Identifying sex and individuals of pine marten using snow track measurements

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"As a first step in understanding the structure and dynamics of a natural population it is essential to know something about the population size."(Seber 1982). Many methods have been developed to estimate the density of pine martens (Teplov 1952, Gusev 1965), including snow tracking (Grakov 1981, Becker 1991, Jedrzejewski and Jedrzejewska 1993, Zalewski et al. 1995), trapping (Kohn et al. 1993), and telemetry (Clark et al. 1989, Marchesi 1989, Kohn et al. 1993, Zalewski et al. 1995). All of these methods are biased (Raphael 1994). When snow tracking, it is possible to track only during the second or third days after fresh snowfall, which may occur rarely. Furthermore, to estimate density, one also needs to know the mean daily distance covered by martens in the studied population (Gusev 1965, Priklonsky 1965). The trapping and telemetry methods do not ensure that all individuals in the study area are detected, especially when there is a low capture rate of martens (Raphael 1994). Smallwood and Fitzhugh (1993) proposed a simple method to estimate numbers of individuals occurring in a study area by using track measurements; they identified all mountain lions (*Puma concolor*) inhabiting their study area.

I evaluated the use of snow track measurements to distinguish individuals or sex of pine marten (*Martes martes*) in the temperate, lowland forests of eastern Poland.

Materials and methods

From winter 1993 to winter 1996, I caught and collared 8 pine martens (3 males and 5 females) in Bialowieza National Park (52°43'N, 23°54'E) in northeastern Poland (Zalewski 1997). Martens were located during inactive periods in daytime, then snow-tracked up to 10 m from the resting sites. Track measurements were taken when marten moved in a 2-gait pattern and when they were not jumping between logs. Therefore, measurements were taken in areas without logs or dense shrub cover. The 2-gait pattern is most common in marten movements (Halfpenny et al. 1995) and is very easy to find in the field. I took 4 measurements: (1) pit width, (2) pit length, (3) width of 2 pits, and (4) the mean of 10 lengths of the leap (Figure 1). In addition, I calculated average length of the shortest leap, because when animals move in a 2-gait pattern, the shortest leap strongly relates to the body length. To

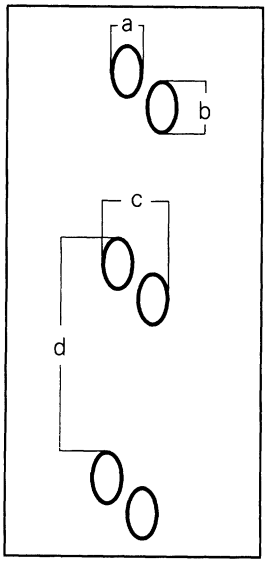

Figure 1. Scheme of measurements of pine marten tracks in snow: a–pit width, b–pit length, c–width of two pits, d–leap length.

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Table 1. Range and average track measurements (cm) and effectiveness to discriminate sex of pine marten by stepwise discriminant analysis for two groups (males and females).

Measurement	Males (n=15)			Females (n=26)		
	Range	Average	% of tracks correctly grouped	Range	Average	% of tracks correctly grouped
Average leap length	55.9–97.8	68.6	80.0	40.1–80.5	50.7	88.5
Average length of 5 shortest leaps	55.3–87.2	63.6	86.7	34.8–73.8	46.3	92.3
Pit[1] width	3.5–5.0	4.1	66.7	3.5–4.5	3.7	65.4
Pit[1] length	5.5–9.0	6.9	53.3	5.0–8.5	6.7	46.2
Width of two pits	6.0–13.5	8.9	60.0	6.5–9.0	7.6	76.9

[1] Pit is a print of a marten foot in snow.

calculate the shortest leap length from each sample of 10 measurements of leap length, I calculated the average using only the 5 shortest leaps (average length of 5 shortest leaps). I measured tracks in snow depths varying from 1 to 60 cm.

Results

Average track measurements for males were generally larger than those for females, but there also was some overlap between sexes (Table 1). Single-track measurement did not adequately describe the sex of pine martens, but average length of the 5 shortest leaps correctly grouped 86.7% males and 92.3% females. Stepwise discriminant analysis for the 2 groups (males and females) showed that only 2 of 5 variables—average length of 5 shortest leaps and pit width—were required to distinguish males and females. The sex determination key is:

X= -9.40+0.10 (average length of 5 shortest leaps) +1.10 (pit width).

These 2 variables provided 85.4 % correct classification (73.3% males and 92.3% females, $F_{2,38}$=20.63, P<0.001). Group/centroids were 1.34 and -0.78, for males and females, respectively.

Individual differences among track measurements were very low, and measurements greatly overlapped (Table 2). Stepwise discriminant analysis selected only one variable (average length of 5 shortest leaps) to separate individuals, but it provided only 43.9% correct classifications ($F_{7,23}$=14.5, P<0.001 (Table 3). The biggest male (No. 3) was classified in 100% of cases, but other individuals were classified in very low percentages of cases. Snow depth did not significantly influence any measurements in separate individuals (ANCOVA $F_{1,7}$< 0.7, P>0.05).

Discussion

My results suggest that it is not always possible to use snow track measurements to recognize individuals of pine marten and probably other medium-sized carnivores. Thus, estimates of population density based exclusively on this method may be greatly biased. Identifying individuals by their tracks is possible in larger animals, such as mountain lion (Smallwood and Fitzhugh 1993). In that study, 10 measurements of tracks were used. Some of them, such as angle between toes or middle lobe width, could be difficult to measure in the snow for small or medium-sized carnivores. Such measurements

Table 2. Length of 5 shortest leaps for individual martens.

Parameter	Length of 5 shortest leaps of individual martens							
	Females					Males		
	F9 (900)[1]	F8 (950)	F1 (1000)	F11 (1025)	F12 (1125)	M14 (1290)	M5 (1400)	M3 (1525)
Range	40.4–42.6	45.8–73.8	39.0–42.2	34.8–62.8	40.4–48.0	53.0–66.2	50.6–60.2	68.2–87.0
n	2	3	3	11	7	4	6	5
$\bar{x}$	41.5	56.6	40.4	48.3	42.7	58.1	56.5	76.5
SD	1.55	15.06	1.62	7.39	2.97	5.69	3.29	8.82

[1] Body mass (g).

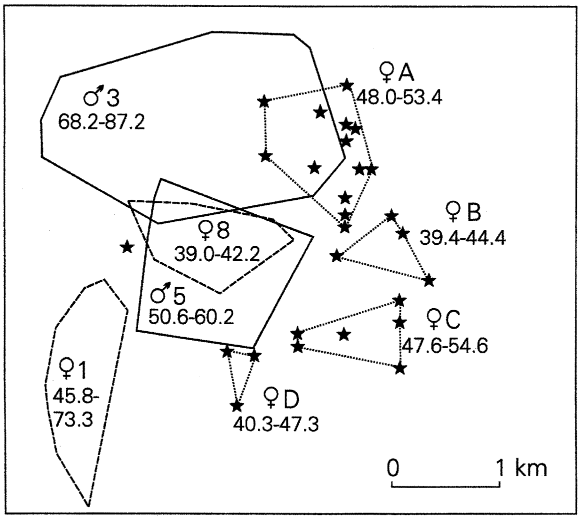
Table 3. Effectiveness to discriminate 8 martens by length of 5 shortest leaps. Boldfaced numerals are correct classifications, italics are incorrect classifications.

Individual marten	Total n measurements	N measurements of given individual classified as:							
		F9	F1	F8	F11	F12	M14	M5	M3
F9	2	-	-	*1*	-	*1*	-	-	-
F1	3	-	-	-	*2*	-	-	-	*1*
F8	3	-	-	**2**	-	*1*	-	-	-
F11	11	*1*	-	*1*	**5**	*2*	*1*	*1*	-
F12	7	-	-	*4*	*1*	**2**	-	-	-
M14	4	-	-	-	-	-	**2**	*2*	-
M5	6	-	*1*	-	*1*	-	*2*	**2**	-
M3	5	-	-	-	-	-	-	-	**5**

were impossible to take in pine marten tracks due to hair around the foot pads.

The pine marten is a solitary carnivore with an intersexual spacing pattern (Powell 1979), and home ranges of same sexes overlap to some degree. However, home ranges of opposite sexes can overlap considerably (Marchesi 1989, Balharry 1993, Zalewski et al. 1995). Therefore, the problem in estimating density by telemetry is to distingush individuals of opposite sex which use the same area as the radiotracked individuals. In radiotracking methods, it is often necessary to distinguish unmarked females in home ranges of radiotracked males because females are less susceptible to trapping than males (Buskirk and Lindstedt 1989, Krohn et al. 1994). Track measurements can be used to determine tracks of unmarked females inside or around a home range of a radiocollared male or vice versa.

Distinguishing males and females also is possible using the relative position of scat to urine and to hind footprints (Formozov 1989, Sidorovich 1991). However, for pine marten, the average distance between scats on a marten's trail was 1.4 km (Jedrzejewski and Jedrzejewska 1993). Thus, to determine sex, it would be necessary to walk long distances while snow tracking. Moreover, I observed that martens often moved around the defecation site after scat deposition. In such cases, determining the position of scat and urine relative to hind footprints was not possible. Consequently, track measurement is a more reliable method of identifying the sex of martens. Additionally, it is possible in some cases to plot the approximate distribution of home ranges of unmarked animals using track measurements, espe-



----- home ranges of radiotracked females
——— home ranges of radiotracked males
★ females snow track distribution in winter 1983–84
40.3-47.3 range of the average lengths of 5 shortest leaps (in cm)

Figure 2. Example of winter home range distribution of radiotracked martens and snow tracks of martens. Similar values of length of 5 shortest leaps in the same area (thus, presumably belonging to one individual) were connected with a dotted line.

Figure 3. Pine marten fitted with radiotransmitter. Photo by A. Zalewski.

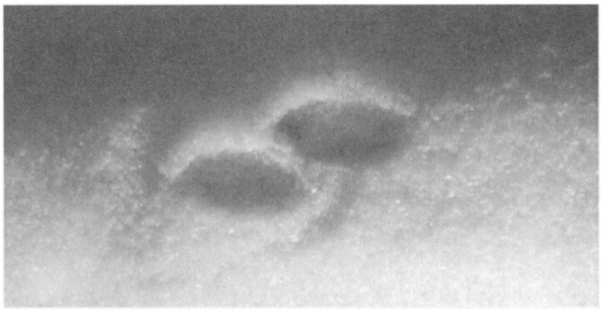


Figure 4. Pine marten tracks. Photo by A. Zalewski.

cially when individuals are very big (like No. 3) or when the average length of the 5 shortest leaps of neighboring individuals do not overlap (see females A, B, C, D on Figure 2). However, the plotted distribution of females was possible only when the home range of female No. 8, whose average length of the 5 shortest leaps is similar to those of females B and D, was known.

In conclusion, track measurement (especially the average length of the 5 shortest leaps) is recommended as a complementary method for studying the spatial distribution of pine martens. It may help to estimate density or to plot the distribution of uncollared animals to analyze home range use by radiocollared individuals.

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