

Background for managing grizzly bears in the national parks of Canada

by K. R. D. Mundy and D. R. Flook

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Young adult grizzly bear feeding on Beaver River
garbage dump, Glacier, British Columbia, June
1969. Sightings of bears on this site ceased when
dumping was halted in August with the completion
of an incinerator near Rogers Pass. Information
and photo by T. Gibbons.



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Abstract

This report was prepared to provide a basis for managing national parks in Canada so as to maintain grizzly bear populations and provide an acceptable degree of public safety.

Glacier National Park, British Columbia, with its productive vegetation probably carries the densest grizzly bear population of the Canadian parks. In 1962, the density was at least one bear per 11 square miles (28 km²) based on sightings of different bears, and was estimated as one per 7 square miles (18 km²) from the ratio of ear-tagged to unmarked animals seen.

Age of sexual maturity, litter size and breeding interval are discussed. The theoretical rate of increase in the absence of mortality would be between 16 and 24 per cent annually. The oldest bears examined were 23 years old. Fighting, parasites and shooting are discussed as potential causes of mortality.

Grizzlies in the Canadian parks eat prey, carrion and berries when available, but complete their requirements with less concentrated plant foods.

Repeated sightings of most recognizable bears were closer together than 10 miles (16 km). Several transported to new areas returned to their capture localities. The greatest recorded homing distance was about 45 miles (72 km).

The natural tendency of grizzlies in the national parks is to move from forests and avalanche slopes of low elevation in the spring and early summer to alpine meadows during summer and down to the valley floors in autumn. Countering this natural tendency, garbage in open dumps or overflow from badly designed incinerators attract bears to the settled areas throughout these seasons.

Incidents of threats and attacks by grizzly bears on man in the parks are described and factors associated with belligerence are discussed.

Recommendations for management are as follows:

1. Installing supplementary-heated incinerators of adequate capacity away from centres of human habitation.
2. Installing concrete "bear-proof" garbage bins wherever garbage receptacles are needed.
3. Picking up garbage every evening.
4. Releasing ear-tagged bears on back roads closed to the public when removal is required.
5. Locating campgrounds outside favourite grizzly habitat.
6. Assigning special wilderness status to certain areas of grizzly range.
7. Maintaining a current record of sightings of grizzlies and advising hikers to avoid areas occupied by grizzlies.
8. Advising hikers to make noise.
9. Restricting dogs to visitor service areas.
10. Issuing plastic bags to trail users and requiring them to pack out unburned garbage.
11. Collecting data on distribution, numbers, human conflicts and removal of bears.
12. Informing public of life history, behaviour and status of grizzly bears.

Résumé

Le présent rapport a été rédigé afin de dispenser des éléments de base facilitant la gestion des parcs nationaux au Canada, en vue d'assurer la conservation des populations de grizzlis (ours bruns) et d'assurer un niveau de sécurité satisfaisant pour le public.

Avec sa riche végétation, le parc national Glacier (C.-B.) possède probablement la population de grizzlis la plus dense de tous les parcs canadiens. En 1962, cette densité était d'au moins un animal par onze milles carrés (28 km²), d'après le nombre des divers ours rencontrés; à partir du rapport "animaux marqués/animaux non marqués" aperçus, on a estimé la densité des grizzlis à un individu par sept milles carrés (18 km²).

L'auteur traite de l'âge de la maturité sexuelle, de l'importance numérique des portées et des intervalles de reproduction. Le taux théorique d'accroissement serait de l'ordre de 16 à 24% par an (en l'absence de mortalité des animaux). Les grizzlis les plus âgés qui aient été examinés avaient 23 ans. Parmi les causes possibles de mortalité, l'auteur évoque les bagarres entre animaux, les parasites et la chasse.

Dans les parcs canadiens, les grizzlis consomment leurs proies, des charognes et des baies lorsqu'ils en trouvent, mais complètent leurs besoins par des végétaux moins nutritifs.

Les ours les plus repérables, observés de façon répétée, étaient distancés d'au plus dix milles (16 km). Plusieurs animaux transportés dans de nouvelles régions sont retournés sur le lieu de leur capture. La plus grande distance parcourue par un grizzli pour revenir sur son territoire a été d'environ 45 milles (72 km).

Dans les parcs nationaux, les grizzlis ont naturellement tendance à quitter, au printemps et au début de l'été, les forêts et les pentes d'avalanche de faible altitude pour se rendre dans des prairies alpines qu'ils laissent à l'automne pour gagner le fond des vallées. Cependant, leur attirance pour les dépotoirs ou pour les décharges d'inci-

Introduction

nérateurs mal conçus vient à l'encontre de cette tendance naturelle, et nombre de grizzlis viennent rôder durant ces saisons à proximité de zones habitées par l'homme.

On trouvera une description de cas où des grizzlis ont menacé et attaqué des humains dans des parcs, ainsi qu'un exposé sur les facteurs liés à leur agressivité.

Sur le plan de la gestion, les recommandations sont les suivantes:

1. installation d'incinérateurs pourvus d'un chauffage supplémentaire, d'une capacité appropriée, loin des secteurs habités par l'homme;
2. installation de réservoirs à déchets en béton "à l'épreuve des grizzlis", partout où de telles installations sont nécessaires;
3. enlèvement des ordures tous les soirs;
4. relâcher lorsqu'il y a lieu les ours étiquetés sur des chemins secondaires interdits au public;
5. aménagement des terrains de camping hors des lieux de prédilection des grizzlis;
6. classement à titre d'enclaves vierges particulières de certaines zones habitées par les grizzlis;
7. maintien d'un registre des observations de grizzlis et recommandations aux promeneurs d'éviter les secteurs que fréquentent ces animaux;
8. conseiller aux promeneurs d'être bruyants;
9. n'admettre les chiens que dans les zones de tourisme;
10. remettre des sacs de plastique aux utilisateurs des sentiers et leur demander de rapporter dans ces emballages les ordures non brûlées;
11. recueillir des données sur la répartition de ces animaux, leur nombre, leur transport dans de nouveaux secteurs, ainsi que sur les aspects antagoniques de leur présence et de celle de l'homme;
12. informer le public sur le mode de vie, le comportement, la situation des grizzlis.

Whenever grizzly bears (*Ursus arctos* L.) and man meet there is some risk of conflict. Largely because grizzlies pose a potential threat to man and his livestock, he has eliminated them near settled areas and, as settlement advanced, has gradually reduced their range. Resource exploitation and tourism are bringing about the rapid settlement of wild lands of western Canada. To assure the maintenance of wild stocks of grizzlies, we need areas of adequate size where the preservation of the species and its habitat is a primary objective. National parks, the only federal lands in Canada that meet this requirement (National and Historic Parks Branch, 1969:5), should therefore be managed so as to assure that grizzly populations are maintained.

Seven national parks in Canada support populations of grizzly bears: Jasper (4,200 square miles), Banff (2,585 square miles), and Waterton Lakes (204 square miles) on the east slope of the Rocky Mountains in Alberta; Yoho (507 square miles) and Kootenay (587 square miles) on the west slope of the Rockies in British Columbia; and Glacier (521 square miles) and Mt. Revelstoke (100 square miles) in the Selkirk Mountains of British Columbia.

In addition to preserving samples of nature, it is also an objective of national parks to provide opportunities for the public to enjoy them. In some national parks this brings grizzlies into proximity with people, thus increasing the risk of attacks. As park officials must provide some degree of safety to the public, they have frequently had grizzly bears destroyed. The proximity of grizzlies and people, therefore, in addition to threatening the welfare of park visitors and causing them anxiety, threatens the security of the grizzly bear populations.

We have prepared this report to provide a basis on which managers of the national parks can deal with the grizzly bear problem. We shall discuss factors affecting the welfare of grizzlies in the parks, as well as factors influencing the frequency and outcome of encounters between people and bears.

Hereafter, we shall omit the words “national park” in reference to individual parks and will refer collectively to Jasper, Banff, Waterton Lakes, Kootenay, Yoho, Glacier, and Mt. Revelstoke national parks as the “mountain parks.”

Field studies in Glacier were concentrated in the valleys of the Illecillewaet and Beaver rivers and Connaught Creek, through which run the Canadian Pacific Railway and the Trans-Canada Highway. Limited data were gathered for comparison in some high areas in the park.

Since 1951, park wardens in all the western national parks have been issued wildlife data cards, to be used for reporting significant observations. Although the system was voluntary, the wardens’ interest in grizzlies has produced a large number of useful records.

To obtain information on movements, we combined our efforts with those of wardens who were moving bears from areas of human habitation by capturing them in traps built of metal culverts mounted on wheels. In 1961 and 1962, 12 grizzlies were captured and released: 10 in Glacier, 2 in Banff. Eleven were caught in traps and were immobilized with succinylcholine chloride (Craighead *et al.*, 1960). One free-roaming grizzly was immobilized by the same drug administered in a projectile-syringe fired from a carbon dioxide-powered gun. Each grizzly was weighed by drawing the trap onto a platform scale and weighing both. Each grizzly was then ear-tagged with a numbered aluminium tag and a coloured polyvinyl strip.

Food habits were studied by analysing 54 faecal samples collected in Glacier during 1961 and 1962. Faeces of grizzlies were distinguished from those of black bears (*U. americanus*) by larger size or associated tracks. Faecal samples were broken up and washed on a 5 mm mesh screen. The material retained was mixed and blotted, and five subsamples of 10 ml each were taken. Each subsample was spread in a tray of water and the particles were identified by comparing them with a reference collection

of plants from the area. The volume of each kind of food was measured by water displacement.

The age classes of free-roaming grizzlies were assigned subjectively on the basis of body size until their third summer. Fifteen skulls from bears killed in the parks and 14 skulls from the University of Alberta collection were assigned ages up to 2 years on the basis of tooth replacement (Couturier, 1954). The ages of older bears were assigned by counting cemental layers (Mundy and Fuller, 1964), a method confirmed as valid by Craighead, Craighead and McCutchen (1970) using teeth from bears of known age.

Population density

In 1961, 31 grizzlies thought to be different individuals were sighted in Glacier. In 1962 the number was 45. In 1961 the count was made without regular motor transportation. Also the dry, clear weather removed the snow from the higher elevations early in the spring, and produced an excellent berry crop, distributing the bears in localities where observation was less probable. In 1962, a vehicle enabled regular patrolling of the Illecillewaet and Beaver valleys. Furthermore, the wetness of the 1962 season had the effect of holding the bears at lower elevations where they were more likely to be encountered. For these reasons, the 1962 count is probably more accurate.

Using the 1962 count of 45 bears, a minimum density of one grizzly to approximately 11 square miles (28 km²) is obtained. An alternative technique using the ratio of the number of sightings of ear-tagged to unmarked grizzlies, and the number of tagged grizzlies released into the population gives an estimate of 74 bears in 1962 (Schnabel, 1938), or an estimated density of one grizzly to 7 square miles (18 km²).

The numbers of observations of grizzly bears reported per warden per year for the years in which the wardens’ wildlife reporting scheme was operating before 1966 were as follows:

Glacier	5.6
Jasper	4.2
Banff	1.3
Waterton	1.2
Kootenay	0.8
Yoho	0.7
Mt. Revelstoke	0.6

We think that the wardens’ observations correctly indicated that Glacier had the highest grizzly density of the seven parks though visibility and the effort of the wardens must have varied in different parks. We attribute the greater density in Glacier to the highly productive alpine and sub-climax subalpine shrubby and herbaceous

Figure 1. Section of testis taken by biopsy from a young adult grizzly, June 1 (note spermatozoa in seminiferous tubule)

Figure 2. Section of testis of grizzly killed August 9, probably at 3¼ years, showing seminiferous tubules (note absence of spermatozoa)

0 0.1 mm

vegetation which provides an abundance of food for grizzly bears.

Reproduction

Recent research on the reproductive processes in grizzlies and their conspecifics include studies of grizzlies in Yellowstone National Park, Montana, by Craighead, Hornocker and Craighead (1969) and of Alaska brown bears by Erickson *et al.* (1968) and by Hensel, Troyer and Erickson (1969). We also obtained specific reproductive data from the Canadian parks.

Chronology of breeding and births

In one mating season the female typically has two oestrus periods during which she accepts males, varying in length up to at least 27 days, separated by an interval of 4 to 18 or more days (Craighead *et al.* 1969). Erickson *et al.* (1968) concluded that the dates when male brown bears in Alaska achieved breeding condition varied considerably, although most were capable of breeding from May to July. In our study, a testicular section obtained by biopsy from a 346 pound (157 kg) grizzly bear captured on June 1 in Glacier, showed maturing seminiferous tubules with a few spermia present (Fig. 1).

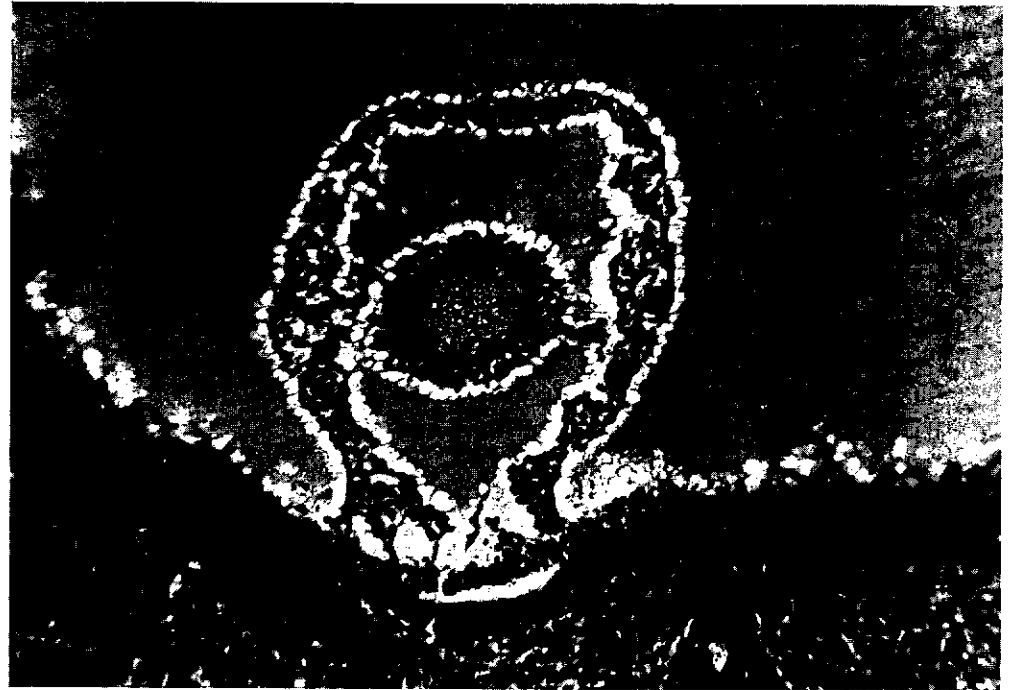
Hensel *et al.* (1969) reported observations of Alaska brown bears mating between May 1 and July 15. Murie (1944) concluded that most grizzlies in Mt. McKinley National Park, Alaska, mated during May and June. Craighead *et al.* (1969) reported pre-copulatory behaviour as early as May 14 and postcopulatory behaviour as late as July 15. They reported that 40 of 49 copulations observed in Yellowstone occurred in June, mostly in the first two weeks. The 21 observations of adult grizzlies in pairs or groups in the mountain parks occurred from April 30 to June 25. Mating was observed on June 13 and June 19 and attempted mating on June 17.

Storer and Tevis (1955) mentioned the separation of the sexes after breeding. Our latest date of observation of paired grizzly bears was June 25, indicating that breeding terminates abruptly in the mountain parks.



Figure 3. Section of ovary of grizzly killed May 11 at 4 years showing Graafian follicle

0 0.1 mm



Hensel *et al.* (1960) presented evidence that gestation in Alaska brown bears lasts approximately 8 months. By recovering free blastocysts 50 days after copulation, Craighead *et al.* (1969) established that implantation is delayed in grizzly bears. Birth of grizzly bears was reported to occur in January by Asdell (1946) and from January to February 15 by Holzworth (1930). Based on breeding occurring in early June and an 8-month gestation period, a peak in the number of births could be expected in early February.

Age of sexual maturity

Studies by Hensel *et al.* (1960) showed that most male Alaska brown bears became sexually mature at 4½ years of age. The age of first conception varied from 4½ to 8½ years in a series of female grizzlies from Yellowstone (Craighead *et al.*, 1969) and from 3½ to 6½ years in a sample of Alaska brown bears (Erickson *et al.*, 1969).

We examined the reproductive tracts of one male and one female, approaching adulthood, from Glacier. Only a few spermatogonia were present in the testes of the male, a 3½-year-old shot on August 12 (Fig. 2). It is unlikely that he would have been capable of breeding at that age. The female, a 4-year-old without young, shot on May 11, had maturing follicles in one ovary (Fig. 3). She probably would have been capable of conception that summer, producing her first young at 5 years.

Interval between pregnancies

Couturier (1954) stated that the female European brown bear, conspecific with the grizzly, normally breeds every 2 years, although sometimes 3 years pass between matings. Craighead *et al.* (1969) reported intervals of 2 and 3 years between litters born to young grizzlies of known history in Yellowstone. Hensel *et al.* (1969) reported that of 10 female Alaska brown bears accompanied by yearlings in July or August, only one had ceased lactating. They suggested, therefore, that most females in that area reproduced every third year.

Table 1 presents data on grizzly in litters grouped according to age, the presence or absence of the dam, and the periods before and after the end of the breeding season. The data are from wardens' data cards from the mountain parks for 1951 through 1963 and Mundy's observations in Glacier in 1961 and 1962. The observations no doubt contain errors in classification; but they indicate the different ages of young at which the maternal bond is broken. In observa-

tions of more than 2,000 Alaska brown bears, Erickson (1964) saw only one female with young of mixed ages. The presence of a yearling or a 2-year-old with a female is therefore good evidence that she does not have a younger litter. In 21 observations of paired adult grizzlies in this study, young bears were seen in only one case.¹ The mating female is apparently dissociated from

¹See observation by T. Klettie, p. 13

Table 1

Presence of grizzly dam in relation to age of young and date* of observation†

	Groups of cubs		Groups of yearlings		Groups of two-year-olds	
	Before June 26	June 26 & later	Before June 26	June 26 & later	Before June 26	June 26 & later
No. groups, dam present	35	74	19	28	6	8
No. groups, dam absent	1	2	3	5	2	6
% young groups, dam absent	3	3	14	15	25	43

*June 25 approximates end of breeding season.

†Observations by park wardens, in the mountain parks, 1951-1963; by Mundy in Glacier, 1961 and 1962.

Table 2
Numbers of young grizzlies observed* with adults

Age (yr.)	No. of litters containing					Total no. of litters	Total no. of young	Average no. young/litters
	1	2	3	4	5			
½	26	56	26	0	0	108	216	2.0
1½	13	22	10	0	0	46	92	2.0
2½	4	9	1	0	0	14	25	1.8

*Observations by park wardens in the mountain parks, 1951-63; by Mundy in Glacier, 1961 and 1962.

Table 3
Numbers of young grizzlies observed in Glacier, British Columbia, 1959 through 1962

Age (yr.)	1959	1960	1961	1962
½	0	8	4	0
1½	0	2	5	8
2½	1	0	8	5

her previous litter. Assuming that females do not regroup with their previous litters after mating, the presence of young with a female after the breeding season would indicate she had not mated.

Grizzly bear cubs of the year are seldom seen without their mothers. Our 111 sightings of cubs included only three observations with no adult present (Table 1): the mother may have been nearby or may have been killed. The data indicate that few if any females produce young in successive years. Eighty-five per cent of the yearling groups seen after the breeding season were with adults, presumably their dams. This indicates that most females pass at least two breeding seasons unmated, after they have successfully given birth. Furthermore, 8 out of 14 groups categorized as 2-year-olds were with adults. This suggests that a substantial number of females pass three breeding seasons unmated while rearing a litter.

Litter sizes and losses of young

Couturier (1954) suggested that the dam's age may influence the number of young. According to him, European brown bears 5 to 7 years of age usually have litters of one; females at their reproductive peak,

litters of two or three; and old bears, litters of one or two. In North America, Craighead *et al.* (1960) found the Yellowstone grizzly's average litter size was 1.8 (1-2) for 11 first litters and 2.0 (1-4) for 4 second litters.

Table 2 consolidates our observations of sows with young, and wardens' reports from the mountain parks for the period 1951-63. All but one litter contained one to three young; the exception being a group of five yearlings with an adult. Erickson and Miller (1963) reported that an Alaska brown bear with three cubs adopted two others of the same size, so our report of five yearlings with a sow is not certain evidence of the birth and survival of quintuplets.

Mean litter sizes in cubs, yearlings and 2-year-olds (Table 2) are strikingly similar. Hensel *et al.* (1969) reported mean litter sizes of 2.23 for 98 litters of cubs and 2.00 for 103 litters of yearlings for Alaska brown bears. Evidently, few litters are partly decimated while still with their dams. Most losses among the young must comprise mortality of entire litters or deaths after separation from the dam.

Reproductive rates

Using the information on ages of sexual maturity, intervals between pregnancies, and litter sizes, we constructed models to compute theoretical annual rates of increase in the absence of mortality. If all litters were twins, the sex ratio was 1:1, each female had her first litter at 7 years and one litter every third year, then the

theoretical rate of increase would be 16 per cent and cubs would comprise 14 per cent of the population. If, however, each female produced her first litter at 5 years of age and one litter every second year thereafter, the theoretical rate of increase would be 24 per cent and cubs would comprise 19 per cent of the population.

Table 3 shows the numbers of cubs, yearlings and 2-year-olds identified in Glacier from 1959 through 1962. Unless young bears immigrated to the park during those years, we can surmise that at least eight cubs were born there each year from 1959 to 1961. If the population were stable at 45 during those years, then 18 per cent of the population would have been cubs; the corresponding rate of increase, ignoring mortality, would have been 22 per cent. This figure falls between the calculated annual rates of unimpeded increase shown in the previous paragraph. Our estimate of an 18 per cent cub component in the Glacier population corresponds to a range of 14 to 23 per cent reported for the brown bears of the U.S.S.R. (Teplov, 1953, as quoted by Novikov, 1956:95). Troyer and Hensel (1964) reported that 26 per cent of 163 live-trapped Alaska brown bears were cubs and 22 per cent yearlings, but suggested that their capture methods may have selected young bears.

If we accept the higher estimate of the Glacier population (74 animals using the Schnabel Index) and assume that 18 per cent were cubs, then about 13 cubs would have been produced annually.

Longevity

We found the remains of one 17-year-old male grizzly in Glacier dead, apparently, from natural causes. The oldest grizzly skulls examined were from three 23-year-old animals that had been shot: a male on the Berland River, Alberta; a male near Revelstoke, British Columbia; and a female on the Beaverfoot River, British Columbia. We estimated their ages from tooth sections. Captive European brown bears have lived to 30 years (Couturier 1954); and

grizzlies have lived to 40 years (Storer and Tevis, 1955).

Potential mortality factors

Intraspecific and interspecific strife

Intraspecific strife may be an important mortality factor among grizzly bears. Couturier (1954) cited European references to male brown bears wounded and killed while fighting during the rut. Wardens reported 21 observations of paired grizzlies in the mountain parks during the breeding season; two reports mentioned fighting between males. On June 14, 1954, E. J. Boutwell observed two adult males fighting at a garbage dump in Glacier; a third bear, apparently female, was present. On June 7, 1961, T. Klettle in Jasper observed a fight between two adults, evidently males; a female with two young, one in a tree, were nearby. Mundy and Flook (1964) reported competition for a female in Glacier. In that incident conflict did not pass the threat stage.

Aggression and dominance have also been noted among bears concentrated at garbage dumps. On August 11, 1956, warden F. Burstrom observed seven grizzlies fighting near the Jasper Park Lodge² incinerator. Two subadult grizzlies at the Beaver River garbage dump consistently retreated when approached by a certain adult. In addition, the smaller subadult retreated whenever its companion threatened. Such substitution of threat and retreat for fighting may be common. Pearson, Morrison, and Olsen (n.d.) noted that fighting usually consists of biting and parrying with the forelegs, and that the participants are seldom injured.

Murie (1961) described how a grizzly with two cubs apparently mistook cubs of another sow for her own. She fought with their mother then killed two of them when they attempted to flee.

In August, Pearson *et al.* (n.d.) found the carcass of a male grizzly, weighing

Table 4
Numbers of helminth parasites in six grizzlies from Alberta and British Columbia

Location	Date killed	Age (yr)	Body weight (kg)	<i>Baylisascaris</i> sp.	<i>Dirofilaria</i> sp.	<i>Taenia hydatigena</i>
Glacier	May 11, 1962	4½		0	0	0
Banff	May 16, 1962	½	9½	0	0	0
Glacier	June 5, 1962	1½		7	1	0
Glacier	Aug 13, 1962	3½	104	80	0	0
Banff	Sept 11, 1962	3½	109	5	0	1
Swan Hills, Alta.	Jan 25, 1963		112	0	0	0

160 pounds (73 kg), a short distance from where they had drugged it with succinylchloride and released it 26 days earlier. Another bear had evidently killed it after a struggle, but had not eaten it.

Troyer and Hensel (1962) reported four instances of cannibalism among Kodiak brown bears. An adult female, caught in a steel trap, was killed and eaten by an adult accompanied by at least one yearling. The three other victims were cubs: two killed and eaten by large males in May, and one killed by a large bear of unknown sex in June. Troyer and Hensel (1964) reported a population density of one brown bear per 0.6 square miles (1.6 km²) on a study area on Kodiak Island. That is about 12 times as great as the density of grizzly bears estimated for Glacier. Jonkel (1970a) noted a high incidence of strife and one case of cannibalism in a dense population of polar bears (*Ursus maritimus*). The frequency of cannibalism and other intraspecific strife may be positively related to population density.

Where grizzlies and black bears fed at the same garbage dump the grizzlies usually dominated. Flook and Burstrom made one observation in which that dominance relationship was reversed. At 2200 hours on July 10, 1957, a grizzly entered the clearing at the Jasper Park Lodge incinerator where an adult black bear with two cubs was foraging. Though slightly smaller, the adult black bear immediately charged. They closed and fought briefly then broke

apart. The grizzly ran away. The black bear followed and overtook the interloper; they rolled over in a brief tussle and separated again. The black bear returned to its cubs, and the grizzly bear walked to the far side of the clearing where it began to feed. Neither animal appeared to have been injured.

Parasites and diseases

The intestinal tracts of six grizzly bears from Glacier, Banff, and Swan Hills, Alberta, were examined for helminth parasites (Table 4). Two intestinal species were found: *Baylisascaris* sp., probably *B. transfuga*, and *Taenia hydatigena*. One specimen of *Dirofilaria* sp., probably *D. ursi*, was found in the dorsal muscles of the neck of a bear.

Choquette, Gibson and Pearson (1969) found *Baylisascaris transfuga*, *Dochmoides yukonensis*, *Diphylllobothrium* sp. (probably *D. ursi*), *Taenia krabbei*, *Dirofilaria ursi*, and larvae of *Trichinella spiralis* in grizzly bears from northern Canada. The apparent absence of helminths from the digestive tracts of our January and May specimens is consistent with the suggestion of Rausch (1954, 1961) and Choquette *et al.* (1969) that bears tend to shed their worm burdens in the autumn.

None of the bears examined in this study had visible signs of disease. Neither our limited data nor the published reports suggest that parasitic or other diseases are major contributors to mortality among wild grizzlies.

²A luxury hotel complex in Jasper Park owned by the Canadian National Railway.

Removal by man

To provide more information on which to assess problems of bears in the parks, park superintendents were instructed in 1963 to report to their regional office the numbers of bears destroyed or captured, transported and released. Control activities for those parks that contain grizzlies are consolidated in Table 5, and for black bears from the same parks in Table 6. Management of both species is interrelated, so it is useful to compare the number of the two species handled. Not all the bears destroyed have been reported through official channels because of a fear of reproach. For that reason the numbers reported are minimum estimates of the numbers killed.

Ten times more black bears than grizzlies have been removed, indicating the former's greater abundance, and its tendency to inhabit lower elevations and to frequent settled areas. About half the black bears and more than half the grizzlies removed were shot. More grizzlies were shot at the Jasper Park Lodge incinerator than at any other location in the mountain parks. In 1959, 1960, 1961 and 1962 respectively 1, 3, 1 and 9 grizzlies were killed in Glacier. A kill of nine bears every year would probably deplete the population because only 8 to 13 cubs were born per year. Similarly, the six grizzlies killed in Yoho during 1968 may have exceeded the annual recruitment.

Most of the area adjacent to the mountain parks consists of forested lands under the jurisdiction of the provinces of Alberta and British Columbia. Grizzlies are hunted there during an annual open season; in addition, they are sometimes shot or trapped on the forest reserves to protect the domestic livestock grazing there. Bears are also destroyed outside the parks when they visit garbage piles at recreational campgrounds, logging and oil exploration camps, and other sites of human activity. Such destruction could remove those bears whose wanderings take them outside park boundaries.

Table 5
Grizzlies removed from mountain parks, 1963-68

Park	Method	1963	1964	1965	1966	1967	1968	Total
Jasper	shot	4	2	0	6	0	2	14
	captured	0	0	0	0	0	0	0
Banff	shot	1	2	2	0	0	0	5
	captured	1	2	4	0	0	1	8
Waterton	shot	2	0	0	0	0	0	2
	captured	0	0	0	0	0	0	0
Kootenay	shot	0	0	0	0	0	0	0
	captured	0	0	0	0	0	0	0
Yoho	shot	1	0	0	0	0	6*	7
	captured	0	0	0	1	0	5*	6
Glacier	shot	0	0	0	0	2	0	2†
	captured	0	1†	0	0	0	4	5†
Revelstoke	shot	0	0	0	0	0	0	0
	captured	0	†	0	0	0	0	0
Total	shot	8	4	2	6	2	8	30
	captured	1	3	4	1	0	10	19

*Incinerator was installed in Yoho in 1968 and many bears, apparently garbage dump habitués, moved into townsite and campgrounds.

†Glacier and Mount Revelstoke reported together in 1964.

Table 6
Black bears removed from mountain parks, 1963-68

Park	Method	1963	1964	1965	1966	1967	1968	Total
Jasper	shot	22	15	10	14	7	14	82
	captured	12	2	23	12	14	19	82
Banff	shot	1	2	7	4*	0	8*	22
	captured	2	19	16	7	14	24	82
Waterton	shot	12	1	10	0	3	9	35
	captured	0	1	0	2	1	10	14
Kootenay	shot	9	3	8	1	0	0	21
	captured	8	0	21	4	1	0	34
Yoho	shot	4	4	1	0	0	22*†	31
	captured	3	1	4	0	0	22†	30
Glacier	shot	3	2†	0	2	4	16	27†
	captured	0	16†	0	2	0	3	21†
Revelstoke	shot	0	†	0	0	0	0	0†
	captured	1	†	0	3	0	1	5†
Total	shot	51	27	36	21	14	69	218
	captured	26	39	64	30	30	79	268

*Two bears in Banff in 1966, and 2 in Banff and 2 in Yoho in 1968, were shot because they had been injured by automobile collisions.

†New incinerator was installed in Yoho in 1968 and many bears, apparently garbage dump habitués, moved into townsite and campgrounds.

‡Glacier and Mount Revelstoke reported together in 1964.

Habitats, foods and movements

Figure 4. Frequency of Mundy's observations of grizzlies in habitat types, by season, Glacier, British Columbia, 1961 and 1962

Figure 5. Frequency of park wardens' observations of grizzlies in habitat types, by season, the mountain parks, 1951 through 1962

Seasonal distribution according to habitat

In 1961 and 1962, Mundy made 51 sightings of grizzlies in Glacier, at locations other than garbage dumps. The habitats in which they were seen are of three broad types: avalanche slopes, forest, and alpine tundra. The distribution of observations by habitat and season in Glacier, for 1961 and 1962, is shown in Figure 4. The distribution of 101 observations by habitat and season in the mountain parks, for the period 1951 through 1962, is presented in Figure 5.

Unfortunately the habitat distribution of bear sightings is influenced by the distribution of observers and the visibility of bears in different habitats. However, based on his experience in Glacier, Mundy (1963) thought the seasonal changes in observations in different habitats reflected shifts in habitat use.

The data from Glacier and from the other mountain parks suggest that grizzlies use avalanche slopes and forest more heavily in spring and early summer, and increase their use of alpine meadows in July and August. This shift correlates with the recession of snow. The grizzly's return to avalanche slopes later in the season may be related to the ripening of the berry crop at lower elevations.

Use of natural foods

The analyses of 54 samples of grizzly bear faeces collected in Glacier in 1961 and 1962 are presented in Table 7. Faeces obviously resulting from ingested garbage were excluded from collections. Observations of grizzly bear feeding activities by wardens in all the mountain parks are consolidated in Table 8. Faeces from low elevations are probably over-represented in the collections and completely digested materials are not represented at all. Certain feeding activities are more readily observable than others because of the nature of the habitat. For example, bears grazing on avalanche slopes or alpine meadows are more readily seen than bears feeding in

Figure 4

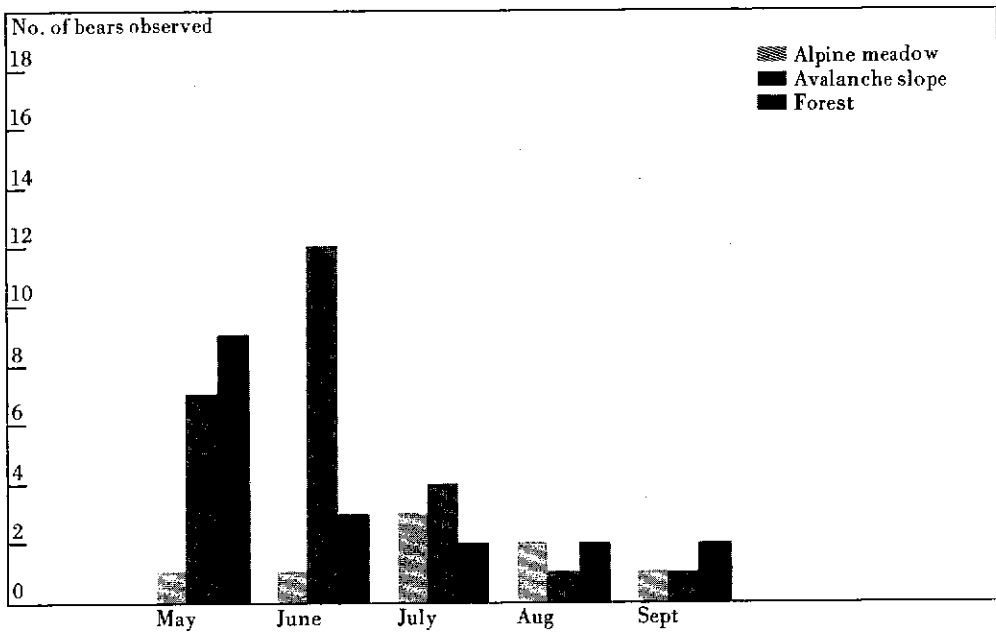
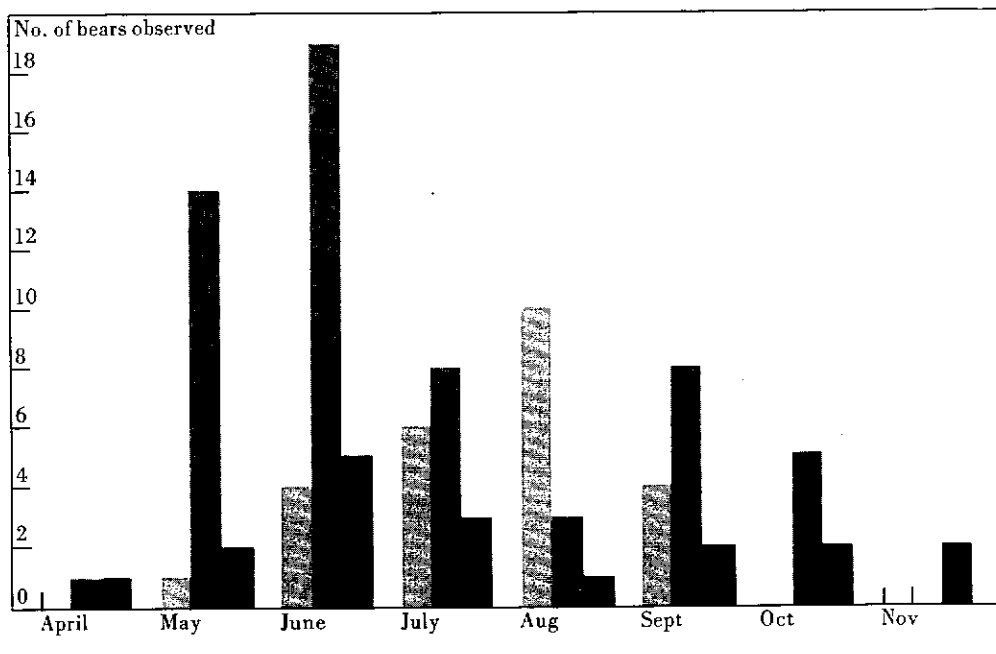


Figure 5



forest or shrubby cover. Observations of apparent predation or attempted predation by grizzlies on large mammals in the mountain parks, noted by wardens and other reputable observers, are listed in Table 9.

The stomach contents of three grizzlies were examined during the study. Those of a cub shot in Banff, in May 1962, consisted of grass, ants and, apparently, milk. The stomach of a yearling shot in Glacier, in June 1962, contained grass; while that of a 2-year-old shot in the same park, in May 1962, contained grass, bird remains and garbage.

In Glacier, the grizzly bear is largely vegetarian (Table 7) because the deep snow limits the abundance of large prey. During his field work in Glacier, Mundy (1963) saw 1 deer (*Odocoileus* sp.), 3 moose (*Alces alces*), 12 mountain goats (*Oreamnos americana*) and 1 wapiti (*Cervus canadensis*). Ungulates are more abundant in the other mountain parks. However, observations by wardens (Table 8) suggest that bears spend more time feeding on plants than on animals. Grizzlies were most often seen feeding on ungulates in the spring (Table 8), during and after the season of highest natural mortality among ungulates (Flook, 1970).

Cowan (1943) provided data on foods of grizzly bears in the Rocky Mountain parks in 1943. In 17 faecal samples collected in Banff from April 24 to July 13, he found the following occurrence of food items: *Hedysarum* sp. 35 per cent, grasses and unidentified vegetation 30 per cent, wapiti 35 per cent, moose 6 per cent, deer 6 per cent, juvenile mountain goat 6 per cent, and hoary marmot (*Marmota caligata*) 6 per cent. Five faecal samples collected from Kootenay park in late June consisted entirely of *Hedysarum* sp. The occurrence of food items in 20 samples collected in Jasper from late July to mid September was: buffalo berries (*Shepherdia canadensis*) 5 per cent, crowberries (*Empetrum* sp.) 5 per cent, unidentified roots 5 per cent, other vegetation 5 per cent, wapiti 50 per cent, moose 25 per cent, and mule deer (*Odocoileus hemionus*) 10 per cent. Cowan

Table 7
Contents identified in faecal samples of grizzlies from Glacier, 1961 and 1962 (figures in percentages)

	May (7 samples)		June-July (8 samples)		Aug-Nov (39 samples)		Total (54 samples)	
	Occurrence	Volume	Occurrence	Volume	Occurrence	Volume	Occurrence	Volume
Grasses and sedges	86	82	62	57	51	35	57	43
Horsetail (<i>Equisetum</i> sp.)	29	1	75	23	13	4	24	5
Forbs	29	15	0	0	0	0	4	2
Gymnosperm cone	14	1	0	0	5	tr*	6	tr
Huckleberries and blueberries (<i>Vaccinium</i> spp.)	0	0	12	9	38	22	29	18
Mountain ash berries (<i>Sorbus</i> sp.)	0	0	12	5	54	38	41	29
Gooseberries (<i>Ribes</i> sp.)	0	0	12	tr	8	tr	7	tr
Total plant		99		94		99		98
Rodents	0	0	12	5	3	1	4	1
Birds	0	0	12	tr	3	tr	4	tr
Insects	14	1	37	tr	8	tr	13	tr
Total animal		1		6		1		2

*tr = Trace.

Table 8
Numbers of observations of different feeding activities of grizzlies reported by wardens from the mountain parks, 1951-62

Feeding activity	April	May	June	July	Aug	Sept	Oct	Total
Grazing plants	1	9	16	4	3	4	3	40
Digging roots	0	5	3	0	2	4	2	16
Feeding on berries	0	0	0	1	4	4	1	10
Total plant	1	14	19	5	9	12	6	66
Hunting rodents	0	1	1	3	7	1	1	14
Feedings on ungulate carcass or prey	1	5	3	1	0	1	1	12
Total animal	1	6	4	4	7	2	2	26

thought that most of the ungulate food was obtained as carrion, but found some evidence of predation. Cowan (1943) also documented peak populations of wapiti, resultant depletion of forage stands, intra-specific competition for forage, and high winter mortality of ungulates in Banff and Jasper. Since then, wapiti populations have been controlled by shooting, and both carrion and weakened potential prey

animals are thought to be less common. Murie (1944) concluded that grizzly bears in Mt. McKinley were usually vegetarian because meat was difficult to obtain.

On August 21, 1959, we saw an adult grizzly and two young eating *Hedysarum* sp. roots near the Moosehorn River in Jasper. Others have observed grizzlies eating these roots (Cowan, 1943, Banff and Kootenay; Murie, 1944, Mt. McKinley;

Table 9
Some incidents of apparent or attempted predation
by grizzlies

Date	Location	Observer	Observation
June 21, 1952	Wolverine Cabin, Jasper	A. Bleuler	Adult feeding on freshly killed yearling moose (<i>Alces alces</i>)
Aug 20, 1959	Verendrye Cr., Kootenay	F. Lightbound	Partly eaten carcass of bull moose
Sept 10, 1960	w. of Mystery L., Jasper	L. Tremblay	Adult and two cubs feeding on carcass of 3-4 year old bighorn (<i>Ovis canadensis</i>) ram
April 7, 1961	Trail Creek, Waterton	A. Russell	Adult chased from carcass of freshly killed adult black bear (<i>Ursus americanus</i>)
Sept 23, 1964	Cascade Valley, Banff	V. Geist	Adult feeding on carcass of freshly killed aged cow moose
July 9, 1955	Cairn Pass, Jasper	M. Schintz	Adult chasing moose, outcome unknown
Sept 1, 1957	Poboctan Pass, Jasper	M. Schintz	Adult and two cubs chasing caribou (<i>Rangifer tarandus</i>), outcome unknown
Sept 6, 1961	Chrome L., Jasper	T. Klettie	Adult chasing cow moose, outcome unknown
May 20, 1962	Near Jasper Highway, Banff	W. McPhee	Adult and two cubs chasing 17 goats (<i>Oreamnos americana</i>), chase abandoned
May 26, 1968	Palliser Range, Banff	J. Rimmer	Adult and two cubs chasing herd of cow wapiti (<i>Cervus canadensis</i>), chase abandoned

Pearson, 1968, Yukon Territory). We may conclude that grizzlies in the national parks of Canada, as in other study areas, are opportunistic feeders. They take advantage of such concentrated sources of energy as prey, carrion and berries, where and when they are available, but complete their requirements with less-concentrated plant foods.

Movements

Of the grizzlies ear-tagged and released in 1961 and 1962, ten were from Glacier, two from Banff. Six Glacier grizzlies and one Banff grizzly were observed later. In Glacier, additional data were obtained on the movements of an untagged female with three young, and the young of a tagged bear. The physical features of Glacier are shown in Appendix 1a, and sightings of recognizable bears are mapped in Appendices 1b to 1f. Sightings of other marked grizzlies in Banff and Jasper will also be discussed.

Size of foraging range

We use the term foraging range rather than home range, because we lack data on the location of winter denning sites and their relationship to areas used during the

snow-free season. The distribution of sightings of grizzlies we recognized can be used to indicate their distribution of movements. Because any bear may have travelled farther than where it was observed, our estimates of foraging range are conservative. Our observations (Appendices 1b to 1f) show, as did those of Murie (1961) in Mt. McKinley, that the ranges of different bears or families overlap.

With two exceptions (Bear 3, Appendix 1c; Bear 9, Appendix 1f), sightings of these repeatedly observed grizzlies were within areas whose extremities were not farther apart than 8 miles (13 km). These sightings were of two adult females with young and of four independent immature bears (Appendices 1b to 1e). Two bears (Bear 5, Appendix 1d; Bear 7, Appendix 1e) were seen during two summer seasons. Bear 3, the only adult male, covered a straight-line distance, between sightings of 10 miles. Bear 9 (see Homing) covered a much wider area during the summer in which she mated, consistent with the view that pregnant females range widely before denning (Storer and Tevis, 1955). In measuring these distances, we excluded those from release sites to previous capture locations.

Murie (1944) reported that the home range of grizzlies in Mt. McKinley averaged about 10 miles (16 km) across. He also stated that the ranges shifted, but that a bear's activity was restricted to a certain area during particular periods.

Craighead and Craighead (1965) reported that, for most if not all of a 3-year period, a radio-tracked female in Yellowstone remained within a 3-by-5-mile (5 by 8 km) area; females with young tended to travel more than those without young; and males tended to range more widely than females.

Undoubtedly the steep topography and the distribution of vegetation types helped to shape the foraging ranges we mapped. We surmise that the attraction of garbage also influenced the movements of certain bears. Furthermore, garbage supplements natural foods, and its availability may have enabled the animals to obtain their energy requirements in areas smaller than they would otherwise have used.

Homing

For many years, wardens have captured grizzlies and black bears in settled areas of the parks and released them in the remote areas. Some of these bears were marked

with paint or ear tags for identification. Some of the marked bears have returned to their foraging areas, and the following examples illustrate the grizzly's homing tendency:

1. Bear No. 2 (Appendix 1b) returned 15 miles (24 km) from its release site to the location of capture within 71 days.

2. Bear No. 4 (Appendix 1c) and her cub, Bear No. 6 (Appendix 1d), were observed feeding regularly at the Summit dump. They were captured 2 days apart and transported 9 miles (14 km) to the Beaver River dump, but they returned to the Summit area and were reunited within 18 days.

3. Bear No. 9 (Appendix 1f), an adult female, was captured at Red Earth Creek in Banff, transported 39 miles (63 km) by road, and released at Flint's Park. Within 23 days she had returned to the capture area, and continued 5 miles (8 km) to the northwest. Later the same season she was reported as far as 30 miles (48 km) northwest of the capture site. She was seen on June 8, 1961, with another adult, probably her mate, and shot in spring 1962, 13 miles (21 km) from the original capture site. At that time she was accompanied by a cub.

4. Two young adults, a male and a female, seen several times near the guest lodge at Bow Lake in Banff were captured in culvert traps on September 7, 1964, at the nearby Mistaya River Warden Station by W. Vroom. They were transported 81 miles (130 km) by road to Flint's Park, ear-tagged, and released on September 8. A park visitor saw the two bears near Bow Lake on September 15 or 16 and on September 26; Vroom identified the female near the Mistaya River Warden Station by the plastic strip in her ear. She was shot near Bow Lake the following spring because she was considered dangerous. Between the capture and release sites are rugged mountains more than 9,000 feet (2745 m) in elevation, and the most direct probable route was about 45 miles (72 km) long, via the head of the Cascade River, Baker Creek, Little Pipestone River, and Molar Creek.

Distribution and movements in relation to food supply

Data presented in the section on habitat suggest that, apart from their attraction to garbage, grizzlies tend to move from avalanche slopes and lower forests in the spring and early summer to alpine meadows in mid summer and then back to the lower elevations in the autumn. These movements seem related to the availability of natural foods.

For the first time in recent years, large volumes of garbage became available at Glacier in the summer of 1957, when crews arrived to clear the right-of-way for the Trans-Canada Highway. From 1957 through 1962, the road construction camps dumped large quantities of garbage at several locations near the highway route. Grizzlies frequented each of four dumps in existence in 1961. Of 18 grizzlies captured in 1961 and 1962, 15 were taken at garbage dumps, or areas where garbage was present. Of eight grizzlies captured in garbage areas and later observed at least once, seven were again seen at dumps. The summer distribution of a substantial number of grizzlies in Glacier was apparently related to the distribution of garbage dumps.

Our observations in July 1961 showed how the availability of garbage could influence the grizzly's activities. At one dump, the appearance of three bears coincided closely with the nightly dumping of garbage between 2030 and 2100 hours. Early on July 27, that garbage pit was filled in, and a new one opened 1 mile (1½ km) away. The regular evening garbage truck passed the old pit at 2040 hours; at 2100 hours two grizzlies approached from different directions. One left in the direction of the new pit, the other walked into the old pit and began to dig. Obviously, the nightly passage of the garbage truck provided a signal to the bears.

Bear No. 3 (Appendix 1c), a male, was trapped in Glacier at a bait located away from any garbage supply and released 2 miles (3 km) away. He was next seen at the Beaver River dump 12 miles (19 km) from his release site, and remained nearby until

the garbage supply declined in September. He was recaptured on October 11 in the Illecillewaet campground, 10 miles (16 km) from the dump.

Until 1969, Jasper Park Lodge hauled its garbage one-half mile (¼ km) to an incinerator, but it was too small and the overflow was dumped on the ground. The first recorded observation of grizzlies at the incinerator was in 1952, when F. Burstrom, warden, saw seven in one evening. Grizzlies were seen there every year until the incinerator was closed in 1969. The 1953 estimate was 10 to 15.

From September 2 to September 7, 1957, Flook and Burstrom marked approximately 13 grizzlies at the site by pouring yellow paint on the feeding bears from a scaffold built against the incinerator. The grizzlies stopped going to the incinerator during the second week in September, after the lodge closed for the season, but L. McGuire saw one marked grizzly on September 13 in the Snowbowl of the Maligne River drainage, approximately 14 miles (22 km) from the incinerator. The grizzlies probably went to the lodge incinerator from quite a wide area.

Although the grizzlies were feeding so close to the lodge, they attacked no one in the vicinity, probably because they feed on garbage mostly at night and because they usually avoid human beings. In addition, Burstrom may have prevented attacks by patrolling the site, on most evenings throughout the summer, to caution tourists.

Black bears also cause problems in park campgrounds, picnic grounds, bungalow camps and even townsites, where they tip over or climb into garbage cans. Grizzlies visit garbage cans less commonly. Black bears readily accept food offered to them and learn to approach park visitors for hand-outs. This increases the risk of attack and makes it necessary to prohibit the feeding of bears. Fortunately, grizzlies in Canadian parks have not adopted that behaviour.

Open garbage dumps distributed throughout the mountain parks, near bungalow camps and other human habitations, are all frequented by black bears, and some by

Growth

grizzlies. A poignant comment in a report by K. Brady of Banff, in August 1968, is worth quoting here.

Less than one month ago the two grizzlies were quite elusive. Now they have become tame and will no doubt present a problem with travellers and campers. An open dump like the one at the 17-mile flats does nothing but encourage bears to become closely associated with people. The end result is that the wildlife must pay.

Growth rates reflect environmental conditions, and are therefore related to the welfare of grizzly populations. Our data on the growth of grizzlies are few, but are given so they will be available for comparison with future data. Appendix 2 shows weight, sex and age of living and dead grizzlies examined during the study. Appendix 3 gives length and zygomatic width of all skulls examined.



Attacks on and threats to man

In spite of the large numbers of park visitors the numbers of fatalities from bear attacks have been low. Only one death has been attributed to a grizzly in the national parks of Canada. On September 26, 1929, park warden P. H. Goodair was found dead near his cabin in the Tonquin Valley in Jasper. Park authorities concluded that he died from injuries inflicted by a grizzly. An adult with young had been seen in the vicinity.

One person was killed by a black bear in the Canadian parks. On August 8, 1958, a small girl was killed by an adult black bear at the Sunwapta Falls Bungalow Camp in Jasper. The bear was believed to have been regularly hand-fed by visitors. An open garbage dump was located near the camp. In national parks of the United States four deaths have been attributed to bears (Reid, 1970).

In Appendix 4, we have summarized the circumstances of six other attacks and 14 threats on people in the national parks of Canada. We have included only those incidents on which we have fairly complete written accounts from the park files, from park wardens' wildlife data cards, or from personal communications.

Factors associated with belligerence

From his literature review Riegelhuth (1966) concluded that most "unprovoked" attacks by grizzlies were preceded by one of three circumstances: approaching a female with young at close range, approaching a bear in possession of a carcass, or surprising a bear at close range.

Herrero (1970) examined records of attacks on people by grizzlies in national parks in the United States and Canada. Forty-five of 66 reported attacks occurred in Yellowstone, most of them in campgrounds. Herrero cited characteristics of the Yellowstone situation that were probably related to the high number of attacks: many years of garbage disposal in open dumps, a dense grizzly population, the location of major campgrounds in choice grizzly habitat, and the habit of some grizzlies of seeking food in campgrounds.

Herrero pointed out that in none of the case histories did hikers report making noise, such as loud talking or bell clanking, just before the attack. He concluded that surprise, both of the bear and of the person(s) was an important element common to many attacks. He believes that for each bear and for each set of circumstances there is a minimum distance to which another bear or a person will be permitted to approach. Intrusion within that radius evokes threat or attack.

It is striking that each of the six attacks described in Appendix 4 was by an adult, presumably female, accompanied by young. Similarly, in 31 of the 39 attacks for which Herrero (1970) knew the age class of the grizzly, the attacker was an adult accompanied by young.

In two of the incidents that we documented, the bear was approached at a rich food supply: Tremblay approached an adult and young at a sheep carcass, Sturdy approached an adult and young at a garbage dump.

The belligerent behaviour of the grizzly that treed Tremblay can almost certainly be attributed to the bullet wounds it had received. In a similar incident near Hinton, Alberta, on September 16, 1965, a grizzly mauled a hunter who had wounded it and, the next day, attacked a forest ranger who was hunting for it (Alberta Department of Lands and Forests, 1966).

In two attacks a dog was present: Branner's dog approached the grizzlies barking, although Gardner's dog apparently did not actively provoke the attack. In both instances of threat described by Wilkins, an adult bear accompanied by young chased a dog. We suggest that a dog's presence may stimulate an adult female with young to attack and if a person is nearby, the attack may be redirected towards him.

We have a similar observation for black bears. On the evening of August 11, 1957, in Prince Albert National Park, Saskatchewan, Flook and A. M. Pearson approached an adult black bear with three cubs, feeding at the base of a garbage dump ramp, near

enough to mark them with paint. This apparently disturbed them very little. We later approached them, this time leading a 5-month-old male Norwegian elk hound on a chain. The bears moved into the forest while we were still farther away than they had previously allowed us to approach. Almost immediately, the adult bear reappeared, running towards us. We released the dog. He ran towards the car with the bear in close pursuit until we fired two shots in the air. The bear ran back into the forest to its cubs.

To help the reader maintain his perspective regarding the risk of a bear attack in a national park, we wish to point out that grizzlies usually avoid people. Herrero (1970) calculated the injury rate from grizzlies in all North American national parks inhabited by this species at 1 per 2 million visitors and the death rate at 1 per 30 million visitors.

The tourist, logging, mining and petroleum industries are bringing more and more people to the hitherto wild lands of western Canada. This will inevitably cause a further decrease in numbers and distribution of grizzlies. National parks, in their role as nature preserves, must therefore provide for the maintenance of grizzly bear populations. At the same time they must reconcile this role with another related function — that of providing the public with the opportunity to enjoy nature. The public must be offered a reasonable degree of safety from attacks by bears, but bear populations must also be protected. In their normal movements many bears may move out of the parks to areas where they are hunted in open season and, more significantly, destroyed as nuisance animals. The capacity of grizzly populations to replace such losses is low. Even under optimum conditions, the yearly death of more than one-fifth of a population would probably lead to its extinction. Furthermore, the killing of bears in national parks compromises national park ideals, and is repugnant to many. Even if killing were balanced by natural replacement, it should be avoided — except as a last resort.

Attacks by grizzlies are infrequent, but the injuries can be severe. The logical way to reduce the risk of attacks is to reduce the probability of encounters between people and bears. Two circumstances increase the contacts between people and grizzlies in the parks: one is the attraction of bears to garbage, the other is the increase in numbers of hikers in the back country.

The garbage problem

In spring grizzlies in the parks would normally move to higher elevations, as the snow recedes, to take advantage of the first green forage. This pattern, if not altered, would take bears away from the main valley floors during periods of heaviest use by visitors. However, garbage, in open dumps or overflowing from badly designed incinerators, influences distribution of bears. The distribution of garbage dumps cor-

Garbage dump near Pocohontas, Jasper National Park. In 1966 an adult grizzly bear with three yearlings frequented this dump and the bungalow camp nearby. In 1967 one of the young chased two children near the camp and was subsequently shot. Information and photo by J. G. Stelfox.

responds closely to the distribution of people, thus the bears' attraction to garbage greatly increases the chances of encounters between bears and people. Some grizzlies are seen only briefly at a garbage dump, others remain in the vicinity for lengthy periods. Considering the numbers of grizzlies frequenting garbage dumps and the numbers of park visitors in the adjacent areas, the frequency of encounters between the two has been surprisingly low, because the grizzly feeds at night and usually avoids people. However, as visitors increase, so will the volume of garbage. If inadequate garbage disposal were to continue, more bears would frequent the settled areas and the risk to visitors would increase.

Jonkel (1970b) described a comparable situation in which polar bears concentrated in and around Fort Churchill, Manitoba, where they fed at a garbage dump. He described three attacks on people, one of them fatal, in three years and pointed out the need for effective garbage disposal.

The need to replace open garbage dumps and inadequate incinerators by supplementary-heated incinerators of adequate size and design is urgent. These would have the capacity to burn peak loads of garbage rapidly and completely, but even the most adequate incinerator will not always be well tended, so bears may be attracted to the vicinity at times. Incinerators should therefore be located away from the centres of human habitation, and roads leading to them should be closed to the public. To make incinerators effective it is also necessary to forbid garbage dumping at the various concessions and satellite visitor service areas throughout the parks and to institute daily garbage hauls to the incinerators. Some have argued that open dumps attract black bears and help keep them out of the townsites. However, open dumps result in high populations of bears living close to townsites. As the bears do not spend all their time on the garbage dumps, the chances of close encounters between people and bears are increased, thus presenting a real hazard. The principles of



Figure 6. "Bear-proof" concrete garbage bin developed and used in Jasper. Photo by D. A. Blood

grizzly management in national parks should also be applied to black bear management: remove all factors which attract them to the settled areas so they will distribute themselves in relation to the natural food sources and remain wild.

"Sanitary" land fills have been suggested as an economical method of garbage disposal in national parks, but these are unacceptable. L. McGuire (pers. comm.), chief park warden, has seen black bears in Prince Albert National Park successfully dig through substantial depths of fill to reach garbage. Although the old garbage dump near Banff was supposed to be a sanitary land fill, burying the garbage never prevented bears from feeding on it. The site attracted large numbers of black bears and a few grizzlies. Fencing could prevent bears from reaching the garbage, but would not stop the odour from attracting them. The success of garbage burial would require that each load of garbage be buried immediately beneath several feet of fill. Not only would this be expensive, but it would also demand an excessive area of land.

Proponents of sanitary land fills argue that incinerators cause air pollution. J. Grange (pers. comm.), regional engineer, Northern Region, Public Health Engineering Division, Department of the Environment, says that the fumes produced by well-designed and properly operated incinerators, particularly those with supplementary heating, are negligible.

It is also necessary to prevent the garbage cans in campgrounds, picnic grounds and townsites from attracting bears. Of containers that we have seen in national parks in western Canada, the only type that has been consistently "bear-proof" is a concrete bin containing a steel barrel (Fig. 6). Refuse is dropped into the barrel through a hinged, bolted lid on the bin. A sliding bar is removed from the front of the bin so that the barrel can be taken out and emptied. This installation was first used in Jasper. This container has a tidy and unobtrusive appearance, in keeping with park objectives. We strongly urge that this type



of container be used throughout parks inhabited by bears and garbage pickups be made every evening to reduce odours during the night.

Unless precautions are taken when new incinerators begin operation, the numbers of bears seeking food in the townsites and other areas of heavy visitor use will suddenly increase, as occurred in Yoho in 1968. Shortly before a new incinerator goes into operation, efforts should be intensified to capture bears feeding on garbage, move them to remote areas and, if they return, to destroy them or donate them to zoos. Once garbage is no longer available and the habitués are removed, the number of grizzly or black bears that must be removed should be small. In addition, regulations against visitors feeding bears must be strictly enforced because black bears are easily habituated to approaching people for food.

In recent years wardens have increased their attempts to capture bears in settled areas of the parks and release them in remote areas, rather than shoot them. These efforts are commendable and we recommend they be continued when and where removal is required. All bears released should be permanently marked with numbered ear tags. Subsequent observations or recaptures will thus provide current data on bear movements and on particular bears. Bears have been moved only to areas accessible by truck. To transfer a "problem" bear to another area used by people only transfers the problem. Because several roads built for fire suppression have now been opened to the public, the areas to which bears can be hauled are limited. We recommend that some roads remain closed to public use if hauling of bears is to be continued.

We must emphasize that capture and transport is not a basic solution to the problem of either grizzly or black bears in the settled areas of the parks. It will no doubt always be necessary to remove a few bears when they take up residence near settled areas. Transferring bears to a remote

area is certainly preferable to shooting but, as our study shows, many grizzlies return to the capture areas or move to another settled area, where they are equally unwelcome. The result is, they eventually have to be shot. Even if a transported bear remains in its new range, its survival opportunities may be reduced by competition or conflict with resident bears. The basic cause of bears concentrating near settled areas and campgrounds is faulty garbage disposal. Until there is proper garbage disposal, all other efforts, including capture and transport, must be regarded as temporary expedients to alleviate immediate problems.

Location of campgrounds

We agree with Herrero (1970) on the importance of locating campgrounds outside choice grizzly habitat. In western Canadian parks this would generally mean excluding such campgrounds from the higher valleys.

Back-country travellers

Random encounters between travellers and grizzlies in the back-country will continue to occur as long as both use the parks. However, such encounters are usually not dangerous and their frequency can be reduced by manipulating the distribution either of the people or of the bears, so that they will tend to use different areas. In addition, the risk of attack can be reduced by informing the public of appropriate behaviour in bear country. These are our recommendations:

1. Special wilderness status should be assigned to certain areas of grizzly range. Such areas should be kept free of improved trails, shelters and roads. It might become necessary to restrict access to such areas, but for the time being it would probably be enough simply to encourage would-be wilderness visitors to choose other areas.

2. Park wardens should maintain a current record of sightings of grizzly bears so dangerous areas can be delineated. Hikers should be advised to avoid areas known to be currently occupied by griz-

lies, particularly those accompanied by young and those showing aggressive tendencies. A system of this kind has been used in Glacier National Park, Montana, with promising results (C. J. Martinka, pers. comm.).

3. Hikers should be encouraged to make enough noise to warn bears of their approach. A bell hung on a pack is a convenient noise-maker.

4. Dogs should be restricted to visitor service areas.

5. Trail-users should be issued with plastic bags in which to seal their garbage, and should be required to pack all garbage that they do not burn to one of the bins serviced by road.

Data collection

To measure the success of efforts to preserve grizzly populations and protect the public in the parks, certain information should be gathered on a continuing basis. Distribution and numbers of grizzlies in relation to habitat, season and human distribution should be studied extensively in all the parks. The need for complete records on the destruction or capture and release of bears should be impressed on park personnel. All reports of conflict between bears and human beings should be recorded so that changes in their frequency can be detected, and behaviour of bears be more accurately predicted. With this information it may be possible to manage parks so as to maintain grizzly populations, while providing an acceptable degree of public safety.

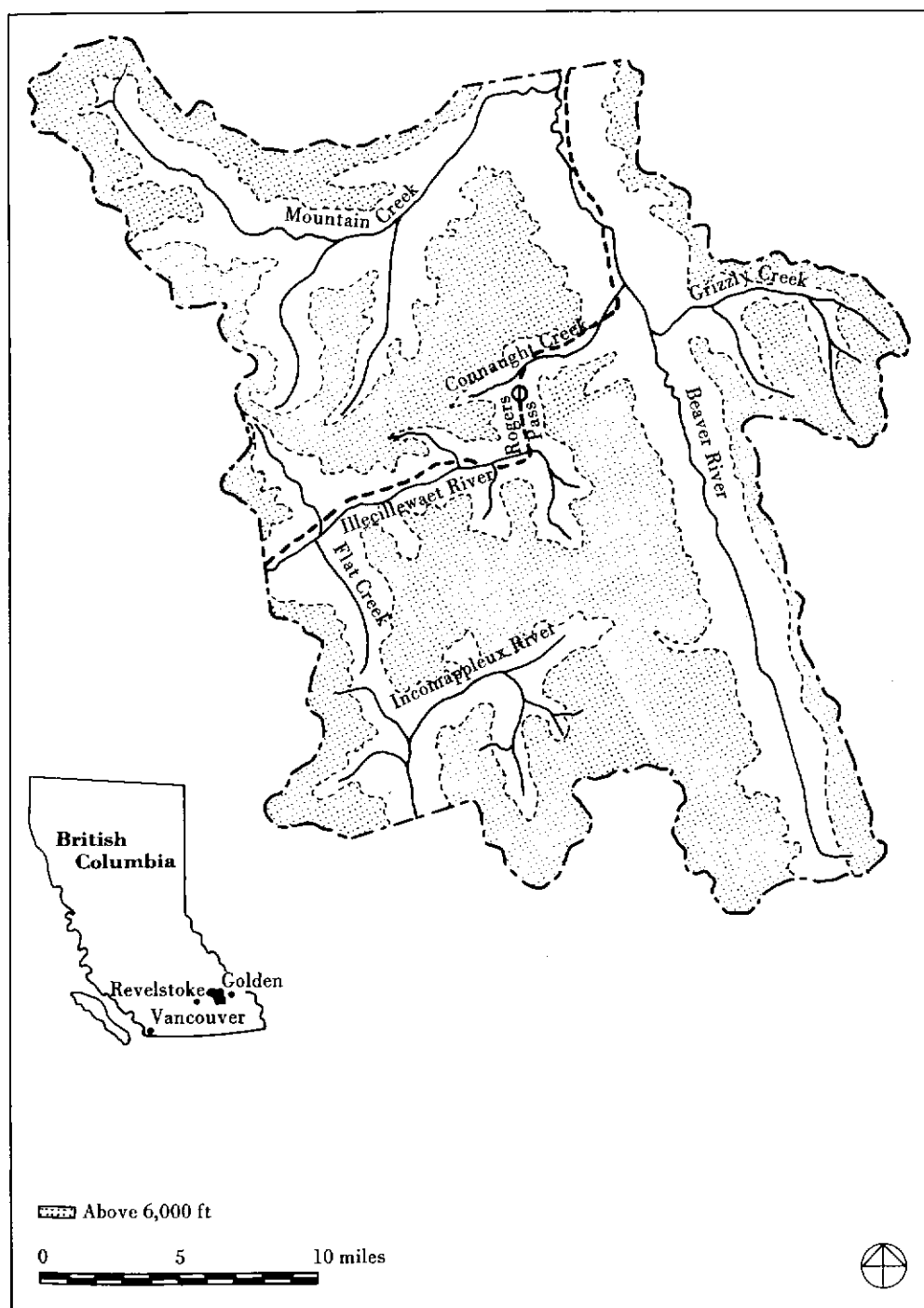
Public information

Interpretive programs should inform the public of the grizzly's life history, behaviour and status, and the factors threatening the species. Public support is needed if government agencies are to maintain wild populations of grizzlies and other large carnivores. Knowledge about bears would help increase the park visitor's safety and peace of mind and add to his enjoyment of the park scene.

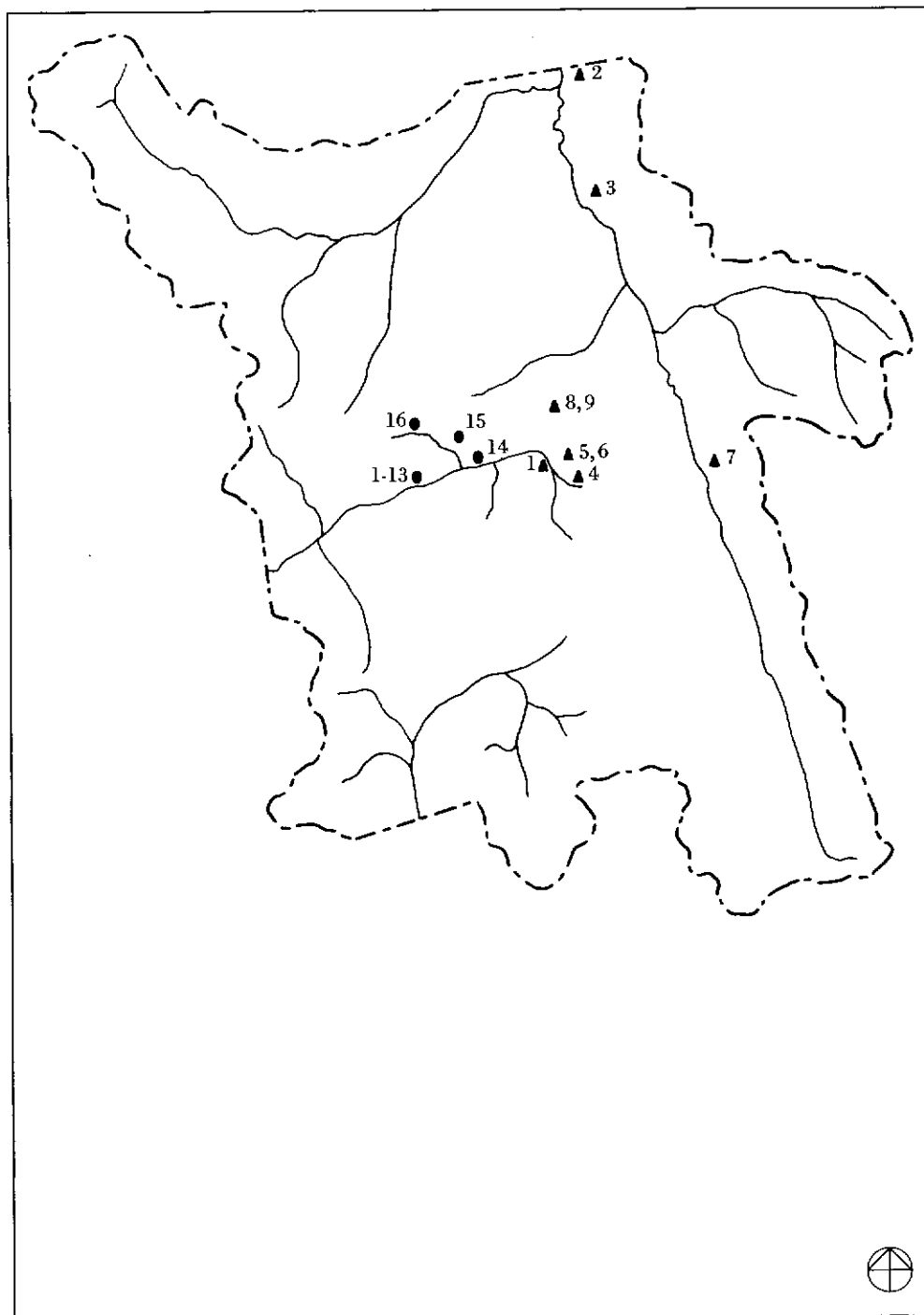
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Appendix 1a



Appendix 1b



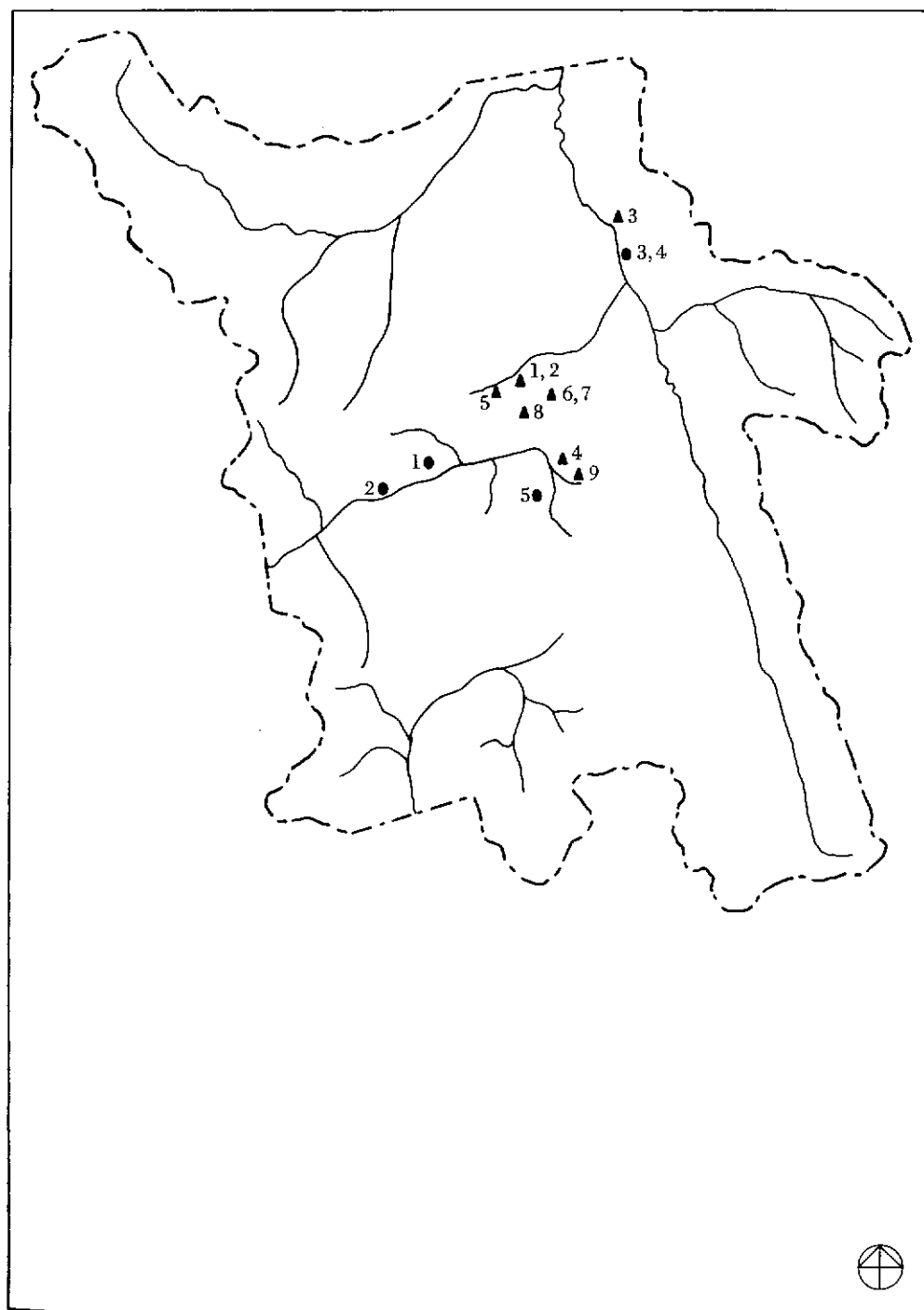
Bear 1 ●

- 1-13 May 8, 9, 23-27, 29, June 3, 5-7, 1962, observed, 1 mile west of Cougar Creek
- 14 June 15, 1962, observed, 1 mile east of Cougar Creek
- 15 June 26, 1962, observed, Cougar Valley
- 16 July 13, 1962, observed, above Nakamu Caves

Bear 2 ▲

- 1 May 9, 1961, captured, Glacier dump
- 2 May 9, 1961, released, east park boundary
- 3 May 20, 1961, observed, 4 miles south of release site
- 4 July 19, 1961, observed, Mt. Sir Donald trail
- 5, 6 July 26, 30, 1961, observed, Illecillewaet dump
- 7 August 9, 1961, observed, Beaver Valley, 7 mile trail camp
- 8 September 19, 1961, observed, Summit dump
- 9 September 20, 1961, shot, Summit dump

Appendix 1c



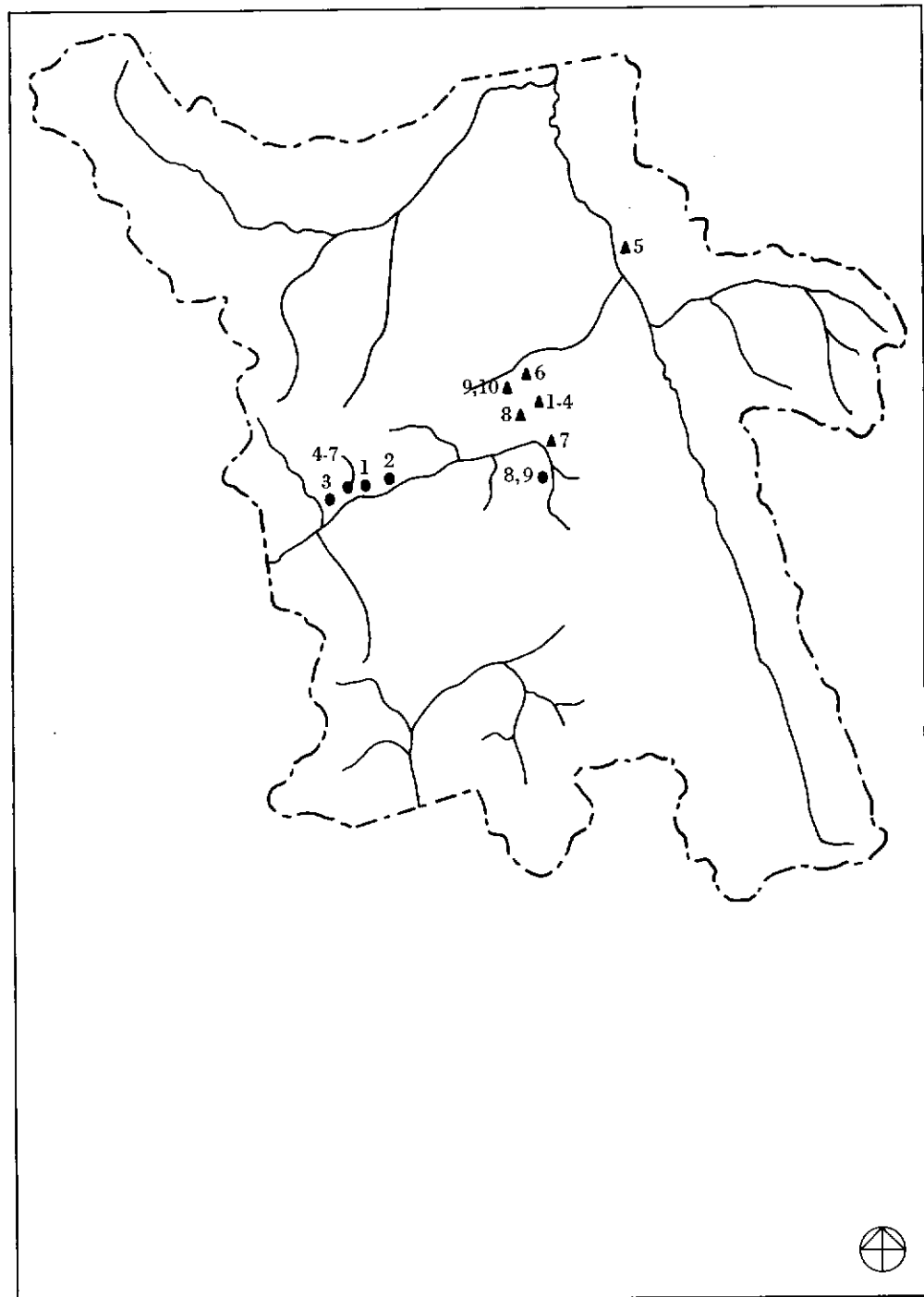
Bear 3 ●

- 1 June 1, 1962, captured, 1 mile west of Cougar Creek
- 2 June 1, 1962, released, 1 mile east of Ross Peak
- 3 August 5, 1962, observed, Beaver River garbage dump
- 4 August 27, 1962, observed, Beaver River garbage dump
- 5 October 11, 1962, recaptured, Illecillewaet campground and released at Mountain Creek

Bear 4 ▲

- 1 June 15, 1962, observed, Summit camp
- 2 June 21, 1962, captured, Summit camp
- 3 June 21, 1962, released, Beaver River
- 4 July 7, 1962, observed, Illecillewaet River
- 5, 6, 7 August 28, 29, 31, 1962, observed near Summit camp
- 8 September 2, 1962, observed, Summit monument
- 9 September 24, 1962, observed, Illecillewaet road

Appendix 1d



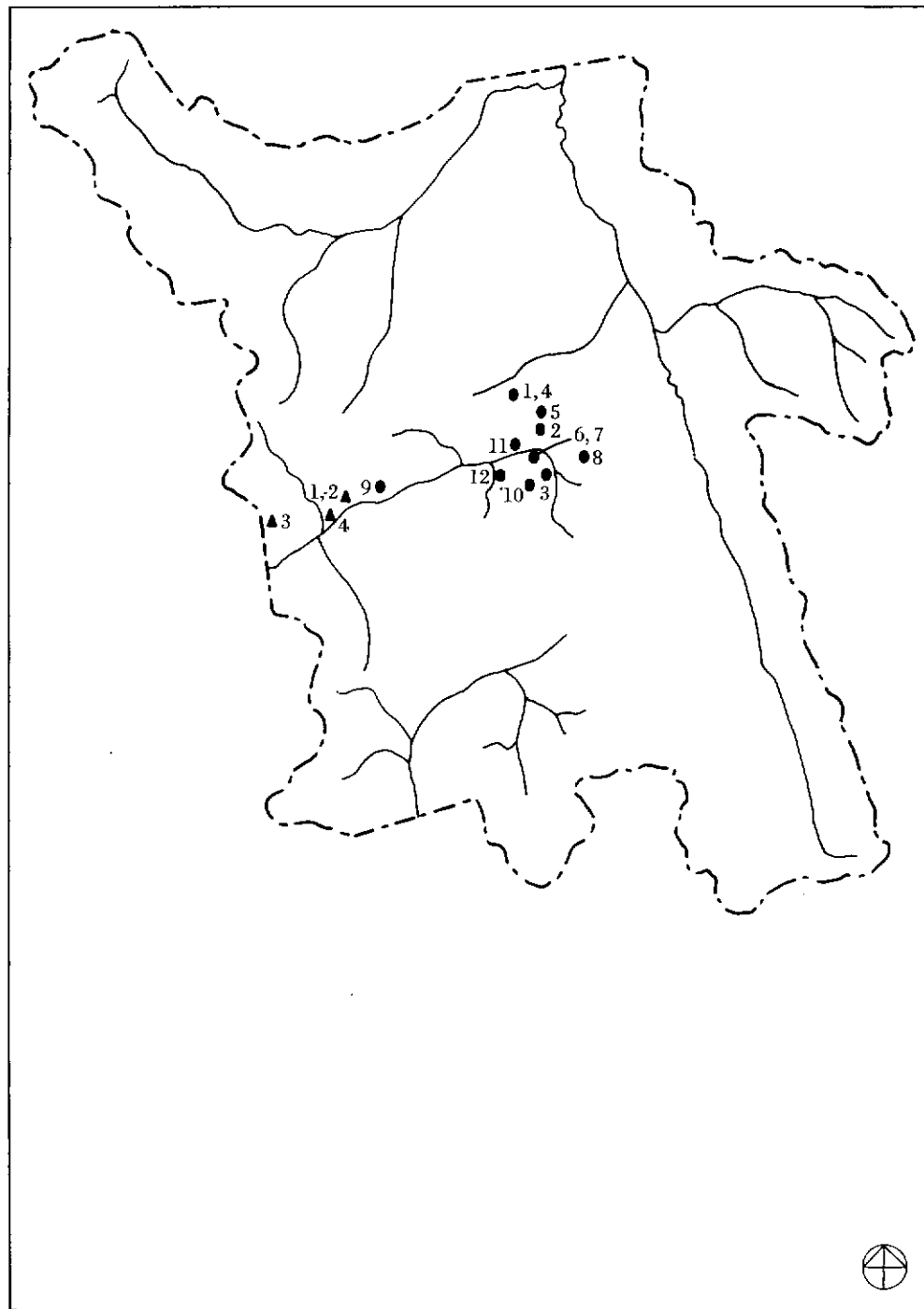
Bear 5 ●

- 1 August 9, 1961, captured, Ross Peak dump
- 2 August 9, 1961, released, 1 mile east of Ross peak
- 3 May 23, 1962, observed, ½ mile west of Ross Peak
- 4 May 26, 1962, observed, Ross Peak
- 5 June 2, 1962, observed, Ross Peak
- 6 June 25, 1962, observed, Ross Peak
- 7 August 2, 1962, captured and released, Ross Peak
- 8 August 9, 1962, observed, Illecillewaet campground
- 9 August 12, 1962, captured and destroyed, Illecillewaet campground

Bear 6 ▲

- 1 June 1, 1962, observed, Summit
- 2 June 15, 1962, observed, Gunsight dump
- 3 June 18, 1962, observed, Summit
- 4 June 19, 1962, captured, Summit camp
- 5 June 19, 1962, released, Beaver dump
- 6 June 24, 1962, observed, Summit camp
- 7 July 7, 1962, observed, Illecillewaet culvert
- 8 August 28, 1962, observed, Summit monument
- 9 August 29, 1962, observed, Summit camp
- 10 September 2, 1962, shot, Summit camp

Appendix 1e



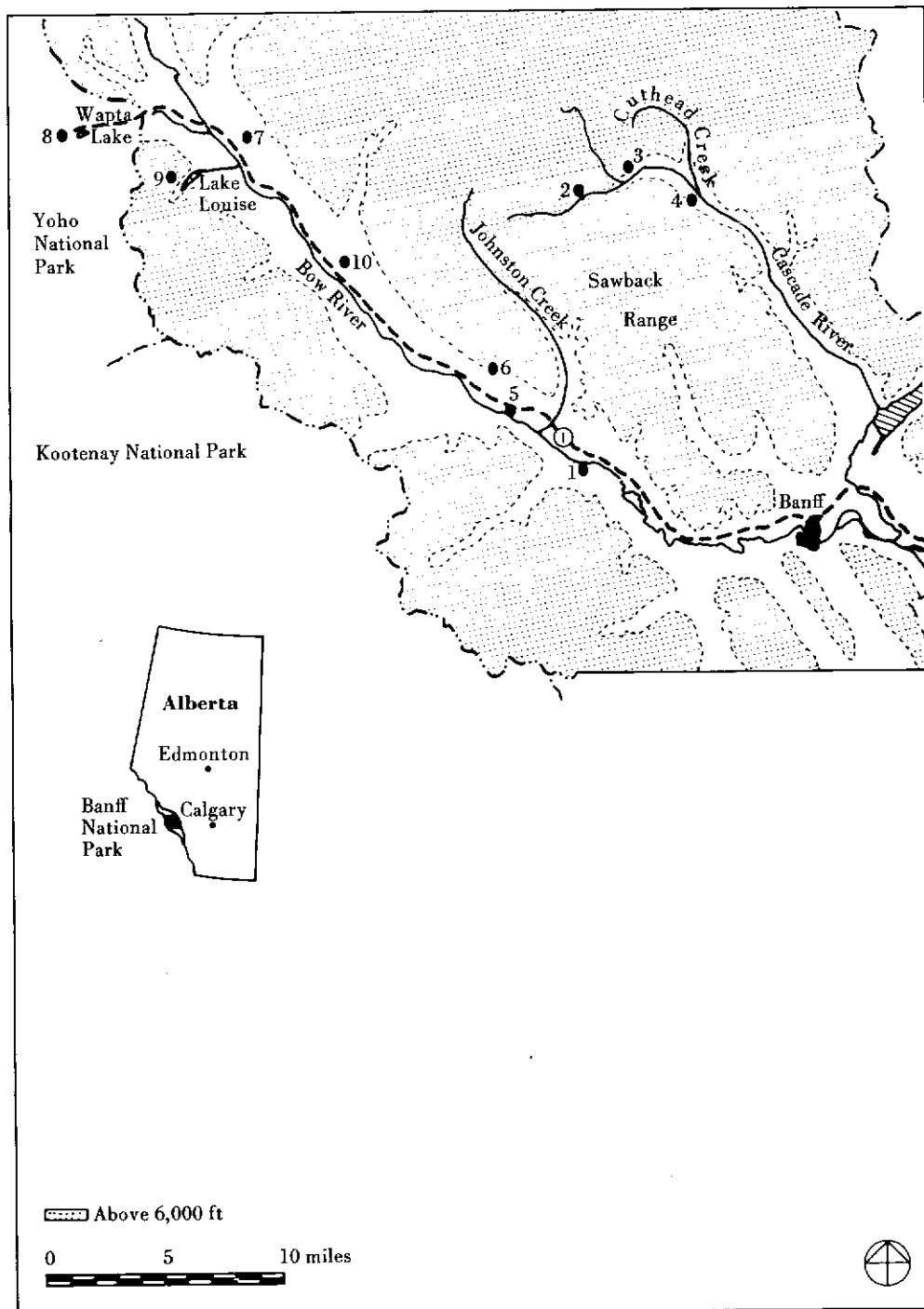
Bear 7 ●

- 1 August 14, 1961, captured, Summit dump
- 2 August 14, 1961, released, 1 mile south of Summit
- 3 August, 1961, observed, Illecillewaet campground
- 4 August 20, 1961, observed, Summit dump
- 5 September, 1961, observed, between Glacier and Summit
- 6, 7 September 6, and October 2, 1961, observed, Glacier Station
- 8 April 9, 1962, observed, Avalanche Creek
- 9 April 26, 1962, observed, ½ mile east of Ross Peak
- 10 May 8, 1962, observed, Illecillewaet campground
- 11 May 10, 1962, observed, Fanhouse
- 12 May 11, 1962, shot, Loop Creek

Bear 8 ▲

- 1, 2 September 2, 1961, captured and released, Ross Peak dump
- 3 May 24, 1962, observed, Mount Fidelity Snow Research Station
- 4 June 2, 1962, observed, Ross Peak

Appendix 1f



Bear 9 ●

- 1 May 14, 1961, captured, Red Earth Creek
- 2 May 14, 1961, released Flint's Park
- 3 May 16, 1961, observed, Cuthead Creek
- 4 May 21, 1961, observed, Stoney Creek
- 5 June 6-7, 1961, observed, Castle siding
- 6 June 8, 1961, observed, Eisenhower Lookout
- 7 June 13, 1961, observed, Lake Louise garbage dump
- 8 June 16, 1961, observed, Wapta Lake garbage dump, Yoho Park
- 9 August 1961, observed, south of Lake Agnes
- 10 May 16, 1962, shot, Eldon

Appendix 2

Weight, sex and age of grizzlies captured or autopsied, Glacier and Banff

Park	Date	Weight * (kg)	Age† (yr)
Males			
Banff	May 16, 1962	9½	< 1
Glacier‡	July 28, 1962	27	1
Calgary zoo‡	Sept 14, 1962	34	1
Glacier‡	July 28, 1962	27	1
Calgary zoo‡	Sept 14, 1962	40	1
Glacier	Aug 9, 1961	91	2
Glacier	Aug 13, 1962	104	3
Banff	Sept 11, 1962	109	3§
Glacier	June 1, 1962	159	adult
Glacier	Sept 2, 1961	234	adult
Glacier	Aug 27, 1962	354	adult
Glacier	Sept 8, 1962	213	adult
Glacier	Sept 16, 1962	227	adult
Females			
Glacier	Aug 14, 1961	113	3
Glacier	June 21, 1962	125	adult
Glacier	Sept 19, 1962	128	adult
Banff	May 14, 1961	131	adult

*To obtain approximate weight in pounds multiply weight in kilograms by 2.2.

†All ages refer to previous birthday.

‡Two successive measurements of same animal.

§Age determined from cemental layers.

Ages of other specimens estimated from body size.

Appendix 3

Skull measurements and ages of grizzlies from
Alberta and British Columbia

Ref. No.	Date	Locality	Zygomatic width (mm)	Greatest length (mm)	Age* (yr)
Males					
CWS 11	May 1962	Banff, Alta.	94	157	< 1
CWS 2	June 1961	Banff, Alta.		250	2
CWS 15	Sept 1962	Banff, Alta.	164	296	3
UA 2537	Oct 1957	Slave Lake, Alta.	160	307	3
UA 2526	Nov 1954	Red Willow Creek, Alta.		400	9
CWS 16	Sept 1962	Glacier, B.C.	207	319	13
UA 2535	May 1957	Freeman River, Alta.	224	365	16
CWS 12	July 1962	Glacier, B.C.	223	366	17
UA 2534	May 1957	Slave Lake, Alta.	231	392	19
UA 2538	May 1958	Berland River, Alta.	224	387	23
CWS 9	May 1962	Mt. Revelstoke, B.C.	223	359	23
Females					
CWS 8	June 1962	Glacier, B.C.	120	217	1
UA 2528	April 1954	60 mi. N. of Whitecourt, Alta.	134	241	1
UA 2536	1957	Tony Creek, Alta.		255	1
CWS 1	Sept 1960	Glacier, B.C.	149	273	1
UA 2529	1956	Eagle Creek, Alta.	134	255	2
CWS 3	Sept 1961	Glacier, B.C.	161	299	3
CWS 6	June 1958	Banff, Alta.	153	275	4
UA 2721	Sept 1960	Hinton, Alta.	179	313	6
UA 2523	Sept 1952	Asclum Creek, Alta.	184	347	7
CWS 5	Oct 1960	Jasper, Alta.	186		11
CWS 10	1962	Beaverfoot River, B.C.	184	306	23
Sex unknown					
UA 3700		Jasper, Alta.	153	290	3
UA 2530		Nass River, B.C.	166	313	4
UA 2524	1954	Fort Assiniboine, Alta.	178	344	4
CWS 7	Nov 1960	Jasper, Alta.	215	333	13
CWS 4	July 1961	Kootenay, B.C.	232	378	16
UA 2525	July 1954	Kimberly, B.C.	215	347	18

*Age determined from tooth replacement in bears up to 2 years of age, and from number of cemental layers in older animals. Ages refer to previous birthday.

Appendix 4

Circumstances of six attacks and fourteen threats by grizzly bears on people in the national parks of Canada

Attacks

1. N. Morant and C. Haesler were walking on a trail near Sherbrooke Lake in Yoho on September 19, 1939, when they saw an adult grizzly with one young on an avalanche slope, about 300 yards (274 m) uphill from them. After they had passed the grizzlies, on the trail below, the adult charged them. Both men climbed small trees, but the grizzly pulled Haesler down and attacked him. Morant came down to help Haesler and was also attacked. They were seriously injured but recovered.

2. G. F. Horsey and his son were walking along the Twin Falls trail in Yoho on July 8, 1943, when they saw an adult grizzly with young rapidly following them. The father and son paused briefly, then began to run up the trail. The young bear apparently left the trail but the adult continued the pursuit, gaining ground rapidly. When it was about 100 feet (30 m) from them, Horsey told his son to leave the trail and try to climb a tree. He himself lay flat across the trail. The bear took one nip at his leg, put a paw on his knee for a moment and then departed into the forest to the opposite side of the trail from where the son had gone.

3. On August 20, 1962, at about 800 hours, N. C. Gardner was walking up Christiana Ridge in Glacier with his German shepherd dog. A bark and a howl from the dog alarmed Gardner and he began to climb a tree. An adult grizzly advanced towards Gardner from downwind, snorting. It first caught his foot, then grasped his thigh. The dog attacked; the grizzly released Gardner and chased the dog, as Gardner called instructions to go home. The grizzly returned to Gardner, who had by then climbed about 5 feet (1.5 m) higher. It attempted to climb up to him. At this stage, Gardner noticed two cubs below. As the adult came close, Gardner punched at its

nose and it dropped to the ground. The bears then apparently left the area. Gardner climbed higher and tied himself to the tree with his shirt. The dog alerted people at the nearby Snow Research Station. Gardner was hospitalized for ten days. He subsequently recovered.

4. On the evening of August 30, 1966, F. Sturdy was walking with a girl near a garbage dump close to Maligne Lake in Jasper when a grizzly bear charged them. The girl fell, and the bear continued chasing Sturdy. He tripped and fell and the bear mauled him. He sustained severe injuries for which he required prolonged hospitalization. The next day tracks showed that the attacking bear was an adult accompanied by three young, probably yearlings. Such a group had been seen earlier the same day about one-quarter mile from the garbage dump.

5. On May 2, 1968, K. Branner was walking with his large dog in the Lake Louise area. He saw an adult grizzly with two young and another adult at about 100 yards (30 m) away. He moved into a small stand of birch trees to avoid being detected, but the dog ran barking towards the bears, then returned to him. The bear, thought to be the mother of the young, charged Branner, who tried to avoid it by dodging behind trees. It bit him slightly above the knee, puncturing the skin; it circled him and tore the cuff from his sweater. Branner then shouted loudly for his dog; at this time the bear left, followed by the other members of the group.

6. On the afternoon of June 5, 1968, L. Jeck, D. Slutker and S. L. Rose were climbing a steep wooded slope south of the Snake Indian River in Jasper. Slutker was well ahead followed by Jeck and Rose. Suddenly, Jeck was confronted by an adult grizzly running downhill towards him, followed by its cubs. He had time only to slap at the adult with a small canvas bag, before he was knocked down. They tumbled downhill for about 50 feet (15 m). The grizzly bit him on the legs, arms and neck

then ran up the hill, pulled Rose from a small tree, from which he had been shouting and severely wounded his shoulder. It then ran to Slutker and bit him severely on the face. All the wounds were inflicted by biting. The three men required surgery and hospitalization.

Threats

1. On July 23, 1951, while driving a jeep on the old Rogers fire road in Glacier, N. C. Gardner was pursued by an adult grizzly, which ran closely behind the vehicle for about 300 yards (274 m) at approximately 30 miles (48 km) per hour. He assumed the bear had young nearby.

2. C. Wilkins reported that, in September 1952, he and two other men with a collie dog surprised an adult grizzly with two cubs at the carcass of a moose tangled in telephone wire, in the Tonquin Valley of Jasper. The men retreated into the forest. The bear, apparently pursuing the dog, met the men at close range, then departed, gathering the cubs en route.

3. Wilkins also reported that in spring 1953 he saw an adult grizzly and two young on the shore of Amethyst Lake in Jasper. To test the grizzlies' reaction Wilkins sent his Airedale dog along the lakeshore. The adult ran for 200 to 300 feet (61 to 92 m) after the dog, the latter continuing to run away from Wilkins. The bear then departed with the cubs.

4. On August 2, 1955 while travelling on horseback with packhorses near the Spray River in Banff, H. Ashly surprised two adult grizzlies drinking in a creek. The bears retreated a short distance, then ran towards him, but stopped before reaching him. The horses remained quiet and the bears departed.

5. On September 1, 1959 while driving between Bow Summit and Lake Louise in Banff, J. Woledge met an adult grizzly with young. He stopped to look at them and the adult charged at the truck three times. Woledge climbed into the truck cab twice, as the grizzly continued advancing when he shouted at it.

6. On August 7, 1960, M. McGraw walked up the Bostock Creek trail in Glacier and lay down to rest at the Summit. On hearing a sound, he opened his eyes to see an adult grizzly standing on its hind legs close behind him. He jumped to his feet. The grizzly knocked off his hard-hat with its forepaw; it swung a forepaw again, and left three tears in his shirt sleeve. McGraw ran back down the trail, the grizzly close behind. Once or twice it passed him and blocked his path, making him go around it. The bear soon departed, leaving him unharmed. McGraw continued running to the nearest cabin. Early in the encounter he had noticed two cubs nearby.

7. L. Tremblay reported that on the evening of September 5, 1960, in Whitehorse Pass near the Jasper boundary, a grizzly "put me up a tree for over two hours." The following day Tremblay, a park warden, shot and killed a large male believed to be the same bear. It had previously been shot in the right front leg, breaking the bone, and in the left thigh. Bears were being hunted on lands adjacent to the park.

8. On September 10, 1960, Tremblay surprised an adult grizzly with cubs at the carcass of a bighorn (*Ovis canadensis*) ram it had apparently killed, near Mystery Lake in Jasper. The adult ran at Tremblay. He fell down, then fired a shot evidently not hitting the grizzly. The bear immediately turned and left.

9. Early on the evening of November 3, 1961, while driving on the Banff-Jasper highway 5 miles (8 km) north of Lake Louise, M. Tarr saw an adult grizzly and two 2-year-olds cross the road ahead and climb the bank. As the truck passed below them, the adult descended and ran after it for about 50 yards (45 m).

10. On June 13, 1962, J. Holstenson and a companion were travelling on horseback on the Pipestone Valley trail in Banff. They met a small grizzly about 2 years old. The bear ran towards them, stopped about 30 feet (9 m) away, appeared to be confused, then departed.

11. On April 20, 1966, at about 1100 hours, S. M. Elder was walking down the Snake Indian trail in Jasper with his female husky dog. He encountered a large grizzly which ran towards him. Elder climbed a tree and the bear stood below on its hind legs, snapping its jaws. It eventually became less excited, stopped snapping, dropped to its four feet, and circled the tree for a few moments before leaving. Elder then came down. The dog had been behind Elder when they encountered the bear; it remained silent and lay down out of sight among shrubs. The bear apparently did not become aware of it. This dog was reported to have been tethered as a pup in the vicinity of a black bear in a Walt Disney filming operation, which may explain its behaviour.

12. On the afternoon of July 10, 1966, while walking at the north end of Maligne Lake, L. Nordland saw four yearling grizzlies running down the trail towards him. An adult bear ran from behind the young towards Nordland. He ran into a tool shed and closed the door.

13. On the evening of October 9, 1966, Mr. and Mrs. S. M. Elder were driving from Maligne Lake towards Jasper. Five miles (8 km) from the lake, they saw an adult grizzly with two cubs illuminated by the headlights. The bears ran down the road ahead of the car for about 200 feet (61 m), then the cubs turned off the road. At that time they were about 80 feet (24 m) in front of the car. Elder sounded the car horn, and the adult turned and charged. Elder stopped and reversed the car rapidly. The bear ran very close to the car for about 100 feet (30 m), then turned back without having struck the car. Elder paced off the distances from the tracks on the next day.

14. On September 9, 1967, S. Peyto, J. Chisholm and D. McTrowe saw an adult grizzly and two small cubs at the upper end of Sawback Lake in Banff. The adult took the cubs up the dead-end valley and returned alone walking down the shore of the lake, roaring as the men departed.

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