NORTH CASCADES NATIONAL PARK

ROSS LAKE AND LAKE CHELAN NATIONAL RECREATION AREAS

SEDRO WOOLLEY, WASHINGTON

PRELIMINARY INVESTIGATION OF THE FEASIBILITY OF REESTABLISHING A GRIZZLY BEAR POPULATION IN THE NORTH CASCADES NATIONAL PARK COMPLEX

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INTRODUCTION

The brown-grizzly (Ursus arctos) of North America is composed of the brown bear race from coastal Alaska (U. arctos middendorffi) and the grizzly (U. arctos horribilis) from interior Alaska, Canada and the western United States. These will hereafter be referred to jointly as "grizzly bears" if racial distinctions are unimportant and not specified. Like so many animal species, the grizzly bear has undergone a severe decline in numbers and range with the advent of civilization, and faces a serious threat of continued decline in some areas. For this reason, the grizzly of the 48 conterminous states was classified as "Threatened" by the U.S. Fish and Wildlife Service in accordance with the Endangered Species Act of 1973 (16 U.S.C. 15533 (a) (i)) Department of the Interior 1975.

Bear biologists have considered several methods of alleviating the pressure on the grizzlies. One possible alternative is transplanting or reestablishing grizzlies into areas of former range. Though not necessarily a biological necessity, it is felt to be a good method for enhancing the overall stability of the grizzly (Jonkel 1975) . The National Park Service (1978) has encouraged reintroductions of extirpated species, provided that:

- adequate habitat exists in the park and on adjacent public lands and waters to support the species;
- the species, based on an effective management plan, does not pose a serious threat to the safety of park visitors or park resources, or to persons or property outside of park boundaries;

- the subspecies being reintroduced most nearly approximates the extirpated subspecies;
- the species disappeared, or was substantially diminished, because of human-induced changes to the ecosystem.

North Cascades National Park is devoid, or nearly so, of a grizzly bear population. Feeling that the park provided a potentially suitable site for a reintroduction project, the park research biologist, Robert Wasem, initiated a study to determine the feasibility of such a project. This report is the product of a preliminary investigation, during the summer of 1978, on the suitability of North Cascades National Park, and Ross Lake and Lake Chelan National Recreation Areas as potential reintroduction sites for grizzly bears.

DEMISE

Prior to 1900, grizzly bears were a fairly common constituent of the wildlife fauna of western North America, occupying such diverse habitats as mountains, grasslands and even ocean beaches. Lacking natural predators or a strong detrimental susceptibility to parasites and diseases, the grizzly's demise appears to have been completely at the hand of man. Numerous factors have been cited as contributing to this decline either through habitat encroachment or direct mortality (Schneider 1977). The grizzly has been a tempting target for settlers and hunters, both as a source of meat and recreation. Negative encounters between bears and humans have also motivated the destruction of the grizzly for real or supposed protection of person, property, and livestock. The impact of this mortality was undoubtedly increased by the advent of large bounties, repeating rifles, poison, and the use of dog packs.

Direct mortality can be devastating to a species such as the grizzly which has a low reproductive rate.

Habitat loss was of equal importance. Construction of settlements, shift to agricultural land use, and mining activity decreased the suitable area available to the wide-ranging grizzly. This most certainly limited the size of the populations living in the remaining good habitat and was disasterous for individuals utilizing marginal areas.

RANGE IN NORTH AMERICA

Because of the close resemblance between grizzly bears and black bears, and the fact that frequently little attempt was made to distinguish between the two, historical and even recent records of the presence of bears are of insufficient detail and reliability to be used for an accurate delineation of the grizzly's historical range. Attempts have been made by Seton (1937) and Schneider (1977), which probably represent the best estimates available. They are fundamentally in agreement, with a few exceptions. This range is thought to include most of North America west of the Mississippi River except Iowa, Missouri, Arkansas and Louisiana, and southerly from Alaska to the central Mexico highlands. Seton's estimate is different from Schneider's in that he has omitted northern Oregon, southern Washington and part of eastern Idaho as original range.

The populations and range of the grizzly declined more or less steadily until the present. The current grizzly bear population in the 48 conterminous states has been independently estimated at 600-700 (J.J. Craighead et al. 1976) and less than 1000 (Martinka 1974). Populations are confined to wilderness areas in Wyoming, Idaho,

Montana, and Washington, with the densest populations in Yellowstone and Glacier National Parks and environs. Evidence indicates that some of these populations are moderately stable, although with such small numbers, the threat of extinction is present. A population may be maintaining a tenuous hold in the Sierra del Nido in Mexico (Leopold 1967, Koford 1969). The outlook is less bleak in Canada and Alaska. There the grizzly maintains a firmer grasp and the number of individuals has been estimated at 30,000 (Cowan 1972).

RANGE IN WASHINGTON AND THE NORTH CASCADES

The entire state of Washington was considered to have been included in the range of the grizzly according to Hall and Kelson (1959), Cahalane (1947), and Herrero (1972). However, as mentioned, Seton (1937) omitted southwestern Washington in his estimate of historical range, probably due to the lack of records from that area. In both cases, however, the North Cascades area was included within the range. The abundance and density of grizzly bears prior to the demise are not known, but by 1921, they had apparently disappeared from most of Washington (Seton 1937). At that time, three populations remained in mountain ranges in the north.

The only old dependable available record of a grizzly for the cascade area was the type specimen for the Chelan bear (Ursus chelan), since reclassified as (U. arctos), which was found near Trinity in Chelan County (Merriam 1918). This is about 15 km east of Glacier Peak near the current Glacier Peak Wilderness Area boundary. Following 1950, records have been more reliable, although at the time the Washington Game Department held an annual "bear" hunting season

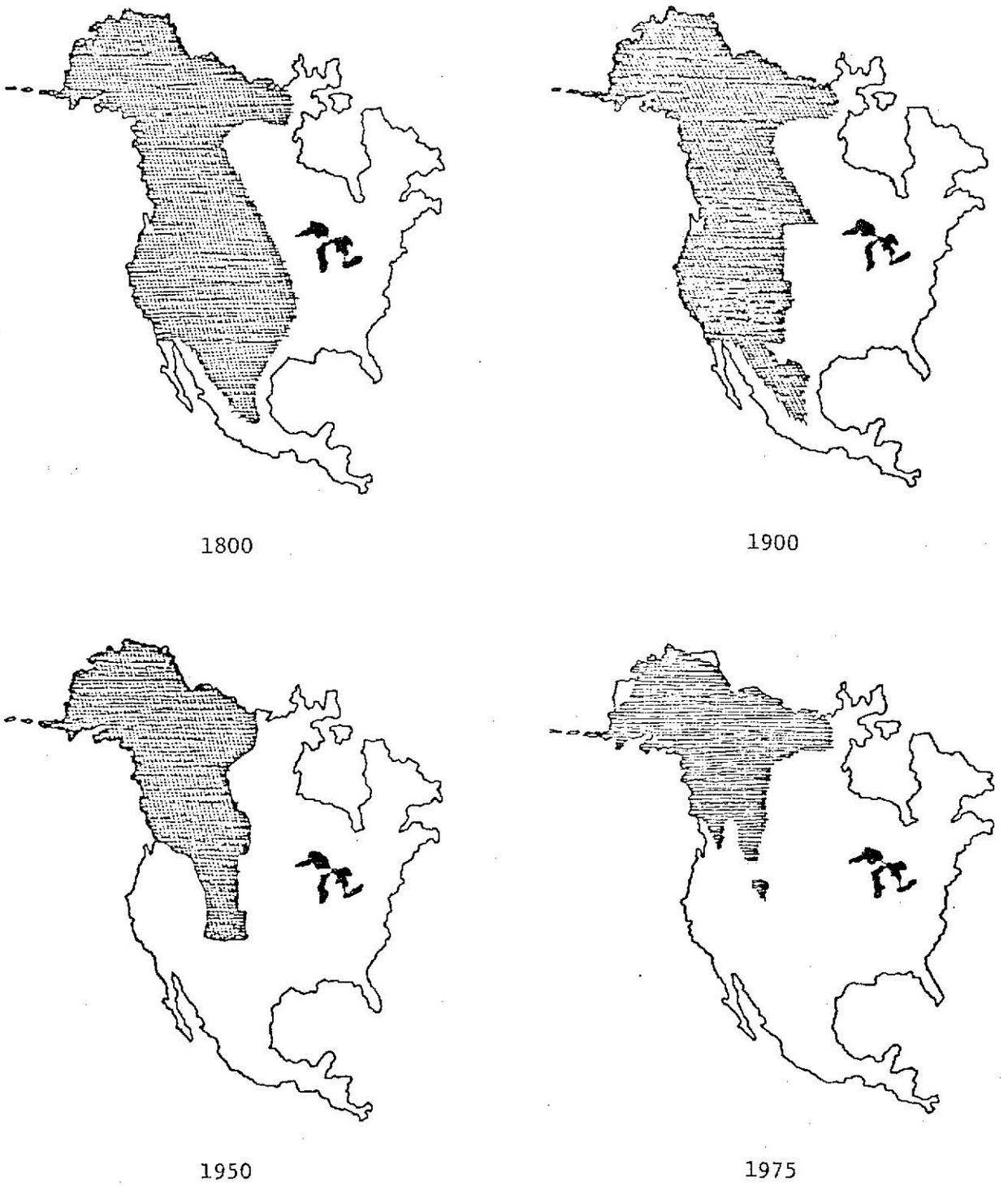


Fig. 1. Range of the grizzly bear (from Schneider 1977).

without making a distinction between grizzly and black bears (Parsons pers. comm.). Numerous sightings and kills have occurred for northeastern Washington up to the present, and it is felt that a small grizzly population probably still resides there (Parsons 1977, Layser 1972).

Fewer records have been reported for the Cascades. Prior to 1964, grizzlies were occasionally killed in the management area which now includes North Cascades National Park, Ross Lake National Recreation Area, and the Pasayten Wilderness Area. One specific sighting was made by Maurice Splane (Mullen 1978) in the Fisher Creek drainage in the mid-fifties. The most recent confirmed grizzly record was of an individual killed by Rocky Wilson of Sedro-Woolley, Washington. This occurred in 1964, also in Fisher Creek basin.

Based on these records the estimated population for Washington has been given as 10 (Cowan 1972, Schneider 1977, and Parsons 1977). Since 1964, no confirmed sightings have occurred in the North Cascades. There have been 5 unconfirmed sightings which have been reported to the National Park Service:

1) In 1970, the Washington State Department of Game's 1969 high lake fishing report summary had a statement "grizzly noted" for the Monogram Lake area. No other details are available.

2) On 26 August, 1972, Harry Wills, the interpretive specialist at North Cascades National Park observed a bear 0.8 km west of Early Winters Creek on State Highway 20, which ran across the road. He stated that it was not overly large but had silver

tipped fur, shoulder hump, and a concave face, and was possibly a grizzly.

3) On 26 July, 1972, Ralph and Dorothy Naas, National Park Service volunteers, Chuck Avendts, Jerry Davis, and Lewis Mehler (spelling uncertain) of the United States Forest Service observed a bear track on Trail 2000, about 1.6 km south of Windy Pass in the Okanogan National Forest. It was indented in mud and measured 14 cm x 25 cm with prominent claw marks deeply indented.

4) On about 25 July, 1978, Tom Graves of Winthrop, Washington observed a bear on a snowfield on the pass between Elbow Basin and Big Face Creek in the Pasayten Wilderness Area, about 7.5 km east of Ross Lake National Recreation Area. He observed the bear from about 0.5 km without the use of binoculars. He states that he was positive that it was a grizzly and knew how to tell them apart from black bears.

   At this time, he also mentioned that he had seen 2 other grizzly bears in about 1967 or 1968. These were in the Pasayten River drainage in the Pasayten Wilderness Area. An aquaintance of his, Dale Tonsin (spelling uncertain) observed the same bears along Robinson Creek the following day, and thought they were grizzlies also.

5) On 26 August, 1978, a warm sunny day, a National Park Service fire lookout, Clifford Thresher saw a bear approximately 0.5 km southeast of Desolation Mountain lookout. He observed it in a rockslide where it may have been attracted by a dead, smelly marmot. The observation was made from a distance of 400 m using 7 X 50 binoculars. The bear stood up and moved off to the southeast into pine trees. Thresher identified this bear as a grizzly - it had a hump between the shoulders and was blonde colored. Thresher had spent time in Alaska where he observed grizzlies and felt confident of the identification.

The absence of confirmed sightings since 1964, along with other evidence such as lack of cub sightings, tends to indicate that a breeding population of grizzlies no longer survives in the North Cascades of Washington, though transient individuals may still on rare occasions move into the area.

HABITAT REQUIREMENTS

As mentioned previously, grizzly bears historically occurred in a wide variety of biogeographical regions ranging from the mountain, prairie, and seashore biomes. This generally indicates a strong tolerance for different habitats, which leads to the assumption that habitat might not generally have been a limiting factor. However, the historical absence of grizzly bears from eastern North America would tend to contradict this assumption.

Currently, in the conterminous United States grizzlies have remained only in mountainous regions. It is not clear whether this is because mountains provide

superior habitats, or simply becuase they are the most consistently extensive areas devoid of heavy human use. Within the mountain biome are numerous habitats or vegetative zones in which the grizzly lives. Some of these, depending on area, are subalpine, whitebark pine (Pinus albicaulis), spruce (Picea spp.), fir (Abies spp.), Douglas-fir (Pseudotsuga menziesii), ponderosa pine (Pinus ponderosa), lodgepole pine (Pinus contorta), sagebrush (Artemisia spp.), willow (Salix spp.), rockslide, avalanche chute, grassland, forest burn, and clearcut (Martinka 1969 and 1972, Shaffer 1971, Interagency Study Team 1976). Habitat use by grizzlies varies a great deal within a given season and between seasons. Much of the shift from one type to another is dependent on changes in food availability in each habitat as the year progresses (see section on home range and movements).

Other biological necessities, such as varying nutritional requirements, need for locating a mate, and need to locate a den site probably induce the shifts in habitat use that are observed. Although trends are discernable, quantitative information on habitat use has been generally unreliable since different data gathering techniques, such as sight records and radiotelemetry vary considerably as to overall observability of the animals in different habitats. Sight records are heavily biased towards meadows, roadsides, and other open areas where bears are much more easily seen than in dense forest (Interagency Study Team 1976).

FEEDING

Generally the grizzly tends to be opportunistic, feeding on the best available food source such as the spring forb emergence or late summer berry crop. Concurrently mammals, insects, and other animals are eaten when discovered either as prey or carrion. See Table 1 for a list of items observed in the grizzly's diet.

Grizzly bears do not normally feed during the winter denning period. Rather they sleep in a reduced metabolic state, depending on their fat reserves. In many areas of their range it appears that early spring is the most stressful period for the grizzly. At this time, they may frequently leave the den before the emergence of new vegetation while snow is still on the ground. Several authors have mentioned the importance of ungulates both as carrion and prey at this time (Stokes 1970, F.C. Craighead and J.J. Craighead 1972, Cole 1972, Martinka 1969).

HOME RANGE AND MOVEMENTS

Grizzly bears are non-territorial in that they do not actively defend an area with distinct boundaries against other individuals. However, most have home ranges within which their activities are confined. The home range is generally a stable unit though it may change to some extent from year to year. The home range can encompass distinct spring, summer, or fall seasonal ranges. These seasonal ranges, which are often linked by migratory corridors, may or may not include the winter denning site.

Table 1. Known food of the grizzly bear and seasons of dominant use.

Food Type	Genus, Family or Order	Common Name	Seasons of Dominant Use *		
Grass	Agropyron	Wheatgrass	Sp	S	F
	Bromus	Cheatgrass		-	
	Calamagrostis	Reedgrass	Sp		
	Hordeum	Meadow Barley	Sp		
	Elymus	Wildrye	Sp		
	Melica	Oniongrass	Sp		
Forbs	Equisetum	Horsetail	Sp	S	
	Lupinus	Lupine		S	
	Streptopus	Twisted Stalk		S	
	Angelica	Angelica	Sp	S	
	Trifolium	Clover	Sp	S	
	Heracleum	Cow Parsnip	Sp	S	
	Ranunculus	Buttercup	Sp	S	
	Utrica	Nettle	Sp		
	Allium	Onion		-	
	Taraxacum	Dandelion	Sp	S	
	Vicea	Vetch	Sp	S	
	Cirsium	Thistle		-	
	Claytonia	Springbeauty		-	
	Disporum	Fairybells		-	
	Lomatium	Desert Parsely		-	
	Perideridia	False Caraway		-	
	Polygonum	Bistort		-	
	Erythronium	Glacier Lilly		-	
	Hedysarum	Hedysarum	Sp		
	Valeriana	Valerian		-	
	Lathyrus	Pea		-	
Shrubs	Vaccinium	Huckleberry		S	F
	Amelanchier	Serviceberry		S	F
	Crataegus	Hawthorne		S	F
	Viburnum	Cranberry		S	F
	Rubus	Salmonberry		S	
	Rosa	Rose		-	
	Berberis	Oregongrape		-	
	Symphoricarpos	Snowberry		-	
	Oplopanax	Devil's Club		S	
	Salix	Willow		-	
	Sambucus	Elderberry		S	F
	Arctostaphylos	Manzanita, Bearberry		-	
	Sorbus	Mountain Ash		S	
	Juniperus	Juniper		-	

Table 1. Continued

Food Type	Genus, Family Order	Common Name	Seasons of Dominant Use *		
Trees	Pinus	Pine		-	
	Rhamnus	Cascara			
Other	Carex	Sedge		-	
	Juncus	Rush			
	Lichen	Lichen		-	
	-	Moss		-	
	-	Fungus		-	
Insects	Vespa	Wasp		-	
	Hymenoptera	Ants, Wasps, Bees		-	
	Formicidae	Ants			
	Coccinellidae	Ladybird Beetles		-	
	Bombus	Bumble Bee		-	
Fish	Salmonidae	Trout, Salmon		-	
Birds	Galliformes	Grouse, Ptarmigan	Sp	S	F
Mammals	Cricetidae	Mice, Volves, Lemmings	Sp	S	F
	Cervus	Elk	Sp	S	F
	Alces	Moose	Sp	S	F
	Odocoileus	Deer	Sp	S	F
	Lepus	Rabbit	Sp	S	F
	Eutamius	Chipmunk	Sp	S	F
	Spermophilus	Ground Squirrel	Sp	S	F

Source: Martinka (1972), Slobodyan (1976), Clark (1957), and Lloyd and Fleck (1977).

* Sp = Spring
S = Summer
F = Fall
\- = Seasonal preference not determined

In many populations there is not extensive overlap in home ranges of individuals. This is particularly true in areas without overly-dense bear concentrations, and where food is rather evenly dispersed (Stokes 1970). The size of individual home ranges varies quite a bit and may be influenced by population density, food supply and social factors such as sex, dominance, and age.

Population density is important in determining home range size because it determines the overall amount of land available per bear within a population. Food is significant because fluctuations in supply increase or decrease the area over which bears must roam in order to find the given amount of food required. An example in which these two factors are probably operating to affect home range size has been observed in an Alaskan brown-grizzly population (Berns and Hensel 1972). There the average home range size is much smaller than is found in other populations of grizzly. This is probably due to the combined effects of high population density and a superior food supply.

As mentioned, social factors are also important in affecting home range size. Most conspicuous are those that pertain to the sex of a bear. For example, adult males tend to have larger home ranges than females in some areas which have been studied. Information on home range size is shown in Table 2. Age, proximity of mates, physical condition and status are other types of social influences that affect home range size, though in a less conspicuous manner (F.C. Craighead 1976).

Within the home range an individual normally moves around frequently. Movement is apparently stimulated by one or more of several factors. One of the most significant of these is food supply. Bears frequently make routine movements between day beds and well established food sources (F.C. Craighead 1976). Individuals also move to

new food sources, such as an ungulate carcass, when the opportunity arises. This may involve distances of up to 30 km, which may be traversed rapidly during a single trek. Another type of movement, apparently induced in part by food supply, is the migration between the early spring, summer, and fall ranges. In addition to linear movements, these migrations frequently traverse an altitudinal gradient. In Glacier National Park, maximum activity was concentrated below 1220 m in early spring, and above 1220 m in the summer. Fall dispersion was more even between both elevations (Martinka 1970). Movement to higher elevations during the summer was also observed by Mundy (1963).

Another important factor influencing movement is season and weather. These are, of course, intimately linked with variations in the presence and quality of the food supply of the grizzly, and are in part responsible for some of the movements already mentioned. Apart from this, weather and season also stimulate movement to and from winter denning areas. It has been reported that individual grizzlies within a population more or less synchronously start denning with the advent of one of the first major snowstorms of the winter (F.C. Craighead and J.J. Craighead 1972).

Another type of movement not directly related to season or food supply is wandering and dispersal by young animals prior to their establishing of a home range (F.C. Craighead 1976). This is fundamentally a social phenomenon dependent most likely on population density and encounters with dominant adult individuals.

A final type of movement is that which is induced by man. This is commonly homing behavior resulting from relocation to another area for management purposes. Chance encounters with man, in both the backcountry and populated areas, probably are responsible for inducing dispersal to a new home range on some occasions.

Information on linear distances traveled by bears in the course of these movements has been recorded using radio-tracking in numerous studies. This data is presented in Table 2.

REPRODUCTION AND DEMOGRAPHY

Copulation has been observed to occur from May until August, after a frequently prolonged period of courtship (Glenn et al. 1976, Herrero 1977). Gestation is approximately eight months but can be quite variable due to delayed implantation in the female. Ranges have been recorded from 194 to 278 days (Erickson 1968). Females generally give birth in the den in February. The average number of cubs at each birth has been estimated at 2.27 in Yellowstone (J.J. Craighead et al. 1976).

Mortality of cubs during their first year has been estimated at 10 percent (Hensel 1969), 5 percent (Martinka 1969), and 7 percent (Troyer 1962). Martinka has suggested that the relatively low mortality rates are attributable to well developed defensive behavior by the mother grizzly. Cubs most frequently separate from their mothers near the end of their second year. However, young bears up to four years of age have been observed with the mother on occasion. Females reproduce only every second or third year. The reproductive rate for the Yellowstone population has been estimated at 0.7 cubs per female per year. Mortality of subadults, 2.5 - 5.5 years old, is quite a bit higher in Yellowstone and Glacier National Parks. This is due in part to competition and social interactions with adult bears, typical in areas of relatively high population density. Mortality decreases significantly beyond the age of about 5.5 years.

Table 2. Estimates of home range and linear movement.

Population location	Average home range area (km^2) Male	Average home range area (km^2) Female	Maximum home range area (km^2) Male	Maximum home range area (km^2) Female	Minimum home range area (km^2) Male	Minimum home range area (km^2) Female	Recorded Linear Movements (km)	Author
Yukon	414	73	-	-	-	-	106 61 48	Pearson (1976)
Southwest Yukon	287	86	-	-	-	-	-	Pearson (1975)
Yellowstone	162	73	435	275	57	18	80	F.C. Craighead (1976)
Kodiak Island	14*		30	36	-	6	76 20	Berns and Hensel (1972)
Yellowstone	109*		435*		-	-	-	J.J. Craighead and F.C. Craighead (1972)
Yellowstone Vicinity	163	308	295	740	93	26	-	Interagency Study Team (1976)

* sex not specified

The exact age of sexual maturity is not entirely known. It is known that the age at first reproduction is extremely variable ranging from 2 years to 9 years for the female (Hensel 1969, J.J. Craighead et al. 1971). This probably reflects variability in the age of sexual maturity to some extent, but social structure of a population could account for such a wide range of variability in the age at first reproduction. Less is known about the reproductive biology of the male. It has been determined that sexual maturity arrives at about 4.5 years (Erickson et al. 1968). It has also been determined, however, that breeding success is dependent to a certain extent on position of social hierarchy in areas of relatively heavy concentrations (Hornocker 1962).

DENNING

During the winter grizzly bears go into an inactive state in the form of prolonged sleep. There is some heated debate over semantics, as to whether this constitutes true hibernation. In any case, during this hibernation, body temperature decreases about 5 C. Heart rate decreases from about 25-43 percent, depending on the age of the bear. Also, over the 5 or 6 month period, bears may not eat anything, losing up to 27 percent of body weight (Folk et al. 1976). Occasional forays to feed on carrion may be made by some individuals.

Dens have frequently been reported as being located on slopes with a southerly exposure (Reynolds et al. 1976, Troyer 1974, Slobodyan 1976). But other studies have shown an opposite trend (Lentfer et al. 1972, F.C. Craighead and J.J. Craighead 1972, Interagency Study Team 1975). There is similarly a wide range of variability in elevation of dens. Troyer and Faro (1974) reported 70 percent of dens were less

than 457 m in Alaska, whereas F.C. Craighead and J.J. Craighead (1972) did not find any dens below 2380 m.

Dens are most frequently located among the roots of trees but occasionally are found in open treeless areas. In Glacier National Park dens were found under conifer roots and amongst alder (Alnus spp.) in the spruce/subalpine fir (Abies lasiocarpa)/Douglas-fir zone (Martinka 1968, Shaffer 1971). Other authors mention dens in forested areas also (F.C. Craighead and J.J. Craighead 1972, Slobodyan 1976). Dens are usually prepared in advance. Grizzlies do not normally make use of natural shelters but rather start from scratch and do their own excavating.

HUMAN/BEAR CONFLICTS

Human/bear encounters are of two basic types. Ones that produce negative impacts on bears have been mentioned previously. Situations that have negative impacts on humans are basically confined simply to encounters in which certain bear behavior results in personal injury or property damage. Beyond the direct effects, conflicts of this type frequently ellicit emotional, managerial, and political responses on the part of the humans. These may be disproportional to the statistical risk of injury or death from grizzlies in comparison with other causes such as vehicle accidents and drownings. Grizzly-caused injuries occur in Glacier National Park at a rate of 1 per 10^6 visitors (Martinka 1969). For an in-depth review of historical and current documentation of human/bear encounters see Herrero (1970a, 1970b, 1976).

Generally speaking, the significance of conflict problems increases as visitation increases simply because the probability of encounters increases. Camping practices and personal behavior of human individuals, as well as park management practices such as temporary closures, and communications to visitors, all affect the probability and outcome of encounters with bears. Although grizzly-caused injury and death can probably never be completely avoided in areas where mutually high numbers of grizzlies and humans occur, the extent can be minimized. Grizzly management is generally improving in most areas and new techniques are being continually developed (see for example Stuart 1977a, and 1977b, McArthur 1978). Any reintroduction should be accompanied by a strong, flexible program for minimizing human/bear encounters and conflicts.

SUITABILITY OF NORTH CASCADES NATIONAL PARK AND VICINITY

In order to successfully reestablish a grizzly bear population it is imperative to determine whether the factors which brought about the recent demise are still in effect, and if so, how they can be alleviated. It is necessary to be able to predict with some confidence whether the bears would survive, and whether there would be any negative ramifications to such a program.

One major factor which was certainly detrimental to grizzlies but now has been eliminated is legal hunting and most other forms of direct mortality. This is due to the recent classification of the grizzly as a "Threatened" species, and because of a general ban on all firearm use and trapping in the park. Also the grizzly has been classified as a protected species under State of Washington law since 1969. This legal protection most likely is not sufficient to revitalize the grizzly population, however.

Another important factor is loss or deterioration of habitat. Due to the current restrictive management of North Cascades National Park, additional decline in habitat inside the park is not a serious threat, though it might continue in surrounding areas. The main question is whether enough sufficient habitat still remains. The historical presence of grizzlies and confirmed occurrence until recently (1964) in the area that is now the park tends to indicate that vegetatively and physiographically the area is probably adequate, although fire suppression practices may have altered the vegetative cover enough to be pertinent. Qualitative features such as climate and vegetative food supply have most likely not changed significantly enough in the recent past to have caused the disappearance. Other factors such as availability of special denning areas, winter ranges, or breeding grounds, which are critical for many species do not appear to be limiting to the grizzly. However, much is not known about habitat requirements.

One known potential deficiency of North Cascades National Park in terms of the qualitative aspects of the habitat is the lack of abundant elk and moose populations. In regions in the Rocky Mountains, it has been observed that grizzlies feed heavily on these and other ungulates both as a prey item and as carrion. This has been mentioned as being particularly important in the early spring prior to the emergence of vegetation. It is not entirely clear whether the deer population in the park would be exploitable by grizzlies. However, the Interagency Study Team (1976) has noted that in areas where bears do not have access to ungulate concentrations they may alternately feed on such items as insects in logs and pine nuts in squirrel (Sciurus spp.) caches.

Another possible deficiency is that damming of the Skagit and other rivers may have depleted a protein-rich source of salmonid fish in their upper reaches. Yellowstone grizzlies are known to feed on spawning cutthroat in some of the inlet and outlet streams of

Yellowstone Lake (Interagency Study Team 1974). However, Jonkel (1975) has shown that grizzlies still survive in areas of Idaho where fish runs have been depleted, though the bears apparently are not thriving.

The grizzly appears to be more susceptable to quanitative deterioration of the environment. As mentioned, they apparently require extensive undisturbed terrain in order to survive. Thus, determining whether the North Cascades National Park and immediately adjacent environs are large enough to support the wide ranging grizzly bear is fundamental. This necessitates investigation of specifically how much area is available for grizzlies and specifically how much area they require.

The wide range of vegetative zones in which grizzlies are found tends to indicate that the variability in habitat types found in different areas of the park are not extreme enough to be of importance. In addition, a grizzly has the capacity for daily movement of a considerable distance which could encompass the extremes of high and low elevation, and wet and dry habitats in the park. For this reason, variations in habitat have not been a major component in the analysis of which of the potentially suitable lands are best for a grizzly reintroduction. The analysis has dealt mainly in terms of potential for human conflicts. This is a reflection of the level of human use (see Fig. 2).

Density and dispersion of human visitation was determined for the overall park complex and categorized in the following way: All roads, settlements, and campgrounds accessible by vehicle were considered as high use areas. All lands within a 1.5 km radius of these areas were also considered as high-use areas simply due to their proximity. Data on backcountry visitation obtained from backpacking permit information was expressed in terms of the average minimum number of visitor nights spent in various trail manage-

ment units for 1975 and 1976. These did not reflect non-overnight use. Trail units were classified as high use areas if visitation exceeded 500 visitor nights per year (V.N.Y.), moderate from 200-500 V.N.Y., and low if less than 200 V.N.Y. All land within a .5 km radius of trails or crosscountry hiking and climbing routes received the same classification as that unit. It should be clarified that an area of low overnight use could possibly have a considerable number of people hiking through during the day if it was located between a trailhead and a high use area further along the trail.

It is possible for grizzlies to coexist in an area where human visitation is moderate, or perhaps even high. However, for the purposes of this study, the political implications of an introduction would dictate a conservative approach. For this reason, only areas of low human visitation were considered as potential grizzly management zones. Areas of any consequence have been delineated into 5 zones of low human use (Fig. 3).

Zone 1

This zone encompasses an approximately 389 km^2 area in the vicinity of Little Beaver Creek. The Little Beaver Creek trail is the main travel route through this area, though part of the Indian Creek trail is included. Ross Lake provides somewhat of a natural barrier to the east. The northern perimeter borders on British Columbia. Though this is known to include wilderness habitat, the implications of an introduced bear crossing this border has not been determined. The southern edge of this area includes the high-use lower Big Beaver Creek area. The remaining perimeter borders moderate-use trails in Brush Creek, upper Big Beaver and Little Beaver valleys.

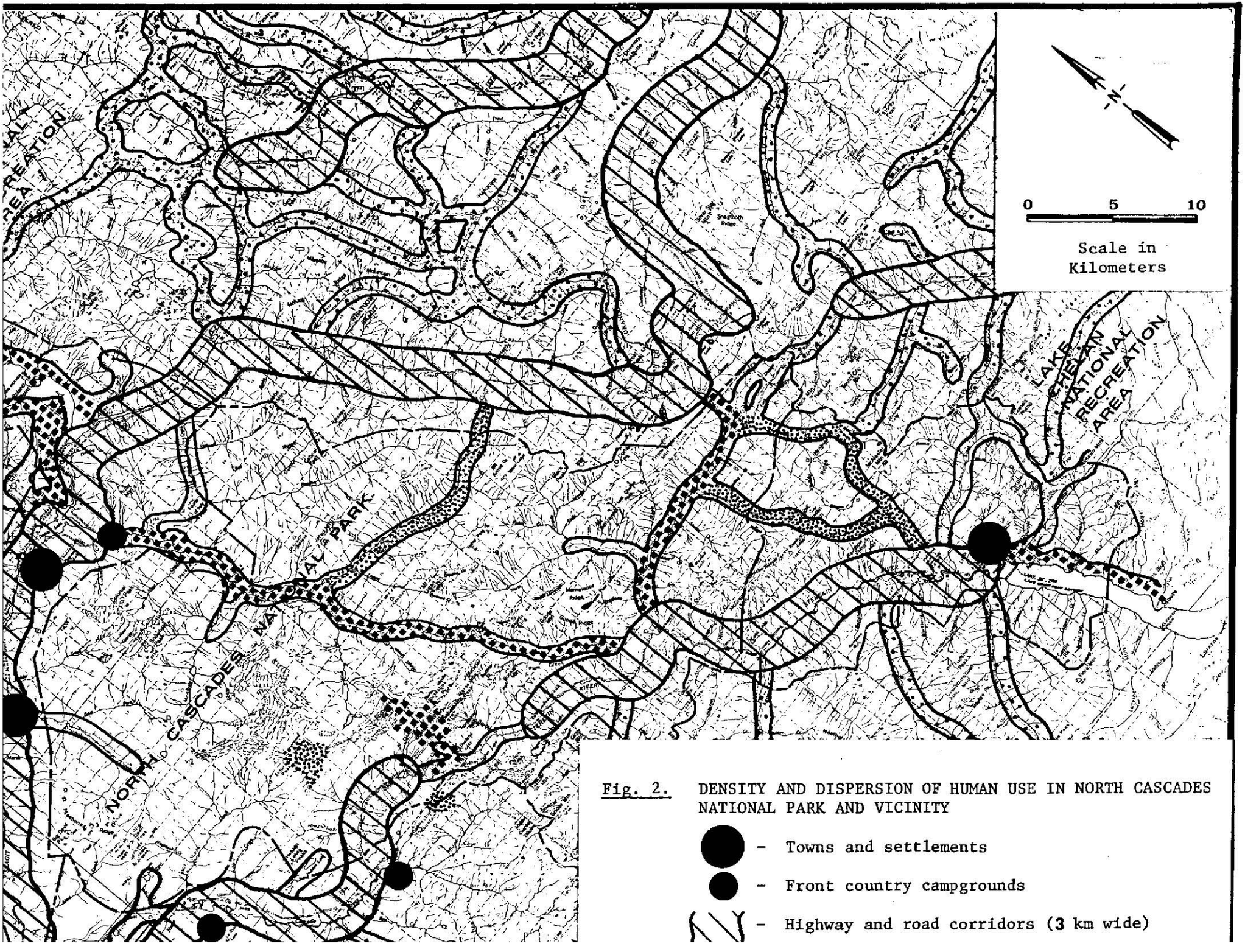
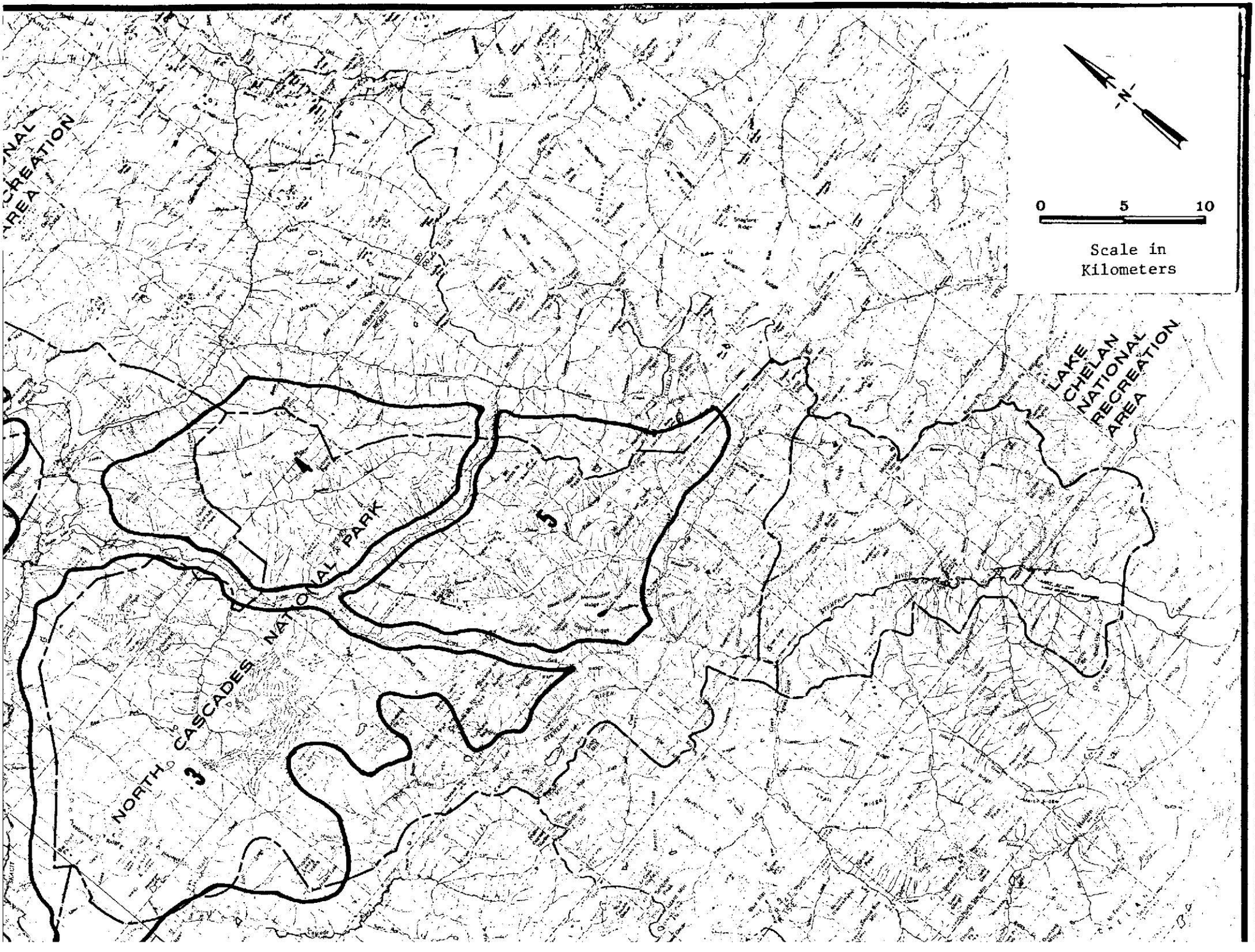


Fig. 2. DENSITY AND DISPERSION OF HUMAN USE IN NORTH CASCADES NATIONAL PARK AND VICINITY

- Towns and settlements
- Front country campgrounds
- Highway and road corridors (3 km wide)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Scale in
Kilometers
LAKE CHELAN NATIONAL RECREATION AREA
NORTH CASCADES NATIONAL PARK
1
3
5

Zone 2

This is by far the largest site with an estimated area of 717 km^2. The area contains Thornton Lake and Stetattle Creek trails and is adjacent to several populated and heavily-used areas. These include Heather Meadows and Baker Lake in Mt. Baker National Forest and the villages of Marblemount, Newhalem, and Diablo along State Highway 20. The northern border is much less sensitive. The Pickett Range was excluded from the zone due to moderate mountaineering of the Pickett Traverse. However, climbers would generally tend to be on glaciers and rock ridges, above the meadows most likely to be preferred by a grizzly. In addition, climbers would possibly be more familiar with backcountry travel and conceivably less prone to encounters with grizzlies at camping sites. A bear moving to the northeast of the Picketts would encounter more low-use land which is separated from the Little Beaver low-use zone by just one moderately-used trail.

Zone 3

The Eldorado Peak zone encompasses about 374 km^2. A significant portion of this is high glacier-covered areas, particularly around Snowfield, Eldorado, and Boston Peaks. The Monogram Lake, Hidden Lake Peak, and McAllister Creek trails are contained in this area. The zone is mostly surrounded by roads, Highway 20 to the north with the towns of Marblemount, Newhalem and Diablo, and the Cascade River Road to the southwest. The upper sections of the Cascade River Road, however, traverse some rather isolated areas of Mt. Baker National Forest in which human use is relatively low. The eastern boundary is delineated by the heavily-used Park Creek and Thunder Creek trails. Colonial Creek campground at the trailhead of the Thunder Creek trail is currently the largest campground in the park complex and has been the prominent site of

recent human conflicts with black bears.

Zone 4

The Panther Creek zone includes 174 km^2. Much of this area is very infrequently traveled. Just the Fourth of July Pass/Panther Creek trail traverses the area. State Highway 20 borders the north and east sides. However, no campgrounds or settlements occur along this stretch. The Okanogan National Forest lies beyond. This zone also is adjacent to Colonial Creek Campground and Thunder Creek trail. To the south lies Fisher Creek basin, the site of the 1964 grizzly kill, through which runs a moderately-used trail.

Zone 5

This area encompasses approximately 166 km^2. It is similar to zone 4 in that it is adjacent to Highway 20, Thunder Creek, Park Creek, and Fisher Creek. The southern boundary is along the Pacific Crest trail on Bridge Creek, with a small section bordering the Stehekin River Road. Visitation there is high. Zone 5 is separated from zone 4 by the moderately-used Fisher Creek trail. A summary of area estimated for all zones is given in Table 3.

Table 3. Area estimates of five low human use zones in North Cascades National Park and vicinity (see Fig. 3).

Zone	1	2	3	4	5
Area (km^2)	389	717	374	174	166

Determination of Size Sufficiency

It is necessary to determine if these low human-use zones are large enough to support grizzly bears. The major factor to consider is the home range requirements of bears. In Table 2, home range data from six studies revealed that the maximum home range of grizzlies varied from 30.3 km^2 to 435 km^2. The average for adults of either sex ranged from 14.2 km^2 to 414 km^2. The range in area of the low human-use zones just described is from 116 km^2 to 717 km^2 (see Table 3).

Erickson (1974), in determining the size sufficiency of the Gila Wilderness Area in New Mexico concluded that the 920 km^2 area available there was adequately large. He pointed out that numerous small populations of grizzly bears are known to persist in relatively small areas. As examples, he cited a population in which 60-80 individuals lived in an area of 639 km^2 in Europe (Curry-Lindahl 1972), and a population in Norway in which 15 bears lived in a 511 km^2 area. Cowan (1972) also mentioned a 60 ± 8 bear population occurring in a 600 km^2 area in Italy. However, the degree of correlation in behavior and population structure between European and North American populations is not known.

This information tends to indicate that, while none of the zones are overly large, zone 2 (717 km^2) at least might be of sufficient size to support some introduced grizzlies. Nevertheless, there will always be a level of uncertainty as to whether a released individual would remain in the area. There are no constraints on movement beyond the arbitrarily delineated zone borders, and the home range of an individual would not necessarily overlap the low human-use zones only.

METHODS OF REINTRODUCTION

The rather involved methods necessary for immobilizing, transporting, and monitoring movements of large carnivores has been worked out to a large extent. This has resulted from research entailing extensive trapping and marking done by J.J. Craighead and F.C. Craighead in Yellowstone as well as the occasional need to remove problem bears from areas with high human use. A listing of management techniques pertaining to handling of grizzlies is available at the North Cascades National Park headquarters in Sedro-Woolley, Washington (Björklund 1978).

Consideration should be given to the age, sex, and history of an individual bear, and to the number of individuals introduced into the park. Cubs have been introduced with apparent success into human constructed dens in new areas (Jonkel et al. 1977). Cubs would be less inclined to disperse and might readily habituate to the new area. However, with the age at first reproduction occuring at from 4 to 9 years, this would be a slow method of establishing a breeding population. Conversely, adults which are sexually mature and able to breed immediately would have a greater tendency to range over greater distances and possibly disperse from the intended management zone.

The sex ratio would also be important. Breeding structure apparently is quite variable. Behaviorally promiscuous (multiple copulation with more than one mate by both male and female), but genetically polygamous (male contributes more genes to next generation per breeding season) mating has been observed in the grizzly (Hornocker 1962, Erickson et al. 1968, Sparrow 1968). This situation indicates the possiblity of introducing more females than males. However, genetically monogamous (equal male and female contribution of genes to the next generation during a breeding season) mating also occurs (Herrero 1977). Herrero felt this might be more common in low density populations. Sex ratios in natural populations have been shown to be approximately 1:1 (Pearson 1976).

The number of bears introduced would have to be determined. Densities of grizzlies in other areas have been summarized by Martinka (1971) and shown to vary from 1.3 - 48 km^2 per bear (Table 4). Density for introduced North Cascades National Park bears should eventually fall within this range. However, it would only be feasible to introduce a very small number initially.

Table 4. Density estimates for various North American grizzly bear populations.

Population Location	Estimated number of square kilometers per bear	Source of data
Kodiak Island, Alaska	1.3	Troyer (1962)
Glacier National Park, British Columbia	12.3	Mundy (1963)
Yukon Territory, Canada	25.6	Pearson (1970)
Mt. McKinley National Park, Alaska	38.4	Dean (1958)
Whitefish Range, Montana	38.4	Jonkel (1962)
Yellowstone National Park, Wyoming	28.2 - 43.5	Cole (1970)
Yukon Territory, Canada	48	Pearson (1967)

The past history of the individual bear should be considered also. Introduction would be counter productive if a bear had been known to have had numerous contacts with humans - those which required relocation measures.

Any bear introduced into the park complex should be monitored over an extensive period of time. This would provide movement data which would provide substantial information on habitat use in this area. In addition, movements into high human use areas would be

monitored thereby increasing the probability of anticipating and avoiding human encounters. Radio-telemetry would probably be the only adequate method for accomplishing this management requirement.

SUMMARY AND CONCLUSIONS

Because of the somewhat tenuous grasp grizzly bears are maintaining following their man-induced decline, a possible reintroduction program in the North Cascades National Park Service Complex was considered to help improve their status. The major questions examined in this study were whether or not the factors influencing demise in the North Cascades are still in effect, whether the habitat is suitable in terms of size and quality, and whether the project would pose a serious threat to human safety. The following information was analyzed in terms of these objectives, and supplemented with life history descriptions.

Some possible improvements which have occurred since the decline are the halt of most direct man-induced mortality because of state law, park regulations and the "Threatened" status, and the fact that further deterioration in habitat is not expected. However, there is a possibility that fire suppression and other unknown factors may have caused the suitability of grizzly habitat to decline. Introduced grizzlies could also suffer from lack of substantial elk and moose populations and perhaps decrease in the number and availability of anadromous fish. Grizzly bears also seem susceptable to quantitative habitat encroachment, and are known to require extensive areas. An attempt was made to determine if North Cascades National Park had regions of sufficient size for a reintroduction program. Levels of human use were used as the main criteria rather than availability of habitat. Since grizzlies are known to utilize such a numerous variety of vegetative zones, it was felt the variability in habitats, which exists in different areas of the park, might not be extreme enough to be of importance. Also, the grizzly can readily

travel long distances which could encompass the extremes of low and high elevation, and wet and dry habitats in different areas of the park. The low human-use areas were determined and delineated into 5 zones. Patterns of overnight human use were described for each zone. None of these zones was as large as would ideally be desired. However, there was some evidence that zone 2, which encompasses the Mt. Blum and Mt. Despair areas, might be sufficiently large. Regardless of size, there would always be some level of risk that bears would disperse to high human use areas. Specific methods pertaining to reintroduction, such as immobilization, handling, and monitoring of movements, were also referred to. Consideration was given to the importance of sex, age and history of the individual bear, as well as sex ratio and number of individuals involved in a reintroduction program.

Several areas will require additional investigation. For example, the effects that forest fire suppression may have had on vegetative cover and plant communities needs to be examined further. Potential release sites, such as Jasper Pass, should be visited and studied. Additional qualitative deficiencies in habitat in the park should be searched for. Comparisons in the ecology of the black bear, which does well in the North Cascades, should perhaps be given some detailed analysis. Political and managmment implications of bears crossing into Canada and onto adjacent Federal and private lands should be considered in more depth. The level of risk to humans should be quantified if possible, and the amount of risk that the National Park Service is willing to accept should be considered. Further study will also be needed on the more specific aspects of the reintroduction, such as the number and sex of bears to be introduced and where they might be obtained.

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