouped by approximate date of deposit to indicate the seasonal importance of each component in the diet.

A list of common plants occurring in the study area was compiled using the predominant plant/habitat lists and USFS range reports. To obtain a list of bear foods common in the study area, this was compared against the list of bear food compiled using the results of my scat analysis and of food habits studies of others working in the area: Tisch (1961), Mealey (1975), Blanchard (1978), J. Sumner and J. Craighead (unpubl. note, Mont. Coop. Wildl. Res. Unit, Missoula, 1975), unpublished reports of the Border Grizzly Project (School of For., Univ. Mont., Missoula, 1975–1978), and unpublished annual reports of the IGBT (U.S. Dep. Interior, Park Serv., Bozeman, Mont., 1976–1977).

Similarly, sheep usage of the study area was determined by observation of grazing sheep, examination of feeding areas before and after sheep grazing, and comparison of observations with the results of detailed sheep feeding studies in the literature (Sampson 1924, Reid 1942, Heady et al. 1947, Hermann 1966). The resulting list of preferred sheep foods was compared against the list of common plants in the study area to yield a list of common sheep foods on the study area.

RESULTS AND DISCUSSION

Six black bears were captured in 1976 and 5 in 1977: 2 adult males, 1 7.5-year-old female, 5 sub-

adult (3.5–4.5 years) males, and 3 subadult females. Two male grizzlies, aged 9 and 4.5 years, were captured in 1976.

Home Ranges and Aggregations

Home ranges were calculated from seasonal locations to indicate concentrated centers of activity and degree of intraspecific habitat utilization, and to provide a base of "normal" movements to compare with movements occurring when sheep were present within the bears' established centers of activity. Black bear summer home ranges varied from 1 km^2 for a bear killed 6 days after his capture to the 83 km^2 combined 1976–77 home range of young adult male No. 3. Home ranges in general did not vary seasonally. Home range size calculated prior to the arrival and after the departure of the sheep did not differ noticeably from the home ranges of bears while sheep were on the study area. The minor variations in concentrated centers of activity corresponded with the seasonal availability of natural bear foods in the study area. The few exceptions are described later when movements of collared bears near sheep herds are discussed. Detailed home range data and figures are available from the author.

One grizzly in the study area was successfully monitored by the IGBT. No. 14, a 9-year-old male grizzly, had a 1976–77 home range encompassing more than 2590 km^2 from north Yellowstone National Park to Grand Teton National Park (R. Knight, pers. commun.).

Several bears had overlapping centers of activity. All of the subadults shared much or all of their home ranges with each other as well as with adults. In 1976, a 3.5-year-old female black bear (No. 2) ranged entirely within the larger home range of a 4.5-year-old male black bear (No. 3). Temporal mutual avoidance was observed. Both bears, subadults in 1976, shared the same productive huckleberry patches, but avoided encounter by occupying opposite sides of the same ridge or drainage, maintaining a minimal 0.5-km separation.

A 3.5-year-old male and a 5.5-year-old male black bear exhibited mutual tolerance in their autumn centers of activity, often occupying seasonally prime habitat within 0.3 km of each other. In contrast, Lindzey and Meslow (1977) reported that subadult black bears in Washington were subordinate to adult males, and utilized home ranges in response to the locations of the dominant adults.

Several aggregations of collared bears and unmarked bears that were distinguishable from each other occurred in areas of concentrated food sources, including 2 females with young and 2 collared bears all feeding within 2 km of each other.

While documentations of black bear/grizzly bear contacts are few, Herrero (1978) suggested that grizzlies prey on black bears, and Jonkel (1967*a*) suspected such an incident. Observations of marked grizzlies during this study were limited to capture locations, aerial observations by the IGBT, and reported interactions with sheep. Parts of the home ranges of subadult black bears Nos. 2 (female) and 3 (male) were within the range of adult male grizzly No. 14. No. 3 moved within 0.7 km of No. 14 and remained in that area prior to, during, and after No. 14's initial capture and release without a detectable reaction to the grizzly. Grizzly No. 14 moved through the occupied home ranges of black bears Nos. 2 and 3 several more times in 1976. No apparent response was exhibited by either species to the presence of the other. Radio-collared black bears exhibited no significant changes in their movements related to the presence of grizzlies, even when grizzlies shared their concentrated centers of activity.

Habitat Use

Based on the 445 dated observations of scats, sightings, captures, and predation incidents recorded during this study, bears used riparian areas in the spring and early summer, and used the diversified grass/forb understory of mesic plateaus and parklands in summer.

Late summer observations were concentrated on the drier (and usually higher) fruit-producing subalpine fir types in August–September, and the hawthorn thickets in October–November. Bear habitat use, determined by the frequency and location of observations, coincided with the seasonal availability of preferred food sources: grass and succulent forbs in spring and early summer, and the abundance of ripening fruits available from July (serviceberries, chokecherries, dogwood berries) through September (huckleberries, berries of mountain-ash [*Sorbus* spp.],

hawthorn apples). A widespread failure of the 1977 huckleberry crop was reflected in the reduced frequency and percent occurrence of huckleberries in 1977 scats as compared with scats from 1976. The increased occurrence of grass in scats deposited in the spring and fall corresponded with the early growth stages of grass and forbs. Nutrient analysis and domestic livestock food habit studies show increased nutrient content and palatability of early-growth grass and forbs (Cook et al. 1948, Blaisdell 1958, Jensen et al. 1972).

Grizzlies eat a high proportion of roots, tuberous plants, and meat; in contrast, black bears utilize a high proportion of fruit crops from forested and riparian habitat. Black bears' use of habitat as determined from 445 black bear observations during this study differed significantly ($X^2 = 121.9$, $P < 0.001$) from grizzly habitat use as determined from 325 IGBT observations of grizzlies in the Yellowstone area (Knight et al. 1976, unpubl. annu. rep.). Black bear use of aspen types was disproportionately high in comparison with their occurrence in the study area: 3% of all scats found, 46% of all sightings, and 16% of all radio-locations occurred in the 2% of the study area classified as aspen dominant. No grizzly use of aspen areas was noted either during the study or historically in the study area.

Bear Food Habits

I collected 238 scats and did not differentiate between grizzly and black bear scats. Grass and grass-like plants occurred in 50% of the 182 scats containing herbaceous vegetation and occurred in proportion to the availability of succulent grasses in the study area. Grass-like plants occurred abundantly in more habitat types but differed greatly in phenological availability. Horsetail (*Equisetum* spp.), dandelion (*Taraxacum* spp.), lomatium (*Lomatium* spp.), clover (*Trifolium* spp.), thistle (*Cirsium* spp.), and a variety of umbellifers (Umbelliferae) were common forbs consumed. Scats containing fruit, particularly hawthorn, huckleberry, serviceberry, and buffaloberry (*Shepherdia canadensis*), were generally concentrated nearer to the food source and contained fewer different components per scat than those containing herbaceous vegetation. Mountain-ash, rose (*Rosa* spp.), and chokecherry were also common. Scats containing fruit had a much greater bulk volume than scats containing grass and forbs.

Nonplant scat components, in order of greatest occurrence, included insects, big game and/or rodents, sheep (including sheep used as bait), indistinguishable meat, eggs, and garbage. Although sheep carcasses were frequently used to bait snares and culverts, carcasses of diseased or injured sheep were commonly available, and scat collections were concentrated on bedgrounds and near sheep herds, only 14 scats (3%) contained sheep and/or indistinguishable meat. Average percent volume of sheep meat in scats containing sheep was 33%. The stomach contents of 2 of the 7 black bears killed as a result of verified or alleged sheep depredations indicated no sheep meat had been eaten. The remaining 5 bears had stomach contents including 55–100% sheep ($\bar{x} = 83\%$). Ants (Formicidae) (35–65%), grass (5%), and huckleberries (25–65%) were the only components occurring with sheep in more than trace amounts.

Stomach contents, however, were only indicators of possible predation. Sheep meat in the stomach verified only that the bear had fed upon sheep, not that it had killed sheep. The presence of maggots in the stomach did not identify scavenging bears either, since many livestock-killing bears characteristically return to their kills. Hair or wool in scats and stomach contents is not a good indicator of bear predation, since bears usually ingest little hair while feeding and will peel hides back to expose the meat on scavenged carcasses as well as fresh kills.

Sheep Use of the Study Area

Habitat use by domestic sheep was largely determined by established grazing practices, as described by Heady et al. (1947), herder compliance with Targhee Forest allotment schedules, and herder preference. Herders chose to concentrate sheep on meadows because quality forage was abundant and surveillance was easier. My observations of grazing sheep and areas grazed by sheep confirmed that sheep on the study area conformed to the feeding behavior documented in the literature, generally utilizing palatable species in proportion to their occurrence, preferring succulent grasses and forbs when available, and

using more browse as grasses and forbs cured in July and August (Strasia et al. 1970, Buchanan et al. 1972).

The 1977 Squirrel Meadows band was tightly herded. As a result, meadows and bedgrounds on that allotment were severely overgrazed and poor weight gains resulted. Sheep ate nearly all green vegetation, including mulesear wyethia (*Wyethia* sp.) and snowberry, plants ungrazed by the loosely herded 1976 band. Shrubs were stripped to a height of 75 cm and trampling was clearly evident in 1977, but not in 1976.

Interactions Between Sheep and Bears

Succulent vegetation is the preferred and major component of the diet of range sheep as documented in the literature and confirmed by personal observation and USFS range utilization records. The importance of the same vegetation to bears is indicated by its high frequency of occurrence and percent content in scats. Sheep had a wider tolerance of plant developmental stages than bears, who consumed grasses and forbs only prior to plant maturity and after the regrowth that occurs in the fall.

The greatest potential for food competition between bears and sheep in the Targhee occurs in the spring and early summer when grasses and forbs are the only important food source available. Bear food failures have been documented in the literature, and they often coincided with increased bear depredations (Hatler 1967, Piekielek and Burton 1975, Rogers 1976). Limited occurrence of available food increases the chance of interaction. Interactions between bears and sheep usually result in conflicts—a more serious problem than competition for food.

Contact between bears and sheep often results in bear predation on sheep or the killing of the bear as a real or alleged threat to the sheep. Black bear predation has been widely documented (Jorgensen et al. 1978), but verification of alleged predation is often lacking. Grizzly–brown bear predation on livestock has been documented and described by Murie (1948) and Mysterud (1974). Although grizzlies are involved in livestock depredation incidents less frequently than black bears, grizzlies usually cause greater damage.

Since 1975, USFWS predator control agents must file justification reports for the removal of bears considered livestock killers. Justification is based on tracks, scats, and the examination of carcasses. Selection of the bear to remove is based upon the tendency of bears to return to their kills. Success is indicated if depredations decrease or stop following a bear's death.

During this study, black bears killed sheep during both day and night, but grizzlies killed only at night. Herders commonly shot black bears on sight, usually without positive identification. Herders who maintained close contact with their sheep, keeping their herds in tight bands, experienced lower predation losses than those who allowed their herds to wander freely. The 1977 Squirrel Meadows herder spent more time with his sheep than the 1976 herder. He reported 32 sheep (1.4% of ewes and lambs combined) lost to predators, compared to the 47 (4.9%) lost to bears and 15 (1.7%) to coyotes (*Canis latrans*) in 1976.

These data are not comparable to those from previous years, when reported losses were highly subjective, inconsistently categorized, and unverified. Losses reported to the USFS included both ewes and lambs. However, allotment use records tallied size of herds by adult ewes only. The percentage of sheep lost (both ewes and lambs) is inflated when figured as losses of a reported herd (ewes only) unless the total herd size is adjusted upward to include both ewes and lambs. Adjusted total percentage losses to all causes for the allotments in the study area for 1976–1977 were 3.4%, or 220 animals (Johnson, USFS, unpublished data). Of those, 127, or 1.9% of the total herd, were killed by bears.

Bear Mortality

Few of the bears killed by herders and permittees as a result of real or alleged predations were reported. Herders often checked snares left by government trappers, and upon finding a bear, killed it and reset the snare for additional bears. Some herders set their own snares. Idaho and Wyoming require the salvage of bears killed in depredation conflicts, but compliance is negligible. The few skulls that were supplied to the Idaho Fish and Game Department usually lacked clear identification data such as sex, location and date of kill, and details of the depredation, so as to negate their scientific value (J. Beecham, pers. commun.)

Of the 17 bears known killed as alleged depredators in 1976, 10 were killed by herders and permittees. USFWS predator control agents documented the 7 others. Of the 18 bears killed in 1977, at least 15 were killed by herders and permittees (information on one bear was ambiguous). Less than half (41% in 1976, 17% in 1977) of known kills were documented by USFWS justification reports. Bears killed by herders were usually reported to me as sex unknown.

If twice as many bears were killed because of alleged depredations as were reported by the USFWS justification reports, a minimum estimated black bear mortality for the study area for 1970–1977 inclusive would be 62 bears, or nearly 8 bears annually. The low rate of reported mortality in 1976 and 1977, years of greater than normal surveillance, suggests that 10–12 or more bears are killed annually in addition to the unknown natural and hunting mortality.

Movements of Collared Bears Near Sheep Herds

Radiotelemetry aided observations of interactions between bears and sheep (and/or the accompanying herders and dogs). All black bears were captured prior to the arrival of sheep except an adult male who was captured several weeks after the sheep had passed his capture site.

Of the 8 black bears successfully monitored on the allotments studied, only 1 was a verified sheep killer. The determination of a bear's activities around sheep was often inconclusive. A bear's movements while near a herd were compared to movements before and after the sheep utilized his established home range. I contacted herders daily to receive predation (or attempted predation) reports if the sheep were within the established home range of a collared bear. I checked the herds and bedgrounds for any sick, lame, or stray sheep. The phenological condition and availability of bear foods, particularly fruit patches near the sheep camp, were noted. Coyote activity (tracks, sightings, scats, predation, dens, howling) was recorded. The movements of each collared bear were plotted against the grazing patterns of sheep herds in the areas and analyzed for possible responses and interactions. (Detailed graphical representations of movements of the bears monitored in relation to sheep herds in their established home ranges are available from the author.)

Two subadult bears demonstrated neutrality toward sheep herds and/or related activities in their home range. Male No. 9, a 3.5-year-old captured in the Squirrel Meadows allotment prior to the sheep's arrival, moved close to the Squirrel Meadows herd twice in 1977, spending 8–10 days near the sheep during each encounter. Temporal movements reduced the chances of direct contact with the sheep and no predation was reported during his proximity. The subadult female captured was monitored intermittently and was not near sheep during monitored periods.

Two subadult females avoided the sheep which were utilizing their home ranges. No. 2, a 3.5-year-old female captured in 1976, had a well-defined and consistent 12-km^2 home range and was in close proximity to the sheep through July and August. When the sheep grazed the hill of productive huckleberries that was her concentrated center of activity, she moved into the swamps of Yellowstone National Park, returning only after the sheep had left. Most of her movements were confined to a small area, and her only departure from her normal habitat was concurrent with the presence of sheep in those areas. No. 11 was captured on the Squirrel Meadows allotment in 1977, but spent most of her time in the Dog Creek allotment, unused that year. She moved between the two allotments most of the summer but avoided the Squirrel Meadows area when sheep were within her home range. The heavy over-grazing in the Squirrel Meadows allotment in 1977 may have been a factor in her preference for the Dog Creek allotment.

Three males showed interest in sheep herds and/or related activities. No. 4, a subadult captured in 1976, was monitored for 6 days, remaining within 1.0 km of his capture site. At 1800 hours on the 6th day after his capture he moved rapidly southeast and was relocated at 2100 hours near the Dog Creek sheep herd more than 7 km away. He was snared that night and killed by a herder the next morning. His stomach contained 10% sheep by volume as compared to the 55–100% sheep by volume found in stomachs of 5 other bears snared and killed by herders.

The snare in which No. 4 was captured had been set for a larger bear, who according to tracks, had been killing sheep regularly for a

week. The snare was set at the bedgrounds used the previous night and was more than 1 km from the sheep. The low percentage volume of sheep in the stomach contents was inconsistent with the accusation that No. 4 had killed and eaten a sheep as well as feeding upon the partially-decayed sheep used for bait. His monitored movements showed no contact with sheep during the 6 days prior to his encounter with the Dog Creek herd.

Adult male No. 7 had a home range of 22.2 km^2, the largest of any marked black bear on my study area, encompassing most of the Squirrel Meadows allotment and the trailing route for the South and Middle Boone sheep herds. He was in close contact with the sheep many times during 1977. The South Boone herder saw and shot at him on 29 June, although no sheep losses or attempted predation occurred. No depredations occurred during any of his monitored associations with the sheep. His centers of activity corresponded with areas of quality seasonal food sources.

Male No. 3 was the only monitored black bear known to kill sheep. In 1976, as a 3.5-year-old, he was located within a few hundred meters, but out of sight, of a large, unmarked adult bear who had been feeding on the fresh carcass of a lamb. No. 3 remained in the area and finished consuming the carcass. He then began moving with the Squirrel Meadows herd, traveling downslope, maintaining a 0.3-km lead in front of the sheep, finally remaining in productive berry habitat when the sheep moved north. He again moved with the sheep during their return. Based on sign, other bears were thought responsible for most of the sheep losses that occurred during No. 3's proximity to the sheep. Grizzly no. 14 was responsible for most of the sheep losses reported by the herder from 9 August to 11 August 1977. The remains of sheep killed in 1976 that were not used to bait snares were left at the site of the kill. No. 3 could not conclusively be eliminated as a sheep killer in 1976, but his monitored movements and behavior, and the kill characteristics, indicated he was scavenging the kills of other bears.

In 1977, No. 3's interactions with the South Boone herd involved more than scavenging. He chased sheep, and was seen with 2 other bears on a kill 10 July. He spent considerable time with the herd while they occupied his seasonal home range, but contact was not known to occur after 20 August.

Grizzly No. 14, a 9-year-old male, was captured in the Squirrel Meadows allotment in 1976 as a result of depredation activities and had no further interactions with any monitored herd that season. In 1977, his wide-ranging movements showed regular contact with the sheep. No. 14 was monitored exclusively by air, so daily temporal locations were not possible. Herders reported probable grizzly depredations on 27 July and 26 August. No. 14 may have been involved, but tracks and scats indicated other grizzlies were also in the area. As in 1976, No. 14's movements within sheep allotments constituted only a small part of the 2590-km^2 home range that had been determined for 1976 and 1977 (R. Knight, pers. commun.).

The data indicate that the presence of sheep did not influence any collared bear to leave its established home range either to approach or avoid the sheep. Movements of monitored bears were generally related to seasonal food availability in their respective areas. Two females, however, moved out of their concentrated centers of activity when the sheep occupied that area, and returned only after the sheep had left. One other possible exception occurred on 29 July 1976, when 3 bears (Nos. 2, 3, and 4) exhibited unusual excursions away from their established home ranges for 1–10 days. All bears began their departures in the evening, and moved southwest to lower elevations and towards the Dog Creek and Squirrel Meadows herds. I was unable to determine the cause of this simultaneous movement. An electrical storm made radio monitoring impossible after 1900 hours. When the weather cleared the following afternoon, No. 3 remained out of radio range (and away from both sheep herds), and No. 4 had been killed by the Dog Creek herder.

Erickson et al. (1964), Stonorov and Stokes (1972), and Egbert and Stokes (1976) have documented aggregations of bears at concentrated feeding sources and have studied the social hierarchy that develops among bears with consistently clumped food sources. Bears may have an increased intraspecific tolerance around sheep because the sheep serve as a clumped food source,

but hierarchies apparently do not develop because the situation is too dynamic.

Killing is thought to be a learned behavior in some species (Polsky 1975). Cowan (1972) suggested that killing requires experience, and in bears, localized, specialized predation techniques may spread through a population via learning behavior. Therefore, some bears may learn the technique of killing livestock and big game from other bears. Monitored bear No. 3 may have benefitted from the experience of the larger bear sighted on 6 August 1976, by utilizing the abandoned carcass. His depredation activities in 1977 suggested that he expanded his interests from scavenging to preying on sheep, possibly as a result of learned behavior.

Results of Bear–Sheep Conflicts

Competition for food is defined as occurring if 2 species utilize the same forage plants on the same range, the plants eaten are an important food source for either or both species, and such plants are somehow limited. In this study the overlap of foods used by both bears and sheep was considerable. Some plants occurred in limited abundance, and nearly all were seasonally limited in palatability and nutrient content. Although concurrent habitat use by bears and sheep was considerable, spatial and temporal movements and mutual avoidance by bears and sheep reduced possible contact. The chance of encounter between bears and sheep, and the sheep kills or destruction of the bear that often resulted, was greatly increased in the spring when the greatest quantity of high quality available forage was concentrated in meadows, and in autumn when bears were concentrated in berry patches near grazing sheep.

Birch (1957) describes competition as occurring between 2 species when the presence of one prevents the other from utilizing a needed resource, or when harm comes to either as a result of common use. Sheep losses due to stampede, straying, and decreased contentment often result when bears encounter sheep, whether predation occurs or not. Likewise, the presence of a bear is grounds for its trapping or removal, whether or not predation or the threat of predation occurs. The displacement of a bear from its preferred habitat could reduce its reproductive success, since Rogers (1976) found that a poor nutritional level adversely affects the reproduction and survival of cubs.

Cowan (1972) calculated that a ratio of 12–18 black bears in the population for each mortality is necessary for the continued viability of that population. Based upon the estimated kill in the 400-km^2 study area of 10–20 bears annually, the supporting resident population must either be abnormally high, or more likely a large number of bears are immigrating from Yellowstone and Grand Teton National Parks. Areas having the greatest bear depredation problem (and consistently high coyote predation) border the parks. An immigrating bear, unfamiliar with a new habitat, may be more inclined to utilize readily available sheep and sheep carrion than a resident who learned the locations of optimal forage areas from its mother, a theory as yet untested.

The conflict between sheep and grizzlies is further complicated by the laws protecting threatened species. During the study, the capture and release of grizzlies involved in sheep kills did not permanently deter their attacks upon sheep. Although monitoring showed that grizzly No. 14 had few contacts with the sheep, those encounters were more serious in terms of predation deaths and stress/stampede losses than were black bear encounters with sheep.

Recommendations

Removal of a livestock-killing bear can be an effective way to reduce or stop depredations. However, since not all bears kill sheep, removal of suspected killer bears should be made very selectively. The chances of capturing a scavenging or innocent bear rather than a sheep killer increase as time elapses between the incident and capture. Setting snares 1 or more days following a kill, particularly after the sheep have moved to a new bedground, increases the chance of capturing an innocent scavenging bear. Bears in the study area did not leave established home ranges to follow sheep herds. Nor did their kills follow a consistent pattern.

Increased contact between sheep and bears can be expected in prime feeding areas with ripe fruit or succulent vegetation. Berry patches often occur on steep, brushy slopes that are marginal sheep range. Potential conflicts can be decreased if herders avoid those areas when possible and increase their surveillance when the sheep are graz-

ing prime bear habitat. Excessive browsing, trailing, and trampling in high-quality habitats should be avoided, not only for the prudent utilization and protection of the sheep range, but also to prevent the unnecessary deterioration of important habitat for bears and other wildlife.

Improved herder technique is probably the greatest factor in reducing all sheep losses, but especially losses to predation. Portable corrals, sheep-protecting dogs, aversion methods, and proper disposal of carcasses are deterrents that can be implemented to some degree on sheep allotments to reduce depredations. The common practice of shooting at bears without positive identification in areas used concurrently by black and grizzly bears increases the chances of killing a grizzly, the ramifications of which should be strongly impressed upon herders and permittees. Notifying enforcement personnel, increasing surveillance, and firing warning shots should be adequate in many cases. Improved USFS inspections of grazing techniques and enforced compliance with regulations by allotment permittees and herders, coupled with improved education regarding preventive predation control and improved reporting of incidents, can greatly increase our presently inadequate understanding of bear–sheep conflicts and their management.

LITERATURE CITED

BARNES, V., AND O. BRAY, 1967. Population characteristics and activities of black bears in Yellowstone National Park. Natl. Park Serv. U.S. Gov. Print. Off., Washington, D.C. 198pp.

BIRCH, L.C. 1957. The meanings of competition. Am. Nat. 91:5 – 18.

BLAISDELL, J. 1958. Seasonal development and yield of native plants on the Upper Snake River plains and their relation to certain climatic factors. U.S. Dep. Agric. Tech. Bull. 1190. 46pp.

BLANCHARD, B. 1978. Grizzly bear distribution in relation to habitat areas and recreational use: Cabin Creek – Hilgard Mountains. M.S. Thesis. Montana State Univ., Bozeman. 75pp.

BUCHANAN, H.W., A. LAYCOCK, AND D.A. PRICE. 1972. Botanical and nutritive content of the summer diet of sheep on a tall forb range in southwestern Montana. J. Anim. Sci. 35:423 – 430.

COOK, C.J., C.W. COOK, AND L.E. HARRIS. 1948. Utilization of northern Utah summer range plants by sheep. J. For. 46:416 – 425.

COWAN, I.M. 1972. The status and conservation of bears (Ursidae) of the world—1970. Int. Conf. Bear Res. and Manage. 2:343 – 367.

EGBERT, A.L., AND A.W. STOKES. 1976. The social behaviour of brown bears on an Alaskan salmon stream. Int. Conf. Bear Res. and Manage. 3:41 – 56.

ERICKSON, A.W., J. NELLOR, AND G.A. PETRIDES. 1964. The black bear in Michigan. Mich. State Univ. Agric. Exp. Stn. Res. Bull. 4. 102pp.

HARVEY, M.J., AND R.W. BARBOUR. 1965. Home range of *Microtus ochrogaster* as determined by a modified minimum area method. J. Mammal. 46:398 – 402.

HATLER, D.F. 1967. Some aspects in the ecology of the black bear, *Ursus americanus,* in interior Alaska. M.S. Thesis. Univ. Alaska, Anchorage. 111pp.

HEADY, H.F., R.T. CLARK, AND R. LOMMASSON. 1947. Range management and sheep production in the Bridger Mountains, Montana. Mont. State Univ. Agric. Exp. Stn. Bull. 444. 30pp.

HERMANN, F.J. 1966. Notes on western range forbs; Cruciferae through Compositae. U.S. Dep. Agric. Handb. 293. U.S. Gov. Print. Off., Washington, D.C. 365pp.

HERRERO, S. 1978. A comparison of some features of the evolution, ecology and behavior of black and grizzly/brown bears. Carnivore 1(1);7 – 17.

JENSEN, C.H., A.D. SMITH, AND G.W. SCOTTER. 1972. Guidelines for grazing sheep on rangelands used by big game in winter. J. Range Manage. 25:346 – 352.

JONKEL, C.J. 1967*a*. The ecology, population dynamics, and management of the black bear in the spruce-fir forest of northwestern Montana. Ph.D. Thesis. Univ. British Columbia, Vancouver. 170pp.

———. 1967*b*. Life history, ecology, and biology of the polar bear, autumn 1966 studies. Can. Wildl. Serv. Prog. Notes 1. 8pp.

JORGENSEN, C.J., R.H. CONNOLLY, R.J. HAMILTON, AND O.T. SANDERS. 1978. Management of black bear depredation problems. Proc. East. Black Bear Workshop 4:297.

LINDZEY, F.G., AND E.C. MESLOW. 1977. Population characteristics of black bears on an island in Washington. J. Wildl. Manage. 41:408 – 412.

MEALEY, S.P. 1975. The natural food habits of free-ranging grizzly bears in Yellowstone National Park, 1973 – 1974. M.S. Thesis. Montana State Univ., Bozeman. 158pp.

MOHR, C.O. 1947. Table of equivalent populations of North American small mammals. Am. Midl. Nat. 37:223 – 249.

MURIE, A. 1948. Cattle on grizzly bear range. J. Wildl. Manage. 12:57 – 72.

MYSTERUD, I. 1974. Sheep killed by brown bear, *Ursus arctos,* in Engerdal, South Norway, during the years 1953 – 1963. Fauna 27:121 – 138.

PIEKIELEK, W., AND T.S. BURTON. 1975. A black bear population study in northern California. Calif. Fish and Game 61:4 – 25.

POLSKY, R.H. 1975. Developmental factors in mammalian predation. Behav. Biol. 15:353 – 382.

REID, E. 1942. Important plants on national forest ranges of eastern Oregon and eastern Washington. U.S. Dep. Agric., For. Serv. Range Res. Rep. 1. 64pp.

ROGERS, L. 1976. Effects of mast and berry crop failures on survival, growth, and reproductive success of black bears. Trans. North Am. Wildl. and Nat. Resour. Conf. 41:431 – 438.

SAMPSON, A.W. 1924. Native American forage plants. John Wiley and Sons, Inc., New York, 435pp.

STONEBERG, R.P., AND C.J. JONKEL. 1966. Age determination of black bears by cementum layers. J. Wildl. Manage. 30:411 – 414.

STONOROV, D., AND A.W. STOKES. 1972. Social behavior of the Alaska brown bear. Int. Conf. Bear Res. and Manage. 2:232 – 242.

STRASIA, C.A., M. THORN, R.W. RICE, AND D.R. SMITH. 1970. Grazing habits, diet, and performance of sheep on alpine ranges. J. Range Manage. 23:201 – 208.

TISCH, E.L. 1961. Seasonal food habits of the black bear in the Whitefish Range of northwestern Montana. M.S. Thesis. Montana State Univ., Missoula. 108pp.