

# A Summary of Grizzly Bear Distribution in Montana: Application of Consistent Methods in 2022

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## INTRODUCTION

Understanding and communicating knowledge about the distribution of grizzly bear populations in the lower-48 States, including Montana, is important for their conservation, management, and for public safety. Previously, our research teams working in grizzly bear ecosystems in the lower-48 States used varying methods to estimate distribution of grizzly bear populations. In the Greater Yellowstone Ecosystem (GYE) and Northern Continental Divide Ecosystem (NCDE), zonal analysis and ordinary kriging were applied to an array of grid cells with or without verified presence of grizzly bears, however the parameters of the methods varied between the two ecosystems. In the Cabinet-Yaak Ecosystem and the Selkirk Ecosystem (SE), population distribution was mapped as the Recovery Zone plus “bears outside of Recovery Zone” (BORZ) areas (Allen 2011). Additionally, the U.S. Fish and Wildlife Service developed a method for estimating areas where grizzly bears “may be present” to help agencies or prospective applicants evaluate whether or not proposed actions may affect grizzly bears (U.S. Fish and Wildlife Service 2020). Since the mid 2010s, cooperating agencies have collaborated in documenting and maintaining a database of verified observations that occur between or well outside of grizzly bear Recovery Zones and these data inform the “may be present” mapping.

Following preliminary analyses and a joint meeting in 2022, we developed guidance for consistent methods to use across all grizzly bear ecosystems in the lower 48 States. First, we defined two levels of distribution: occupied range and extent of occurrence.

***Occupied range*** is an estimate of the roughly contiguous, minimum area within which grizzly bears have established residency or have demonstrated habitat use. It does not include occasional forays outside the estimated range or low-density peripheral areas and therefore does not represent the total known extent of occurrences. The area of occupied range is estimated using methods described by Bjornlie et al. (2014) and detailed below. Due to the smoothing inherent in the methods, range edges may extend over features that might act as partial barriers to grizzly bear movement, such as Interstate Highway 90 or Lake Koocanusa. Range estimates for neighboring populations may also overlap, but this does not represent evidence of genetic or demographic connectivity.

***Extent of occurrence*** is an estimate of the larger area over which grizzly bears have been observed to occur. It encompasses peripheral areas of low density, areas where bear may have made

occasional temporary forays, and areas through which bears may be dispersing or newly colonizing. This area is represented by “may be present” mapping (U.S. Fish and Wildlife Service 2020).

## METHODS

### *Occupied Range*

We estimated grizzly bear occupied range for each population using the methods, grid cell size, and window length developed by Bjornlie et al. (2014) for use in the GYE. Additionally, we screened GPS location data sets and data obtained from relocated bears followed methods as described below.

The basis for analysis of occupied range was the documented presence of grizzly bears within an array of grid cells. Presence data included: known locations of captures, mortalities, human-grizzly bear conflicts, and field collection of hair samples attributed to grizzly bears through DNA analysis; VHF and GPS locations from radio-monitored bears; and locations of sightings or tracks reported or verified by experienced agency personnel from strong descriptive or photographic evidence.

We screened data from GPS collared bears. Unlike other data sources that rarely include more than one location per individual per day, GPS data sets included as many as 48 locations per individual per day. To account for this sizable difference in data frequency, GPS data for each individual were screened to exclude all but 1 randomly selected location per day. This ensured that GPS data were not overrepresented in the data set and were appropriately scaled to the daily activity radius used to determine the grid size (see below).

We also screened data from bears that were relocated as a response to human-bear conflict or for population augmentation. After relocation, bears often wander widely, while trying to return to their original area or while searching for a suitable place to settle. To reduce the effect of these human-influenced movements on occupied range estimates, we excluded post-relocation data if locations were outside of previous estimates of occupied range and they were either: (1) outside of either the bear's known home range or a circular area around the capture site with a radius equal to the mean home-range radius (NCDE: 12 km for females, 21 km for males), indicating they had not successfully returned to their place of origin; or (2) they were wide-ranging and not concentrated (i.e., did not resemble a newly-established home range).

The 1 location per day-screening of GPS locations helped reduce the influence of occasional long-range, single-track excursions made by radio-collared bears (not associated with relocation). If, however, unusual excursions unduly distorted the extent of occupied range, we excluded those locations. Other considerations included known age and population of origin, as subadult individual movements tend to include exploratory excursions.

Grizzly bears are a long-lived species and due to small sample size, a single year of data from observations and radio-collaring efforts cannot accurately represent occupied range. Bjornlie et al. (2014) recommended that location data be pooled over a 15- to 20-year period to ensure the data provide an accurate representation of grizzly bear occupied range. We used a 15-year moving window for the GYE and NCDE populations, in which data from the 15-year period ending with the reporting year were combined for occupied range estimation. For example, for the reporting year 2022, data were combined from 2008 through 2022. Due to the smaller population size and resulting smaller available data sets, we used a 20-year moving window for the Cabinet-Yaak Ecosystem (CYE) and Selkirk Ecosystem (SE) populations.

We overlaid a 3- x 3-km grid across the lower-48 States using ArcGIS and assigned a value of 1 to cells with documented grizzly bear presence within the time window. The 3 x 3-km cell size was selected to represent the area used by a male grizzly bear within a day (Bjornlie et al. 2014), as estimated by roughly doubling the mean daily activity radii measurements for males: 1.4 km for the GYE, 1.3 km for the NCDE, and 1.2km for the CYE and SE.

We used zonal analysis to assign new values to each grid cell as the sum of that cell and its 8 nearest-neighbor cells (i.e., range = 0 to 9). We then applied ordinary kriging to these summed values to obtain a smoothed area within which summed values were generally  $\geq 1$ . If present, small disjunct “islands,” separate from the larger population range, were excluded.

### ***Extent of occurrence***

We delineated the “may be present” area based on 12-digit hydrologic unit code (HUC) boundaries (U.S. Fish and Wildlife Service 2020). We included HUCs if: they overlapped the estimated occupied range (above); they encompassed any GPS locations outside of occupied range during the last 10 years; they encompassed verified outlier locations documented during the last 10 years; or they were adjacent to HUCs that encompassed verified outlier locations during the last 10 years. Twelve digit HUCs are, on average, 40–162 km<sup>2</sup> and approximate the annual home-range size of an adult female grizzly bears (27–242 km<sup>2</sup>). The larger area including adjacent HUCs approximates the home range of an adult male grizzly bear (78–2,115 km<sup>2</sup>).

## **RESULTS**

### ***Occupied range***

GYE - The methods remained unchanged for estimation of occupied range in the GYE, because the adopted methods were from Bjornlie et al. (2014) that were previously developed and used for this population. The 2022 estimate of occupied range was 70,101 km<sup>2</sup>, with 45,072 km<sup>2</sup> within Wyoming, 18,097 km<sup>2</sup> within Montana, and 6,932 km<sup>2</sup> within Idaho (Dellinger and Haroldson 2023; Figure 1). This current estimate encompassed 100% of the Recovery Zone and 97% of the Demographic Monitoring Area (DMA). Of estimated occupied range, 34% was inside the Recovery Zone, 35% was outside the Recovery Zone but inside the DMA, and 31% was outside the DMA. The area of occupied range was similar to the 2020 estimate, which encompassed 70,468 km<sup>2</sup> (<1% change).

NCDE - Previously, distribution in the NCDE was estimated using zonal analysis and ordinary kriging, but some parameters differed from the newly adopted methods. The first parameter that changed was the cell size – from 7 x 7 km to 3 x 3 km. The second parameter that changed was the length of the data window – from 10 years to 15 years. The third parameter that changed was the protocol for including GPS data – from using all data to screening to 1 random location per bear per day.

Using the revised parameters, the 2022 estimate of occupied range for the NCDE grizzly bear population was 55,652 km<sup>2</sup> within Montana (Costello et al. 2023; Figure 2). This current estimate encompassed 100% of the Recovery Zone and 93% of the DMA. Of estimated occupied range, 42% was within the Recovery Zone, 30% was within Zone 1 (outside the Recovery Zone but inside the DMA), and 28% was outside of the DMA. Occupied range was also estimated for 2020 using the revised parameters, to evaluate range expansion during the last two years and to illustrate the influence of the revised parameters on the resulting estimate. The revised 2020 estimate was 50,040 km<sup>2</sup>, indicating that occupied range increased by about 11% between 2020 and 2022.

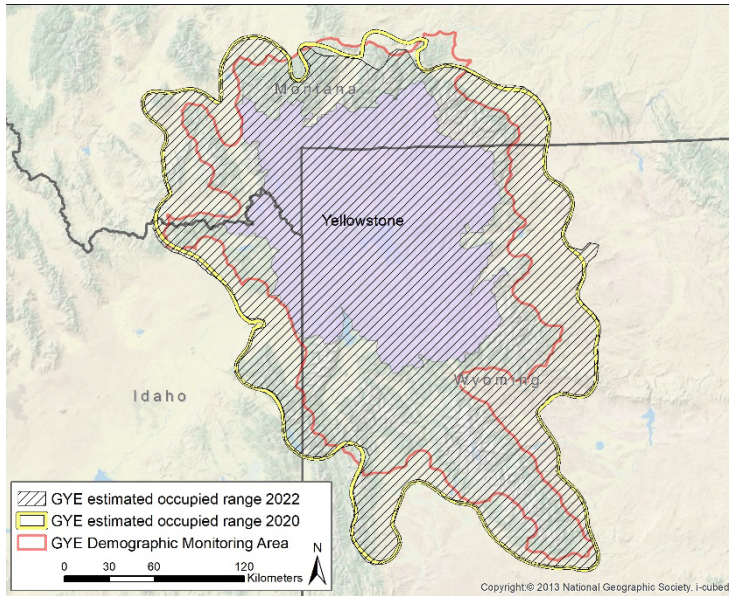


Figure 1. Estimated occupied range of the grizzly bear population in the Greater Yellowstone Ecosystem during 2008–2022 (hatched area) compared with 2006–2020 (yellow boundary). The Grizzly Bear Recovery Zone is represented by the purple polygon.

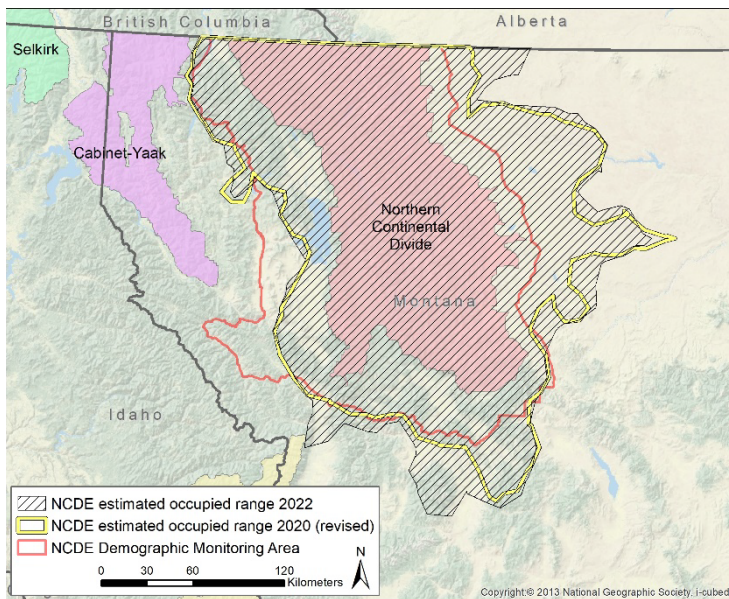


Figure 2. Estimated occupied range of the grizzly bear population in the Northern Continental Divide Ecosystem during 2008–2022 (hatched area) compared to 2006–2020 (yellow boundary). The Grizzly Bear Recovery Zone is represented by the orange polygon.

The revised methods resulted in a more compact and realistic estimate of occupied range than the previous methods (Figure 3). This was primarily due to the revised cell size (3 x 3 km versus 7 x 7 km), although there were some differences in occupied cells due to the revised window length (10 versus 15 years) and use of GPS data (all versus 1 location per day). When cell size was larger, cells containing scattered locations near the periphery were more likely to be connected as near neighbors, and thus included within the kriged surface. For example, the scattered locations in the southern Boulder Mountains (near the intersection of Interstate Highway 90 and Interstate Highway 15) were included in unrevised 2020 range but excluded from the revised 2020 range. Additionally, kriging based on the larger cell size tended to inflate and smooth the contour more than did kriging based on the smaller cell size.

For example, the unrevised 2020 range (and other unrevised ranges dating back to 2004) extended well south of Interstate Highway 90, even though only scattered locations were observed there. In contrast, the revised 2020 estimate (and other revised estimates back to 2004) remained north of Interstate Highway 90. Only the revised 2022 estimate extended south of Interstate Highway 90 (Figure 2), when GPS locations and repeated observations of unmarked bears demonstrated occupancy and sustained use in the Bitterroot and Flint Creek mountains.

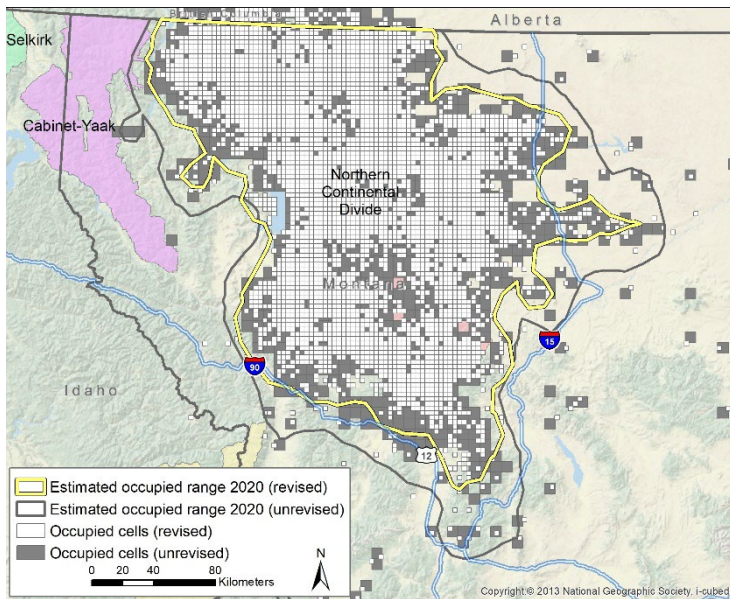


Figure 3. Occupied cells and resulting estimated occupied range for the NCDE grizzly bear population in 2020, comparing revised (white cells and yellow boundary) and unrevised methods (gray cells and gray boundary).

CYE - In 2022, the zonal analysis and ordinary kriging methods were applied to the CYE for the first time. Using the new methods, the 2022 estimate of occupied range for the CYE grizzly bear population (within the US) was 12,337 km<sup>2</sup>, with 8,475 km<sup>2</sup> in Montana and 3,862 km<sup>2</sup> in Idaho (Kasworm et al. 2023a; Figure 4). This current estimate encompassed 96% of the CYE Recovery Zone. Of the estimated occupied range, 52% was within the Recovery Zone and 48% was outside of the Recovery Zone.

SE - In 2022, the zonal analysis and ordinary kriging methods were applied to the SE for the first time. Using the new methods, the 2022 estimate of occupied range for the SE grizzly bear population was 10,928 km<sup>2</sup>, with 4,791 sq. km<sup>2</sup> within British Columbia, 4,483 km<sup>2</sup> within Idaho, and 1,654 km<sup>2</sup> within Washington (Kaworm et al. 2023b; Figure 5). This current estimate encompassed 96% of the SE Recovery Zone. Of the estimated occupied range, 57% was within the Recovery Zone and 42% was outside of the Recovery Zone.

Occupied range estimates for the SE, CYE, and NCDE overlapped spatially (Figure 6). Although a limited number of temporary or permanent movements of bears between these ecosystems have been observed, no evidence of interbreeding among bears from different ecosystems has been observed. Therefore, the three U. S. populations are not, as yet, known to be genetically or demographically connected with one another.



A distance of 98 km separated the estimated occupied range of the GYE population and the nearest other occupied range, that of the NCDE population. This was a slight decrease from the distance of 102 km separating the 2020 estimated occupied ranges (using the revised methods).

Estimated occupied range of the NCDE population slightly overlapped the northern portion of the currently unoccupied Bitterroot Ecosystem (BE) Recovery Zone. In 2020, estimated occupied range of the NCDE population was 26 km from the BE. Estimated occupied ranges of the CYE, GYE, and SE populations were 126 km, 154 km, and 227 km from the BE Recovery Zone in 2022.

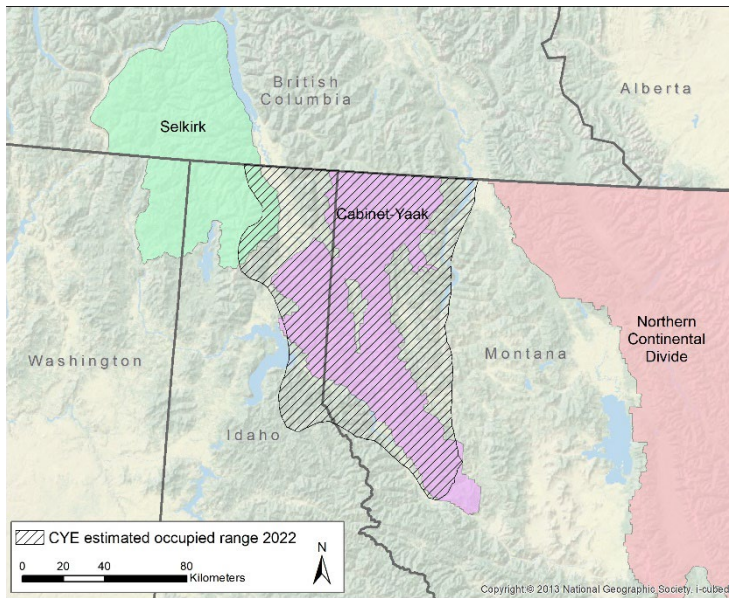


Figure 4. Estimated occupied range (hatched area) of the grizzly bear population in the Cabinet-Yaak Ecosystem (within the US), 2003–2022. The Grizzly Bear Recovery Zone is represented by the purple polygon.

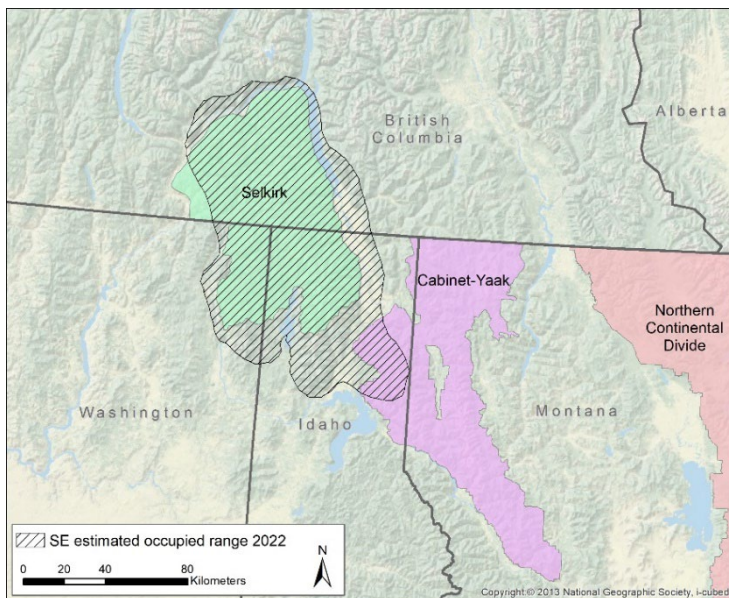


Figure 5. Estimated occupied range (hatched area) of the grizzly bear population in the Selkirk ecosystem, 2003–2022. The Grizzly Bear Recovery Zone is represented by the green polygon.

### Extent of occurrence

In the lower-48 States, the estimated extent of occurrence (July 2023) encompassed 230,586 km<sup>2</sup>, with 137,823 km<sup>2</sup> within Montana, 58,355 km<sup>2</sup> within Wyoming, 29,613 km<sup>2</sup> within Idaho, and 4,788 km<sup>2</sup> within Washington. Compared to the previous estimate (July 2022), estimated extent of occurrence increased by about 2%. In Montana, notable areas added to the extent included the Pryor Mountains, the lower Shields River, additional areas in the upper Missouri River, and additional areas in the Beaverhead Mountains.

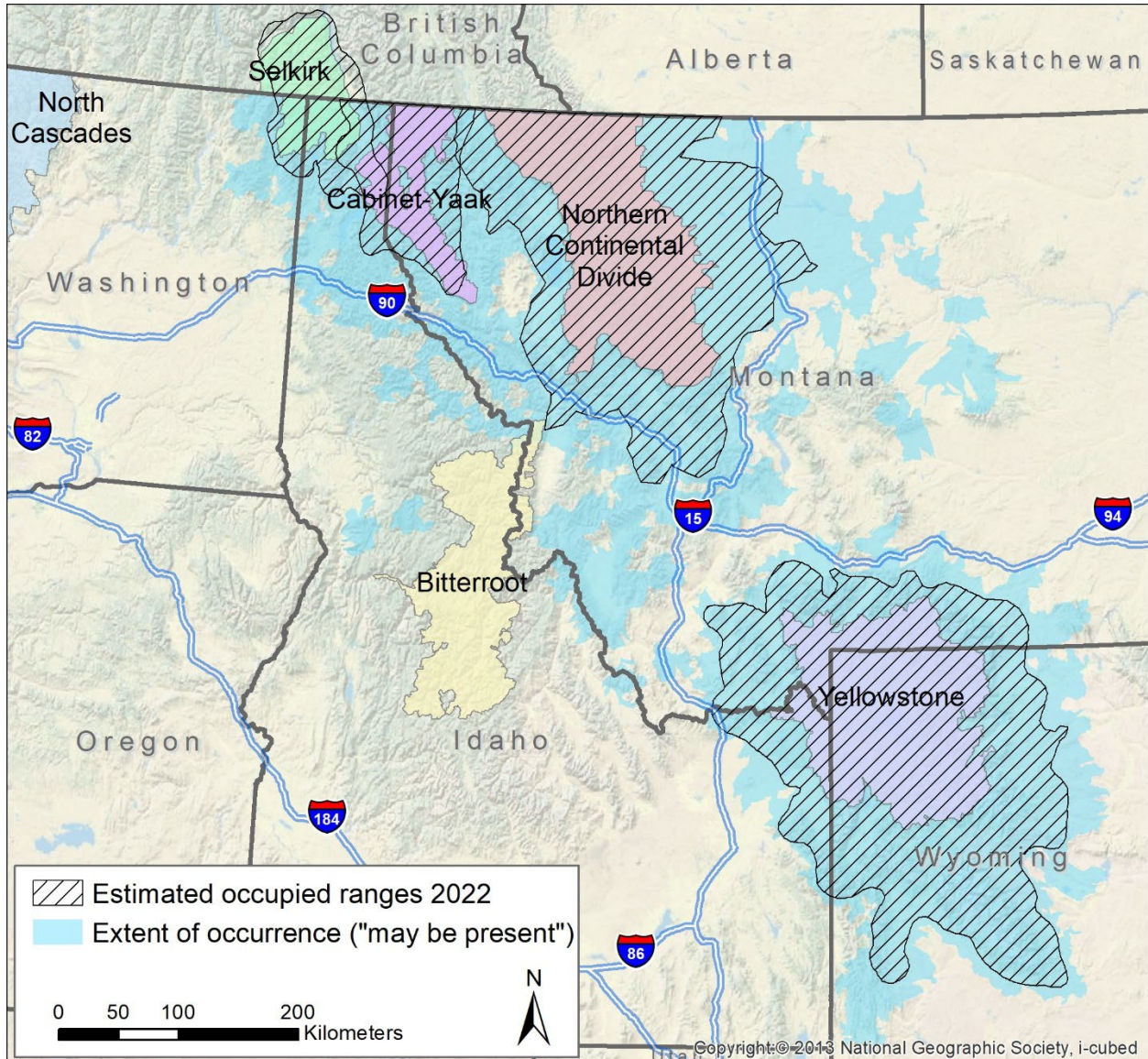


Figure 6. Estimated occupied range and extent of occurrence of grizzly bear populations in the lower-48 States, 2022. Grizzly Bear Recovery Zones for each ecosystem are represented by solid color polygons.



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