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Home ranges of feral cats in Portsmouth Dockyard.

INTRODUCTION

In October, 1975, work was commenced on a study of the cats that inhabit Portsmouth Dockyard, part of Her Majesty's Naval Base, in Hampshire, England. These cats may be described as feral, since they are not domiciled with man. Although they are not completely independent, there are no constraints placed on their breeding, and very few are tame enough to be handled.

About ten thousand people work in the dockyard, and their attitudes towards the cats are important. Many people feed the cats and provide them with shelter in the form of boxes and bedding. However, the dockyard cats are officially considered to be pests, and were trapped and destroyed until the start of this study.

This is the first ecological study of urban feral cats to be undertaken. It is becoming apparent that these cats, in a variety of urban habitats, are much more numerous than was once realised. In view of the threat of rabies entering Britain, information on the ecology and the behaviour of these animals is valuable.

THE HABITAT

Portsmouth dockyard is an irregularly shaped area, including large basins and docks, with a land area of about 100 ha (Fig. 1). It is bounded to the north and west by the waters of Portsmouth harbour, and to the south and east by a high wall. The main existing walls were built in 1711 and 1864, but there was a walled dockyard in Portsmouth as early as 1212. Most of the dockyard is covered by buildings that range in size from one covering nearly two hectares down to those that cover only a few square metres. They are used for a wide variety of purposes and vary in the degree to which they are secure from entry by cats. Most open areas are used for construction work or as open-air stores. The smaller features of the dockyard include netted compounds, piles of various materials, gangways and cars. These all afford cover for cats. In addition to these, there are underground features. Cables and steam pipes run in metal-roofed trenches in most areas of the yard, and there is usually a hole, where the tunnel meets a building, allowing access to cats.

There is little plant life in the dockyard. The most important animal species are cockroaches (*Blatta orientalis* and *Periplanta americana*); crickets (*Acheta domesticus*); feral pigeons (*Columba domestica*); black-headed gulls (*Larus ridibundus*); mice (*Mus musculus*); rats (*Rattus norvegicus* and, possibly, *R. rattus*). There is some evidence that cats feed on the animal life in the dockyard, but the main source of food is that provided by people. This may be from either direct feeding, or from food that is discarded in the large skips, commonest by the docksides.

DATA COLLECTION

Individual cats were recognised by their coat pattern, since it was not considered feasible to mark the animals. It was found that cats with white markings could be easily identified, usually by facial markings alone. Tabby cats without white markings could be identified by variation in body colour and the tabby markings. Black cats could be identified by build, eye shape and colour, bushiness of the tail, white hairs on the chest, notches out of the ears, whether the ears were vertical or spread on the outside edges, and more obvious features such as long hair, or lack of a tail or an eye. Coat patterns were recorded by drawings, on duplicated sheets showing the outline of a cat, facing both ways and full face. Photographs were found to be unsatisfactory for recording coat pattern because many cats were camera-shy, and also because photographs did not always show a cat's most distinctive features. All cats were assigned a number, in the order in which they were seen.

Data were collected by walking around set areas of the dockyard, following a route that covered all parts of the area, without going over the same ground twice. Whenever a cat was observed, the date, time and location were recorded. Most observations were conducted in the afternoons and evenings when the cats were relatively active.

Cats could be sexed by the observation of the testes of the male, production of kittens by the female, or mating. It was also possible to distinguish mature toms from females or young toms on the basis of facial features, build and behaviour. A mature tom-cat has a thicker neck and wider head than a female, mainly due to a ruff of fur. He also tends to have a longer, thinner body and he shows the behavioural trait of spraying urine posteriorly onto objects, which is rarely observed in the female.

The ages of cats that were already adult when the study began could not be ascertained, but the ages of cats that were born during, or shortly before the study commenced, could be determined, Kittens could be aged more accurately the younger they were when first seen, and if their mother had been seen when she was pregnant. Cats were considered to be kittens up to the age of six months, to be juveniles from six months to one year old, and to be adult at one year. The age of sexual maturity varied between toms and females, and between individuals of the same sex. Some females mated when less than a year old, but toms did not.

The sightings for each cat were plotted on photocopied sections of a 1:1250 scale ordnance survey map of the dockyard. The maps were divided into hundred-metre squares, numbered on the National Grid system. Using a transparent plastic overlay, marked off in five-metre squares, it was possible to grid-reference each sighting to the nearest metre. When a cat had moved more than ten metres during observation, or had been encountered more than once during a patrol, the two extreme sightings only were grid-referenced. It was considered that any other approach would have involved either discarding data on the outer regions of the range, or have tended to weight these in comparison with the more central areas. The eight-figure grid-references for each cat were punched onto computer data cards, and all analyses of home range were conducted on the ICL 1907 and ICL 2970 computers at Southampton University. A total of 4945 sightings of 154 cats were grid-referenced during the period from October, 1975, to June, 1977.

DEFINING AND MEASURING HOME RANGE

Home range, as defined by Burt (1943) and restated by Jewell (1966), is 'the area over which an animal normally travels in pursuit of its routine activities'. However, home range use may vary on a daily, monthly or yearly basis. It must be decided whether or not to include dispersal movements of young animals, migration routes, 'exploratory sallies', or excursions for mating.

Numerous methods have been used to analyse home range data, depending on the means of data collection and the animal being studied. It is often useful to define the boundary of a home range and to calculate the area enclosed, although this ignores the way in which the animal uses the area. Many methods of calculating home range area (e.g. inclusive and exclusive boundary strip methods) have been devised to deal with data derived from trapping, which is the commonest way of studying small- and medium-sized mammals, and they allow for the spaces between traps. Data derived from direct observation or radio-tracking, however, are continuous rather than discrete, and give a better estimate of the size and nature of the range.

Three methods of calculating home range were used in this study. The first was the widely-used 'minimum area method' (Mohr, 1947) that involves connecting the outer data points to form a minimum area convex polygon. All data points were considered when drawing a cat's range boundary, thus giving the maximum known area, including excursions and dispersal routes (Fig. 2). This method is referred to as Rmin. The minimum area method is useful in that it allows comparison with other species, but often includes areas where the animal has never been seen, especially in the case of a crescent-shaped range. Harvey and Barbour (1965) developed a 'modified minimum area method' that attempts to minimise this error. This involves the use of what may be called a 'range factor' (RF) to determine the outer boundaries of the range. Thus, if two points would be connected, according to Mohr's method, with a line exceeding RF, they were not directly connected. Instead, the boundary line was formed by connecting one of these points to the 'next outermost point', provided that this line did not exceed RF. Points that were further than RF than any other point were joined to the nearest point by a line, considered to be a lane, one foot wide, and were designated as 'sallies outside the area'. Harvey and Barbour used an RF of one quarter of the range length.

A modified version of this method (referred to as Rmod) was used to analyse the cat data. An RF of half the maximum distance from a data point to the geometric mean of all points was used. A half-metre boundary was added around the range, 'excursions' thus being included as lanes one metre wide. This method gave interesting results, but was found to be difficult to program due to the subjectiveness of the term 'next outermost point'. There were some cases where the programmed method did not give the expected results. The main disadvantage of Harvey and Barbour's method is that it gives different results, depending on whether the points are connected in a clockwise or anticlockwise direction (Fig. 2). Ideally, one would like to obtain the maximum area that is enclosed by lines not exceeding RF.

The third method used gave similar or identical results to Harvey and Barbour's method, depending on the data, but was calculated on a different basis. The RF was first calculated in the same way as for Rmod, and then all lines interconnecting points were drawn, provided that they did not exceed RF. This resulted in the formation of one or more 'reachable subgraphs' (RSs). An RS may be one point, or a group of points that are interconnected. A boundary line was then drawn around each RS, following the outer connecting lines. New points were, therefore, created where connecting lines intersected. All RSs were then joined according to the principle of the 'minimum spanning tree' that connects all loci to give the shortest total line (Prim, 1957). The RSs were only joined at data points on the boundary lines, not at intersection points. This method is referred to as the 'restricted method' (Rres), and the range area does not depend on the order in which the points were connected (Fig. 3).

Three other measures were also calculated from the data for each cat. These were the home range length; the mean distance between each point and every other point ('mean distance'); and the 'variability coefficient' (V.C.), which is the standard deviation of the distances from each point to every other point, divided by the mean distance. The V.C. is a measure of the degree of clumping of sightings and, therefore, of home range use. A high V.C. indicates strong clumping of sightings. The V.C. of a uniform distribution of sightings has been calculated to be 0.47.

THE EFFECT OF NUMBER OF SIGHTINGS

When range area (Rmin and Rmod) was plotted against the number of sightings for individual cats, it was found that the range area increased with increased number of sightings, even when the cat had been seen over seventy times. This effect has been observed in other animals (Ables, 1969, on foxes and Cheeseman, 1975, on rodents), and the home range is usually considered to have stabilised after a large number of observations. Examination of the graphs, however, suggests that it is probable that the range size would have continued to increase had these authors made further observations. In this study, the greatest rate of increase in range size usually occurred over the first ten or twenty sightings, but the rate of increase overall varied greatly between individual cats. Home range length also increased with the number of sightings, but the variability coefficient stabilised after about twenty sightings.

The number of sightings grid-referenced for individual cats varied from three to 79. The final range size (Rmin) and number of sightings for each cat were plotted. Adult males (excluding toms not adult at the start of the study) and females were considered separately, and the correlation coefficient (r) calculated for both sets of data. For the toms, the correlation was significant ($r(45) = 0.394$, $P < .01$), but for the females it was not ($r(70) = 0.191$). Since, from examination of the plots, it was obvious that the strongest correlation was for cats that had only been seen a few times, toms that had been seen less than twenty time were excluded from the data, and females that had been seen less than fifteen times were similarly rejected. The correlation coefficients were then recalculated, and neither was significant (toms, $r(30) = 0.147$; females, $r(66) = -0.003$).

In view of this, it is probably justifiable to take overall averages of the range sizes for adult males and females, excluding cats that have. been seen less than twenty or fifteen times, respectively. These averages will tend to underestimate the true range sizes, but are comparable when the average number of sightings is similar. All following results given exclude the 35 cats with insufficient data.

THE EFFECT OF THE ENVIRONMENT

In general, the more favourable the environment, the greater the density of animals and the smaller the home range or territory. In the dockyard, there is a plentiful supply of food and shelter, and the density of adult cats averages two per hectare. This is much higher than the densities of cats found in rural areas (e.g. one per eight hectares, Hubbs, 1951). Not only do the dockyard cats have small home ranges, but the ranges of toms overlap extensively, and females share family group ranges. This social grouping in an animal that is usually considered to be solitary is probably an adaptation to a favourable environment, with local concentrations of resources. It has been suggested for some species of mongoose that, since large groups cannot find sufficient vertebrate food, they have specialized in invertebrate feeding in order to obtain the advantages of group life (Rood, 1975). This may be a rather back-to-front way of looking at the situation, but it illustrates the relationship between type of food supply and the opportunities for living in groups.

The dockyard habitat is not stable, since there is continuous redevelopment and turnover of stored materials. There can also be changes in the quantity or location of available food. These changes can result in changes in range use within the range area, or even in changes in the observed home range. However, female cats are apparently very reluctant to leave the areas in which they are established. One group of cats continued to live in and around a building while it was demolished and rebuilt.

THE EFFECT OF THE SEX OF ADULT CATS

There are marked differences between the ranges of adult male and female cats (Table I). The range areas of toms are an order of magnitude greater than those of females, for all three methods of calculation, and they average three times the length. Toms also have a lower average V.C. than females, indicating more uniform use of the range area.

Three-quarters of the females live in groups, sharing their ranges with one or more other adult females. Examples of group range sizes are given in Table II. Group range sizes are probably dependant on the resources available, and seem to be independent of the number of cats in the group. Female cats usually spend most of their time in one small area, where there is food and shelter (Fig. 4), and the number of times they venture away from this 'core area' (Kaufmann, 1962) seems to depend only an the temperament of the cat. Most females, therefore, have high V.C.s, but some utilize only the core area of the group range. These cats tend to have low V.C.s, since their sightings tend to be evenly distributed over small ranges.

Toms are usually seen at sites fairly evenly distributed through their ranges, although they tend to visit the core areas of several groups of females more frequently than other areas. The use of each part of the range varies with time, possibly including new areas. Toms may venture some way from their usual range during January and February when most of the females start to come into oestrus.

Tables III and IV show the percentage of cats in each class of range size and variability coefficient, for comparison of toms and females.

THE EFFECT OF THE AGE 0F THE CATS

Kittens usually remain in the nest in which they were born until they are weaned, unless they are moved by the mother. As they grow older, they become more adventurous and start to explore the area over which their mother, or the group, ranges. By the time they are adult (at one year), they have a range the same size as an adult female cat, regardless of their sex.

Young females remain with the group into which they were born, but the fate of young males may vary. Between the age of one and two years, most toms leave the group, probably chased away by the toms that visit the core area. Many of these emigrating toms die or disappear, the remainder establishing themselves in new areas and developing the large range areas and behavioural characteristics of mature toms. These successful emigrants, therefore, have very large cumulative ranges, but they do not return to their original areas (Fig. 2).

Table V shows the difference in home range between the young toms that remained where they were born and those that emigrated. It should be noted that while the Rmin area for those emigrating is greater than for mature toms (Table I), the Rmod and Rres areas are slightly smaller as these minimise effect of the dispersal route. The young toms that remain with their original group do not show any of the characteristics of mature males, and continue to range over an area comparable to that of adult female ranges. It is possible that they may mature at a later age and adopt a dominant position should the opportunity present itself. It is also possible that mature toms with relatively small ranges are cats that never left their original groups.

CONCLUSIONS

The home ranges of the cats in Portsmouth dockyard are strongly influenced by the favourable environment and the localised concentrations of resources. The small, shared family ranges of females and young are probably the most efficient way of exploiting this situation. The large, overlapping ranges of the toms will prevent excessive inbreeding, as will the emigration of young toms into new areas.

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Literature cited:

Ables:, E.D. 1969. Home-range studies of red foxes (Vulpes vulpes). J. Mammal. 50: 108-120.

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

Cheeseman, C.L. 1975. The population ecology of small rodents in the grassland of Rwenzori National Park, Uganda. Unpublished Ph.D. thesis, University of Southampton.

Harvey, M.J. and R.W. Barbour. 1965. Home range of Microtus ochrogaster as determined by a modified minimum area method. J. Mammal. 46: 398-402.

Hubbs, E.L. 1951. Food habits of feral house cats in the Sacramento Valley. California Fish and Game 37: 177-189.

Jewell, P.A. 1966, The concept of home range in mammals. Symp. Zool. Soc. Lond. 18: 85-109.

Kaufmann, J.H. 1962. Ecology and social behavior of the coati, Nasua narica, on Barro Colorado Island, Panama. Univ. Calif. Publ. Zool. 60: 95-222.

Rohr, C.O. 1947. Table of equivalent populations of North American small mammals. Amer. Midland Nat. 37: 223-249.

Prim, R.C. 1957. Shortest connection networks and some generalizations. Bell System Tech. J. 36: 1389-1401.

Rood, J.P. 1975. Population dynamics and food habits of the banded mongoose. E. Afr. Wildl. J, 13: 89-111.

TABLE I

	Females		Males	
	Average	Range	Average	Range
Rmin	0.84 ha	0.03-4.24 ha	8.4 ha	0.8-24.0 ha
Rres	0•30 ha	0.02-1.23 ha	3.3 ha	0.2-12.3 ha
Rmod	0.37 ha	0.02-3.13 ha	3.7 ha	0.2-16.4 ha
HRL	161.1 m	40.5-329.2,m	484.2 m	131.9-927.3 m
V.C.	0.86	0.51-1.45	0.75	0.53-1.39

A comparison of the home ranges of females (68 cats, average of 38 sightings) and males (32 cats, average of 40 sightings). (HRL= home range length).

TABLE II

Group	No. of cats	No. of sightings	Range Size (ha)
B	6	289	2.39
C	7	313	3.43
G	2	44	0.95
I	9	325	0.60
M	3	49	1.77

Examples of group range sizes (Rmin). The number of cats given is the number of adult females, excluding those born during the study. The locations of these groups are shown in Fig. 1.

TABLE III

Range size (ha.)	% of cats in each range size class: Females	Males
0-1	64.7	6.3
1-2	23.5	6.3
2-3	8.8	6.3
3-4	1.5	-
4-5	1.5	15.6
5-6	-	12.5
6-7	_	_
7-8	-	6.3
8-9	-	9.4
9-10	_	_
10-11	-	6.3
11-12	-	6'3
12-20	_	15.6
over 20	-	9.4

Home ranges of female and male cats (Rmin) as percentage of total females (N = 68) and total males (N = 32).

TABLE IV

Variability coefficient	% of cats in each V.C. class	
	Females	Males
0.50-0.59	5.9	15.6
0.60-0.69	20.6	37,5
0.70-0.79	14.7	21.9
0.80-0.89	22.1	9.4
0.90-0.99	10.3	6,3
1.00-1.09	13.2	-
1.10-1.19	4.4	3.1
1.20-1.29	1.5	-
1.30-1.39	5.9	6.3
1.40-1.49	1.5	-

Variability coefficients (V.C.) of female and male cats, as percentage of total females (N = 68) and total males (N = 32).

TABLE V

	Remained		Emigrated	
	Average	Range	Average	Range
Rmin	0.99 ha	0.08-2.?? ha	10.6 ha	1.3-26.1 ha
Rmod	0•37 ha	0.03-1,65 ha	3.0 ha	0.5-g.4 ha
HRL	184.3 m	67.2-285.6 m	5? 6.9 m	232.5-1203.1 m
V.C.	0.73	0.56-0.93	1.00	0.68-1.93

A comparison of the home ranges of young toms (1-2 years old) that remained where they were born (9 cats, average of 33 sightings) or emigrated (10 cats, average of 40 sightings).

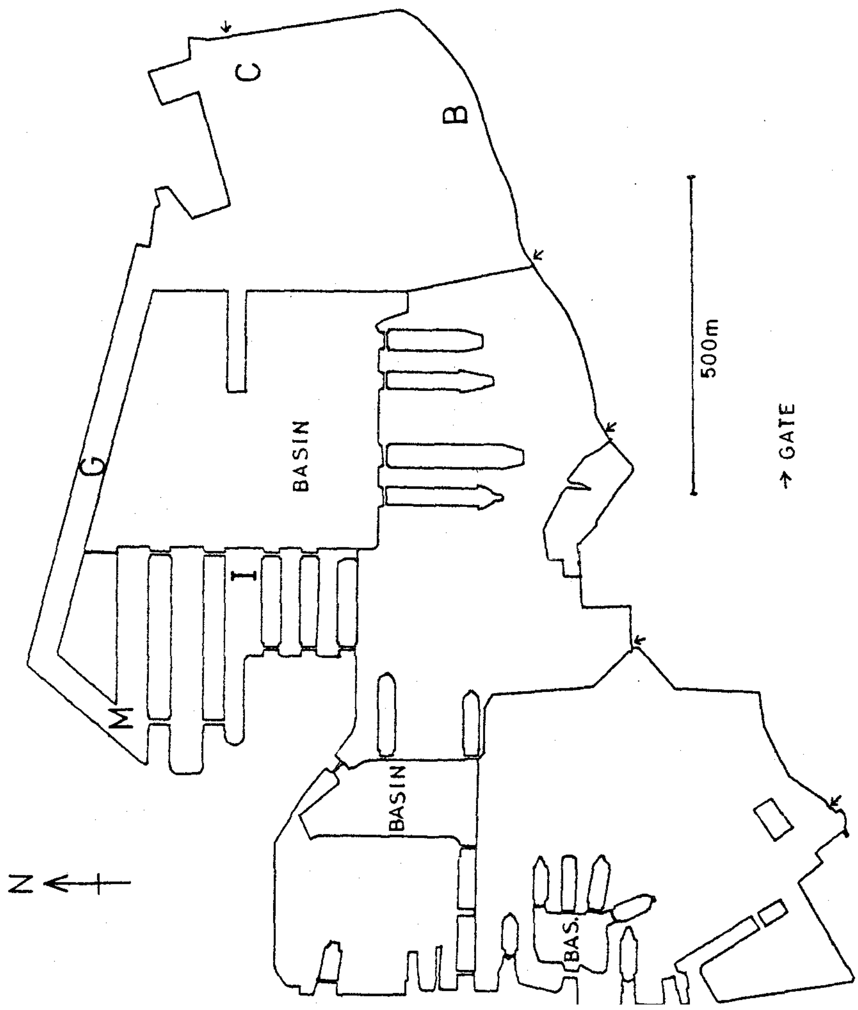

FIG 1. Map of Portsmouth Dockyard, showing basins and docks.
(Letters refer to the groups listed in Table II.)

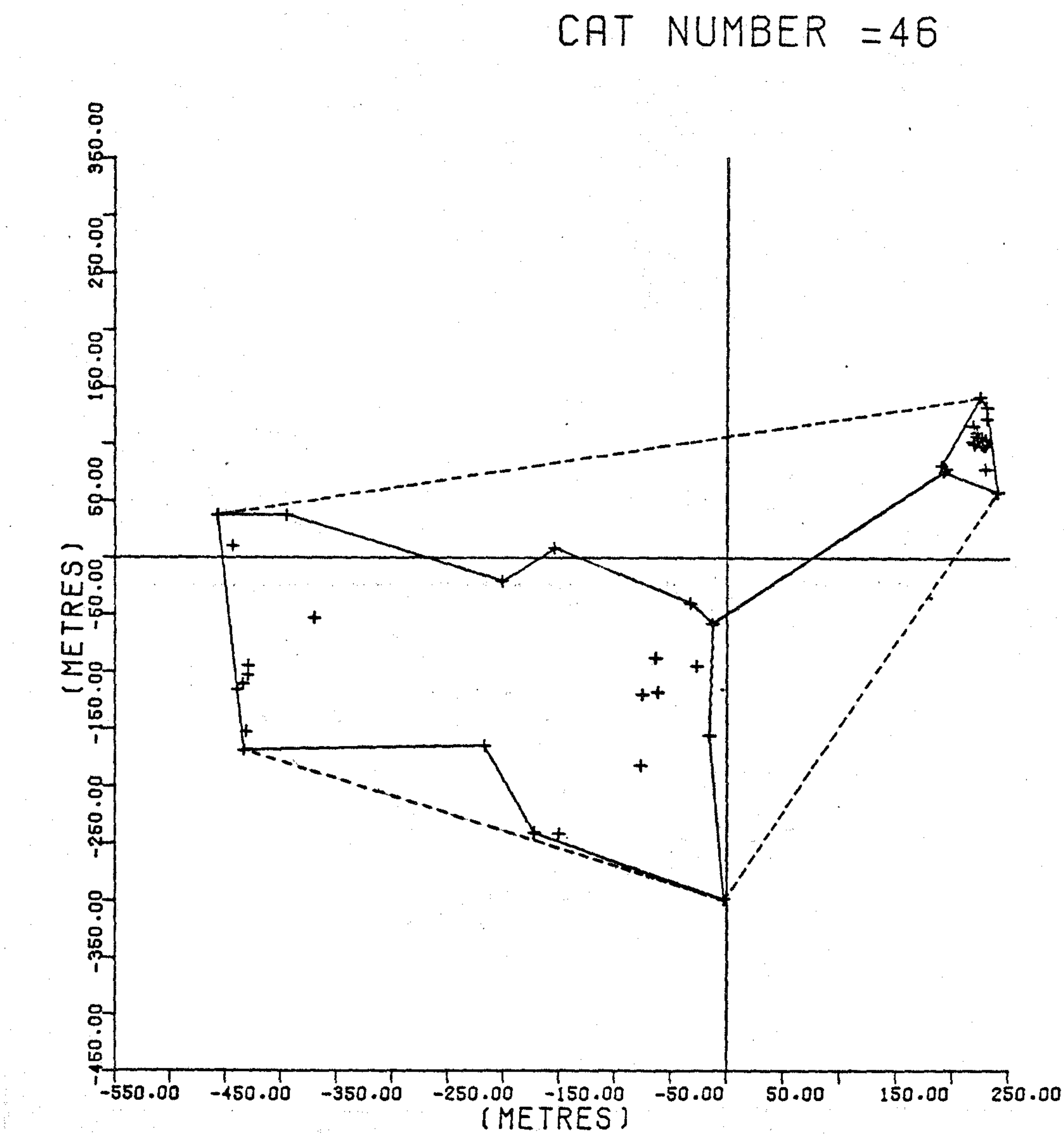

FIG 2. Home range of a young tom which emigrated, by Rmin (dashed line) and Rmod (solid line).

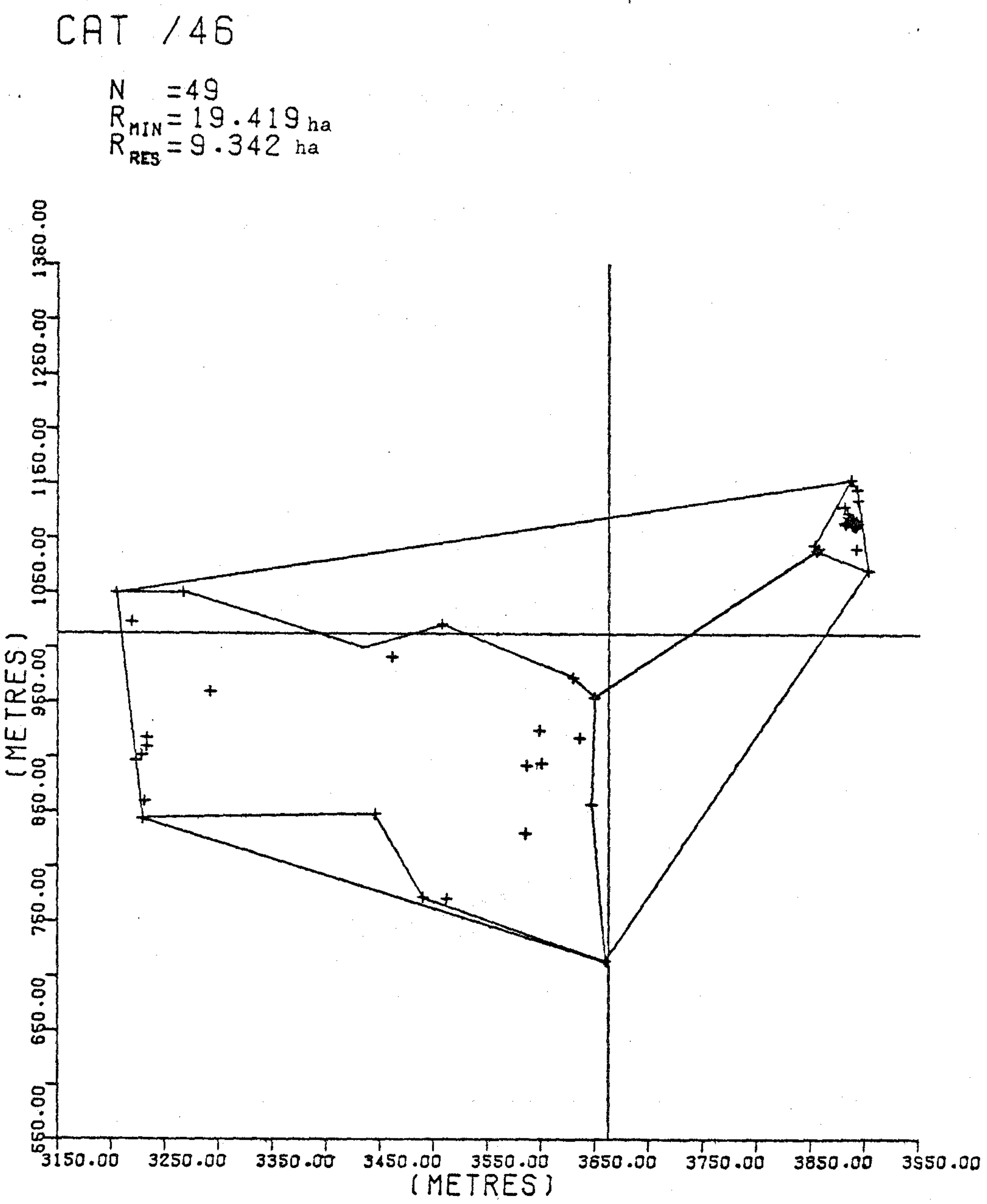

FIG 3. Home range of the tom shown in Fig. 2, by Rmin (outer line) and Rres (inner line). Note the intersection point in the upper line of the larger reachable subgraph. (49 sightings)

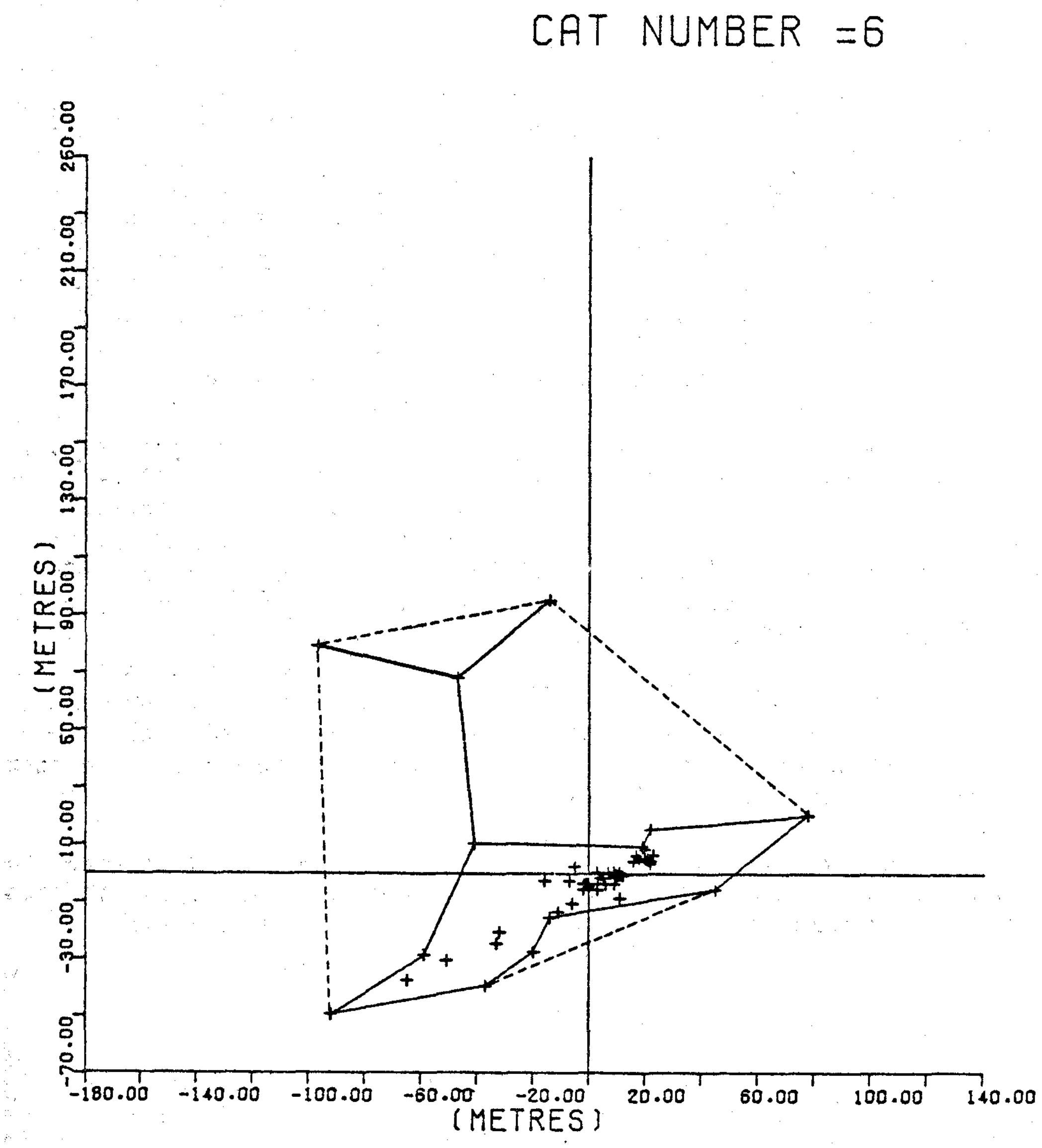

FIG 4. Home range of an adult female, by Rmin (dashed line) and Rmod (solid line), to show the core area. (68 sightings)