

FINAL REPORT

for Rocky Mountain National Park, Estes Park, Colorado,

USA

**Population demographics, habitat utilization, critical habitats, and condition of black bears in
Rocky Mountain National Park.**

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Summary

1. We evaluated home-range size, overlap, and distributional patterns of black bears in Rocky Mountain National Park (RMNP) from 2003–2006. Mean size of male home-ranges (100% MCP = 103.0 km²) was significantly larger than female home-ranges (100% MCP = 47.3 km²) and was larger than values reported previously for RMNP (95% MCP = 35.6 km²), though they were within the range of expected values for the western U.S. (74.2–144.5 km²).
2. Mean size of female home-ranges was smaller than previously reported for RMNP (95% MCP = 53.9 km²) but still substantially larger than the western U.S. average (20.1–36.1 km²).
3. Sizes of female home ranges were positively related to surrogates of vegetation productivity including maximum temperature (MaxTemp) and growing degree days (GDD), but negatively correlated with precipitation (Precip).
4. Seasonal home-range size did not vary within years for males or females, but was significantly different between males and females.
5. The percentage of overlap for annual female home-ranges varied across years and was strongly related to MaxTemp and loosely related to Precip and GDD.
6. Distributional patterns of female black bears varied by year; significant changes in distribution were related to MaxTemp and Precip during autumn, but not annually or for other seasons.
7. Patterns in home-range sizes of black bears in RMNP suggest lower habitat quality for black bears in RMNP when compared to other western localities. Cool, wet years increased habitat quality for black bears in RMNP, while hot, dry years reduced habitat quality for black bears.
8. Historical data (1984–1991) from RMNP included some of the lightest weights ever recorded for black bears in North America but did not include direct measures of body condition.
9. Size of black bears during the contemporary period (2003–2006) was comparable to other western U.S. populations. Also, body fat (BF) and body condition index (BCI) of black bears during the contemporary period indicated high levels of condition.
10. BCI, BF, and body weights of female black bears all increased over the last 15–20 years; similar values for males were not significant, though small sample sizes limited power.
11. Increases in black bear size and condition were most parsimoniously related to increased use of human-use areas and anthropogenic food sources.
12. We used 3 approaches to estimate population size and density of black bears in RMNP: 1) minimum number known, 2) occupancy modeling, and 3) catch per unit effort (CPUE).
13. We used information from capture and remote-sensored cameras, as well as visitor information, to derive a minimum known population estimate of 20–24 individuals. We used the median value of 22 combined with a 3,203-m area of effect around the RMNP boundary to produce a density estimate of 1.35 bears/100 km².

14. The best approximating occupancy model indicated that 41.2% of RMNP was occupied by black bears.

15. We combined the occupancy estimate with mean home-range size and overlap for male and female black bears to determine a density estimate of 1.29 bears/100 km² (90% CI = 0.16–2.41) in RMNP.

16. We also related CPUE to density estimates for 8 low-density populations using linear regression to estimate population size for black bears in RMNP. Density estimates from CPUE models (1.03 bears/100 km², 90% CI = 0.27–3.67) were well within the 90% CI for occupancy estimates and suggest these approaches may be useful for future population monitoring.

17. The current status of RMNP's black bear population appears to be stable to increasing (see 20 below), although distributions may be shifting toward human-use areas.

18. Black bears in RMNP exhibited earlier age of first reproduction (historical = 7.5 years, contemporary = 5.5 years) and higher cub survival (historical = 43%, contemporary = 71%) than historic values; litter size and adult and subadult survival were similar between periods.

19. Enhanced reproductive attributes resulted in higher recruitment (yearlings/female/year; historical = 0.34, contemporary = 0.56), a greater number of reproductive years (historical = 7.5, contemporary = 9.5), and higher reproductive output per female lifetime (number of cubs reaching reproductive age/female reproductive lifetime; historical = 0.73, contemporary = 1.80) for 2003–2006 data as compared to 1984–1991 data for RMNP. Current reproductive rates in RMNP are similar to other western U.S. populations.

20. Population modeling using historic and contemporary demographics predicted a much larger population size at the end of 10-year simulations for the contemporary period (90% probability of a final population size of ≤ 53 versus ≤ 19) using the same initial population size and each period's respective population age/sex structure.

21. Higher potential rate-of-population-increase in the contemporary period reflects increased productivity of the black bear population as survival rates were similar between periods.

22. This increased productivity may be related to better nutritional condition of reproductive females from the current population (weight: historical = 60 kg, contemporary = 68 kg; body fat: historical = 15%, contemporary = 23%).

23. We observed differences in the relationship between den locations and most habitat and physiographic factors (aspect, elevation, covertype, distance to roads and trails) between historic and contemporary periods in RMNP.

24. Maximum entropy modeling of den locations resulted in different habitat variables being included in the best models of suitable denning sites for the historic (slope, elevation, covertype) and contemporary periods (slope, distance to roads, aspect, canopy height) and indicate a shift in den locations over the last 15–20 years towards areas characterized by higher human presence.

25. Shifts of preferred denning locations towards areas of higher human influence supports other data (bear condition, home range locations, habitat use associations, etc.) that suggests that black bears appear to be habituating to humans.

26. Date of den entrance was most strongly influenced by age class and correlates of vegetation productivity (growing-season precipitation and temperature), with den entrance typically later for adult black bears during cooler, wetter years. Sex of black bears was loosely correlated to time of den exit; males emerged before females.

27. Most common foods of black bears as determined by adjusted volumetric values from scat analyses annually were grasses (24.2%), berries (16.8%), and ants (31.2%). Use of grasses, berries, and small mammals varied by season, with greatest use of grasses (49.1%) occurring during spring and berries (31.6%) and small mammals (14%) during autumn.

28. Focal animal observation yielded similar trends annually for time spent foraging on grasses (17.8), berries (10.2), and insects (61.3) with all 3 differing between spring and summer seasons; no analyses were conducted for autumn given small sample sizes.

29. Nutritional assessments indicated highest values for gross energy and crude fat in black bear diets during summer; no seasonal differences were noted for fecal nitrogen.

30. Gross energy was typically lowest for grasses and other herbaceous plants but highest for ants and ungulates. Fecal nitrogen was strongly related to most animal sources but was negatively correlated with vegetative matter. Crude fat showed the strongest positive relationship with berries, though this was likely influenced by the presence of seeds in the analysis.

31. Historic diets of black bears in RMNP showed greater frequency of ants but less grass, while contemporary diets included substantially greater amounts of anthropogenic foods. This increased use of human foods likely contributed to increases in observed body size (weight females: historic = 52 kg, contemporary = 58 kg), body condition (body fat females: historic = 15.0%, contemporary = 22.8%), and population growth rate (historic $\lambda = 1.01$, contemporary $\lambda = 1.11$) for the contemporary black bear population.

32. We assessed habitat selection across 3 spatial scales (landscape, home-range, and site-specific) to delineate critical habitats for black bears in RMNP for both historic (1984– 1991) and contemporary populations.

33. Black bear habitat selection at both landscape and home-range scales was highly variable both historically and contemporarily, although black bears were commonly associated with aspen covertypes and human-use sites and avoided open covertypes.

34. Relationships were more consistent for landscape metrics, with black bears preferring highly diverse landscapes high in edge and comprised of small patches both in the contemporary and historic periods.

35. Nutritional condition of black bears in RMNP was most strongly positively associated with aspen, mesic shrublands, and human-use areas, while limber pine and mixed conifer had the most consistent negative influence on bear body fat and body condition indices.

36. Human-use areas were also used at a much higher rate during the contemporary period (70% of black bear locations in human-use areas) than historically (51% of black bear locations in human-use areas), suggesting increasing habituation of black bears for human influenced habitats. This trend likely was driven by high yield resource capture (i.e., anthropogenic food sources).

37. Site-specific analyses indicated that black bears preferred north and east facing aspects, greater numbers of logs and ant mounds, and less grass and woody cover at foraging sites as compared to random sites. Site-specific preferences correspond to habitat attributes that predict greater quantity and quality of plant and insect foods for black bears.

38. Few differences were found between resting and foraging locations. However, observed differences indicated a preference for steeper slopes and denser woody understory cover at resting sites. Both of these attributes relate to less disturbance and greater security.
39. Collectively, analyses suggested that small, evenly distributed patches of aspen, human-use, and mesic shrubland covertypes provided the best habitat for black bears in RMNP.
40. Covertypes composition is likely less important than high habitat diversity in RMNP. Black bear distribution patterns are tied closely to actual distribution of food sources that show high annual, seasonal, and spatial variability in RMNP. By maximizing diversity within home-ranges, black bears likely assure that at least some of these components will be present in home-ranges. Black bears more frequently shift distribution during years when foods are less available due to climatic effects, further reflecting the need for high habitat diversity to ensure that at least some types of foods are available to black bears annually in RMNP.
41. Management strategies designed to provide or increase the diversity of RMNP's landscape and provide key structures associated with bear foraging (i.e., dead and down logs, etc.) may help reverse an apparent shift in black bear use to high human-use sites while maintaining increased black bear condition in RMNP.