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Distribution of Grizzly Bears in the U.S. Northern Rockies

Abstract

The current estimated distribution area of grizzly bears (*Ursus arctos*) in the U.S. Northern Rockies suggests they have recently expanded their distribution in this region. Expansion beyond designated recovery zones has important conservation and land management implications. Using a computer home range program, HOME RANGER, and about 3,000 recorded locations of grizzly bear observations obtained from numerous state and federal agencies, current distribution of grizzly bears was estimated as an aid to recovery efforts. I estimated the distribution area of grizzly bears in the U.S. Northern Rockies at about 102,524 km^2. This is significantly larger than previously reported by other sources, and greatly exceeds the 56,043 km^2 area delimited as grizzly bear recovery zones by the U.S. Fish and Wildlife Service. I suggest there is merit in expanding designated recovery zones. Greater research and management attention must be paid to peripheral areas as range expansion by bears may outpace management response, with potentially negative consequences to both bears and humans.

Introduction

The grizzly bear (*Ursus arctos*) was listed as a threatened species in the contiguous U.S. states pursuant to the federal Endangered Species Act in 1975. Grizzly bears now occur on less than 2% of their historic distribution area (U.S. Fish and Wildlife Service 1993) in the contiguous states. The U.S. Fish and Wildlife Service (1993, 2000) has identified five grizzly bear recovery zones within the U.S. northern Rockies: the Northern Continental Divide, Yellowstone, Cabinet-Yaak, Selkirk, and Selway-Bitterroot areas (Figure 1).

The central goal in recovery planning for threatened and endangered species is to increase both the numbers and distribution of the species. Current information on the distribution of grizzly bears is therefore vital to the design and implementation of management programs to ensure survival of the species, recovery of viable populations, and reductions in bear/human conflicts. The bounds of animal populations should initially be delimited based on animal locations (Craighead, et al. 1995). Merriam (1922) and Mattson, et al. (1995) have provided estimates of distribution area for the contiguous states and other investigators have described distribution for discrete population areas (Basile 1982; Dood, et al. 1986; Blanchard, et al. 1992). Here I describe a larger area of distribution for grizzly bears in the U.S. northern Rockies than has previously been given and I suggest the current extent of recovery zones be re-examined.

I address three fundamental questions: 1)What is the current distribution of grizzly bears in the U.S. northern Rockies?; 2) How does this distribution compare with recovery zones designated by the U.S. Fish and Wildlife Service?; 3) Is there merit to enlarging the recovery zones?

Methods

The area analyzed is the U.S. northern Rockies generally bounded by the 49° and 42° N. latitudes and 119° and 108° W. longitudes, shown in Figure 1. A Geographic Information System (GIS), Arc/Info 7.11 and ArcView 3.0 with Spatial Analyst (Environmental Systems Research Institute 1997) were used to plot digitized locations and for spatial analysis. Two categories of data were used to estimate current grizzly bear distribution. These were: 1) digitized data used with a home range program to construct distributional isopleths; 2) undigitized observational data used for comparison with the isopleths.

Construction of Isopleths

I used the program HOME RANGER Version 1.0 (Hovey 1998) and the adaptive kernel method, to construct 95%, 96%, 97%, 98%, 99%, and 100% isopleths for the Yellowstone, Northern Continental Divide, Cabinet-Yaak, and Selkirk areas, to represent distribution areas. HOME RANGER has a larger capacity (two billion data points) than other home range estimators such as CALHOME (Kie, et al. 1996), making HOME RANGER more

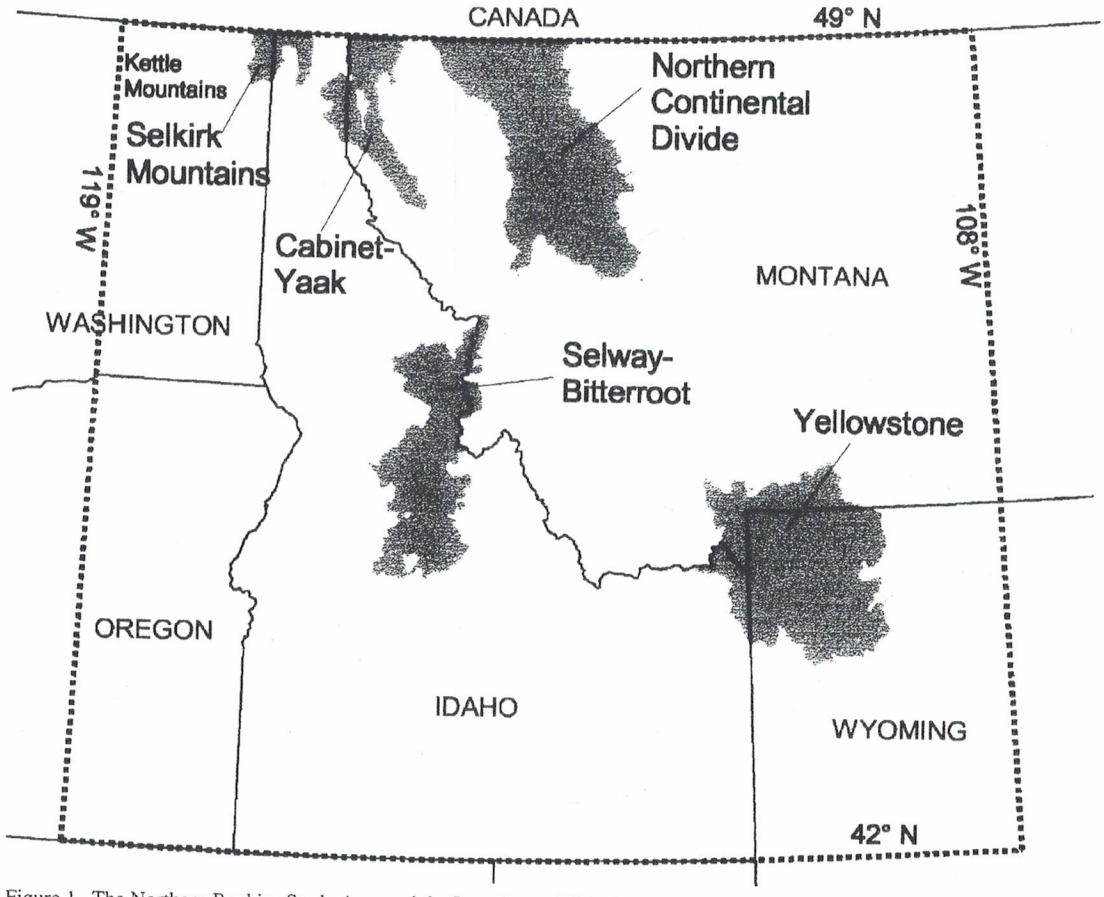

Figure 1. The Northern Rockies Study Area and the Locations of Grizzly Bear Recovery Zones.

useful for this work since two of the data sets had n > 500.

I used data from grizzly bear observations recorded by state and federal wildlife management agencies and expressed as Universal Transverse Mercator (UTM) coordinates, that were digitized and plotted. In cases where there was more than one source of data for an area, the data were pooled. For the Yellowstone area (n = 1,426), sources for recorded locations were Craighead, et al. (1988); Dood and Pac (1993); Pac and Dood (1999); Gunther, et al. (1992-1997). For the Northern Continental Divide area (n = 418), sources were Dood and Pac (1993); Pac and Dood (1999). Sources for the Cabinet-Yaak area were Groves (1987) and digital data provided by the U.S. Fish and Wildlife Service (n = 871). Sources for the Selkirk Mountains were the Washington Department of Wildlife (1998), and digital data provided by the Idaho Department of Fish and Game (n = 138). The source for the Salmon-Selway-Bitterroot region of north-central Idaho was Groves (1987), and for the Kettle Range in northeast Washington was the Washington Department of Wildlife (1998). However, data from central Idaho were relatively sparse (n = 81) and collected in the period from 1930 to 1985 and in the Kettle Range of northeastern Washington, total observations (n = 5) were low. Thus, not enough data points from recent observations were available for construction of HOME RANGER-based isopleths and no results are reported for those two areas.

The UTM coordinates used were approximate and may contain error. For example, most Cabinet-Yaak data had a 100 m resolution (within 100m of the "true" location), but some data points had up to 1 km resolution (W. Kasworm, U.S. Fish

and Wildlife Service, pers. comm.). I considered this level of error acceptable at the population area level, which encompassed thousands of km^2.

Different types of observations were used to increase sample sizes. By each area these were: Yellowstone, locations of mortalities, management actions, and conflicts; Northern Continental Divide, locations of mortalities and sightings of females with cubs; Cabinet-Yaak, observations from sighting reports and mortalities; Selkirk Mountains, observations from sighting reports. Outlying data points were evaluated for their temporal distribution to ensure that estimated distribution was current, as opposed to historic. Areas with observations from both the 1980s and 1990s were considered part of the current distribution area. Comparison data from observations prior to the 1980s (historic) were used to detect potential increases in distribution area. Portions of the Northern Continental Divide, Cabinet-Yaak and Selkirk isopleths within Canada were excluded from size calculations since the purpose of this work was to estimate distribution in the U.S. northern Rockies. As an additional approximation of distribution, areas adjacent to the isopleths were examined and based on my best judgment were adjusted where they were identified as occupied grizzly bear habitat by state fish and game agencies or other sources.

Data Used for Comparison with the Isopleths

To check the accuracy of my results from HOME RANGER, I used a wide array of mostly undigitized data sources for comparison (Table 1). Non-digital comparison data could not be used for construction of isopleths because the locations were approximate and UTM coordinates were not available. Thus, I duplicated these non-digital data on transparent overlays and placed those on top of maps including HOME RANGER isopleths for comparative analysis.

Results

The 99% isopleths constructed using HOME RANGER best described distribution (Figures 2, 3, 4, and 5). Based on the comparative analysis, the 95-98% isopleths underrepresented distribution and excluded numerous locations of females with cubs (resident bears) and the 100% isopleth overrepresented distribution by including vast land areas of unoccupied habitat between outlying points. Thus, the 99% isopleth represents an estimated distribution boundary for grizzly bears, with verified observations of bears occurring at some unknown frequency beyond these bounds.

By summing the area encompassed by the 99% isopleths and adding portions of three additional areas (Yellowstone, Selkirk Mountains and Cabinet-Yaak areas) to this total, I estimated a distribution area for grizzly bears in the U.S. northern Rockies at about 102,524 km^2 (Figure 6; Table 2). In the Yellowstone area a portion of the Teton and Gros Ventre Ranges just south of the isopleth, and the Tobacco Root Mountains to the northwest of the isopleth were added based on a map of 1998 distribution provided by the Wyoming Game and Fish Department (D. Moody, pers. comm.). In the Selkirk Mountains an area to the south and west of the main isopleth was added to incorporate observations from the late 1990s including a documented female with cubs. Small adjustments were made to the periphery of the Cabinet-Yaak isopleth to incorporate recent observations. This broader boundary provides no information on the density, population trend or health of the populations within, and it encompasses areas that may be occupied sporadically, at low frequency and at low densities. For the smaller Cabinet-Yaak and Selkirk geographic areas, the 99% isopleth was adjusted for sample size, which adjusts the *ad hoc* smoothing factor, *h*. This reduced the buffer distance around the periphery of the locations, and I concluded this better represented distribution.

My estimated distribution area exceeds by about 46,476 km^2 the area encompassed by the recovery zones with the largest additional area in the Yellowstone region and the least in the Selkirk Mountains. Only in the Northern Continental Divide region did my estimated distribution substantially coincide with the recovery zone, with the exception of the east side (Figure 6). Agricultural activity and human settlement bracket this recovery zone on the west and east. Grizzly bears expanded their distribution area in the Yellowstone region during the 1980s and 1990s to the south and southeast of the recovery zone. Expansion occurred to the east of the Northern Continental Divide recovery zone and may now be occurring in the Selkirk Mountains.

TABLE 1. Data used for Comparison with the HOME RANGER Isopleths.

Area	Data Type	N	Years Collected	Source
Yellowstone	Recorded Observations Outside Yellowstone National Park	144	1970-1974	Knight, et al. (1975)
Yellowstone	Reported Sightings	349	1975-1977	Knight, et al. (1976-1978)
Yellowstone	Verified Observations	1,073	1973-1979	Basile (1982)
Yellowstone	Verified Observations	701	1980-1984	Knight, et al. (1981-1985)
Yellowstone	Map of All Verified Observations	N/A	1980-1989	Blanchard, et al. (1992)
Yellowstone	Recorded Initial Locations of Females With Cubs	248	1988-1997	Knight, et al. (1989-1993); Knight & Blanchard (1994-1996); Knight, et al. (1997); Haroldson, et al. (1998)
Yellowstone	Recorded Observations	33	1983-1989	McDonald, et al. (1990), shown in Craighead, et al. (1995)
Yellowstone	Composite Home Ranges of Radio-collared bears	57	1975-1987	Knight, et al. (1988)
Yellowstone	Composite Home Ranges of Radio-collared bears	26	1975-1998	Provided to author by Wyoming Game & Fish Department
Yellowstone	Estimated Distribution	N/A	1998	Provided to author by Wyoming Game & Fish Department
Targhee National Forest	Summary of Observations	181	1965-1984	Orme & Williams (1986)
Northern Continental Divide	Recorded Locations of Mortalities	288	1970-1984	Dood, et al. (1986)
Northern Continental Divide	Total Recorded Observations from the Rocky Mountain Front	3,587	1976-1985	Aune, et al. (1986)
Northern Continental Divide	Composite Home Ranges of Male & Female Radio-collared bears	28	1977-1987	Aune & Kasworm (1989)
Northern Continental Divide	Composite Home Ranges of Radio-collared bears on the Blackfeet Reservation & Glacier National Park	7	N/A	Carney (1990), shown in Dood & Pac (1993)
Northern Continental Divide	Composite Home Ranges of Male & Female Radio-collared bears	50	1987-1995	Mace & Waller (1998)
Cabinet-Yaak	Composite Home Ranges of Male & Female Radio-collared bears	18	1983-1994	Kasworm & Servheen (1995)
Selkirk	Composite Home Ranges of Male & Female Radio-collared bears	11	1983-1993	Provided to author by Idaho Fish & Game Department

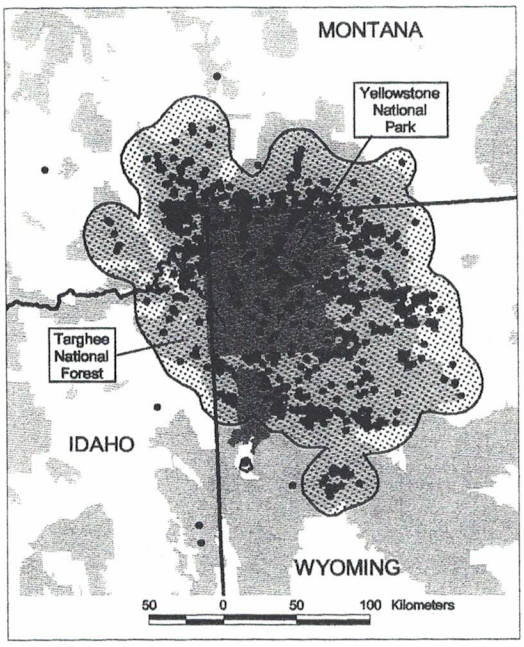

Figure 2. HOME RANGER 99% Isopleth, Yellowstone Ecosystem.

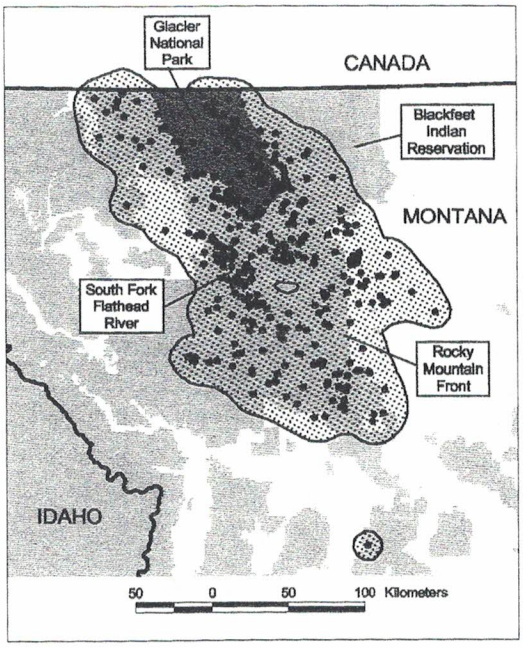

Figure 3. HOME RANGER 99% Isopleth, Northern Continental Divide Ecosystem.

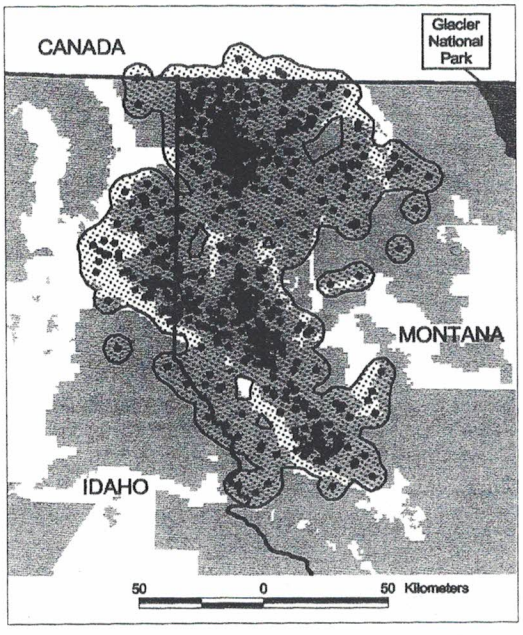

Figure 4. HOME RANGER 99% Isopleth, Cabinet-Yaak Ecosystem.

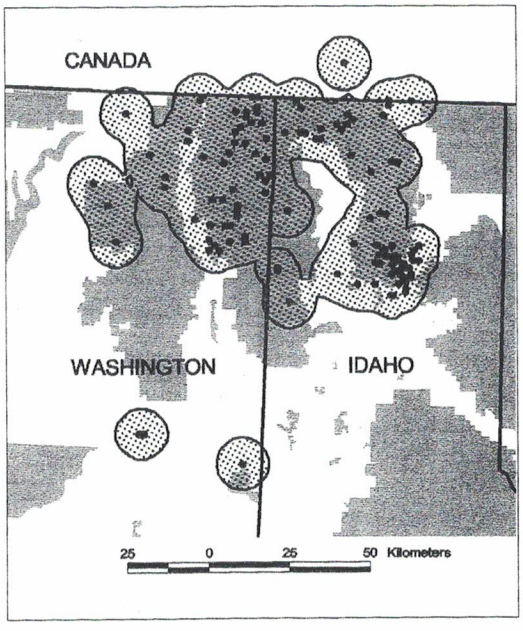

Figure 5. HOME RANGER 99% Isopleth, Selkirk Mountains Ecosystem.

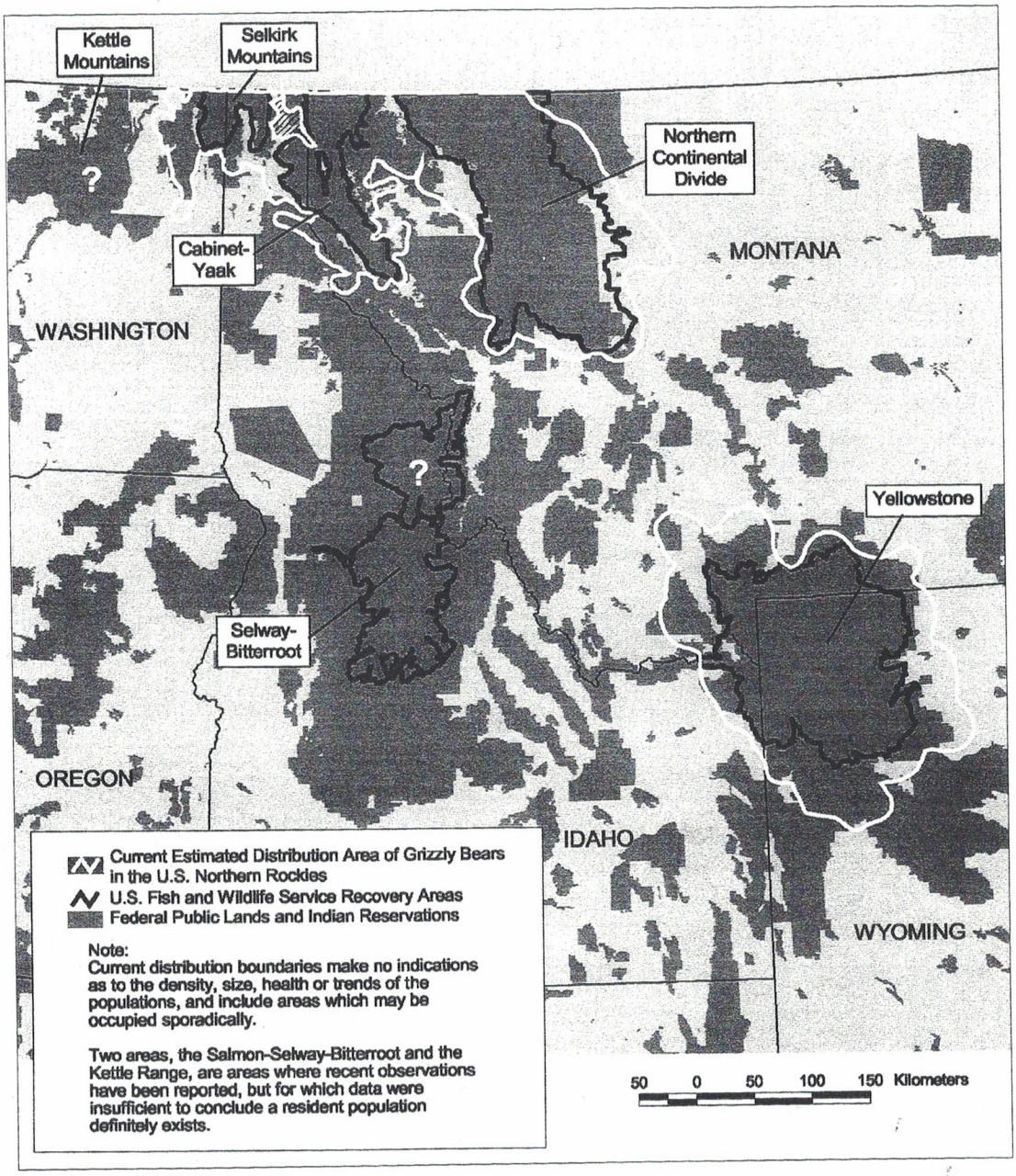

Figure 6. Current Estimated Distribution of Grizzly Bears in the U.S. Northern Rockies.

Two areas, the Salmon-Selway-Bitterroot in north-central Idaho and the Kettle Range in northeast Washington, may support very small populations or the occasional dispersing individual although recent observations provide evidence of grizzly bears in the Kettle Range (Washington Department of Wildlife 1998) and a potential source population occurs across the Canadian border (Horejsi 1999) and sightings of grizzly bears continue to be reported in the Salmon-Selway-Bitterroot (Lolo National Forest 1998). My results also show significant overlap among the Northern

TABLE 2. Area (km^2) for the 95-99% Isopleths. Areas calculated using ArcView 3.0 to display HOME RANGER isopleths. Internal islands not included in totals. All external islands included in totals except for two from Canada from the Cabinet-Yaak ecosystem. *Adhoc h* = 5.0.

	Isopleth				
Area	99%	98%	97%	96%	95%
Yellowstone	43598.3	36217.5	32477.0	29831.3	27818.6
NCDE	33666.6	30061.7	27685.6	25796.8	24364.6
Cabinet-Yaak[1]	14694.3	12762.4	11559.8	10467.4	9684.1
Selkirk Mountains[1]	6387.4	5524.3	5064.6	4654.4	4332.4
Total	98346.5[2]	84565.9	76787.0	70749.8	66199.8

[1]*Adhoc h* adjusted for sample size by HOME RANGER.

[2]Three areas were added to the 99% isopleths which resulted in a total estimated distribution area of 102,524 km^2.

Continental Divide, Cabinet-Yaak, and Selkirk distribution areas and I suggest they may be biologically linked, although due to the low density of locations within the overlap zone, the connection may be tenuous. Merriam (1922) considered this as a single population.

The locations of radio-collared grizzly bears and mortality locations provided the most reliable information, as location and species were confirmed. Larger sample sizes, longer duration of data collection, and larger amounts of comparison data gave me greater confidence in these results. Thus, I have highest confidence in the Yellowstone distribution results, and least in the Selkirk Mountains. I am confident I did not overestimate distribution because observations of females with cubs, management actions and mortalities have occurred beyond the isopleths.

Discussion

Should Recovery Zones Be Enlarged?

Grizzly bear recovery zone boundaries, with a few modifications, date to when grizzly bear populations were at a historic low point which precipitated protection under the Endangered Species Act. Thus, potential expansions in distribution area have significant implications for conservation management of the species. Based on recent history in Wyoming, there can be a lag time between expansion and detection or acknowledgment by managers, which leaves large gaps in management efficiency and success. Moreover, significant expansions beyond the recovery zones results in a bifurcated management regime where some portions of grizzly bear populations receive full legal protection under the Endangered Species Act, whereas other portions receive reduced protection or no protection. Bears occurring outside recovery zones receive no formal consideration by the U.S. Fish and Wildlife Service pursuant to Section 7 of the Endangered Species Act on projects which may adversely modify habitat and/or elevate mortality risks. Other differences include no food storage orders for backcountry users such as hunters and hikers and no restrictions on road density and vegetation cover standards specific to grizzly bears. Failure to document or account for grizzly bear presence may increase the chances of surprise encounters between humans and bears. Higher risks/rates of conflict may reduce human tolerance for grizzly bears thereby increasing bear mortality and overall risk to the species.

Lower or nonexistent standards for grizzly bear habitat protection may result in the impediment of movements among isolated populations, thus preventing a key conservation goal. The smaller recovery zones limit potential increases in total population size, a critical factor in conservation of the species for both demographic and genetic concerns. Allendorf and Ryman (In press) report that the effective population size (N_e) to total population size (N) ratio for grizzly bears is about 1:5 and long-term persistence may require approximately 5,000 individuals in a single population or meta-population. Applying the 1:5 N_e:N to the total population recovery goal (U.S. Fish and Wildlife Service 1993, 2000) for the five northern Rockies recovery zones (N = 1,026 with the Bitterroot, where reintroductions are being considered, and N = 746 without it), the recovery zones in sum would support $N_e < 250$, far less than the minimum $N_e = 500$ cited by numerous

investigators (Frankham, 1995; Nunney and Campbell, 1993) for minimum species viability. I argue these are compelling reasons for expanding the designated recovery zones, necessary to meet basic conservation goals for the species.

Capture and Data Bias Issues

With access to locations of radio-collared bears obtained via telemetry, my estimates of distribution, particularly in the Yellowstone area, would have likely resulted in a smaller estimated distribution area. For example, Blanchard and Knight (1991) reported 6,299 radio-relocations of 97 radio-collared bears between 1975-1987 in the Yellowstone area, with most inside Yellowstone National Park. Due to the large number of locations in the center of the area, the result would be an imploded distribution boundary for isopleths < 100% using HOME RANGER. This phenomenon reveals the effects of study area and capture bias in wildlife research studies. For practical and budgetary reasons, most grizzly bear core study areas are located within higher productivity habitats to increase trapping success and sample sizes (Metzgar and Bader 1992; Mattson 1997) and many study areas are much smaller than the recovery zone (Wielgus, et al. 1994; Mace and Waller 1997; U.S. Fish and Wildlife Service 1999). Overflights are generally limited to the recovery zones with minimal effort to document bear distribution beyond the periphery (C. Schwartz, Interagency Grizzly Bear Study Team, pers. comm.). Study effort has also moved from year to year (Blanchard, et al. 1992). Thus, the distribution area of a population based exclusively on data obtained from radio-collared animals may be significantly underestimated, unless capture bias issues are resolved within the overall study design. Otherwise, there is less ability to detect expansions and contractions in distribution area since peripheral areas are not routinely sampled. I argue for a concerted effort to document bear distribution and status in areas beyond the current recovery area boundaries to gain a more comprehensive view of the populations.

Conclusions

I provided evidence that the distribution of grizzly bears in the U.S. northern Rockies is significantly greater than is circumscribed by recovery zones outlined in the Grizzly Bear Recovery Plan (U.S. Fish and Wildlife Service 1993). Whereas a significant amount of this area encompasses private lands, large portions of their distribution was located on federal public lands. Although it is unrealistic to expect grizzly bear recovery throughout their historic range, I argue that the size and boundaries of recovery areas should be expanded and critical habitat designation should be considered, particularly on public lands. Lands currently outside the recovery areas receive no special consideration as grizzly bear habitat within the land management planning process. Enlarging the recovery zones will also provide additional opportunities for management on private lands where inclusion could foster cooperation and coordination between public and private landowners thus increasing the potential for recovery and sound management. Increasing the amount of habitat area is necessary to meet all seasonal requirements in order to expand the grizzly bear population to viable levels.

The estimated distribution areas for the Northern Continental Divide, Cabinet-Yaak, and Selkirk areas show overlap, suggesting that interchange between these populations is possible, although in no way should this suggest that the Cabinet-Yaak and Selkirk populations are not at critically low population size (n < 50). The data do indicate that measures should be taken to enhance the connection between these areas, including enlarging and managing the three areas as one recovery area.

Programs that estimate the home range of a species have utility in estimating distribution areas for populations, depending on the nature of the available data, the existence of comparison data sets, and familiarity with the home range characteristics and life histories of the species under study. There is a level of error associated with any method used to estimate population distribution or individual home ranges, particularly for wide-ranging, low density species such as grizzly bears. However, I believe the method I used provided reasonably accurate results. Combined with locations from radio-collared grizzly bears and annual updating, this method could provide a quick and relatively simple system for tracking of distribution trends for grizzly bears, reducing lag effects and the need for periodic, dramatic management interventions.

An annual assessment of distribution is particularly important given there is significant annual variation in individual grizzly bear ranges depending on weather and major food source availability (Mattson 1997). During drought years and major food source failures, bears make use of areas which may not be used during good food source years. Recovery planning could be improved by incorporating these sporadically used, but occasionally critical habitats.

More systematic, uniform, and unbiased methods of obtaining and recording grizzly bear observations are needed to more accurately and frequently estimate distribution of the species. Failure to pay more attention to expansions and contractions of grizzly bear distribution could leave significant portions of remaining grizzly bear populations subject to unnecessary risks and could delay detection of range collapse so that management interventions are untimely.

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