MANAGING NORTHERN FORESTS FOR BLACK BEARS[1]

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ABSTRACT. — Wild, radio-collared black bears (Ursus americanus) that became habituated to close (0-12 ft) observation by researchers showed activity patterns and habitat use patterns similar to those of radio-collared bears monitored from airplanes. The habituated bears were active mainly by day, sleeping from 1-3 hours after sunset until dawn with periodic naps through the day. Food, shade, security, and water were important habitat components. In early spring, the grass understory of forested wetlands provided the majority of food although these wetlands comprised <1% of the study area. Wetlands were also used for cooling. Dense thickets of balsam fir (Abies balsamea) saplings were preferred for shade. White pines (Pinus strobus) >20 in dbh located <200 yds from forested wetland feeding areas provided the majority of refuge trees for mothers with cubs in early spring although these trees comprised <1% of all trees >10 in dbh. Late spring diets included newly sprouting upland forbs, expanding aspen (Populus tremuloides) leaves, and ants. In summer, berries, nuts, ants, and forbs were major foods. Forest edges, mature forests, marshes and moist areas all contained major foods. The most important fall food is acorns. Management recommendations are included for each season.

INTRODUCTION

The original range of the black bear (Ursus americanus) coincided with forested regions throughout North America (Pelton 1982). That range has been reduced through forest removal or fragmentation and continues to be reduced by an expanding human population. However, extensive range remains, especially in northern or mountainous regions unsuitable for commercial agriculture. Many of these areas are managed for timber production, recreation, and wildlife, but more detailed information on bear habitat requirements is needed. A study was conducted to obtain habitat information that managers can integrate into resource management plans and use in opportunity area planning and implementation.

METHODS

Three methods were used to learn habitat needs of black bears in northeastern Minnesota. First, 83 radio-collared black bears were monitored to determine home range size and how the availability of certain forest types affects survival, growth, and reproduction (Rogers 1987a). Secondly, more

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than 1,200 fecal scats were examined to determine differences in diet between years when bears thrived and years when their growth and reproduction were poor. Habitats that produced the foods identified in the scats were then studied to determine what forestry practices led to those habitats being productive (Arimond 1979). Thirdly, current studies involve observing four wild, free-ranging, radio-collared black bears that are habituated to observers.

The habituated bears, who allowed observers to record data from within 4 yards for 24 hours at a time, showed movement and activity patterns similar to those of bears radio-tracked remotely. Although aware of the observers, the habituated bears paid little attention to them. The bears foraged and napped by day and slept at night as has been reported for other bears (Rogers 1987a). Mothers tended and nursed their cubs, and the cubs showed normal growth.

Data recorded from habituated bears Included: habitat type, amount eaten of each food in each habitat, number of minutes spent on each activity in each habitat, and reactions to insects, weather, other bears, and other animals. Each of the three methods (radio-tracking, scat analysis, direct observation) provided unique but complementary information. Continuing study will involve further observation of habituated bears.

STUDY AREA

The studies were conducted in the Superior National Forest in northeastern Minnesota. The study area is approximately one-fourth lowland and three-fourths upland, with upland mixed coniferous-deciduous forest communities predominating (Peek et al. 1976). Vegetation is typical of the northern Great Lakes region, containing components of both the boreal forest and the temperate deciduous forest (Maycock and Curtis I960). Common upland trees are aspen (Populus tremuloides, P. grandidentata), paper birch (Betula papyrifera), red pine (Pinus resinosa), white pine (P. strobus), jack pine (P. banksiana), white spruce (Picea glauca), and balsam fir (Abies balsamea). Common lowland trees are black spruce (P. mariana), balsam fir, tamarack (Larix laricina), white cedar (Thuja occidentalis), black ash (Fraxinus nigra), and paper birch. Soils are noncalcareous sands and gravels and are often shallow, especially northward where rock outcrops are common on the Laurentian Shield (Minnesota Soil Atlas 1981). Glacial deposits tend to be deeper and more loamy southward toward Lake Superior and beyond (Wright and Watts 1969, Ojakangas and Matsch (1982).

BEAR MOVEMENTS

Radio-tracking revealed that black bears in northeastern Minnesota use larger areas than bears elsewhere (Rogers 1987b), probably due to the low fertility of the area (Rogers 1987a). Adult females maintained territories averaging 2.5 miles in diameter, and males concentrated their activities in ranges averaging 7.5 miles in diameter. These ranges are not unusually large, but 40% of the females (N=105) and 69% of the males (N=32) ranged 4-125 miles outside those areas in late summer and fall before returning to their usual areas for denning (Rogers 1987a). Most (70%) of the long movements (N=66) were to areas of deeper, more loamy soil and greater fruit and nut production than in the main study area.

SPRING HABITAT USE

Bears emerged from their dens when the weather turned warm enough in late March or April, but most remained lethargic until late April or early May when aspen catkins and green vegetation became available (Rogers 1987a). Swamp grasses, especially blue joint reedgrass (Calamagrostis canadensis) and fowl mannagrass (Glyceria striata) were major foods in early spring. These species were found in the understories of tamarack swamps, alder (Alnus rugosa) swamps, and especially back ash swamps. In the spring of 1987, unusually low water levels increased bear access to swamp grass. The bears concentrated their feeding in ash swamps even though that cover type constituted <1% of the study area.

As upland forbs emerged, bears in the study area added large-leafed aster (Aster macrophyllus), false lily-of-the-valley (Mainanthemum canadensis), smooth bedstraw (Galium triflorum), interrupted fern (Osmunda claytonia). and peavine (Lathyrus spp.) to their diets but ceased eating all but peavine when the leaves reached full size. As wild calla (Calla palustris) and jewelweed (Impatiens capensis) began to emerge, bears added these wetland and lowland plants to their diets and continued to eat them through summer. In other northern forests, jack-in-the-pulpit (Arisaema triphyllum) corns and young skunk cabbage (Symplocarpus foetidus) leaves are important spring foods (Elowe 1984, W. Breckenrldge, pers, commun.), further indicating the importance of forested wetlands and lowlands to black bears. Most of the feeding on upland forbs by habituated bears was in the vicinity of ash swamps that they continued to use through May.

The presence of large pines appeared to be a major determinant of habitat selection in spring, especially by mothers with cubs. Nearly all the feeding by a mother with cubs was within 200 yards of white pines >20 inches dbh, which she used as refuges for her resting cubs. Elowe (1984, 1987) found that mothers with cubs in Massachusetts centered their

spring activities around large white pines and hemlocks in the vicinities of forested wetlands. Both white pines and hemlocks have rough, strong bark suitable for climbing by cubs. Cubs have been observed falling from aspen trees, spruce trees, and young red pines because their claws slipped on the smooth or flaky bark (Rogers and Wilker, unpubl. data). At least one death from a fall has been reported (Elowe 1987). Where large white pines and forested wetlands were near lightly traveled roads, the bears fed heavily on roadside dandelion (Taraxaum officinale), red clover (Trifolium pratense), and peavine in mid-May.

During May, ants surfaced and became part of the diet. By late May, ant pupae become abundant in the colonies while most upland forbs reached full size and were rejected. Ants, primarily carpenter ants (Camponotus spp.) in logs and stumps in open areas, then became the primary food until fruit ripened in early July. Most of the logs were from balsam fir trees that had been killed by spruce budworms (Choristoneura fumiferana) 1-2 decades earlier (Hardy et al. 1986). Logs in forest openings tended to hold the most ants.

SUMMER HABITAT USE

Fruit and hazelnuts (Corylus cornuta) were preferred summer foods and the major determinants of weight gain, reproductive rate, and cub survival for northeastern Minnesota bears (Rogers 1976, 1987a). Young females typically did not produce their first litters until after a year of abundant fruit and nuts; some females failed to reproduce until 8 years of age (average 6.3 years) (Rogers 1987a).

Under ideal food conditions, reproduction begins at 3-4 years of age (Alt 1980, Kordek and Lindzey 1980). Cub survival (N=11 years, 181 cubs) ranged from 59% to 88%, depending upon fruit and nut production in the year of conception and the first year of post-partum life (Rogers 1987a).

Important fruits in northeastern Minnesota were wild sarsaparilla berries (Aralia nudicaulis), cherries (Prunus virginianus, P. pensylvanicus), blueberries (Vaccinium angustifolium, V. myrtilloides), serviceberries (Amelanchier spp.), dogwood berries (Cornus rugosa, C. stolonifera), raspberries (Rubus strigosus), and mountain-ash berries (Sorbus spp.). In other northern forests, feral apples (Pyrus malus), buffalo berries (Shepherdia canadensis), black cherries (Prunus serotina), and blackberries (Rubus spp.) are also important summer foods (Elowe 1984, Bertagnoli 1986).

Few black bear foods (e.g., wild sarsaparilla berries and hazelnuts) are shade tolerant species. Black cherry and oak are forest canopy species but require openings for regeneration. Most fruit producing species require much sunlight for maximum production. In northeastern Minnesota, blueberry, raspberry, and cherry (P. virginianus, P. pensylvanicus) production varied inversely with tree density during a 4-year study of 29 unburned sites (Table 1) (Arimond 1979).

Table 1. Combined production of blueberries, cherries, and raspberries in stands of different tree density in northeastern Minnesota, 1974-1977 (from Arimond 1979).

Trees/acre	No.	Average fruit production	
	Stands	lbs/acre	Range (lbs/acre)
Few or none	8	80	11-194
192-311	9	12	0-101
418-480	6	5	0-32
511-848	6	<1	0-3

The only burned site studied was more productive than any of the unburned sites; blueberry production averaged 318 lbs/acre during 1974-1977 (Arimond 1979). Two sites treated with 2,4-D produced only raspberries for the 3-4 years of study after treatment (Arimond 1979).

Forest openings such as burns, clearcuts. select cut areas, edges of rock outcrops, old homesteads, marsh edges, insect damaged areas, untraveled roadsides, power line rights-of-way, and old growth forests with numerous windfall openings are favored feeding areas in summers with good berry crops because these areas have the right amount of sunlight to stimulate berry production. Plants with no tree cover in southeastern Manitoba were found to experience greater frost damage and a less favorable water economy than plants under partial shade, with consequent lower productivity (Hoefs and Shay 1981). This may partly explain why feeding in large openings is concentrated near the edges where understory vegetation may be protected from thermal extremes. Black bears may also avoid the centers of large openings because of the absence of shade and escape cover (Jonkel and Cowan 1971). Black bears are easily heat-stressed in full sunlight (Rogers, unpublished data). McCollum (1973) found a dramatic decline in use of clearcuts beyond 200 yards of forest cover. Hugie (1982) reported little use beyond 135 yards of forest cover.

In a black cherry stand in Michigan. >90% of the fecal droppings of bears were within 10 feet of scattered, large (>10 inch dbh) hemlock trees (Rogers, unpubl. data). Elowe (pers. commun.) observed similar use of large hemlocks in New England. This suggests that refuge trees influence habitat use even within forest habitat in summer.

Although upland openings are favored feeding sites in summers with good berry crops (or mature upland stands when wild sarsaparilla berries are abundant), bears seek other habitats in years when berry crops fail. In 1987, when berries were scarce, a habituated female obtained much of her food in July and early August from alder and tamarack swamps where she ate wild calla and jewelweed. Other feeding sites were along seldom traveled forest roadsides, where she ate clover (Trifolium spp.) and wild lettuce (Lactuca 8pp.), and in mature upland spruce stands, where she ate bunchberries (Cornus canadensis). In early August, hazelnuts ripened and became her primary food from mid-August until they disappeared. During this period, she foraged far outside her territory, finding a productive hazel stand 22 miles away. She fed mainly in a 5 acre area there for 22 days, eating 2,605 hazelnuts in 24 hours on 27-28 August. The hazelnuts disappeared from that stand during the next week, and the bear started home. She arrived home on 7 September after pausing 2 days enroute in a round-leafed dogwood stand.

FALL HABITAT USE

Probably the greatest habitat deficiency in northeastern Minnesota and other forests north of Lake Superior is the paucity of nutritious fall foods. Hazelnuts, ants, and most species of berries become scarce in September. Bears then must turn to vegetation such as clover and peavine (or, in some years, to hornets) and begin losing weight. Acorn producing oak stands (primarily northern red oak, Quercus rubra) are uncommon, constituting <0.05% of the region. Bears that find the few oak stands show superior growth and reproduction because acorns allow them to extend their annual growth period into fall. Black bears can learn the locations of mature oak stands and pass this information on to their offspring (Garshelis and Pelton 1981, Rogers 1987a). A bear clan with a tradition of traveling 22 miles to an oak stand each fall showed the greatest weight gains and the highest reproductive rate observed in northeastern Minnesota among bears that ate only natural food (Rogers 1987a). A young female in this clan was the only study female to reproduce by 4 years of age without having access to garbage (Rogers 1987a).

South and east of Lake Superior, more fall foods are available due to a greater variety and prevalence of oak species, the presence of beech (Fagus grandifolia), and a more common occurrence of feral apples. However, even in those areas, northern red oak is the primary producer of fall mast.

DENNING HABITAT

Black bears in the northern Great Lakes Region commonly spend 4-7 months a year in dens. They enter dens between September and December, depending upon regional norms of food availability, and leave them between late March and early May, depending upon spring thaws and the presence of cubs (Rogers 1987a). Cubs are born in January every other year if nutrition is adequate or less often if the mothers are unable to gain sufficient weight in summer and fall (Rogers 1987a).

Preferred maternal dens are tree cavities (Jonkel and Cowan 1971, Johnson et al. 1978, Lentz 1980, Lentz et al. 1980, Rogers 1987a). These provide good thermal protection and reduce vulnerability to predation, human disturbance, harassment by dogs, and flooding by rain or meltwater. Cubs depend upon their mothers for warmth and will die if dens are flooded or mothers are disturbed and forced to leave the cubs for long (Smith 1946, Johnson and Pelton 1980, Alt 1984). However, tree dens are less critical in northern habitats than they are farther south where winter thaws and disturbance are more likely. In northeastern Minnesota, where most forests are second growth with few trees large enough to have suitable cavities, bears used burrows, rock crevices, brush piles, rock-raked windrows, and surface nests (Rogers 1987a). Winter thaws there were not sufficient to flood dens, and few people other than loggers used the forest in winter. One family of bears was killed and eaten by wolves (Canis lupus), but this was the only predation to occur during overwinter observations of 206 occupied dens (Rogers and Mech 1981). Overwinter survival was >99%. Denning habitat did not appear to be a critical habitat feature in that area.

BLACK BEAR HABITAT MANAGEMENT

Probably the most important consideration for maintaining black bear habitat is maintaining large enough blocks of diverse forested land with few enough permanent human residents that black bears can reproduce faster than they are killed. More than 30% of the mortality among black bears (N=35) that reached the age of independence (1.5 years) in northeastern Minnesota was from human-related causes, primarily bullets (Rogers 1987a). Hunting deaths are not considered a long-term threat because those deaths can be regulated through game regulations, but the killing of nuisance bears by permanent human residents is unregulated, and the presence of permanent residents can reduce population viability. The lower the land fertility or the higher the permanent human population, the more land will be required to maintain a viable population of bears (Rogers and Alien 1987). Another factor in bear survival is human attitudes. Black bears in Wisconsin and Pennsylvania coexist with higher human populations than in northeastern Minnesota due to lower

poaching/nuisance losses. Thus, education may ameliorate problems of high human density (Rogers and Allen 1987).

Although bear density strongly depends upon human tolerance, reproductive success of adult females and survival of cubs through 1.5 years of age depend primarily upon food supply. Consequently, silvicultural prescriptions should be oriented toward increasing production and diversity of food species, especially fruit and nut producing species. One of the most effective actions a forest manager can take to maintain bear habitat is to maintain mature stands of oak where these are scarce. Within the Superior National Forest, oak cutting is now banned except for regeneration cuts (E. Lindquist, pers. commun. 1987). Outside the Forest, some of the scarce, mature, red oak stands have been cut for firewood, significantly reducing habitat quality for black bears and other species.

Once a red oak stand is lost, it is difficult to reestablish without specific management toward that goal (R. Jacobs, pers. commun.). Time to full maturity is long. Northern red oak begins to fruit when approximately 25 years old but does not produce abundant acorns until 50 years of age (Fowells 1965). Some acorns then are produced each year with good crops every 2 to 5 years for 100 years or longer (Fowells 1965, Elias 1980). Production may maximize at 20-22 inches dbh and decline with decreasing size, according to a study in the southern portion of the species' range (Downs and McQuilkin 1944). A 10 inch dbh tree may produce 0.4 lbs of acorns/year, a 14 inch dbh tree may produce 15.8 lbs/yr (Shaw 1970). A fully stocked mature stand would be expected to include 70-90 square feet/acre basal area of mature trees, 15 square feet/acre of pole-sized trees, and 5 square feet/acre of smaller trees.

Maintaining mature stands of other locally scarce, food producing trees such as mountain-ash (Sorbus spp.), black cherry, feral apples, wild plum (Prunus spp.), and beech is also beneficial. Most other fruit or mast producing species of northern forests are shrubs or forbs and tend to be more common. Many of these understory species are shade intolerant, and their fruit production can be enhanced by thinning the overstory, as has been shown in Washington (Lindzey and Meslow 1977), Montana (Jonkel and Cowan 1971), Michigan (Manville 1983) and Minnesota (Arimond 1979) (Table 1). However, thinning of commercial stands can severely damage established shrub species; therefore, an effort should be made to minimize damage to ground species. Prescribed burning (Arimond 1979, Gruell 1980) and curtailing of grazing can also improve productivity of fruit and mast producing species. Containerized plantings or seeding in favorable sites may increase distribution (Irwin and Hammond 1985). The value of forest openings to bears and other omnivores can be further enhanced by plantings of legumes (Trifolium spp., Vicia spp., Lathyrus spp.) (Jonkel and Cowan 1971:21).

Clearcuts may be beneficial or detrimental depending upon their size, configuration, and herbicide treatment. Benefits of clearcuts decrease with increasing size because of the reluctance of bears to move far from forest cover (Young 1980). Islands or peninsulas of forest cover in clearcuts can increase use of surrounding open areas (Lindzey and Meslow 1977), especially by mothers with cubs due to their greater reluctance to leave forest cover (Herrero 1979). Broadcast application of herbicide can kill all the major fruit and mast producing species of the northeastern United States. Reestablishing those species requires 4-10 years or more (Arimond 1979, Rogers, unpubl. data). However, hand application of herbicide allows survival of berry producing species and enhances fruit production under the opened canopy (McComb and Hurst 1987). Logs from herbicided trees can become suitable for ant colonies within 10 years (Rogers and Wilker, unpubl. data). Several researchers found that bears avoided clearcuts for approximately 10 years after timber harvest but favored them after that interval (Jonkel and Cowan 1971, Lindzey and Meslow 1977, Kellyhouse 1980). Whether this initial period of avoidance was due to lack of shade and escape cover, reduced food supply as a result of herbicide treatment, or other factors is unknown.

Forested or shrub wetlands with understories of blue joint reedgrass, fowl mannagrass, or wild calla are important spring and summer feeding areas but are commonly distributed in such small patches (<2 acres) that they often are not delineated on survey maps and are consequently clearcut along with surrounding stands. Where such wetlands constitute less than 45 acres per square mile (7% of the area [Elowe 1984]), uncut buffer zones of 200 yard radius would help maintain the wetlands and the surrounding high use uplands for black bears, wood ducks (Aix sponsa), white-tailed deer (Odocoileus virginianus), muskrats (Ondatra zibethicus), and other herbivores (Martin et al. 1951, Elowe 1984, Rogers and Allen 1987). Minimizing disturbances of wetlands in spring when they receive greatest use will further benefit these species.

Habitat selection by mothers with cubs, and perhaps by other bears, partially depends upon the presence of white pines or hemlocks >12 inches dbh, especially in spring. The presence of at least one of these trees per 10 acres (65/square mile) in and around feeding areas would enhance habitat quality for black bears. This spacing is based on the assumption that bears will feed up to 200 yards from each tree (Rogers and Wilker, unpubl. data; Elowe 1987). However, additional refuge trees may be

beneficial, especially around forested wetlands used in spring when cubs are small. In observed feeding areas with several refuge trees per acre, nearly all refuge trees were used, even in late summer feeding areas.

In summary, silvicultural prescriptions should be oriented toward increasing production and diversity of food species. Black bears depend upon a diversity of foods, particularly in northern areas where fruit and mast crops frequently fail due to extreme weather. A diversity of foods, including a diversity of fruit and nut species, increases the likelihood of an adequate food supply due to differences in the times of flowering and fruiting of the different species. Of utmost importance in the maintenance of bear habitat is maintaining adequate space. The wide-ranging habits of black bears and their attraction to people's food make this species one of the first to be extirpated when forests are reduced or fragmented by the expanding human population. State and National Forests tend to be less fertile than the forests that covered much of the black bear's original range. The amount of land in those forests is sufficient, with proper management, to insure viable populations of black bears for the foreseeable future.

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