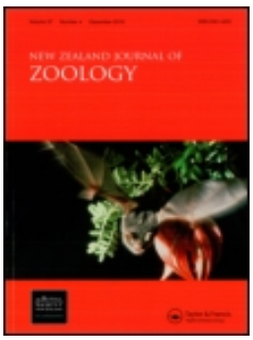

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Movements and home range of ferrets (*Mustela furo*) at Pukepuke Lagoon, New Zealand

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Ferrets at Pukepuke Lagoon were live-trapped during the periods November 1970 to August 1973 and January 1976 to July 1977. Although the sex ratio of the 75 trapped ferrets was equal, there was a strong bias towards male captures in the earlier period (58.4%) and towards female captures in the later period (68.7%). Habitat modification and changes in the trapping programme for the later period probably resulted in the increased abundance and capture rate of females. Between consecutive captures 58.2% of male movements exceeded 250 m, as against only 39.7% of female movements; the mean distance between consecutive captures was 435 m for males and 285 m for females. Mean monthly movements varied from 700 m in January to 315 m in June for males, and from 360 m in March to 150 m in September for females. Juveniles of both sexes moved similar, intermediate distances. Dispersing juveniles were trapped from January until April; males tended to appear in traps earlier in the year than females. Only 4 of 14 juvenile males settled as residents, but 15 of 28 juvenile females did so. Male and female home ranges overlapped extensively, but within each sex individual ranges were usually separate. Resident males maintained a well defined spacing pattern, adjusting their boundaries if a juvenile settled or a neighbouring range became vacant. In 1976 six females had overlapping ranges in an area of abundant food. Female ranges (12.4 ha) were on average smaller than male ranges (31.3 ha); home ranges of both sexes were smaller during the breeding season (August–February) than at other times.

Keywords: Carnivora; Mustelidae; *Mustela furo*; movements; home range; dispersion; population structure; Pukepuke Lagoon; ferret

INTRODUCTION

Ferrets (*Mustela furo* L.) have been introduced into New Zealand, and now occur in farmland and scrubland in many regions of the North Island and South Island, usually in association with rabbits (*Oryctolagus cuniculus*) (Marshall 1963). In the late 1880s large numbers of ferrets, stoats (*M. erminea*), and weasels (*M. nivalis*) were released in an unsuccessful attempt to control rabbits, which had become serious agricultural pests soon after their establishment in the 1860s.

Ferrets are a domesticated strain of either the European polecat (*M. putorius*) or the steppe polecat (*M. eversmanni*) (Corbet & Southern 1977); the two forms interbreed freely. Populations of wild ferrets have become established in many parts of the world after escapes or liberations. Ferrets show marked sexual dimorphism (see Moors 1980), males weighing about twice as much as females (Roser & Lavers 1976). Both sexes are strongly carnivorous, and eat mainly rabbits, rodents, and birds (Gibb & Flux 1973, Roser & Lavers 1976). Little is known of their movements or dispersion, apart from the preliminary results of Lavers (1973).

In this paper we report results from a live-trapping study of ferrets conducted in 1970–73 and 1976–77 at Pukepuke Lagoon, North Island. Data are presented on their movements and home ranges, and are analysed in relation to sex, age, and season. These data greatly supplement those previously discussed by Lavers (1973), and incorporate new analyses of those results.

STUDY AREA AND METHODS

Pukepuke Lagoon (40°20′S, 175°16′E) is one of several small lakes along the south-west coast of the North Island which have formed between unconsolidated and consolidated sand dunes (Cunningham *et al.* 1953). The lagoon and its associated swampland was designated a Wildlife Management Reserve in 1968, and has since been managed principally for waterfowl. Ferrets and feral cats (*Felis catus*) are the most abundant carnivores; stoats and weasels are also present.

The Reserve (Fig. 1) includes 15 ha of open water, 89 ha of surrounding swamp, where the vegetation is mainly raupo (*Typha muelleri*), niggerhead (*Carex secta*), flax (*Phormium tenax*),

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Table 1. Numbers of ferrets tagged and total captures, Pukepuke; classification as juvenile or adult refers to age at first capture

	Period*	Male Juv.	Male Ad.	Female Juv.	Female Ad.		Sex ratio (% ♂♂ of all ages)
Number tagged	I	7	17	14	5	**43**	55.8
	II	7	7	14	4	**32**	43.7
Total captures	I	270		192		**462**	58.4
	II	107		235		**342**	31.3
		377		**427**		**804**	46.9
Average number of captures per individual, and c.v. of mean (%)	I	11.3 (149.6)		10.1 (140.8)		10.7 (144.9)	—
	II	7.6 (149.5)		13.1 (101.5)		10.7 (117.4)	—

*Period I: 34 months, November 1970 – August 1973; Period II: 19 months, January 1976 – July 1977

and cabbage tree (*Cordyline australis*), and a small section (17 ha) of consolidated dunes. It is surrounded by farmland which is well developed in the east but elsewhere is being reclaimed from sand country where scattered cabbage trees, swampy areas, and lupins (*Lupinus arboreus*) occur. Cut-over pine forest (*Pinus* spp.) is found to the west of the Reserve, and other small pine plantations lie to the north and south.

Live-trapping was carried out from November 1970 until August 1973 (period I) and again in the same area from January 1976 until July 1977 (period II) (Fig. 1). Up to 62 wooden traps, spaced at intervals of 30–150 m (average 75 m), were operated during period I (i.e., the "inner" trap line of Lavers (1973)); 43 traps at intervals of 65–300 m (average 155 m) were used during period II. The traps were set for 3–5 nights each month, and were checked at least once per day. Until January 1972 the traps were set without bait, but subsequently all were baited, usually with dead laboratory mice and a smear of rabbit gut. Captured ferrets were ear-tagged, sexed, and weighed, and the usual trapping details were recorded. During period II close-up Polaroid photographs were taken of the ferrets' facial markings to aid in identifying animals which had lost their ear-tags (the facial markings are unique for each individual).

Juvenile ferrets were recognised from January to July by their lack of a palpable sagittal crest and their usually small size at first capture. All juveniles were classed as adults from 1 August (i.e., at an age of about 9 months), by which time they had attained adult weight, were developing a sagittal crest, and were close to sexual maturity. Ferrets caught in three or more consecutive trapping sessions were classed as residents, and all others were treated as non-residents. Residents were assumed to be present on the study area continuously, even if they were not caught in all possible trapping sessions.

In each trapping session the minimum distances travelled by ferrets between consecutive captures were measured from the straight-line distances separating the pairs of trap-sites. Consecutive captures in the same trap were excluded from these analyses. Variations in the extent of these movements were analysed in relation to the age and sex of ferrets and the time of year.

Home range boundaries were plotted for residents by joining their outermost capture sites during the periods August–February and March–July. The former period encompasses the breeding season, and the latter includes the months when the ferret population was relatively stable. Areas of ranges were calculated for ferrets caught at least six times during three consecutive trapping sessions. These areas represented only minimum estimates of the actual size of the ranges, because some ranges extended beyond the study area.

RESULTS

Captures and Residence

Capture data for the 75 ferrets (38 males, 37 females) caught during the study are summarised in Table 1. Captures of females comprised 53.1% of the total (n = 804). The sex ratio of ferrets tagged did not differ significantly from unity, either overall or during each trapping period. In contrast, the sex ratio of captures was strongly biased towards males in period I (χ^2 = 6.58, $P < 0.02$) and towards females in period II (χ^2 = 23.95, $P < 0.001$). This reversal was due to differences between periods in the relative numbers of female ferrets tagged and in the mean frequencies with which ferrets of both sexes were captured. In proportion to the length of the period, almost twice as many females were tagged in period II (0.94 per month) as in period I (0.56 per month), whereas the corresponding values for males remained similar (0.70 in I, 0.74 in II). Relative to the first period, the average number of

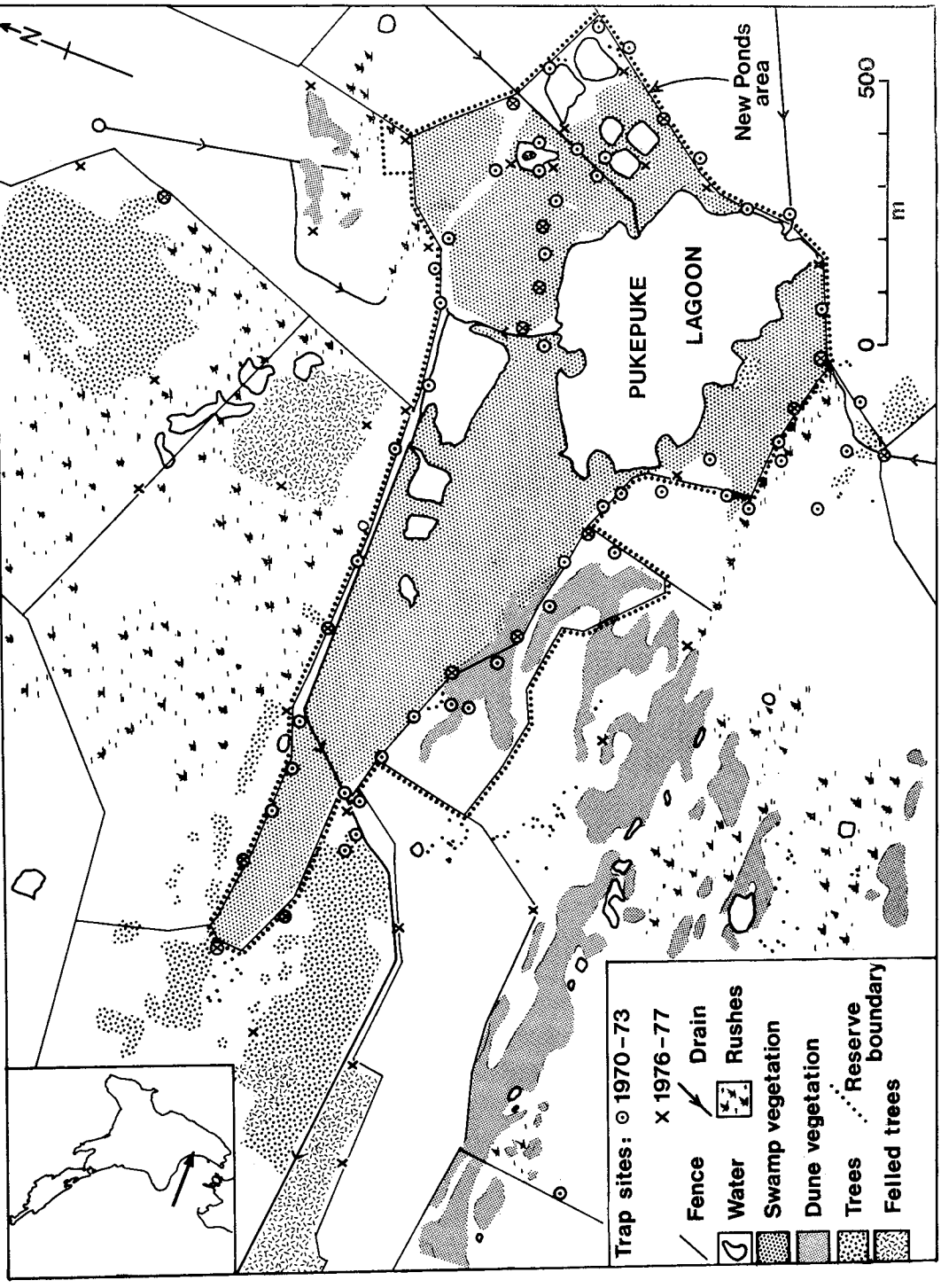

Fig. 1. Study area at Pukepuke Lagoon, and boundaries of Reserve. Trap sites for the two periods of study and vegetation types are keyed (inset); unshaded areas are pasture.

Table 2. Timing of dispersal of juvenile ferrets at Pukepuke, as revealed by months when individual juveniles were first captured (data for 1970–73 and 1976–77 combined)

	Males		Females		
	n	%	*n*	%	
Jan	3	21.4	1	3.6	**4**
Feb	4	28.6	9	32.1	**13**
Mar	5	35.7	10	35.7	**15**
Apr	2	14.3	8	28.6	**10**
	14		**28**		**42**

captures per female increased by 31% in the second, whereas that for males decreased by 33% (Table 1). Variability between individual ferrets in total number of captures (as measured by the coefficient of variation for the average values; see Table 1) was similar for males in both periods, but was greatly reduced for females in period II. Taken together, these data indicate that females—but not males—were more abundant and were trapped more readily during period II than during period I.

Of the 42 juveniles tagged, 21 were caught in each period. The numbers of ferrets first captured as adults and juveniles were similar during period I, but juveniles (especially females) predominated during period II (Table 1). There was an annual influx of juveniles in late summer and autumn, when litters broke up, with a tendency for juvenile males to appear in the traps earlier than females (Table 2). No new juveniles were trapped after April. Nineteen of the 42 tagged juveniles settled on the study area. More females than males became residents: in 1970–73 the numbers were respectively six and two, and in 1976–77 were nine and two.

During period I 9 males and 7 females were resident (Table 3), whereas during period II there were 5 males and 11 females. For most of period II three or four males and up to nine females were resident together, giving an average sex ratio for residents of 1 : 2.5 (male : female). This preponderance of females contrasted sharply with the corresponding value of 1 : 1.1 in 1970–73, when up to five of each sex were present. Ten of the 14 resident males were first tagged as adults, in contrast with only 3 of the 18 resident females (Table 3)—a highly significant difference ($\chi^2 = 9.79$, $P < 0.01$). Resident males were trapped an average of 22.9 times, and resident females 21.4 times (Table 3). During period I the average duration of residence was 9.9 months for males and 14.6 months for females, as against 7.8 months and 20.3 months respectively during period II. Of the eight resident males which disappeared without trace during the study, six (75.0%) did so between August and March, i.e., during or shortly after the breeding season. By contrast, only three resident females disappeared then, but six (67.7%) were lost between April and July. The longest residence was 30 months for ♀ 906, which remained on the study area from February 1971 until August 1973. This female was an adult when first tagged, and must have been at least 3.5 years old when last captured. No ferrets caught in 1970–73 were recaptured in 1976–77, so 3–5 years is probably the maximum age attained by ferrets at Pukepuke.

Table 3. Summary of trapping histories of resident ferrets at Pukepuke

Ferret	Date first caught	Age group at first capture	Total captures	Duration of residence (months)
♂				
901	5 Nov 70	Ad	14	8
902	15 Dec 70	Ad	9	9.5
910	22 Jul 71	Ad	9	4
917	22 Feb 72	Juv	25	6†
2356	27 Mar 72	Ad	53	17*
2364	25 Apr 72	Ad	63	16*
2365	27 Jun 72	Ad	31	14*
2375	21 Nov 72	Ad	8	8.5*
8925	27 Feb 73	Juv	23	6*
502	13 Jan 76	Ad	20	10.5
503	13 Jan 76	Juv	10	11
520	24 Mar 76	Juv	42	12
533	16 Apr 76	Ad	6	3.5
536	13 Oct 76	Ad	8	2
Average (n = 14):			**22.9**	**9.1**
♀				
906	25 Feb 71	Ad	28	30*
913	24 Mar 72	Juv	45	19*
921	25 Mar 71	Juv	18	17†
922	23 Feb 72	Juv	44	18
2352	23 Feb 72	Juv	6	7
8926	28 Feb 73	Juv	18	6*
8928	21 Mar 73	Juv	8	5*
507	15 Jan 76	Ad	3	2†
511	19 Feb 76	Ad	13	5.5
516	17 Mar 76	Juv	34	13
519	23 Mar 76	Juv	19	15*
526	25 Mar 76	Juv	13	8.5
527	25 Mar 76	Juv	42	16*
529	13 Apr 76	Juv	41	14.5*
530	14 Apr 76	Juv	12	10
531	14 Apr 76	Juv	14	11.5
532	13 Apr 76	Juv	13	12.5
557	16 Feb 77	Juv	14	4.5
Average (n = 18):			**21.4**	**11.9**

*Still alive when trapping ceased in 1973 or 1977
†Known to have died

Movements between Consecutive Captures

The spacing of traps did not bias the extent of movements between consecutive captures. There was always an excess of vacant traps, and the frequency distributions of distances between neighbouring

Table 4. Distribution of minimum distances travelled by ferrets between consecutive captures, Pukepuke. In December–March most juveniles dispersed and established home ranges; in April–July the numbers of residents and boundaries of their ranges were relatively stable; breeding occurred during August–November

Distance (m)	Males Total *n*	Males Total %	Males Dec–Mar	Males Apr–Jul	Males Aug–Nov	Females Total *n*	Females Total %	Females Dec–Mar	Females Apr–Jul	Females Aug–Nov
0–250	84	41.8	19	30	35	108	60.3	34	52	22
251–500	59	29.4	22	13	25	52	29.1	14	36	2
501–750	23	11.4	4	14	4	11	6.1	4	7	0
751–1000	13	6.5	6	4	3	5	2.8	4	1	0
>1000	22	10.9	15	1	6	3	1.7	2	0	1
	201		**66**	**62**	**73**	**179**		**58**	**96**	**25**
Average distance (m):	435		565	364	384	285		345	270	204

Table 5. Distribution of distances between consecutive captures of adult and juvenile Pukepuke ferrets in periods when both age classes were present

Distance (m)	January–March* Ad ♂	Juv ♂	Ad ♀	Juv ♀	April–July Ad ♂	Juv ♂	Ad ♀	Juv ♀
0–250	8	3	26	5	17	13	21	31
251–500	8	6	8	4	6	7	8	28
501–750	0	3	2	2	8	6	2	5
751–1000	4	2	2	3	4	0	1	0
>1000	11	0	1	0	1	0	0	0
Average distance (m):	675	440	297	444	403	310	267	272

*Data for adults in December omitted because no juveniles were trapped then

traps were independent of those between consecutive captures ($P < 0.005$ in both periods for G-tests of independence; Sokal & Rohlf 1969).

There were no significant differences between periods I and II in the frequency distribution of capture distances, and accordingly we have combined the two sets of data.

Half the distances ($n = 192$ of 380 total) traversed by ferrets between consecutive captures were less than 250 m, but 42 (11.1%) exceeded 750 m, and the longest was 1890 m. By contrast only two (1.9%) inter-trap distances exceeded 250 m. The distribution of distances between consecutive captures is shown for each sex in Table 4. The total distribution for males was significantly different from that for females ($G = 22.75$, $P < 0.005$), mainly because females rarely travelled beyond 750 m. The majority (58.2%) of male movements exceeded 250 m, whereas only 39.7% of female movements were in that category; the difference was highly significant ($\chi^2 = 13.02$, $P < 0.001$). The mean distance between consecutive captures was 435 m (range 75–1890 m) for males and 285 m (range 45–1490 m) for females. There were monthly variations for both sexes in the average distance traversed, but only those for males were statistically significant ($F = 1.98$, $P < 0.05$). Males travelled furthest in January (average distance 700 m) and least far in June (315 m), as against March (360 m) and September (150 m) respectively for females.

Differences between the sexes are also evident if the data are subdivided into three 4-month periods broadly corresponding with different stages in the annual cycle of ferrets at Pukepuke (Table 4). Frequency distributions for males and females differed significantly in each period (G-tests, $P < 0.005$), the frequencies at longer distances always being greater for males than for females. When the three distributions were compared for each sex, significant differences were found between them all for males (G-tests, $P < 0.05$), but only between August–November and the other two for females (G-tests, $P < 0.025$). There was a prominently bimodal distribution for males in December–March, and the bimodality remained even when movements beyond 1000 m were assigned to additional 250 m classes: 5 (7.6%) were in the 1001–1250 m class, and 10 (15.2%) were in the 1251–1500 m class. The distribution for females during August–November was conspicuous for the exceptional restriction in movements—88.0% were less than 250 m.

The frequency distributions for adult and juvenile ferrets are set out in Table 5 for the two periods of the year when both age groups were present. From

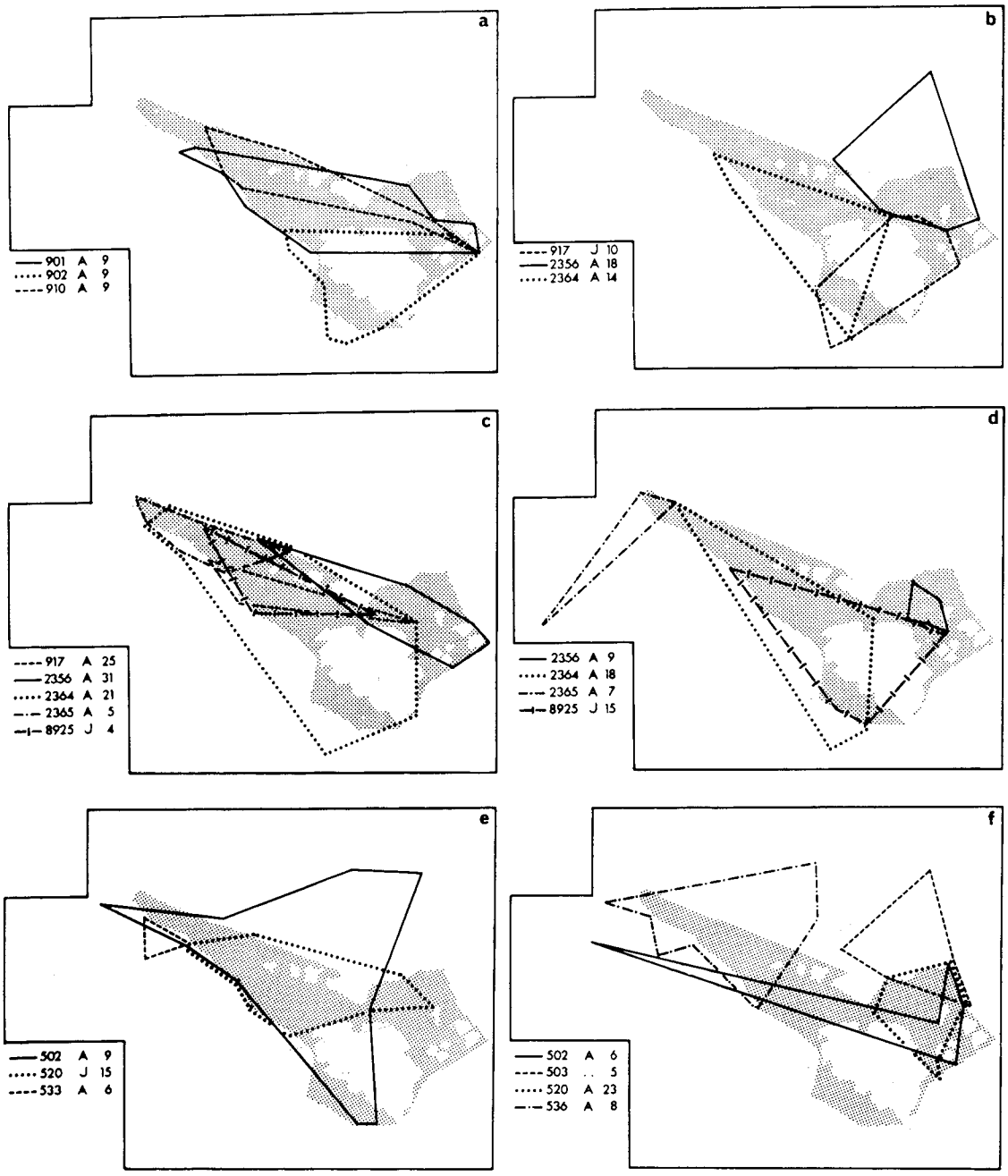

Fig. 2. Distribution of home ranges of resident male ferrets, Pukepuke Lagoon: (a) November 1970 – February 1972; (b) March–July 1972; (c) August 1972 – February 1973; (d) March–July 1973; (e) March–July 1976; (f) August 1976 – February 1977. Ear-tag number, age group (A, adult; J, juvenile), and number of captures used to estimate home range given for each ferret. Shaded area as in Fig. 1.

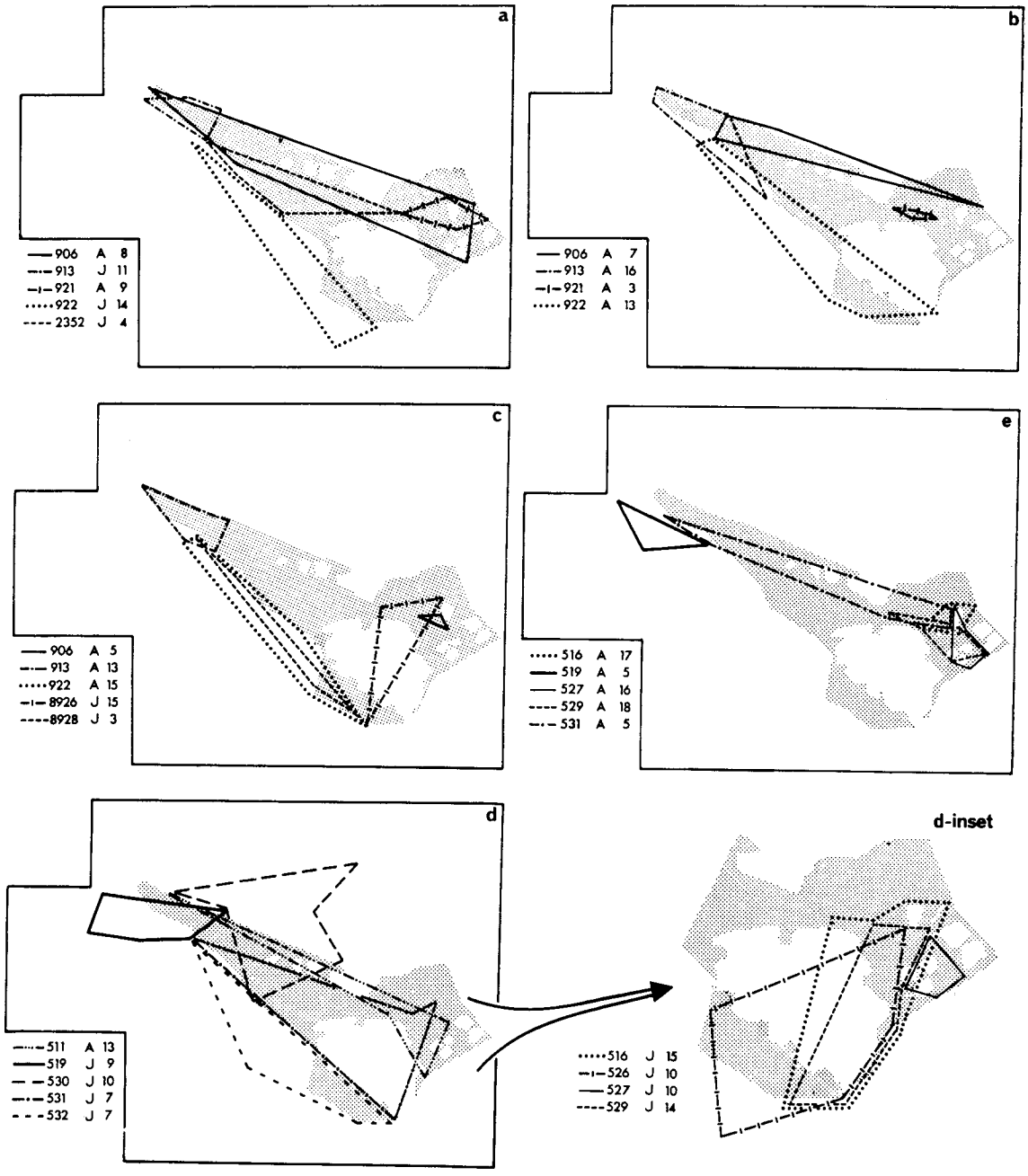

Fig. 3. Distribution of home ranges of resident female ferrets, Pukepuke Lagoon: (a) March–July 1972; (b) August 1972 – February 1973; (c) March–July 1973; (d) March–July 1976; (e) August 1976 – February 1977. (No females were resident November 1970 – January 1972.) The ranges of ♀ 511, ♀ 531, and ♀ 532 have been omitted from 'd-inset' in the interests of clarity. Conventions as for Fig. 2.

January until March there was a highly significant difference between adult and juvenile males ($G = 16.2$, $P < 0.005$) but not between adult and juvenile females. The distributions for adult males and females were strikingly different ($G = 22.3$, $P < 0.005$); their respective modal classes were at opposite ends of the distributions, and the average distance traversed by males between successive captures was more than twice that for females. In contrast, juveniles of both sexes had similar distributions and average distances between consecutive captures.

The movements of both sex and age groups were more restricted in April–July than in January–March, and the contrast was most pronounced for adult males (Table 5; $G = 24.1$, $P < 0.005$). The modal class for each sex and age group was 0–250 m, and there was a total of only 6 movements (3.8%) beyond 750 m, as against 23 (23.5%) in January–March. There were no significant differences between any of the April–July distributions.

Arrangement and Areas of Home Ranges

The home ranges of resident ferrets are shown diagrammatically in Fig. 2 and 3 for six periods between 1970 and 1977. Coincident boundaries of different ranges have been separated in the figures for clarity. Some boundaries appear to cross the open water of the lagoon. This is possible in summer, when water levels are usually low, but at other times the ferrets may have kept closer to the raupo. However, ferrets at Pukepuke swim readily and well, so that water boundaries are not entirely unrealistic.

During the initial 14 months of the study (November 1970 to January 1972) no females were resident (by our criterion of capture in at least three successive trapping sessions), so only male ranges are shown for that period (Fig. 2a). The periods in Fig. 2 and 3 cover the two main parts of the annual cycle of ferrets at Pukepuke: August–February, when breeding occurs, adult males become more mobile, and juveniles begin to disperse; and March–July, when territories are established and dispersion patterns are relatively stable.

The boundaries or location of individual ranges were often not constant from one period to the next, especially among males (e.g., ♂ 502, Fig. 2e,f). Male ranges overlapped extensively with female ranges, but within each sex individual ranges were largely separate. Most overlaps depicted in Fig. 2 and 3 (apart from those for females in Fig. 3d) were more apparent than real. Some were due to the replacement of one resident by another (e.g., ♂ 901 by ♂ 910, Fig. 2a), and others reflected the use of common areas, but at different times (e.g., ♂ 2364, ♂ 2365, Fig. 2c).

Table 6. Areas (ha) of home ranges of Pukepuke resident ferrets caught at least six times in three consecutive trapping sessions; the timing of periods corresponds with that in Fig. 2 and 3.

Ferret	Mar–Jul 1972	Aug 1972–Feb 73	Mar–Jul 1973	Mar–Jul 1976	Aug 1976–Feb 77
♂					
917	24.8				
2356	49.0	18.1	<3.0		
2364	28.9	56.7	38.9		
2365		11.2			
8925			33.3		
502				72.2	25.5
520				31.0	13.2
536					32.8
♀					
906	34.4	10.2			
913	1.9	6.5	3.5		
922	20.3	19.9	15.6		
8926			7.4		
511				13.8	
516				14.1	1.9
519				13.9	
526				19.3	
527				2.1	2.7
529				12.5	3.1
530				33.3	
557					10.9

Between March 1972 and July 1973 neighbouring adult males maintained a well defined spacing pattern. The boundary between the ranges of ♂ 2356 and ♂ 2364 was distinct, with little overlap (Fig. 2b–d). Although Fig. 2c shows the ranges of ♂ 2364 and ♂ 2365 overlapping completely, the captures responsible for this situation occurred only in December 1972. Male 2365 was not captured at that time, and was probably in the part of its range which extended beyond the study area. At all other times ♂ 2364 was caught only on the edge of ♂ 2365's range. A similar pattern of dispersion occurred in 1976–77, except for ♂ 502, the range of which initially covered that of at least two other males. Once ♂ 503 and juvenile ♂ 520 had settled, the range of ♂ 502 decreased, and a more stable situation existed (Fig. 2f).

Each year some juveniles settled as residents—usually a single male (in 1972, 1973, and 1976) and up to eight females (3 in 1972, 2 in 1973, 8 in 1976, and 1 in 1977). Resident adult males apparently tolerated juvenile males settling within their home ranges, and adjusted their areas of occupation accordingly. Because of this it appears that there were large areas of overlap between the ranges of juvenile and adult males (Fig. 2b,d,e), whereas the ranges of each were usually temporally separated. For example, the trapping records show that adult

♂ 2364 paid only a few visits to that part of its range occupied by juvenile ♂ 917 (Fig. 2b). However, after the death of ♂ 917 in September 1972 ♂ 2364 quickly extended its range in the east (Fig. 2c). Another juvenile (♂ 8925) settled in the following year, and again ♂ 2364 was captured only occasionally in those parts of its range inhabited by the juvenile. The range of juvenile ♂ 520 was nearly totally encompassed by that of adult ♂ 502 in March–July 1976; both ferrets were trapped in the same area within a few days of each other in March and April 1976 (Fig. 2e). However, during September 1976 ♂ 520 settled around the New Ponds (Fig. 2f) and ♂ 502 was caught there three times, but in different traps from those visited by ♂ 520. Thereafter ♂ 502 was not captured anywhere within the range of ♂ 520.

Female ferrets maintained distinct ranges with relatively little overlap of boundaries (except during March–July 1976). Most females remained on much the same part of the study area throughout their capture history. However, the trapping records for ♀ 906 and ♀ 922 show that at times they shifted their ranges; the reasons for this are unknown. The composite range of ♀ 906 covered the northern half of the Reserve (Fig. 3a,b), but at times this female was present only in the west (March–June 1972, August–December 1972) or in the east (July–August 1972, March–August 1973). Female 922 ranged across the south of the Reserve from March to June 1972, remained in the south-east from June to August, and was then caught only in the west in September. She was not recaptured until January 1973, after which she moved widely throughout the range shown in Fig. 3c.

Fig. 3d,e illustrate the unusual dispersion pattern that occurred when eight juvenile females settled in the study area in 1976. Six had overlapping ranges in a small eastern part of the Reserve centred on the developed New Ponds area. This contrasted markedly with the sparse dispersion pattern and small degree of overlap apparent earlier (Fig. 3a–c).

Female ferrets tended to have smaller home ranges than males (Table 6). Nevertheless, there was much variation in size, both in terms of successive ranges held by the same individual and in comparisons between the sexes. Only one male range (7.1%) covered less than 10 ha, whereas eight female ranges (42.1%) were in that category ($\chi^2 = 4.99$, $P < 0.05$). The overall average area was 31.3 ± 18.6 ha for males and 12.4 ± 9.6 ha for females. Ranges of both sexes tended to be bigger in March–July than in August–February; the respective averages were 35.1 ha cf. 26.3 ha for males and 14.8 ha cf. 7.9 ha for females.

DISCUSSION

Captures and Residence

Overall, similar numbers of male and female ferrets were trapped, in terms of both individuals and average numbers of captures (Table 1). Nevertheless, there were marked differences between the study periods in these variables. Males predominated in the capture records in 1970–73, whereas females predominated in 1976–77. This contrast was due partly to the greater abundance of females in period II. Between March and July 1976 six juvenile females settled in the eastern section of the study area, which at other times encompassed the home ranges of only one or two (maximum three) resident females (Fig. 3). A likely explanation for this unusual occurrence was the availability at the time of a rich food supply (see below). The contrast between study periods was also due to between-sex differences in ease of capture. The mean number of captures per male declined by one-third in period II, but variability between individuals in total captures remained the same (Table 1). This suggests that captures of males were influenced more by the trapping methods than by their behavioural responses towards traps. Although the same traps were used in both study periods, there were differences in both the spacing and siting of traps (Fig. 1). Apparently trapping conditions were more favourable for males in 1970–73 than in 1976–77. Females, however, showed the opposite reaction. Their mean number of captures rose from 10.1 in period I to 13.1 in period II, and individual variability in total captures decreased substantially in the latter period (i.e., relatively fewer females were especially trap-shy or trap-prone). These changes could have been due either to alterations in behaviour or to the differing trapping schemes, or both. We have no data with which to distinguish these alternatives.

In trapping studies of mustelids it is usual to find a bias in favour of males in the sex ratio of captures (see King 1975, 1980). The opposite bias noted at Pukepuke in 1976–77, when female captures accounted for 68.7% of the total, was due to several factors. First, females were both more abundant and more readily trapped than males in period II. In particular, there were substantially more resident females than males throughout 1976–77 (Table 3), and resident ferrets accounted for over 80% of captures in both periods. Second, as a result of the requirements of other investigations of the ferrets, trapping effort during 1977 was not spread evenly across the study area. Trapping pressure was most intense in the eastern sections of the Reserve, where females were the more common sex.

A large majority of the resident males at Pukepuke first settled as adults (Table 3). Most juvenile males

must therefore have spent their first winter as transients, and were likely to have finally established home ranges away from their natal areas. By contrast, most new female residents were juveniles. Often they took up residence a few months after being first trapped as newly independent young, and it seems probable that most did not disperse far from their birthplace before settling. Erlinge (1977) has reported the same behaviour in young female stoats. Female ferrets tended to be resident for longer than males. For example, 10 resident females (55.6%) but only 4 resident males (28.6%) lived on the study area for more than 12 months (Table 3). Similar between-sex differences have been noted for stoats by Simms (1979).

Movements

The distances traversed between consecutive captures by Pukepuke ferrets varied according to sex, age, variations reflected real changes in the patterns of and time of year. We consider that the observed movement of the ferrets, particularly because the extent of the movements was not biased by the spacing of the traps. The consistently greater average distances travelled by males relative to females were probably due primarily to the larger size of the males' ranges. Both the average home range area and the average distance between consecutive captures of males were roughly double the corresponding values for females (Tables 4 and 6). Superimposed on this basic difference in movements and dispersion were the effects of the breeding season and the dispersal and settlement of juveniles. Additional factors such as food supply and location of den sites would have influenced movements, but we have no information about them.

Relative to the preceeding 4 months, males extended their movements in August–November (Table 4), when the breeding season was under way, presumably because they were searching for oestrous females. Like other mustelids, ferrets are polygamous and males face a selection pressure to mate with as many females as possible. Similar increases in the movements of breeding males have been reported for stoats (Erlinge 1977), weasels (Moors 1974, Erlinge 1974), and mink (*Mustela vison*) (Gerell 1970). The greatly reduced mobility of female ferrets at that time (Table 4) was probably due to the demands of pregnancy and lactation.

Juvenile ferrets began dispersing in January (Table 2). Their investigations of unfamiliar ground would have led both sexes to encounter traps relatively often, and to have covered similar distances between consecutive captures (Table 5). This situation parallels that found with juvenile weasels by Moors (1974); dispersing males and females both travelled an average of 480 m between successive captures.

Adult male ferrets travelled extensively between January and March (Table 5), often from one end of their range to the other. Presumably these males were moving about their ranges in reaction to the presence of dispersing juveniles. Such behaviour would explain the apparent anomaly of large movements during a period when home ranges were reduced in size (Table 6). By April both juvenile and adult residents had established their winter ranges, and trap-revealed movements were reduced. Few transients were trapped then, and the majority of the population were residents.

Home Range

Home ranges of males and females overlapped considerably. However, within each sex most ranges overlapped only near their borders, and—except for females in 1976 (Fig. 3d)—each ferret occupied part of its range to the exclusion of others. This pattern of dispersion is characteristic of many mustelids, particularly those in the genus *Mustela*, and is described by Powell (1979) as 'intrasexual territoriality'. Individuals are solitary except for reproductive purposes, but at the population level there is an organised pattern of spacing between individuals (Powell 1979).

Scent marking and dominance relationships are the principal mechanisms by which this spacing pattern is achieved in mustelids (see Powell 1979), and we found evidence of both types of behaviour. Ferrets often defecated on the lids of traps, simultaneously liberating scent from their anal glands (Stubbe 1972, Lavers 1973). During the breeding season several battle-scarred males were trapped; the wounds were mainly on the neck and shoulders (Lavers 1973). Males were also observed fighting at that time (D. J. Baker-Gabb, pers. comm.).

Considerable overlap of six females' ranges was observed in the modified New Ponds area in 1976 (Fig. 3d). This situation arose when dense stands of grasses had grown on the sandy soil displaced during excavations for the ponds. This habitat supported large numbers of prey species, particularly house mice (*Mus musculus*). These mammals are an important food for female ferrets at Pukepuke in autumn and winter (Roser & Lavers 1976). The range overlaps occurred in those seasons in 1976, and we consider that this especially favourable food supply modified the normal pattern of dispersion of the females. Apart from these females, all residents occupied parts of their ranges to the exclusion of conspecifics of the same sex.

Simms (1979) found that male stoats retained exclusive use only of portions of their ranges, and concluded that these areas were maintained primarily

through mutual avoidance and occasionally by combat. We found that the area of exclusive use did not necessarily remain the same throughout the trapping history of an individual ferret. Some shifted the centre of their activity to a particular part of their home range for a period, and then moved back to the original area (e.g., ♀ 906). Others responded to the presence of settling juveniles by rarely visiting that part of their range (e.g., ♂ 2364), and to vacant neighbouring ranges by expanding their domain in that direction (e.g., ♂ 2364).

Female ferrets occupied smaller areas and moved over shorter distances than males (Tables 4 and 6). During the breeding season their movements were very restricted, but we have too few captures from that period to say whether they were particularly territorial at that time (cf. Erlinge 1977). The small size of female ferrets relative to males makes it energetically profitable for them to hunt smaller prey (Roser & Lavers 1976, Moors 1980) and to occupy smaller home ranges, especially where acceptable prey species are abundant.

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