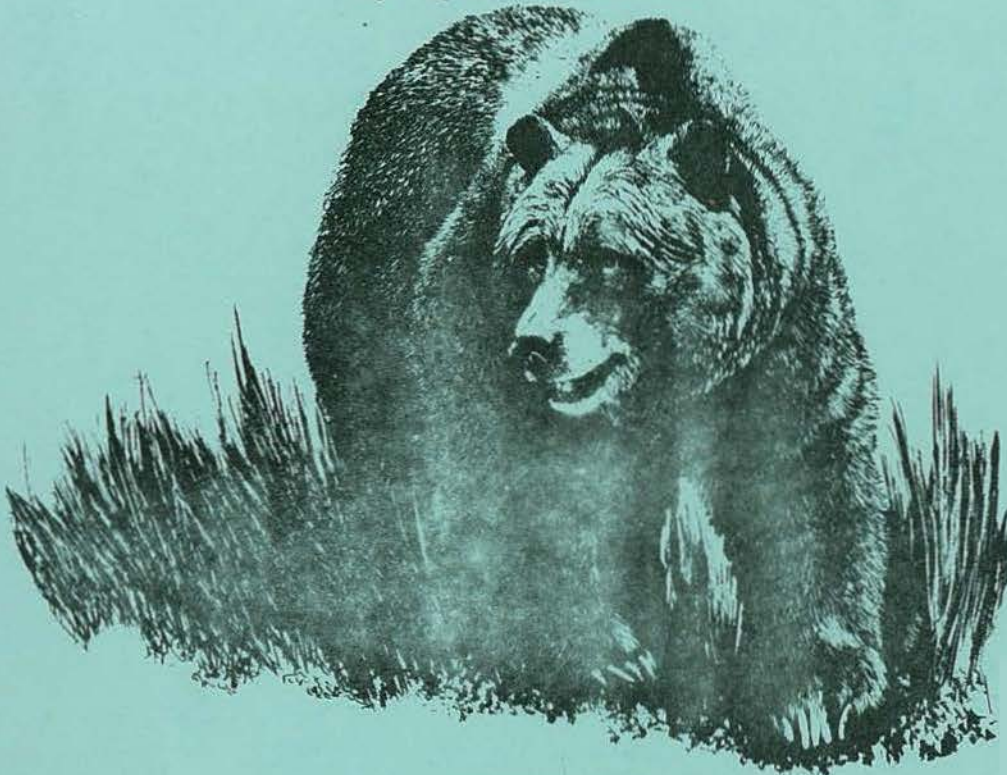


ALASKA DEPARTMENT OF FISH AND GAME
JUNEAU, ALASKA

GROUND TRACKING OF ARCTIC GRIZZLY BEARS

By Spencer Linderman



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Final Report
Federal Aid in Wildlife Restoration
Project W-17-6, Job 4.12R

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FINAL REPORT (RESEARCH)

State: Alaska

Cooperators: Spencer Linderman, Harry Reynolds and Renewable Resources Consulting Services, Ltd.

Project No: W-17-6 Project Title: Big Game Investigations

Job No: 4.12R Job Title: Ground Tracking of Arctic Grizzly Bears

Period Covered: July 1, 1973 to June 30, 1974

SUMMARY

A mature male grizzly bear was immobilized May 10, 1973, fitted with a radio transmitter collar and followed from the ground and from aircraft until June 18. Visual contact with the bear was maintained, whenever possible, at distances of 0.5 to 1.0 miles. The radio collar seemed to be a minor but constant irritation.

Aircraft did not usually produce a strong response by the bear unless they passed within about 500 feet. Observations of feeding indicated the bear ate mostly grasses, sedges and overwintered berries. The bear also ate remains of caribou killed by wolves. Analysis of activity patterns showed that feeding was the predominant activity for morning-midday, while resting and traveling predominated for evening-night. During the period of observation the marked bear ranged over a 27-mile length of the Canning River and a 4-mile section of a major tributary. Breeding behavior was observed and described. Ground tracking, with the aid of a radio transmitter, is considered technically feasible, but demanding.

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BACKGROUND

In April 1972 a two-year study (originally under Job 4.0 S&I) of Arctic grizzlies (*Ursus arctos*) was initiated in the Canning River drainage of the eastern Brooks Range conducted jointly with Renewable Resources Consulting Services, Ltd. This firm was conducting ecological surveys for the Arctic Natural Gas pipeline consortium.

The study was divided into two parts: 1) a widespread effort to capture and mark every bear in the drainage to determine movement patterns by aerial resightings and 2) 24-hour ground tracking of a single individual. This is a report on the second objective.

OBJECTIVES

Twenty-four hour per day visual ground tracking of a single adult male grizzly bear from spring emergence to fall denning to determine:

1. Daily and seasonal movements,
2. Diurnal and seasonal activity patterns,
3. Food habits,
4. Seasonal use of plant communities,
5. Behavioral reactions to human disturbances, especially aircraft, and
6. Denning behavior.

These objectives were only partially attained because of early termination of this part of the study in mid-June.

PROCEDURES

A 14.5-year-old, 350-pound, male grizzly, named Z.B., was drugged and captured on May 10, 1973 in the upper Canning River, Brooks Range, from a FH-1100 helicopter using Palmer Cap-Chur equipment and sernylan at 0.75 mg per pound body weight. He was fitted with a 2 1/4-pound radio transmitting collar of 1 1/4-inch flexible vinyl tubing, with a battery pack and transmitter located underneath his chin. Alternating red and yellow Saflag streamers, 2 x 6 inches, were attached to the top of the collar, behind the head, as an aid in maintaining visual contact, and to avoid having the bear chased and recaptured again by the tagging crew, which continued to work in the study area.

On May 14, a two-man crew began maintaining visual contact with the bear 24 hours per day. Seven days tracking, two days off and seven days tracking was the schedule attempted. Long Arctic days permitted the 24-hour visual contact.

No attempt was made to get closer than 1/2 mile from Z.B. and distances usually ranged from 1/2 to 1 mile. Observations were made through binoculars and a 20-45x variable spotting scope. The two people worked in shifts, maintaining watch when the bear was sleeping as well as when awake. The tracking and observations were intended to be entirely by sight as much as possible. A radio was only used as an aid when Z.B. could not be seen during snowstorms, heavy ground fog, rain or when he was in dense willow thickets.

Lightweight backpacking gear permitted the observation camps to be moved on short notice as Z.B.'s movements dictated. All camps and observation points were placed high on mountainsides to reduce the chance of variable winds carrying our scent to Z.B. and unnaturally affecting movements. No wood fires were built.

Two antennas were used in tracking. A high gain, straight wire, dipole attached from tail wheel to wing strut of the aircraft was used to pick up the radio signal when relocating Z.B. after the two-day rest periods. A 12-inch, hand-held loop antenna provided greater directional and close range sensitivity once the general area was located, and was the only antenna carried for ground tracking. The dipole had approximately 10-15 miles range and the loop was useful to 2-3 miles.

A small HF band "handy talky" radio and antenna were carried to report changes of location. Detailed field notes were recorded throughout the effort. During periods of substantial activity one person often recorded while the other observed. Remains of kills upon which Z.B. fed were examined to determine species, sex and age of the animals. Feces and vacated grazing areas were also examined to supplement feeding observations. Daily movements were plotted on one inch: a mile maps.

RESULTS

Behavioral Effects of Collar and Trackers

Efforts to reduce disturbance of Z.B. by our presence were apparently successful. Only once did our presence visibly affect him and that was

when the helicopter inadvertently set us down too near him on a mountainside after attempts to pinpoint his location by radio had failed. Variable mountain wind currents carried our scent to him and he hastily departed over the snowfields on top of the mountains.

The relatively light 2 1/4-pound radio collar caused no damage to Z.B. Upon its removal June 17, after a malfunction, not only were there no skin abrasions or lesions, but the neck hair under the collar was not rubbed, broken or even matted. Presence of the collar precipitated visible reaction, however, especially in the first week after collaring. Z.B. would stop to shake his head and shoulders momentarily several times per hour when he was active. This behavior appeared to decrease somewhat with time.

Z.B. also rubbed his neck against the tall riparian willow bushes and even on the ground and rocks, though these were rare occasions. It was obvious that not all these reactions were precipitated by the collar alone since he frequently rubbed and scratched the rest of his body, especially the back, and sometimes the neck area was excluded altogether.

A dextrous maneuver seen on several occasions was Z.B.'s ability to stand with his back to a clump of willows, reach above his head with a foreleg, bend a branch down across his neck and shoulder, and rub his neck against the branch held in that manner. This action seemed specifically aimed at the neck-collar area. Z.B. was also eating willow buds occasionally during this period and, at first, we thought he was merely stabilizing himself in an upright position with his back against the bushes while reaching up and pulling down the ends of branches for their buds. Although he did eat willow buds, further observations showed that he was specifically scratching himself at least some of the times.

Another apparent method of scratching was walking directly over a tall, but limber willow stem so that it bent horizontally and scratched the belly from front to rear as Z.B. walked over. In passing willows, Z.B. would also lift his chin up and to the side, catch a branch under his chin, then lower his head to trap the branch and "strip" it under his chin and neck as he continued to walk. Although this behavior could have been associated with examining the ends of branches for buds, it appeared primarily used for rubbing on the head and neck.

These various activities were not associated strictly with the presence of the collar, for during the short time Z.B. was under observation without a collar, he rubbed his chin and side of his face against willows and purposely sidestepped over willows so he could walk over them bending them beneath him fore and aft to rub on them.

In summary, we do not believe the collar was a major irritant and that it did not significantly affect behavior. It was apparently a rather constant minor irritation, however.

Aircraft and Bear

Five helicopter and six fixed-wing aircraft flights were recorded with simultaneous observations of Z.B. No aircraft flights occurred

when other bears were under observation. In general, even helicopters had to be quite close, approximately 400 to 500 feet or less, to elicit a strong response (e.g. running) on a single low pass. Sometimes even these distances were not sufficient as one of the examples in Appendix I illustrates. At distances of greater than 500 feet to approximately 1/4 mile, repeated passes appeared to be necessary to elicit a strong response even though one may assume there must have been some degree of negative pre-conditioning during the initial capture and processing of Z.B.

Z.B.'s generally mild behavior in response to aircraft may have been atypical, especially when considering that most observations of bears made on surveys are those of bears fleeing from the aircraft and often at distances considerably greater than 500 feet away. However, it is unknown how many more bears may have escaped detection by reacting in a possibly more normal and less violent manner than those that are seen. During the course of this study unmarked bears often appeared, and one could speculate that some or all of these may have been "residents" which were finally seen rather than new immigrants to the study area, random searching by aircraft continued throughout the study. Thus, we do not know if the responses of Z.B. to aircraft were normal.

Hiding from aircraft was a common behavior and a significant problem in relocating radioed grizzlies in a ten-year Canadian Wildlife Service study of Interior grizzlies (A. Pearson, CWS, pers. comm.). One possible example of hiding was seen with Z.B.

It seems to me that hiding may result from the cumulative effects of aerial harassment, as in the Canadian study or in heavily hunted populations. If Z.B.'s behavior is "normal" for the population studied, however, hiding would not be a problem in attempting to locate bears aerially.

In fact, the other extreme seemed to pose almost as great a problem. That is, Z.B. usually barely moved at all even with close approaches by aircraft. Because of his superb protective coloration Z.B. was rarely seen by the low level aircraft that were searching for bears, even though he was lying on open tundra in plain view more often than not. Z.B. often merely raised his head as aircraft flew past or over, and in only two of six flights by aircraft in which the aircraft observers were close enough to readily detect Z.B. was he actually seen. Appendix I contains examples of Z.B.'s typical reactions to aircraft.

Feeding and food habits

Observations of feeding activities and examination of feces and vacated feeding spots produced a general picture of food habits between early May and June.

Moose (*Alces alces*) and caribou (*Rangifer tarandus*) carrion appeared to be quite important during spring and is probably more important than during summer. Food sources are limited when bears emerge in late April. Snow cover then is nearly total except for windblown areas. Numerous bears were found on moose carcasses in late April to late May during aerial surveys.

In mid to late May snow began melting in patches on river bars of major valleys, exposing overwintered Alpine bearberries (*Arctostaphylos alpina*) which were heavily utilized along with some roots. Dry grass was also found in large amounts in one of the few fecal samples collected in mid-May. Caribou were migrating through the Canning River drainage at this time and, although Z.B. never killed an animal himself during the time observed, he appropriated two caribou killed by the same single wolf (*Canis lupus*) between May 14-20.

Both kills were made in relatively open spaces. There appeared to be some unwillingness by Z.B. to devour them in the open, however. Rather, Z.B. dragged the entire carcass, in one case, and parts in another, into brush. He did eat and sleep on parts of one carcass in the open, however. Z.B. remained attracted to the first carcass 32 hours and to the second 19 hours.

Alpine bearberries continued to be used when available through late May, but usage of *Hedysarum* sp. roots increased. This was perhaps due to increased areas of bare ground, but also melting ground surfaces made digging easier. It may be nearly impossible to extract *Hedysarum* sp. roots from frozen ground in any number judging from the structure of the roots.

Z.B. occasionally consumed newly emerged buds of *Salix* sp. by clumsily balancing on his hind legs and using his paws and mouth to feed on the ends of small twigs. Sometimes he assumed a more stable position by sitting under a large willow bush with his back against the "trunk," reaching up to the overhanging umbrella of branches and drawing them down with his paws. This position also permitted him the advantage of being able to scratch his back in between bites. Willow appeared to be a relatively unimportant source of food.

Green vegetation began appearing in early June and comprised almost the total diet by mid-June. *Equisetum* sp. was heavily used and continued to be used throughout the summer (Reynolds, pers. comm.). Green grasses (and perhaps some sedges), apparently poorly digested, formed 100 percent of fecal samples collected from Z.B. in mid-June at the time he was recaptured. Reynolds (pers. comm.) said soapberries (*Shepherdia canadensis*) were used very heavily in late summer.

The abundant green forage emerging in June appears to substantially reduce the need for scavenging or predation. It is possible this could be the primary reason sows with cubs generally emerge later than boars. They may find it prohibitively difficult to find enough kills and/or carrion in this period, or to compete with boars for the available food before substantial snow melt occurs. Black bear (*Ursus americanus*) studies in which it was found that black bears continued to lose weight for two or three months after emergence lend some support to this hypothesis (Poelker and Hartwell 1973).

Resting

Z.B. was generally not secretive in his choice of resting spots. He seemed to prefer drier areas out of the river or creek bottom itself

and sometimes scraped a few pawful of substrate away before lying down. About half the time he could be found lying on the open tundra on the bank just above the river, creek or gully where he foraged. He sometimes rested in willow thickets on river bars but as much or more often he laid down in completely open areas. The brown hair of various shades was excellent camouflage and blended perfectly with the brown tundra of early summer.

There apparently was some tendency to rest in thickets in bad weather and more open places in good weather, but this was slight. He also seemed to pick areas exposed to the sun or at least definitely did not seek out shade at this time of year.

On three different occasions Z.B. climbed a little way up the lower mountain slopes, scooped out a shallow hole in talus slopes and lay down, and once he scooped out a hole in a snowdrift before lying down.

While on the caribou kills Z.B. either slept belly down, draped over the carcass, or in the shallow depression formed by scooping snow over the carcass when he was finished eating. Infrequently he rested 10 or 15 feet away for short periods.

Z.B. almost always rested directly after eating and did not engage in long travels until rested. He appeared to be a restless sleeper, however, and never remained in the same position for long. Periods of very deep sleep appeared short or nonexistent. Increasing frequency of changes of position and restlessness seemed to characterize behavior late in the rest period.

Traveling

Traveling was defined in a strict sense of movement only, with no associated feeding. Most often Z.B. walked and fed, stopping here and there, or intensively used one area with very little movement as in digging roots or feeding on carrion. The distinction of a separate "traveling" class of behavior appeared to be real, however. Z.B. sometimes simply began moving with no apparent interest in feeding or any other activity.

Excluding several short travels to and away from carrion while Z.B. remained on or near them, traveling generally appeared to occur after feeding, and from very scanty data, seemed generally to be followed by a rest period. His travels often lasted for several hours, and obstacles such as deep, rotten snow, thin ice and open creeks did not slow him, much less divert or stop his march. Measured rate of travel was about 3-4 m.p.h. Traveling seemed to occur most frequently during the twilight hours between 9 p.m. and 4 a.m.

Breeding Behavior

One detailed observation of breeding behavior was recorded on June 17-18. After approximately two hours of searching for Z.B. with a helicopter on June 16, Z.B. was sighted in a broad, low tributary valley of the Canning River in the company of a 4.5-year-old collared female.

The female, W.B., ran off, crossed the South Fork of the Canning River and ran up the other side while we tranquilized Z.B. and fitted a new radio. The helicopter departed and we began our observation again at 0400 on June 17.

At 1035 we saw the female alternately running and walking upstream in the area of Z.B.'s tagging. She continued gradually upstream, stopping frequently to raise her head and smell the wind. Z.B. was slightly downstream of her and sleeping, not yet completely free of the effects of the drug although he had been up and moving some. At 1053 the female stood oriented downstream for one full minute, then lay down in the sun next to the creek among very sparse willows. She continued to raise her head and smell the wind frequently, perhaps for our lingering scent from the tagging spot, or for Z.B.

At 1457 a large, dark 19.5-year-old boar named S.B. appeared at the tagging area next to the creek, smelled the trampled ground, then rubbed his neck and collar on the tundra for 10 seconds. He then headed diagonally upstream toward the creek, apparently following the female's trail. S.B. reached the creek, crossed to the middle, lay down in the water for 30 seconds (it was a warm, sunny day), then headed upstream to where the female had been lying. Meanwhile, she had moved further upstream. S.B. was evidently following her scent and traveled upstream at a fast walk, stopping only infrequently to look about. At 1541 S.B. was a mile upstream of where he was first observed, and the female was only a hundred yards ahead, then she started to run upstream ahead of S.B. In general, there ensued a walking "chase" in which the female kept 3 to 15 yards ahead of S.B., sometimes stopping to wait for him to catch up, and sometimes turning to face him until he came near. The detailed description of this behavior is provided in Appendix II. This interaction, beginning at 1541, did not end until 38 minutes later at the end of the 17-minute copulation period. A limited amount of "display" occurred after this, but mostly the two bears fed and rested together for the next 6-3/4 hours (until 2305) when they began a slow upstream movement while feeding, led by S.B.

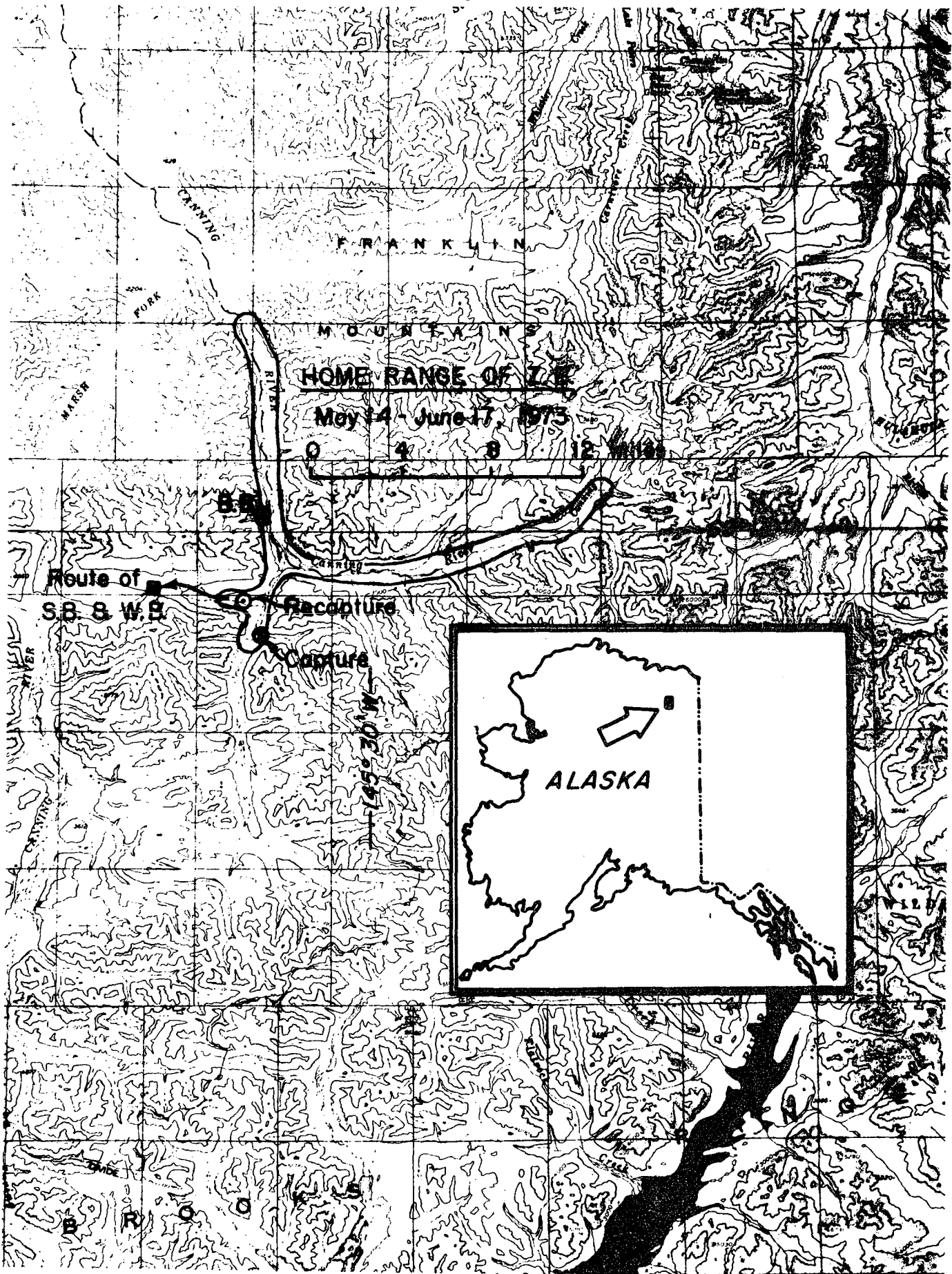
At 2350 the female left S.B., crossed the creek and began digging on a hillside. She soon discovered S.B. was 1/2 mile upstream from her and still moving whereupon she began rapidly walking in that direction, apparently following by smell the same path taken by S.B. S.B. disappeared over the top of the pass at the head of the valley at 0030 June 18 with the female five minutes behind and alternately running and walking to catch up. The location and direction of movement are shown in Fig. 1.

Z.B., considerably downstream of the preceding action, slept through most of it, probably still slightly under the influence of the drug. This observation occurred 4 miles from the 4.5-year-old female's place of capture 16 days earlier, 6 miles from the 14.5-year-old Z.B.'s place of capture 38 days earlier and 38 miles from 19.5-year-old S.B.'s place of capture 37 days earlier.

Interactions with other animals

Z.B. had the opportunity to interact with caribou, moose, ravens (*Corvus corax*), a wolf, an eagle and other bears. All of the close

Fig. 1. Home range of grizzly bear "Z.B.", May 14-June 17, 1973.
S.B., W.B. and B.B. = other grizzlies found in the area.



interspecific interactions we observed centered around the two caribou kills, however.

Although other grizzlies in the study were commonly found on moose carcasses early in the spring, Z.B. appeared to peacefully co-exist with the 8-12 moose inhabiting the high willows of the 10-mile length of the upper Canning which was his most frequented section of range. Several times we saw Z.B. enter dense, isolated willow bars which also contained one to three moose, including cows and calves, and a short while later exit the other end of the bar. Sometimes we could see that the moose appeared aware of Z.B.'s presence and would slowly move through the willows themselves, but there were never any violent reactions or attempts to escape such close proximity to the bear.

Small bands of caribou migrated down the Canning River in late May and moved past Z.B., from 25-200 yards away. Z.B. never seemed to be in sight of the caribou, however, and was either resting at these times or feeding in the willows. He may have been aware of their presence, though, through smell.

On only one occasion did any interaction occur and that was inadvertent. After feeding on a caribou carcass, Z.B. trudged up the mountainside to a large snowbank at the foot of a talus slope, scooped out a hole and flopped into it in the hot, early afternoon. Two small groups of caribou passed down the valley while he slept. At 1900 hours, 19 caribou were 200 yards away and feeding slowly toward where Z.B. lay. One hundred yards away they encountered his fresh trail and showed no reaction at all. At 50 yards, one caribou lay down while the others fed even closer.

Z.B., always a somewhat restless sleeper, was sprawled on his back in the hole, quite invisible to the caribou and apparently unaware of them also. He stretched his hind legs in the air once which the caribou apparently did not notice, then he suddenly rolled over, waving all four feet in the air. The caribou closest (less than 50 yards) ran down the hill instantly, though Z.B. resumed sleeping, still not aware anything was around. The caribou did not run far but then continued down the hill, turned upstream and angled up the mountainside single file, and continued to criss-cross up and down the valley for the next 30 minutes, stopping once at one of Z.B.'s trails to smell, continuing on, then reversing direction again. Z.B. continued to sleep through this period.

Ravens seemed to be a considerable problem for Z.B. He zealously guarded his appropriated kills from the smallest infringement by ravens and in turn the ravens harassed him almost unmercifully. Z.B. often had to sleep on top of the kills to protect them from ravens, and even then they would attempt to sneak up behind him to grab a bite. Although the ravens were amazingly sly, we never once saw one get a single bite of caribou when Z.B. was on the kills. At the last moment, whether Z.B. was attempting to sleep, or awake and feeding, and regardless of the number of birds (up to 10) he had to watch, Z.B. would swing his head around in time or swat at them with a paw. However, Z.B. never struck one of them, though the raucous cries of fighting and escaping birds resounded across the valley for hours. In the end, the ravens would give up tormenting Z.B. and he would finally be able to rest.

We discovered the first caribou kill when we spotted a single grey wolf feeding on the carcass of a pregnant female two miles downstream of our position at 1420 on May 17. The wolf fed briefly then departed downstream. A golden eagle (*Aquila chrysaetos*) which had been sitting on the snow 200 yards away then came in to the kill and began feeding. When Z.B. arrived at the kill almost two hours later, the eagle reluctantly gave way to him and was never seen again on the kill, even when Z.B. was away from it. The wolf was not seen to return either while Z.B. was on the kill, although he inspected the kill site at night on May 19 after Z.B. had left.

At 0040 May 19, Z.B. finished with the carcass and walked away, obviously smelling the air, and even rose up on his hind legs once to smell. Walking slowly downstream he came upon a very fresh yearling caribou carcass less than 1/2 mile from the first carcass. Picking up a big piece of rib cage and front legs in his mouth he carried it off the gravel bar, across the creek and upstream 50 yards where he lay down with it in the willows and began eating.

At 0400 Z.B. was sleeping next to the major portion of the carcass he had dragged off into the bushes when a single grey wolf appeared 15 feet away. Z.B. sat up and faced him as the wolf circled half way around the bear and carcass then walked away, crossed the creek and fed on the sparse remains of the carcass remaining at the original kill site. Z.B. lay back down close to the carcass. The wolf fed only a few minutes, then departed downstream. Probably there was almost nothing left to feed upon. We suspected this was the same single grey wolf seen on the first carcass and was probably the predator which killed them.

At 1732 the same day, we spotted a single grey wolf 1-1/2 miles away, moving rapidly upstream. At 1750 the wolf arrived at the major part of the carcass again and Z.B. was again resting beside it. Upon the wolf's arrival, Z.B. immediately stood up on all four feet facing the wolf. In only a few seconds, the wolf trotted away. Z.B. remained standing two minutes then curled up next to the carcass again.

In another minute though, Z.B. was up again, walked to the edge of the creek, sniffing and looking in the direction the wolf had gone, crossed the creek to the kill site, sniffed around looking in the direction the wolf had gone, then walked 15 feet in that direction. Then he stopped, returned to the kill site, pawed through the remains for 20 seconds and returned to the piece of carcass in the bushes.

Z.B. sat down and began eating on the carcass for the next 25 minutes, then lay down and slept for 20 minutes before arising, returning to the kill site to poke around a few minutes and permanently abandoning the second caribou kill.

Meanwhile, the wolf arrived 1/2 mile upstream at the first caribou carcass, sniffed around for a minute, then walked off 50 yards and lay down on the snow. Two hours after Z.B. permanently left the second kill, the wolf returned to the site, found the bear gone and lay down and began chewing on the remains at 2100 hours. We never again saw the wolf or again saw Z.B. eating carrion. It appeared that bear-wolf

encounters were common to these two individuals and no time was wasted in sparring or contesting the carcass. The meetings lasted only a few seconds and neither animal appeared excited or alarmed.

The only contact with another grizzly, besides the breeding observations described elsewhere, occurred on May 25 when we discovered a blond bear, probably a female, 1/2 mile from our camp. Her location is shown as "B.B." on Figs. 1 and 3. Detailed observations could not be made because we had to vacate our camp just before the bears met. Z.B. was on a collision course with our location and we had to climb higher on the mountain. We did watch the blond bear, standing 30 yards uphill from the tracks Z.B. made as he passed her, and for the next 20 minutes she continually sniffed the air every few feet as she very slowly traveled in the direction of the tracks. The two bears may have had a short encounter in the stream bed below us, but Z.B. was soon seen two miles upstream, feeding on overwintered berries while we continued to watch the blond bear digging roots. I suspect no more contact occurred than close range sighting and smelling of each other, which was interesting in view of the probable sex of the bear and the date of meeting in relation to the breeding season.

Movements

Z.B.'s movements appeared to be controlled almost exclusively by food availability. During May, Z.B. was found solely on the river bars of the main Canning River. Rarely did we see him on the banks more than 50 feet above the river during this early period. Not surprisingly, snow first melted off the floor of the main river valley, uncovering overwintered *Arctostaphylos alpina* berries and providing patches of bare earth that were dug up for roots. Not until green grasses appeared in mid-June did Z.B. occupy side tributaries or did his movements begin to broaden away from the main Canning River valley.

Z.B.'s home range, determined from all known positions between tagging on May 10 until ground tracking ceased on June 18, was a 27 mile length of the Canning River from its headwaters nearly to the Marsh Fork junction plus a four mile section of a major tributary of the Canning (Fig. 1). By June 17, the broad, low valley indicated was snow free and lush with grass along its creek. This movement to higher elevations and a side tributary coincided with a general "disappearance" of bears in the main valleys as reported by the rest of the study team who were still attempting to locate and tag bears.

Daily movements varied from zero, when Z.B. was on a kill, to 16 miles during a 10-hour period (Figs. 2 and 3). Daily movements averaged about six to eight miles per day, however, when Z.B. was not on a kill. In general, Z.B. repeatedly traveled up and down a limited section of the Canning during our observation period.

Activity Patterns

Despite the limited number of days of observation, some patterns of activity did emerge among the three general types of behavior --feeding, resting or traveling. For all days of 24 hour observations combined, Z.B. spent 31 percent of his time feeding, 59 percent resting and 10 percent traveling.

Fig. 2. Daily movements of grizzly bear "Z.B.", May 14-20, 1973.

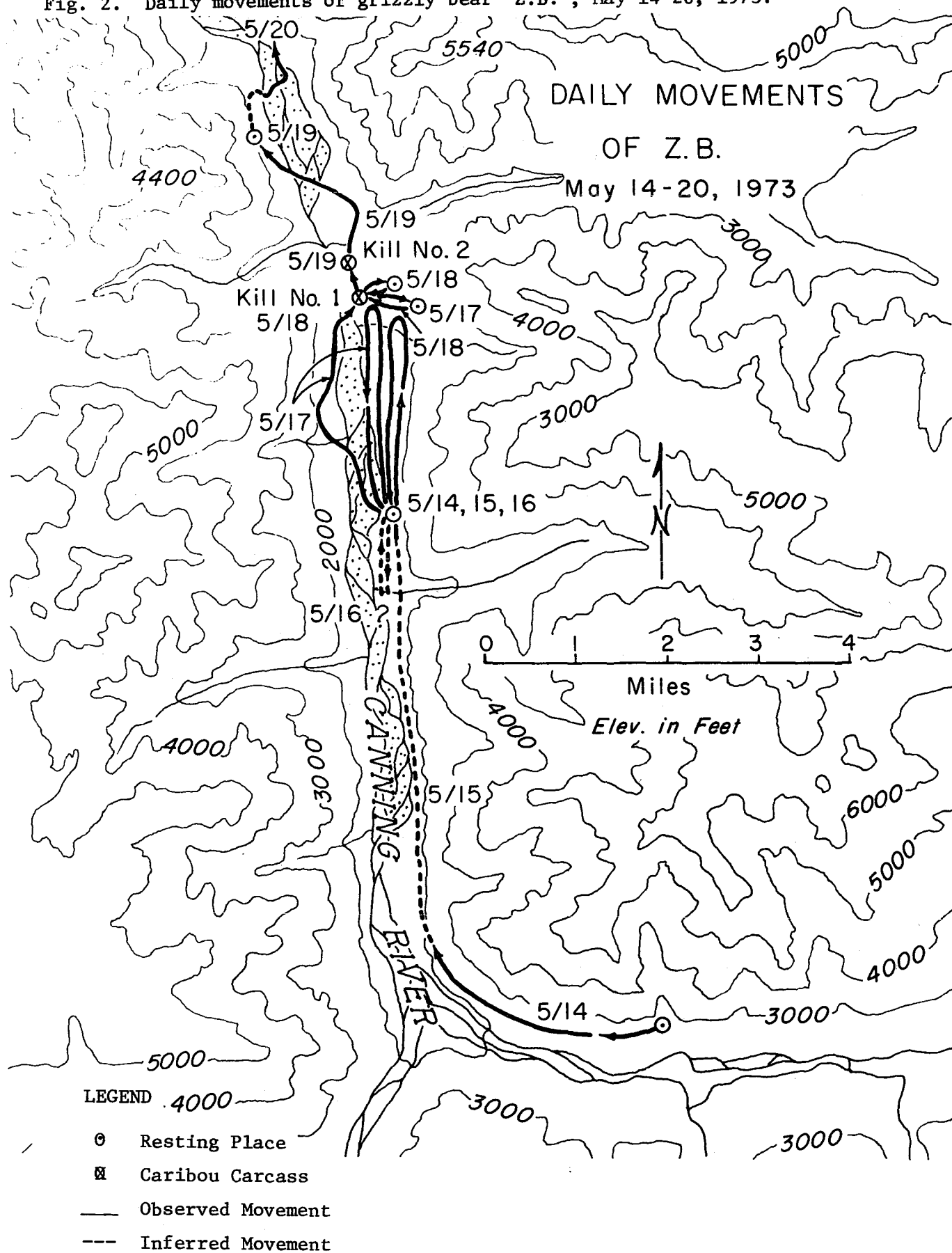
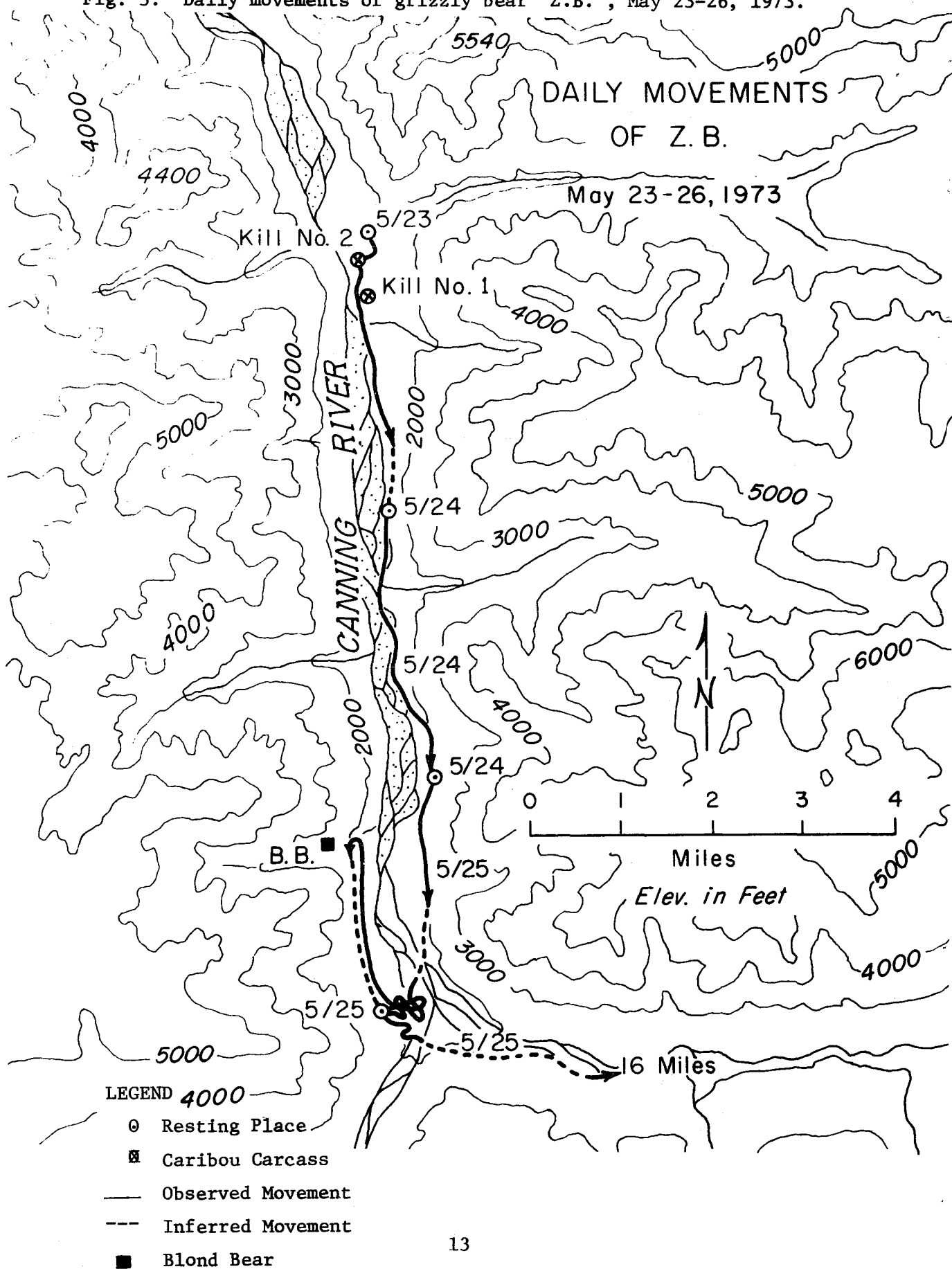


Fig. 3. Daily movements of grizzly bear "Z.B.", May 23-26, 1973.



When individual days were divided into six hour segments, however, it was obvious that the different activities were not uniformly distributed throughout the day. Table 1 shows the percent of Z.B.'s time devoted to each activity during different quarters of the day. The 24-hour day was divided into quarters at those points which appeared to maximize variation between quarters.

Table 1. Percent activity by six hour periods for all observations combined.

Activity	Time			
	Morning 0330-0930	Midday 0930-1530	Evening 1530-2130	Night 2130-0330
Feeding	42	40	29	16
Resting	54	57	60	64
Traveling	4	3	11	20

"T" tests were used to determine if differences existed in the mean time spent for any given activity among the different quarters of the day. Table 2 gives the means and Table 3 shows the results of the "t" tests which were significantly different at 95 percent and 99 percent levels of confidence.

Table 2. Mean number of hours spent feeding, resting, or traveling per quarter of the day.¹

	<u>Feeding</u>	<u>Resting</u>	<u>Traveling</u>
Morning (0330-0930)	3.3	3.7	.2
Midday (0930-1530)	2.7	4.0	.2
Evening (1530-2130)	2.3	4.8	1.0
Night (2130-0330)	1.5	5.3	1.3

1 Total hours per quarter do not equal 6 hours because of sampling method error.

Table 3. "T"-test results for differences in mean time spent for a given activity versus quarter of the day. X = Significant difference.

	<u>Level of Significance</u>	
	95%	99%
<u>Feeding</u>		
morning vs. evening	X	
morning vs. night		X
<u>Resting</u>		
morning vs. evening		X
morning vs. night		X
midday vs. night	X	

Table 3. Cont.

Traveling

morning vs. night	X
midday vs. night	X

From these tables, one can determine that Z.B. fed more in the morning than either evening or night. Conversely, he rested more in the evening or night than in the morning (and also rested more at night than in the midday), and that he traveled more at night than either morning or midday.

When the 24 hour day was divided in half, at the points which maximized the variation in time spent feeding, the day was divided at 0330 and 1530 into the two parts. Maximizing the variation for time spent resting produced a day divided at exactly the same points as feeding. Interestingly, the traveling activity pattern produced the same results, and if the 24-hour day was divided into a 0330 to 1530 "morning-midday" period and a 1530 to 0330 "evening-night" period, variation in time spent for each of the three activities was maximized. Feeding was the predominant activity for morning-midday and resting and traveling for evening-night. These differences were all significant at the 99 percent level (Table 4).

Table 4. Mean number of hours spent feeding, resting, or traveling per 1/2 day.¹

	<u>Feeding</u>	<u>Resting</u>	<u>Traveling</u>
morning-midday (0330 to 1530)	3.0	3.8	0.2
evening-night (1530 to 0330)		1.9	5.1
			1.2

¹ Total hours per half day do not equal 12 hours because of sampling method error.

Since an average of only 15 percent of Z.B.'s time during evening-night was spent traveling, I do not believe this accounts for the popular notion that bears are more easily observed from the air at night than in the day. From our observations Z.B. should have been approximately as visible during feeding as during traveling. There must be other factors operating, or the limited amount of data on this one bear do not reflect the usual patterns. Activity patterns could also change through summer and fall. Especially, there were indications that the high temperatures of summer midday might reduce activity. We observed two instances in which bears laid down in a water pool or stream on hot middays for a few seconds, apparently to cool off. I believe early June was too early to notice a regular midday reduction of activity due to heat. Temperatures were beginning to get hot, however, especially in direct sunlight where temperatures greater than 90-100°F could be experienced. Snow and rain appeared to not affect normal activity patterns, but data were limited.

General Comments

Visual ground tracking of grizzly bears in the Arctic is difficult, though definitely feasible. We found that a two-man team was necessary to provide 24-hour monitoring. Radio collaring assistance was still necessary, however, because visual contact was too frequently lost during snowstorms, rain, ground fog and when Z.B. occasionally entered large areas of dense willows. Loss of contact in willows was generally not a problem in the spring, however, because patches tended to be small and we could see into them from our elevated camp sites. Leafing out of the willows in summer would definitely reduce visibility and could reduce the amount and completeness of data collected, depending on the bears' habits at that time. As already indicated, the trend of dispersal from the valley floors of major drainages in early summer to higher elevations in side tributaries where fewer willows exist, may mitigate the adverse effects of leafing vegetation. High water and rotten snow during spring breakup were other serious problems affecting our ability to maintain visual contact with Z.B.

By essentially living half way up the mountain sides while Z.B. occupied the valley floor, we were very successful in preventing our presence from affecting Z.B.'s movements and behavior.

One of the shortcomings of the 32MHz frequency radio collar used on Z.B. was that the frequency seemed susceptible to being reflected by the terrain features. Tests conducted from time to time while in visual contact with Z.B. showed that the bearing obtained did not always point directly to Z.B. No common source of this error was obvious. This shortcoming was the factor directly responsible for the one time Z.B. became aware of our presence and fled. Since we could not pinpoint his location on that occasion we had to utilize a helicopter to relocate him. The helicopter dropped us too close to Z.B. and he smelled us.

This radio contact was also "line-of-sight" with its inherent limitations. If Z.B. rested his head between two tussocks on the bare tundra, the signal could be nulled. The radio generally fulfilled its purpose, however, of allowing us to relocate Z.B. after loss of visual contact, though its undesirable characteristics prevented us from making accurate plots of movements during snowstorms and heavy ground fog.

The radio failed after a few weeks because of its lightness of construction. It had not been designed for use on bears. Also, a web collar, rather than the more rigid vinyl tugging used may have been less irritating to the bear.

In summary, visual ground tracking of a grizzly bear on a 24 hour basis was a demanding, sometimes monotonous, and often difficult task. It is a feasible and highly effective technique, however, for gathering life history information. There is no other way to acquire the detailed information afforded by this approach.

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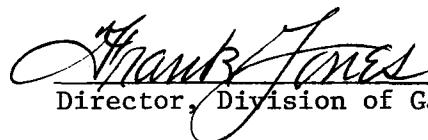
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Appendix I. Reactions to Aircraft.

May 14 at 1609 hours Z.B. was resting on the lower slopes of the mountains at one side of the main river valley. Sixty-five seconds after first hearing a Cessna 185 at 500 feet AGL, and when the aircraft was still one mile down river from the bear, Z.B. raised his head to stare out across the river and watch the plane pass by approximately 3/4 mile away. As soon as the plane was out of sight of the bear, Z.B. put his head down and resumed his resting position. The C-185 could be heard by us for more than three minutes total time. The aircraft continued up the valley then returned a few minutes later at 1000 feet AGL, flying parallel to the river on the same side as Z.B. and about 1/3 mile away. When the aircraft was 1/2 mile away, but just before coming into sight of the bear, Z.B. raised the front half of his body off the ground and remained in that position as the C-185 passed and until the plane was three miles away and well out of sight.

On May 18 at 1613 hours, Z.B. was resting after a big meal, in a scooped out snow drift at the base of the mountains along the river. An FH1100 helicopter at 500 feet AGL approached flying up the center of the river valley approximately 3/4 mile from Z.B., then turned to the opposite side of the valley and landed at our camp, one mile from Z.B. The helicopter could be heard by us for three minutes before arrival. During the whole episode of landing, shutting down, warming up and departing Z.B. raised his head only once to look about.

A bit later, at midnight, Z.B. was standing over a caribou kill eating, when a fixed wing aircraft passed high overhead, but with a distinctly audible sound. Z.B. gave no indication of its presence.

On May 19 at 0923 hours, just after Z.B. finished eating and lay down on top of a caribou carcass, we heard the distant hum of an aircraft for 30 seconds. Z.B. raised his head and looked upstream in the direction of the sound.

On May 24 at 2305 hours, Z.B. was lying on open tundra at the brink of the river bank when a C-185 came down the valley at 400 feet AGL on the opposite side of the river from him (1/2 mile away). He passed downstream, then returned via the same route. Z.B. then sat up and when the aircraft made a third pass, but this time at 200 feet AGL and (unwittingly) nearly directly over Z.B., he ran down the bank into heavy willows on the gravel bars.

An observation on May 20 at 1009 hours may illustrate several of the generalizations about Z.B.'s behavior. Z.B. had been up from a nap for a half hour, defecated and was traveling steadily upstream, poking about, scratching himself on willows but not yet feeding. He was on the open gravel river bars, crossing one channel when he heard a helicopter coming downstream. Z.B. stopped and looked in the direction of the sound a few moments, looked behind him to the left and right, then continued walking upstream on the open bars. The helicopter passed

directly over him at 400 feet AGL and turned and went back upstream, but several hundred yards away along the side of the valley. The helicopter then made a second low pass downstream and this time Z.B. took off, charged across the river, climbed the river bank at a run, stopped once, then walked rapidly downstream. The helicopter was approaching on another close pass when Z.B. began running again, stopped and turned toward the sound, then resumed running and continued to run at least a quarter mile until out of sight downstream.

Appendix II. Breeding behavior (based on field notes).

June 17

1541 hours: Spotted W.B. 100 yards ahead, started to run upstream, she stopped, looked back, running again, stopped, looked back, he is running toward her, still about 100 yards away, she ran up hill, stopped, he is walking forward, he turned and walked away from her, she is standing uphill from him, looking toward him (75 yards away), she took a few steps toward him, he is walking upstream, not directly toward her (cannot see her), she takes few more steps toward him, 50 yards apart, he seems to be following her trail, she walks toward him 30 yards apart, walking toward each other, just 10 yards apart, she did not go straight toward him but turned and went upstream, he followed after her 10-15 yards apart, both heading upstream, S.B. holds head down while walking, W.B. holds head more horizontal, bears are about 6-7 yards apart, now traveling upstream and slightly away from creek, both stopped, W.B. looking back at S.B., he moves on, she moves on, moving downstream, zig-zagging their way up the hill, he stops, she stops, looks back, both moving uphill, about five paces apart at times (3 yards), W.B. in the lead, S.B. behind, both are moving at a brisk walk, S.B. caught up to her, she turned sideways, he put his head up to her neck for a few seconds, then continued walking, S.B. two yards behind, she ran ahead, then stopped and turned, again he approached face to neck, then they continued walking, bears have left creek and have been traveling north across valley, almost to north side, bears traveling almost nose to tail, she stopped turned, confronted him face to face for a few seconds then continued on, stopped, did same thing, stopped, confrontation is longer each time, facing him than backing up a few steps, she turns and they continue on up the hill, she stopped, he pulls up beside her, then off again, W.B. still in lead, she stopped, he attempted to mount, put paw over her back, he is mounting her, parted for 50 seconds, mounted her again for about 4 or 5 seconds, both bears disappeared behind ridge, reappeared, S.B. attempted to mount her again but was unsuccessful, bears are out of sight again, bears move forward, stop, mounting takes place and then they move forward, mounted her again, she turns a few steps while he is on her (i.e. turns half way around) every now and again, then stands perfectly still, 4-1/2 minutes have passed, he is still on her, she takes few more steps (after being still for approximately a minute and a half) and turns in half circle, two separate movements by female, taking a few steps and/or turning in a half circle have occurred in sequence or separately several times during mounting which now has been in progress for nine minutes.

1618: She began throwing head side to side, attempted to grab his leg, threw herself down on side.

1619: Parted, stood side by side, lasted 17 minutes.

1620: Began walking few steps with her in lead again, he is approximately 3-5 yards behind, he goes downhill, she stopped, looking, then follows him 10 yards, he comes back uphill and disappeared, she stopped.

1623: Cat and mouse play, male out of sight, female standing on ridge looking across little gully to where he disappeared, looking towards him, then away, shook, still looking towards him.

1625: Female sat down, facing direction he has gone.

1626: Male reappeared, crossed gully toward female who has started walking up the mountain a few steps, bears about 10 yards apart, male moves closer to about 15 feet, both are walking up hillside, heads are down (eating?) as they stop for a few seconds, then continue walking and stopping to eat.

1630: Still walking and eating together.

1634: Male flopped down on ground, female continues to feed.

1640: Male up and both feed.

1644: Both lying down five yards apart, and apparently asleep.

1655: W.B. changed position and five yards on other side of S.B., no sign of Z.B.

1658: W.B. up and started downhill, S.B. following after W.B. 50 yards down, she stopped and waited for him then traveling down together, W.B. leading.

1700: Stopped, standing laterally apart 20 yards.

1701: S.B. crashes on side, W.B. stands then crashes on stomach at 1703, 3-4 yards apart.

1735: Both bears sleeping.

1737: Both bears walking, walked a few hundred yards then began feeding.

1740: S.B. male crashes again, W.B. female still feeding, she gets about 100 yards away, S.B. male lifts his head, watching her leave, finally scrambles to his feet and follows after her, she lies down, he lies down within 10 feet of her, (S.B. male walks with a very strange gait, swings his hind feet forward with a wide rolling movement as though his hips were very stiff).

1745: S.B. male still lying down, W.B. female up and walking (S.W. across valley), she gets about 150 yards away, he lifts his head, looks around, staggers to his feet, shakes his body, and takes out after her.

1750: They are both still traveling, not stopping to eat.

1752: They stop, facing each others heads, he turns and approaches her rear, she moves away, bears are face to face again, and once again he approaches her rear, face to face once more, heads very close together, then she hits him in the face with her left front paw (playfully?), then backs up several steps as he approaches her.

1755: Both bears lie down, very close together, almost appear to be touching.

1756: Both bears are up, S.B. male standing still, W.B. female walking away.

1758: W.B. female is 100 yards away from S.B. male still walking fast, he hasn't moved.

1759: S.B. male gets to his feet and takes after her once again.

1800: S.B. male catches up to her, she is feeding (head down), he approaches her rear, she turns around quickly to face him, resumes feeding and S.B. male immediately crashes once again.

1801: W.B. female is off traveling once again, S.B. male is still lying down, she stops to feed approximately 100 yards away from him.

1805: W.B. female has disappeared from view into a little gully. S.B. male lifts his head, is on his feet again after her, they both reappear on far side of gully and began feeding, they are partly hidden from view by contours of land and vegetation.

1810: S.B. male appears to be lying down once again and W.B. female is walking around.

1814: Both bears are up feeding, within a few feet of each other.

1816: W.B. female disappears into gully, S.B. male follows her.

1820: S.B. male reappears, standing up, then crashes, out of sight, W.B. female walking away, about 150 yards from where S.B. male was last seen.

1824: W.B. female stops, lifts head, smelling, then sits down for approximately 30 seconds, then she is up again walking, stops again sniffing east, no sign of S.B. male.

1830: She is still walking fairly fast, has reached the main creek flowing through the valley and is traveling downstream.

1831: She is feeding on vegetation, still no sign of S.B. male, he must be napping.

1833: She stops, turns around, stands up looking direction from which she had come, walks a few steps forward, stops and stands up again, looking back, continues walking downstream.

1836: She stops and looks back once again, then begins feeding on vegetation, walks a few steps then stops to "graze."

1850: W.B. female still feeding in same area.

1855: W.B. female still feeding in same area, no sign of S.B. male.

1859: W.B. female feeding, stops occasionally to look back upstream, here comes S.B. male walking right toward her, W.B. female lies down, head oriented in the direction of S.B. male, who begins feeding on vegetation.

1902: W.B. female gets up, begins feeding also, two bears are about 10 yards apart.

1905: Two bears are still feeding about 15 feet apart, W.B. female is lying down while eating.

1906: W.B. female begins walking, followed very closely by S.B. male, he appears to be sniffing at her rear, she turns several times to look back at him, she finally sits down on hind feet, he walks around sniffing(?) her, they lick or bite at each others heads, for a few seconds they appear to wrestle with mouths and heads, then she backs up and breaks away, she sits down again and he walks around her sniffing, she lies down, he walks around her once more and lies down next to her.

1925: Two bears are sleeping in same location.

1931: Two bears are sleeping in same location.

1944: Two bears are sleeping in same location.

2000: Two bears are feeding in same general vicinity.

2012: Two bears are feeding in same area.

2017: Two bears are feeding in same area.

2030: Bears are lying down (sleeping?) in the same area where they have been feeding.

2046: Both bears are feeding in same area as they have been for the last hour or more.

2050: Z.B. (!) spotted on top of the bank where he was last seen this morning (must have been sleeping behind that bank all day), he was standing up when first seen, now is lying down (2057).

2100: S.B. male and W.B. female are still feeding in same general area, they are about 150 yards apart, Z.B. is still lying down.

2104: S.B. male who wandered upstream has returned downstream to W.B., he approaches her, she turns sideways, then turns to face him, they held their heads together several seconds but could not see what they are doing, S.B. turned and walked away, both resumed feeding, Z.B. is still lying in same position and location.

2108: Z.B. lifted his legs in the air, rolled over and lifted his head, but lay back down in same position.

2118: Z.B. still lying down, but has changed positions, his head is now uphill, cannot see S.B. or W.B. (in a gully or the willows?).

2125: Z.B. in same location and position, still cannot see S.B. or W.B.

2130: Z.B. still lying down.

2145: Z.B. still lying down.

2210: Supercub approaches from south, upwind, and Z.B. appeared to raise head or whole front half when plane very near (sound was carried away from bear on plane's approach), 1/4 to 1/2 mile away, plane circled over on sheep survey 2,000 feet above ground level and headed back south, Z.B. lay down in 20 seconds, wind northeast 10-20 mph.

2212-2217: Z.B. up, changed position, over a bit and down on same gravel bar.

2223: W.B., S.B. spotted lying almost touching at edge of stream on green bank, 30 yards upstream from junction of Rolling Bear Creek (RBC) and the small tributary entering upstream from north, Prairie Hill Gulch (PHG).

2235: All hands same.

2242: W.B., S.B. walked over edge to stream, out of sight.

2255: S.B. feeding on green bar between two streams.

2300: W.B. feeding also, 20-30 yards apart, Z.B. lying down.

2305: W.B., S.B. fed close together then began slow movement upstream, S.B. leading.