TEMPORAL AND SPATIAL ACTIVITY PATTERNS AMONG COASTAL BEAR POPULATIONS

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Abstract: We examined temporal and spatial activity of grizzly bears (*Ursus arctos*) and black bears (*Ursus americanus*) in 3 areas of coastal British Columbia to investigate (1) variation within and between the 2 species, and (2) the influence of human activity on bear activity. Bear detections at remote camera sites were used to measure activity. The Nimpkish Valley had black bears only, and high human use divided into periods with and without hunting. Black bears were active primarily during the day, whether there was hunting or not. In the Khutzeymateen Valley, grizzly bears were active primarily during the day, and black bears were nocturnal; there was no human use. Black bears likely avoided some areas because of the presence of grizzly bears. The Tweedsmuir study area had black bears and grizzly bears in areas of both low and high human use. Grizzly bears were detected more frequently than black bears in low and high human use areas. During periods when bears were fishing for salmon (*Oncorhynchus* spp.), lone adult grizzly bears and grizzly bear family groups were both detected less frequently and were more active during the night in the area of high human use than in the area of low human use. Subadult grizzly bears were detected more frequently in the area of high human use than in the area of low human use, and they tended to be more active during the day. Coastal grizzly bears were generally diurnal in areas of low human use. In areas of high human use, grizzly bears had different temporal and spatial activity patterns, and the magnitude and direction of these differences varied between age and sex classes. Black bears seemed to alter their temporal patterns of activity more in response to grizzly bear activity than to human activity.

Ursus 10:539–546

Key words: activity patterns, black bear, British Columbia, brown bear, grizzly bear, *Ursus americanus, Ursus arctos.*

Black bears in North America are generally diurnal in the West (Amstrup and Beecham 1976, Lindzey and Meslow 1977, Ayres et al. 1986), Northeast (Larivière et al. 1994), and Southeast (Garshelis and Pelton 1980). Nocturnal activity of black bears has been attributed to human food sources such as orchards, garbage dumps, and campgrounds (Ayres et al. 1986, Larivière et al. 1994).

Several studies of grizzly bear diel activity indicated that they are nocturnal or crepuscular (Roth and Huber 1986, LeFranc et al. 1987, Clevenger et al. 1990, Gunther 1990). McCann (1991) found that during the berry season, grizzly bears in southeast British Columbia were active primarily during the day and least active at night. Stemlock and Dean (1986) found that grizzly bears in central Alaska were most active during daylight hours. Bears were usually active throughout the day as day length decreased in fall. In a period of 24-hour light, Hechtel (1985) found considerable variation among individual bears in their diel activity patterns.

It has been suggested that good vision, which allows discrimination of colors and details at close range, results in more efficient foraging during daylight hours (Bacon and Burghardt 1976, Larivière et al. 1994). This advantage should be particularly true when bears search for and feed on berries and salmon, foods that require good visual acuity.

There is evidence for temporal and spatial avoidance of humans by grizzly bears (Warner 1987, McLellan and Shackleton 1988, Mattson 1990, Reinhart and Mattson 1990), especially non-habituated adults (Olson and Gilbert 1994). It is important to understand whether human activity negatively affects the temporal and spatial activity pattern of bears, because displacement into sub-optimal habitats or reduced feeding efficiency can affect the net energy available for growth and reproduction.

We examined temporal and spatial activity of grizzly bears and black bears in 3 areas of coastal British Columbia to investigate variation within and between the species and the influence of human activity on bear activity. We split our analysis into periods when bears were primarily focused on foraging for berries or salmon to minimize variation in activity patterns associated with different habitat use. In areas of low human activity, we expected grizzly bears to be active primarily during the day to maximize feeding efficiency. We expected black bears to also be active during the day, but influenced by grizzly bears. In areas with high human activity, we expected both species to alter their temporal and spatial patterns of activity to avoid humans.

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STUDY AREAS

Nimpkish Valley

The Nimpkish Valley study area was located approximately 40 km south of Port McNeill on northern Vancouver Island, British Columbia (50°13'N, 126°36'W; Fig. 1). Road access in the study area was extensive and human use was high throughout the year. The high density web of logging roads and secondary spur roads were frequently used by logging trucks, other forestry related vehicles, recreational vehicles, and researchers. Human activity off the main roads and away from vehicles during the period without hunting (approx. 16 Jun–11 Sep in 1992 through 1994) was mainly silvicultural work or research related. During the hunting season (approx. 10 Sep–11 Dec), mule deer (*Odocoileus hemionus*) and black bear hunters were also active off the main roads.

Khutzeymateen Valley

The Khutzeymateen Valley study area was located 45 km northeast of Prince Rupert, British Columbia, at the head of Khutzeymateen Inlet (54°37'N, 129°54'W). During berry season (25 Jul–22 Aug 1991), bears ate several species of berries as well as forbs. In the salmon season (23 Aug until den entrance), bears ate primarily spawning salmon and their carcasses.

The Khutzeymateen Valley is the core of a grizzly bear no-hunting zone established in 1984. No humans except researchers used the valley during this study.

Tweedsmuir

The Tweedsmuir study area was 50 km east of Bella Coola, British Columbia (52°22'N, 126°5'W). During berry season (10 Jul–19 Aug in 1993 and 1994), bears concentrated their feeding activity on valley bottoms and floodplains, where they fed on berries, roots, and insects. During salmon season (20 Aug to den entrance), bears fished for spawning salmon and fed on their carcasses.

The core of the study area was along the Atnarko River. The river was divided into an area of low human use (upper Atnarko River) and high human use (lower Atnarko River). On the upper Atnarko River, human activity was limited to hiking and Department of Fisheries and Oceans stream surveys. On the lower Atnarko River, anglers, boaters, hikers, and pine mushroom (*Trichloma ponderosum*) harvesters were active on the river and dispersed over the floodplain. A number of boat launches, 2 day-use areas, 2 public campgrounds, 1 private campground, an artificial spawning channel, and the community of Stuie (<10 residents, including a commercial fishing lodge) were near the lower river. The peak in angler activity on the lower Atnarko River occurred during the chinook salmon (*Oncorhynchus tshawytscha)* season between 15 June and 15 July. Another increase in anglers occurred during the coho salmon (*Oncorhynchus kisutch*) season, which began in early September and tapered off in late November. Commercial pine mushroom harvesting was most intensive from mid-September to mid-October.

Hunting for black bears and mule deer began in early September and was confined mostly to areas near the highway north of the Atnarko River. There has been no legal hunting of grizzly bears in the core study area since 1976, but there have been limited-entry hunts in areas adjacent to the lower Atnarko River. Between 1991 and 1994, 2 food-conditioned subadult females were killed in control actions on the lower Atnarko River.

METHODS

Temporal and spatial activity of grizzly bears and black bears were determined from remote camera data. Remote cameras recorded the date and time of photographs; therefore, the timing of bear detections and the number of hours between bear detections were used to indicate temporal activity patterns and overall activity levels, respectively. Remote camera units (Wildlife and Nature Photography, Columbia Falls, Mont. and Cygnus Technologies, Penticton, B.C., Canada) similar to those used by Mace et al. (1994) were used in all 3 study areas.

Camera sites were along well-used bear trails and at bear marking trees. The camera unit was mounted on the side of a tree 2–3 m from the ground and angled so that the focal point of the camera was 3–4 m away on the bear trail. Site disturbance was minimal. A small amount of commercially available beaver (*Castor canadensis*) or

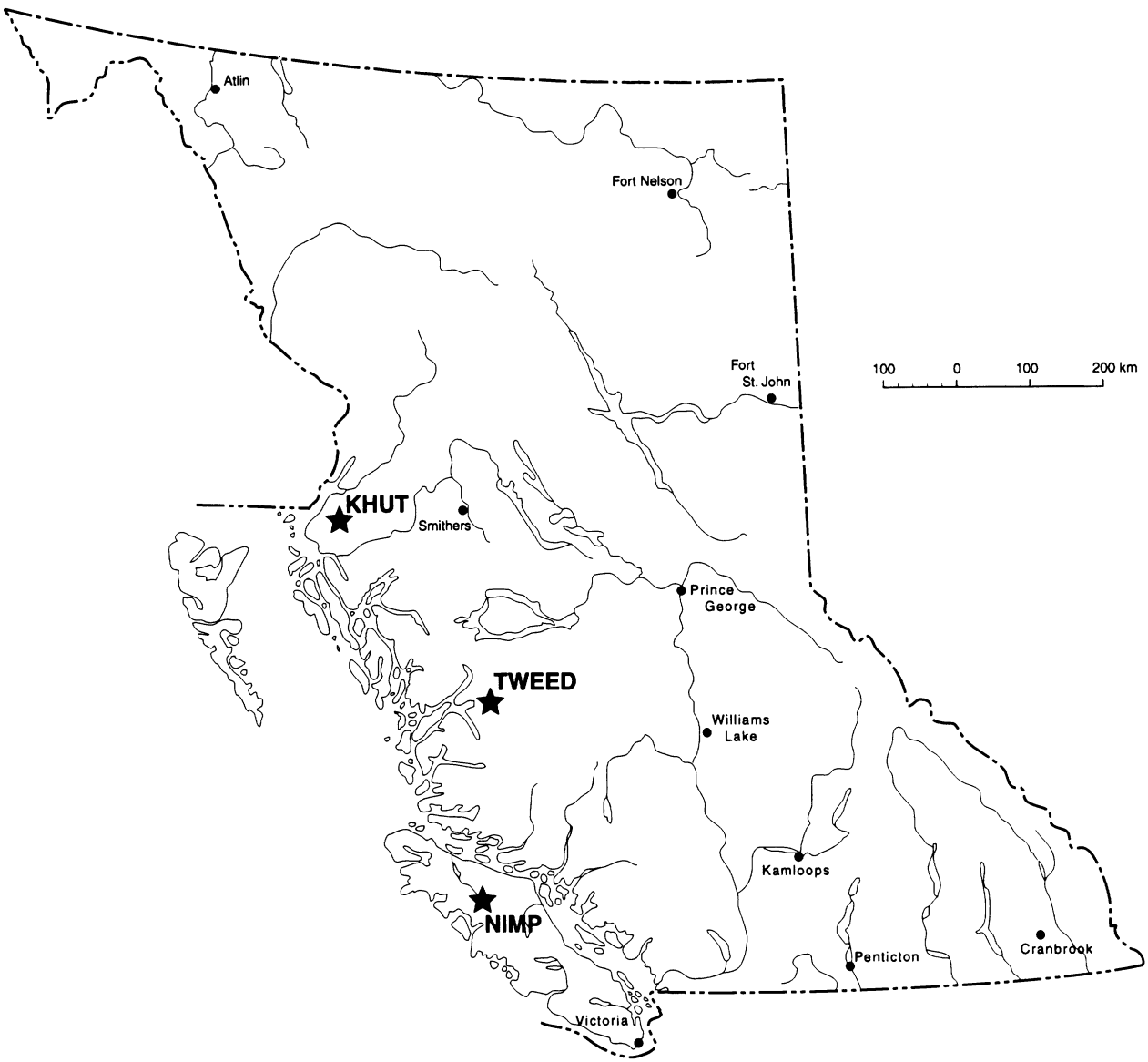

Fig. 1. The location of the Nimpkish Valley (NIMP), Khutzeymateen Valley (KHUT), and Tweedsmuir (TWEED) study areas in British Columbia, Canada.

bear scent was periodically placed at the camera's focal point to prolong the bear's time in the field of view.

We avoided visiting the cameras to minimize human scent, and the time between visits varied among study areas. During the Khutzeymateen study, cameras were visited every 3–7 days; during the Tweedsmuir and Nimpkish studies, cameras were visited every 14–21 days.

A camera detection was considered a single visit by a bear to a remote camera site. To be counted as a detection, photographs of the same individual had to be separated by >24 hours. This criteria required that individual bears be identified. Individuals were distinguished by the presence of radiocollars or ear tags; the overall body shape, height, and length; head shape and size; coat color, pattern, and length over short periods; features such as scars and missing ears; and by comparison with photographs of marked individuals. If we questioned identity of similar individuals in any 24-hour period, only the first detection was used.

In the Tweedsmuir study area, distinguishable individuals were categorized as lone adult grizzly bear, grizzly bear family group, subadult grizzly bear, or black bear.

Bear activity was compared between day and night (defined by sunrise and sunset, respectively). Sunrise and sunset times were obtained from Environment Canada or the Pacific Space Centre, Vancouver. All times were in Pacific Standard Time (PST).

Chi-square goodness-of-fit and Chi-square contingency tables (Zar 1984) were used to test for significant differences in the frequency of bear detections between species, times, and areas ($\alpha = 0.05$).

RESULTS

Nimpkish Valley

We used 16 or 17 cameras at 19 sites in the core of the study area during 1992, 1993, and 1994. Cameras were placed along travel routes in areas and periods of berry feeding and were thus thought to provide representative data on activity during the berry season (16 Jun–19 Oct in 1992–94). The berry season was divided into periods with and without hunting to investigate variation in black bear temporal activity as a result of changes in the level and type of human activity. Cameras were active for 98,322 hours during the berry seasons, 70,256 hours during the no-hunting period and 28,066 hours during the hunting period.

Black bears were more active during the day than at night during the berry season ($\chi^2 = 42.38$, 1 df, $P < 0.001$). This diurnal pattern was consistent in both the no-hunting and hunting periods (no-hunting: $\chi^2 = 2.95$, 1 df, $P < 0.001$; hunting: $\chi^2 = 20.81$, 1 df, $P < 0.001$; Fig. 2). The frequency of day versus night detections was independent of period ($\chi^2 = 0.59$, 1 df, $P = 0.44$).

Khutzeymateen Valley

We used 8 cameras at 9 sites between 31 July and 29 September 1991. Camera sites were located where bear movement was restricted by topography and bear use was expected to be high. Bear trails used for camera sites were adjacent to rivers or creeks; thus we expected that the data would more accurately represent activity in the salmon season than the berry season. However, activity during the berry season was measurable as these trails were also used to access berry feeding and bedding sites. Cameras were active for 8,468 hours, 2,852 hours during the berry season and 5,616 hours during the salmon season.

Black bears were more active during the night than the day during camera operation ($\chi^2 = 9.78$, 1 df, $P < 0.005$). This nocturnal pattern was consistent in both the berry and salmon seasons (berry: $\chi^2 = 4.85$, 1 df, $P < 0.05$; salmon: $\chi^2 = 5.10$, 1 df, $P < 0.025$; Fig. 3). The frequency of night versus day detections was independent of season ($\chi^2 = 0.20$, 1 df, $P = 0.66$).

Grizzly bears were more active during the day than the night during camera operation ($\chi^2 = 13.41$, 1 df, $P < 0.005$). This diurnal pattern was consistent in both the berry and salmon seasons (berry: $\chi^2 = 7.50$, 1 df, $P < 0.01$; salmon: $\chi^2 = 6.58$, 1 df, $P < 0.025$). The frequency of day versus night detections was independent of season ($\chi^2 = 2.47$, 1 df, $P = 0.12$).

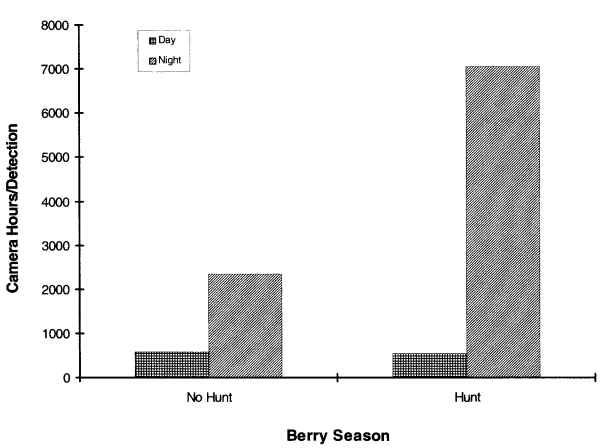

Fig. 2. Remote camera hours/detection of black bears during the no-hunting and hunting periods of the berry season in the Nimpkish Valley, B.C., Canada, 1992–94.

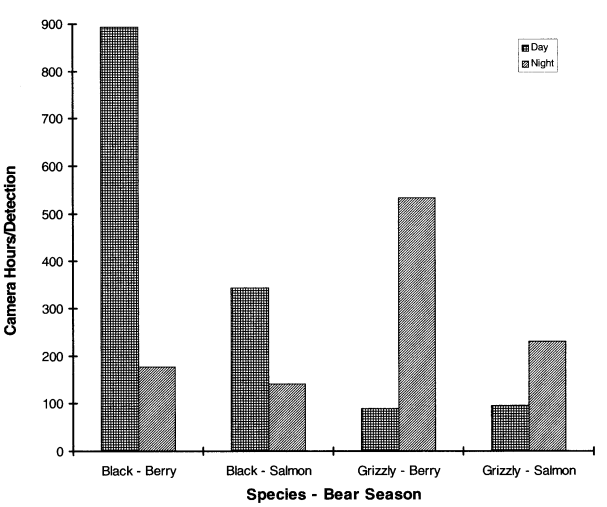

Fig. 3. Remote camera hours/detection of black bears and grizzly bears during the berry and salmon seasons in the Khutzeymateen Valley, B.C., Canada, 1991.

Grizzly bears were detected more frequently than black bears in the berry season ($\chi^2 = 9.00$, 1 df, $P < 0.001$); however, in the salmon season there was no difference ($\chi^2 = 3.66$, 1 df, $P > 0.05$). Grizzly bears and black bears had different temporal patterns of activity in both seasons. Grizzly bears were significantly more active during the day than black bears (berry: $\chi^2 = 13.03$, 1 df, $P < 0.001$; salmon: $\chi^2 = 11.53$, 1 df, $P < 0.001$).

Grizzly bears and black bears had significantly different detection distributions among the main drainages in which cameras were located ($\chi^2 = 22.24$, 1 df, $P < 0.001$; Fig. 4). There were 2 locations in the Khutzeymateen Valley where there were few or no detections of black bears.

Tweedsmuir

We used 17–19 cameras at 23 sites along the Atnarko River during 1993 and 1994. Camera sites were established along travel corridors where bear use was expected to be high. Most camera sites were adjacent to the Atnarko River and were not directly associated with major berry feeding areas; therefore, data on activity patterns were expected to represent salmon season better than the berry season.

Cameras were active for 71,438 hours in 1993 and 1994; 31,882 hours on the upper Atnarko River and 39,556 hours on the lower Atnarko River. The upper Atnarko River was considered a control area of low human use and the lower Atnarko River a test area of high human use.

Upper Atnarko.—The only time black bears were detected on the upper Atnarko River was during the berry season. Frequency of detections did not differ between day and night ($\chi^2 = 2.86$, 1 df, $P > 0.05$; Fig. 5). Grizzly bears were more active during the day than at night in the berry season ($\chi^2 = 7.19$, 1 df, $P < 0.001$), but were equally active during the day and at night in the salmon season ($\chi^2 = 2.24$, 1 df, $P > 0.10$).

There was no difference in the frequency of detections of grizzly bears and black bears during the berry season ($\chi^2 = 0.42$, 1 df, $P > 0.25$), and the frequency of day versus night detections was independent of species ($\chi^2 = 1.36$,

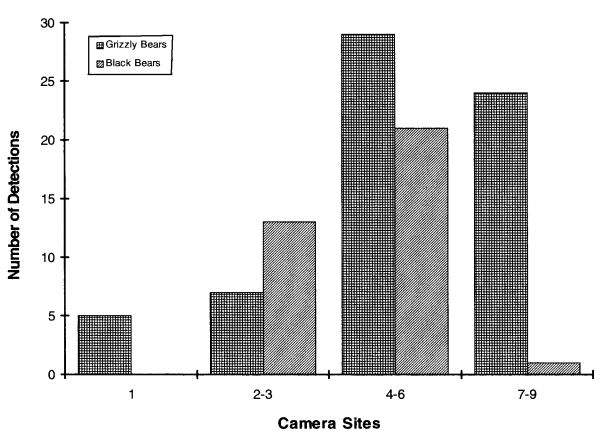

Fig. 4. The number of detections of grizzly bears and black bears at remote camera sites in different drainages of the Khutzeymateen Valley, B.C., Canada, 1991. Camera sites: 1 = Khutzeymateen River estuary, 2–3 = Lower Khutzeymateen River, 4–6 = Kateen River, 7–9 = Carm Creek.

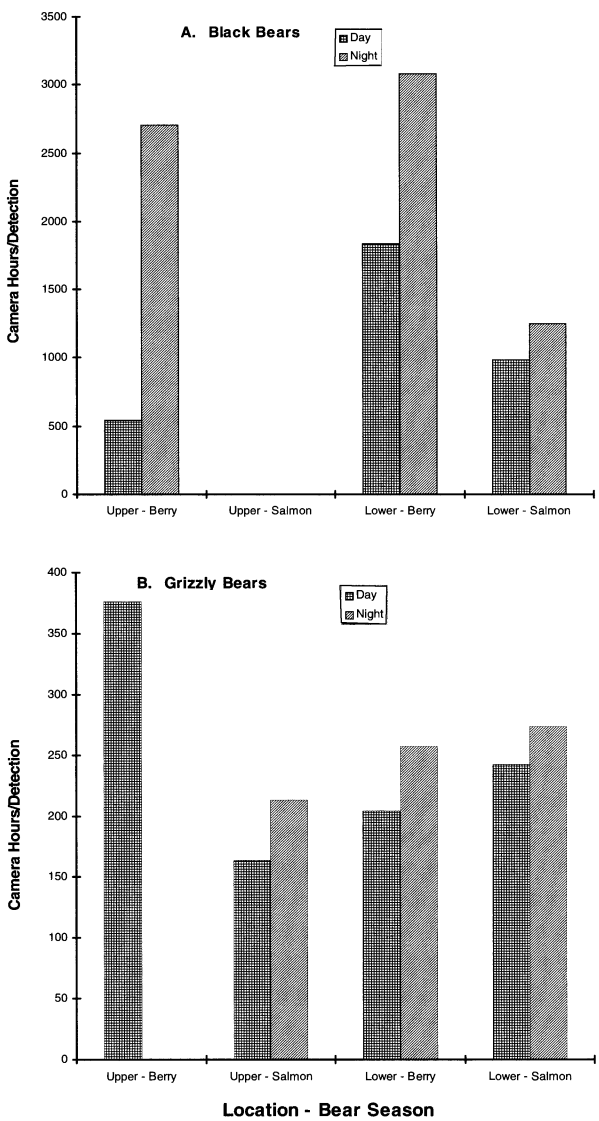

Fig. 5. Remote camera hours/detection of (A) black bears and (B) grizzly bears during the berry and salmon seasons on the lower and upper Atnarko River, B.C., Canada, 1993 and 1994.

1 df, $P > 0.10$). During the salmon season, grizzly bears were detected much more frequently than black bears ($\chi^2 = 123.72$, 1 df, $P < 0.001$).

The majority of grizzly bear detections during the berry season were subadults, but during the salmon season there were more lone adults and family groups detected (Fig. 6). During the salmon season, subadults and lone adults were equally active during the day and night (subadults: $\chi^2 = 2.46$, 1 df, $P > 0.10$; lone adults: $\chi^2 = 1.73$, 1 df, $P > 0.10$), but family groups were most active during the day ($\chi^2 = 9.50$, 1 df, $P < 0.001$).

Lower Atnarko.—There were only 4 black bear detections on the lower Atnarko River during the berry season. In the salmon season black bears were equally active during the day and night ($\chi^2 = 0.39$, 1 df, $P > 0.25$). Grizzly bears were equally active during the day and night in both the berry and salmon seasons (berry: $\chi^2 = 0.44$, 1 df, $P > 0.25$; salmon $\chi^2 = 0.47$, 1 df, $P > 0.25$). Grizzly bears were detected more frequently than black bears during both the berry and salmon seasons (berry: $\chi^2 = 28.49$, 1 df, $P < 0.001$; salmon: $\chi^2 = 57.19$, 1 df, $P < 0.001$), and the frequency of day versus night detections was independent of species (berry: $\chi^2 = 0.06$, 1 df, $P > 0.25$; salmon: $\chi^2 = 0.07$, 1 df, $P > 0.25$).

During the berry season, subadults and lone adults were as active during the day as they were at night (subadults: $\chi^2 = 0.49$, 1 df, $P > 0.25$; lone adults: $\chi^2 = 0.35$, 1 df, $P > 0.25$). Few family groups were detected, but the detections were equally frequent between day and night.

During the salmon season, subadult grizzly bears were most active during the day ($\chi^2 = 5.58$, 1 df, $P < 0.025$), while lone adults and family groups were equally active during the day and night (lone adults: $\chi^2 = 3.54$, 1 df, $P > 0.05$, family groups: $\chi^2 = 0.56$, 1 df, $P > 0.25$).

All Study Areas

We assumed that detections at cameras were independent events. We assumed this because at least 24 hours separated photographs of the same bear and because we were conservative about including photographs of similar looking individuals in the same 24-hour period. We determined the percent of detections during camera sessions that were marked or distinct individuals. No known individual accounted for >3% of detections in the Nimpkish Valley, >9% of detections in the Khutzeymateen Valley or >6% on the upper Atnarko River; however, one subadult grizzly bear accounted for 13% of grizzly bear detections or 21% of subadult grizzly bear detections on the lower Atnarko River. This individual may have biased the temporal activity pattern attributed to all subadult grizzly bears on the lower Atnarko.

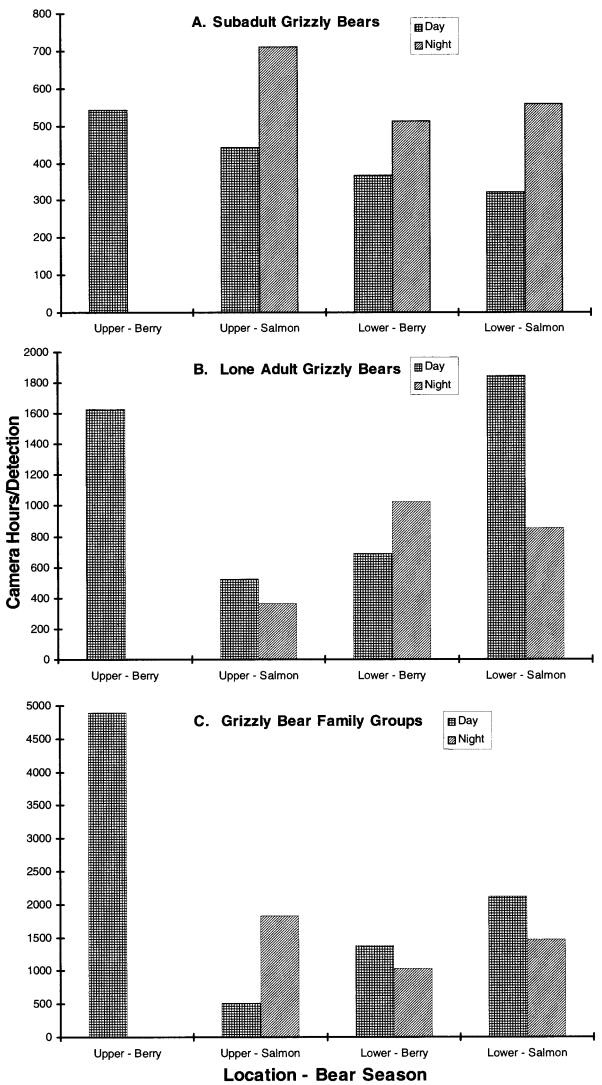

Fig. 6. Remote camera hours/detection of (A) subadult grizzly bears, (B) lone adult grizzly bears, and (C) grizzly bear family groups during the berry and salmon seasons on the lower and upper Atnarko River, B.C., Canada, 1993 and 1994.

DISCUSSION

Nimpkish Valley

Despite relatively high levels of human activity in both the no-hunting and hunting periods, black bears in the Nimpkish Valley were primarily active during the day. During the hunting season there was an influx of mule deer and bear hunters into the study area, which added to existing high levels of human activity. Hunting was mostly from roads; however, there was more movement

through areas where black bears were active than in the no-hunting period (e.g., clearcuts). The majority of hunting occurred in the early morning after sunrise (H. Davis unpubl. data). We expected black bears would alter their temporal activity and level of activity as a result of these changes in the level and type of human activity, but no change was detected.

Khutzeymateen Valley

Black bears had different temporal and spatial activity patterns than grizzly bears, apparently to avoid grizzly bears using the floodplain in the berry and salmon seasons. During a 3-year grizzly bear ecology study in the Khutzeymateen Valley, grizzly bears spent the majority of the berry and salmon seasons on the lower slopes and valley bottoms. Black bears were not radiocollared; however, it appeared that mainly lone adult male black bears used the lower slopes and valley bottoms (MacHutchon et al. 1993). While black bears were detected as frequently as grizzly bears at some fishing locations (e.g., cameras 4–6; Kateen River), detections occurred mostly during the night when fishing likely was more difficult. At a fishing area in a tributary of the Khutzeymateen River (cameras 7–9; Carm Creek), only 1 black bear was detected during camera operation and only 2 black bears were seen in this tributary during the 3-year study. Grizzly bears were frequently detected and observed in this tributary (MacHutchon et al. 1993).

Tweedsmuir

Radiotelemetry and field observations during a 3-year grizzly bear study in the Tweedsmuir area (S. Himmer and M. Gallagher unpubl. data) suggested that subadults, lone adults, and family groups had different activity patterns; therefore, we considered it important to try and distinguish between these age and sex groups. We were careful about categorizing grizzly bears as subadults, lone adults, or family groups in the Tweedsmuir; however, we could have erred in categorizing individuals as subadults or lone adults. This potential error was equally likely at all times, locations, and bear seasons, so we do not believe it affected the relative differences.

Black bears were present in an area of relatively low human use and low grizzly bear activity on the upper Atnarko River. When grizzly bear numbers increased during the salmon season, black bears were not detected, yet they were frequently seen beside the nearby highway (S. Himmer unpubl. data). The increase in grizzly bear activity during the salmon season was primarily lone adults and family groups, and this may have caused black bears to leave the area.

Black bear detections on the lower Atnarko River almost doubled during the salmon season, but grizzly bear detections were relatively constant between seasons. The presence of humans may have provided black bears a degree of protection from grizzly bears (Mattson 1990). In addition, although the overall level of grizzly bear activity was constant between seasons, the level of activity declined for lone adult grizzly bears and grizzly bear family groups.

Lone adult grizzly bears and grizzly bear family groups may have increased their activity on the upper Atnarko River during the salmon season because of increasing human use of the lower river. There was no evidence to suggest that grizzly bear family groups spatially avoided lone adult grizzly bears on the upper Atnarko during this season, but grizzly bear family groups tended to be less active at night when lone adults were most active.

Human use along the lower Atnarko River during the berry season was fishing concentrated along the river edge. During this period, most radiocollared grizzly bears spent the majority of their time feeding on berries in the adjacent Talchako River Valley (S. Himmer and M. Gallagher unpubl. data). Detections at remote camera sites during late July and early August were thought to be the movement of grizzly bears from berry patches to the river to check on the availability of salmon. The tendency toward more night activity along the lower river compared to the upper river during this time may have been to avoid anglers.

The level of activity of subadult grizzly bears on the lower Atnarko River remained relatively constant between the berry and salmon seasons, and those present were more active in the day. In contrast, the level of activity of lone adult and family groups declined in the salmon season, and those present tended to be more active in the night.

Subadult grizzly bear activity tends to be less affected by humans because of their greater habituation to humans (Warner 1987, Aumiller and Matt 1994), and subadults have been shown to be disproportionately represented in areas near human activity or developments (Mattson et al 1987, Nadeau 1987, Mattson 1990). This has been attributed to reduced competition, reduced agonistic interactions with adults, and increased access to productive feeding sites (Mattson 1990). Field observations on the lower Atnarko River suggested that subadults were generally less wary of humans than adults were.

Females with young that were on the lower Atnarko River in 1994 moved elsewhere by mid-September, a period which coincided with the highest mushroom picking activity and the coho fishing season (S. Himmer and M. Gallagher unpubl. data). This pattern was not observed

in 1993, a year during which mushroom picking was considered poor and the fishing season was less active. Non-habituated adult grizzly bears have been found to avoid areas of human use elsewhere (Warner 1987, McLellan and Shackleton 1988, Mattson 1990, Reinhart and Mattson 1990, Olson and Gilbert 1994).

Comparison among Areas

Black bears seemed to alter their temporal and spatial activity patterns more in response to grizzly bears than to humans. In the absence of grizzly bears, but in an area with high human activity, black bears were active during the day. In contrast, in an area of high grizzly bear use but low human use, black bears either did not use the area or were active at night when grizzly bears were least active. Black bears active in an area with both grizzly bear use and human use appeared to avoid the areas of highest grizzly bear use by using areas of high human activity where grizzly bears may have been displaced.

In the relative absence of human activity, grizzly bears were active during the day. In response to human activity, grizzly bears appeared to alter their temporal and spatial activity patterns, although the magnitude and direction of these changes varied between age and sex classes as well as level of human activity.

LITERATURE CITED

AMSTRUP, S.C., AND J. BEECHAM. 1976. Activity patterns of radio-collared black bears in Idaho. J. Wildl. Manage. 40:340–348.

AUMILLER, L., AND C. MATT. 1994. Management of McNeil River State Game Sanctuary for viewing of brown bears. Int. Conf. Bear Res. and Manage. 9:51–61.

AYRES, L.A., L.S. CHOW, AND D.M. GRABER. 1986. Black bear activity patterns and human induced modifications in Sequoia National Park. Int. Conf. Bear Res. Manage. 6:151–154.

BACON, E.S., AND G.M. BURGHARDT. 1976. Learning and color discrimination in the American black bear. Int. Conf. Bear Res. and Manage. 3:27–36.

CLEVENGER, A.P., F.J. PURROY, AND M.R. PELTON. 1990. Movement and activity patterns of a European brown bear in the Cantabrian Mountains, Spain. Int. Conf. Bear Res. and Manage. 8:205–211.

GARSHELIS, D.L., AND M.R. PELTON. 1980. Activity of black bears in the Great Smoky Mountains National Park. J. Mammal. 61:8–19.

GUNTHER, K.A. 1990. Visitor impact on grizzly bear activity in Pelican Valley, Yellowstone National Park. Int. Conf. Bear Res. and Manage. 8:73–78.

HECHTEL, J.L. 1985. Activity and food habits of barren ground grizzly bears in Arctic Alaska. M.S. Thesis, Univ. Montana, Missoula. 74pp.

LARIVIÈRE, S., J. HUOT, AND C. SAMSON. 1994. Daily activity patterns of female black bears in a northern mixed-forest environment. J. Mammal. 75:613–620.

LEFRANC, M.N., JR., M.B. MOSS, K.A. PATNODE, AND W.C. SUGG III, EDITORS. 1987. Grizzly bear compendium. Interagency Grizzly Bear Comm., Bozeman, Mont. 540pp.

LINDZEY, F.G., AND C.E. MESLOW. 1977. Home range and habitat use by black bears in southwestern Washington. J. Wildl. Manage. 41:413–425.

MACE, R.D., T.L. MANLEY, AND K.E. AUNE. 1994. Estimating grizzly bear population size using camera resightings. Wildl. Soc. Bull. 22:74–83.

MACHUTCHON, A.G., S. HIMMER, AND C.A. BRYDEN. 1993. Khutzeymateen Valley grizzly bear study final report. B.C. Minist. Environ., Lands and Parks, Wildl. Rep. No. R-25, B.C. Minist. For., Wildl. Hab. Res. Rep. No. WHR-31, Victoria, Can. 105pp.

MATTSON, D.J. 1990. Human impacts on bear habitat use. Int. Conf. Bear Res. and Manage. 8:33–56.

———, R.R. KNIGHT, AND B.M. BLANCHARD. 1987. The effects of developments and primary roads on grizzly bear habitat use in Yellowstone National Park, Wyoming. Int. Conf. Bear Res. and Manage. 7:259–273.

MCCANN, R.K. 1991. Activity measures of free-ranging grizzly bears (*Ursus arctos*) in the Flathead drainage. M.S. Thesis, Univ. B.C., Vancouver, Can. 116pp.

MCLELLAN, B.N., AND D.M. SHACKLETON. 1988. Grizzly bears and resource extraction industries: effects of roads on behaviour, habitat use and demography. J. Appl. Ecol. 25:451–460.

NADEAU, S.M. 1987. Habitats, trails and campground situations associated with grizzly–human confrontations in Glacier National Park, Montana. M.S. Thesis, Univ. Montana, Missoula. 98pp.

OLSON, T.L., AND, B.K. GILBERT. 1994. Variable impacts of people on brown bear use of an Alaskan river. Int. Conf. Bear Res. and Manage. 9:97–106.

REINHART, D.P., AND D.J. MATTSON. 1990. Bear use of cutthroat trout spawning streams in Yellowstone National Park. Int. Conf. Bear Res. and Manage. 8:343–350.

ROTH, H.U., AND D. HUBER. 1986. Diel activity of brown bears in Plitvice Lakes National Park, Yugoslavia. Int. Conf. Bear Res. and Manage. 6:177–181.

STEMLOCK J.J., AND F.C. DEAN. 1986. Brown bear activity and habitat use, Denali National Park—1980. Int. Conf. Bear Res. and Manage. 6:155–167.

WARNER, S. 1987. Visitor impact on brown bears, Admiralty Island, Alaska. Int. Conf. Bear Res. and Manage. 7:377–382.

ZAR, J.H. 1984. Biostatistical analysis. Second ed. Prentice-Hall, Inc., Englewood Cliffs, N.J. 718pp.