The Role of Habitat Quality in the Natural Regulation of Black Bear Populations

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Abstract: A key factor in black bear habitat quality is the ability of habitat to provide abundant, reliable, and well-distributed food in the spring, summer, and fall. Food supply directly affects growth rate, female age of first reproduction, and cub survival through 1.5 years of age. Food supply may secondarily affect movements, aggression, social organization, cub vulnerability to predation (including predation by other bears), and perhaps susceptibility to disease and parasites. Water and shade are necessities in warm climates but are provided coincident with the forest habitat that provides food. Escape cover, including well-distributed large trees of species that have sturdy, creviced bark for cubs to climb, may be of particular importance where predators (including conspecifics) are abundant. Food acts in a largely density-independent manner in limiting reproduction and cub survival. Factors that act in a density-dependent manner to regulate black bear populations are poorly known. Cub mortality results mostly from natural causes that vary among populations, but the causes have not been well studied because few studies of cubs have employed radio collars. Causes of deaths of radio-collared adults are documented frequently but are mostly from human-related causes; how the few natural deaths of adults might relate to natural regulation is open to speculation. Causes of death, particularly for cubs and dispersing subadults, need further study. We also need to determine the effects of food supply and forest structure on other environmental factors such as competition, predation (including predation by other bears), parasites, disease, human-related mortality, pollution, and weather. We do not know whether any of the environmental factors act in a density-dependent manner to regulate black bear populations and at what population densities these factors may exert an influence. Most populations studied to date have been artificially limited by hunting or other management actions, and densities have probably been below levels at which intrinsic factors are likely to be of primary regulatory significance.

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Introduction

Little is known about natural regulation of black bear populations. Too many unstudied factors remain to permit conclusive analysis. Cub mortality *rates* are fairly well known, but *causes* of cub deaths are not. In most studies other than Al LeCount's cub radio-collaring projects in Arizona (this publication), cub disappearances have provided little information on proximate or ultimate causes of death. Causes of deaths of older bears are documented frequently, but most are human-related, especially in hunted populations. How the few natural deaths might relate to natural regulation of population density is open to speculation.

In this paper, I discuss the role of habitat quality in the natural regulation of black bear populations. Habitat is defined in the narrow sense: food, water, thermal cover, and escape cover. A broader sense might include competitors, predators (including other bears), parasites, disease, people, pollution, and weather-factors that might better be termed environmental factors. Food, water, and cover probably mitigate or exacerbate effects of environmental factors on bears (see next section). Effects of predators and competitors will be addressed in detail by the other papers in this report.

Food

Probably the most important aspect of habitat is its ability to reliably provide abundant, well-distributed food. When food is scarce or is concentrated in a small area, malnourishment, social strife, or both are likely. Lack of food can stimulate unusual movements that lead to unusual social encounters (Schorger 1949, Rogers 1987*a*). Weakened cubs and yearlings may become vulnerable to predators, including other bears (Rogers 1987*a*). Starving adults may be more likely to prey on young bears (Rogers 1987*a*). Black bears that aggregate at clumped food sources during food shortages compete more aggressively than usual and inflict unusually severe injuries (Rogers 1987*a*). Malnourished bears may also be more susceptible to disease or parasites (Jonkel and Cowan 1971, Rogers and Rogers 1976). Black bears that forage farther than usual may be more vulnerable to being killed by vehicles or as nuisances (Rogers 1976, 1987*a*). These situations are indirect effects of food shortage.

Food shortage directly affects survival, growth, maturation, and reproductive success (Rogers 1976, 1987*a*; Bunnell and Tait 1981). In the wild, reproduction in black bears is controlled mainly in a density-independent manner by fruit and mast supplies that fluctuate in abundance from year to year (Rogers 1976, 1983, 1987a, Bunnell and Tait 1981, Pelton 1989). Food shortage acts primarily in a density-independent manner because food supplies vary much more widely than black bear populations do. Black bear populations typically fluctuate within a narrow range, increasing or decreasing slowly over a period of years. The doubling or halving of a bear population over a period of years would be a noteworthy event, but major foods such as fruits and nuts commonly vary more than 50-fold from year to year (Hamer et al. 1979, Arimond 1979). This variation also helps explain why bear populations show little or no compensatory recruitment following periods of heavy mortality (Miller 1990).

Food shortages are not always absolute. Shortages may also be relative shortages in which food is present but is so spread out that bears cannot feed efficiently enough to gain sufficient weight for reproduction, survival, or both (Andrewartha and Birch 1954).

Captive black bears that receive rich diets develop and reproduce more rapidly than wild bears do, even when the captives are caged with larger bears that dominate them (Rogers 1976). Captive bears of either sex typically produce their first litters at three years of age (Rogers 1976), while wild ones do so at three to eight years (Table 1). This variation suggests that any effects of social factors on growth and maturation, as might be mediated through the endocrine system (Christian 1950, Christian and Davis 1964), are minor relative to nutritional factors (Rogers 1976).

Table 1. Reproductive parameters of female black bears eating natural foods only and supplemental garbage in northeastern Minnesota, 1970-80.

Reproductive Parameter	Mean	Range	N
Natural Foods Only			
Age at first reproduction	6.3 years	4-8 years	17
Intervals between litters	2.3 years	2-4 years	36
No. cubs in first litter	2.1 cubs	1-3 cubs	17
No. cubs in subsequent litters	2.5 cubs	1-3 cubs	35
With Supplemental Garbage			
Age at first reproduction	4.4 years	3-5 years	11
Intervals between litters	2.0 years	2 years	8
No. cubs in first litter	2.5 cubs	1-3 cubs	8
No. cubs in subsequent litters	3.4 cubs	3-4 cub	1

Source: Rogers 1989.
Note: Excluding intervals of one year due to litters being lost before mating seasons.

In the wild, supplemental food similarly enhances growth rates and reproduction. In northeastern Minnesota, females that ate only natural foods matured more slowly and had lower reproductive rates than those that supplemented their wild diets with garbage (Table 1). The females also matured more slowly and had lower reproductive rates than bears in Pennsylvania (Kordek and Lindzey 1980), where high-energy food is available for a greater part of the year. High-energy mast becomes scarce in northeastern Minnesota by early September, but a variety of hard mast species are often available in Pennsylvania until early December (Rogers 1987*a*, Alt 1980, Kordek and Lindzey 1980). The longer growing period in Pennsylvania enables females to begin reproducing 2 to 3 years earlier (38% by age 3, 88% by age 4) than in Minnesota where the average of first reproduction is 6.3 years (Alt 1980, Kordek and Lindzey 1980, Rogers 1987a). Thus, by the time

Minnesota females produce their first litters, 88% of Pennsylvania females have produced 2 litters, and some of the cubs from the first litters are producing cubs of their own (Alt 1980, Kordek and Lindzey 1980, Rogers 1987a).

Survival through 1.5 years of age also depends primarily upon food supply (Rogers 1976, 1983, 1987a; Bunnell and Tait 1981). In northeastern Minnesota, natural mortality among cubs and yearlings became heavy at the end of 3 successive years of scarce fruit and nuts (1974-76). In 1976, 10 of 20 cubs died, and 3 of 4 yearlings died the following spring (Rogers 1983). During the 3 years of scarce food, the population in the study area declined 35% from 1 bear per 4.1 km in June 1974 to 1 bear per 6.3 km in June 1977. The decline was not entirely due to natural mortality, however, because some bears were shot foraging for garbage (Rogers 1983).

Food scarcity directly increases yearling mortality: death was nearly certain for male and female yearlings that left their dens in spring weighing less than 10 kg, but survival was high for those that left their dens weighing greater than 13 kg (Table 2). Before dying, at least one of the starving yearlings was found to be too weak to climb a tree (Rogers 1987). In such cases, bears would be vulnerable to predation as well as starvation. In Pennsylvania, all studied yearlings exceeded 18 kg (range 18.6 to 63.6 kg) and survival was high (Alt 1980). The fact that black bear yearlings weighing only 13 kg survive as well, or nearly as well, as yearlings several times heavier suggests that growth plasticity is an adaptation to a variable food source. Starvation deaths are rare after 1.5 years of age in northeastern Minnesota.

Table 2. Survival of yearlings as related to body weight in northeastern Minnesota.

Body Weight at 14 Months of Age	Number Surviving as Learned by Telemetry	Number Surviving as Learned by Recaptures
< 10kg	0 of 6	1 of 19
10-13 kg	7 of 9	9 of 18
> 13kg	15 of 15	22 of 31
all weights	22 of 30	32 of 68

Note: Recapture data includes both radio-collared and nonradio-collared eartagged yearlings. Recapture data tends to underestimate proportion of yearlings surviving because dispersal reduced chances of recapture for some bears.

The presettlement range of the black bear extended from Mexico and Florida north to treeline, which demonstrates that black bears can live anywhere in North America where extensive forests exist. The adaptable black bear, with its ability to grow slowly if necessary, can maintain populations even where land is of relatively low fertility. However, where food is scarce, reproductive success is also low, and mortality rates among adults must be correspondingly low to assure population viability. Food supply may *limit* populations but has not been shown to work in a density-dependent manner to *regulate* populations.

Water

Water must be readily available and well distributed throughout the year if black bears are to use an area in an unrestricted manner (Hugie 1979). Black bears drink frequently when feeding on vegetation, nuts, or insects but seldom drink when feeding on berries (Rogers and Allen 1987). They wallow to cool off on hot days in all seasons (Kellyhouse 1980, Rogers and Allen 1987). Heat stress may prevent bears from fully using forest openings on sunny days (Jonkel and Cowan 1971, Rogers 1980, Rogers and Allen 1987). Wetland and riparian habitats are used for cooling and provide seasonal foods (Rogers and Allen 1987). Drought is one of the causes of berry crop failures in northern forests, especially where soils are shallow and easily desiccated (Rogers 1987*a*). Precipitation exceeds evaporation and transpiration over most of the forested black bear range, making water readily available for drinking or cooling in most regions. The arid Southwest has the greatest potential for water shortage sufficient to render areas unlivable due to lack of water per se or due to secondary effects on forest cover or food. Water may *limit* populations in some regions but probably does not *regulate* them since water shortage would seldom be expected to operate in a density-dependent manner.

Precipitation, humidity, and soil moisture could indirectly affect black bear populations through effects on life cycles of parasites. However, this theory has not been studied. Black bears are tolerant or immune to many diseases, and no wild population has been reported to be decimated by disease or parasites (Rogers and Rogers 1976, Rogers 1983).

Thermal Cover

Thermal cover is shade in areas and seasons in which bears have problems dissipating heat. In northeastern Minnesota, black bears pant and seek shade after a few minutes in direct sunlight on warm, humid days (pers. obser.). By contrast, in northern Labrador, the weather is cool and the humidity is low, and black bears live on the open tundra without forest cover (A. Veitch, pers. comm. 1990).

Thermal cover is a hibernaculum in winter. Hibernacula include burrows, hollow trees, rock crevices, brush piles, and surface nests (Rogers 1987a). The latter are typically built next to windfalls or other windbreaks (Rogers 1987a).

Newborn cubs depend upon their mothers for warmth and will die if dens are flooded or if mothers are disturbed and forced to leave the cubs for long (Smith 1946, Johnson and Pelton 1980, Alt 1984). Temperatures in black bear dens remain approximately at ambient (outside) temperatures if the entrances are open. Dens whose entrances are blocked with snow have temperatures slightly warmer than soil temperatures (Rogers 1987a). Tree dens appear to be preferred (Johnson and Pelton 1981) but are not of critical importance in boreal habitat (northeastern Minnesota) where overwinter survival is greater than 99% despite a paucity of tree dens (Rogers 1987a, Rogers and Alien 1987). Tree dens are probably of greater importance farther south where winter thaws, ground den flooding, and winter disturbances by humans or dogs are more likely (Johnson and Pelton 1981, Alt and Gruttadauria 1984, Rogers 1987a). Under those conditions tree dens may improve reproductive success for pregnant females, although mature males commonly seek ground dens (Johnson and Pelton 1981). Whether den sites might act in a density-dependent manner to regulate bear populations depends upon local needs and local abundance of dens. Den sites were not in short supply in northeastern Minnesota (Rogers 1987*a*).

Escape Cover

Escape cover provides protection from predators and other bears. A component of escape cover is readily available, large (>20 inches dbh) trees with sturdy, creviced bark that cubs can safely climb. Cubs sometimes fall from trees with slippery or shaggy bark. Although none of eight observed falls involving spring cubs in northeastern Minnesota were fatal, falls that occur while cubs are escaping from predators could be fatal. The importance of large refuge trees to cub survival and to the natural regulation of black bear populations has not been tested, although mothers strongly select large trees with sturdy, creviced bark as refuge trees. Preferred refuge trees in the northeastern United States are large (20-44 inch dbh) white pines *(Pinus strobus)* and hemlocks *(Tsuga canadensis)* (Elowe 1984, 1987; Rogers et al. 1988). However, black bears survive without trees on the tundra of northern Labrador where wolf and black bear densities are low and grizzly bears no longer live (A. Veitch, pers. comm. 1990).

In areas or times of food scarcity, black bears may roam farther than usual, sometimes beyond the normal range of the species (Rogers 1987*a*). Potential problems associated with habitat fragmentation or limited forest habitat increase in importance when bears range more widely. Thus, habitat fragmentation or limited habitat area may limit bear populations where nonhabitat areas act as sinks in which bears are shot or otherwise killed. Such limitation may not constitute regulation, however, because subsequent reproduction may not compensate in a density-dependent manner. Understanding this aspect of limitation in relation to regulation is confounded by problems of highly variable food supplies, questions of whether dispersal is voluntary or involuntary (Rogers 1987*b*), and by questions concerning black bear social organization (Rogers 1987*a*). Available information suggests that social factors may play a greater role in determining *which* members of a population can occupy an area than in determining *how many* can do so (Rogers 1987*a*).

In the winter, dens provide protection from predators and disturbance (Johnson and Pelton 1981). The need for secure dens, rather than surface nests, may depend in part on densities of predators, including humans, domestic dogs, and bears.

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