# BLACK BEAR HOMING TENDENCIES, RESPONSE TO BEING CHASED BY HUNTING DOGS, REPRODUCTIVE BIOLOGY, DENNING BEHAVIOR, HOME RANGE, DIEL MOVEMENTS, AND HABITAT USE IN NORTHERN WISCONSIN

by

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## PREFACE

This thesis consists of 5 papers presenting information that I collected while studying black bears (*Ursus americanus*) in northern Wisconsin. The papers are written in the format of The Journal of Wildlife Management (JWM). "Homing tendencies of translocated nuisance black bears in northern Wisconsin" and "The response of black bears to being chased by hunting dogs", were presented at the 7th Eastern Black Bear Workshop in March 1984 and will be published in these proceedings. "Reproductive biology and denning behavior of black bears in northern Wisconsin" and "Home range, diel movements, and habitat use of black bears in northern Wisconsin" will be submitted to the JWM. "Incident of a snare imbedded in the neck of a black bear" will be submitted to The Wildlife Society Bulletin.

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# HOMING TENDENCIES OF TRANSLOCATED NUISANCE BLACK BEARS IN NORTHERN WISCONSIN

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Abstract: Homing tendencies of translocated nuisance black bears (*Ursus americanus*) were studied by radio-telemetry in 6 counties of northern Wisconsin during 1981-82. Types of complaints from Wisconsin residents include garbage feeding (restaurants, dumps, residences, and campgrounds), apiary damage, livestock injury, property damage, and general nuisance. General nuisance complaints result from landowners seeing bears around their residences or barnyards. Nineteen nuisance bears were translocated 20 times during 1981-82. All bears were translocated an average distance of 65.9 km (range: 9.3-120.7); relocation distance for returning and nonreturning bears averaged 65.0 and 65.3 km, respectively. Seven of 11 females and 5 of 7 male bears returned to their original home range; 3 bears (1 male, 2 females) returned to the exact nuisance site. A yearling male was the only bear that established a home range in the vicinity of the release site. Persistent nuisance behavior, either on the way to their home range or

upon return, was verified for 11 of 18 bears. The mean age of all radio-tagged nuisance bears was 5.7 years (range: 1.5-15.5); there was no difference ($P>0.01$) between the mean age of males (6.1 years) and females (5.5 years). The average maximum homing time for all bears was 23.8 days (range: 3-146); females and males averaged 33.8 and 13.8 days, respectively. Hourly movements of 1 yearling female, 1 subadult female, and 2 adult females were determined for at least 24 continuous hours after release; all exhibited circling or zigzag movements after release. Average rates of travel for individual bears ranged from 469 to 1591 m/hr. One adult female was tracked for the first 2 days and the last 4 days of her 9-day return trip to her home range. She traveled 68.8 km (straightline distance) from the release site to within 4.8 km of her capture site in 9 days. Her rate of travel increased from 12 to 34 km/day as she neared her home range and activity period changed from diurnal to nocturnal. Her route during the last 4 days paralleled a major highway and skirted the boundaries of 3 cities. Harvest mortality data from 114 marked (95 ear-tagged only, 19 radio-tagged) and translocated nuisance bears in northern Wisconsin were analyzed. Fifty bears (44%) were harvested from 1979 through 1982; 18 of these 50 bears were harvested within their home range (within 10 and 15 km of the trap site for females and males, respectively). Returning bears were older ($\bar{X}=5.4$ years) than nonreturning bears ($\bar{X}$=3.8 years) ($P<0.05$). Ear-tagged bears were translocated a mean distance of 50.3 km (range: 8.4-120.7); there was a significant difference ($P<0.10$) between the mean relocation distances of returning (44.4 km) and nonreturning bears (53.7 km). There was no difference ($P>0.10$) between the mean distances of the kill from the release site for returning (46.5 km) and nonreturning bears (36.8 km). Returning bears lived longer ($\bar{X}$=288 days) after translocation ($P<0.05$) than nonreturning bears ($\bar{X}$=166 days). Eighteen of 32 nonreturning bears were killed < 30 km from the release site. Of the 14 bears that were killed > 30 km from the release site, 6 were killed within a bearing of 22.5°, and 10 within 50° on either side of the homeward vector.

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The black bear is a valuable hunted and nonhunted wildlife resource of Wisconsin. A viable population has produced a nuisance bear condition that has intensified with increased urbanization, recreational activities, and agricultural development. Types of complaints from Wisconsin residents include garbage feeding (restaurants, residences, dumps, and campgrounds), apiary, crop, livestock and property damage, and general nuisance. General nuisance complaints arise from landowners seeing bears near their homes or barnyards. The Wisconsin Department of Natural Resources (WDNR) started ear-tagging nuisance black bears in 1979, although they had been trapping and translocating bears for many years before that time; the results of these translocations were largely unknown.

Many wildlife agencies frequently translocate bears that have behavior patterns which conflict with people. Reported results of this practice vary and the fate of many translocated bears remains unknown because, with the exception of Alt et al. (1977) and Harger (1970), studies have relied on recapturing or seeing the bears to determine the success of translocation efforts. Alt et al. (1977) reported that 4 of 6 radio-tagged, and translocated bears in Pennsylvania returned to capture areas; 1 bear was translocated twice. Harger (1970) reported that 3 of 4 radio-tagged bears which were translocated 5 times in Upper Michigan, returned to their home range and, as determined from eartag recovery data, 12 of 18 translocated adult bears had also returned to their home range. This differs with Erickson and Petrides (1964) statement that Upper Michigan nuisance bears could be translocated with great likelihood of their not returning because only 2 of 17 bears homed in their study. The objective of this cooperative study between the University of Wisconsin-Stevens Point (UWSP) and the WDNR was to determine the final disposition of translocated nuisance black bears in northern Wisconsin during 1981 and 1982.

The project was funded by the UWSP, WDNR, and the Wisconsin Bear Hunters Association. J.Koch provided trapping and drugging expertise, J.Wilson taught us the art of foot-snaring, B.Kohn advised and loaned equipment, and many UWSP graduate and undergraduate students helped with field work and data analysis. D. Zekor did the tooth sectioning and aging.

## STUDY AREA

Nuisance black bears were trapped and translocated in 6 counties (Price, Ashland, Sawyer, Bayfield, Iron, Rusk) of northcentral Wisconsin (Fig. 1). Most (76.5%) of the 1.98 million ha study area is forested (commercial timber production, productive reserved, and unproductive status); non-forest lands are cropland, pasture, marsh, wooded pasture, industrial and urban areas (Wis. Dep. Nat. Resour., unpubl. data).

The area is dominated by Northern Mesic Forest with scattered small units of Boreal Forest and conifer swamp (Curtis 1959). Major tree species of the Northern Mesic Forest include sugar maple (*Acer saccharum*), basswood (*Tilia americana*), aspen (*Populus* spp.), balsam fir (*Abies balsamea*), and eastern hemlock (*Tsuga canadensis*). The mean

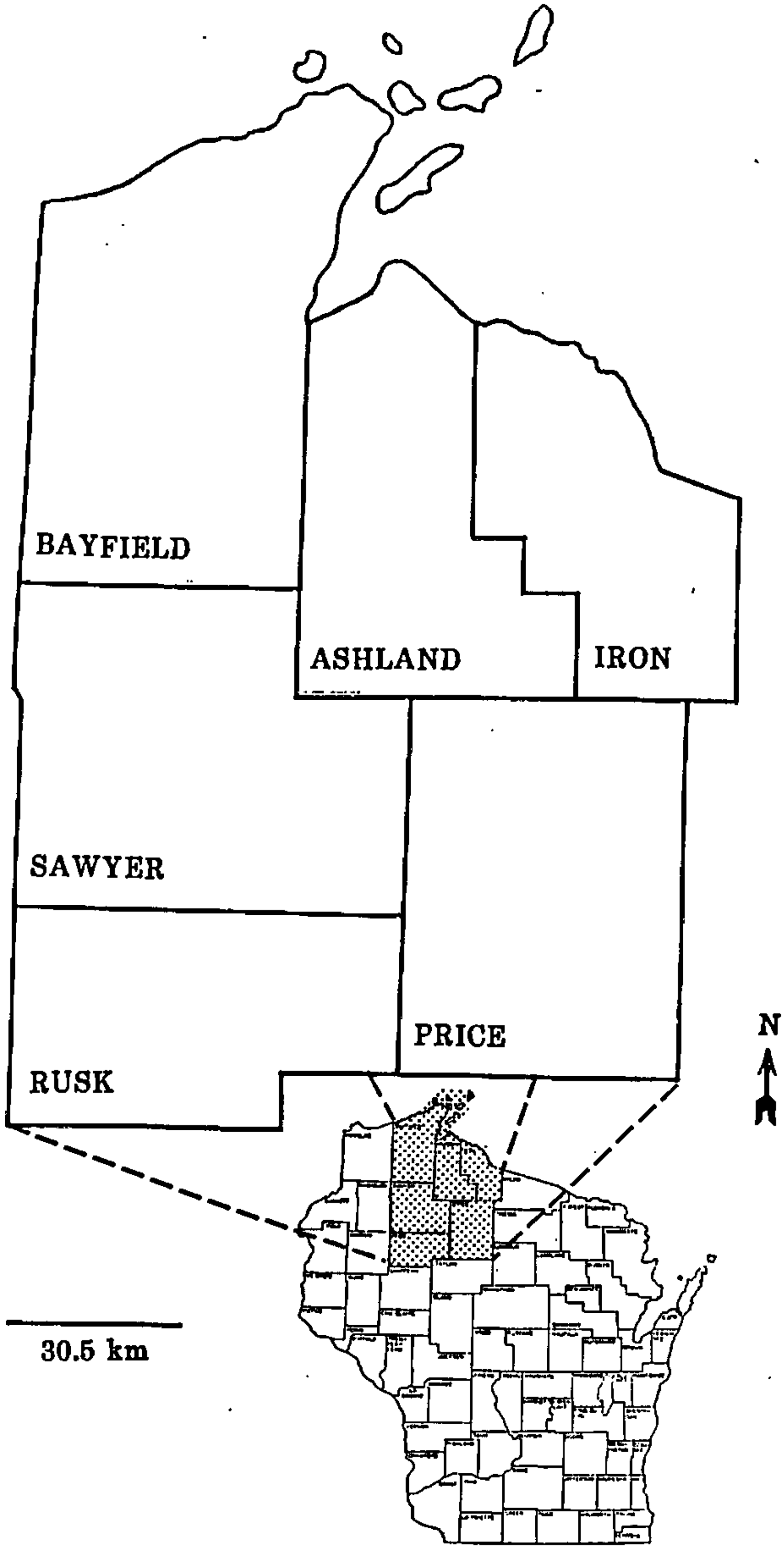



Fig. 1. Nuisance black bear study area.

annual precipitation is 81-86 cm with an average seasonal snowfall of 178-203 cm. The area is composed of end and ground moraine, and glacier-formed lake basins. Major soils of the region are Iron River, Gogebic, and Kennan series (Hole 1976).

## METHODS

Nuisance black bears were trapped with culvert traps (Erickson 1957), barrel traps (Kohn 1982), and Aldrich foot snares (Johnson and Pelton 1980). Bears were immobilized with ketamine hydrochloride (Vetalar, Park-Davis, Morris Plains, N.J.) at a dosage rate of 1cc/9.1 kg. of estimated body weight, fitted with 150-51 MHz radio-collars (Automatic Telemetry Systems, Bethal, Minn., and Telonics, Mesa, Ariz.), sexed, weighed, measured, ear-tagged, and had the first premolar removed for aging (Waddell 1975). Tooth sectioning and aging were done at UWSP, using cementum annuli counts. Rogers (1978) determined that the first cementum annuli starts to form between 5 and 8 months of age in black bears; therefore the ages of bears in this study were established by adding 0.5 year to the annulation count. Bears were classified into 4 age groups; cubs (<1 year), yearlings (1 to 2 years), subadults (2 to 3 years), and adults (>3 years). A blood sample was taken from the femoral vein for blood parasite detection; parasites were collected from pelage and feces. Bears were translocated varying distances to federal, state, or county lands within the study area. Specific release sites were determined by WDNR and were selected only on the basis of their convenient distance from the nuisance site.

Bear radio locations were determined from the ground by triangulation with a null-peak receiving antenna mounted on a truck, and from the air with aircraft equipped with strut-mounted H-antennas (Telonics, Mesa, Ariz.). Bearings were taken as prescribed by Heezen and Tester (1967) to minimize the resulting error polygon. Locations were plotted on Wisconsin Department of Transportation airphotos (scale=1:4800). Maximum error from the ground was 2.4 and 3.6 ha for stationary and moving animals, respectively; accuracy from the air, with a minimum of 4 passes, was 0.97 ha. Bears were designated as having returned to their annual home range when they were within 3.2 km of the original nuisance site. Four bears were tracked for at least 24 consecutive hours to determine immediate post-release movements.

Mortality data were also obtained from 50 ear-tagged nuisance black bears that were shot between 1979 and 1982; bears were killed by hunters or landowners at the nuisance site (hereafter: "harvested bears"). Harvested bears were designated as having returned to their home range if they were shot within 15 km (males) and 10 km (females) of their original nuisance; these distances were determined from home ranges established by radio-tagged bears within the study area and are similar to those reported by Alt (1977) (15 km from trap site for males, and 7 km for females).

## RESULTS AND DISCUSSION

### Homing Tendencies

Nineteen radio-collared bears (12 females, 7 males) were translocated a mean distance of 65.9 km (range: 9.3-120.7), a total of 20 times during their active seasons in 1981 and 1982 (Table 1). There was no significant difference (P>0.01) between the mean relocation distance of male (62.4 km) and female (68.4 km) bears.

Seven of 11 female bears returned to their home range; 1 females (Yearling-K) is missing. One non-homing female (J) may have been relocated within her home range but in an unique situation (Fig. 2). She was trapped on Stockton Island of the Apostle Islands National Lakeshore after repeatedly visiting a developed campground, and translocated 9.3 km to Manitou Island. She consequently swam at least 2.5 km to Oak Island where she raided a backcountry campsite and then swam at least 2.1 km to the mainland where she frequented a dump on the Red Cliff Indian Reservation. Movements of black bears between islands has been documented by Payne (1975) in Newfoundland. In March 1983, parts of

Table 1. Radio-tagged nuisance black bear translocation data for 1981-82 in north central Wisconsin.

| Bear | Age (yrs) | Relocation distance (km) | Homed | Maximum homing time (days) | Rate of return (km/day) | Persistent nuisance behavior |
|---|---|---|---|---|---|---|
| Females | | | | | | |
| A | 3.5 | 70.0 | No | - | - | Yes |
| B | 6.5 | 72.4 | Yes | 11 | 6.6 | Yes |
| C | 3.5 | 80.1 | Yes | 146 | 0.5 | No |
| D | 5.5 | 40.4 | Yes | 4 | 10.1 | Yes |
| E | 6.5 | 55.5 | Yes | 25 | 2.2 | No |
| F | 6.5 | 62.2 | Yes | 8 | 7.8 | Yes |
| G | 9.5 | 68.8 | Yes | 9[a] | 7.6 | Yes |
| H | 2.5 | 57.8 | No | - | - | Yes |
| I | 3.5 | 77.5 | Yes | 351[b] | ? | Yes |
| J | 9.5 | 9.3[c] | No | - | - | Yes |
| K | 1.5 | 77.1 | Missing | - | - | ? |
| L | 7.5 | 91.1 | No | - | - | No |
| $\bar{X}$ | 5.5 | 68.4 | - | 33.8 | 5.8 | - |
| Males | | | | | | |
| M | 1.5 | 42.4 | No | - | - | No |
| N | 5.5 | 61.4 | Yes | 29 | 2.1 | No |
| P[d] | 5.5 | 50.7<br>46.5 | Yes<br>Yes | 7<br>3 | 7.2<br>15.5 | Yes |
| Q | 5.5 | 120.7 | No[e] | - | - | Yes |
| R | 4.5 | 66.6 | Yes | 12 | 5.6 | Yes |
| S | 15.5 | 56.9 | Yes | 6 | 9.5 | No |
| T | 4.5 | 54.5 | Yes | 26 | 2.1 | No |
| $\bar{X}$ | 6.1 | 62.4 | - | 13.6 | 7.0 | - |
| All bears | | | | | | |
| $\bar{X}$ | 5.7 | 65.9 | - | 23.8 | 6.4 | - |

[a] Exact homing time.

[b] Lost her radio collar and was recaptured in 1983 at an apiary.

[c] Probably released within her home range.

[d] Translocated twice.

[e] Exhibited homing movements but was harvested before reaching his original home range.

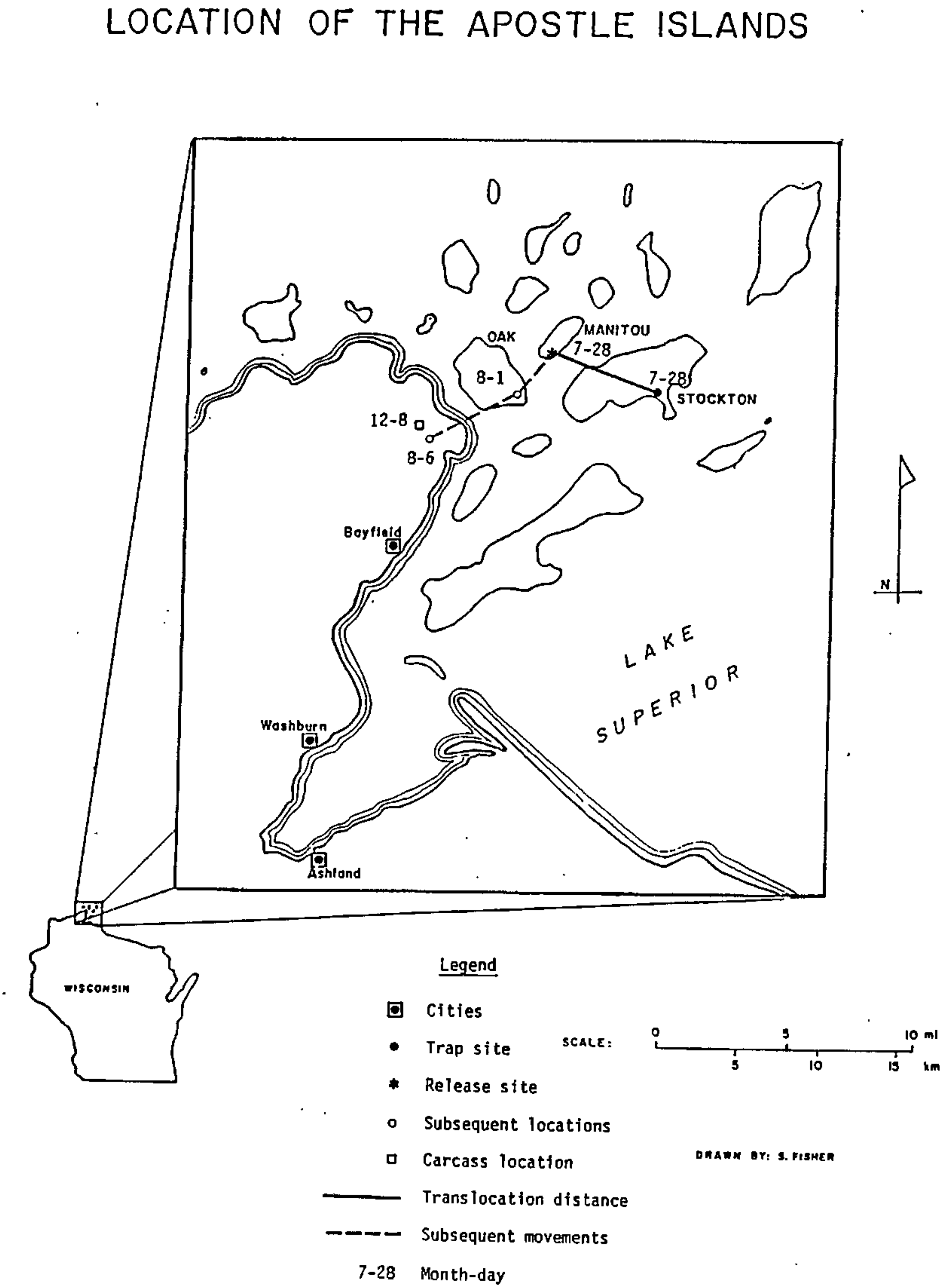


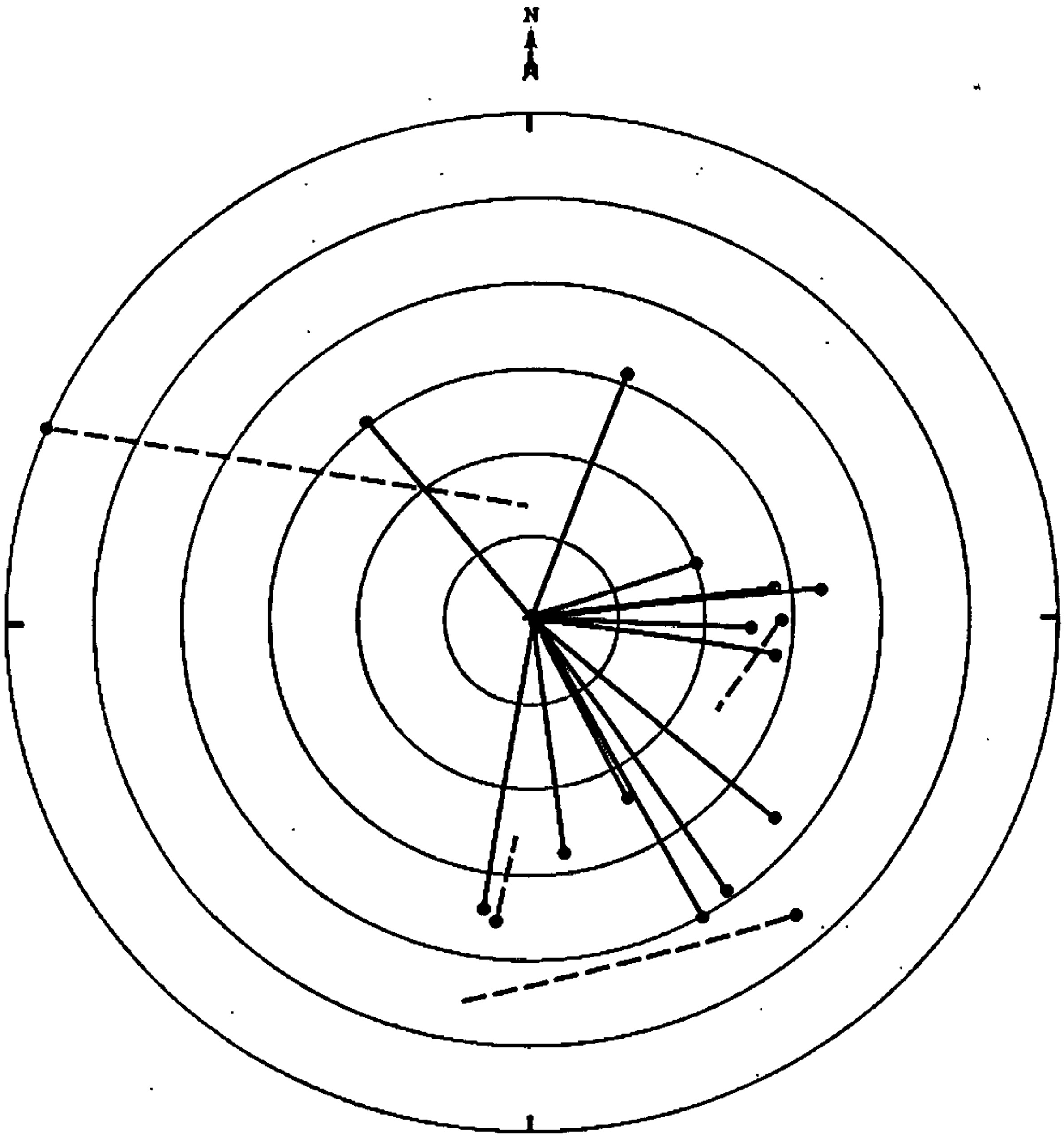

Fig. 2. Post-release movements of adult Female-J.

her scavenged carcass were found 1.2 km from the dump. Exact cause of death is unknown; however, we suspect that she was shot during 1 of her several visits to the dump. Neither of 2 other non-homing females (Adult-A, and Subadult-H) remained in the area of their release sites (Fig. 3 ).

Five of 7 males returned to their home range; Male-P was translocated twice (Table 1). Yearling Male-M was the only bear that established a home range in its release area. Adult Male-Q was probably homing when he was harvested 26.2 km north of his capture site (Fig. 3).

Reoccurrent nuisance behavior, either while homing or once back in their home area, was verified for 11 of 18 translocated bears (Table 1). Only 3 of the 11 bears returned to their original nuisance site. Adult Female-F was shot when she returned to the apiary of her original capture; adult Female-E returned to forage at a dump where she was originally caught; and adult Male-Q was recaptured after repeatedly visiting the same residential garbage site where he was initially captured. Five of the 11 bears that persisted in nuisance behavior were causing economic loss by damaging agricultural crops or beehives; the remaining 6 were feeding on garbage or were general nuisance complaints.

Most (13 of 18) translocated bears in Wisconsin returned to their original home area. Successful translocations of black bears in Montana were highly




Legend

A- adult female ● Release point

H- subadult female ———— Returned to home range

L- adult female ------ Did not return to home range

Q- adult male Center circle represents bear home range.

Fig. 3. Movements of 16 translocated nuisance black bears in northern Wisconsin, 1981-82.

correlated with distance moved, number of ridges, elevation gain, and physiographic barriers; relocation distances < 60 km contributed little to translocation success (McArthur 1981). Distance is the only 1 of those factors that could influence translocations in Wisconsin. The mean translocation distance of returning bears in this study was 65.0 km (range: 40.4-120.7); whereas, that of those not returning was 65.3 km (range: 42.2-91.9). Two bears (Male-Q, Female-C) returned after being moved 120.7 and 80.1 km, respectively (Fig. 3). Alt et al. (1977) reported that translocating adult bears > 64.0 km appeared to reduce nuisance activity and homing in Pennsylvania.

Young bears (< 3.5 years) in this study did not return to their capture areas (N=3). The mean age of all nuisance bears in this study was 5.7 years (range: 1.5-15.5) (Table 1); there was no difference ($P>0.01$) between the mean age of males (5.7 years) and females (5.5 years). The age of 4 bears that did not home, Females-A, -H, -L, and Male-M, was 3.5, 2.5, 7.5, and 1.5 years, respectively. Yearling Male-M was the only bear that was known to have established a new home range in a release area. These results are consistant with findings of Alt et al. (1977) and Harger (1967). Females-A and -H, both with cubs, had exhibited homeward movements when they were last located, but the study ended before homing or home ranges were determined. Female-L was the only adult bear (7.5 years) that did not travel in a homeward direction. Homing of young animals may require more than 2 years.

## Homing Time and Post-release Behavior

Homing times reported in Table 1 are maximum approximations and varied with the frequency of monitoring flights. The exact homing time was determined for 1 bear (adult Female-G). Attempts to constantly monitor other homing bears were unsuccessful because of the large roadless areas. All other homing times presented in Table 1 are the maximum number of days between release and when a bears return to the home area was verified.

Male bears in this study appeared to return to the original home area sooner than females. All bears returned in an average time of 23.8 days (range: 3-146); females averaged 33.8 days (range: 4-146), and males averaged 13.8 days (range: 3-29). Rates of return averaged 5.8 km/day (range: 0.5-10.1) for females and 7.0 km/day (range: 2.1-15.5) for males; the average rate of return for all bears is 6.4 km/day (Table 1). These mean rates of return are similar to those from radio-tagged bears in Pennslyvania (5.4 km/day) (Alt et al. 1977), but slower than return rates reported by Harger (1970) for Upper Michigan (12.7 km/day). Adult Female-C remained in her release area for at least 35 days until approximately 1 month prior to denning when she returned to her original home area. The rate of return for adult Female-I is unknown; she lost her radio collar in 1982 but was recaptured in her home area the next year at an apiary complaint site.

Immediate post-release movements were determined for 3 adult females (G,I,L), 1 yearling female (K), 2 adult males (R,S), 1 yearling male (M), and 1 subadult female (A). Yearling Male-M remained at his release site for 2 days; he ultimately established a home range in the release area. Adult Male-R was approximately 1.6 km from his release site the day after his release and was located in his original home area 12 days later. Adult Male-S was 10.7 km west of his release site approximately 20 hours after his release; 6 days later he was in his original home range. Subadult Female-A remained within 4.4 km of the release site for 5 days and then initiated large wandering movements. Continuous monitoring for 24 hours during this time revealed an average rate of travel of 1591 m/hr (range: 148-7273). She spent the next 18 days within 0.8 km of a cornfield where she fed regularly. She left this area, and contact was lost, when she was chased by bear hounds. Approximately 1 month later, a radio-tagged bear fitting her description was seen within the city limits of Stanley, WI, 54.7 km southwest of the cornfield. One year later she was in a den with 2 cubs, 20.1 km north of her release site and 50.3 km southwest of her original capture site.

The behavior of 1 yearling female (K) suggests that she sought security in the dense swamps after having been moved into unfamiliar territory. She moved in small circles within 1256 m of the release site at an average speed of 529 m/hr (range: 56-1505) for the first 24 hours. Most of her time over the next 24 hours (11 of 16 locations) was spent in a conifer or alder (Alnus spp.) swamp; the remaining time was spent in upland hardwoods. A 6-hour rest period the first night after release was spent in the same conifer swamp. We lost contact with her 22 days after release when she was still within 6 km of the release site; her final status is unknown.

Adult Female-I remained within 1003 m of her release site for 29 continuous hours; her average rate of travel was 469 m/hr (range: 62-1023). Her movements were straight-line, forth and back, rather than circular and alternated between upland hardwoods and an alder swamp. She was also inactive for 6 hours during the first night after release.

Adult Female-L circled for 7 hours immediately after release; her movements were in a straight line for 22 hours after that. She traveled at an average rate of 1459 m/hr (range: 359-4975) in a direction away from her original home area and was inactive in an upland hardwood stand for 7 hours during that first night. On the second day, she headed in a homeward direction at an average speed of 2392 m/hr (range: 156-4344). Contact with her was lost after that until she was illegally shot by a hunter in November 1984, 77.2 km west of her release site.

Adult Female-G was tracked during the first 2 days following release and the last 4 days of her homing trip. Movements were circular and diurnal during the first 2 days separated by an 8-hour night rest period. She moved for 3 hours at a mean speed of 1443 m/hr (range: 421-2329) before bedding down on the first day (Table 2). Her rate of travel during the second day averaged 675 m/hr (range: 272-1115). Contact was lost when she entered a large roadless tract of land but was regained 4 days later; she had moved 33 km in a homeward direction during 105 hours of constant rain which did not seem to affect her speed. Her straightline rate of travel during this time was 8 km/day; her actual speed was probably 12 km/day, the same as that of her next 2 days (18 and 19 July, Table 2). Her mean rate of travel increased from 479 to 1431 m/hr as she neared her home area (Table 2). In contrast to the first 2 days after release, her longest movements and greatest rate of travel occurred at night between 1900 and 0800 hours. Harger (1970) reported that 4 of 5 radio-tagged bears in Upper Michigan had moved diurnally after being translocated distances that ranged from 30.5 to 70.0 km. Conversely, Alt (1977) reported nocturnal movements in 3 of 6 radio-tagged Pennsylvania bears which had been translocated distances

Table 2. Hourly movements of adult Female-G after translocation.

| Time period | Minutes(hr)/ time period | Distance moved (m) | Rate of travel m/hr | Rate of travel km/day |
|---|---|---|---|---|
| 12 July 1982 | | | | |
| 1751-1850 | 59 (0.98) | 413 | 421 | 10 |
| 1850-1949 | 59 (0.98) | 1546 | 1578 | 38 |
| 1949-2050 | 61 (1.02) | 2376 | 2329 | 56 |
| X̄ | 60 (1.00) | 1445 | 1443 | 35 |
| 13 July 1982 | | | | |
| 0447-0551 | 64 (1.07) | 686 | 641 | 15 |
| 0551-0653 | 63 (1.05) | 1171 | 1115 | 27 |
| 0653-0756 | 64 (1.07) | 744 | 695 | 17 |
| 0756-0853 | 58 (0.97) | 893 | 921 | 22 |
| 0853-0952 | 59 (0.98) | 566 | 578 | 14 |
| 0952-1055 | 64 (1.07) | 293 | 274 | 7 |
| 1055-1214 | 79 (1.32) | 1195 | 905 | 22 |
| 1214-1455 | 161 (2.68) | 730 | 272 | 7 |
| X̄ | 77 (1.28) | 785 | 675 | 17 |
| 18 July 1982 | | | | |
| 0922-1401 | 279 (4.65) | 538 | 116 | 3 |
| 1401-1458 | 57 (0.95) | 101 | 106 | 3 |
| 1458-1659 | 121 (2.02) | 547 | 271 | 7 |
| 1659-1757 | 58 (0.97) | 226 | 233 | 6 |
| 1757-1858 | 61 (1.02) | 160 | 157 | 4 |
| 1858-2057 | 119 (1.98) | 1229 | 621 | 15 |
| 2057-2159 | 62 (1.03) | 1104 | 1072 | 26 |
| 2159-2257 | 58 (0.97) | 1214 | 1252 | 30 |
| X̄ | 102 (1.70) | 640 | 479 | 12 |
| 19 July 1982 | | | | |
| 0157-0302 | 65 (1.08) | 2626 | 2431 | 58 |
| 0756-0901 | 65 (1.08) | 250 | 231 | 6 |
| 0901-1100 | 119 (1.98) | 254 | 128 | 3 |
| 1100-1157 | 57 (0.95) | 62 | 65 | 2 |
| 1255-1355 | 60 (1.00) | 62 | 62 | 1 |
| 1555-1657 | 58 (0.97) | 235 | 242 | 6 |
| 1955-2056 | 61 (1.02) | 125 | 123 | 3 |
| 2056-2159 | 63 (1.05) | 408 | 389 | 9 |
| 2159-2259 | 60 (1.00) | 595 | 595 | 14 |
| 2259-2359 | 60 (1.00) | 907 | 907 | 22 |
| X̄ | 67 (1.10) | 552 | 517 | 12 |
| 20 July 1982 | | | | |
| 2359-0104 | 65 (1.10) | 1637 | 1488 | 36 |
| 0104-0159 | 55 (0.92) | 768 | 835 | 20 |
| 0159-0515 | 196 (3.30) | 4627 | 1402 | 34 |
| 0515-0556 | 41 (0.68) | 1200 | 1765 | 42 |
| 0556-0657 | 61 (1.02) | 749 | 734 | 18 |
| 0657-0758 | 61 (1.02) | 307 | 301 | 7 |
| 0758-0901 | 63 (1.05) | 221 | 210 | 5 |
| 1055-1157 | 62 (1.03) | 595 | 578 | 14 |
| 1157-1259 | 62 (1.03) | 778 | 755 | 18 |
| 1259-1356 | 57 (0.95) | 259 | 273 | 7 |
| 1554-1659 | 65 (1.08) | 653 | 605 | 15 |
| 1855-1956 | 61 (1.02) | 552 | 541 | 13 |
| 1956-2055 | 59 (0.98) | 1546 | 1578 | 38 |
| 2055-2158 | 63 (1.05) | 1416 | 1349 | 32 |
| 2158-2257 | 59 (0.98) | 1286 | 1312 | 31 |
| 2257-2358 | 61 (1.02) | 1018 | 998 | 24 |
| X̄ | 68 (1.10) | 1101 | 920 | 22 |

Table 2. (Con't)

| Time period | Minutes(hr)/ time period | Distance moved (m) | Rate of travel m/hr | Rate of travel km/day |
|---|---|---|---|---|
| 21 July 1982 | | | | |
| 0255-0359 | 64 (1.07) | 1325 | 1238 | 30 |
| 0359-0500 | 61 (1.02) | 1406 | 1378 | 33 |
| 0500-0556 | 56 (0.93) | 1925 | 2070 | 50 |
| 0556-0656 | 60 (1.00) | 1973 | 1973 | 47 |
| 0656-0802 | 66 (1.10) | 1248 | 1135 | 27 |
| 0802-0857 | 55 (0.92) | 125 | 136 | 3 |
| 1910-1958 | 48 (0.80) | 1891 | 2364 | 57 |
| 1958-2059 | 61 (1.02) | 1224 | 1200 | 29 |
| 2059-2158 | 59 (0.98) | 1675 | 1709 | 41 |
| 2158-2257 | 59 (0.98) | 1661 | 1695 | 41 |
| 2257-2401 | 64 (1.07) | 897 | 838 | 20 |
| 2401-0101[a] | 60 (1.00) | 1430 | 1430 | 34 |
| $\bar{X}$ | 59 (0.99) | 1398 | 1431 | 34 |

[a] This location is included under 21 July 1982 because the bear was approximately 4.8 km (3 miles) from her capture site, and tracking ended at this time.

ranging from 14.4 to 31.6 km. Translocated bear movements may change from diurnal to nocturnal as they enter familiar territory near their home area.

It is possible that Female-G used a recognizable land feature to navigate back to her home area when she paralleled a major highway and skirted 3 communities (Fig. 4). Harger (1970) reported that bears in Upper Michigan apparently did not use recognizable land features to navigate after being translocated. Female-G may have recognized Highway 13 by the large volume of traffic and used it to navigate to her original home area. Her daily rate of travel during the last 4 days averaged 20 km/day (range: 12-34) with the fastest rate being on the day before she reached home.

Movements And Mortality Of Translocated Nuisance Bears

The criterion used to designate the homing propensity of harvested bears was conservative, i.e., 15 km from trap site for males and 10 km for females. This homing definition is based on 3 assumptions: (1) bears were not chased from their home areas by dogs and then harvested, (2) bears were not attracted to bait stations outside of their home areas, and (3) hunters were accurate in reporting the location of the kill.

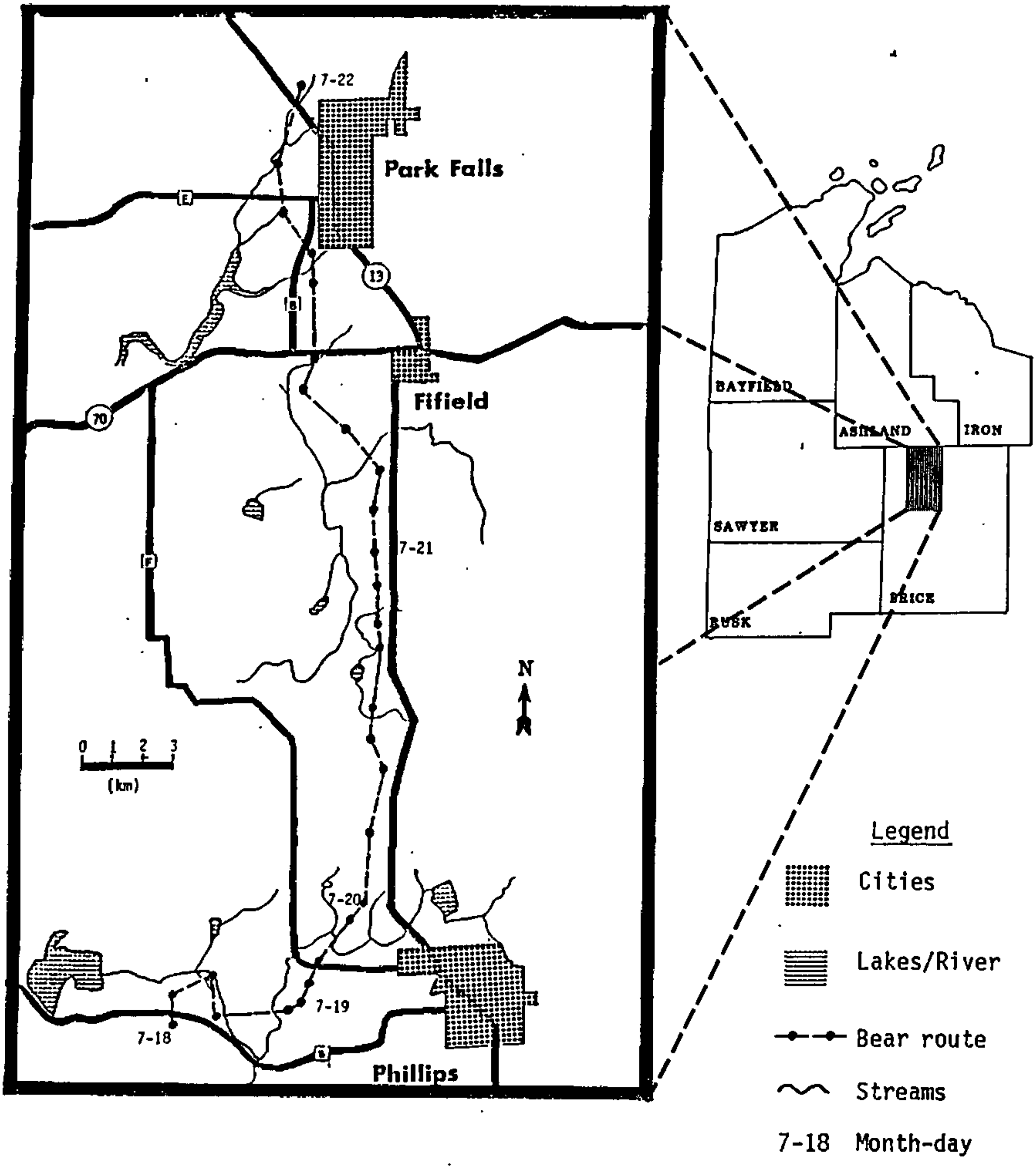



Fig. 4. Last 4 days of adult Female-G's homing movements.

Data from radio-tagged bears in this study indicates that some of the bears that were designated as nonreturning, could have returned, and were subsequently harvested outside of their home area. Adult Male-R was located 35 km from the farthest edge of his normal home range during the 1981 bear season. Yearling Male-M was chased by radio-collared dogs 20 km from the farthest edge of his normal home range and returned the next day when chased again.

At least 18 of 50 translocated and subsequently harvested bears were determined to have returned to their home areas (Table 3). There was a significant difference ($P<0.05$) between the mean ages of returning (5.4 years) and nonreturning (3.2 years) bears; ages were unknown for 30 of the bears (Table 3). This is consistent with results reported by Alt et al. (1977), Harger (1970), and data from radio-tagged bears in this study. These translocated bears did not remain in the immediate vicinity of the release site. The distance of the kill from the release site and the trap site were determined for the 50 ear-tagged bears; there was no difference ($P>0.10$) in the mean distance of the kill from the release site for returning (46.5 km) and nonreturning (36.8 km) bears (Table 3). This suggests that whether the bears returned to their home area or not, they did not remain in the immediate vicinity of the release site. There was a significant difference ($P<0.005$) between

Table 3. Kill data of Wisconsin translocated nuisance bears; 1979-82.

| Bear | Age (yrs) | Sex | Distance of kill from: Release site(km) | Trap site(km) | Distance relocated (km) | Time between release and kill (days) |
|---|---|---|---|---|---|---|
| Returned:[a] | | | | | | |
| Known age | | | | | | |
| 1 | 2.5 | M | 51.2 | 9.5 | 53.0 | 92 |
| 2 | 3.5 | F | 76.8 | 6.0 | 80.1 | 475 |
| 3 | 4.5 | M | 40.4 | 11.2 | 39.6 | 393 |
| 4 | 5.5 | F | 74.8 | 9.3 | 67.5 | 370 |
| 5 | 5.5 | F | 44.7 | 4.8 | 40.4 | 75 |
| 6 | 6.5 | F | 62.2 | 0.0 | 62.2 | 22 |
| 7 | 9.5 | F | 25.0 | 2.6 | 27.5 | 384 |
| Unknown age | | | | | | |
| 8 | ? | F | 49.8 | 2.5 | 51.0 | 464 |
| 9 | ? | M | 20.5 | 15.0 | 8.4 | 351 |
| 10 | ? | M | 68.9 | 5.6 | 63.6 | 485 |
| 11 | ? | M | 48.4 | 13.2 | 43.3 | 44 |
| 12 | ? | F | 54.2 | 2.8 | 53.0 | 354 |
| 13 | ? | M | 9.9 | 1.7 | 11.8 | 12 |
| 14 | ? | F | 38.5 | 2.3 | 36.7 | 135 |
| 15 | ? | M | 32.3 | 8.4 | 26.3 | 402 |
| 16 | ? | M | 68.0 | 9.9 | 63.0 | 889 |
| 17 | ? | M | 31.6 | 3.5 | 31.0 | 128 |
| 18 | ? | M | 40.2 | 0.7 | 40.3 | 115 |
| X̄ | 5.4 | - | 46.5 | 6.1 | 44.4 | 288 |
| Nonreturning:[b] | | | | | | |
| Known age | | | | | | |
| 19 | 0.5 | M | 9.9 | 25.3 | 27.2 | 973 |
| 20 | 1.5 | M | 10.5 | 22.3 | 27.5 | 370 |
| 21 | 1.5 | M | 27.4 | 84.7 | 63.0 | 29 |
| 22 | 1.5 | M | 19.7 | 57.0 | 37.3 | 93 |
| 23 | 1.5 | M | 43.7 | 77.0 | 67.4 | 373 |
| 24 | 2.5 | M | 26.0 | 19.3 | 37.6 | 84 |
| 25 | 2.5 | M | 83.8 | 74.5 | 41.2 | 81 |
| 26 | 2.5 | M | 6.3 | 28.6 | 32.4 | 29 |
| 27 | 3.5 | M | 16.7 | 23.2 | 37.0 | 45 |
| 28 | 4.5 | M | 52.8 | 23.6 | 37.3 | 67 |
| 29 | 4.5 | M | 42.3 | 61.8 | 37.8 | 65 |
| 30 | 5.5 | M | 96.5 | 26.2 | 120.7 | 90 |
| 31 | 9.5 | F | 10.6 | 16.9 | 9.3 | ? |
| Unknown age | | | | | | |
| 32 | ? | M | 10.7 | 62.0 | 65.9 | 86 |
| 33 | ? | M | 49.8 | 19.0 | 39.3 | 71 |
| 34 | ? | F | 8.0 | 86.2 | 90.2 | 19 |
| 35 | ? | M | 3.4 | 57.9 | 59.5 | 10 |
| 36 | ? | M | 21.8 | 129.0 | 107.8 | 49 |
| 37 | ? | M | 37.7 | 66.1 | 44.3 | 59 |
| 38 | ? | M | 179.8 | 131.6 | 48.2 | 88 |
| 39 | ? | M | 40.8 | 26.6 | 66.2 | 409 |
| 40 | ? | M | 46.0 | 54.0 | 73.0 | 399 |
| 41 | ? | M | 12.4 | 45.2 | 56.7 | 399 |
| 42 | ? | M | 16.2 | 25.5 | 41.6 | 133 |
| 43 | ? | M | 23.3 | 21.6 | 30.8 | 46 |
| 44 | ? | F | 48.9 | 53.4 | 36.2 | 359 |
| 45 | ? | M | 67.7 | 27.5 | 55.0 | 53 |
| 46 | ? | M | 11.4 | 33.9 | 35.8 | 29 |
| 47 | ? | M | 58.6 | 50.0 | 91.0 | 423 |
| 48 | ? | M | 61.0 | 46.0 | 77.5 | 135 |
| 49 | ? | M | 11.2 | 73.2 | 70.8 | 39 |
| 50 | ? | F | 24.2 | 29.2 | 52.9 | 33 |
| X̄ | 3.2 | - | 36.8 | 49.3 | 53.7 | 166 |
| All bears | | | | | | |
| X̄ | 4.0 | - | 40.3 | 33.7 | 50.3 | 211 |

[a] Bears shot within 15 km (males) and 10 km (females) of the original nuisance site.

[b] Bears shot farther than 15 km (males) and 10 km (females) from the original nuisance site.

the mean distance of the kill from the trap site for returning (6.1 km) and nonreturning (49.3 km) bears (Table 3). This is logical because of the conservative definition of returning bears.

Most nonreturning harvested bears, were relocated farther than returning bears. There was a significant difference ($P<0.10$) in the mean relocation distance between returning (44.4 km) and nonreturning (53.7 km) bears (Table 3); all were relocated a mean distance of 50.3 km (range: 8.4-120.7). Longer relocation distances have been shown to decrease the number of bears returning to their home areas (Alt et al. 1977, McArthur 1981, Beeman and Pelton 1976, Sauer et al. 1969). The younger ages and longer translocation distances of nonreturning bears in this study may have influenced their being harvested outside of their home areas.

Most bears that returned to their home areas survived longer. The length of time between release and kill averaged 211 days for all bears (Table 3). Returning bears had a significally greater ($P<0.05$) number of days ($\bar{X}$=288 days) between release and kill than nonreturning bears ($\bar{X}$=166 days; Table 3).

Most of the 32 nonreturning bears were killed close to the release site or between the release and trap site. Bears seemed to be particularly vulnerable near the release site with 18 being killed < 30 km from the release site (Fig. 5).

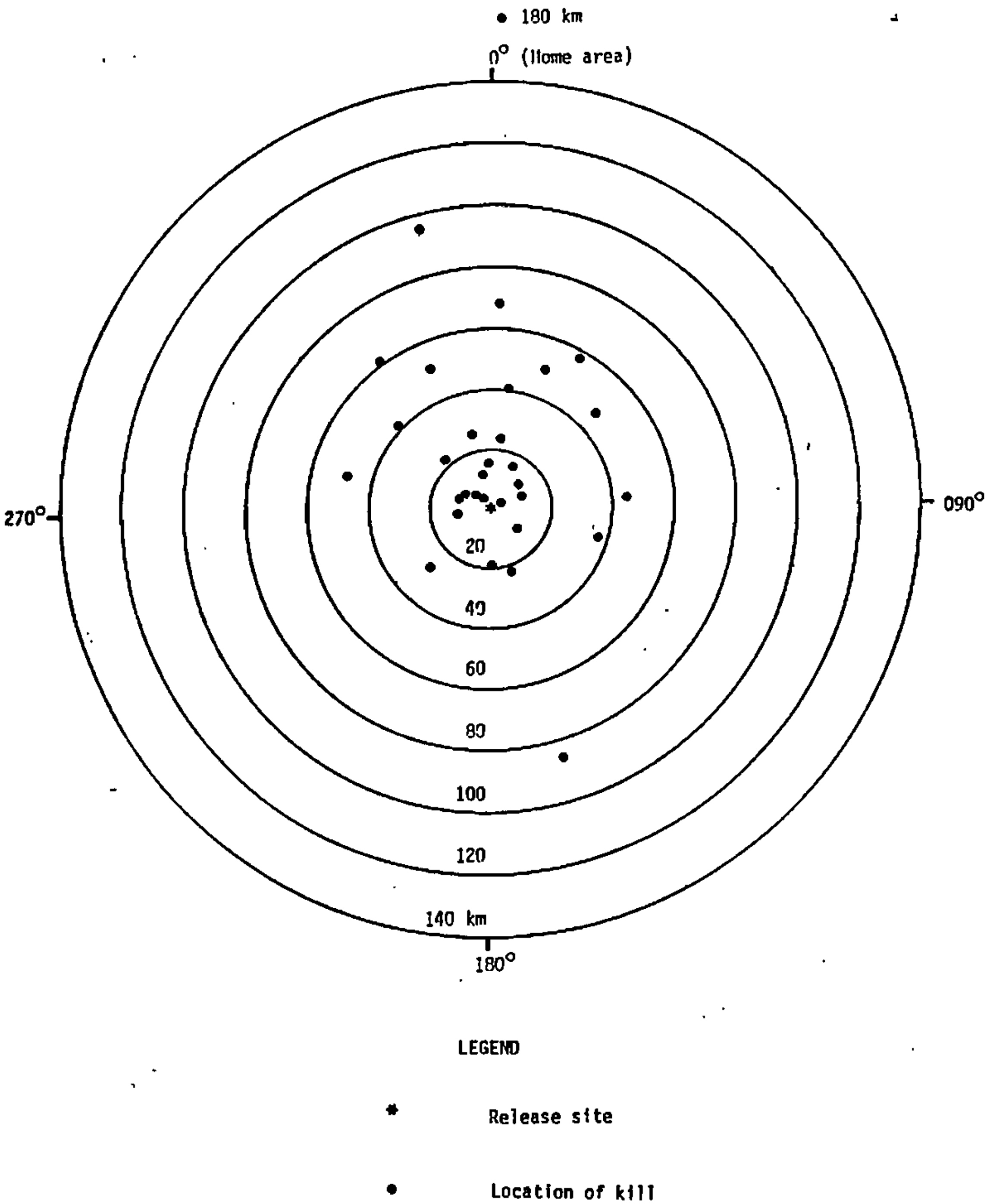



Fig. 5 . Bearing and distance of kill from release site for 32 nonreturning nuisance black bears in Wisconsin; 1979-82.

Of the 14 bears that were killed > 30 km from the release site, 6 were killed within a bearing of 22.5°, and 10 within 50° on either side of the homeward vector. Harger (1970) reported 9 of 17 adult nonhoming bears moved within 22.5° either side of the homeward vector; the remaining 8 bears movements exceeded 90° either side of the homing vector.

A total of 114 bears were tagged in the northwest district of Wisconsin from 1979 through 1982; 50 were harvested during 1980-82 for a mortality rate of 44% for the this time period. The harvest rate for bears tagged and shot the same year was 28% (Kohn, Pers. comm.), 1% higher than the reproductive rate (27 cubs/100 adults) determined by Kohn (1982).

## MANAGEMENT IMPLICATIONS

This study has shown that translocating nuisance bears is only a temporary solution to a specific problem. This is similar to findings from Pennslyvania (Alt 1977) and Upper Michigan (Harger 1970), but dissimilar to those of Erickson and Petrides (1964) who also worked in Upper Michigan. Graber (1981) recommends killing rather than relocating problem bears as a management technique for Yosemite National Park because this practice would eliminate the impact on the population receiving the translocated animal and force the Park Service and the public to acknowledge the failure of management. While this procedure might be a possible solution for a nonhunted National Park population, it is not acceptable for a Wisconsin state-wide management policy and is an ethically undesirable solution to a human created problem.

We recommend that nuisance bears be trapped and then moved no further than 8km from the trap site. This procedure would lower transportation costs, decrease man-hours, and reduce stress on the translocated animal. We did not find any reference to the effects of stress on translocated bears; however, a bear's home range may provide psychic as well as physical needs (Beeman and Pelton 1976). The psychic role of the bear's home area allows the animal to fully use the available resources of its range with assurance and efficency (Beeman and Pelton 1976); therefore, a bear that is moved from a familiar area may be subjected to increased stress and vulnerability to hunting.

## Recommended Changes in WDNR Nuisance Bear Procedure

The following changes are presented for consideration:

1. A public education program that would provide information on nuisance black bears for landowners and the general public should be developed. The program should include information on behavior and natural history, electric

fence designs, methods of storing garbage, and instructions on human behavior when confronted by a bear.

2. Permits for private citizens to kill nuisance bears should be eliminated; managing the wildlife resources of Wisconsin is the responsibilty of experienced WDNR personnel. There were 88 shooting permits issued in 1981-82 during which 24 bears were killed; 20 bears were killed without permits (Wis. Dep. Nat. Resour., unpubl. data). It is likely that the actual illegal kill was more than 20 animals. It is also likely that a number of nontarget bears are mistakenly killed when a landowner is placed in the position of determining the identity and when a nuisance bear should be killed.

3. A concerted effort should be made to prosecute illegal killers of nuisance bears. Violators often use defense of life and property as reasons for killing nuisance bears. We have found bears to be nonaggressive (< 1% are aggressive) and do not believe that this defense is legitimate in the majority of the bear/human interactions.

4. Electric fences should be required and operating at apiaries before responses to nuisance complaints in bear range are made by WDNR personnel. The Florida Game and Fresh Water Fish Commission is presently trying to implement this policy change and are receiving favorable responses from beekeepers; in most cases the cost of electric fences and maintainance is less than losses sustained at unprotected apiaries (Maehr and Brady 1982).

There were 141 bear complaints at aparies during 1981-82 in Wisconsin (Wis. Dep. Nat. Resour., unpubl. data); relatively few were protected by electric fences.

5. Nuisance bear data collection should be standardized and uniformly practiced throughout Wisconsin. Nuisance bears should be weighed, have a tooth pulled for aging, measured and ear-tagged; this would require approximately 1 hour by experienced personnel. The additional age and condition data from the bears easily justifies the expense of scales, measuring tapes, and tooth elevators. A sample data sheet is presented in Appendix A.

## Additional Research

Alternatives to lethal control or translocation need to be developed. Wisconsin has the unique opportunity to research deterent techniques for nuisance bears. Some nonlethal forms of negative conditioning that have potential for being effective include electro-shock treatment, tasar guns, drug combinations, aversive conditioning, sonic treatments, and debilitating gases.

LITERATURE CITED

Alt, G. L. 1977. Home range, annual activity patterns, and movements of black bears in northeastern Pennsylvania. M. S. Thesis. Pennsylvania State Univ., Univ. Park. 67pp.

__________ , G. J. Matula, Jr., F. W. Alt, and J. S. Lindzey. 1977. Movements of translocated nuisance black bears of northeastern Pennsylvania. Trans. Northeast Fish and Wildl. Conf. 34:119-126.

Beeman, L. E., and M. R. Pelton. 1976. Homing of black bears in the Great Smoky Mountains National Park. Pages 87-95 in M. R. Pelton, J. W. Lentfer, and G. E. Folk, Jr., eds. Bears-Their biology and management. Int. Union Conserv. Nat. Publ. New Ser. 40. Morges, Switzerland.

Curtis, J. T. 1959. The vegetation of Wisconsin. Univ. Wisconsin Press, Madison. 657pp.

Erickson, A. W. 1957. Techniques for live-trapping and handling black bears. Trans. North Am. Wildl. Conf. 22:520-543.

______________ , and G. A. Petrides. 1964. Population structure, movements, and mortality of trapped bears in Michigan. Pages 46-67 in A. W. Erickson, J. Nellor, and G. A. Petrides, eds. The black bear in Michigan. Mich. Agric. Exp. Stn. Res. Bull. 4.

Graber, D. M. 1981. Ecology and management of black bears in Yosemite National Park. Ph.D. Diss. Univ. California, Berkeley. 206pp.

Harger, E. M. 1967. Homing behavior of black bears. Mich. Dep. Conserv. Res. and Dev. Rep. 118. 13pp.

__________ . 1970. A study of homing behavior of black bears. M. S. Thesis. North. Michigan Univ., Marquette. 81pp.

Heezen, K. L., and J. R. Tester. 1967. Evaluation of radio-tracking by triangulation with special reference to deer movements. J. Wildl. Manage. 31:124-141.

Hole, F. D. 1976. Soils of Wisconsin. Univ. Wisconsin Press, Madison. 233pp.

Johnson, K. G., and M. R. Pelton. 1980. Prebaiting and snaring techniques for black bears. Wildl. Soc. Bull. 8:46-54.

Kohn, B. E. 1982. Status and management of black bears in Wisconsin. Wisconsin Dep. Nat. Resour. Tech. Bull. No. 129. 31pp.

Maehr, D. S., and J. R. Brady. 1982. Florida black bear-beekeeper conflict: 1981 beekeeper survey. Am. Bee J. 122:372-375.

McArthur, K. L. 1981. Factors contributing to effectiveness of black bear transplants. J. Wildl. Manage. 45:102-110.

Payne, N. F. 1975. Unusual movements of Newfoundland black bears. J. Wildl. Manage. 39:812-813.

Rogers, L. L. 1978. Interpretation of cementum annuli in first premolars of bears. Proc. East. Black Bear Workshop 4:102-112.

Sauer, P. R., S. L. Free, and S. D. Browne. 1969. Movements of tagged black bears in the Adirondacks. N. Y. Fish and Game J. 16:205-223.

Waddell, T. E. 1975. A technique for extracting a bear's first premolar. Arizona Fish and Game Dep. Wildl. Digest Game Manage. Abstr. No. 9. 3pp.

Appendix A. Field data sheet.

## FIELD DATA SHEET

Right Ear Tag No.______ Date__________ Sex_____ Weight_________ Age_________

Left Ear Tag No. _______ Cubs: YES NO Number_______ Weights________________

Trap Location: County___________ Sec.______ T____N R_____E W 40________________

Release Site: County___________ Sec.______ T____N R_____E W 40________________

Habitat:(Circle One) Dump, Campground, Park, Residence, Resort, Beehive,

Farm(______________________), Other________________

Drug: Dose__________ Time Given_______________ Reaction________________

Dose__________ Time Given_______________ Reaction________________

Dose__________ Time Given_______________ Reaction________________

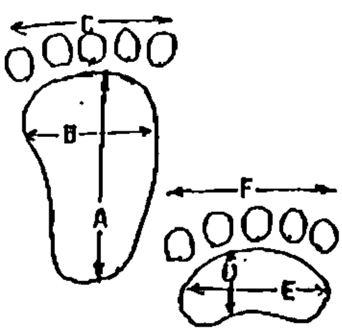
Dose__________ Time Given_______________ Reaction________________

Measurements: Total Length___________ Max. Girth____________ Neck Circum.________

Head Circum.___________ Head Width____________ Canine Length________

Nipple (Circle One: White Pigmented)________________

Degree Of Vulval Swelling________________




Foot Measurements: A_______ B_______ C_______ D_______ E_______

F_______

Blood Sample Collected: YES NO Amount Taken_________Comments________________

Parasites Collected: YES NO Comments________________

Coat Color:_______________ Hide Condition________________

Unusual Markings________________

Injuries________________

Remarks:

# THE RESPONSE OF BLACK BEARS TO BEING CHASED BY HUNTING DOGS

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Abstract: The responses of radio-tagged black bears (*Ursus americanus*) to being chased by radio-tagged hunting dogs (*Canis familiaris*) were studied in northern Wisconsin during 1981-82. Home ranges of bears were determined before they were chased. Eight chases of 5 individual bears (1 yearling male, 1 adult barren female, 1 adult female with 3 cubs, and 2 adult males) were conducted; the yearling male, female with cubs, and 1 adult male were each chased twice. All chases were conducted between 10 July and 20 August, an approved dog-training period in Wisconsin. The mean length of the chases was 1.9 hours (range: 0.0-5.0). The average distance of the chases was 11.1 km (range: 1.2-29.2). The average rate of travel for all bears was 4.4 km/hr (range: 0.8-7.9); individual bears traveled at rates ranging from 0.2 to 15.3 km/hr during certain portions of the chases. The yearling male was the only bear that was chased from his home range but he returned the next day when chased again; all others remained and denned in their home ranges. Bears were not physically affected by chases as indicated by their weight

and lack of injuries when inspected in their dens approximately 7 months after the chases. Bears displayed bursts of speed to outdistance the dogs and then slowed down until the dogs got closer; they repeated this pattern until they escaped or the dogs were removed from the chase. Alder (*Alnus* spp.), conifer, or hardwood swamps were common escape habitats; a portion of which was traversed during all chases. Circling, back tracking, and zig-zagging in the swamps were common escape tactics used by the bears; the female with cubs was the only bear known to have fought with the dogs during any of the chases. No bears were known to have treed during any chase.

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The controversy about the use of dogs for hunting game animals has intensified. Dogs are used to hunt several species of wild animals in Wisconsin but the hunting of black bears with dogs has generated the most recent concern. There are those who consider the practice to be highly disruptive to the normal behavior of bears and therefore, inhumane. There are also conflicting opinions among hunters who hunt by different methods. Those who still-hunt over bait claim that hunting dogs chase bears out of their home ranges or preferred habitat for prolonged periods of time. Additional criticisms include the accusations that dogs give hunters unfair advantage because bears tree and can be easily shot, and that packs of dogs injure or kill bears, particularly cubs and yearlings. This is typical of situations in which increased use of a finite resource magnifies conflicts of interest. When this occurs, more intensive management practices become necessary to maintain the integrity of the resource. Guidelines for management practices must be firmly based on facts.

Bear hunters that use dogs harvested 40% of the bears killed from 1977 to 1981 in Wisconsin; 46% were harvested by hunters using bait (Wis. Dep. Nat. Resour., unpubl. data). Harger (1978) reported that Michigan bear hunters took 33% or less of the total harvest by using dogs. In contrast, 90% of the bears are harvested with dogs in Washington (Parsons and Poelker 1975). Conley (1974) states that hunting with dogs is more effective than still-hunting in Tennessee as 21.4% of the hunters harvest 43.9% of the bears. The numbers of hunters using different hunting methods (still-hunting or dog-hunting) are unknown for Wisconsin.

Current information about the behavior of bears when chased by dogs is meager and usually obtained from data collected by interviews at hunter registration stations or through hunter questionaires. Poelker and Hartwell (1973) reported that dog-hunting was selective for female bears as determined from sex ratios of bears killed during a bear population control operation in Washington. Hardy (1974) hypothesized that, because of differential behavior, female bears with cubs would be selectively taken by hunting dogs in North Carolina. On the basis of post-season questionaires, Willey (1972) concluded that adult male bears were selected for by dog-hunting in Vermont; there hunters avoided cubs, females, and even young male bears in their quest for larger trophies. Habitat type was reported to be a factor in the vulnerability of dog-hunted bears in North Carolina, where none of 45 known bear kills occurred within hardwood swamp habitat; presumably because hunters stopped their dogs before they entered this densely vegetated area that contained large expanses of water (Hamilton 1978). A higher crippling loss is reported for still-hunted bears (14%) than for dog-hunted bears (2%) in Washington (Parsons and Poelker 1975); they also state that hunting with dogs is necessary to adequately harvest bears that are damaging trees in Washington forests.

The objective of this study, conducted during the summers of 1981 and 1982, was to determine the responses of black bears to being chased by hunting dogs. The project was supported by the University of Wisconsin-Stevens Point, Wisconsin Department of Natural Resources, Wisconsin Bear Hunters Association, and the U.S. Forest Service. The following bear hunters volunteered use of their time, dogs, and equipment: R. J. Bauduin, B. Wendt, "Doc" Johnson,

"Otto", D. Sammuals, and T. Offner. R. K. Murphy donated time, telemetry expertise, and use of his truck during the chases.

## STUDY AREA

Chases were conducted in Price and Sawyer counties of northern Wisconsin. Most (81%) of the 647,520 ha study area is forested land (commercial timber production, productive reserved, and unproductive status); non-forest lands are croplands, pasture, marsh, wooded pasture, industrial, and urban areas (Wis. Dep. Nat. Resour., unpubl. data).

The area is dominated by Northern Mesic Forest with scattered units of Boreal Forest, and conifer swamp (Curtis 1959). Major tree species of the Northern Mesic Forest include sugar maple (*Acer saccharum*), basswood (*Tilia americana*), aspen (*Populus* spp.), balsam fir (*Abies balsamea*), eastern hemlock (*Tsuga canadensis*), black spruce (*Abies mariana*), tamarack (*Larix laricina*), white pine (*Pinus stobus*), and black ash (*Fraxinus nigra*) (Curtis 1959). The mean annual precipitation is 81-86 cm with an average seasonal snowfall of 178-203 cm. The area is composed of end and ground moraine, and glacier formed lake basins. Major soils of the region are Iron River, Gogebic, and Kennan series (Hole 1976).

## METHODS

Black bears were trapped with culvert (Erickson 1957), and barrel traps (Kohn 1982) in cooperation with the WDNR nuisance bear program. Trapped bears were immobilized with ketamine hydrochloride (Vetalar, Parke-Davis, Morris Plains, N.J.), radio-tagged (150-51 MHz; Automatic Telemetry Systems, Bethal, Minn., and Telonics, Mesa, Ariz.), ear-tagged, weighed, sexed, measured; parasites were collected (external, fecal, blood), and the first premolar was removed for aging. Tooth sectioning and aging were done at UWSP, using cementum annuli counts. Bears were translocated varying distances to public lands within the study area (Massopust and Anderson 1984). All bears, except 1 yearling male, returned to their original home range; the yearling male established a home range in the release area.

Home ranges of bears were delineated (Mohr 1947) before they were chased by dogs; bears in areas with road systems judged to be adequate for triangulation were selected for chases. Breeds of dogs included Plotts, Walkers, Redbones, and Blueticks. A maximum of 6 dogs comprised a pack and 2 to 5 of them were also equipped with radio-collars (150-51 MHz). All chases were conducted between 10 July and 20 August, an approved dog-training period in Wisconsin. Bears were located initially by aircraft equipped with H-antennas

(Telonics, Inc., Mesa, Ariz.) and receiver or by truck equipped with an 8-element Yagi antennae and receiver. Chases were started after a radio-telemetry operator and a dog handler located the bear with portable receiving equipment; dogs were kept on a leash by a handler until they scented the bear. Chases were monitored from 2 vehicles equipped with receiving equipment; bearings on the bear and as many dogs as possible were taken from each vehicle every 5 minutes. Telemetry data collectors in the vehicles and dog handlers were in radio contact with each other but information about the bear's location and direction of travel was purposely withheld from the dog handlers.

Locations were plotted on Wisconsin Department of Transportation airphotos (scale: 1:4800). Occasionally, only 1 bearing was obtained on bear and dogs while 1 vehicle was in transit to a new location; in these cases, the route of bear and dogs was determined from the bear's rate of travel, the sound of baying dogs, and the 1-line bearing.

## RESULTS AND DISCUSSION

Five black bears (2 adult males, 1 yearling male, 1 solitary female, and 1 adult female with 3 cubs) were chased 8 times during 1981-82; yearling Male-A, adult Male-C, and adult Female-E were each chased twice (Table 1). A

Table 1. Results of 8 experimental chases of 5 black bears by hunting dogs in Wisconsin.

| Bear | Sex | Age (years) | Date of chase | Duration[a] of chase (hours) | Distance[b] of chase (km) | Average rate of travel km/hour(range) |
|---|---|---|---|---|---|---|
| A | M | 1.5 | 16 Aug. 81 | 2.5 | 9.5 | 3.6 (0.2-14.1) |
| | | | 17 Aug. 81 | 5.0 | 25.8 | 5.1 (0.2-15.3) |
| B | F | 5.5 | 1 Aug. 81 | 3.0 | 13.2 | 3.2 (0.4-9.2) |
| C | M | 5.5 | 7 Aug. 82 | 0.0 | 1.3[c] | 0.8 (0.2-1.9) |
| | | | 15 Aug. 82 | 3.3 | 29.2 | 5.3 (0.3-10.5) |
| D | M | 4.5 | 24 July 82 | 1.0 | 4.4 | 7.5 (1.5-12.0) |
| E[d] | F | 7.5 | 24 July 82 | 0.0 | 1.2[e] | 7.9 (1.8-15.3) |
| | | | 8 Aug. 82 | 0.3 | 4.2 | 1.8 (0.3-4.3) |
| $\bar{X}$ | - | 4.9 | | 1.9 | 11.1 | 4.4 |

[a] Includes only the time dogs were chasing the bear; does not include the time needed to start the dogs on the scent trail, the time after the dogs lost the bear, or the time dogs were on the bear's back trail.

[b] Total distance bears traveled in direct or indirect response to the dogs; direct response resulted from the dogs chasing the bear; indirect response resulted when the dogs lost the scent trail, or were removed from the scent trail by the dog handlers.

[c] Distance bear traveled in response to the dogs following his back trail.

[d] Female with 3 cubs.

[e] Distance bear traveled after fighting with the dogs.

description of individual chases is presented below because of the variety of behavioral responses by bears to the dogs.

Yearling Male

Yearling Male-A was chased on 2 consecutive days. He was located in a black spruce swamp on the first day from the air (Fig. 1). The dogs had difficulty in finding his scent, presumably because of the knee-deep water in the swamp. Initially, only 1 of 6 dogs was chasing the bear; the rest joined the chase after the bear left the swamp. The chase proceeded southward for approximately 1 hour until the bear doubled back after entering another black spruce/tamarack swamp. The bear then traveled southwest through an upland hardwood stand with a sparse understory at his fastest rate of travel for the day (14.1 km/hr). Approximately 2 hours into the chase, the bear again doubled back in a conifer swamp but failed to elude the dogs; he then proceeded northwest and finally escaped the dogs in an alder swamp that was 1.0 km southwest of his previously determined home range; the chase was concluded at this point. The bear had traveled 9.5 km at a mean rate of 3.6 km/hr (range: 0.2-14.1) during the chase (Table 1); he never treed nor came to bay at any time.

This same bear was chased a 2nd time the next day. He was initially located by aircraft 6.2 km south of his home range and the dogs were released within 100 m of him (Fig.

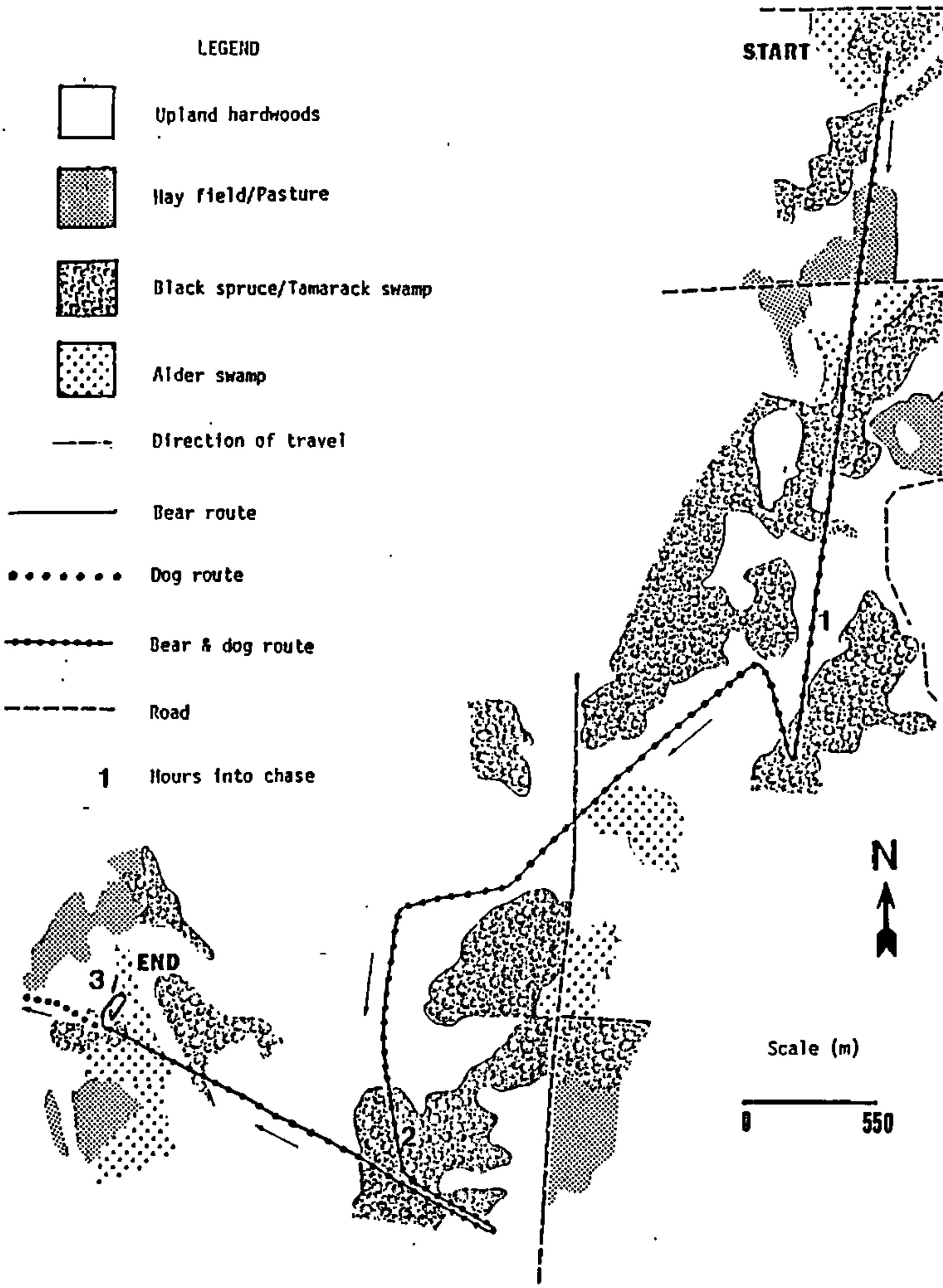


Fig. 1. First experimental chase of yearling Male-A, 16 August 1981, Price County, Wisconsin.

2). The chase proceeded northwards, with occasional east-west movements, during which time the bear swam a lake and a cranberry (Vaccinium spp.) marsh; 4 dogs also swam the lake, and 3 the cranberry marsh. Two hours into the chase, the bear entered his normal home range where he circled in a conifer swamp; he failed to elude the dogs with this maneuver and continued northward. He would outdistance the dogs with a burst of speed and then slow down until the dogs caught up, at which time he would proceed with another burst of speed. This pattern continued until the dogs were withdrawn after 5 hours. The bear never treed nor came to bay during the chase. His rate of travel ranged from 0.2 to 15.3 km/hr ($\bar{X}$=5.1) and he traveled a distance of 25.8 km (Table 1). He was within his normal home range at the end of the chase where he remained and denned that year. One dog died 4 hours into the chase. It bore no wounds and probably died from exhaustion.

Solitary Female

The chase of adult Female-B was started after she was seen crossing a road; the dogs readily picked up her scent where she had entered an upland hardwood stand. She headed southeast into an alder swamp, changed directions abrubtly, and headed in a southwest direction where she eluded the dogs 45 minutes into the chase after entering a stand of upland hardwoods surrounded by the alder swamp; the dog pack

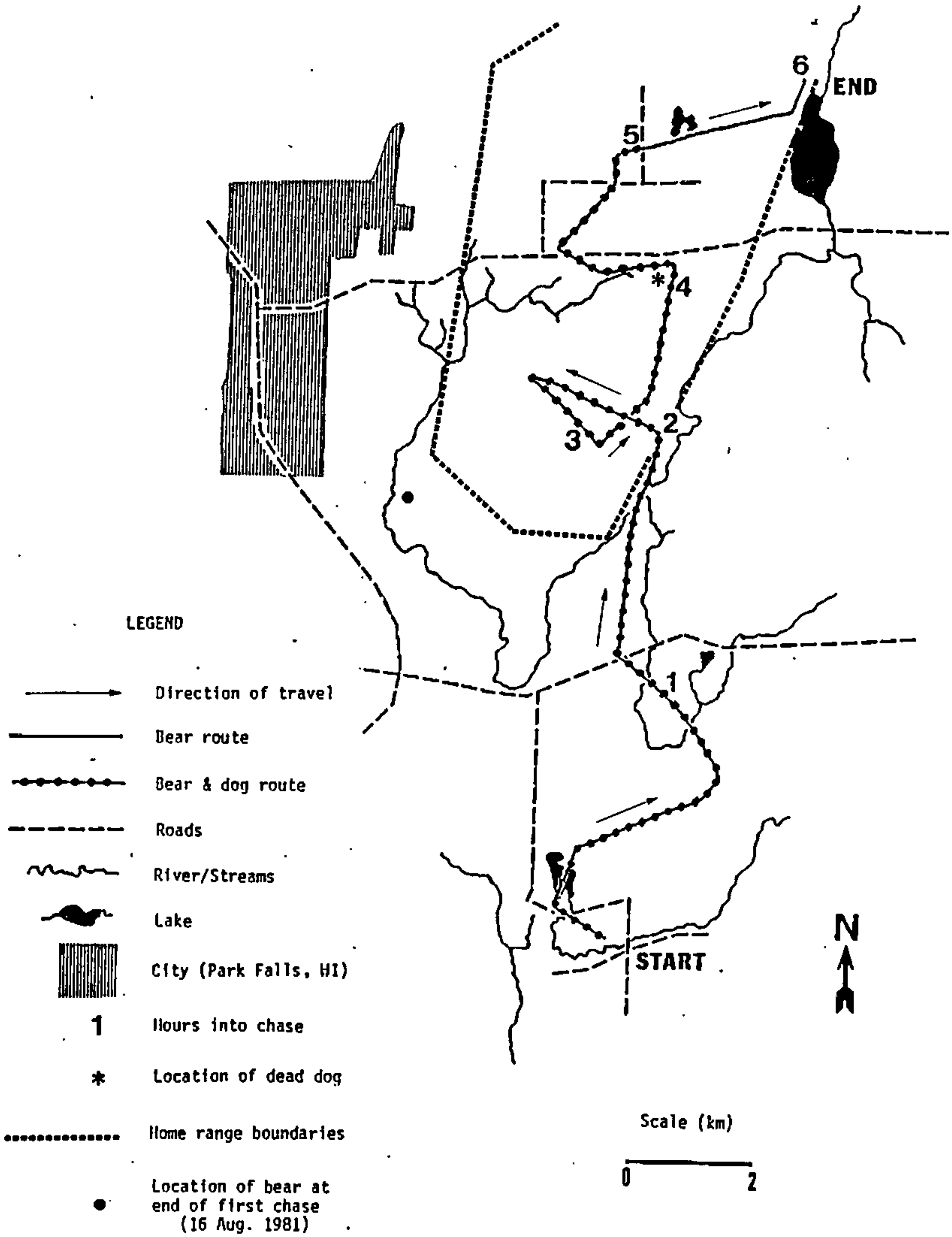


Fig. 2. Second experimental chase of yearling Male-A, 17 August 1981, Price County, Wisconsin.

split after losing the bear's scent trail (Fig. 3). The bear turned north, moving between an upland hardwood stand and alder swamp. She then moved north and circled near a road where the volume of traffic presumably kept her from immediately crossing. Several dogs were released at that point but they failed to chase her from the edge of the road; 1 dog was lying down within 100 m of the bear's location and failed to pick up her scent. The bear finally crossed the road and the dog pack was again started on her scent trail. She traveled east and circled in another alder swamp; failing to elude the dogs, she headed north and entered another alder swamp where she escaped them. This bear traveled 13.2 km at a mean rate of 3.2 km/hr (range: 0.4-9.2), and never treed nor came to bay at any time. Her rate of travel was faster during the second segment of the chase, ranging from 3.4 to 9.2 km/hr; this is reasonable because the dogs remained on her scent-trail longer than during the initial part of the chase. She was within her home range when the chase concluded and remained there until she was harvested by hunters using dogs in September 1981 during the bear hunting season.

Adult Males

Adult Male-C was chased on 2 seperate days. The 1st chase resulted in the dogs following his back-trail to the southwest; he moved to the east but was not running fast,

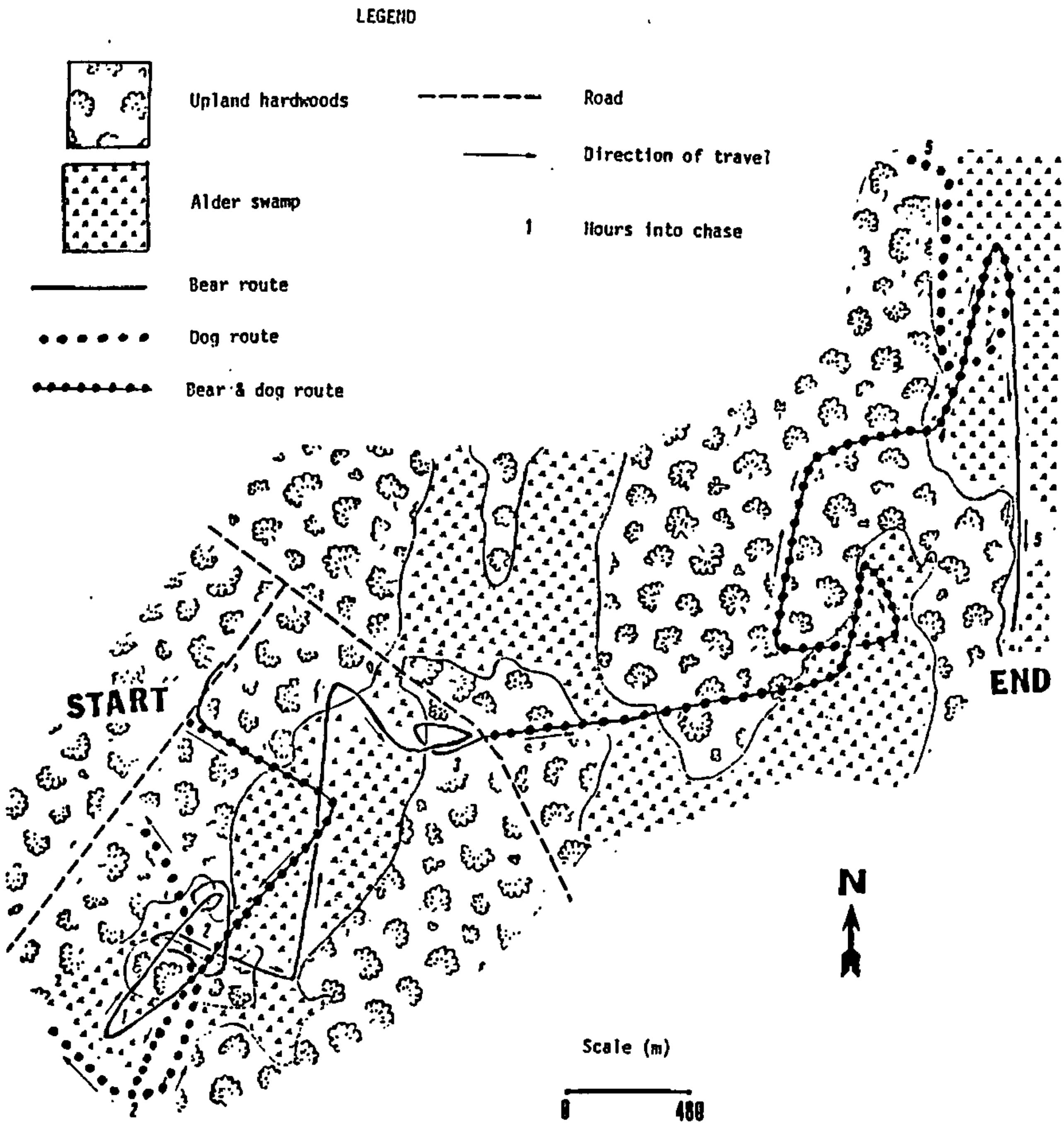


Fig. 3. Experimental chase of solitary, adult Female-B, 1 August 1981, Sawyer County, Wisconsin.

probably because the dogs were moving away from him at that time (Fig. 4). He had traveled 1.3 km at an average rate of 0.8 km/hr (range: 0.2-1.9) (Table 1). His fastest rate of travel (1.9 km/hr) occurred while he was moving through the alder swamp. This bear never treed and was in his home range when monitoring concluded.

This same bear was chased 8 days later. The dogs readily scented the bear and began chasing him to the northwest (Fig. 5). He circled in an upland hardwood stand and headed south towards the closest conifer swamp. The dogs lost the bear 1 hour into the chase at the edge between an upland hardwood stand and conifer-alder swamps (hereafter: "edge area"). The bear headed east and south at rates of travel ranging from 0.3 to 10.5 km/hr; he traveled fastest (10.5 km/hr) during this time when the dogs were not on his trail. He continued east and became stationary in a conifer swamp 4 hours after the beginning of the chase. The chase was started again after the bear zig-zagged between a conifer swamp and an upland hardwood stand trying to elude the research team with radio-receiver and dogs. He displayed a burst of speed (8.1-9.9 km/hr) when the dogs picked up his scent trail and headed back on the same general route that he had traversed earlier. There were 2 common areas that he used on the return chase; the first (6 hours into the chase) was upland hardwoods along the edge of a clearcut, and the second was the edge area where he had

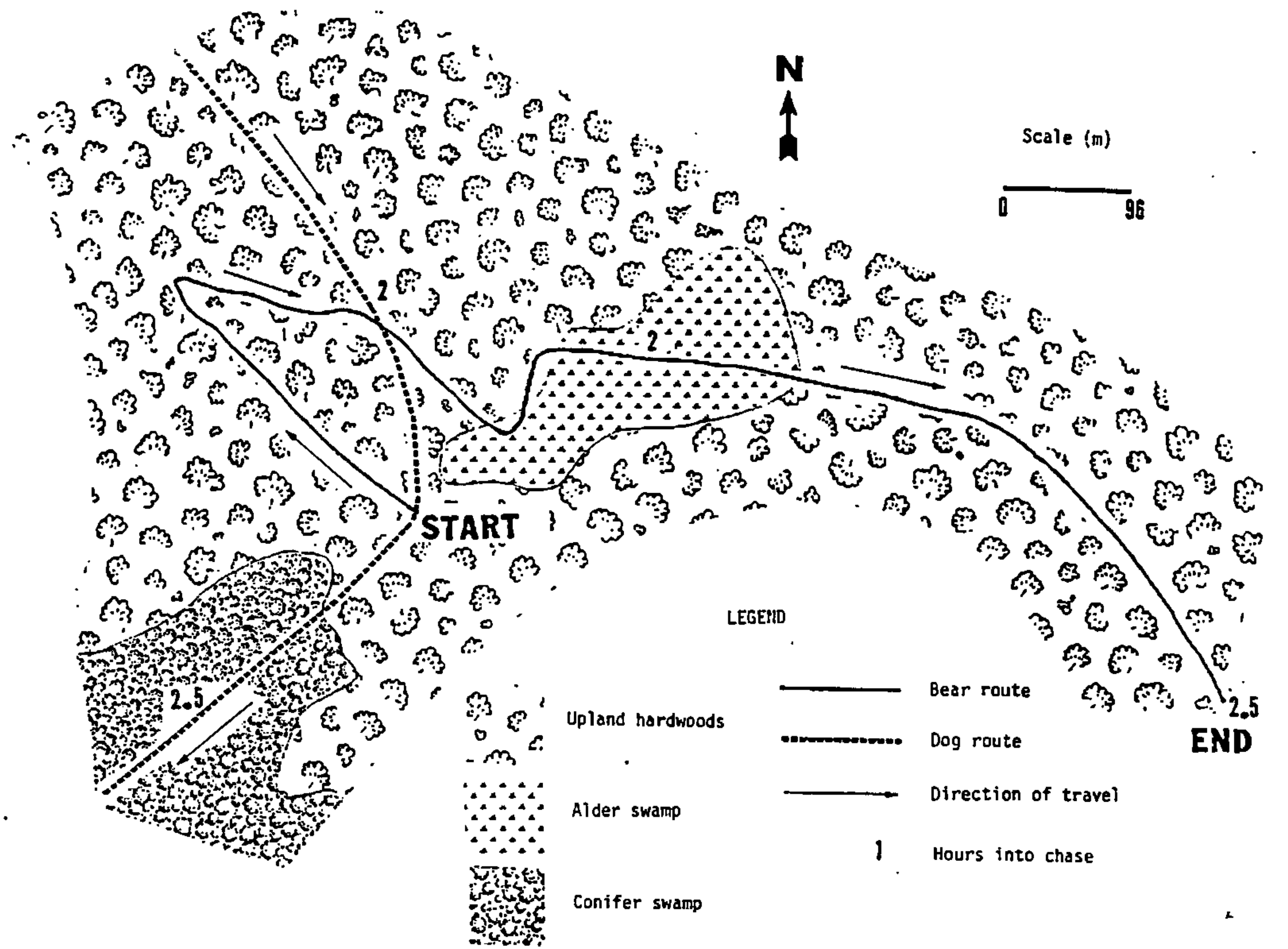


Fig. 4. First experimental chase of adult Male-C, 7 August 1982, Sawyer County, Wisconsin.

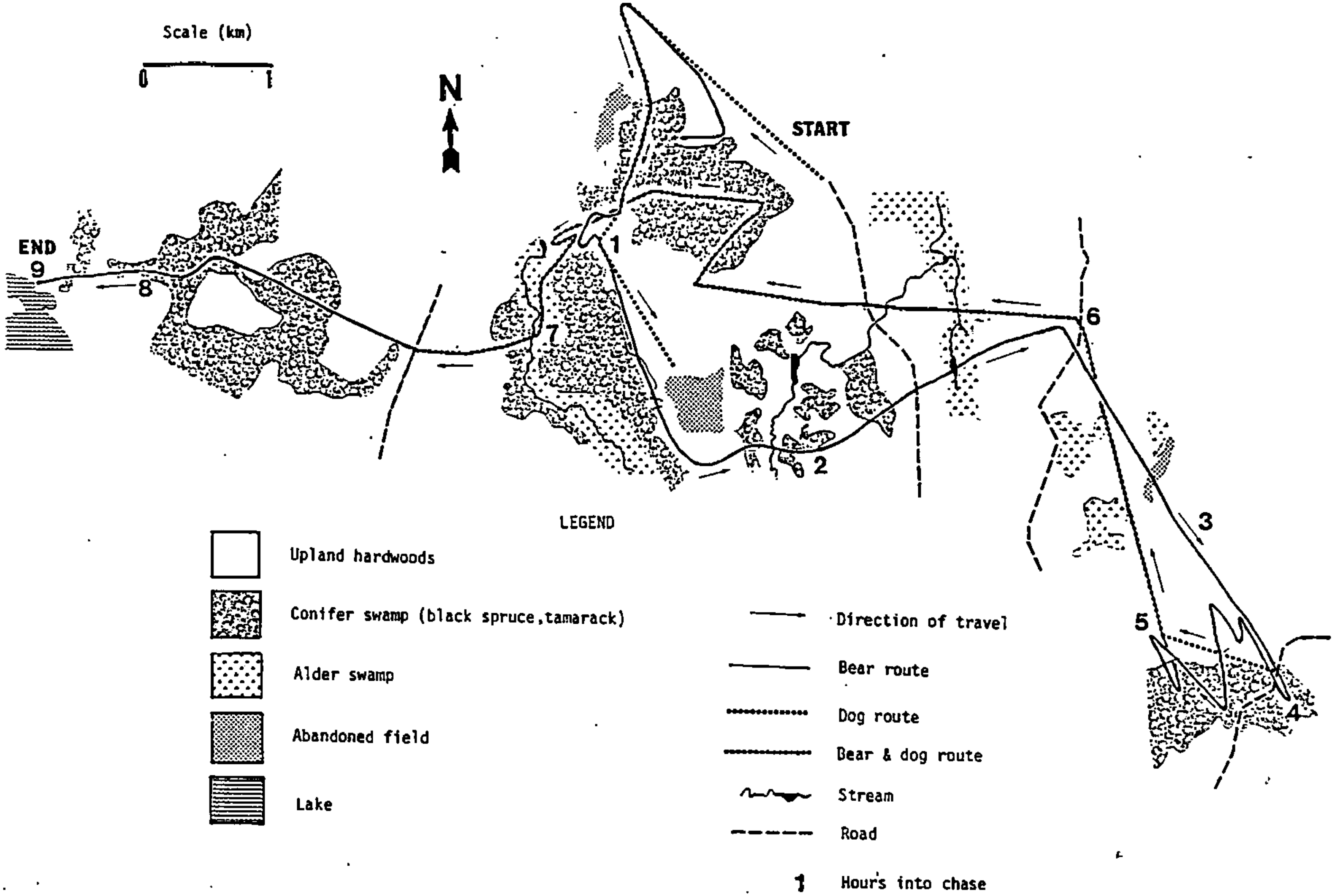


Fig. 5. Second experimental chase of adult Male-C, 15 August 1982, Sawyer County, Wisconsin.

eluded the dogs during the 1st segment of the chase. The bear doubled back once again in the edge area but failed to elude the dogs; the chase was concluded when the dogs reached a road. His rate of travel averaged 5.3 km/hr (range: 0.3-10.5) and he traveled a distance of 29.2 km (Table 1). He never treed during the chase and was in his home range when monitoring concluded. Subsequent monitoring showed that he remained, and denned in his home range.

Monitoring the chase of adult Male-D was somewhat unsuccessful because he entered a 104 $km^2$ area without navigable roads after the chase began. This bear initially entered a hardwood swamp and, failing to elude the dogs, rapidly (9.8-12.0 km/hr) traveled through a sugar maple stand and into an aspen stand where his signal was lost after 1 hour (Fig. 6). He had traveled 4.4 km at a mean rate of 7.5 km/hr (range: 1.5-12.0) before the signal was lost (Table 1). We suspect that this bear treed; however, the dog handlers were not able to reach the dogs in time to verify this. This bear also remained, and denned in his original home range.

### Female With Cubs

Female-E and her 3 cubs were chased twice. She was located in a aspen stand on the 1st day, remained there while the dogs were being led towards her, and fought with them when they arrived (Fig. 7). The fight lasted 10

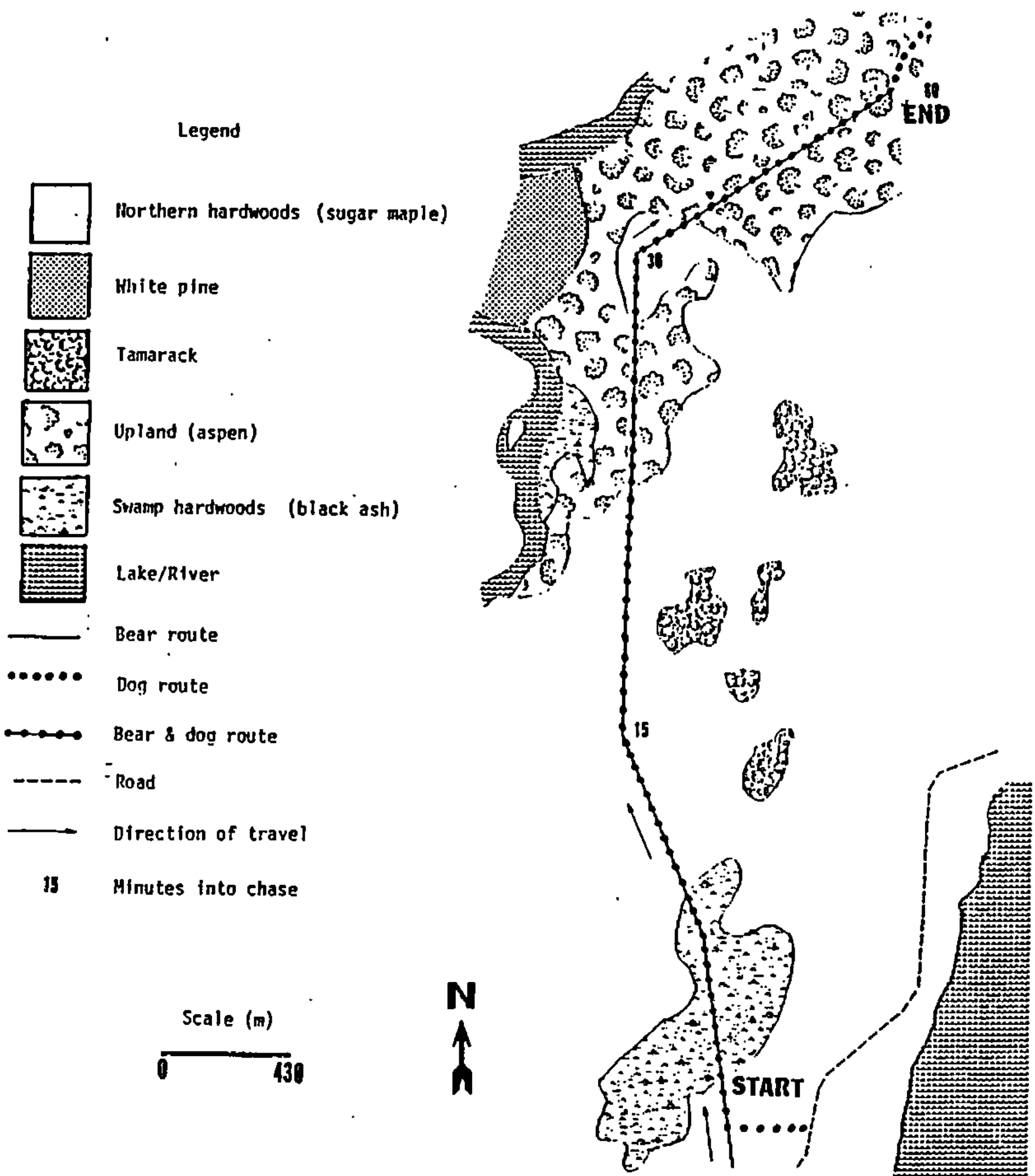


Fig. 6. Experimental chase of adult Male-D, 24 July 1982, Sawyer County, Wisconsin.

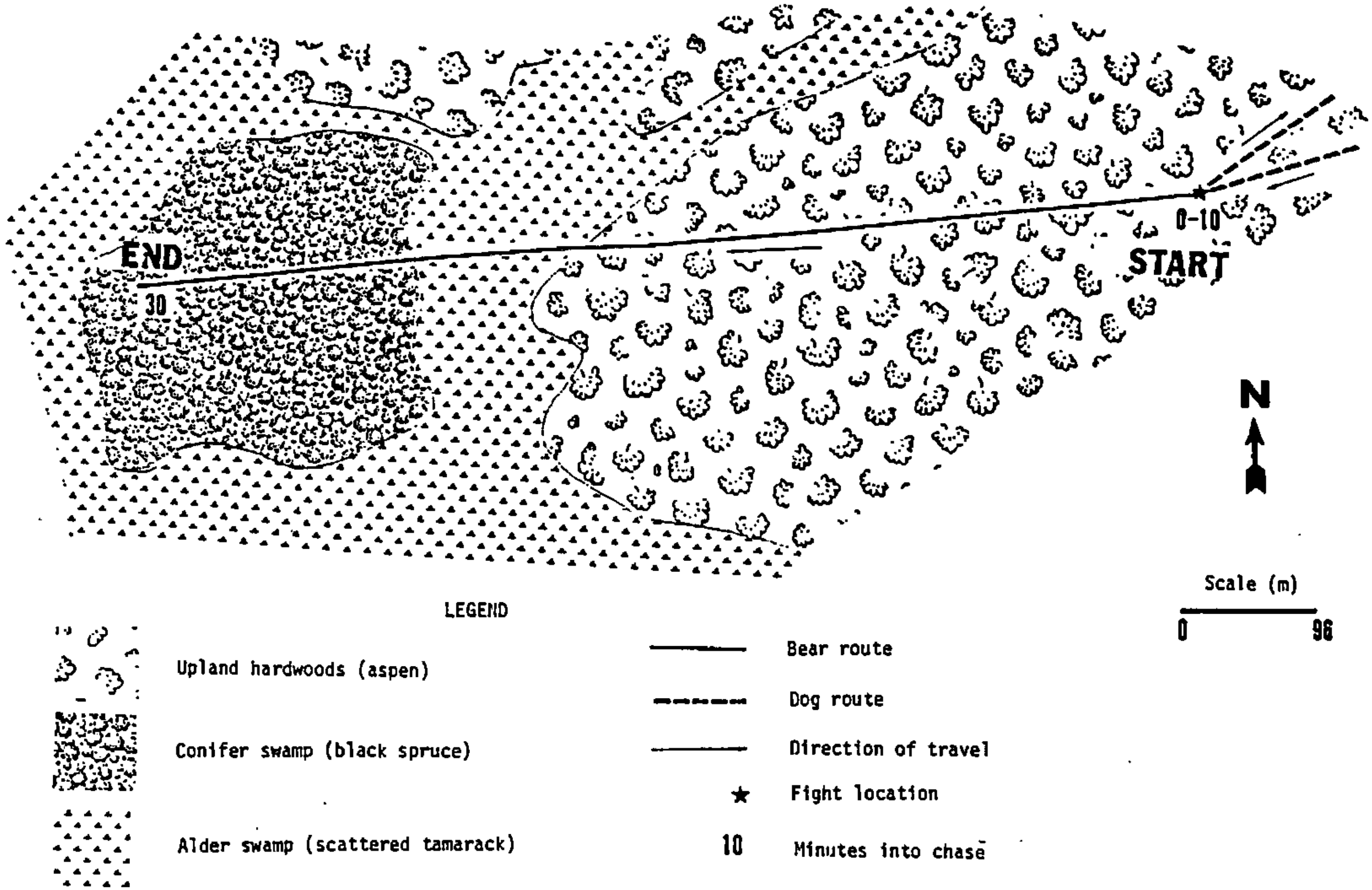


Fig. 7. First experimental chase of Female-E and her 3 cubs, 24 July 1982, Sawyer County, Wisconsin.

minutes after which the dogs were removed from the fight because she was wounding them. She traveled 1.2 km to a conifer stand west of the fight location at an average rate of 7.9 km/hr (range: 1.8-15.3) (Table 1), after the dogs were removed. One dog required medical attention to canine wounds on its back and legs.

This same female and her cubs were chased 15 days later. The dog pack had no difficulty picking up a scent trail but they separated after about 45 minutes into the chase (Fig. 8). There are 3 plausible reasons for this: (1) the cubs were separated from their mother and the dogs were following individual cubs, (2) the dogs were following the bear's back trail from before the start of the chase, or (3) the dogs were chasing another nonradio-tagged bear that was in the area. The mother circled in a grass-forb field while the dogs were chasing to the east, which lends credence to reason-1. The dogs rejoined the female 2 hours into the chase and brought her to bay in the field. Whether the cubs had rejoined the mother, or the dogs finally found her scent is unknown. The dogs fought with her and were finally removed because the handlers feared injury to their dogs. She traveled south after the dogs were removed, and then moved back into the field when the dogs were gone. The cubs were never seen during any part of the chase. The female had traveled 4.2 km at an average rate of 1.8 km/hr (range: 0.3-4.3) during the chase (Table 1). This female

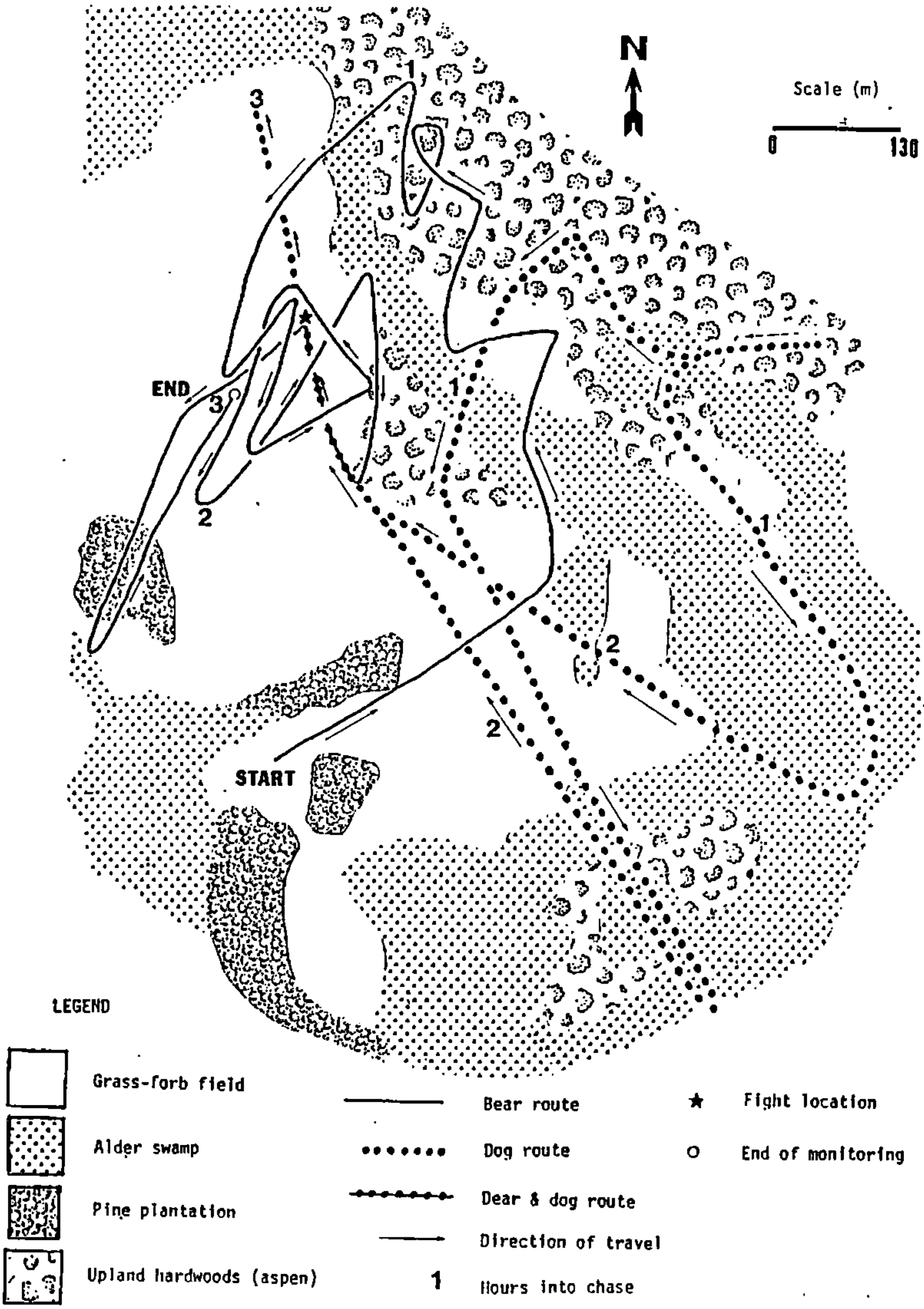


Fig. 8. Second experimental chase of Female-E and her 3 cubs, 8 August 1982, Sawyer County, Wisconsin.

and her cubs remained and denned in their home range; all were in good physical condition as indicated by weight and lack of injuries when examined in their den the following March.

## Escape Behavior

The commonest escape pattern of bears during a chase, was to outdistance the dogs with a burst of speed when they were close and then travel at a slower rate until the dogs approached closer. The exception to this pattern occurred with Female-E and her 3 cubs. She did not run from the dogs during the 1st chase; she waited for the dogs, fought them, and then rapidly traveled to a nearby conifer swamp after the dogs were removed from the fight (Fig. 7).

A portion of the escape route of every bear was through either an alder, conifer, or hardwood swamp. A common escape behavior of the bears was to circle or back-track in the swamps (Fig. 1,2,3,5). The water in these swamps appeared to make tracking difficult for the dogs. Lakes, streams, and rivers were no obstacle to bears or dogs (Fig. 2,5). Similar escape behavior has been documented for other black bears (Hamilton 1978), and white-tailed deer (Sweeny et al. 1971) when they were chased by dogs.

Post-chase Movements

The bears did not slow down immediately after the dogs were removed from the chases. Post-chase movements were determined for 7 of 8 chases. The fastest average rate of travel for all the chases (7.9 km/hr) was executed by Female-E, with 3 cubs, after the dogs were removed from the scene of the fight. However, after her 2nd chase, she moved at rates of only 2.5 to 3.8 km/hr for 35 minutes before becoming stationary. Solitary Female-B decreased her rate of travel from 9.2 to 0.5 km/hr approximately 3 hours after entering the alder swamp where she had eluded the dogs. During his second chase, adult Male-C traveled at rates from 2.9 to 10.0 km/hr for 2 hours after the dogs were removed from his scent trail; he had a slower rate of travel during his first chase (0.2-1.9 km/hr) because the dogs were on his back trail. Yearling Male-A was 1 km southwest of his home range when his first chase ended; the next day he was 6.2 km south of his home range. He decreased his rate of travel from 7.3 to 2.7 km/hr during the 1-hour period following his 2nd chase.

CONCLUSIONS

1. Most bears remain in their home ranges during and after the chase.

2. Bears are not physically affected by chases as indicated by their physical condition (weight and lack of injuries) when inspected in their dens about 7 months after the chases.

3. When chased, bears outdistanced the dogs with bursts of speed and then slowed down until the dogs got closer; this pattern was repeated until they escaped, or the dogs were removed from the chase. The bears continued to move after the dogs were removed from the chase.

4. Alder, conifer, or hardwood swamps were common escape habitats. Part of all the chases traversed these habitat types. Standing water may have made it difficult for dogs to follow the scent trail. Bears increased their speed when in upland hardwood stands. The proximity of the dog-pack to the bears varied with each chase and was difficult to accurately determine because the dogs were usually widely spaced behind the bear.

5. Circling, back tracking, and zig-zagging in the swamps were common escape tactics used by the bears. A female with 3 cubs was the only bear that was known to have fought with the dogs during these chases. No bears were known to have treed during any chase. The dogs occassionally started a chase on a bear's back-trail and in 1 such instance never recovered the "hot" scent trail.

Black bears do not appear to be adversely affected by being chased with trained dogs. The variables of hunter motivation, skill with firearms, and knowledge of the terrain are factors that would influence the number of bears that could have been harvested during the above chases.

LITERATURE CITED

Conley, R. H. 1974. Methods of harvesting black bear in the southern Appalachian Mountains of Tennessee. Proc. East. Black Bear Workshop 2:195-206.

Curtis, J. T. 1959. The vegetation of Wisconsin. Univ. Wisconsin Press, Madison. 657pp.

Erickson, A. W. 1957. Techniques for live-trapping and handling black bears. Trans. North Am. Wildl. Conf. 22:520-543.

Hamilton, R. J. 1978. Ecology of the black bear in southeastern North Carolina. M. S. Thesis. Univ. Georgia, Athens. 213pp.

Hardy, D. M. 1974. Habitat requirements of the black bear in Dane County, North Carolina. M. S. Thesis. Virginia Polytechnic Inst. State Univ., Blacksburg. 121pp.

Harger, E. M. 1978. Hunting methods and their effect on the black bear population. Proc. East. Black Bear Workshop 2:200-206.

Hole, F. D. 1976. Soils of Wisconsin. Univ. Wisconsin Press, Madison. 233pp.

Kohn, B. E. 1982. Status and management of black bears in Wisconsin. Wisconsin Dep. Nat. Resour. Tech. Bull. No. 129. 31pp.

Massopust, J. L., and R. K. Anderson. 1984. Homing tendencies of translocated black bears in northern Wisconsin. Proc. East. Workshop Black Bear Manage. and Res. 7:(In press).

Mohr, C. O. 1947. Table of equivalent populations of North American small mammals. Am. Midl. Nat. 37:223-249.

Parsons, L. D., and R. J. Poelker. 1975. A comparison of the 1975 spring bear hunt in western Washington with 1970-1974 data. Washington State Game Dep., Olympia. 51pp.

Poelker, R. J., and H. D. Hartwell. 1973. Black bear of Washington. Washington State Game Dep., Olympia, 180pp.

Sweeny, J. R., R. L. Marchinton, and J. M. Sweeny. 1971. Responses of radio-monitored white-tailed deer chased by hunting dogs. J. Wildl. Manage. 35:707-716.

Willey, C. H. 1972. Vulnerability of bears to hunting. Pages 24-27 in R. L. Miller, ed. Proceedings of the 1972 black bear conference. New York State Dep. Environ. Conserv. Delmar, N. Y.

# REPRODUCTIVE BIOLOGY AND DENNING BEHAVIOR OF BLACK BEARS IN NORTHERN WISCONSIN

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Abstract: The productivity of 8 female black bears (Ursus americanus), den entrance dates of 6 bears (3 females, 3 males), and den site characteristics of 21 dens (9 females, 5 males) were determined during 1982-84 in northern Wisconsin. The mean weight of females with cubs or yearlings was 79.9 kg (range: 68.0-93.0). The weights of 28 cubs averaged 2.1 kg (range: 1.2-3.3) during the time period of 1 to 24 March; yearling weights averaged 22.1 kg (range: 16.8-29.5). The mean age of reproducing females was 6.3 years (range: 2.5-10.5). The average litter size was 3.0 cubs (range: 2-4) and the cub sex ratio was slightly unbalanced towards males (1 female: 1.2 male). The approximate den entrance dates for all bears was between 10 and 25 October. Twelve dens were partially excavated holes under the root mass of windblown trees, 4 in excavated holes, 2 at ground level under brush piles, 1 in a hollow tree, 1 partially exposed den under tag alder (Alnus rugosa) roots, and 1 totally exposed bowl-shaped nest in an alder swamp. There was no difference ($P>0.10$) in

slopes of den sites between males ($\bar{X}$=1.9°; range: 0-5) and females ($\bar{X}$=3.0°; range: 0-10). One adult male had 2 den entrances. Five den entrances faced north (315-360° or 0-045°), 2 east (045-135°), 4 south (135-225°), and 9 west (225-315°). There was no difference (P>0.10) in mean den entrance aspect between males ($\bar{X}$=225°; range: 026-331 ) and females ($\bar{X}$=188°; range: 006-358 ). There was no difference (P>0.10) in entrance size between males ($\bar{X}$=0.49 $m^2$; range: 0.14-0.95) and females ($\bar{X}$=0.71 $m^2$; range: 0.26-2.70). The mean chamber volume for females and males was identical (0.93 $m^3$) with chamber volumes ranging from 0.28 to 2.21 $m^3$ and 0.27 to 1.80 $m^3$ for females and males, respectivily. Males had a significantly greater (P<0.05) amount of nest material ($\bar{X}$=17.9 liters; range: 3-65) than females ($\bar{X}$=8.5 liters; range: 0.5-40.0).

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Information on the reproductive rates and denning requirements of the black bear are important data for management decisions. Although Wisconsin has data on summer litter sizes (Schorger 1949, Kohn 1982), little is known about den reproductive rates, denning weights of females and cubs, and den site characteristics. Reproduction and den requirements vary considerably with regions (Harlow 1961, Stickley 1961, Erickson et al. 1964, Jonkel and Cowan 1971, Collins 1973, Poelker and Hartwell 1973, Piekielek and Burton 1975, Lindzey 1976, Rogers 1976, Reynolds 1977, Alt 1982). Den sites need to provide protection because parturition takes place during hibernation when bears are in a unique physiologic state and are independent of food, water, defecation, and urination (Folk 1980). Therefore, den sites could become a limiting factor to a black bear population if habitat deterioration or loss reduces the availability of suitable denning sites. However, reports from previous studies indicate that den requirements are of little significance to survival because of the variability in den sites chosen by bears (Lindzey and Meslow 1976, Johnson and Pelton 1981). Knowledge of bear behavior, movements, and den entry dates can also be useful in altering the age and sex composition of bear harvests (Lindzey 1981).

The objectives of this study were to determine the productivity, den entry dates, and den site characteristics of black bears in Wisconsin. The study was funded by the University of Wisconsin-Stevens Point (UWSP), the Wisconsin Department of Natural Resources (WDNR), Wisconsin Bear Hunters Association, and the National Rifle Association. Thanks are due to J. Koch for providing his trapping and drugging expertise, J. Wilson for teaching us the art of

foot snaring, B. Kohn for his advice and use of equipment, and UWSP students who helped with field work and data analysis.

STUDY AREA

Black bears dens were investigated in Ashland, Bayfield, Iron, Marathon, Price, Sawyer, and Taylor counties of northern Wisconsin. Most (71.1%) of the 2.16 million ha study area is forested (commerical timber production, productive reserved, and unproductive status); non-forest lands are cropland, pasture, marsh, wooded pasture, industrial and urban areas (Wis. Dep. Nat. Resour., unpubl. data).

The area is dominated by Northern Mesic Forest with scattered small units of Boreal Forest, and conifer swamp (Curtis 1959). Major tree species of the Northern Mesic Forest include sugar maple (Acer saccharum), red maple (Acer rubrum), white birch (Betula papyrifera), oak (Quercus spp.), Americam elm (Ulmus americana), cherry (Prunus spp.), basswood (Tilia americana), aspen (Populus spp.), balsam fir (Abies balsamea), and eastern hemlock (Tsuga canadensis) (Curtis 1959). The mean annual precipitation is 81-86 cm with an average seasonal snowfall of 178-203 cm. The area is composed of end and ground moraine, and glacier-formed lake basins. Major soils of the region are

Iron River, Gogebic, and Kennan series (Hole 1976).

METHODS

Black bears were trapped with culvert traps (Erickson 1957), barrel traps (Kohn 1982), and Aldrich foot snares (Johnson and Pelton 1980) in cooperation with the WDNR nuisance bear program. They were immobilized, fitted with radio collars (150-51 MHz), sexed, weighed, measured, ear-tagged, had their first premolar removed for aging, and translocated to public lands (Massopust and Anderson 1984). Tooth sectioning and aging were done at UWSP, using cementum annuli counts. Bears were divided into 4 age classes; cubs (<1 year), yearlings (>1 to 2 years), subadults (>2 to 3 years), and adults (>3 years).

Den entrance dates are defined as the median day between the last autumn location and the beginning of stationary locations indicating the bears had denned (O'Pezio et al. 1983). The reduced range of the signal from the transmitters and repeated locations in the same place were used to determine when the bears were in their dens.

Bears were immobilized in their dens in early March 1982-84 with ketamine hydrochloride (KHC), using a doseage of 1cc KHC/9.1 kg of body weight; cubs were handled without being tranqualized. Drug was administered with a pole syringe (Kohn 1982),or a Cap-Chur pistol (Palmer Chemical and

Equipment Co., Douglasville, Ga.). Adult bears were taken from their dens, weighed, retagged if ear-tags were missing, measured for body temperature with a rectal thermometer, and refitted with radio collars (1982 and 1984) or divested of them (1983); numbers, sex, rectal temperatures, weights of cubs and yearlings were obtained, and the quantity of nest material was visually estimated. Measurements of the den were taken. Bears were then placed inside and the den was covered with brush and snow to approximate the original undisturbed condition. Slopes of den sites were measured with a clinometer or visually estimated. The Students T-test was used to analyze differences in den dimensions, bear weights, and cub sex ratios.

## RESULTS AND DISCUSSION

### Productivity

The mean den weight of females with cubs or yearlings was 79.9 kg (range: 68.0-93.0, N=10) in early March (Table 1). Although pre-denning weights were not determined in this study, the female denning weights were above the minimal limit for successful reproduction in Minnesota (3.5 years or older, weight > 67 kg on 1 October) (Rogers 1976). We have near den entrance weight of but 1 female (No. 1); she weighed 136.1 kg when captured on 25 September 1981 and 86.2 kg in the den on 13 March 1982, a

Table 1. Productivity data of black bears in Wisconsin, 1982-84.

| Bear | March den weight (kg) | Age (years) | Litter size | Cub sex ratio (F:M) | Cub weights (kg) | Yearling weights (kg) |
|---|---|---|---|---|---|---|
| 1 | 86.2 | 6.5 | 3 | 2:1 | M =2.2<br>F =1.7<br>F =1.6 | |
| 1 | 71.2 | 7.5 | 3 | 2:1 | | M =22.7<br>F =19.5<br>F =16.8 |
| 2 | 68.0 | 2.5 | 2 | 1:1 | M =2.1<br>F =1.9 | |
| 3 | 90.7 | 9.5 | 3 | 0:3 | M =2.3<br>M =2.6<br>M =2.5 | |
| 4 | 70.3 | 4.5 | 3 | 2:1 | M =2.4<br>F =2.5<br>F =2.5 | |
| 4[a] | 83.0 | 6.5 | 4 | 1:1 | M =2.0<br>M =2.3<br>F =1.6<br>F =1.5 | |
| 5 | 74.8 | 4.5 | 3 | 2:1 | M =2.2<br>F =1.2<br>F =2.3 | |
| 6 | ? | 6.5 | 2[b] | ? | ? | |
| 6 | ? | 7.5 | 1 | 0:1 | | M =29.5 |
| 6 | 88.9 | 8.5 | 4 | 1:3 | M =2.0<br>M =2.0<br>M =1.6<br>F =1.4 | |
| 7 | 72.6 | 5.5 | 2 | 1:1 | M =2.8<br>F =2.5 | |
| 8 | 93.0 | 10.5 | 4 | 1:1 | M =2.1<br>M =3.3<br>F =2.1<br>F =2.6 | |
| $\bar{X}$ | 79.9 | 6.3[c] | 3 | 1:1.2 | M =2.3<br>F =2.0 | M =26.1<br>F =18.2 |

[a] Female-4 was out of her den when checked on 9 March 1983; no data were collected that year.

[b] Female-6 was denned inside a hollow American elm tree and had at least 2 cubs during 1982.

[c] Average age was calculated using the ages of females at the time they were first checked in their dens.

37% loss. The combined weights of her 3 cubs was 7.12 kg on 13 March 1982.

Translocation may have precluded reproduction of Female-8 (age: 3.5 years, weight: 56.7 kg, and in breeding condition at the time of capture). She remained within 18.5 km of her translocation site (80.1 km from the capture site) from 8 June 1981 to 13 July 1981. She was next located on 9 October 1981, 13.7 km south of her original capture site; by 1 November 1981 she was denned within her home range. She weighed 61.2 kg in the den on 20 March 1982. It is possible that she was unable to fully exploit the food resources at her translocation site or while returning, and this kept her weight below that necessary for successful reproduction.

The weights of all cubs averaged 2.1 kg (range: 1.2-3.3) from 1 to 24 March. The mean weights of males (2.3 kg) were heavier ($P<0.05$) than females (2.0 kg). Yearling weights averaged 22.1 kg (range: 16.8-29.5, N=4); male yearlings ($\bar{X}$=26.1 kg) were heavier ($P<0.10$) than females ($\bar{X}$=18.2 kg). The mean weight of cubs was close to that reported in Minnesota ($\bar{X}$=2.2 kg; Rogers 1976), less than that (3.1 kg) in Pennslyvania (Alt 1980), and heavier than that (1.64 kg) reported by Hugie (1982) in Maine.

One subadult female (No. 2, 2.5 years) produced cubs. Reported minimum breeding age of bears varies from 2.5 years in Pennslyvania (38% of this cohort; Kordek and Lindzey 1980) and Wisconsin (N=1; Kohn 1982), to 4.5 years in Montana where females did not produce a successful litter until age 6.5 even though some were in estrus at 4.5 years (Jonkel and Cowan 1971).

The mean natal den litter size was 3.0 cubs (range: 2-4). Reported litter sizes vary with the geographical location and range from 1.67 cubs/litter in California to 2.9 cubs/litter in Pennslyvania (Table 2). Schorger (1949) and Kohn (1982) both report average litter sizes of 2.4 cubs for Wisconsin. Over-summer mortality rate of 18 cubs in this study was 5.6%, i.e., 1 cub was not with its mother during the second den season. Hugie (1982) suggests a cub mortality rate of 8% as determined from comparison of corpora lutea with observations 6-8 months after birth in Maine.

Sex ratio of cubs was slightly unbalanced towards males (1 female: 1.2 male) but did not differ statistically ($P>0.10$). This is slightly different than the reported sex ratios of 1:1 from Montana (Jonkel and Cowan 1971), Michigan (Erickson and Petrides 1964), Virginia (Du Brock 1980), and North Carolina (Collins 1973). Rogers (1977) also reported a cub sex ratio of 1:1.2 in favor of males. Knudsen (1961) reports a trapping record sex ratio of 1:1 for combined age-classes of Wisconsin bears in 1959 and 1960, but unbalanced towards males in 1958. Kohn (1982) reported a sex ratio of 1:1.3 favoring males in the total Wisconsin

Table 2. Comparison of average black bear litter sizes throughout the United States.

| Reference | Geographical location | Litter size | Method of determining litter size |
|---|---|---|---|
| Piekielek and Burton (1975) | California | 1.67 | Capture and field observations |
| Jonkel and Cowan (1971) | Montana | 1.7 | Capture and field observations |
| Poelker and Hartwell (1973) | Washington | 1.9 | Corpora lutea counts |
| Reynolds (1977) | Idaho | 1.9 | Unknown |
| Schwartz et al. (1983) | Alaska | 1.9 | Natal den examination |
| Hugie (1983) | Maine | 2.09[a] | Field observations and reproductive tracts |
| Beeman (1975) | Tennessee and N. Carolina[b] | 2.1 | Capture and field observations |
| Erickson et al. (1964) | Michigan | 2.15 | Capture and field observations |
| Collins (1973) | N. Carolina | 2.17 | Corpora lutea counts |
| Harlow (1961) | Florida | 2.2 | Capture and field observations |
| Kohn (1982) | Wisconsin | 2.4 | Capture and field observations |
| Schorger (1949) | Wisconsin | 2.4 | Newspaper articles |
| Du Brock (1980) | Virginia | 2.5 | Field observations |
| Stickley (1961) | Virginia | 2.6 | Corpora albicantia counts |
| Rogers (1976) | Minnesota | 2.7 | Natal den examination |
| Alt (1982) | Pennsylvania | 2.9 | Natal den examination |
| Massopust (This study) | Wisconsin | 3.0 | Natal den examination |

[a] Statewide average.

[b] Great Smoky Mountains National Park.

bear harvest, and a female to male sex ratio of 1:0.9 for bears > 4 years old.

Den Entrance Dates

Approximate den entrance dates were calculated for 3 adult solitary females (2 were pregnant), 2 adult males, and 1 yearling male during 1981. The number of days between the last fall location and the date the bears were determined to have denned ranged from 3 to 23 days. The median den entrance dates for all bears was between 10 and 25 October. Monitoring concluded on 1 November 1981 when all, except 1 adult male that was 4 km from his ultimate hibernation site, were denned. The median den entrance date for adult Males-11 and -12 was 25 October (range: 22 < 27 October), and 17 October (range: 12 < 22 October), respectively. Adult Female-1 denned between 7 and 27 October (median entrance date: 17 October). All dens were on the periphery of respective home ranges.

Denning-related movements and behavior of other bears was unusual. Yearling Male-13 denned between 9 and 12 October (median: 11 October) where he remained until 1 November when monitoring concluded; in March 1982, he was in a different den 2.8 km to the east. We suspect that he was disturbed from his original den by white-tailed deer (Odecoileus virginianus) hunters in late November.

Adult Female-8 spent a minimum of 35 days (8 June 1981 to 13 July 1981) in the vicinity of her translocation release site, 80.1 km from point of capture. On 9 October she was 13.7 km from her ultimate den site on the periphery of her original home range. She was denned by 1 November (median den entrance date: 20 October).

Adult Female-6 was located in the same place on 18 and 22 September. We suspected that she had been shot during that bear hunting season but on 23 September flushed her from the upslope side of a den entrance under a white pine (Pinus strobus) stump. The excavation was apparently complete but the chamber was devoid of nest materials. She was 3.7 km south of her first den from 2-7 October and by 12 October she had moved 4.2 km northeast to den in a hollow American elm tree (Ulmus americana).

Den Site Characteristics

Characteristics of 21 dens (9 female and 5 male individuals) were determined in March 1982-84 (Table 3). Dens for 2 females (-1 and -6) and 3 males (-11, -12, -13) were examined for 3 and 2 consecutive years respectively; none were reused.

Twelve dens were partially excavated holes under the root mass of windblown trees, 4 in excavated holes, 2 at ground level under brushpiles, 1 in a hollow tree, 1 partially exposed under alder roots, and 1 a totally

Table 3. Den site characteristics of black bears in Wisconsin, 1982-84.

| Bear | General den location description | Number of entrances | Azimuth of entrance (Degrees) | Entrance | | | Chamber | | | | Nest material (liters) | Slope (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Height (cm) | Width (cm) | Size ($m^2$) | Height (cm) | Width (cm) | Length (cm) | Volume ($m^3$) | | |
| Female | | | | | | | | | | | | |
| 1 | Windblown aspen root mass | 1 | 284 | 65 | 66 | 0.43 | 72 | 82 | 127 | 0.75 | 7 | 3 |
| 1 | Brushpile; red maple clearcut | 1 | 230 | 93 | 290 | 2.70 | 270 | 82 | 100 | 2.21 | 10.5 | 9 |
| 2 | Windblown balsam fir root mass | 1 | 162 | 47 | 56 | 0.26 | 61 | 76 | 100 | 0.46 | 3.5 | 0 |
| 3 | Windblown balsam fir root mass | 1 | 204 | 86 | 81 | 0.70 | 79 | 58 | 71 | 0.33 | 2 | 1 |
| 4 | Excavated hole; aspen sapling area | 1 | 180 | 49 | 62 | 0.30 | 57 | 85 | 150 | 0.73 | 1 | 3 |
| 4 | Windblown white birch root mass | 1 | 358 | 50 | 132 | 0.66 | 75 | 144 | 154 | 1.66 | 17.5 | 0 |
| 5[a] | Windblown oak root mass; alder area | - | - | open | open | - | 87 | 180 | 120 | 1.88 | 9.5 | 0 |
| 6 | Hollow elm tree | 1 | up[b] | 107 | 97 | 1.04 | ? | ? | ? | ? | ? | 0 |
| 6 | Excavated hole under live aspen | 1 | 227 | 65 | 58 | 0.38 | 66 | 69 | 84 | 0.38 | 0.5 | 9 |
| 6 | Windblown balsam fir root mass | 1 | 006 | 47 | 67 | 0.31 | 75 | 119 | 92 | 0.82 | 0.5 | 10 |
| 7 | Exposed den; base of windblown aspen | - | - | open | open | - | 65 | 122 | 97 | 0.77 | 9.5 | 0 |

Table 3. (Continued).

| Bear | General den location description | Number of entrances | Azimuth of entrance (Degrees) | Entrance | | | Chamber | | | | Nest material (liters) | Slope (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Height (cm) | Width (cm) | Size ($m^2$) | Height (cm) | Width (cm) | Length (cm) | Volume ($m^3$) | | |
| Female | | | | | | | | | | | | |
| 8[c] | Bowl-shaped nest; base of standing dead balsam fir | - | - | open | open | - | - | 135 | 109 | - | 40 | 0 |
| 9 | Exposed den under alder root mass | 1 | 043 | 56 | 67 | 0.38 | 58 | 61 | 79 | 0.28 | 1 | 0 |
| $\overline{X}$ | - | 1 | 188 | 67 | 98 | 0.71 | 88 | 101 | 107 | 0.93 | 8.5 | 2.7 |
| Male | | | | | | | | | | | | |
| 10 | Windblown red maple root mass | 1 | 278 | 86 | 110 | 0.95 | 76 | 177 | 134 | 1.80 | 13 | 3.5 |
| 11 | Excavated hole under alder | 1 | 331 | 50 | 60 | 0.30 | 77 | 85 | 103 | 0.67 | 10 | 3 |
| 11 | Windblown balsam fir root mass | 2 | 244 | 80<br>63 | 88<br>140 | 0.70<br>0.88 | 70 | 124 | 158 | 1.37 | 17.5 | 0 |
| 12 | Windblown white birch root mass | 1 | 284 | 49 | 61 | 0.30 | 70 | 127 | 161 | 1.43 | 6 | 0 |
| 12 | Windblown hemlock root mass | 1 | 132 | 61 | 81 | 0.49 | 61 | 102 | 98 | 0.61 | 65 | 1 |
| 13 | Excavated hole; aspen area | 1 | 306 | 56 | 74 | 0.41 | 55 | 97 | 108 | 0.58 | 9 | 0 |
| 13 | Windblown aspen root mass | 1 | 278 | 43 | 60 | 0.26 | 62 | 90 | 120 | 0.67 | 20 | 2 |

Table 3. (Continued).

| Bear | General den location description | Number of entrances | Azimuth of entrance (Degrees) | Entrance Height (cm) | Entrance Width (cm) | Entrance Size (m) | Chamber Height (cm) | Chamber Width (cm) | Chamber Length (cm) | Chamber Volume (m) | Nest material (liters) | Slope (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | | | | | | | | | | | | |
| 14 | Brushpile; cherry sapling area | 1 | 026 | 33 | 43 | 0.14 | 51 | 74 | 71 | 0.27 | 3 | 4 |
| $\bar{X}$ | - | 1.1 | 225 | 58 | 80 | 0.49 | 65 | 110 | 119 | 0.93 | 17.9 | 1.7 |
| All bears | | | | | | | | | | | | |
| $\bar{X}$ | - | 1.06 | 206 | 62 | 89 | 0.61 | 78 | 104 | 112 | 0.93 | 12.3 | 2.3 |

[a] Above ground den in a wet alder/willow swamp.

[b] Den entrance of hollow american elm tree was approximately 10 m above ground level; bears at ground level.

[c] Above ground den in an alder swamp.

exposed bowl-shaped nest in an alder swamp. There was no difference ($P>0.10$) in slopes of den sites between males ($\bar{X}=1.9°$; range: 0-5 ) and females ($\bar{X}=3.0°$; range: 0-10 ).

The den of Female-6 in the hollow tree was unique because of our disturbance causing her to abandon her original ground den. Use of trees for dens has been described for Wisconsin (Schorger 1949), Upper Michigan (Switzenberg 1955), Montana (Jonkel and Cowan 1971), Louisana (Taylor 1971), Tennessee (Conley 1976), Washington (Lindzey and Meslow 1976), North Carolina (Hamilton and Marchington 1980), and the Great Smoky Mountains National Park (Pelton et al. 1980, Johnson and Pelton 1981). Schorger (1949) suggests that more females with cubs may have denned in trees when wolves were plentiful in Wisconsin. Johnson et al. (1978) reported that tree cavities provide a 15.05% energy savings over ground dens and afford protection from harassment by humans and other animals. Energy conservation may be a factor in poor food areas or years; however, exposed dens of pregnant females did not affect productivity in Wisconsin instances. We have randomly looked for large hollow trees that may be adequate for denning while in the field and have found them to be scarce in northern Wisconsin.

Den entrance aspects were not randomly oriented ($\chi^2=5.20$, 3 df, $P<0.05$); 9 faced west (225-315°), 5 north (315-360° or 0-045°), 2 east (045-135°), and 4 south (135-225°).

There was no difference ($P>0.10$) in mean den entrance aspect between males ($\bar{X}=225°$; range: 026-331) and females ($\bar{X}=188$; range: 006-358). Aspect of den entrances did not influence den site selection in Washington (Lindzey and Meslow 1976), Alberta (Tietje and Ruff 1980), and Kenai Penninsula, Alaska (Schwartz et al. 1983). In contrast, Hugie (1982) reported that dens in Maine predominately faced north and east; Novick et al. (1981) reported that most dens faced either south or southeast in southern California. Craighead and Craighead (1972) determined that grizzly bears (Ursus arctos) selected north facing slopes for dens because of the insulative properties of greater snow depth on these slopes. One adult male den had 2 entrances.

There was no difference ($P>0.10$) in entrance size between males ($\bar{X}=0.49$ $m^2$; range: 0.14-0.95) and females ($\bar{X}=0.71$ $m^2$; range: 0.26-2.70). Den entrances of adult males in Alberta were larger than those of other cohorts; adult female den entrances were not significantly larger than subadults or yearling bears (Tietje and Ruff 1980). On Kenai Penninsula, Alaska, den entrances were larger for adult bears than juveniles; however, no difference in entrance size was determined between sexes (Schwartz et al. 1983).

The mean chamber volume for females and males was identical (0.93 $m^3$) and ranged from 0.28 to 2.21 $m^3$ and 0.27 to 1.80 $m^3$ for females and males, respectivily. Subadult

Female-2 and yearling Male-13 had smaller den chambers than adults in this study. Lindzey and Meslow (1976) reported that den chambers of females appeared larger than yearling bears but did not differ statistically ($P>0.05$); they suggest the similarity in chamber size reflects the tendency for bears on Long Island, Washington to reuse dens constructed in previous years. Schwartz et al. (1983) determined that adult den chambers were larger than juveniles on Kenai Penninsula, Alaska; they state that other than physical difference in size, juvenile bears learn how to construct bigger dens with age. Adult males had larger den chambers than other cohorts in Cold Lake, Alberta; larger chambers associated with larger bears may be an adaptation to the cold winters at Cold Lake (Tietje and Ruff 1980). Subadult Female-2 and yearling Male-13 had smaller den chambers than adults in this study.

All dens contained nest material gathered from the immediate vicinity of the den site. Males had a significantly greater ($P<0.05$) amount of nest material in their dens than females. The average quantity of nest material was 17.9 liters (range: 3-65) and 8.5 liters (range: 0.5-40.0) for males and females , respectivily. Nest material was composed of grasses (Graminae), sedges (_Carex_ spp.), leaves, ferns, eastern hemlock twigs, club moss (_Lycopodium obscurum_), blackberry stems (_Rubus_ spp.), and wood chips. The nest material in the den of 1 male contained snowshoe hare (Lepus americana) fur. One female den, near a city limits, contained pieces of snow-fence and stones, apparently thrown into the den by human visitors. The propensity of black bears to line dens with material varies with the geographic regions. In Montana, 10 of 31 (32%) bears had nest material in their dens (Jonkel and Cowan 1971). Erickson (1964) determined that 39% of the bears lined their dens in Michigan. In Maine, 45% of male dens had nest material compared to 97% of the females (Hugie 1982). Tietje and Ruff (1980) reported that 35 of 37 (97%) dens at Cold Lake, Alberta were excavated and that all excavated dens were lined. Similarly, 48 of 49 (98%) dens in Kenai Penninsula, Alaska contained bedding material (Schwartz et al. 1983).

## MANAGEMENT IMPLICATIONS

More information is needed on productivity and cub surviorship through yearling dispersal to better evaluate the effects of the recent bear harvests in Wisconsin (1981: 1243, 1982: 1430, 1983: 934, and 1984: approximately 1150; Wis. Dep. Nat. Resour. unpubl. data). Knowledge of the movements, habitat use, and mortality of dispersing yearling bears could aid significantly in the formulation of new harvest strategies. The mean litter size (3.0) observed in the small sample (N=9) during this study is the largest reported in published literature. The relationship between reproductive rates and forage season food supply, as it relates to general habitat, should be studied in greater detail. Those data, when combined with more definitive information on denning behavior, can aid in establishing hunting regulations that would prevent overharvest of bears in Wisconsin.

Pre-denning diel movements should be determined for all bear cohorts during the foraging period (23 July to 30 September) which includes the hunting season. There is no difference ($P>0.10$) between the size of female ($\bar{X}=11.04$ km$^2$, range: 2.47-23.35) and male ($\bar{X}=8.71$ km$^2$, range: 2.94-18.71) foraging ranges (Massopust and Anderson, In prep.); however, the rate at which males and females traverse their foraging range is not known. This may be an important factor in their vulnerabilty to hunting.

Den sites do not appear to be a limiting factor for bears in Wisconsin. However, hollow trees that are large enough to hold a bear should be preserved. These trees should be identified and marked for preservation prior to timber sales and timber stand improvements because of their scarcity in the young forests of northern Wisconsin.

## LITERATURE CITED

Alt, G. L. 1980. Rate of growth and size of Pennsylvania black bears. Pa. Game News 51:7-17.

________. 1982. Reproductive biology of Pennsylvania's black bear. Pa. Game News 53:9-15.

Collins, J. M. 1973. Some aspects of reproduction and age structures in the black bear in North Carolina. Proc. Southeast. Assoc. of Game and Fish Comm. 27:163-170.

Conley, R. H. 1976. Tennessee state report on black bear management and research. Third East. Workshop on Black Bear Manage. and Res. 3:78-80.

Craighead, F. C., Jr., and J. J. Craighead. 1972. Grizzly bear prehibernation and denning activities as determined by radiotracking. Wildl. Monogr. 32. 35pp.

Curtis, J. T. 1959. The vegetation of Wisconsin. Univ. Wis. Press, Madison. 657pp.

DuBrock, C. W. 1980. An analysis of Virginia black bear population dynamics. M. S. Thesis, Va. Polytechnic Inst. and State Univ., Blacksburg. 113pp.

Erickson, A. W. 1957. Techniques for live-trapping and handling black bears. Trans. N. Am. Wildl. and Nat. Resour. Conf. 22:520-543.

____________. 1964. An analysis of black bear kill statistics for Michigan. Pages 69-102 in The black bear in Michigan. Mich. Agric. Exp. Stn. Res. Bull. 4.

______________, and G. A. Petrides. 1964. Population, structure, movements and mortality of tagged black bears in Michigan. Pages 47-67 in The black bear in Michigan. Mich. Agric. Exp. Res. Stn. Bull. 4.

______________, J. E. Nellor, and G. A. Petrides. 1964. The black bear in Michigan. Mich. Agric. Exp. Res. Stn. Bull. 4. 102pp.

Folk, G. E., Jr., J. M. Hunt, and M. A. Folk. 1980. Further evidence for hibernation of bears. Pages 43-47 in C. J. Martinka, and K. L. McArthur, eds. Bears. Their biology and management. Bear Biol. Assoc. Conf. Ser. 3. U. S. Gov. Print. Off., Washington, D. C.

Hamilton, R. J., and R. L. Marchington. 1980. Denning and related activities of black bears in the coastal plain of North Carolina. Pages 121-126 in C. J. Martinka, and K. L. McArthur, eds. Bears. Their biology and management. Bear Biol. Assoc. Conf. Ser. 3. U. S. Gov. Print. Off., Washington, D. C.

Harlow, R. F. 1961. Characteristics and status of Florida black bear. Trans. N. Am. Wildl. and Nat. Resour. Conf. 26:481-495.

Hole, F. D. 1976. Soils of Wisconsin. Univ. Wisconsin Press, Madison. 233pp.

Hugie, R. D. 1982. Black bear ecology and management in the northern conifer-decidous forests of Maine. Ph.D. Diss. Univ. Mont., Missoula. 215pp.

Johnson, K. G., D. O. Johnson, and M. R. Pelton. 1978. Simulation of winter heat loss for a black bear in a closed tree den. Proc. East. Black Bear Workshop 4:155-166.

______________, and M. R. Pelton. 1980. Environmental relationships and the denning period of black bears in Tennessee. J. Mammal. 61:653-660.

______________, and ____________. 1981. Selection and availability of dens for black bears in Tennessee. J. Wildl. Manage. 45:111-119.

Jonkel, C. J., and I. McT. Cowan. 1971. The black bear in the spruce-fir forest. Wildl. Monogr. 27. 57pp.

Knudsen, G. J. 1961. We learn about bears. Wis. Conserv. Bull. 26(6):13-15.

Kordek, W. S., and J. S. Lindzey. 1980. Preliminary analysis of female reproductive tracts from Pennsylvania black bears. Pages 159-161 in C. J. Martinka and K. L. Mc Arthur, eds. Bears. Their biology and management. Bear Biol. Assoc. Conf. Ser. 3. U. S. Gov. Print. Off., Washington D. C.

Kohn, B. E. 1982. Status and management of black bears in Wisconsin. Wis. Dept. Nat. Resour. Tech. Bull. 129. 31pp.

Linzey, F. G. 1976. Black bear population ecology. Ph.D. Thesis. Oreg. State Univ., Corvallis. 103pp.

__________. 1981. Denning dates and hunting seasons for black bears. Wildl. Soc. Bull. 9:212-216.

__________, and E. C. Meslow. 1976. Characteristics of black bear dens on Long Island, Washington. Northwest Sci. 50:236-242.

Massopust, J. L., and R. K. Anderson. 1984. Homing tendencies of translocated nuisance black bears in northern Wisconsin. Proc. East. Workshop Black Bear Manage. and Res. 7:(In press).

Novick, H. J., J. M. Siperet, and G. R. Stewart. 1981. Denning characteristics of black bears, Ursus americanus, in the San Bernardino Mountains of southern California. Calif. Fish and Game. 67:52-61.

O'Pezio, J., S. H. Clark, and C. Hackford. 1983. Chronology of denning by black bears in the Catskill region of New York. New York Fish and Game J. 30:1-11.

Pelton, M. R., L. E. Beeman, and D. C. Eagar. 1980. Den selection by black bears in the Great Smoky Mountains National Park. Pages 149-151 in C. J. Martinka and K. L. Mc Arthur, eds. Bears. Their biology and management. Bear Biol. Assoc. Conf. Ser. 3. U. S. Gov. Print. Off., Washington D. C.

Piekieklek, R. J., and T. S. Burton. 1975. A black bear population study in northern California. Calif. Fish and Game. 61:4-25.

Poelker, R. J., and H. D. Hartwell. 1973. Black bear of Washington. Washington State Game Dep., Olympia. 180pp.

Reynolds, D. G. 1977. Home range activities and reproduction of black bears in west-central Idaho. M. S. Thesis. Univ. Idaho, Moscow. 38pp.

Rogers, L. L. 1976. Effects of mast and berry crop failures on survival, growth and reproductive success of black bears. Trans. N. Amer. Wildl. Nat. and Resour. Conf. 41:431-438.

____________. 1977. Social relationships, movements, and population dynamics of black bears in northeastern Minnesota. Ph.D. Diss. Univ. Minnesota, Minneapolis. 194pp.

Schwartz, C. C., A. W. Franzmann, and D. C. Johnson. 1983. Black bear predation on moose (Bear ecology studies). Alaska Dep. Fish and Game, Final Rep. Job 17.3 R, Juneau. 135pp.

Schorger, A. W. 1949. The black bear in early Wisconsin. Trans. Wis. Acad. Sci. Arts Letters. 39:151-194.

Stickley, A. R., Jr. 1961. A black bear tagging study in Virginia. Proc. Ann. Conf. Southeast Assoc. Game and Fish Comm. 15:43-54.

Switzenberg, D. F. 1955. Black bear denning in a tree. J. Mammal. 36:459.

Taylor, D. F. 1971. A radio-telemetry study of the black bear (Euarctos americanus) with notes on it's history and present status in Louisiana. M. S. Thesis. La. State Univ., Baton Rouge. 87pp.

Tietje, W. D., and R. L. Ruff. 1980. Denning behavior of black bears in boreal forest of Alberta. J. Wildl. Manage. 44:858-870.

# HOME RANGE, DIEL MOVEMENTS, AND HABITAT USE OF BLACK BEARS IN NORTHERN WISCONSIN

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Abstract: Annual home ranges, seasonal ranges (prebreeding, breeding, foraging, and denning), and diel movements were determined for 9 black bears (*Ursus americanus*) (5 adult females, 1 yearling male, and 3 adult males); habitat use was determined for 5 of the 9 bears (2 adult females, 1 yearling male, and 2 adult males). Male bears had significantly larger ($P<0.005$) annual home ranges ($\bar{X}=93.0$ km$^2$; range: 60.9-119.2) than females ($\bar{X}=18.8$ km$^2$; range: 12.6-35.4). Prebreeding ranges were determined only for male bears and averaged 19.1 km$^2$ (range: 8.9-32.0). Breeding ranges of males ($\bar{X}=56.9$ km$^2$; range: 34.4-86.9) were significantly larger ($P<0.005$) than females ($\bar{X}=11.1$ km$^2$; range: 3.5-30.3). There was no difference ($P>0.10$) between the size of male ($\bar{X}=8.7$ km$^2$; range: 2.9-18.7) and female ($\bar{X}=11.0$ km$^2$; range: 2.5-23.4) forage ranges. Male bears had larger ($P<0.025$) denning ranges ($\bar{X}=8.9$ km$^2$; range: 0.2-14.6) than females ($\bar{X}=1.6$ km$^2$; range: 1.4-1.6). Diel movement parameters studied were average total daily movement, daily

range length, net daily movement, and rate of travel. There was no difference (P>0.10) between females and males in the average total daily movement (F=8.9 km, range: 3.2-22.5; M=10.4 km, range: 8.4-13.0), daily range length (F=3.5 km, range: 1.3-8.5; M=3.0 km, range: 2.4-3.8), net daily movement (F=2.3 km, range: 1.1-3.8; M=1.7 km, range: 0.4-2.5), and rate of travel (F=0.53 km/hr, range: 0.02-2.45; M=0.55 km/hr, range: 0.05-1.80). There was a significant difference (P<0.10) in the circuity of the travel route with females traveling in more of a straight line (0.28) than males (0.18). All bears tended to rest between approximately 2200 and 0500 hours; 11 of 14 of these rest periods were on the edge of, or within conifer swamps. Three classifications of habitat were identified within the diel movements of 5 bears: optimal foraging, transit, and resting habitats. Optimal foraging habitats were comprised of trembling aspen (Populus tremuloides, IV=134.11), red maple (Acer rubrum, IV=119.73), white ash (Fraxinus americana, IV=71.22), yellow birch (Betula alleghaniensis, IV=97.58), and openings. The important structural characteristics of optimal foraging habitats are dense understory with limited horizontal visability and prevalence of food plants such as beaked hazelnut (Corylus cornuta), grasses (Graminae), sedges (Carex spp.), blackberry (Rubus spp.), and strawberry (Fragaria spp.). Transit habitats had an open understory with good horizontal visability and consisted of sugar maple (Acer saccharum, IV=136.43), white birch (Betula papyrifera, IV=102.17), and an alder (Alnus spp.) swamp. Lowland conifer areas were selected for night-resting areas; they consisted of black spruce (Picea mariana, IV=222.30), tamarack (Larix laricina, IV=202.84), and balsam fir (Abies balsamea, IV =179.79).

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The diel movements, activity patterns, home range, and habitat of black bears are important factors to consider in the formulation of a management program. Management of black bears in Wisconsin has consisted primarily of regulating the harvest; habitat management is not being conducted exclusively for bears. Previous studies of bear movements in Wisconsin (Knudsen 1961, Kohn 1982) have relied on capture-recapture methods and do not provide detailed ecological information.

Home range and habitat use studies of bears in other states or geographical regions are not directly comparable to Wisconsin because of differences in habitats, data collection, and analysis methods. Studies in states near to Wisconsin report differences in home range sizes; in Minnesota they averaged 9.6 $km^2$ and 129.4 $km^2$ for female and male bears, respectivily (Rogers 1977), and 68.9 $km^2$ for females and 150.4 $km^2$ for males in Lower Michigan (Manville 1983). The objective of this study was to determine the home range, habitat use, and diel movement parameters of black bears in northern Wisconsin during 1981-82.

The project was funded by the University of Wisconsin-Stevens Point (UWSP), the Wisconsin Department of Natural Resources (WDNR), and the Wisconsin Bear Hunters Association. J. Koch provided trapping and drugging expertise, J. Wilson taught us the art of foot-snaring, B. Kohn advised and loaned equipment and many UWSP graduate and undergraduate students helped with field work and data analysis. D. Zekor did the tooth sectioning and aging.

## STUDY AREA

The study was conducted in 6 counties (Ashland, Bayfield, Iron, Price, Taylor, and Sawyer) of northcentral Wisconsin (Fig. 1). Most (79%) of the 1.75 million hectare study area is forested (commercial timber production, productive reserved, and unproductive status); non-forest lands are cropland, pasture, marsh, wooded pasture, industrial and urban areas (Wis. Dep. Nat. Resour., unpubl. data).

The area is dominated by Northern Mesic Forest with scattered units of Boreal Forest, and conifer swamp (Curtis

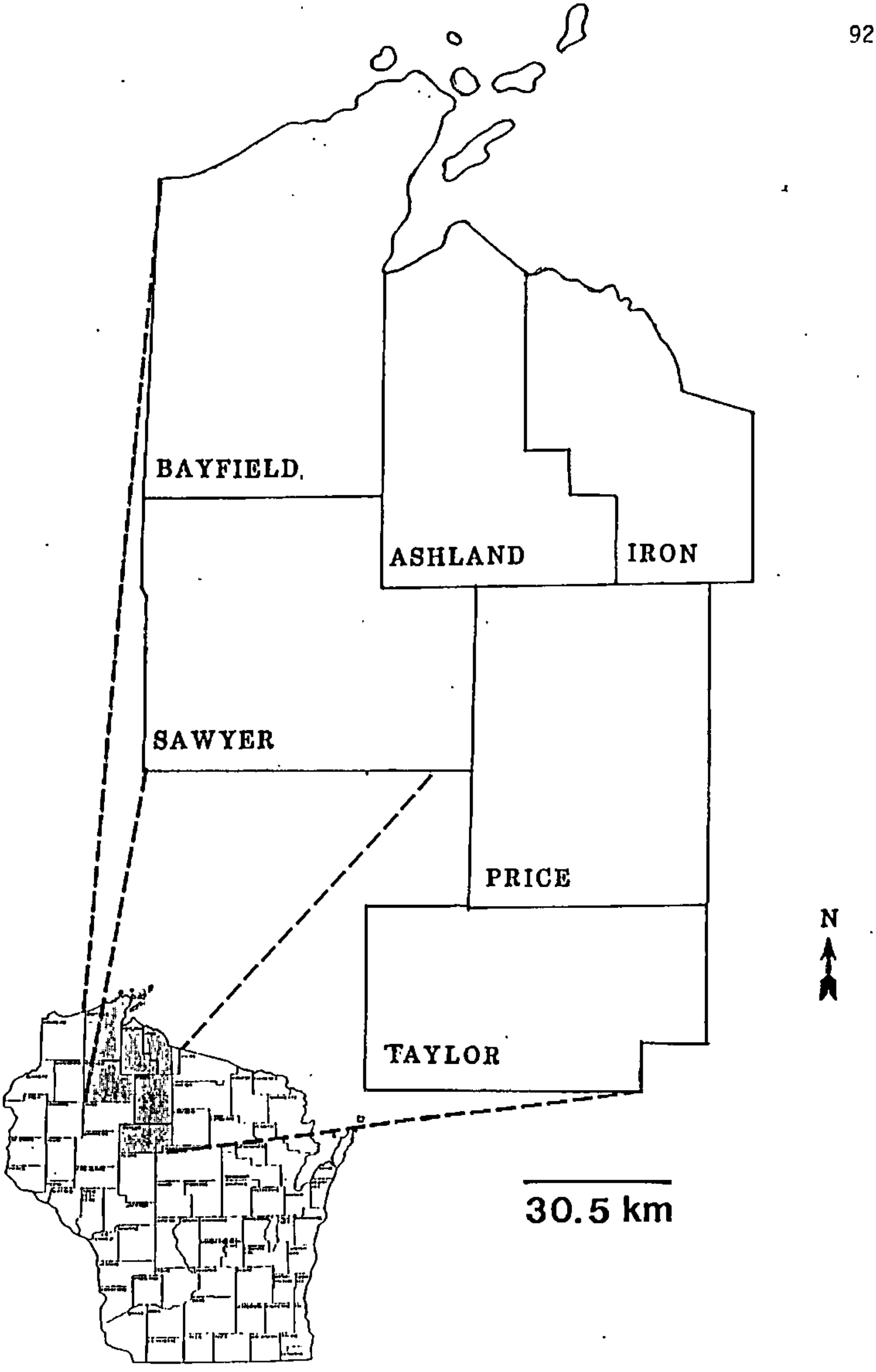


Fig. 1. Black bear home range and habitat use study area in northern Wisconsin, 1981-82.

1959). Major tree species of the Northern Mesic Forest include sugar maple, basswood (*Tilia americana*), aspen (*Populus* spp.), balsam fir, eastern hemlock (*Tsuga canadensis*), black spruce , and tamarack (Curtis 1959). The mean annual precipitation is 81-86 cm with an average seasonal snowfall of 178-203 cm. The area is composed of end and ground moraine, and glacier formed lake basins. Major soils of the region are Iron River, Gogebic, and Kennan series (Hole 1976).

## METHODS

Black bears were trapped with culvert (Erickson 1957), barrel traps (Kohn 1982), and foot snares (Johnson and Pelton 1980) in cooperation with the WDNR nuisance bear program. Bears were immobilized with ketamine hydrochloride (Vetalar, Park-Davis, Morris Plains, N.J.) at a doseage rate of lcc/9.1 kg. of estimated body weight, fitted with 150-51 MHz radio-collars (Automatic Telemetry Systems, Bethal, Minn., and Telonics, Mesa, Ariz.), sexed, weighed, measured, ear-tagged, and had the first premolar removed for aging (Waddell 1975). Tooth sectioning and aging were done at UWSP, using cementum annuli counts. Rogers (1978) determined that the first cementum annuli starts to form between 5 and 8 months of age in black bears; therefore, the ages of bears in this study were established by adding 0.5 year to the annulation count. Bears were classified into 4 age groups; cubs(<1 year), yearlings (1 to 2 years), subadults (2 to 3 years), and adults (>3 years). A blood sample was taken from the femoral vein for blood parasite detection; parasites were collected from pelage and feces.

Bear radio locations were determined from the ground by triangulation with a null-peak or 8-element Yagi receiving antennas mounted on a truck, and from the air with aircraft equipped with strut-mounted H-antennas (Telonics, Mesa, Ariz.). Bearings were taken as prescribed by Heezen and Tester (1967) to minimize the resulting error polygon. Locations were plotted on Wisconsin Department of Transportation airphotos (scale=1:4800). Diel movements were determined by tracking bears for at least 24 hours and triangulating the bear's position every hour. Those locations were plotted as points and distances measured between consecutive hourly locations for analysis of these data. Maximum error, as determined from field tests with transmitters at known locations, was 2.4 and 3.6 ha for stationary and moving animals respectively; accuracy from the air, with a minimum of 4 passes, was 0.97 ha.

Bears were choosen for diel movement study on the basis of the availability of traversible roads adequate for triangulation. Diel movements were analyized as described by Garshelis et al. (1983) and are summarized here. Parameters analyized included total daily movement (sum of distances between 24 consecutive hourly locations), daily range length (maximum distance between radio-locations in a 24-hour period), net daily movement (distance between beginning and end points in a 24-hour sequence of locations), and circuity of the travel route. Circuity of the route was determined by dividing the net daily movement by the total daily movement; a value of 1.0 indicates a straight-line movement and a value of 0.0 indicates that the animal returned to the original location at the start of monitoring.

Home range is defined as the area traversed by an animal during its normal activities of food-gathering, mating, and caring for young (Burt 1943). Annual home ranges and seasonal ranges were determined by connecting the outermost locations (convex polygon) and measuring the enclosed area with a polar planimeter (Mohr 1947). Seasonal ranges were defined as prebreeding (30 April to 3 June), breeding (4 June to 22 July), foraging (23 July to 30 September), and denning (1 October to 1 November). The dates for the breeding season were determined by Kohn (1982); no Wisconsin female bears in estrus were present in his trapping sample before 4 June or after 22 July. Seasonal ranges were not computed unless at least 3 locations were obtained during the designated seasonal time period. The Students T-test was used to determine any differences in average ranges and diel movement parameters between female and male bears.

Habitat use was determined from bear diel locations. Bear routes were plotted on airphotos and the cover-types delineated. If the error polygon covered 2 different cover-types, each was cover-typed and the bear's location was classified as being on the edge of the 2 cover-types. A transect was established through the longest axis of the cover-type and the tree stratum (> 10.16 cm DBH) was sampled at random points along its length by the point-quarter method (Cottam and Curtis 1956). The shrub (< 10.16 cm DBH and > 1 m in height) and herb (< 1 m in height) strata were sampled for species present at each point-quarter station with 2.5 m and a 1.0 m quadrats, respectivily (Curtis 1959). Importance Values (IV) were calculated by adding the relative density, relative dominance, and relative frequency for each tree species in each cover-type. Cover-types were named after the tree species with the highest IV. A Continuum Index (CI) was calculated for each cover-type to characterize it in terms of its successional stage on a scale of 300 to 3000 (Curtis 1959). Similar cover-types of all bears were combined for analysis; point-quarter and quadrat data were also analyzed for individual bears. All point-quarter and quadrat data are presented in the Appendices.

## RESULTS AND DISCUSSION

### Annual and Seasonal Range Sizes

Male bears have significantly larger ($P<0.005$) average annual home ranges (AHR) than females; 18.8 $km^2$ (range: 12.6-35.4) and 93.0 $km^2$ (range: 60.9-119.2) for female and male bears respectivily (Table 1). Females with cubs (C, E, and G) had the smallest AHR of all bears, ranging from 12.6 $km^2$ to 16.7 $km^2$. The AHR of adult Female-B (35.4 $km^2$) may be a more accurate representation for solitary adult females than that of adult Female-A (14.1 $km^2$) because of the relatively few radio-locations obtained on Female-A during the foraging and denning seasons. Yearling Male-H had the smallest AHR (60.9 $km^2$) of all male bears; this was a newly established AHR after translocation (Massopust and Anderson 1984). Prebreeding ranges were determined only for male bears and averaged 19.1 $km^2$ (range: 8.9-32.0). Breeding ranges of males ($\bar{X}$=56.9 $km^2$, range: 34.4-86.9) were significantly larger ($P<0.005$) than females ($\bar{X}$=11.1 $km^2$, range: 3.5-30.3). Solitary Female-B had the largest breeding range (30.3 $km^2$) of all female bears and it is slightly less than her AHR (35.4 $km^2$). There was no difference ($P>0.10$) between the size of female ($\bar{X}$=11.0 $km^2$, range: 2.5-23.4) and male ($\bar{X}$=8.7 $km^2$, range: 2.9-18.7) forage ranges.

Table 1. Range sizes of 11 black bears in northern Wisconsin, 1981-82.

| Bear | Sex | Age (years) | Seasonal ranges ($km^2$) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Prebreeding | Breeding | Foraging | Denning | Annual[a] |
| A | F | 3.5 | - | 8.5 | - | - | 14.1 |
| B | F | 5.5 | - | 30.3 | 14.4 | - | 35.4 |
| C[b] | F | 6.5 | - | 8.0 | - | 1.4 | 12.6 |
| D | F | 6.5 | - | - | 7.1 | - | - |
| E[b] | F | 5.5 | - | 5.4 | 2.5 | 1.7 | 16.7 |
| F | F | 9.5 | - | - | 23.4 | - | - |
| G[b] | F | 6.5 | - | 3.5 | 7.9 | - | 15.3 |
| | $\overline{X}$ | 6.2 | - | 11.1 | 11.1 | 1.6 | 18.8 |
| H | M | 1.5 | 8.9 | 34.4 | 7.5 | 8.9 | 60.9 |
| I | M | 4.5 | 32.0 | 62.5 | 8.1 | 14.6 | 99.8 |
| | | | | | 2.9[c] | | |
| J | M | 5.5 | 16.3 | 43.9 | 6.3 | 13.3 | 92.1 |
| | | | | | | 7.3[c] | |
| K | M | 15.5 | - | 86.9 | 18.7 | 0.2 | 119.2 |
| | $\overline{X}$ | 6.8 | 19.1 | 56.9 | 8.7 | 8.9 | 93.0 |

[a] Annual range size does not equal the sum of the seasonal ranges because of overlap.

[b] Female with cubs.

[c] Different seasonal range was used during 1982.

The AHRs of black bears in Wisconsin most closely approximate those of bears in Cold Lake, Alberta where Young and Ruff (1982) determined that females had an average AHR of 19.6 $km^2$ and predicted a mean AHR of 119 $km^2$ for males. Female and male black bears in Minnesota had mean AHRs of 9.6 $km^2$ and 129.4 $km^2$ respectively (Rogers 1977:178, 71). Based on telemetry data, Manville (1983) determined that female and male AHRs in lower Michigan averaged 68.9 $km^2$ and 150.4 $km^2$, respectively. A previous trap-recapture study in Wisconsin (Kohn 1982) determined minimum home range sizes to be 13.7 $km^2$ and 71.2 $km^2$ for females and males, respectively. These are minimum estimates because of restrictions in trap placement and the small number of captures (Kohn 1982).

The quality of bear habitat may be directly related to the AHR size of female bears. Since females move less than males, the area occupied by females represents a minimum area needed to assure adequate food supplies for self-maintainance and development of young (Amstrup and Beecham 1976). Therefore, AHR of female bears estimated by the same method, could be used to compare the quality of habitat between different areas in a region (Young and Ruff 1982). The quality of bear habitat in Wisconsin is good, based on the relatively small average female home range (18.8 $km^2$).

Diel Movements

Diel movements were determined during May, June, July, and August and were similar for male and female bears. There was no difference (P>0.10) between females and males in their average total daily movement (F=8.9 km, range: 3.2-22.5; M=10.4 km, range: 8.4-13.0), daily range length (F=3.5 km, range: 1.3-8.5; M=3.0 km, range: 2.4-3.8) net daily movement (F=2.3 km, range: 1.1-3.8; M=1.7 km, range: 0.4-2.5), and rate of travel (F=0.53 km/hr, range: 0.02-2.45; M=0.55 km/hr, range: 0.05-1.80) (Table 2). There was a significant difference (P<0.10) in the circuity of the travel route with females traveling in more of a straight line (0.28) than males (0.18). The least and most circuitious diel travel route of male bears were 0.30 and 0.03 for adult Male-I and adult Male-J, respectively; adult Female-A had the least circuitious diel travel route (0.43) and adult Female-E had the most circuitious route (0.12) (Fig. 2).

All bears tended to rest between approximately 2200 and 0500 hrs. Eleven of these 14 rest periods were spent on the edge of, or within conifer swamps. Cooler air drainage at night and the soft substrate of conifer swamps may provide physical comfort for resting during the summer.

The lack of differences between female and male diel movement parameters in this study may be a product of the small male sample size (N=4). However, Garshelis et al. (1983) also reported no sex related differences in diel

Table 2. Diel movement parameters of 9 black bears in northern Wisconsin, 1981-82.

| Bear | Sex | Age (years) | Date | Total daily[a] movement (km) | Daily range[b] length (km) | Net daily[c] movement (km) | Circuity of[d] travel route | Mean rate of travel km/hr (range) |
|---|---|---|---|---|---|---|---|---|
| Females | | | | | | | | |
| A | F | 3.5 | 12 June 81 | 8.9 | 4.5 | 3.8 | 0.43 | 0.50 (0.06-1.33) |
| B | F | 5.5 | 19 July 81 | 8.9 | 4.4 | 2.3 | 0.26 | 0.79 (0.03-2.45) |
| | | | 25 Aug. 81 | 7.0 | 2.5 | 2.3 | 0.33 | 0.44 (0.15-1.45) |
| C[e] | F | 6.5 | 1 June 82 | 6.4 | 2.0 | 1.2 | 0.19 | 0.38 (0.11-0.84) |
| | | | 17 June 82 | 5.2 | 1.7 | 1.3 | 0.25 | 0.35 (0.10-0.97) |
| | | | 6 July 82 | 9.4 | 3.2 | 3.1 | 0.33 | 0.62 (0.15-2.00) |
| D | F | 6.5 | 27 Aug. 81 | 10.5 | 3.2 | 2.5 | 0.24 | 0.54 (0.02-1.68) |
| E[e] | F | 5.5 | 8 June 82 | 3.2 | 1.3 | 1.2 | 0.38 | 0.21 (0.08-0.47) |
| | | | 21 June 82 | 9.3 | 3.9 | 1.1 | 0.12 | 0.58 (0.09-1.47) |
| | | | 20 Aug. 82 | 7.1 | 3.0 | 2.6 | 0.37 | 0.40 (0.08-0.95) |
| F | F | 9.5 | 11 Aug. 82 | 22.5 | 8.5 | 3.4 | 0.15 | 0.98 (0.33-2.04) |
| $\bar{X}$ | - | 6.2 | - | 8.9 | 3.5 | 2.3 | 0.28 | 0.53 |

Table 2. (Continued).

| Bear | Sex | Age (years) | Date | Total daily[a] movement (km) | Daily range[b] length (km) | Net daily[c] movement (km) | Circuity of[d] travel route | Mean rate of travel km/hr (range) |
|---|---|---|---|---|---|---|---|---|
| Males | | | | | | | | |
| H | M | 1.5 | 8 July 81 | 10.3 | 2.4 | 1.5 | 0.15 | 0.51 (0.05-1.54) |
| I | M | 4.5 | 29 May 82 | 8.4 | 2.6 | 2.5 | 0.30 | 0.46 (0.05-0.90) |
| J | M | 5.5 | 27 May 82 | 9.8 | 3.1 | 2.3 | 0.23 | 0.54 (0.12-1.48) |
| | | | 30 July 82 | 13.0 | 3.8 | 0.4 | 0.03 | 0.67 (0.05-1.80) |
| $\bar{X}$ | - | 3.8 | - | 10.4 | 3.0 | 1.7 | 0.18 | 0.55 |
| All bears | | | | | | | | |
| $\bar{X}$ | - | 5.4 | - | 9.3 | 3.3 | 2.1 | 0.25 | 0.53 |

[a] Sum of distances between 24 consecutive hourly locations.

[b] Maximum distance between radio-locations in a 24-hour period.

[c] Distance between beginning and end points in a 24-hour sequence of locations.

[d] Net movement divided by total distance traveled; 1.0 indicates straight-line movement and 0.0 indicates the bear returned to the original location.

[e] Female with 3 cubs.

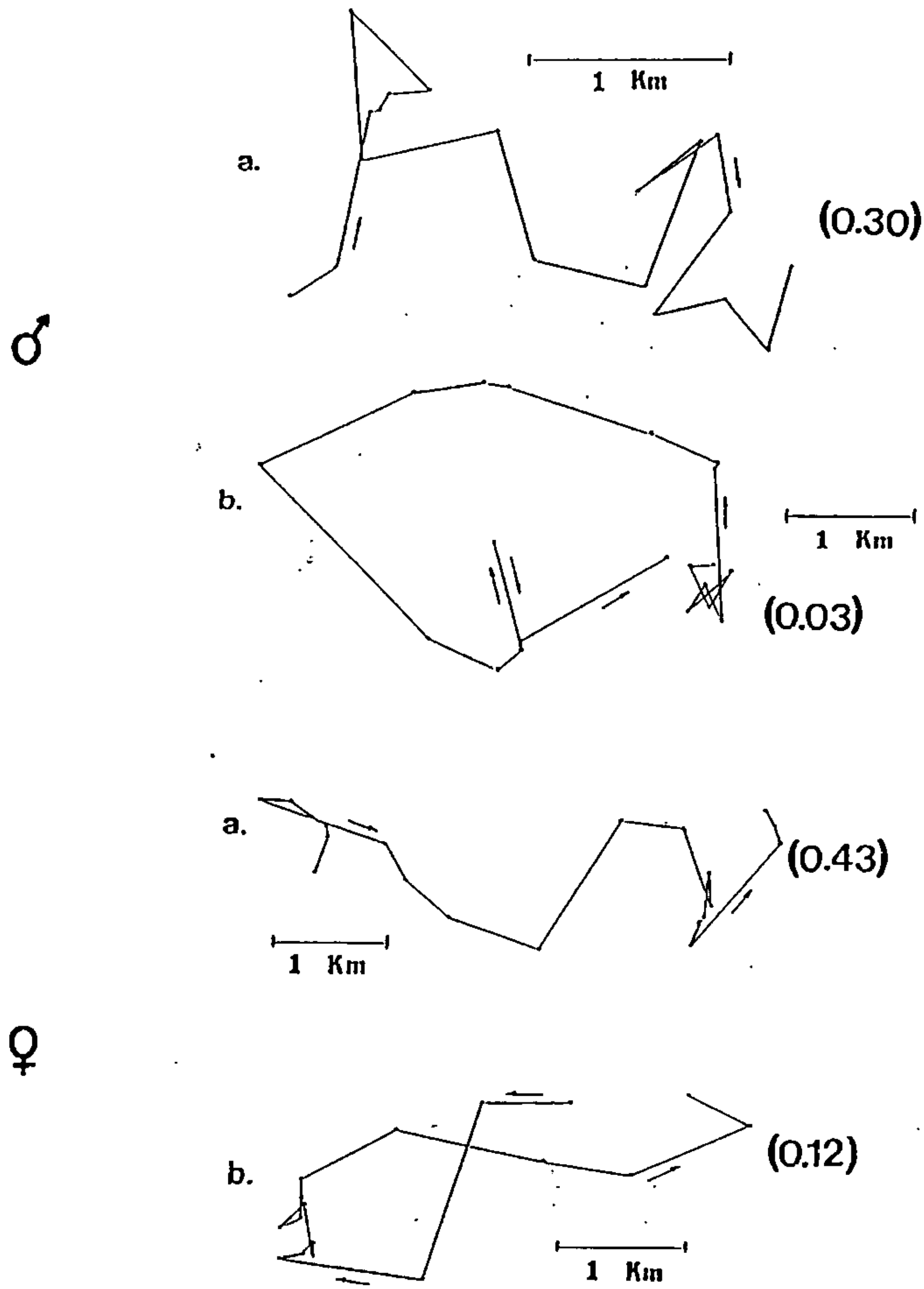


Fig. 2. Minimum (a.) and maximum (b.) circuity of diel travel routes for male and female black bears in northern Wisconsin, 1981-82. A value of 1.0 indicates straight-line movement and 0.0 indicates the bear returned to the original location.

movements of bears in Tennessee. Most of the Tennessee bears were subadults which showed little difference in activity when compared to adults (Garshelis and Pelton 1980). All except 1 yearling male were adults in this study (Table 2).

The more circuitious routes of the 4 male bears (0.18) may be a product of mutual avoidance by males during the breeding season (4 June to 22 July) (Table 2). Circuity of diel travel routes are assumed to be affected by distribution and abundance of food, and social interactions (Garshelis et al. 1983). Bears in Tennessee tended to travel in a more circuitious route in the fall than in spring and summer because of higher bear densities in the fall feeding areas (Garshelis and Pelton 1980). We did not monitor diel movements in the fall.

Habitat Use

Optimal foraging, transit, and resting habitats were identified within the diel movements of 5 black bears (1 yearling male, 2 adult males, 1 solitary female, and 1 female with 3 cubs). Optimal foraging habitats consisted of forest stands where bears were presumably feeding and therefore moved little. The definition of optimal foraging (hereafter: foraging) involves 4 categories of choice by the animal: 1. what to eat, 2. where to find it, particularly when food is not distributed evenly in the habitat, 3. how long to spend, and 4. optimal directions, patterns, and speed of movements (Grier 1984: 175). Transit habitats consisted of easily traversable forest stands used as travel lanes between foraging habitats. Resting habitats were conifer swamps that were used by all bears at some time for night-resting.

Foraging Habitat

Foraging habitat cover-types were comprised of trembling aspen (IV=134.11), red maple (IV=119.73), white ash (IV=71.22), yellow birch (IV=97.58), and openings. They were characterized by midsuccessional vegetation (CI range: 1444.99-2409.52) with considerable diversity of species within the stands. All of the above cover-types, except the white ash cover-type, had beaked hazelnut in the shrub strata and all cover-types, except yellow birch, had black cherry (Prunus serotina) in the shrub or herb strata. All foraging habitat herb strata contained grasses, sedges, blackberry, strawberry, aster (Aster spp.), goldenrod (Solidago spp.), vilot (Viola spp.), lady fern (Athyrium filix-femina), sphagnum moss (Sphagnum spp.), thistle (Cirsium spp.), and mushrooms. Norton (1981) determined from the analysis of black bear scat in Wisconsin that the principal spring and summer foods were grasses, sedges, sweet cicely (Osmorhiza claytonii), and the catkins and leaves of trembling aspen; consumption of green vegetation declined in August and changed to predominately black cherry. All the above shrub and herb species probably provide some food value to bears but would not show up in Norton's (1981) scat analysis because of the digestion process which would make many fragments unidentifiable.

Openings were not used extensively by bears during our minimal monitoring of diel movements in this study, although they were present within all bear home ranges; 5 of 216 hours (2.3%) were spent in openings. A solitary female used a wildlife management opening and a female with 3 cubs used a powerline right-of-way for foraging. The female with cubs discontinued use of the powerline right-of-way after it was sprayed with herbicide. Norton (1981) reported intensive summer use of openings by bears in Wisconsin. The use of openings probably depends on the extent to which they occur within an individual bear's home range and food abundance in other habitat types within the AHR.

The size of trees (dominance) and the cover-type densities did not appear to be as important in a bears use of foraging habitats as did the species composition and structural characteristics of the understory. The size of the most important trees, as indicated by the relative dominance, ranged from 48.39% for trembling aspen cover-type to 30.53% for the yellow birch cover-type. Tree densities in foraging habitats ranged from 95.16 trees/acre (trembling aspen) to 39.76 trees/acre (red maple); relative densities were also variable ranging from 48.11% for the trembling aspen to 36.36% for the yellow birch cover-type. Although quantitative measurements were not made in the shrub and herb strata, the understory of most foraging habitats (except openings which were devoid of a dense shrub strata) was dense with limited horizontal visability.

The red maple cover-type was an extensive area (7209 $km^2$) of windblown trees, a result of a severe windstorm on 4 July 1977. The tree canopy was severely reduced (density of red maple: 39.76 trees/acre), the shrub and herb strata was dense and, in combination with the windblown trees, restricted human travel.

Transit Habitat

Transit habitat cover-types were late succession sugar maple (IV=136.43; CI=2438.93), white birch (IV=102.17; CI=1762.77), and an alder swamp. The significant structural characteristics of transit habitat was an open understory with good horizontal visability. Tree strata species composition, density, and relative dominance were dissimilar between the sugar maple and white birch cover-types. Tree densities were 89.48 and 69.23 trees/acre for sugar maple and white birch cover-types respectively; dominance values were 52.97% for the sugar maple and 34.30% for the white birch cover-types. The alder swamp was used as transit habitat in the area of the windblown red maple forage habitat. It differed structurely from the other transit habitats in that the understory was dense with poor horizontal visability but travel here was easier than in the adjacent blowdown area. The sugar maple and white birch cover-types had sugar maple, beaked hazelnut, hop-hornbeam (*Ostrya virginiana*), red maple, leatherwood (*Dirca palustris*), trembling aspen, balsam fir, black cherry, and choke cherry (*Prunus virginiana*) in the shrub strata. The 6 most common plants in the herb strata of the sugar maple and white birch cover-types included grasses, sedges, sugar maple, canada mayflower (*Maianthemum canadense*), sphagnum moss, and wild sarsaparilla (*Aralia nudicaulis*). In the alder cover-type the most common herb species were sphagnum moss, sedges, blackberry, grasses, alder, and crested fern (*Dryopteris cristata*) with beaked hazelnut and alder in the shrub strata.

## Resting Habitat

Bears used conifer swamps for summer night-resting habitat. The security of dense cover, cool air drainage into the lowlands, and a soft sphagnum moss groundcover that provided physical comfort probably made them attractive to bears. Cover-types included black spruce (IV=222.30), tamarack (IV=202.84), and balsam fir (IV=179.79); all in early stages of succession with CI's ranging from 430.44 (tamarack) to 1300.93 (balsam fir). There was no consistency in the species composition of shrub strata with black spruce being the only species that was present in 2 (black spruce and tamarack) cover-types. The species composition of the herb stratum in resting habitats varied considerably with sedges, sphagnum moss, bluebead (Clintonia borealis), canada mayflower, and club moss (Lycopodium spp.) being present in all. Tree densities ranged from 53.79 trees/acre for the tamarack cover-type to 146.69 trees/acre for the balsam fir; relative dominance values ranged from 60.97% to 78.25% for the balsam fir and black spruce cover-types, respectively.

## MANAGEMENT IMPLICATIONS

Bears used young aspen stands extensively for foraging in this study. Aspen has also been identified as quality bear habitat in other Wisconsin studies (Norton 1981, Kohn 1982). Bear forage production in aspen cover-types can be maintained with even-aged silviculture (10-year cutting cycle; 40-year rotation) akin to that which was prescribed for ruffed grouse (Bonasa umbellus) habitat management by Gullion (1972). At this time, it appears as though 4, 16.2 ha cutting compartments per 259 ha would provide near optimum forage habitat within the normal home range of a sow with cubs, the critical reproductive cohort of a bear population. A more precise prescription needs to be formulated through more intensive habitat-use studies that could best be accomplished by continuous monitoring of radio-tagged individuals over an extended period of time.

Bears in this study also used young (15-25 cm dbh) stands of red maple, white ash, and yellow birch for foraging. These northern hardwoods have a greater life expectancy and rotation age than aspen; therefore, silvicultural practices that would regenerate these cover-types and also provide adequate forage habitat for bears would differ from those prescribed for aspen. Stands beyond the 25-30 cm dbh class were not extensively used for foraging, presumably because forage vegetation was limited. Shelterwood silviculture of northern hardwoods, with 40% canopy removal during the preparatory cut, would regenerate the tree species and also foster some growth of bear forage plants. Removal of an additional 10-20% of the canopy at this time would encourage a denser growth of desirable forage vegetation (e.g., blackberry, hazelnut, black cherry). Preparatory cuts beyond prescription could be effected on forest lands that have multiple-use objectives in order to establish optimum bear forage habitat. Compartment sizes could be smaller than those prescribed for aspen (8.1 ha) and more compartments would be possible per unit area (8/259 ha) because of the longer rotation age (120 years) of northern hardwoods; each 8.1 ha compartment would be on a 15-year cutting cycle. Specific site characteristics should be carefully evaluated to identify potential bear habitat management units that are low quality for trees but high quality for forage plants. Clear-cutting northern hardwoods would produce bear forage habitat for a longer period of time than would the shelterwood system, but at the expense of reduced tree regeneration; this option should be considered for off-site areas.

The current WDNR opening creation and maintainance program , along with natural openings, appears to provide sufficient open habitat for bears in the areas we studied. Herbicide use to retard plant succession needs evaluation since application seemed to discourage bear use of an opening in 1 instance.

Transit habitat (older sugar maple and white birch stands) were not limiting in this study and may not even be necessary if all other life-supporting habitats were in close juxtaposition; additional research is also needed here.

Conifer swamps appear to be a focal point in bear home ranges as they were consistantly used for night-resting. The number and spacing of these resting habitats does not appear to be a limiting factor although the importance of this habitat in juxtaposition to forage habitat needs further evaluation. Conifer swamps should be preserved or treated with a system of uneven-aged silviculture. If clear-cuts are to be prescribed, a strip-cutting harvest design with strips (79.2 m wide) perpendicular to prevailing winds at seed dispersal time, and on a rotation compatible with the tree species, would favor conifer regeneration and maintain habitat preferred by bears for night-resting.

Oaks (Quercus spp.) are relatively sparse in northern Wisconsin and should be favored wherever they occur because of their mast production for bears and other wildlife species. Foraging habitats of bears in this study contained scattered oaks but no well-stocked stands were present within any of the areas cover-typed. Where well-stocked stands of oak do exist, silviculture that would maintain mature mast-producing trees and insure regeneration should be practiced.

Many northern hardwood areas in Wisconsin are maturing to a point where optimum bear forage habitat will become limiting in the relatively near future; barring major natural phenomena such as fires or wind storms. For these areas, management strategies that would perpetuate early to mid-successional stages of northern hardwoods need to be designed and practiced if optimum bear habitat is to be maintained. Additional bear habitat-use data will be needed to formulate an explicite and functional management prescription. Habitat management, and a carefully regulated harvest program, can insure a viable black bear population for the enjoyment of future generations of Wisconsin citizens.

LITERATURE CITED

Amstrup, S. C., and G. M. Burghardt. 1976. Activity patterns of radio-collared black bears in Idaho. J. Wildl. Manage. 40:340-348.

Burt, W. H. 1943. Territorality and home range concepts as applied to mammals. J. Mammal. 24:346-352.

Cotham, G., and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecol. 37:451-460.

Curtis, J. T. 1959. The vegetation of Wisconsin. Univ. Wis. Press, Madison. 657pp.

Erickson, A. W. 1957. Techniques for live-trapping and handling black bears. Trans. North Am. Wildl. Conf. 22:520-543.

Garshelis, D. L., H. B. Quigley, C. R. Villarrubia, and M. R. Pelton. 1983. Diel movements of black bears in the southern Appalachians. Pages 11-19 in E. C. Meslow, ed. Bears-Their biology and management. Bear Biol. Assoc. Conf. Ser. 5. U. S. Gov. Print. Off., Washington D. C.

_______________. 1978. Movement ecology and activity behavior of black bears in the Great Smoky Mountains National Park. M. S. Thesis, Univ. Tenn., Knoxville. 117pp.

Grier, J. W. 1984. Biology of animal behavior. Times Mirror/Mosby College Publishing, St. Louis. 693pp.

Gullion, G. W. 1972. Improving your forested lands for ruffed grouse. Pub. No. 1439, Misc. J. Series, Minn. Agr. Exp. Sta., St. Paul. 34pp.

Heezen, K. L., and J. R. Tester. 1967. Evaluation of radio-tracking by triangulation with special reference to deer movements. J. Wildl. Manage. 31:124-141.

Hole, F. D. 1976. Soils of Wisconsin. Univ. Wis. Press, Madison. 233pp.

Johnson, K. G., and M. R. Pelton. 1980. Prebaiting and snaring techniques for black bears. Wildl. Soc. Bull. 8:46-54.

Knudsen, G. J. 1961. We learn about bears. Wis. Conserv. Bull. 26(6):13-15.

Kohn, B. E. 1982. Status and management of black bears in Wisconsin. Wis. Dep. Nat. Resour. Tech. Bull. No. 129. 31pp.

Mannville, A. M. II. 1983. Human impact on the black bear in Michigan's lower peninsula. Pages 20-33 in E. C. Meslow, ed. Bears-Their biology and management . Bear Biol. Assoc. Conf. 5. U. S. Gov. Print. Off., Washington D. C.

Massopust, J. L., and R. K. Anderson. 1984. Homing tendencies of translocated nuisance black bears in northern Wisconsin. Proc. East. Workshop Black Bear Manage. and Res. 7:(In press).

Mohr, C. O. 1947. Table of equivalent populations of North American small mammals. Am. Midl. Nat. 37:223-249.

Norton, N. C. 1981. Food habits, growth, and cover types used by northern Wisconsin black bears. M. S. Thesis, Univ. Wis., Stevens Point. 48pp.

Rogers, L. L. 1977. Social relationships, movements, and population dynamics of black bears in northeastern Minnesota. Ph.D. Diss. Univ. Minn., Minneapolis. 194pp.

____________. 1978. Interpretation of cementum annuli in first premolars of bears. Proc. East. Black Bear Workshop 4:102-112.

Springer, J. T. 1979. Some sources of bias and sampling error in radio triangulation. J. Wild. Manage. 43:926-935.

Waddell, T. E. 1975. A technique for extracting a bear's first premolar. Ariz. Fish and Game Dep. Wildl. Digest Game Manage. Abstr. No. 9. 3pp.

Young, B. F., and R. L. Ruff. 1982. Population dynamics and movements of black bears in east central Alberta. J. Wildl. Manage. 46:845-860.

Appendix A. Tree species total density and continuum index for cover-types used by 5 black bears in northern Wisconsin, 1981-82.

| Bear | Sex | Age (years) | Cover-type[a] | Total density (trees/acre) | Continuum Index |
|---|---|---|---|---|---|
| H | M | 1.5 | Aspen 1 | 327 | 1264.38 |
| | | | Aspen 2 | 184 | 1653.10 |
| | | | Balsam fir 1 | 351 | 2078.79 |
| | | | Balsam fir 2 | 99 | 1164.57 |
| | | | Black spruce | 157 | 575.55 |
| | | | Sugar maple | 174 | 2581.26 |
| | | | Tamarack | 426 | 599.28 |
| J | M | 5.5 | Aspen | 111 | 1159.16 |
| | | | Black spruce | 38 | 480.55 |
| | | | Red maple 1 | 177 | 2239.19 |
| | | | Red maple 2 | 125 | 2146.88 |
| | | | Red maple 3 | 124 | 2245.64 |
| | | | Red maple 4 | 109 | 2097.60 |
| | | | Red maple 5 | 85 | 1791.31 |
| | | | Red maple 6 | 15 | 1298.53 |
| | | | Sugar maple | 196 | 2189.73 |
| | | | Tamarack 1 | 246 | 300.00 |
| | | | Tamarack 2 | 112 | 375.00 |
| | | | Tamarack 3 | 47 | 300.00 |
| | | | White birch | 141 | 1860.83 |

Appendix A. (Continued).

| Bear | Sex | Age (years) | Cover-type[a] | Total density (trees/acre) | Continuum Index |
|---|---|---|---|---|---|
| I | M | 4.5 | Aspen 1 | 341 | 1090.13 |
| | | | Aspen 2 | 298 | 1311.31 |
| | | | Black spruce | 356 | 539.35 |
| | | | Sugar maple | 196 | 2739.84 |
| | | | White birch | 279 | 1609.34 |
| B | F | 5.5 | Aspen | 122 | 1122.41 |
| | | | White ash | 204 | 2409.52 |
| | | | Yellow birch | 184 | 2248.96 |
| | | | Tamarack | 32 | 439.53 |
| C[b] | F | 6.5 | Aspen 1 | 213 | 1691.98 |
| | | | Aspen 2 | 188 | 1237.37 |
| | | | Balsam fir | 612 | 1463.59 |

[a] Cover-type name was determined by the tree species with the highest Importance Value in each stand.

[b] Female with 3 cubs.

Appendix 8. Parameters of trembling aspen cover-type used as foraging habitat by black bears in northern Wisconsin, 1981-82.

| Species | No. of trees | No. of points | Average dominance /tree | Density (Trees/ acre) | Relative density (%) | Dominance | Relative dominance (%) | Frequency | Relative frequency (%) | Importance value |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree strata (≥10.16 cm dbh) | | | | | | | | | | |
| Populus tremuloides | 140 | 62 | 0.33 | 95.16 | 48.11 | 31.40 | 48.39 | 0.85 | 37.61 | 134.11 |
| Acer saccharum | 38 | 20 | 0.60 | 25.83 | 13.06 | 15.50 | 23.89 | 0.27 | 11.95 | 48.90 |
| Acer rubrum | 40 | 27 | 0.20 | 27.20 | 13.75 | 5.44 | 8.38 | 0.37 | 16.37 | 38.50 |
| Abies balsamea | 16 | 11 | 0.26 | 10.88 | 5.50 | 2.83 | 4.36 | 0.15 | 6.64 | 16.50 |
| Betula papyrifera | 12 | 11 | 0.16 | 8.25 | 4.17 | 1.32 | 2.03 | 0.15 | 6.64 | 12.84 |
| Tilia americana | 11 | 9 | 0.25 | 7.48 | 3.78 | 1.87 | 2.88 | 0.12 | 5.31 | 11.97 |
| Quercus macrocarpa | 3 | 3 | 0.22 | 2.04 | 1.03 | 0.45 | 0.69 | 0.04 | 1.77 | 8.88 |
| Larix laricina | 7 | 3 | 0.26 | 4.77 | 2.41 | 1.24 | 1.91 | 0.04 | 1.77 | 6.09 |
| Ulmus americana | 5 | 4 | 0.28 | 3.40 | 1.72 | 0.95 | 1.46 | 0.05 | 2.21 | 5.39 |
| Picea glauca | 4 | 4 | 0.35 | 2.71 | 1.37 | 0.95 | 1.46 | 0.05 | 2.21 | 5.04 |
| Pinus strobus | 3 | 2 | 0.66 | 2.04 | 1.03 | 1.35 | 2.08 | 0.03 | 1.33 | 4.44 |
| Prunus serotina | 3 | 3 | 0.20 | 2.04 | 1.03 | 0.41 | 0.63 | 0.04 | 1.77 | 3.43 |
| Picea mariana | 2 | 2 | 0.16 | 1.36 | 0.69 | 0.22 | 0.34 | 0.03 | 1.33 | 2.36 |
| Betula alleghaniensis | 2 | 2 | 0.16 | 1.36 | 0.69 | 0.22 | 0.34 | 0.03 | 1.33 | 2.36 |
| Fraxinus pennsylvanica | 2 | 1 | 0.20 | 1.36 | 0.69 | 0.27 | 0.42 | 0.01 | 0.44 | 1.55 |

Appendix B. (Continued).

| Species | No. of trees | No. of points | Average dominance /tree | Density (Trees/ acre) | Relative density (%) | Dominance | Relative dominance (%) | Frequency | Relative frequency (%) | Importance value |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree strata (≥10.16 cm dbh) | | | | | | | | | | |
| Populus grandidentata | 1 | 1 | 0.35 | 0.67 | 0.34 | 0.23 | 0.35 | 0.01 | 0.44 | 1.13 |
| Fraxinus americana | 1 | 1 | 0.27 | 0.67 | 0.34 | 0.18 | 0.28 | 0.01 | 0.44 | 1.06 |
| Carpinus caroliniana | 1 | 1 | 0.09 | 0.67 | 0.34 | 0.06 | 0.09 | 0.01 | 0.44 | 0.87 |
| Total | 291 | 167 | - | - | 100.05 | 64.89 | 99.98 | 2.26 | 100.00 | 305.42 |

Continuum Index = 1444.99

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Corylus cornuta | 34.13 | 78.08 |
| Populus tremuloides | 7.19 | 16.44 |
| Prunus virginiana | 6.59 | 15.07 |
| Acer saccharum | 5.99 | 13.70 |
| Prunus serotina | 5.39 | 12.33 |

Appendix B. (Continued).

| Species | Presence (%) | Average frequency (%) |
| --- | --- | --- |
| Shrub strata | | |
| Amelanchier spp. | 4.19 | 9.59 |
| Acer rubrum | 3.59 | 8.22 |
| Alnus rugosa | 3.59 | 8.22 |
| Carpinus caroliniana | 3.59 | 8.22 |
| Salix spp. | 3.59 | 8.22 |
| Abies balsamea | 2.99 | 6.85 |
| Cornus stolonifera | 2.40 | 5.48 |
| Populus grandidentata | 2.40 | 5.48 |
| Acer spicatum | 1.80 | 4.11 |
| Ostrya virginiana | 1.80 | 4.11 |
| Tilia americana | 1.80 | 4.11 |
| Ulmus americana | 1.80 | 4.11 |
| Ilex verticiulata | 1.20 | 2.74 |
| Picea mariana | 1.20 | 2.74 |
| Amelanchier sanguinea | 0.60 | 1.37 |
| Cornus florida | 0.60 | 1.37 |
| Cornus racemosa | 0.60 | 1.37 |
| Cretaegus spp. | 0.60 | 1.37 |
| Fraxinus pennsylvanica | 0.60 | 1.37 |
| Larix laricina | 0.60 | 1.37 |
| Spirea alba | 0.60 | 1.37 |
| Viburnum rafinesquianum | 0.60 | 1.37 |
| Total | 100.03 | - |

Appendix B. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Graminae | 8.02 | 94.52 |
| Carex spp. | 6.16 | 72.60 |
| Aster macrophyllus | 5.70 | 67.12 |
| Sphagnum spp. | 4.07 | 47.95 |
| Fragaria vesca | 3.84 | 45.21 |
| Maianthemum canadense | 3.72 | 43.84 |
| Rubus spp. | 3.49 | 41.10 |
| Cornus canadensis | 2.79 | 32.88 |
| Pteridium aquilinum | 2.79 | 32.88 |
| Trientalis borealis | 2.79 | 32.88 |
| Aralia nudicaulis | 2.44 | 28.77 |
| Acer rubrum | 2.33 | 27.40 |
| Dierville lonicera | 1.98 | 23.29 |
| Athyrium filix-femina | 1.74 | 20.55 |
| Clintonia borealis | 1.74 | 20.55 |
| Fragaria virginiana | 1.74 | 20.55 |
| Lycopodium obscurum | 1.63 | 19.18 |
| Solidago spp. | 1.63 | 19.18 |
| Acer saccharum | 1.51 | 17.81 |
| Viola spp. | 1.51 | 17.81 |
| Anemone quinquefolia | 1.40 | 16.44 |
| Corylus cornuta | 1.40 | 16.44 |
| Equisetum spp. | 1.40 | 16.44 |
| Hieracium auranticum | 1.40 | 16.44 |

Appendix B. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Galium triflorum | 1.28 | 15.07 |
| Hepatica americana | 1.28 | 15.07 |
| Populus tremuloides | 1.05 | 12.33 |
| Waldesteinia fragarioides | 1.05 | 12.33 |
| Mitchella repens | 0.93 | 10.96 |
| Prunus serotina | 0.93 | 10.96 |
| Sanicula marilandica | 0.93 | 10.96 |
| Smilacina spp. | 0.93 | 10.96 |
| Uvularia sessilifolia | 0.93 | 10.96 |
| Aster spp. | 0.81 | 9.59 |
| Mushroom | 0.81 | 9.59 |
| Prunus virginiana | 0.81 | 9.59 |
| Abies balsamea | 0.70 | 8.22 |
| Lichens | 0.70 | 8.22 |
| Ostrya virginiana | 0.70 | 8.22 |
| Polygonatum biflorum | 0.70 | 8.22 |
| Thalictrum polygamum | 0.70 | 8.22 |
| Dryopteris spinulosa | 0.58 | 6.85 |
| Lycopodium complanatum | 0.58 | 6.85 |
| Apocynum andro saemifolium | 0.47 | 5.48 |
| Carpinus caroliniana | 0.47 | 5.48 |
| Polygonum scandens | 0.47 | 5.48 |
| Quercus macrocarpa | 0.47 | 5.48 |
| Taraxacum officinale | 0.47 | 5.48 |

Appendix B. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Thalictrum dioicum | 0.47 | 5.48 |
| Achillea millefolium | 0.35 | 4.11 |
| Chamaedaphne calyculata | 0.35 | 4.11 |
| Cornus alternifolia | 0.35 | 4.11 |
| Geum aleppicum | 0.35 | 4.11 |
| Impatiens biflora | 0.35 | 4.11 |
| Lathyrus ochroleucus | 0.35 | 4.11 |
| Lonicera spp. | 0.35 | 4.11 |
| Onoclea sensibilis | 0.35 | 4.11 |
| Polytrichum commune | 0.35 | 4.11 |
| Pyrola spp. | 0.35 | 4.11 |
| Ribes spp. | 0.35 | 4.11 |
| Scutellaria ebilobiifolia | 0.35 | 4.11 |
| Streptopus roseus | 0.35 | 4.11 |
| Vaccinium myrtilloides | 0.35 | 4.11 |
| Cornus stolonifera | 0.23 | 2.74 |
| Epilobium aungustifolium | 0.23 | 2.74 |
| Gaultheria procumbens | 0.23 | 2.74 |
| Hepitica spp. | 0.23 | 2.74 |
| Lathyrus spp. | 0.23 | 2.74 |
| Lycopodium spp. | 0.23 | 2.74 |
| Osmorhiza claytonii | 0.23 | 2.74 |
| Osmunda claytoniana | 0.23 | 2.74 |
| Populus spp. | 0.23 | 2.74 |
| Prenanthes alba | 0.23 | 2.74 |

Appendix B. (Continued).

| Species | Presence (%) | Average frequency (%) |
| --- | --- | --- |
| Herb strata | | |
| Prunella vulgaris | 0.23 | 2.74 |
| Pyrola minor | 0.23 | 2.74 |
| Ranunculus acris | 0.23 | 2.74 |
| Solidago spp. | 0.23 | 2.74 |
| Trillium grandifolium | 0.23 | 2.74 |
| Viburnum spp. | 0.23 | 2.74 |
| Viola pubescens | 0.23 | 2.74 |
| Alnus rugosa | 0.12 | 1.37 |
| Amelanchier spp. | 0.12 | 1.37 |
| Aster divaricatus | 0.12 | 1.37 |
| Betula papyrifera | 0.12 | 1.37 |
| Blephelia hirsuta | 0.12 | 1.37 |
| Botrychium virginianum | 0.12 | 1.37 |
| Caulophyllum thalictroides | 0.12 | 1.37 |
| Cirsium spp. | 0.12 | 1.37 |
| Clematis virginiana | 0.12 | 1.37 |
| Convolvulus spithamaeus | 0.12 | 1.37 |
| Cornus rugosa | 0.12 | 1.37 |
| Eupatorium maculatum | 0.12 | 1.37 |
| Fraxinus spp. | 0.12 | 1.37 |
| Galium asprellum | 0.12 | 1.37 |
| Gaultheria hispidula | 0.12 | 1.37 |
| Geranium maculatum | 0.12 | 1.37 |
| Houstonia serpyllifolia | 0.12 | 1.37 |
| Hybanthus concolor | 0.12 | 1.37 |

Appendix B. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Ilex verticillata | 0.12 | 1.37 |
| Impatiens spp. | 0.12 | 1.37 |
| Kalmia polifolia | 0.12 | 1.37 |
| Lactuca canadensis | 0.12 | 1.37 |
| Larix laricina | 0.12 | 1.37 |
| Lathyrus ochroleucus | 0.12 | 1.37 |
| Lycopodium clavatum | 0.12 | 1.37 |
| Lycopodium tristachyum | 0.12 | 1.37 |
| Matteuccia struthiopteris | 0.12 | 1.37 |
| Mitella diphylla | 0.12 | 1.37 |
| Picea mariana | 0.12 | 1.37 |
| Polygonum arifolium | 0.12 | 1.37 |
| Polygonum cilinode | 0.12 | 1.37 |
| Polygonum sagittatum | 0.12 | 1.37 |
| Prenanthes altissima | 0.12 | 1.37 |
| Rosa multiflora | 0.12 | 1.37 |
| Salix spp. | 0.12 | 1.37 |
| Sonchus oleraceus | 0.12 | 1.37 |
| Spirea tomentosa | 0.12 | 1.37 |
| Tilia americana | 0.12 | 1.37 |
| Trifolium pratense | 0.12 | 1.37 |
| Ulmus spp. | 0.12 | 1.37 |
| Uvularia perfoliata | 0.12 | 1.37 |
| Total | 100.17 | - |

Appendix C. Parameters of red maple cover-type used as foraging habitat by black bears in northern Wisconsin, 1981-82.

| Species | No. of trees | No. of points | Average dominance /tree | Density (Trees/ acre) | Relative density (%) | Dominance | Relative dominance (%) | Frequency | Relative frequency (%) | Importance value |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree strata (≳ 10.16 cm dbh) | | | | | | | | | | |
| Acer rubrum | 67 | 30 | 0.28 | 39.76 | 45.27 | 11.13 | 39.36 | 0.73 | 35.10 | 119.73 |
| Acer saccharum | 34 | 18 | 0.27 | 20.17 | 22.97 | 5.45 | 19.27 | 0.44 | 21.15 | 63.39 |
| Abies balsamea | 11 | 10 | 0.39 | 6.53 | 7.43 | 2.55 | 9.02 | 0.24 | 11.54 | 27.99 |
| Picea glauca | 7 | 4 | 0.73 | 4.15 | 4.73 | 3.03 | 10.71 | 0.10 | 4.81 | 20.25 |
| Larix laricina | 4 | 3 | 0.89 | 2.37 | 2.70 | 2.11 | 7.46 | 0.07 | 3.37 | 13.53 |
| Betula papyrifera | 5 | 4 | 0.42 | 2.97 | 3.38 | 1.25 | 4.42 | 0.10 | 4.81 | 12.61 |
| Populus tremuloides | 4 | 4 | 0.21 | 2.37 | 2.70 | 0.50 | 1.77 | 0.10 | 4.81 | 9.28 |
| Ulmus americana | 4 | 3 | 0.21 | 2.37 | 2.70 | 0.50 | 1.77 | 0.07 | 3.37 | 7.84 |
| Carpinus caroliniana | 3 | 2 | 0.16 | 1.78 | 2.03 | 0.28 | 0.99 | 0.05 | 2.40 | 5.42 |
| Thuja occidentalis | 2 | 2 | 0.35 | 1.19 | 1.35 | 0.42 | 1.49 | 0.05 | 2.40 | 5.24 |
| Prunus serotina | 2 | 2 | 0.27 | 1.19 | 1.35 | 0.32 | 1.13 | 0.05 | 2.40 | 4.88 |
| Picea mariana | 2 | 1 | 0.23 | 1.19 | 1.35 | 0.27 | 0.95 | 0.02 | 0.96 | 3.26 |
| Fraxinus nigra | 1 | 1 | 0.44 | 0.60 | 0.68 | 0.26 | 0.92 | 0.02 | 0.96 | 2.56 |
| Fraxinus americana | 1 | 1 | 0.27 | 0.60 | 0.68 | 0.16 | 0.57 | 0.02 | 0.96 | 2.21 |

Appendix C. (Continued).

| Species | No. of trees | No. of points | Average dominance /tree | Density (Trees/ acre) | Relative density (%) | Dominance | Relative dominance (%) | Frequency | Relative frequency (%) | Importance value |
|---|---|---|---|---|---|---|---|---|---|---|
| Ostrya virginiana | 1 | 1 | 0.09 | 0.60 | 0.68 | 0.05 | 0.18 | 0.02 | 0.96 | 1.82 |
| Total | 148 | 86 | - | - | 100.00 | 28.28 | 100.01 | 2.08 | 100.00 | 300.01 |

Continuum Index = 1977.65

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Corylus cornuta | 33.80 | 58.54 |
| Alnus rugosa | 15.49 | 26.83 |
| Populus tremuloides | 9.86 | 17.07 |
| Acer rubrum | 8.45 | 14.63 |
| Prunus serotina | 7.04 | 12.20 |
| Cornus alternifolia | 4.23 | 7.32 |
| Rubus spp. | 4.23 | 7.32 |
| Abies balsamea | 2.82 | 4.88 |
| Acer saccharum | 2.82 | 4.88 |

Appendix C. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Fraxinus nigra | 2.82 | 4.88 |
| Ilex verticillata | 2.82 | 4.88 |
| Salix spp. | 2.82 | 4.88 |
| Carpinus caroliniana | 1.41 | 2.44 |
| Quercus bicolor | 1.41 | 2.44 |
| Total | 100.02 | - |

Appendix C. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Graminae | 9.02 | 85.37 |
| Carex spp. | 8.25 | 78.05 |
| Sphagnum spp. | 6.70 | 63.41 |
| Rubus spp. | 6.44 | 60.98 |
| Fragaria virginiana | 3.87 | 36.59 |
| Aster macrophyllus | 3.35 | 31.71 |
| Fragaria vesca | 3.35 | 31.71 |
| Pteridium aquilinum | 3.09 | 29.27 |
| Clintonia borealis | 2.58 | 24.39 |
| Cornus canadensis | 2.58 | 24.39 |
| Acer rubrum | 2.06 | 19.51 |
| Aster spp. | 2.06 | 19.51 |
| Prunus serotina | 2.06 | 19.51 |
| Solidago spp. | 2.06 | 19.51 |
| Trientalis borealis | 2.06 | 19.51 |
| Corylus cornuta | 1.80 | 17.07 |
| Galium asperllum | 1.80 | 17.07 |
| Lycopodium obscurum | 1.80 | 17.07 |
| Maianthemum canadense | 1.80 | 17.07 |
| Dierville lonicera | 1.55 | 14.63 |
| Equisetum spp. | 1.55 | 14.63 |
| Impatiens biflora | 1.55 | 14.63 |
| Viola spp. | 1.55 | 14.63 |
| Athyrium filix-femina | 1.03 | 9.76 |

Appendix C. (Continued).

| Species | Presence (%) | Average frequency (%) |
| --- | --- | --- |
| Herb strata | | |
| Botrychium virginianum | 1.03 | 9.76 |
| Dryopteris spinulosa | 1.03 | 9.76 |
| Galium triflorum | 1.03 | 9.76 |
| Hepatica americana | 1.03 | 9.76 |
| Hieracium auranticum | 1.03 | 9.76 |
| Pyrola spp. | 1.03 | 9.76 |
| Alnus rugosa | 0.77 | 7.32 |
| Anemone quinquefolia | 0.77 | 7.32 |
| Cirsium spp. | 0.77 | 7.32 |
| Fraxinus americana | 0.77 | 7.32 |
| Fraxinus nigra | 0.77 | 7.32 |
| Mushroom | 0.77 | 7.32 |
| Ribes spp. | 0.77 | 7.32 |
| Salix spp. | 0.77 | 7.32 |
| Viola pubescens | 0.77 | 7.32 |
| Acer spicatum | 0.52 | 4.88 |
| Geranium maculatum | 0.52 | 4.88 |
| Geum macrophyllum | 0.52 | 4.88 |
| Lactuca spp. | 0.52 | 4.88 |
| Lycopodium lucidulum | 0.52 | 4.88 |
| Mitchella repens | 0.52 | 4.88 |
| Osmunda claytoniana | 0.52 | 4.88 |
| Polygonum saggitatum | 0.52 | 4.88 |
| Prunus virginiana | 0.52 | 4.88 |

Appendix C. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Sanicula marilandica | 0.52 | 4.88 |
| Ulmus americana | 0.52 | 4.88 |
| Abies balsamea | 0.26 | 2.44 |
| Acer saccharum | 0.26 | 2.44 |
| Amelanchier spp. | 0.26 | 2.44 |
| Apocynum androsaemifolium | 0.26 | 2.44 |
| Aralia nudicaulus | 0.26 | 2.44 |
| Carpinus caroliniana | 0.26 | 2.44 |
| Clemantis virginiana | 0.26 | 2.44 |
| Cornus alternifolia | 0.26 | 2.44 |
| Cornus racemosa | 0.26 | 2.44 |
| Corylus americana | 0.26 | 2.44 |
| Dryopteris marginalis | 0.26 | 2.44 |
| Epilobium glandulosum | 0.26 | 2.44 |
| Gaultheria hispidula | 0.26 | 2.44 |
| Gaultheria procumbens | 0.26 | 2.44 |
| Geum aleppicum | 0.26 | 2.44 |
| Glyceria canadensis | 0.26 | 2.44 |
| Ilex verticillata | 0.26 | 2.44 |
| Lactuca scariola | 0.26 | 2.44 |
| Lycopodium complanatum | 0.26 | 2.44 |
| Lycopus spp. | 0.26 | 2.44 |
| Mentha spp. | 0.26 | 2.44 |
| Ostrya virginiana | 0.26 | 2.44 |

Appendix C. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Polytrichum commune | 0.26 | 2.44 |
| Ranunculus spp. | 0.26 | 2.44 |
| Sonchus oleraceus | 0.26 | 2.44 |
| Streptopus roseus | 0.26 | 2.44 |
| Uvularia sessilifolia | 0.26 | 2.44 |
| Vaccinium spp. | 0.26 | 2.44 |
| Total | 100.07 | - |

Appendix O. Parameters of white ash cover-type used as foraging habitat by black bears in northern Wisconsin, 1981-82.

| Species | No. of trees | No. of points | Average dominance /tree | Density (Trees/ acre) | Relative density (%) | Dominance | Relative dominance (%) | Frequency | Relative frequency (%) | Importance value |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree strata (≥10.16 cm dbh) | | | | | | | | | | |
| Fraxinus americana | 6 | 5 | 0.27 | 43.66 | 21.43 | 11.79 | 18.65 | 0.71 | 31.14 | 71.22 |
| Fraxinus nigra | 6 | 3 | 0.17 | 43.66 | 21.43 | 7.42 | 11.74 | 0.43 | 18.86 | 52.03 |
| Acer saccharum | 4 | 1 | 0.66 | 29.11 | 14.29 | 19.21 | 30.39 | 0.14 | 6.14 | 50.82 |
| Tsuga canadensis | 2 | 1 | 0.92 | 14.55 | 7.14 | 13.39 | 21.18 | 0.14 | 6.14 | 34.46 |
| Ulmus americana | 4 | 2 | 0.12 | 29.11 | 14.29 | 3.49 | 5.52 | 0.29 | 12.79 | 32.60 |
| Tilia americana | 3 | 2 | 0.22 | 21.82 | 10.71 | 4.80 | 7.59 | 0.29 | 12.79 | 31.09 |
| Betula alleghaniensis | 2 | 1 | 0.17 | 14.55 | 7.14 | 2.47 | 3.91 | 0.14 | 6.14 | 17.19 |
| Ostrya virginiana | 1 | 1 | 0.09 | 7.27 | 3.57 | 0.65 | 1.03 | 0.14 | 6.14 | 10.74 |
| Total | 28 | 16 | - | - | 100.00 | 63.22 | 100.01 | 2.28 | 100.14 | 300.15 |

Continuum Index = 2409.52

Appendix D. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Acer saccharum | 20.00 | 42.86 |
| Fraxinus americana | 13.33 | 28.57 |
| Sambucus pubens | 13.33 | 28.57 |
| Ulmus americana | 13.33 | 28.57 |
| Cornus alternifolia | 6.67 | 14.29 |
| Ostrya virginiana | 6.67 | 14.29 |
| Prunus serotina | 6.67 | 14.29 |
| Rubus spp. | 6.67 | 14.29 |
| Tilia americana | 6.67 | 14.29 |
| Viburnum lentago | 6.67 | 14.29 |
| Total | 100.01 | - |
| Herb strata | | |
| Carex spp. | 6.00 | 85.71 |
| Graminae | 6.00 | 85.71 |
| Viola spp. | 6.00 | 85.71 |
| Solidago spp. | 5.00 | 71.43 |
| Dryopteris spinulosa | 4.00 | 57.14 |
| Laportea canadensis | 4.00 | 57.14 |
| Rubus spp. | 4.00 | 57.14 |
| Sphagnum spp. | 4.00 | 57.14 |
| Acer saccharum | 3.00 | 42.86 |
| Fraxinus americana | 3.00 | 42.86 |
| Osmorhiza claytoni | 3.00 | 42.86 |

Appendix D. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Polygonum scandens | 3.00 | 42.86 |
| Sonchus oleraceus | 3.00 | 42.86 |
| Tiarella cordifolia | 3.00 | 42.86 |
| Arisaema triphyllum | 2.00 | 28.57 |
| Betula alleghenìensis | 2.00 | 28.57 |
| Cirsium spp. | 2.00 | 28.57 |
| Cornus alternifolia | 2.00 | 28.57 |
| Fragaria virginiana | 2.00 | 28.57 |
| Galium triflorum | 2.00 | 28.57 |
| Matteuccia pennsylvanica | 2.00 | 28.57 |
| Sambucus pubens | 2.00 | 28.57 |
| Thelypteris phegopteris | 2.00 | 28.57 |
| Uvularia sessilifolia | 2.00 | 28.57 |
| Acer rubrum | 1.00 | 14.29 |
| Actaea pachypoda | 1.00 | 14.29 |
| Adiantum pedatum | 1.00 | 14.29 |
| Anaphalis margaritacea | 1.00 | 14.29 |
| Apocynum androsaemifolium | 1.00 | 14.29 |
| Athyrium filix-femina | 1.00 | 14.29 |
| Aster macrophyllus | 1.00 | 14.29 |
| Aster spp. | 1.00 | 14.29 |
| Diervìlle lonicera | 1.00 | 14.29 |
| Erigeron canadensis | 1.00 | 14.29 |
| Galium asprellum | 1.00 | 14.29 |

Appendix D. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Hieracium auranticum | 1.00 | 14.29 |
| Hydrophyllum virginianum | 1.00 | 14.29 |
| Lactuca canadensis | 1.00 | 14.29 |
| Lychnis alba | 1.00 | 14.29 |
| Lycopus virginicus | 1.00 | 14.29 |
| Maianthemum canadense | 1.00 | 14.29 |
| Mushroom | 1.00 | 14.29 |
| Onoclea sensibilis | 1.00 | 14.29 |
| Partheniscicus quinquefolia | 1.00 | 14.29 |
| Ribes spp. | 1.00 | 14.29 |
| Taraxacum officinale | 1.00 | 14.29 |
| Viola pubescens | 1.00 | 14.29 |
| Total | 100.00 | - |

Appendix E. Parameters of yellow birch cover-type used as foraging habitat by black bears in northern Wisconsin, 1981-82.

| Species | No. of trees | No. of points | Average dominance /tree | Density (Trees/ acre) | Relative density (%) | Dominance | Relative dominance (%) | Frequency | Relative frequency (%) | Importance value |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree strata (≥ 10.16 cm dbh) | | | | | | | | | | |
| Betula alleghaniensis | 16 | 8 | 0.39 | 66.77 | 36.36 | 14.18 | 30.53 | 0.31 | 30.69 | 97.58 |
| Fraxinus nigra | 13 | 7 | 0.27 | 54.26 | 29.55 | 7.98 | 17.18 | 0.27 | 26.73 | 73.46 |
| Acer saccharum | 4 | 2 | 1.44 | 16.69 | 9.09 | 13.09 | 28.18 | 0.08 | 7.92 | 45.19 |
| Acer rubrum | 5 | 4 | 0.24 | 20.86 | 11.36 | 2.73 | 5.88 | 0.15 | 14.85 | 32.09 |
| Tsuga canadensis | 3 | 2 | 0.88 | 12.52 | 6.82 | 6.00 | 12.92 | 0.08 | 7.92 | 27.66 |
| Fraxinus americana | 1 | 1 | 0.55 | 4.17 | 2.27 | 1.25 | 2.69 | 0.04 | 3.96 | 8.92 |
| Abies balsamea | 1 | 1 | 0.27 | 4.17 | 2.27 | 0.61 | 1.31 | 0.04 | 3.96 | 7.54 |
| Betula papyrifera | 1 | 1 | 0.27 | 4.17 | 2.27 | 0.61 | 1.31 | 0.04 | 3.96 | 7.54 |
| Total | 44 | 26 | - | - | 99.99 | 46.45 | 100.00 | 1.01 | 99.99 | 299.98 |

Continuum Index = 2248.96

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Corylus cornuta | 12.12 | 36.36 |

Appendix E. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Fraxinus americana | 12.12 | 36.36 |
| Fraxinus nigra | 12.12 | 36.36 |
| Betula alleghaniensis | 9.09 | 27.27 |
| Acer rubrum | 6.06 | 18.18 |
| Acer saccharum | 6.06 | 18.18 |
| Alnus rugosa | 6.06 | 18.18 |
| Ostrya virginiana | 6.06 | 18.18 |
| Abies balsamea | 3.03 | 9.09 |
| Acer spicatum | 3.03 | 9.09 |
| Betula papyrifera | 3.03 | 9.09 |
| Ilex verticillata | 3.03 | 9.09 |
| Quercus ellipsoidalis | 3.03 | 9.09 |
| Rhus spp. | 3.03 | 9.09 |
| Rubus spp. | 3.03 | 9.09 |
| Salix spp. | 3.03 | 9.09 |
| Sambucus pubens | 3.03 | 9.09 |
| Tilia americana | 3.03 | 9.09 |
| Total | 99.99 | - |
| Herb strata | | |
| Carex spp. | 7.04 | 90.91 |
| Graminae | 6.34 | 81.81 |
| Sphagnum spp. | 4.93 | 63.63 |
| Viola spp. | 4.23 | 54.54 |
| Athyrium filix-femina | 3.52 | 45.45 |

Appendix E. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Arisaema triphyllum | 3.52 | 45.45 |
| Dryopteris spinulosa | 3.52 | 45.45 |
| Galium triflorum | 3.52 | 45.45 |
| Acer rubrum | 2.82 | 36.36 |
| Fraxinus nigra | 2.82 | 36.36 |
| Maianthemum canadense | 2.82 | 36.36 |
| Mushroom | 2.82 | 36.36 |
| Rubus spp. | 2.82 | 36.36 |
| Abies balsamea | 2.11 | 27.27 |
| Acer saccharum | 2.11 | 27.27 |
| Equisetum spp. | 2.11 | 27.27 |
| Lichens | 2.11 | 27.27 |
| Adiantum pedatum | 1.41 | 18.18 |
| Betula allegheniensis | 1.41 | 18.18 |
| Chrysosplenium americanum | 1.41 | 18.18 |
| Cornus alternifolia | 1.41 | 18.18 |
| Galium asprellum | 1.41 | 18.18 |
| Lactuca canadensis | 1.41 | 18.18 |
| Lycopus uniflorus | 1.41 | 18.18 |
| Onoclea sensibilis | 1.41 | 18.18 |
| Scutellaria laterifolia | 1.41 | 18.18 |
| Thelypteris phegopteris | 1.41 | 18.18 |
| Trientalis borealis | 1.41 | 18.18 |
| Amphicarpa bracteata | 0.70 | 9.09 |

Appendix E. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Anemone quinquefolia | 0.70 | 9.09 |
| Aquilegia canadensis | 0.70 | 9.09 |
| Asclepias exaltata | 0.70 | 9.09 |
| Aster spp. | 0.70 | 9.09 |
| Bidens spp. | 0.70 | 9.09 |
| Caltha palustris | 0.70 | 9.09 |
| Caulophyllum thalictroides | 0.70 | 9.09 |
| Circaea quadrisulcata | 0.70 | 9.09 |
| Cirsium spp. | 0.70 | 9.09 |
| Clintonia borealis | 0.70 | 9.09 |
| Cornus canadensis | 0.70 | 9.09 |
| Corylus cornuta | 0.70 | 9.09 |
| Fraxinus americana | 0.70 | 9.09 |
| Fragaria virginiana | 0.70 | 9.09 |
| Gymnocarpium dryopteris | 0.70 | 9.09 |
| Hieracium gronovii | 0.70 | 9.09 |
| Impatiens pallida | 0.70 | 9.09 |
| Lonicera spp. | 0.70 | 9.09 |
| Lycopodium complanatum | 0.70 | 9.09 |
| Matteucia pennsylvanica | 0.70 | 9.09 |
| Osmunda claytoniana | 0.70 | 9.09 |
| Oxalis montana | 0.70 | 9.09 |
| Parthenocissus quinquefolia | 0.70 | 9.09 |
| Polygonum arifolium | 0.70 | 9.09 |

Appendix E. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Polygonum scandens | 0.70 | 9.09 |
| Polygonum spp. | 0.70 | 9.09 |
| Populus tremuloides | 0.70 | 9.09 |
| Prunus virginiana | 0.70 | 9.09 |
| Quercus rubra | 0.70 | 9.09 |
| Ribes spp. | 0.70 | 9.09 |
| Solidago spp. | 0.70 | 9.09 |
| Sonchus oleraceus | 0.70 | 9.09 |
| Taraxacum officinale | 0.70 | 9.09 |
| Tsuga canadensis | 0.70 | 9.09 |
| Urtica dioica | 0.70 | 9.09 |
| Total | 99.87 | - |

Appendix F. Parameters of opening cover-type used as foraging habitat by black bears in northern Wisconsin, 1981-82.

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Populus tremuloides | 27.50 | 91.67 |
| Corylus cornuta | 20.00 | 66.67 |
| Salix spp. | 17.50 | 58.33 |
| Prunus virginiana | 10.00 | 33.33 |
| Ulmus americana | 10.00 | 33.33 |
| Abies balsamea | 2.50 | 8.33 |
| Acer saccharum | 2.50 | 8.33 |
| Acer spicatum | 2.50 | 8.33 |
| Alnus spp. | 2.50 | 8.33 |
| Prunus serotina | 2.50 | 8.33 |
| Spirea alba | 2.50 | 8.33 |
| Total | 100.00 | - |
| Herb strata | | |
| Graminae | 8.00 | 100.00 |
| Fragaria virginiana | 6.67 | 83.33 |
| Aster macrophyllus | 6.00 | 75.00 |
| Pteridium aquilinum | 5.33 | 66.67 |
| Hieracium auranticum | 4.67 | 58.33 |
| Carex spp. | 4.00 | 50.00 |
| Dierville lonicera | 4.00 | 50.00 |
| Rubus spp. | 4.00 | 50.00 |
| Trifolium pratense | 4.00 | 50.00 |
| Aster spp. | 3.33 | 41.67 |

Appendix F. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Cornus canadensis | 3.33 | 41.67 |
| Solidago spp. | 3.33 | 41.67 |
| Sphagnum spp. | 3.33 | 41.67 |
| Taraxacum officinale | 3.33 | 41.67 |
| Apocynum androsaemifolium | 2.67 | 33.33 |
| Epilobium angustifolium | 2.67 | 33.33 |
| Populus tremuloides | 2.67 | 33.33 |
| Achillea millefolium | 2.00 | 25.00 |
| Anaphalis margaritacae | 2.00 | 25.00 |
| Athyrium filix-femina | 2.00 | 25.00 |
| Lycopodium obscurum | 2.00 | 25.00 |
| Achillea millefolium | 1.33 | 16.67 |
| Anemone quinquefolia | 1.33 | 16.67 |
| Cirsium spp. | 1.33 | 16.67 |
| Onoclea sensibilis | 1.33 | 16.67 |
| Salix spp. | 1.33 | 16.67 |
| Streptopus roseus | 1.33 | 16.67 |
| Vaccinium myrtilloides | 1.33 | 16.67 |
| Antennaria spp. | 0.67 | 8.33 |
| Asclepias spp. | 0.67 | 8.33 |
| Asclepias syriaca | 0.67 | 8.33 |
| Castilleja coccinea | 0.67 | 8.33 |
| Corylus cornuta | 0.67 | 8.33 |
| Desmodium spp. | 0.67 | 8.33 |

Appendix F. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Hieracium vulgatum | 0.67 | 8.33 |
| Maianthemum canadense | 0.67 | 8.33 |
| Mushroom | 0.67 | 8.33 |
| Oenothera biennis | 0.67 | 8.33 |
| Polygonatum biflorum | 0.67 | 8.33 |
| Polygonum scandens | 0.67 | 8.33 |
| Pyrola spp. | 0.67 | 8.33 |
| Trientalis borealis | 0.67 | 8.33 |
| Trifolium repens | 0.67 | 8.33 |
| Uvularia sessilifolia | 0.67 | 8.33 |
| Viola spp. | 0.67 | 8.33 |
| Total | 100.03 | - |

Appendix G. Parameters of sugar maple cover-type used as transit habitat by black bears in northern Wisconsin, 1981-82.

| Species | No. of trees | No. of points | Average dominance /tree | Density (Trees/ acre) | Relative density (%) | Dominance | Relative dominance (%) | Frequency | Relative frequency (%) | Importance value |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree strata (≥ 10.16 cm dbh) | | | | | | | | | | |
| Acer saccharum | 76 | 29 | 0.43 | 89.48 | 48.72 | 38.48 | 52.97 | 0.74 | 34.74 | 136.43 |
| Abies balsamea | 23 | 12 | 0.16 | 27.07 | 14.74 | 4.33 | 5.96 | 0.31 | 14.55 | 35.25 |
| Acer rubrum | 15 | 10 | 0.33 | 18.67 | 9.62 | 6.16 | 8.48 | 0.26 | 12.21 | 30.31 |
| Tilia americana | 11 | 8 | 0.70 | 12.95 | 7.05 | 9.07 | 12.48 | 0.21 | 9.86 | 29.39 |
| Betula allegheniensis | 6 | 5 | 0.48 | 7.07 | 3.85 | 3.39 | 4.67 | 0.13 | 6.10 | 14.62 |
| Populus tremuloides | 5 | 5 | 0.37 | 5.90 | 3.21 | 2.18 | 3.00 | 0.13 | 6.10 | 12.31 |
| Fraxinus nigra | 6 | 3 | 0.38 | 7.07 | 3.85 | 2.69 | 3.70 | 0.08 | 3.76 | 11.31 |
| Betula papyrifera | 4 | 3 | 0.69 | 4.70 | 2.56 | 3.24 | 4.46 | 0.08 | 3.76 | 10.78 |
| Fraxinus americana | 3 | 2 | 0.35 | 3.53 | 1.92 | 1.24 | 1.71 | 0.05 | 2.35 | 5.98 |
| Tsuga canadensis | 3 | 2 | 0.29 | 3.53 | 1.92 | 1.02 | 1.40 | 0.05 | 2.35 | 5.67 |
| Quercue rubra | 2 | 1 | 0.27 | 2.35 | 1.28 | 0.63 | 0.87 | 0.03 | 1.41 | 3.56 |
| Ostrya virginiana | 1 | 1 | 0.09 | 1.18 | 0.64 | 0.11 | 0.15 | 0.03 | 1.41 | 2.20 |
| Picea glauca | 1 | 1 | 0.09 | 1.18 | 0.64 | 0.11 | 0.15 | 0.03 | 1.41 | 2.20 |
| Total | 156 | 82 | - | - | 100.00 | 72.65 | 100.00 | 2.13 | 100.01 | 300.01 |

Continuum Index = 2438.93

Appendix G. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Acer saccharum | 14.29 | 25.64 |
| Corylus cornuta | 14.29 | 25.64 |
| Abies balsamea | 12.86 | 23.08 |
| Ostrya virginiana | 12.86 | 23.08 |
| Populus tremuloides | 7.14 | 12.82 |
| Acer spicatum | 4.29 | 7.69 |
| Alnus rugosa | 4.29 | 7.69 |
| Dirca palustris | 4.29 | 7.69 |
| Tilia americana | 4.29 | 7.69 |
| Amelanchier spp. | 2.86 | 5.13 |
| Cornus florida | 2.86 | 5.13 |
| Sambucus pubens | 2.86 | 5.13 |
| Tsuga canadensis | 2.86 | 5.13 |
| Acer rubrum | 1.43 | 2.56 |
| Fraxinus americana | 1.43 | 2.56 |
| Fraxinus nigra | 1.43 | 2.56 |
| Prunus serotina | 1.43 | 2.56 |
| Prunus virginiana | 1.43 | 2.56 |
| Quercus alba | 1.43 | 2.56 |
| Salix spp. | 1.43 | 2.56 |
| Total | 100.05 | - |

Appendix G. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Graminae | 9.29 | 76.92 |
| Carex spp. | 8.67 | 71.79 |
| Acer saccharum | 5.88 | 48.72 |
| Sphagnum spp. | 3.72 | 30.77 |
| Aralia nudicaulus | 3.10 | 25.64 |
| Maianthemum canadense | 2.79 | 23.08 |
| Trientalis borealis | 2.79 | 23.08 |
| Aster macrophyllus | 2.48 | 20.51 |
| Cornus canadensis | 2.48 | 20.51 |
| Polygonatum biflorum | 2.48 | 20.51 |
| Hieracium auranticum | 2.17 | 17.95 |
| Mitchella repens | 2.17 | 17.95 |
| Acer rubrum | 1.86 | 15.38 |
| Athyrium filix-femina | 1.86 | 15.38 |
| Corylus cornuta | 1.86 | 15.38 |
| Fragaria vesca | 1.86 | 15.38 |
| Lycopodium complanatum | 1.86 | 15.38 |
| Rubus spp. | 1.86 | 15.38 |
| Streptopus roseus | 1.86 | 15.38 |
| Fragaria virginiana | 1.55 | 12.82 |
| Osmorhiza claytoni | 1.55 | 12.82 |
| Pteridium aquilinum | 1.55 | 12.82 |
| Cornus alternifolia | 1.24 | 10.26 |
| Dryopteris spinulosa | 1.24 | 10.26 |

Appendix G. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Impatiens biflora | 1.24 | 10.26 |
| Lycopodium obscurum | 1.24 | 10.26 |
| Prunus virginiana | 1.24 | 10.26 |
| Viola spp. | 1.24 | 10.26 |
| Alnus rugosa | 0.93 | 7.69 |
| Botryelium virginianum | 0.93 | 7.69 |
| Clintonia borealis | 0.93 | 7.69 |
| Fraxinus americana | 0.93 | 7.69 |
| Fraxinus nigra | 0.93 | 7.69 |
| Mushroom | 0.93 | 7.69 |
| Osmorphiza claytoni | 0.93 | 7.69 |
| Populus tremuloides | 0.93 | 7.69 |
| Pyrola spp. | 0.93 | 7.69 |
| Ranunculus acris | 0.93 | 7.69 |
| Abies balsamea | 0.62 | 5.13 |
| Acer spicatum | 0.62 | 5.13 |
| Anemone quinquefolia | 0.62 | 5.13 |
| Arisaema triphylum | 0.62 | 5.13 |
| Dirca palustris | 0.62 | 5.13 |
| Hieracium spp. | 0.62 | 5.13 |
| Lathyrus spp. | 0.62 | 5.13 |
| Lichens | 0.62 | 5.13 |
| Prunus serotina | 0.62 | 5.13 |
| Quercus borealis | 0.62 | 5.13 |

Appendix G. (Continued).

| Species | Presence (%) | Average frequency (%) |
| --- | --- | --- |
| Herb strata | | |
| Sarracenia purpurea | 0.62 | 5.13 |
| Thalictrum spp. | 0.62 | 5.13 |
| Tilia americana | 0.62 | 5.13 |
| Trillium grandiflorum | 0.62 | 5.13 |
| Aster ontarionis | 0.31 | 2.56 |
| Aster spp. | 0.31 | 2.56 |
| Betula papyrifera | 0.31 | 2.56 |
| Caulophyllum thalictroides | 0.31 | 2.56 |
| Cirsium spp. | 0.31 | 2.56 |
| Cornus florida | 0.31 | 2.56 |
| Dierville lonicera | 0.31 | 2.56 |
| Eleocharis spp. | 0.31 | 2.56 |
| Equisetum spp. | 0.31 | 2.56 |
| Fragaria virginiana | 0.31 | 2.56 |
| Fraxinus spp. | 0.31 | 2.56 |
| Galium triflorum | 0.31 | 2.56 |
| Impatiens capensis | 0.31 | 2.56 |
| Lycopodium lucidulum | 0.31 | 2.56 |
| Mitella diphylla | 0.31 | 2.56 |
| Ostrya virginiana | 0.31 | 2.56 |
| Oxalis stricta | 0.31 | 2.56 |
| Polygonum sagitatum | 0.31 | 2.56 |
| Polytrichum commune | 0.31 | 2.56 |
| Prenanthes alba | 0.31 | 2.56 |

Appendix G. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Quercus macrocarpa | 0.31 | 2.56 |
| Quercus rubra | 0.31 | 2.56 |
| Ribes spp. | 0.31 | 2.56 |
| Sanicula marilandica | 0.31 | 2.56 |
| Scutellaria lateriflora | 0.31 | 2.56 |
| Sonchus oleraceus | 0.31 | 2.56 |
| Stellaria graminea | 0.31 | 2.56 |
| Tanacetum vulgare | 0.31 | 2.56 |
| Waldsteinia fragariodes | 0.31 | 2.56 |
| Total | 100.10 | - |

Appendix H. Parameters of white birch cover-type used as transit habitat by black bears in northern Wisconsin, 1981-82.

| Species | No. of trees | No. of points | Average dominance /tree | Density (Trees/ acre) | Relative density (%) | Dominance | Relative dominance (%) | Frequency | Relative frequency (%) | Importance value |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree strata (≥10.16 cm dbh) | | | | | | | | | | |
| Betula papyrifera | 22 | 11 | 0.31 | 69.23 | 36.67 | 21.46 | 34.30 | 0.73 | 31.20 | 102.17 |
| Acer saccharum | 12 | 7 | 0.33 | 37.76 | 20.00 | 12.46 | 19.91 | 0.47 | 20.09 | 60.00 |
| Populus tremuloides | 6 | 4 | 0.51 | 18.88 | 10.00 | 9.63 | 15.39 | 0.27 | 11.54 | 36.93 |
| Quercus macrocarpa | 5 | 3 | 0.37 | 15.73 | 8.33 | 5.82 | 9.30 | 0.20 | 8.55 | 26.18 |
| Acer rubrum | 4 | 2 | 0.25 | 12.59 | 6.67 | 3.15 | 5.03 | 0.13 | 5.56 | 17.26 |
| Abies balsamea | 4 | 2 | 0.20 | 12.59 | 6.67 | 2.52 | 4.03 | 0.13 | 5.56 | 16.26 |
| Tilia americana | 3 | 2 | 0.22 | 9.44 | 5.00 | 2.08 | 3.32 | 0.13 | 5.56 | 13.88 |
| Fraxinus americana | 1 | 1 | 0.79 | 3.15 | 1.67 | 2.49 | 3.98 | 0.07 | 2.99 | 8.64 |
| Betula alleghaniensis | 1 | 1 | 0.66 | 3.15 | 1.67 | 2.08 | 3.32 | 0.07 | 2.99 | 7.98 |
| Fraxinus nigra | 1 | 1 | 0.14 | 3.15 | 1.67 | 0.44 | 0.70 | 0.07 | 2.99 | 5.36 |
| Quercus rubra | 1 | 1 | 0.14 | 3.15 | 1.67 | 0.44 | 0.70 | 0.07 | 2.99 | 5.36 |
| Total | 60 | 35 | - | - | 100.02 | 62.57 | 99.98 | 2.34 | 100.02 | 300.02 |

Continuum Index = 1762.77

Appendix H. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Acer saccharum | 33.33 | 73.33 |
| Corylus cornuta | 21.21 | 46.67 |
| Ostrya virginiana | 12.12 | 26.67 |
| Acer rubrum | 9.09 | 20.00 |
| Dirca palustris | 9.09 | 20.00 |
| Populus tremuloides | 6.06 | 13.33 |
| Abies balsamea | 3.03 | 6.64 |
| Prunus serotina | 3.03 | 6.67 |
| Prunus virginiana | 3.03 | 6.67 |
| Total | 99.99 | - |
| Herb strata | | |
| Graminae | 9.56 | 86.67 |
| Carex spp. | 7.35 | 66.67 |
| Acer saccharum | 4.41 | 40.00 |
| Maianthemum canadense | 4.41 | 40.00 |
| Sphagnum spp. | 4.41 | 40.00 |
| Araila nudicaulis | 3.68 | 33.33 |
| Aster macrophyllus | 3.68 | 33.33 |
| Dirca palustris | 2.94 | 26.67 |
| Pteridium aquilinum | 2.94 | 26.67 |
| Rubus spp. | 2.94 | 26.67 |
| Viola spp. | 2.94 | 26.67 |
| Acer rubrum | 2.21 | 20.00 |

Appendix H. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Cornus canadensis | 2.21 | 20.00 |
| Fragaria vesca | 2.21 | 20.00 |
| Fragaria virginiana | 2.21 | 20.00 |
| Hepatica americana | 2.21 | 20.00 |
| Lichens | 2.21 | 20.00 |
| Mushroom | 2.21 | 20.00 |
| Streptopus roseus | 2.21 | 20.00 |
| Thalictum polygamum | 2.21 | 20.00 |
| Botrychium virginianum | 1.47 | 13.33 |
| Clintonia borealis | 1.47 | 13.33 |
| Corylus cornuta | 1.47 | 13.33 |
| Dierville lonicera | 1.47 | 13.33 |
| Fraxinus americana | 1.47 | 13.33 |
| Lathyrus ochroleucus | 1.47 | 13.33 |
| Osmorhiza claytonii | 1.47 | 13.33 |
| Polytricum commune | 1.47 | 13.33 |
| Prunus virginiana | 1.47 | 13.33 |
| Quercus macrocarpa | 1.47 | 13.33 |
| Trientalis borealis | 1.47 | 13.33 |
| Abies balsamea | 0.74 | 6.67 |
| Agrimonia spp. | 0.74 | 6.67 |
| Anemone quinquefolia | 0.74 | 6.67 |
| Aster spp. | 0.74 | 6.67 |
| Athyrium filix-femina | 0.74 | 6.67 |

Appendix H. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Betula papyrifera | 0.74 | 6.67 |
| Coptis groenlandicum | 0.74 | 6.67 |
| Cornus alternifolia | 0.74 | 6.67 |
| Geum allepicum | 0.74 | 6.67 |
| Hieracium spp. | 0.74 | 6.67 |
| Impatiens biflora | 0.74 | 6.67 |
| Mitchella repens | 0.74 | 6.67 |
| Ostrya virginiana | 0.74 | 6.67 |
| Polygonatum sessilifolia | 0.74 | 6.67 |
| Populus tremuloides | 0.74 | 6.67 |
| Prunus serotina | 0.74 | 6.67 |
| Pyrola spp. | 0.74 | 6.67 |
| Quercus alba | 0.74 | 6.67 |
| Ribes spp. | 0.74 | 6.67 |
| Uvularia sessilifolia | 0.74 | 6.67 |
| Total | 100.12 | - |

Appendix I. Parameters of alder cover-type used as transit habitat by black bears in northern Wisconsin, 1981-82.

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Alnus rugosa | 92.31 | 100.00 |
| Corylus cornuta | 7.69 | 8.33 |
| Total | 100.00 | - |
| Herb strata | | |
| Sphagnum spp. | 11.01 | 100.00 |
| Carex spp. | 10.09 | 91.67 |
| Rubus spp. | 8.26 | 75.00 |
| Graminae | 7.34 | 66.67 |
| Alnus rugosa | 6.42 | 58.33 |
| Dryopteris cristata | 6.42 | 58.33 |
| Athyrium filix-femina | 5.50 | 50.00 |
| Viola spp. | 5.50 | 50.00 |
| Aster spp. | 4.59 | 41.67 |
| Impatiens biflora | 4.59 | 41.67 |
| Solidago spp. | 4.59 | 41.67 |
| Agastache nepetoides | 2.75 | 25.00 |
| Dryopteris marginalis | 2.75 | 25.00 |
| Fragaria virginiana | 2.75 | 25.00 |
| Anemone quinquefolia | 1.83 | 16.67 |
| Epilobium glandulosum | 1.83 | 16.67 |
| Equisetum spp. | 1.83 | 16.67 |
| Galium asprellum | 1.83 | 16.67 |
| Osmunda claytoniana | 1.83 | 16.67 |

Appendix I. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Acer rubrum | 0.92 | 8.33 |
| Amphicarpa bracteata | 0.92 | 8.33 |
| Fragaria vesca | 0.92 | 8.33 |
| Lichens | 0.92 | 8.33 |
| Maianthemum canadense | 0.92 | 8.33 |
| Mitchella repens | 0.92 | 8.33 |
| Mushroom | 0.92 | 8.33 |
| Onoclea sensibilis | 0.92 | 8.33 |
| Polygonum saggitatum | 0.92 | 8.33 |
| Total | 99.99 | - |

Appendix J. Parameters of black spruce cover-type used as resting habitat by black bears in northern Wisconsin, 1981-82.

| Species | No. of trees | No. of points | Average dominance /tree | Density (Trees/ acre) | Relative density (%) | Dominance | Relative dominance (%) | Frequency | Relative frequency (%) | Importance value |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree strata (≥10.16 cm dbh) | | | | | | | | | | |
| Picea mariana | 72 | 23 | 0.11 | 67.33 | 78.26 | 7.41 | 78.25 | 1.00 | 65.79 | 222.30 |
| Larix laricina | 20 | 12 | 0.11 | 18.71 | 21.74 | 2.06 | 21.75 | 0.52 | 34.21 | 77.70 |
| Total | 92 | 35 | - | - | 100.00 | 9.47 | 100.00 | 1.52 | 100.00 | 300.00 |
| | | | | | | | | | Continuum Index = 522.30 | |

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Picea mariana | 81.82 | 78.26 |
| Lonicera spp. | 13.64 | 13.04 |
| Larix laricina | 4.55 | 4.35 |
| Total | 100.01 | - |

Appendix J. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Carex spp. | 11.64 | 95.65 |
| Sphagnum spp. | 11.64 | 95.65 |
| Ledum groenlandicum | 9.52 | 78.26 |
| Picea mariana | 8.47 | 69.57 |
| Chamaedaphne calyculata | 7.94 | 65.22 |
| Andromeda glaucophylla | 6.35 | 52.17 |
| Eriophorum spp. | 5.82 | 47.83 |
| Kalmia polifolia | 5.82 | 47.83 |
| Clintonia borealis | 5.29 | 43.48 |
| Mushroom | 5.29 | 43.48 |
| Lichens | 4.23 | 34.78 |
| Vaccinium macrocarpa | 3.70 | 30.43 |
| Maianthemum canadense | 3.17 | 26.09 |
| Gaultheria hispidula | 2.12 | 17.39 |
| Lycopodium obscurum | 2.12 | 17.39 |
| Vaccinium oxycoccus | 2.12 | 17.39 |
| Monotropa uniflora | 1.06 | 8.70 |
| Vaccinium angustifolium | 1.06 | 8.70 |
| Vaccinium spp. | 1.06 | 8.70 |
| Eleocharis spp. | 0.53 | 4.35 |
| Larix laricina | 0.53 | 4.35 |
| Sarracenia purpurea | 0.53 | 4.35 |
| Total | 100.01 | - |

Appendix K. Parameters of tamarack cover-type used as resting habitat by black bears in northern Wisconsin, 1981-82.

| Species | No. of trees | No. of points | Average dominance /tree | Density (Trees/ acre) | Relative density (%) | Dominance | Relative dominance (%) | Frequency | Relative frequency (%) | Importance value |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree strata (≥10.16 cm dbh) | | | | | | | | | | |
| Larix laricina | 54 | 19 | 0.13 | 53.79 | 67.50 | 6.99 | 74.05 | 0.95 | 61.29 | 202.84 |
| Picea mariana | 22 | 11 | 0.09 | 21.91 | 27.50 | 1.97 | 20.87 | 0.55 | 35.48 | 83.85 |
| Abies balsamea | 4 | 1 | 0.12 | 3.98 | 5.00 | 0.48 | 5.08 | 0.05 | 3.23 | 13.31 |
| Total | 80 | 31 | - | - | 100.00 | 9.44 | 100.00 | 1.55 | 100.00 | 300.00 |
| | | | | | | | | | Continuum Index = 430.44 | |

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Larix laricina | 43.75 | 70.00 |
| Picea mariana | 34.38 | 55.00 |
| Alnus rugosa | 18.75 | 30.00 |
| Salix spp. | 3.13 | 5.00 |
| Total | 100.01 | - |

Appendix K. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Sphagnum spp. | 11.17 | 100.00 |
| Ledum groenlandicum | 10.61 | 95.00 |
| Kalmia polifolia | 7.82 | 70.00 |
| Chamaedaphne calyculata | 6.15 | 55.00 |
| Vaccinium spp. | 5.59 | 50.00 |
| Picea mariana | 5.03 | 45.00 |
| Vaccinium oxycoccus | 5.03 | 45.00 |
| Smilacina trifolia | 3.91 | 35.00 |
| Carex spp. | 3.35 | 30.00 |
| Eriophorum spp. | 3.35 | 30.00 |
| Lichens | 3.35 | 30.00 |
| Gaultheria hispidula | 2.79 | 25.00 |
| Graminae | 2.79 | 25.00 |
| Alnus spp. | 2.23 | 20.00 |
| Larix laricina | 2.23 | 20.00 |
| Mushroom | 2.23 | 20.00 |
| Polytrichium commune | 1.68 | 15.00 |
| Vaccinium macrocarpon | 1.68 | 15.00 |
| Vaccinium myrtilloides | 1.68 | 15.00 |
| Alnus rugosa | 1.12 | 10.00 |
| Dryopteris spinulosa | 1.12 | 10.00 |

Appendix K. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Lycopodium annotinum | 1.12 | 10.00 |
| Lycopodium lucidulum | 1.12 | 10.00 |
| Trientalis borealis | 1.12 | 10.00 |
| Abies balsamea | 0.56 | 5.00 |
| Acer rubrum | 0.56 | 5.00 |
| Amelanchier spp. | 0.56 | 5.00 |
| Andromeda glaucophylla | 0.56 | 5.00 |
| Arctostaphylos spp. | 0.56 | 5.00 |
| Botrichyium virginianum | 0.56 | 5.00 |
| Clintonia borealis | 0.56 | 5.00 |
| Coptis groenlandica | 0.56 | 5.00 |
| Cornus canadensis | 0.56 | 5.00 |
| Corylus cornuta | 0.56 | 5.00 |
| Dryopteris cristata | 0.56 | 5.00 |
| Fragaria vesca | 0.56 | 5.00 |
| Galium triflorum | 0.56 | 5.00 |
| Gaultheria procumbens | 0.56 | 5.00 |
| Linnaea borealis | 0.56 | 5.00 |
| Maianthemum canadense | 0.56 | 5.00 |
| Polygala paucifolia | 0.56 | 5.00 |
| Prunus serotina | 0.56 | 5.00 |
| Rubus spp. | 0.56 | 5.00 |
| Viburnum trilobum | 0.56 | 5.00 |
| Viola spp. | 0.56 | 5.00 |
| Total | 100.03 | - |

Appendix L. Parameters of balsam fir cover-type used as resting habitat by black bears in northern Wisconsin, 1981-82.

| Species | No. of trees | No. of points | Average dominance /tree | Density (Trees acre) | Relative density (%) | Dominance | Relative dominance (%) | Frequency | Relative frequency (%) | Importance value |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree strata (≥10.16 cm dbh) | | | | | | | | | | |
| Abies balsamea | 29 | 10 | 0.28 | 146.69 | 65.91 | 41.07 | 60.97 | 0.91 | 52.91 | 179.79 |
| Thuja occidentalis | 9 | 4 | 0.32 | 45.51 | 20.45 | 14.56 | 21.62 | 0.36 | 20.93 | 63.00 |
| Acer rubrum | 2 | 2 | 0.49 | 10.13 | 4.55 | 4.96 | 7.36 | 0.18 | 10.47 | 22.38 |
| Larix laricina | 2 | 1 | 0.49 | 10.13 | 4.55 | 4.96 | 7.36 | 0.09 | 5.23 | 17.14 |
| Betula papyrifera | 1 | 1 | 0.27 | 5.05 | 2.27 | 1.36 | 2.02 | 0.09 | 5.23 | 9.52 |
| Fraxinus nigra | 1 | 1 | 0.09 | 5.05 | 2.27 | 0.45 | 0.67 | 0.09 | 5.23 | 8.17 |
| Total | 44 | 19 | - | - | 100.00 | 67.36 | 100.00 | 1.72 | 100.00 | 300.00 |

Continuum Index =1300.93

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Corylus cornuta | 25.00 | 27.27 |
| Alnus rugosa | 16.67 | 18.18 |
| Amelanchier spp. | 16.67 | 18.18 |

Appendix L. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Shrub strata | | |
| Acer spicatum | 8.33 | 9.09 |
| Fraxinus nigra | 8.33 | 9.09 |
| Ostrya virginiana | 8.33 | 9.09 |
| Prunus serotina | 8.33 | 9.09 |
| Prunus virginiana | 8.33 | 9.09 |
| Total | 99.99 | - |
| Herb strata | | |
| Clintonia borealis | 7.08 | 72.73 |
| Coptis groenlandica | 6.19 | 63.64 |
| Fragaria vesca | 6.19 | 63.64 |
| Graminae | 6.19 | 63.64 |
| Maianthemum canadense | 5.31 | 54.55 |
| Trientalis borealis | 5.31 | 54.55 |
| Abies balsamea | 4.42 | 45.45 |
| Carex spp. | 4.42 | 45.45 |
| Dryopteris spinulosa | 4.42 | 45.45 |
| Sphagnum spp. | 4.42 | 45.45 |
| Aralia nudicaulis | 3.54 | 36.36 |
| Galium triflorum | 3.54 | 36.36 |
| Acer rubrum | 2.65 | 27.27 |
| Aster macrophyllus | 2.65 | 27.27 |
| Dierville lonicera | 2.65 | 27.27 |
| Lycopodium obscurum | 2.65 | 27.27 |
| Rubus spp. | 2.65 | 27.27 |

Appendix L. (Continued).

| Species | Presence (%) | Average frequency (%) |
|---|---|---|
| Herb strata | | |
| Acer saccharum | 1.77 | 18.18 |
| Cornus canadensis | 1.77 | 18.18 |
| Gymnocarpium dryopteris | 1.77 | 18.18 |
| Mitchella repens | 1.77 | 18.18 |
| Oxalis spp. | 1.77 | 18.18 |
| Viola palleus | 1.77 | 18.18 |
| Viola spp. | 1.77 | 18.18 |
| Anemone quinquefolia | 0.88 | 9.09 |
| Athyrium filix-femina | 0.88 | 9.09 |
| Betula lutea | 0.88 | 9.09 |
| Cornus alternifolia | 0.88 | 9.09 |
| Cornus florida | 0.88 | 9.09 |
| Gaultheria hispidula | 0.88 | 9.09 |
| Lonicera spp. | 0.88 | 9.09 |
| Lycopodium clavatum | 0.88 | 9.09 |
| Onoclea sensibilis | 0.88 | 9.09 |
| Oxalis montana | 0.88 | 9.09 |
| Populus tremuloides | 0.88 | 9.09 |
| Prunus serotina | 0.88 | 9.09 |
| Pteridium aquilinum | 0.88 | 9.09 |
| Pyrola spp. | 0.88 | 9.09 |
| Waldsteinia fragariodes | 0.88 | 9.09 |
| Total | 99.87 | - |

# INCIDENT OF A SNARE IMBEDDED IN THE NECK OF A BLACK BEAR

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The following incident occurred during a nuisance black bear (Ursus americanus) telemetry study; a cooperative project between the University of Wisconsin-Stevens Point and the Wisconsin Department of Natural Resources (WDNR). A male bear (5.5 years, 113 kg) was captured in a culvert trap (Erickson, Trans. North Am. Wildl. Conf. 22:520-543, 1957) on 22 May 1981 after feeding from garbage cans at a canoe landing on the Flambeau River in Sawyer County, Wisconsin. When the trap was approached the bear exhibited heavy panting, jaw-popping, and swatting with the forepaws in a greater frequency than did other bears that were captured during this study. The bear was translocated 50.7 km and immobilized with 10cc of ketamine hydrochloride at the release site. A No.2 Kleflock Snare was found imbedded in his neck during examination. It was imbedded almost to the spine dorsally but was free from the sides and ventral portion of the neck. The bear's neck circumference was 73 cm; that of the snare was 61 cm. A wound, about 7cm wide, was present near the throat; it gradually narrowed up the sides of the neck to the points where the snare became imbedded in the dorsal neck muscles. The wound was open and the infected flesh emitted a putrid odor.

We cut the snare cable with wire cutters and pulled it from the flesh. The bear tried to rise twice during this process and was given an additional 3cc of drug 12 minutes after the initial injection, and 2cc 3 minutes later. A radio-collar was attached anterior to the wound and the bear was released.

He was recaptured 7 days later in his original home range after feeding from garbage cans at a different canoe landing on the Flambeau River. He was not immobilized after this capture but examination while he was in the trap showed that the wound was starting to cicatrize. The bear was translocated again (46.5 km) to a different release site; 4 days later he was again back in his home range. His subsequent movements, until mid-August 1981, appeared normal when compared to other males that were radio-tagged during this study. The bear probably became ensnared after he emerged from his den in 1981, judging from the condition of the wound and the rust-free snare. It is probable that the bear broke the steel cable by rearing back, since the snare slide mechanism was positioned near the throat and the cable was imbedded into the dorsal neck muscles.

The radio collar fell off of the bear between 15 and 18 August 1981; the belt leather, which had been added to lengthen the collar, had become brittle and broke. There was no evidence of the bear having removed or damaged the radio collar. The same belt material had been used on another adult male's radio collar; it remained strong and pliable after 283 days on the bear. The deterioration of the leather was probably hastened by the purulent flesh and water from a river which the bear swam frequently.

Snaring is an illegal means of harvesting animals in Wisconsin. Snares are used to capture some nuisance bears and animals for research purposes. The snare imbedded in this bear's neck was a size used for coyotes and bobcats. No coyote or bobcat research, that may have used snares, was being conducted in northern Wisconsin; therefore, it is logical to assume that the snare was being used for the illegal taking of animals.

The instances of bears taken as nontarget animals in snares has been meagerly documented. Rogers (Proc. Northwest Sect., The Wildl. Soc., 14:194-211, 1983) reported that coyote bounty-trappers in Upper Michigan claimed to have caught numerous bear cubs and killed them to avoid conflicts with the mothers. Payne (J. Wildl. Manage. 39:812-813, 1975) reported capturing a female bear in Newfoundland with a severely depressed thoracic cavity that probably resulted from an illegal snare. Conners (Outdoor Life, Dec. 1962) published a photograph of a bear that was hung from the neck by a snare set for a wolf on the Bad

River Indian Reservation, Wisconsin. Mortality from illegal snaring and/or trapping may be a significant bear mortality factor.