HUMAN IMPACT ON THE BLACK BEAR IN MICHIGAN'S LOWER PENINSULA

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Abstract: Thirty-five black bears (*Ursus americanus*) were captured (22 males, 13 females), 25 were radio-collared, 4,224 telemetric observations, and 1,112 radio triangulations were made from ground and air between September 1977 and March 1980 in connection with a study of the interactions between humans and bears in Michigan's Lower Peninsula (mainly in Crawford, Kalkaska, Missaukee, and Roscommon counties). Identified positive effects of humans on bears included changes in hunting regulations possibly resulting in an increasing bear population; bears frequently using oil pipeline right-of-ways, oil well service lanes, and lumber roads as travel routes; early-successional vegetational stages induced by roadside cutting, commercial lumbering, clear-cutting deer (*Odocoileus virginianus*) management projects, and controlled burns; and bee-keeping. Negative effects included loss of habitat due to human encroachment, heavy automobile traffic, hunting aided by service roads, marked bears (11 of 28) and females with cubs being shot, and bears which fled their dens when approached. Questionable impacts included proximity of den sites to centers of human activity, closure of most sanitary landfills, and disturbance by small game and deer gun hunters. Unknown impacts included those of oil wells, snowmobile activity near denned bears, and contact between humans and bears. Data were insufficient to indicate whether a high incidence of periodontal disease (11 of 35 bears in varying degrees of severity) affected bear behavior, although diseased animals suffered tooth loss and jaw and gum atrophy. Twenty-three marked animals were sighted and reported 63 different times by the public. Forty-six nuisance and damage complaints were reported in the study area between August 1977 and July 1980. Average home range for males ($\geq$ 6 months telemetric data) was 150.4 km^2 (SD = 96.6 km^2); for females, 68.9 km^2 (SD = 64.0 km^2). Six adult males made seasonal summer treks of 140, 105, 50, 47, 42, and 32 km from fall-winter-spring home ranges, returning before denning.

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The Higgins-Houghton lakes area in Michigan's northern Lower Peninsula is unique for several reasons. The region is one of Michigan's largest resort areas. Yet adjacent to and immediately west of the 2 lakes lies the Dead Stream Swamp, the largest swamp and roadless tract in the Lower Peninsula (R.I. Blouch, unpubl. rep., Mich. Dep. Conserv. Game Div., 1960). The Dead Stream Swamp is perhaps one of the best haunts of the black bear in the Lower Peninsula. Prior to 1965, bear hunting, including large organized hunts with dogs, was popular in the Swamp and adjoining areas. Before the late 1940's, virtually all black bears killed by hunters were taken in connection with deer hunting. The average annual harvest of bears in the Lower Peninsula, 1936–1946, was 374 bears (SD = 124.6) (Erickson 1964:71). During October 1946, the Dead Stream Swamp was opened to bear hunting with dogs; 300 permits were issued to hunters on a first come, first serve basis. A record Lower Peninsula harvest of 839 bears was recorded in 1947. The popularity of organized hunts continued until 1965 when an apparently-reduced bear population caused the entire Lower Peninsula to be closed to bear hunting from 1965 to 1968. Since 1969, bear hunting was allowed only under special permits. The Dead Stream Swamp west of U.S. Highway 27 in Roscommon County (since 1973), and all of Missaukee County (since 1965), were closed to bear hunting.

In recent past history the Higgins-Houghton lakes area was associated primarily with summertime resort activities. More recently, the area became a growing, popular, year-round residential and resort community. The resident human population, particularly in Roscommon County, increased tremendously. In light of these developments in the area, the major emphasis of this study was to evaluate the impact of an increasing human population and related human activities on the bear population.

There was evidence that the number of black bears had rapidly declined in the northern Lower Peninsula during the 45 years preceding 1975 (Harger 1974:20, Manville 1978:207). Since that date, however, the bear population in the Lower Peninsula seemed to have increased (Mich. Dep. Nat. Resour., pers. commun.). A steadily increasing human population inevitably results in a loss of bear habitat (Cardoza 1976:90, Willey 1978:16, 73). In addition in this area, further destruction of the range was threatened by oil-field operations in the Peninsula's remaining prime bear habitat.

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Until this study was undertaken, black bear research in Michigan had been conducted only in the Upper Peninsula (Erickson 1964, Marks 1964, Rogers 1975, Rogers et al. 1976*a*, 1976*b*) with the exception of some early research by Erickson (1964) in the Dead Stream Swamp. No human impact studies specifically related to habitat alteration and hydrocarbon development had been published on the black bear in the Great Lakes region. The only published bear investigations anywhere in the United States that relate to gas and oil exploration were conducted with respect to the grizzly bear (*Ursus arctos*) (Harding and Nagy 1980, Schallenberger 1980). Jonkel (pages 23-25 *in* unpubl. rep., Mont. Coop. Wildl. Res. Unit, Missoula, 1977) reported 4 grizzlies using livestock grazing and oil and gas leasing areas in Montana. Fuller and Keith (1980) reported that ongoing development of the Athabasca Oil Sands in northeast Alberta was subjecting the black bear to increased human disturbance there. The effects of these disturbances, however, were not reported.

The historical impacts of humans on black bears in the East were reported by Pelton and Burghardt (1976). They concluded that the disappearance of large, protected, relatively uninhabited tracts of land was the primary reason for the decline of the black bear from precolonial population levels. Heavy logging and the growth of human populations hastened the bear's decline. Raybourne (1978) mentioned that black bears were common throughout Virginia in colonial times, but increasing human populations and land development eliminated much of the bear's habitat, so by the 1970's the bear was confined to a fraction of its former range in that state. Jonkel and Cowan (1971) reported that sheep herders and commercial trappers earlier in the century shot considerable numbers of black bears in Montana, decimating the population. Intensive logging was reported as a further threat.

McCaffrey et al. (unpubl. rep., N.Y. State Dep. Environ. Conserv., 1974) discussed bear conflicts with people in the Catskills, New York, and concluded that if the bear population there increased without suitable available habitat, human–bear conflicts would likely increase. Collins (1978) reported that the decline of the black bear in North Carolina was due to encroachment by man with resulting habitat loss. He related this specifically to the draining of thousands of hectares of swamps and bays, clearing and transforming this habitat into agricultural lands and areas for further human development. Pulpwood cutting, draining, chopping, clearing of large pine site areas, poaching, encroachment by man, lack of available habitat, and human disturbance were reported by McDaniel (1974*a*, 1974*b*) as responsible for the precarious state of the black bear in Florida. It was added to Florida's threatened wildlife list in 1974. Lindzey and Meslow (1977) discussed effects of logging on black bears in Long Island, Washington. Bears were found to select areas logged between 1963 and 1968, but against those logged in 1935, probably because of the greater availability of berry-producing shrub species. Timbered areas were important to bears, however, since they apparently offered security to bears chased by humans or by other bears (Lindzey and Meslow 1976). Loss of habitat as a result of encroachment by humans also was reported in Arkansas (B.W. Conley 1978) and in Tennessee (R.H. Conley 1978).

Hunting was listed as the greatest recent impact on bears in Pennsylvania (Alt 1978). The 1-day 1976 season resulted in the record harvest of 605 bears in a single day. Because of this heavy kill, the season was closed during the following 2 years to allow the population to recuperate.

In Michigan's Lower Peninsula, Harger (1974:20) stated that the greatest threat to bears was people. He believed that, as a result of overdevelopment and commercialization, people were pushing the bear out of its range.

Streeter et al. (1979) reported that increasing needs and demands for energy, coal, oil shale, and uranium mining will continue to create sizable impacts on bears as well as other wildlife. These impacts not only included loss of habitat due to construction, but pressure from workers through hunting, poaching, snowmobiling, etc.

Nuisance problems and damage caused by black bears were reported extensively in the literature. Eager and Pelton (1978) and Tate and Pelton (1983) reported interactions between black bears and humans in Great Smoky Mountains National Park, Tennessee. They found that only about 5% of the marked bears in the Park were roadside "panhandlers," often dominant males. Bears also learned to associate backpacks

with food. There was reason to believe that enriched diets of female panhandlers increased cub production.

Rogers (1970:47) in Minnesota indicated that nearly every radio-tagged bear living within 9.7 km of a dump visited such a food source, especially when natural foods were scarce. Because of nuisance problems caused by bears tipping over garbage cans at nearby dwellings, however, at least 26 bears were reported killed in the vicinity of 2 small dumps. Rogers et al. (1976*a*) captured 126 black bears at garbage dumps, campgrounds, and residential areas in Michigan's Upper Peninsula during the summer of 1968. Forty-two percent of these bears (excluding cubs) captured in campgrounds or residential areas were males less than 4 years of age, indicating that young males exhibited less attachment to an area than did females or older males.

Cardoza (1976:75–77) reported that although most publicized nuisance bear encounters between bears and man occurred in the national parks, problems in the Northeast included chronic dump confrontations in the Adirondacks, scavenger bears in some northern New Hampshire towns, and a bear in a Connecticut campground for 6 weeks. R.L. Peterson, (cited by Cardoza 1976:76) suggested that black bears have been responsible for more human injuries than any other North American predator, due probably to heedless human actions rather than innate bear viciousness.

Graber and White (1978) reported that a sharp increase in human–bear conflicts in Yosemite National Park, California, resulted in a comprehensive human–bear management plan including capture and relocation of nuisance animals, intentional elimination of some animals, elimination of human food sources, better law enforcement and public education, and further research and monitoring. As a result, property damage, human injury, and the proportion of human foods in the diet of black bears declined.

Black bear damage by girdling conifers in northwest Washington was reported by Poelker and Hartwell (1973:17–20) as having a significant impact on conifer tree production in that state. Bray (1974) related black bear nuisance problems, in part, to mast production; in years when mast was low, bears moved out of their normal range, creating problems for landowners by raiding chicken coops, farms, livestock, etc. As a result, this increased bear vulnerability to poaching.

Bear depredation of beekeeping operations was reported as a worldwide problem, with at least 5 bear species identified as bee pests (Ambrose and Sanders 1978:167). The largest loss estimate of black bear depredation to apiaries was reported in Alberta in 1973 where damage was set at $200,000 despite removal of 400 bears from the affected area (J.R. Gunson cited by Ambrose and Sanders 1978:168). In the past, hive depredation was controlled, in part, by the "Florida" electric fence (Robinson 1965), flashing lights, radios, repellents, platforms, and trapping and harvesting of nuisance animals (Ambrose and Sanders 1978:172–173).

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STUDY AREA

The study centered in the Higgins-Houghton lakes region of Missaukee and Roscommon counties. Missaukee County grew in resident population from 6,784 in 1960 to 7,126 (5%) in 1970, but by 1976 had increased to 9,200 (a further 29%). Roscommon County had even more dramatic growth from 7,200 in 1960 to 9,892 (37%) in 1970, to 15,100 (a further 53%) by 1976. It was projected that by the end of 1980 the county population would double from its 1976 level (Roscommon Co. Chamb. Commer., pers. commun.). The 1980 population in the immediate Houghton Lakeshore vicinity alone was 8,500 residents. In addition to these permanent residents, the Higgins and Houghton lakes area receives heavy year-round use by transient

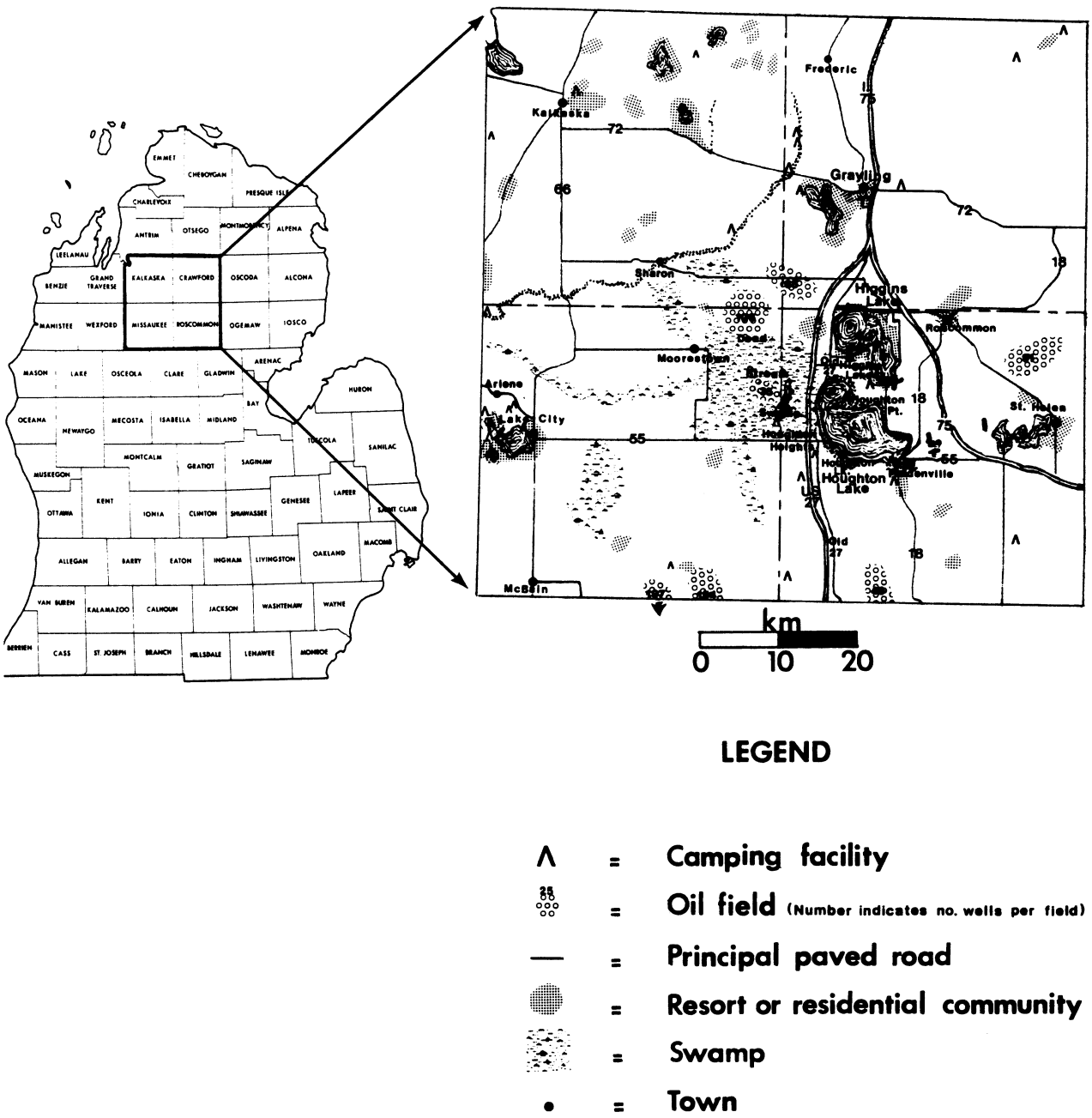

Fig. 1. The Dead Stream Swamp and adjacent wetlands in Roscommon, Missaukee, and adjoining counties in the study area, Michigan.

vacationers. Sail and power boating, bow and rifle hunting, fishing, trail-biking, camping, hiking, snowmobiling, and cross-country skiing are popular sports all of which attract many participants and occasionally bring humans into contact with bears.

The Dead Stream Swamp and adjoining wetlands in Roscommon and Missaukee counties

comprise about 130 km^2 (Fig. 1) and have been closed to bear hunting since 1965. Two heavily-populated resorts are situated on Higgins and Houghton lakes, east of the Swamp. Six popular public campgrounds also are located near the Swamp. The Swamp is unique for several reasons. Although heavily lumbered in the early 1900's, it contains a nearly continuous, thick stand of white cedar (*Thuja occidentalis*), ideal for winter denning habitat. Resort development is greatest to the east and northeast of the Swamp, while farming is heaviest to the west and southwest. Two heavily used, major highways pass through portions of the Swamp (Michigan State Highway M-55 and Expressway U.S. 27). Seven active oil fields are situated around the Higgins-Houghton lakes area containing some 694 active wells. New wells continued to be drilled in all oil fields during this study.

The northern Lower Peninsula contains 3 dominant vegetation types: bog conifer, Great Lakes pine forest, and northern hardwoods (Kuchler 1964). Bog conifer, found in the upper northern and extreme northern Lower Peninsula, is dominated by larch (*Larix laricina*), black spruce (*Picea mariana*), and white cedar, and comprises approximately 5% of the Lower Peninsula vegetation north of Houghton Lake. The Great Lakes pine forest, characterized by jack pine (*Pinus banksiana*), red pine (*P. resinosa*), and white pine (*P. strobus*), occupies approximately 35% of the Lower Peninsula vegetation north of Houghton Lake. The northern hardwoods vegetation type takes up approximately 60% of the area north of Houghton Lake. It is dominated by sugar maple (*Acer saccharum*), yellow birch (*Betula allegheniensis*), beech (*Fagus grandifolia*), and hemlock (*Tsuga canadensis*).

The climate of the study area is humid. Annual temperatures range between 4.4 and 10 C, with summer temperatures averaging 15.6 to 21.1 C and winter temperatures −28.9 to −17.8 C. Average annual precipitation is 7.6 to 12.7 cm. There are less than 100 clear days per average year. In most years, snow stays on the ground over 120 days, and the growing season is short, averaging 80 to 120 days (Lehr et al. 1975).

Soils are sandy and sandy loam to rocky, with various quantities of glacial drift. The Lower Peninsula was covered by the Wisconsin glaciation of the Pleistocene (Leet and Judson 1965:196).

The elevation at the Houghton Lake Airport is 350.5 m above sea level. Other than a few hills which do not rise more than 73 m above the surrounding landscape, the topography near Higgins and Houghton lakes is relatively flat. The topography of more northern areas in the Lower Peninsula varies from lowland swamps to rolling, glaciated hills. North of Houghton Lake, ponds and lakes are more numerous. In the western and northwestern parts of the Lower Peninsula, some hills extend 230 m or more above the surrounding landscape.

METHODS AND MATERIALS

Bears were captured in barrel traps, culvert traps, Aldrich foot snares, and in dens. In one case, a pack of bear-hunting dogs was used to tree a female which had previously eluded recapture in the den. For capture in dens, bears were usually first located from the air, and later tracked from the ground to the den.

For most of the study, bears were immobilized with combined doses of ketamine hydrochloride (Vetalar; 2.3 mg/kg body weight) and promazine hydrochloride (Sparine; 0.1 mg/kg body weight). They were injected with hypodermic syringes mounted on hand-held jab sticks. Bears in dens were immobilized with ketamine hydrochloride at a reduced dosage (1.2 mg/kg body weight) plus promazine hydrochloride (0.1 mg/kg body weight). They were injected either by hand, with a hand-held jab stick, or with a 0.22 caliber Cap-Chur dart rifle depending on the bear's activity. A CO_2 Cap-Chur dart pistol proved inoperable due to the cold.

After immobilization and following procaine hydrochloride desensitization, a first premolar (P1) tooth was extracted from each animal for cementum annuli aging purposes. Tooth-extraction wounds were checked for proper healing in recaptured bears.

Each bear was marked with numbered, metal cattle ear-tags placed in the dorsal, proximal portion of each ear. Plastic fluorescent red, orange, green, and chrome streamers 15 cm long were attached to each ear-tag, using combinations of 2 colors. Transmitter collars were color-coded using from 1 to 4 different plastic, fluorescent colored streamers. Strips were glued to the collars with epoxy or sewn on with monofilament fishing line. The major purpose for color-marking tagged bears was for visual identification by the

public and in the hope that hunters sighting color-marked bears would spare them for research.

Bears were examined carefully for evidence of serious cases of dental caries and periodontal disease which might alter their normal behavior. Disease conditions also were checked in recaptured animals.

The signal frequencies of all collars were set between 150.8 and 151.5 MHz. The signal strength of collars enabled reception up to 6.3 km on the ground (average of perhaps 1.6 km) and up to 56.3 km from the aircraft 2.4 km above ground. Ground tracking was conducted from automobile, truck, van, trail bike, snowmobile, and foot. Radio signals were received with 3-element Yagi antennas. For continuous ground tracking, a hand-held collapsible Yagi antenna was most convenient. Larger 3-element Yagi antennas were used for aerial tracking, and were occasionally used on the ground. One of these was mounted on the right and another on the left wing strut of the various aircraft used. On one occasion aerial tracking was conducted from a helicopter. A few tests were made with an 8-element null-peak Yagi antenna, but tracking was equally successful with the smaller 3-element Yagi.

During periods of continuous ground tracking, radio-collared bears were located by means of 2 or more radio "fixes" often resulting in a " triangulated location." When possible, radio signal observations were made from mapped landmarks.

Tracks were counted on the Pole Bridge Road (a county dirt road at the south end of the Dead Stream Swamp), on a gas line right-of-way at the west end of the Swamp, and on 3 roads in the Jackson's Corners area at the northeast corner of the Swamp. Tracks were measured and photographed, and locations of bear trails and clawed marker trees were logged.

Burt (1943) defined "home range" as the area an animal covers in its day-to-day travels. To calculate home range in this study, boundaries were delineated using convex polygons (Southwood 1966) which most effectively included areas of possible impact by humans on bears.

The effects of humans on bears were classified as (1) positive, (2) negative, (3) questionable, or (4) unknown. The distances of dens from centers of human activity were calculated. A human activity center was defined as an area with daily or nearly daily human use. When bears were shot, the distance from known point of harvest to nearest improved public road was calculated.

Major vegetation cover types were delineated by interpretation of aerial photographs, state forest cover type maps, U.S. Geological Survey quadrangle maps, and field reconnaisance. Radio-locations of collared bears were plotted on quadrangle maps, and these locations were transcribed to respective vegetation cover types.

Loss of bear habitat by human encroachment, residential and commercial development, clear-cutting, land-filling, dredging, building construction, digging, etc. was noted. The approximate amounts of altered habitat were recorded.

The randomization test for 2 independent samples, with a power efficiency of 100% (Siegel 1956:155–156), was used twice to analyze data. The difference between sexes regarding the distance from point of harvest to nearest improved road was tested, as was the difference between sexes regarding the average calculated distances of denned bears from centers of human activity. The Pearson product moment test (Sokol and Rohlf 1973:271–272) was used to determine correlations between distance from point of harvest to nearest improved road, between age when shot, and between estimated weight at time of harvest for hunter-killed bears. Correlations also were made between the number of shots heard fired while ground-tracking bears, and the movements of bears from previous locations as an apparent result of such disturbances. Direct and step-wise 2-group discriminant function analysis (Klecka 1975:434–467) was used to analyze 2 major categories of bears: nuisance and non-nuisance animals. Five bears were classified as nuisance animals; reasons were: (1) captured as a nuisance animal (caused property damage, frightened residents, and partially lost fear of humans), (2) shot as a nuisance animal (caused property damage and frightened residents), and (3) reported sighted as a nuisance animal (ate garbage or pet food, partially lost fear of humans, and frightened residents). The remaining 19 bears were categorized as non-nuisance animals. Seven discriminating variables were used to measure characteristics on which the groups were expected to differ: (1) sex, (2) incidence of periodontal disease, (3) number of sightings by the

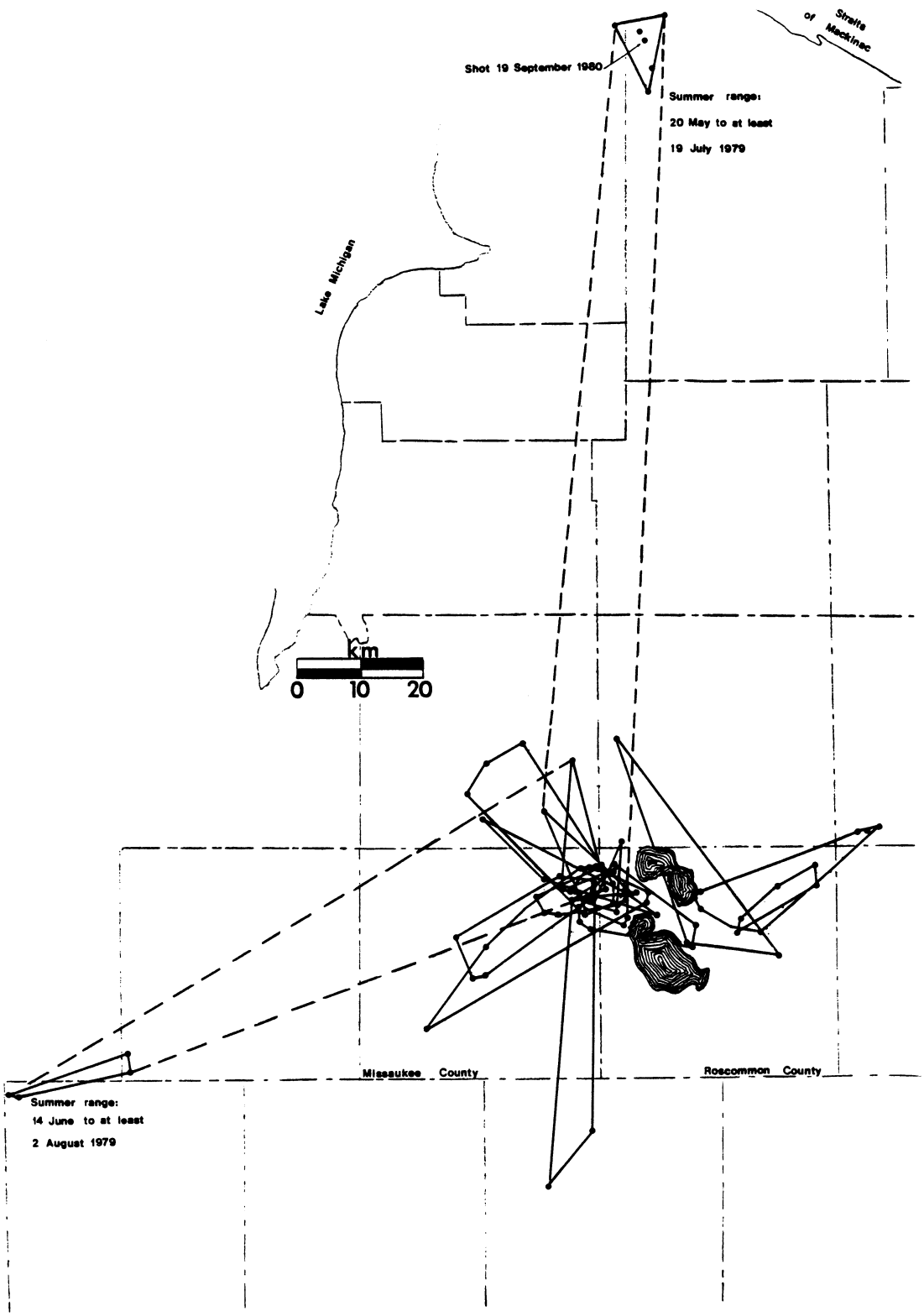

Fig. 2. Home ranges of 16 radio-tagged males captured between September 1977 and July 1979 in the Higgins-Houghton lakes area, Michigan. Ranges are delineated using convex polygons.

public, (4) average distance of dens from nearest center of human activity, (5) estimate of home range size, (6) distance bear shot from nearest improved road, and (7) number of towns, residential communities, and resorts ($\leqslant$ 50 persons) within the bear's range. The shortcoming of this technique involved the small nuisance group sample size; statistical results must therefore be interpreted with caution.

RESULTS AND DISCUSSION

Fate of Captured Bears

Of the 35 bears captured between September 1977 and January 1980, 25 were radio-collared for up to a 22-month period. Seventeen (48.6% of the total captured population) died during the study, while 13 collared bears (52% of the collared population) died. Of the latter, 8 were shot by hunters (3 illegally), 2 were shot as nuisance bears, 1 died of a drug-related problem, 1 was killed by a car, and 1 died of apparent strangulation. One uncollared bear was shot by a hunter.

Radio Locations, Home Ranges, and Movements

Some 4,224 radio fixes (279 aerial fixes from 44 flights, 3,945 ground fixes, and 1,112 verified radio triangulations) were made on 25 collared bears between September 1977 and March 1980, enabling calculations of estimated home ranges for these animals. Home range size based on $\geqslant$6 months of telemetric data averaged 150.4 km^2 (range 6.0 to 308.2 km^2, SD = 96.6 km^2) for males (N = 11) and 68.9 km^2 (range 17.4 to 173.7 km^2, SD = 64.0 km^2) for females (N = 5). Calculated home ranges for all radio-collared males (N = 16) averaged 127.6 km^2 (SD = 106.9 km^2); for females (N = 8), 66.2 km^2 (SD = 64.7 km^2) (Figs. 2 and 3).

Erickson and Petrides (1964:60) stated that bears in Michigan's Upper Peninsula had an average annual home range of 38.9 km^2. By recapture techniques, they estimated home range areas of 51.8 and 25.9 km^2 for males and females. Rogers (1977) in Minnesota estimated that home ranges for mature females averaged 9.6 km^2; mature males used much larger areas that included territories of 7–15 females. Jonkel and Cowan (1971:23) estimated home range areas of 30.8 and 5.2 km^2 for male and female black bears in

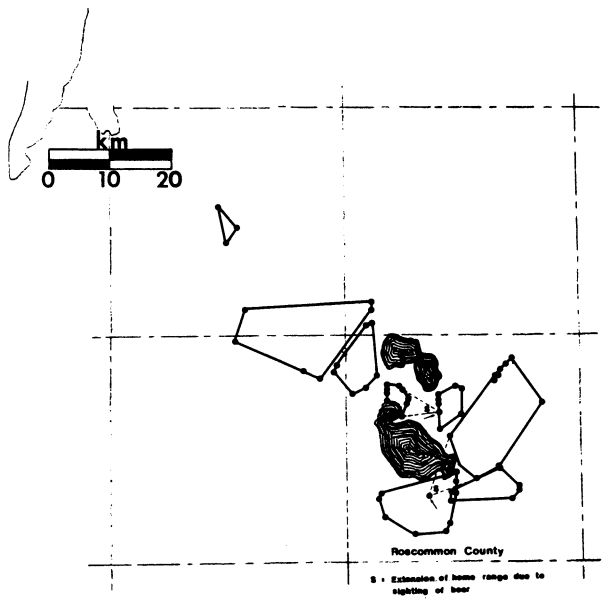

Fig. 3. Home ranges of 8 radio-tagged females captured between September 1977 and August 1978 in the Higgins-Houghton lakes area, Michigan. Ranges are delineated using convex polygons.

Montana. Poelker and Hartwell (1973:72–73), using radiotelemetry techniques, found that 2 male black bears in Washington occupied ranges of 82.6 and 87 km^2; average home range area of females was only 5.3 km^2, however. Amstrup and Beecham (1976) felt that the quantity, quality, and distribution of food, as influenced by topography and climate, probably set minimums on the sizes of bears' home ranges. Lindzey and Meslow (1977) felt that the differences in range sizes of bears, both within and between different regions, were likely due to differences in resource availability. To these data I would add the variable of impact of humans on bears as another factor influencing home range size.

Six adult males made seasonal treks of 140, 105, 50, 47, 42, and 32 km from fall-winter-spring ranges. The movements of 3 occurred during the breeding season, while 2 others were known to move after the season. Four of the 6 were radio-located within a 13-km^2 area of the Dead Stream Swamp by 5 November 1979, in apparent preparation for denning. It is difficult to explain the reason for extensive movements of 2 males. Weights of the 2 bears in decreasing order of distance travelled were 65 and 82 kg, respectively. Since movements occurred during the

breeding season, migrations may have resulted because of competition from more dominant males. Food was likely not the reason since berry crops were very abundant in the study area at that time. Hugie (unpubl. paper presented at 5th Int. Conf. Bear Res. and Manage., Madison, Wis., 1980) in Maine noted that 3 adult males moved extensively following the breeding season, returning just before denning. Rogers (1977) in Minnesota found that both males and females in late summer and early fall often left their usual ranges to exploit distant sources of seasonally abundant foods. Some males and females moved as far as 201 and 92 km, respectively, from their usual ranges; all returned for denning.

Sightings

Local residents reported seeing 16 collared (and later identified), 2 marked, and perhaps 5 different unidentified, radio-collared bears between September 1977 and September 1980. These 23 bears were seen and reported 63 separate times. Ten sightings were made by hunters who shot collared bears, or by individuals who saw the animals illegally harvested or loaded into vehicles, or who found the carcasses. One car-killed bear was included in the list. Color markings did not appear to deter many hunters from shooting marked bears as was previously hoped; 9 collared or marked bears were hunter-killed, 6 legally and 3 illegally.

Positive Impacts of Humans on Bears

Changes in Hunting Regulations. — Prior to 1969, hunters in the Lower Peninsula could shoot a bear in September, October, and November as a bonus on their deer tag, but since that date, a permit system was implemented. From 1977 to 1979, 3,000 gun permits and 1,000 bow permits were issued for a 10-day gun and separate 10-day bow bear season.

Evidence indicated that the bear population in the Higgins-Houghton lakes area (Crawford, Kalkaska, Missaukee, and Roscommon counties) had increased since 1975, likely a result of changes in hunting regulations. Closure of hunting in the Dead Stream Swamp and in all of Missaukee County in 1965, elimination of the use of dogs in packs greater than 6 in 1976, the registration of dog packs in 1976, termination of non-permit bear hunting in the Lower Peninsula, and declines in hunting pressure following permit implementation appeared to have benefited the bear population.

Bear harvest data prior to 1975 in the Higgins-Houghton lakes area were unavailable. Although harvests in Crawford, Kalkaska, and Roscommon counties fluctuated between 1975 and 1979 (6, 8, 21, 13, and 16 bears shot, respectively), cropping did not appear detrimental to the population as sightings of unmarked bears were commonly reported during spring, summer, and fall 1978 and 1979. No detailed records of sightings of unmarked bears were kept, however.

Service Roads as Travel Lanes. — Track counts, scats, and radio-monitoring of 14 bears showed that they used oil pipeline right-of-ways, oil well service roads, and lumber roads as travel lanes. Off-road travel lanes, particularly swamp and forest bear trails, stream banks, and river bottoms, however, were used by bears probably more than 95% of the time. During periods of low human presence or activity (< 5 persons hiking per day, no camping, no trapping, no hunting), the Pole Bridge Road, a travel lane into the Dead Stream Swamp, was used by a least 6 different bears. At least 5 different bears frequented an old lumber road in the northeast portion of the Swamp. Another lumber road in the same vicinity was used by at least 4 different bears. A main pipeline right-of-way road was traveled by at least 6 different bears during the fall 1978. A service road to an oil well was used as a travel lane by at least 4 different bears. Next to this road, a plastic and fiberglass wellhead cover was chewed and clawed by bears in October 1979. After replacement later that month, bears again damaged the cover in November.

Changes in Plant Succession. — Man-induced early plant successional stages have benefited bears; fruiting and berry plant species were more abundant in areas clearcut by humans. In Roscommon County, 31 roadsides contained early plant successional species present after roadside cutting which had been fed upon by bears. Roadside cut areas contained chokecherries (*Prunus virginiana*), pin cherries (*P. pensylvanica*), black raspberries (*Rubus occidentalis*), blueberries (*Vaccinium* spp.), serviceberries (*Amelanchier* spp.), hawthorne (*Crataegus* spp.), and apples (*Pyrus malus*) eaten by bears during the summer and fall, 1977–1979. Cherry trees

had broken limbs, had been knocked over, or were clawed by bears; serviceberry bushes and hawthornes were broken; bear scats laden with cherry pits, raspberry seeds, and partially digested blueberries were found among these fruiting species; scats were found around hawthorne and apple trees; and tracks often were present. In Missaukee County, 21 roadsides contained fruiting plant species also eaten by bears in 1977–1979. Other habitat changes influencing the stage of plant succession included commercial lumbering, clearcutting for deer management, controlled burns for management of Kirtland's warbler (*Dendroica kirtlandii*), and construction of new service roads to oil wells. Between 1970 and 1978, an estimated 2,776,334 cords of timber were cut in the northern Lower Peninsula. During this same period, some 31,716 ha of timber were cut for game management improvement and between 1973 and 1978, 4,109 ha of forest were burned in the northern Lower Peninsula (N. Hussain, Mich. Dep. Nat. Resour. For. Div., pers. commun.).

Bee-keeping.—This human activity provided bears with an additional, supplementary source of food. Damage to hives was extensive, as 14 of 46 (30.4%) nuisance or damage complaints reported between September 1977 and July 1980 involved damage to bee hives. In Missaukee County, for example, apiarists maintained at least 1,000 hives in the field in 1980. Yet between May 1975 and September 1980, one bee keeper totally lost 63 hives to bears while 200 other hives were knocked over and partially damaged. In the 12 years before 1980, bee keepers in Missaukee County totally lost 230 hives to bears ($23,000 estimated loss) (D. Byrne, apiarist, pers. commun.). Clearly, the impact of humans on bears from a supplementary food standpoint has been positive.

Negative Impacts

Habitat Loss.—The greatest threat to bears in the study area was loss of habitat due to human encroachment. Swamps were land-filled for residential and commercial development in the Prudenville area, Roscommon County, between 1977 and 1980, destroying some 40 ha of prime bear habitat. Two radio-collared bears were located near this swamp, as was an unmarked bear seen several times in Prudenville. More significantly, construction of pipe and pumping facilities for wastewater treatment around Houghton Lake resulted in loss of several hundred hectares of swamp habitat. The construction of a 40± ha wastewater treatment facility, dug in an oak (*Quercus* spp.) upland, eliminated part of a prime feeding area for bears. Another wastewater treatment facility, southwest of Houghton Lake, eliminated 50+ ha of abandoned farmland. A 16± ha gravel pit between Higgins and Houghton lakes, situated in oak and northern hardwoods uplands, continued to increase in size, disrupting potential denning and feeding areas.

Recreational activities were encouraged at Houghton Lake, particularly by the presence of 46 motels of which 40 were open year-round, 3 trailer parks, 3 recreational areas, 14 restaurants, 8 food and beverage stores, 7 sporting goods stores, and 75 businesses and professional services. Two motels and 2 State public campgrounds were located on the Higgins Lakeshore (Houghton Lake Chamber of Commerce 1980).

Highway Traffic.—Heavy traffic on 3 major highways restricted movements of 4 females, marking their home range boundaries. Heavy southbound traffic on U.S. 27 restricted movement of a subadult female in September 1978; U.S. 27 marked the eastern boundary of her range. U.S. 27 also marked the western boundary of another female's range, and heavily traveled M-55 delineated the northern boundary of yet a 3rd female's home range. State highway M-18 marked the eastern boundary of a 4th female's range. Apparently male movements were not blocked by major highways as they readily crossed them. One adult male, however, was car-killed while crossing I-75. Eight unmarked bears were reported hit by cars in the study area and 7 killed.

Hunting Access.—Bear hunting was likely aided by service roads to oil wells. Hunting pressure on bears was heavier in areas that contained extensive road systems. These areas provided easy access, and with citizens band (CB) radio contact between hunters, chances of shooting a fleeing bear were enhanced. Access, however, appeared to be more significant than CB radio use (Mich. Dep. Nat. Resour., pers. commun.).

The average distance from the nearest light-duty road with an all-weather improved surface to the point of harvest of 9 marked bears was 0.46 km. The average distance from road to point of

harvest for males ($N = 5$) was 0.59 km; for females, 0.3 km.

Results of the randomization test for 2 independent samples indicated no significant difference between the sexes regarding the distance from point of harvest to the nearest improved road. However, there tended to be differences in this distance for bears of different ages and body weights. For distance vs. age, there was a negative product moment correlation of $r = -0.63$ ($P < 0.1$, df = 7, 0.582) for both sexes. For distance vs. estimated weight at time of harvest, there was a correlation of $r = -0.70$ ($P < 0.05$, df = 7, 0.666). These data indicated that with increasing ages and weights of males and females together, the distances from point of harvest to nearest improved road decreased, suggesting decreased fear and/or increased tolerance of man with increasing bear age and weight.

Hunting Mortality.—The negative impact of hunters on marked bears proved to be significant. Of 28 animals marked (25 radio-tagged), 11 (39.3%) were shot. Three were shot over baits, 1 was shot as a nuisance over garbage, 1 was shot as a nuisance while destroying bee hives, 2 were shot by hunters using dogs, 1 was taken only with a gun, and the harvest technique of 3 shot illegally was not known. From 1977 to 1980, 16.7, 17.4, 18.2 and 10%, respectively, of the marked population known or suspected of being alive each year were shot. A 39% harvest during this study was a sizable loss to the marked population.

Orphaned cubs.—Hunting females with cubs is legal in Michigan while shooting cubs of the year is not. Of 4 females shot between fall 1978 and 1979, 2 were shot in the company of 2 and 3 cubs. Although Erickson (1959) found that cubs in Michigan's Upper Peninsula as young as 5.5 months and as small as 8.2 kg may be self-sufficient, cub survival likely is greatly enhanced in the company and protection of the mother.

Disturbance by Investigators.—My impact on denned bears often was negative; 48.9% of the time bears examined in dens fled the site before I actually arrived. Forty-five attempts were made to immobilize bears in dens. One bear ran in conditions as cold as −28.9 C with as much as 1.22 m of snow on the ground. Of the 10 animals that fled their dens 22 times, 81.8% left before being sighted, but usually were heard escaping through exposed brush, so evasions were made while I was approximately 70 to 125 m from the sites. Only 4 bears on 5 occasions were successfully approached in dens but not drugged without fleeing. Generally, the wariness of animals in cold, snow-laden conditions was much greater than had previously been expected.

Questionable Impacts

Proximity to Human Activity.—The average den site distance from a human center of activity for males was 1.26 km ($N = 10$, range 0.15 to 2.74 km, SD = 0.73 km); for females, 0.55 km ($N = 7$, range 0.01 to 1.17 km, SD = 0.35 km); and for both sexes, 0.94 km. There was a significant difference between sexes regarding the average distance from dens ($P < 0.01$, df = 15, 2.951) using the randomization test for 2 independent samples. Females, even those with cubs, tended to den closer to centers of human activity than males, which may have been due, in part, to the selection of upland den sites by females which were closer to centers of human activity than swamp sites selected by males.

Dump Closures.—The closure of most sanitary landfills, and the centralization and proper maintenance of dumps in the Higgins-Houghton lakes area possibly had a negative impact on bears. At least 6 bears appeared to feed at a landfill in northwest Roscommon County and after its closure in 1978, only 1 landfill remained open in the County. Only 2 bears were eventually captured at this new landfill in 1978, and track counts and triangulations in 1978 and 1979 indicated that possibly no other bears were using the site. Nuisance complaints in the study area increased from 6 during the fall 1977, to 9 in 1978, to 22 in 1979, dropping to 9 in 1980 (tallied only through July) (Table 1). The question remains, were dump closures responsible for the increase in nuisance and damage complaints in 1979, or were the statistics only circumstantial? Food was plentiful in the study area during spring, summer, and fall 1979.

Hunting and Noise Disturbance—The effects of small game and deer gun hunters on bears were generally questionable. Five bears moved an average of 1.5 km (range 0.5 to 5.06 km) 10 times, probably due to disturbances caused by nearby gunshots (9 times) or loud trail bikes (once). A Pearson product moment correlation was conducted between the number of shots fired during

continuous tracking per unit area, and between the movement of bears from previous locations as an apparent result of disturbances; the result was not statistically significant.

Unknown Impacts

Oil Wells.—The effects of oil wells on bears were unknown, although 6 adult males were located from 0.09 to 0.3 km from active oil wells whose exhausts were audible up to 2.4 km or more. One adult male denned within 0.15 km of an active well in December 1978, easily within hearing distance of the exhaust, but moved 1.0 km into a cedar swamp south of the oil field in January 1979. An adult female was radio-tracked 6 separate times close to different oil wells (0.11, 0.16, 0.16, 0.16. 0.21, and 0.39 km distance). Whether the noise and the H_2S odor indeed bothered bears, or whether they learned to acclimate to these disturbances, was unknown.

Snowmobiles.—The effects of snowmobile activity on denned bears were unknown, although 2 females denned extremely close to actively used trails, 0.07 and 0.09 km. The 1st bear remained in her 1978–1979 den all winter, even though snowmobiles were actually seen passing the den. The other female stayed in her den during periods of snowmobile activity in December 1978, but moved from her den in late December when I attempted to anesthetize her at night.

Human Contact.—Contact between humans and bears (63 sightings of marked bears and numerous sightings of unmarked animals) may have resulted in some bears partially losing their fear of humans. Increased nuisance complaints, particularly animals threatening or scaring humans (18 complaints, see Table 1), may have resulted from loss of fear of humans. The behavior of several marked bears was reported as "very bold": a female placed her paws on a large picture window, and was hand fed suet and cookies; another female stopped in the middle of a road when sighted by an oil company employee; a 3rd female was seen breaking into a dog pen, eating dog food, later was almost hit by a lumber truck while walking across the highway, and was seen by a State patrolman who had to frighten her from his yard. A male visited a Bible camp for nearly 2 weeks, frightened campers, destroyed property, and walked in front of the spotlights by the main lodge. Another female was radio-located next to a public golf course and next to a group of trail bikers, while a large unmarked male extensively damaged 3 cabins, frightening the residents in the process. Another unmarked bear frightened a deer hunter who yelled at the animal without scaring it, and an unmarked bear, reported killing dogs in Prudenville, was seen by a State trooper walking down a paved street in Prudenville "bold as brass."

Table 1. Black bear nuisance and damage complaints in Cheboygan, Crawford, Kalkaska, Missaukee, and Roscommon counties, Michigan, September 1977 to July 1980.

Nature of complaint/damage	No. reported
Bear damaged bee hives, ate honey	14
Bear harassed, injured, or killed animals	
Chased horses	1
Injured cattle	1
Injured leashed dog	1
Killed dog(s)	3
Total	6
Bear damaged property	
Tore clothes line	1
Tore up 3 hunting blinds, ate C-rations	1
Damaged cabin(s)	4
Damaged oil wellhead covers	2
Total	8
Bear frightened people	
Frightened guests at restaurant	1
In camp	2
Put paws on picture window, ate suet	1
In yard	4
Ate garbage and/or popcorn	5
Broke into dog pen, ate dog food	1
In Bible camp	1
In tent	1
Female with cubs crossed golf course	1
In downtown Prudenville	1
Total	18
Grand total	46

Nuisance Bears

Using the direct method, discriminant function analysis indicated that, in decreasing order of significance, (1) nuisance bears were more likely, if shot, to be close to improved all-weather roads, (2) were more likely to be sighted by the public, and (3) were more likely to be shot than non-nuisance animals. When the Wilks stepwise method was used, however, the model predicted that (1) nuisance bears would be sighted more often than non-nuisance animals, and (2) would have more towns, residential communities, and resorts in their respective home ranges than

non-nuisance bears. Because of the small sample size of the nuisance group ($N = 5$ bears), the results of both direct and stepwise analysis must be viewed with caution. To provide more meaningful results, a larger sample size was needed.

Periodontal Disease

This disease was present in 11 (31.4%) of 35 animals examined, including a serious case in 1 animal (atrophy of buccal and lingual gum tissue, loss of premolars, and infection) and a critical one in another (nearly complete exposure of the canine root, atrophy of the gum and jawbone, and infection). The disease did not appear to be age-dependent, occurring in bears ranging from 1.5 to 6.5 years of age at the time of capture. Although it was difficult to determine the behavioral effects of the disease, the bear with a critical infection used 3 different den sites during both winters of 1977–78 and 1978–79 (only once did I disrupt the bear in its den). The animal was shot as a nuisance in July 1980 raiding bird feeders and bee hives. Bears with serious, severe, or critical cases of this disease may have had difficulty feeding, which could increase chances of them becoming nuisance animals. The cause of the disease was unknown.

Vegetation Types Used by Bears

Collared bears (unadjusted for an even sex ratio) used swamp conifer habitat types (white cedar, balsam fir [*Abies balsamea*], black spruce, and larch) most heavily on a year-round basis. Males used this type 158 times (40.1% of the time), while females used it 154 times (33.4% of the time). Lowland brush (alder [*Alnus* spp.], dogwood [*Cornus* spp.], willow [*Salix* spp.], huckleberry [*Gaylussacia* spp.], blueberry, and cranberry [*Vaccinium* spp.]) was next most heavily used by bears. Males were located 74 times in this type (using it 18.8% of the time) while females were located in it 97 times (using it 21% of the time). Lowland hardwoods were 3rd most heavily used, males and females using them 77 times each (19.5 and 16.7%, respectively). Lowland swamp, brush, and hardwood habitat appeared critical for bears. Upland northern hardwoods were 4th in habitat use importance (24 and 67 locations for males and females, 6.1 and 14.5% use, respectively). For the bear population to survive and persist in the Lower Peninsula, these habitat types must be maintained. Yet continuing increases in the human population will likely result in further loss of critical habitat unless large blocks of land are preserved.

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