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NAVIGATION BY ADULT BLACK BEARS

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Translocated large mammals have returned home from up to the following distances: white-tailed deer (*Odocoileus virginianus*), 560 km (Harm, 1945); polar bear (*Ursus maritimus*), 480 km (Stirling et al., 1977); timber wolf (*Canis lupus*), 282 km (Henshaw and Stephenson, 1974); grizzly bear (*Ursus arctos*), 258 km (Miller and Ballard, 1982); black bear (*Ursus americanus*), *229* km (Harger, 1970); house cat, 217 km (Carthy, 1956); red fox (*Vulpes vulpes*), 56 km (Phillips and Mech, 1970); and mule deer (*Odocoileus hemionus*), 50 km (Eberhardt and Pickens, 1979). However, questions remain as to whether homing by large mammals is achieved by chance, expanding search patterns, familiarity with large areas, or some means of navigation (Beeman and Pelton, 1976). Data used to assess which of these mechanisms is used for homing should be collected in a variety of regions to minimize the influence of any local features that might hinder or aid homing. Such data are available for black bears. Researchers have translocated black bears in various regions of North America and have studied nontranslocated bears sufficiently to determine a distance beyond which nearly all bears should be unfamiliar.

Translocation data sets were included for analysis it they conformed to the following criteria. (1) Marked black bears were transported >64 km, which is the distance beyond which most bears should be unfamiliar (see below). (2) Distance and direction of movements after release were described for individuals. (3) Sufficient age data were included to exclude bears younger than 2 years. Cubs and yearlings have previously been shown to return home less frequently than older bears (Alt et al., 1977; Harger, 1970; Massopust and Anderson, 1984). (4) The bears were not released in national parks. Hunting was the primary means of recovery and is prohibited in national parks.

Eight data sets were used in which 77 black bears were translocated an average of 106 km (median 88 km, range 64 to 271 km) in seven states or provinces (Table 1). The bears in those studies were drugged for ear-tagging or radio-collaring, and they typically remained unconscious or semiconscious in metal box-traps during immediate transit by road. Sex ratios (male: female) varied from 20:0 in New Hampshire (Orff, 1982) to 2:6 in Wisconsin (Massopust and Anderson, 1984). Overall, sex ratio was approximately 52:25 (three data sets gave sex ratios as percent males rather than giving sex of individuals). Kill locations provided most of the movement data, but a few end points were determined by telemetry or recapture. Direction of movement was calculated as the bearing of the final location from the release point relative to home (Fig. 1). Bears were considered to have returned home if they were found within 8 to 20 km of the original capture site, depending upon the distance criterion for homing used by researchers in the individual studies; home ranges differed with sex and region. Data for all 77 bears were pooled to test the null hypothesis that bear movements were not oriented toward home. Distance and direction of travel from release points to recovery sites (or to final telemetry locations) were used to test that hypothesis (Batschelet, 1981).

The 77 bears showed a highly significant ($P < 0.0001$; Rayleigh test, Batschelet, 1981) preference for the home direction (Fig. 1), and 34 of them reached home before they were shot, recaptured, or their radio-collars expired (Table 1). The 43 that did not return should include those with poorest homing ability, those deflected by physiographic barriers, and any not inclined to return because they were not residents of the capture area. Nevertheless, homeward orientation among those 43 was also significant ($P < 0.002$) (Fig. 1),

TABLE 1.—*Movements of translocated black bears at least 2 years old.*

Study area	Bears translocated and recovered (*n*)	Bears with final location within 22.5º of home directions (*n*)	Bears that reached home (*n*)	Source
Translocated 64 to 120 km				
Alberta	10	3	2	Gunson, unpubl. data
Michigan	19	14	11	Harger, 1970
Michigan	4	1	0	Erickson et al., 1964
Minnesota	4	3	2	Rogers, unpubl. data
Newfoundland	1	1	1	Payne, 1975
New Hampshire	8	5	4	Orff,1982
Oregon	1	1	1	McCollum, 1974
Wisconsin	7	7	6	Massopust and Anderson, 1984
	54	35 (65%)	27 (50%)	
Translocated 120 to 220 km				
Michgan	4	4	0	Harger, 1970
Michigan	1	1	1	Erickson et al., 1964
New Hampshire	12	7	5	Orff**,** 1982
Wisconsin	1	1	0	Massopust and Anderson, 1984
	18	13 (72%)	6 (33%)	
Translocated 220 to 271 km				
Michigan	5	4 (80%)	1 (20%)	Harger, 1970
Total	77	52 (68%)	34 (44%)	

which indicates that random movement or ever-widening search patterns were not the basic mechanisms of homing.

Homeward orientation also did not depend upon familiarity with release areas. The minimum release distance of 64 km assured that nearly all bears were released in unfamiliar areas. Studies of nontranslocated black bears have shown that movements >64 km are rare: 17 studies showed no movements that far, 4 studies showed only one such movement each (Kohn, 1981; Lindzey et al., 1976; Stickley, 1961; Zytaruk and Cartwright, 1978), and a 9-year study involving 315 bears in Minnesota showed only 17 such movements (Rogers, 1977). Fourteen of the 17 far-ranging individuals in that study were dispersing 2- or 3-year-old males whose travels would probably acquaint them with distant areas in only one direction from their eventual adult ranges. The longest movement in an equally extensive study in Pennsylvania was only 53 km (Alt, 1978). Thus, the percentage of bears familiar with areas more than 64 km from their capture sites is too low to explain the homeward orientation by 68% of the 77 bears translocated >64 km (Table 1). Further, there was no decline (actually, an insignificant increase) in the percentage of bears that moved toward home (i.e., within 22.5° of the home direction) when transportation distance was increased to more than 120 km (Table 1). The opposite would be expected if bears navigated by familiar landmarks because fewer bears would be familiar with the more distant release areas.

Time from release to the final location was available for 48 bears. Elapsed time for 20 bears that returned home averaged 297 days (median 286, range 8-1,215 days), whereas time from release to the final location for the 28 bears that did not reach home averaged 228 days (median 116, range 2-1,445 days). In both cases, some of the bears may have reached their final location long before they were killed. Conversely, some that did not reach home might have done so with more time. Of the bears that did not reach home, a greater proportion (6/15 = 40%) of those killed less than the median 116 days after release were headed within 22.5° of homeward than of those killed > 116 days after release (3/13 = 23%); however, the difference was not significant (one-tailed Fisher exact test, $P = 0.21$). The percentage of bears that had been resident at the capture location prior to capture is unknown.

Sexes of individuals were available for 34 males and 15 females. Fewer males (18 of 34) than females (12 of 15) moved within 22.5° of the home direction, but the difference was not significant (2 by 2 contingency table with Yate's correction, $\chi^2 = 2.17$, $P > 0.10$). The longest movement, 229 km, involved a female (Harger, 1970). The longest translocation, 271 km, also involved a female; she returned 89 km in 6 days (14.8 km/day) before being killed (Harger, 1970).

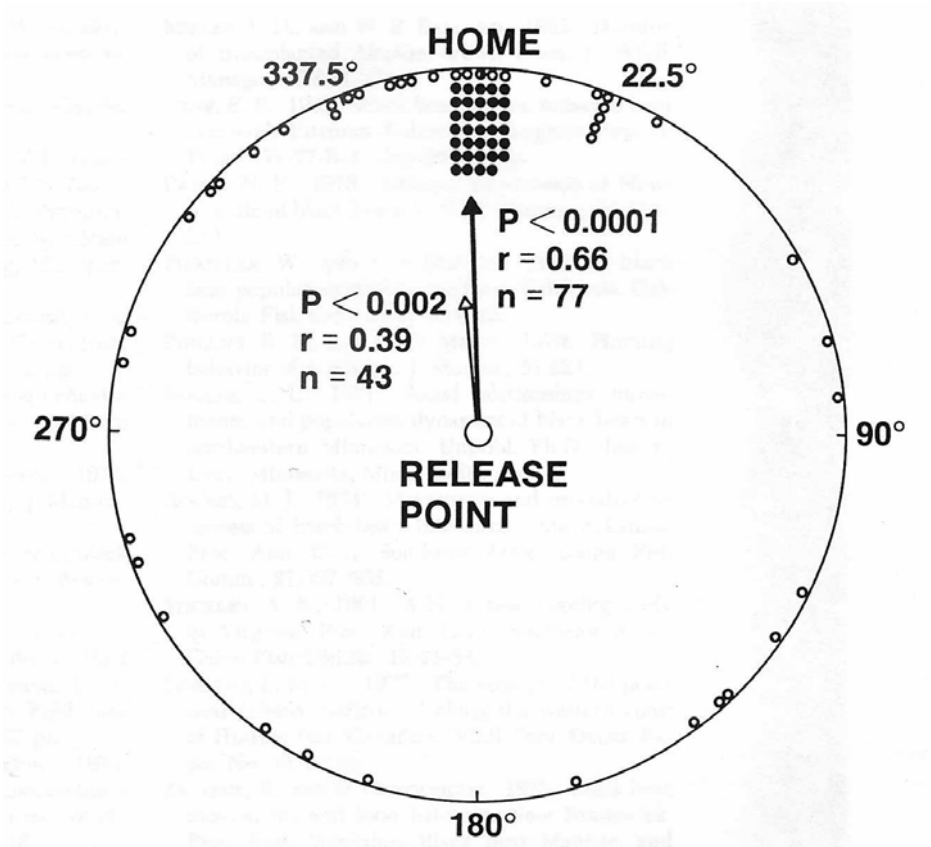

FIG. 1.—Pooled data from seven states and provinces (listed in Table 1) showing directions moved by black bears ≥2 years old after being translocated 64 to 271 km and released. Home direction for all bears was set to 0°. Solid circles represent 34 individuals that returned home. Open circles represent last known locations of 43 bears that did not reach home. The solid arrow point indicates the mean vector for the entire sample (358 ± 13°, 95% confidence limit, $r = 0.66$, $n = 77$). The open arrow point indicates the mean vector for 43 bears that did not reach home (354 ± 30°, 95% confidence limit, $r = 0.39$).

The data indicate that random movements or expanding search patterns were not the basic mechanisms for homing and that ability to orient homeward did not depend upon familiarity with release areas. The orientation and navigation methods used are unknown but were effective at translocation distances up to at least 271 km. How much farther these methods are effective is unknown. Black bears that were translocated from Minnesota to Arkansas (> 1,400 km) moved in random directions after release (Rogers, 1974).

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