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DENNING AND HIBERNATION BEHAVIOR OF BEARS IN YELLOWSTONE NATIONAL PARK

Hibernation is an adaptation to a seasonal shortage of food, low environmental temperatures, and snow cover on the ground (Craighead and Craighead 1972; Tietje and Ruff 1980). Bears hibernate during the winter months in most areas of the world. Duration of winter denning is dependent upon latitude and varies from a few days or weeks for black bears in Mexico to 6 months or more for bears in Alaska (Kolenosky and Strathearn 1987, Haroldson et al. 2002). The denning period in Yellowstone National Park is approximately 5 months.

For many years some people did not consider bears to be true hibernators. Mammals considered true, or deep hibernators, such as chipmunks and ground squirrels, experience a drastic decrease in body temperature during hibernation. Body temperature for hibernating bears remains above 88º F (31º C) which is within 12º F (11º C) of their normal body temperature of 100º - 101º F (37.7º - 38.3º C) (Bagget 1984). This allows bears to react to danger quicker than hibernators whose body temperature may be less than 40º F (4º C) and who have to warm up before they can move quickly (Bagget 1984). Many scientists now consider bears to be super hibernators. Due to the highly insulative pelts of bears and their lower surface area to mass ratio than smaller hibernators, body heat is lost slowly which enables bears to cut their metabolic rate by 50-60% (Craighead and Craighead 1972; Rogers 1981). Respirations in bears decrease from 6-10 breaths per minute normally, to 1 breath every 45 seconds during hibernation. They experience a drop in heart rate from 40-50 beats per minute during the summer to 8-19 beats per minute during hibernation. Mammals that experience lower body temperatures during hibernation, such as chipmunks and ground squirrels, must awaken every few days to raise their body temperature, move around, urinate, and eat (Rogers 1981). Grizzly bears and black bears generally do not eat, drink, defecate, or urinate during hibernation. Bears live off of a layer of fat built up during the summer and fall months prior to hibernation. Waste products are produced, however, instead of disposing of their metabolic waste, bears recycle it. The urea produced from fat metabolism (fatal at high levels) is broken down and the resulting nitrogen is used by the bear to build protein, which allows them to maintain muscle mass and organ tissues (Rogers 1981). Bears lose fat and may actually increase lean-body mass while hibernating due to this nitrogen recycling (Wickelgren 1988). Bears may loose 15-30 % of their body weight during hibernation (Rogers 1981).

It was once thought that bears ate roughage prior to den entrance to scour their digestive tract and form a plug in the anus to prevent them from eating any more food that fall. Actually, the plug, made up of feces, dead intestinal cells, hair, and bedding material, forms during hibernation and not before (Rogers 1981). Bears continue to produce some feces during hibernation yet they do not defecate (Rogers 1981). It is possible this plug may keep the bear from defecating inside the den during hibernation as fecal plugs are found just inside or outside the dens of bears that have just emerged (Rogers 1981). It was also once believed that bears obtained nutrients from sucking their paws during hibernation. This idea most likely arose from observations of bears licking the bottom of their paws during the last half of the denning period when their old, callused footpads slough off (Rogers 1977). The sucking and licking action apparently helps toughen the new footpads so bears can walk on them without pain or difficulty when they emerge from the den and begin searching for food (Beecham et al. 1983).

In the Yellowstone ecosystem, grizzly bears tend to dig or locate dens on the mid to upper one-third of 30º - 60º slopes with northern exposures between 6,562 - 10,006 ft, x = 8103 ft (2,000 - 3,050 meters, x = 2,470 m) in elevation (Judd et al. 1986). Pregnant females den at higher elevations than other females and male bears (Haroldson et al 2002). Black bears locate or excavate dens on 20º - 40º slopes (x= 27.8º) with northerly aspects between 5,800 - 8,599 ft, x = 7,346 ft (1,768 - 2,621 meters, x = 2,239 m) in elevation (Mack 1990). There are several different types of dens utilized by bears. Black bears tend to excavate dens, den under windfalls, in hollow trees or caves, and in previously occupied dens (Jonkel 1980). Grizzly bears tend to excavate dens at the base of large trees often on densely vegetated north-facing slopes. This is advantageous in the Yellowstone ecosystem due to prevailing SW winds which accumulate snow on northerly slopes and insulate dens from temperatures which often drop as low as -40º F to -60º F (-40º C - -51º C) (Craighead and Craighead 1972; Jonkel 1980; Vroom et al.

1980). Grizzly bears in YNP usually dig new dens but on occasion, dens (especially natural cavities) are re-utilized (Craighead and Craighead 1972; Judd et al. 1986; Miller 1990). Most dens are dug in sandy loam soils with some occurring in clay loam and rocky silt soils (Judd et al. 1986). Reuse of excavated dens is rare but does occasionally occur. Usually excavated dens collapse the spring after they are dug due to runoff and are unusable. Some grizzly bears excavate dens long before the onset of hibernation while other bears tend to wait to almost the last minute to construct dens (Craighead and Craighead 1972). Major den excavation is completed in 3-7 days during which a bear may move up to a ton of material (Brown 1993; Craighead and Craighead 1972). After completion of a den (which consists of an entrance, a short tunnel, and a chamber) bears will cover the chamber floor with bedding material ranging from spruce boughs to duff. The bedding material has many air pockets which trap body heat and form a microclimate around the bear helping to keep it warm (Craighead and Craighead 1972). These bedding materials are related to availability at the den site and not on the bears preference (Judd et al. 1986). The den entrance is usually just large enough for the bear to squeeze through. This minimal opening size helps prevent heat loss during hibernation since a smaller opening will be covered with snow more quickly than a large opening. In some dens the tunnel is dug straight into a hillside or at a slightly upward angle, an energy efficient design that reduces heat loss from the den chamber. However, some dens are not energy efficient and have tunnels dug at a downward angle which allows heat to escape through the den entrance. In most dens, the chamber is dug only slightly larger than the bear allowing for efficient heat retention. However in some natural cavities used as dens, the chamber is much larger than the bear. Males and females with young usually dig the largest dens.

Movement to dens is correlated to weather and snow conditions with most movement usually occurring from late October to mid November (Judd et al. 1986). However, Craighead and Craighead (1972) found hibernation onset varied by as much as one month depending on weather conditions. Latitude also influences den entrance, with bears in northern latitudes denning earlier and longer than bears in southern latitudes (Haroldson et al. 2002). Bears will remain in the area of their den for a few weeks and enter a state of lethargy during which they eat nothing and sleep frequently (Craighead and Craighead 1972). According to Craighead and Craighead (1972) and Servheen and Klaver (1983), final den entry occurs during severe snowstorms. In theory the fresh snow will hide any tracks or other evidence of where the bear's den is located. Pregnant females usually enter dens first, followed by females with young, subadults, and lastly, adult males (Haroldson et al. 2002, Linnell et al. 200). Grizzly and black bears breed from May through July but embryonic implantation does not occur until around December, about one month after solitary females den. The cubs are born in late January or early February and are naked, blind, and helpless (Rogers 1981). They measure only about 8 inches (20 cm) long and weigh from 8 - 12 ounces (224 - 336 g). The newborn cubs do not hibernate. They sleep next to their mother, nurse, and grow rapidly. When black bear cubs emerge from the den at about three months of age, they weigh about 4 - 8 pounds (1.8 - 3.6 kg) and are able to follow their mother around in search of food (Rogers 1981). At ten weeks of age, grizzly bear cubs weigh 10 - 20 pounds (4.5 - 9.0 kg) (Brown 1993).

When temperatures warm up and food is available in the form of winter-killed ungulates or early spring vegetation, bears emerge from their dens. Male bears emerge first, usually from early to mid-March (average days denned = 131 days), followed by solitary females and females with yearlings or two-years olds (average days denned = 151 days) in late March through mid-Aril (Haroldson et al. 2002). The last to emerge are females with new-born cubs (average days denned = 171), from mid April through early May (Haroldson et al. 2002). Males, subadults, solitary females, and females with yearlings or two-year-olds usually leave the vicinity of their den within a week of emergence while females with new-born cubs remain in the general vicinity of the den for several more weeks (Lindzey and Meslow 1976, Haroldson et al. 2002).

Several physiological processes bears undergo during hibernation are of interest to medical researchers. When bears are hibernating and metabolizing body fat, their cholesterol levels are twice as high as during the summer and twice as high as the cholesterol levels of most humans (Baggett 1984). Bears, however, do not suffer from hardening of the arteries (*arteriosclerosis*) or gallstones, conditions which result from high levels of cholesterol in humans. The bear's liver secretes a substance that dissolves gallstones in humans without surgery. Another mystery of hibernation is that bears do not lose bone mass during hibernation. All other mammals which maintain non-weight bearing positions for an extended period of time suffer from *osteoporosis*, or a weakening of the bones (Wickelgren 1988). When the substance responsible for this phenomenon is discovered it may help people who suffer from weak bones.

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