MOVEMENT OF MARKED SIKA (*CERVUS NIPPON*) AND RED DEER (*CERVUS ELAPHUS*) IN CENTRAL NORTH ISAND, NEW ZEALAND

MAVIS M. DAVIDSON

18 Kitchener Terrace, Wellington 4, New Zealand

(First received for publication 25 July 1978; in revised form 4 December 1978)

ABSTRACT

Movement of sika deer (**Cervus nippon**), within the area from the 1905 liberation point in the northern Kaimanawa Forest to the Ruahine Range some 90 km south, was studied over the period 1964-74 using self-tagging collars. Fifty-four sika and 30 red deer (**Cervus elaphus**), mostly hunter-killed, were recovered. For sika deer, the average distance travelled from tagging to kill site was 2.2 km after an average of 16.9 months; for red deer, an average distance of 3 km in an average of 17 months. The only significant difference found was between sexes of sika deer, the males travelling further than the females ($p = 0.05$). Recovery of collared deer from the marking areas showed that they returned annually to feeding grounds. Collar recoveries also indicated a southward dispersal. There was a greater susceptibility to marking for adult females than males; yearling males were more susceptible than yearling females. Only one marked deer, a sika stag, was recovered from the Ruahine Range.

INTRODUCTION

Because of concern by the New Zealand Forest Service that sika deer (*Cervus nippon*) might have a more harmful effect on forests (Davidson, 1973a) than red deer (*Cervus elaphus*), a study was initiated to determine the factors underlying the movement of sika deer. Sika had been liberated in 1905 on the eastern edge of the northern Kaimanawa Forest, and had moved some 90 km southward along the Kaweka Range to the Ruahine Range*, where a colony of sika had been reported in 1955 (Logan, 1957).

The opinion was widely held that there was considerable antagonism between sika and red deer and that sika deer, being more aggressive, would actively displace red deer (Logan, 1957; Kiddie, 1962). The further view was held that this replacement of red deer by sika deer was due to the ability of sika deer to thrive after depletion of vegetation to a point unfavourable for red deer (McKelvey, 1959). At the time the study was initiated (1962) it was considered important to know the worth of these opinions, for as catchments in the Ruahine Range were already in a critical condition in the presence of red deer, it might be undesirable for sika to further colonise there. Because of the concern regarding possible infiltration of the Ruahine Range by sika deer a project

* Now Kaimanawa, Kaweka, and Ruahine Forest Parks.

was mounted to study the movement of this species, in the course of which more general studies of their biology were made (Davidson, 1973a; 1973b; 1976).

METHOD

Hawkins *et al.* (1967) have reviewed methods for capturing and marking deer. In this study an automatic tagging collar of braided nylon or polythene rope was used in a non-killing snare (Fig. 1; Verme, 1962). A collar size of 49 cm circumference (including clips) was chosen to allow for the likelihood of capturing both sika and red deer, and for such extremes as swelling of the neck of stags during the "roar" (rut) and the smallness of the head of fawns.

Collar snares were set with a diameter of about 38 cm, the maximum circumference (collar plus wire) being some 1.5 m. The distance from the ground to the lowest point of the snare was in general 40 cm but this depended on terrain. Serial numbers and "Forestry" were stamped on copper sleeves (28.5 × 9.5 mm) through which the braid was threaded.

Setting of a trial consignment of 400 snares started in September 1964, in shrublands (mostly *Leptospermum* spp.) adjacent to the northern Kaimanawa and Kaweka (*Nothofagus* spp.) forests (McKelvey and Nicholls, 1957). In April 1965, snaring was commenced in the shrub areas of the Oamaru River flats which were under observation

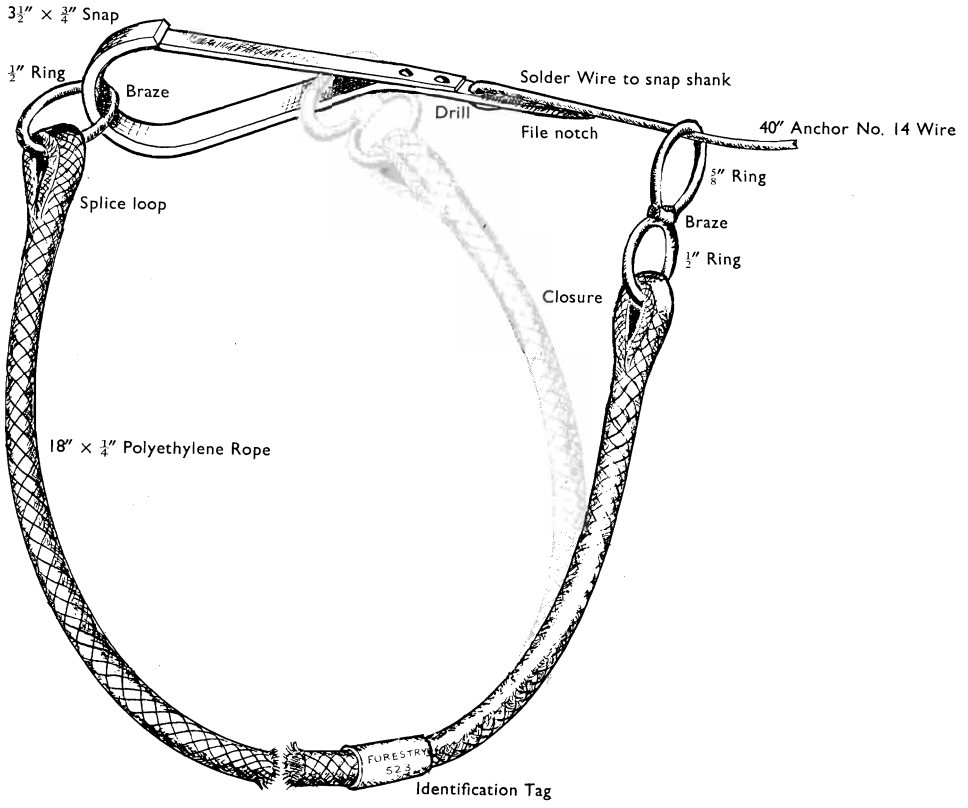

FIG. 1—Principle and construction of automatic tagging device (after Verme, 1962).

from the sika research hide (Fig. 4). Another 2 000 snares were received in October 1965 and snaring was extended progressively to the extensive, eroded grass and shrublands of the south-eastern (Lotkow and Castle Rock), south (Kohinga, Omahaki, and Burns), and south-western (Timahanga, Pohokura, and Comet) Kaweka region (Figs. 2, 3, 4). Oamaru snares which were intact in December 1966 (when the main study finished), were removed and re-set in the southern Kaweka. Until the end of 1966 checks of snares had been irregular, but thereafter they were at half-yearly intervals.

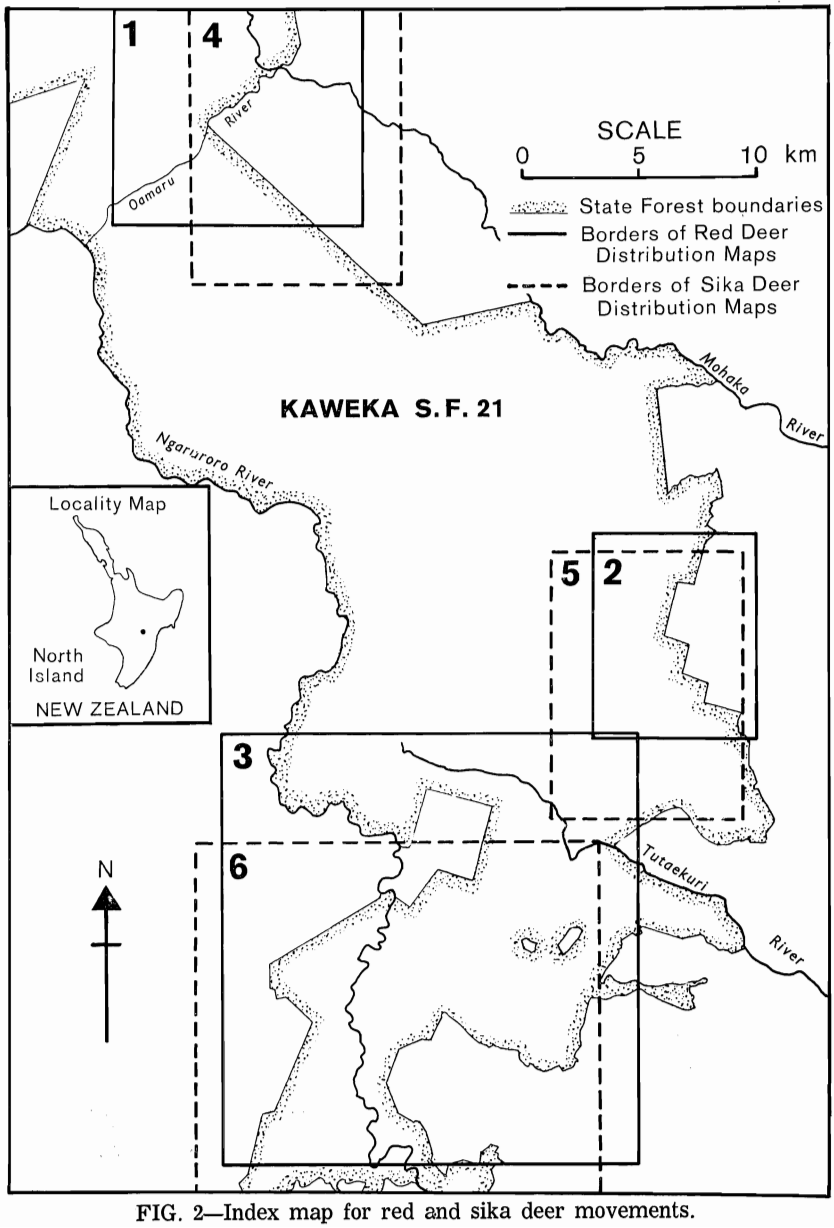

FIG. 2—Index map for red and sika deer movements.

By the end of 1966 a total of 1 200 new snares had been used, although many of these had been repaired and reset many times. With the exception of 365 collars which were left set in the "corridor" between the highlands of the Kaweka and Ruahine ranges, all snares were taken out in June 1967. The "corridor" snares were maintained until June 1974.

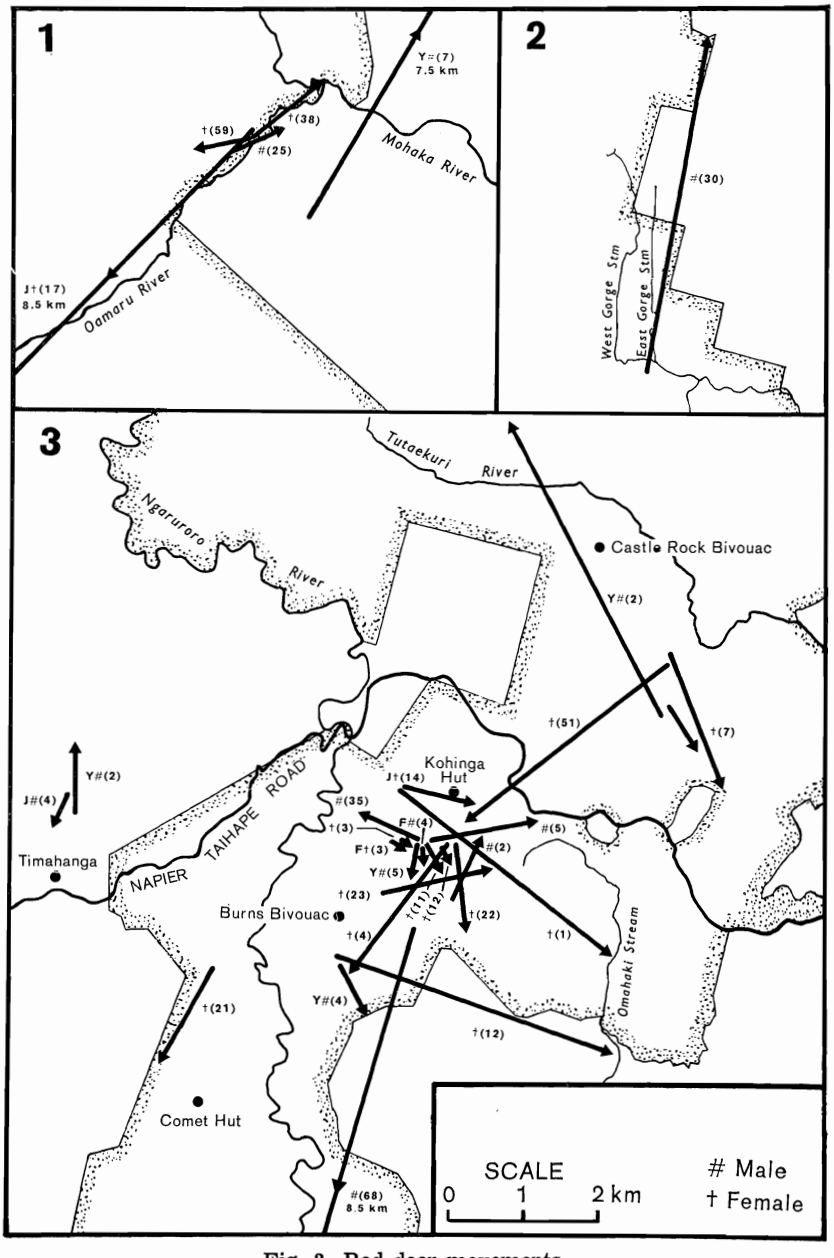

Fig. 3—Red deer movements.

Six categories were used for recording the fate of the collars, i.e., missing, sprung broken, sprung closed, sprung, OK, and not found. For "missing", it was assumed that the collar had been taken by a deer, although at least two goats, and a number of sheep were marked. Pigs were present in some areas at certain times but none was observed to be marked, although some snares were lost in places where they had been rooting.

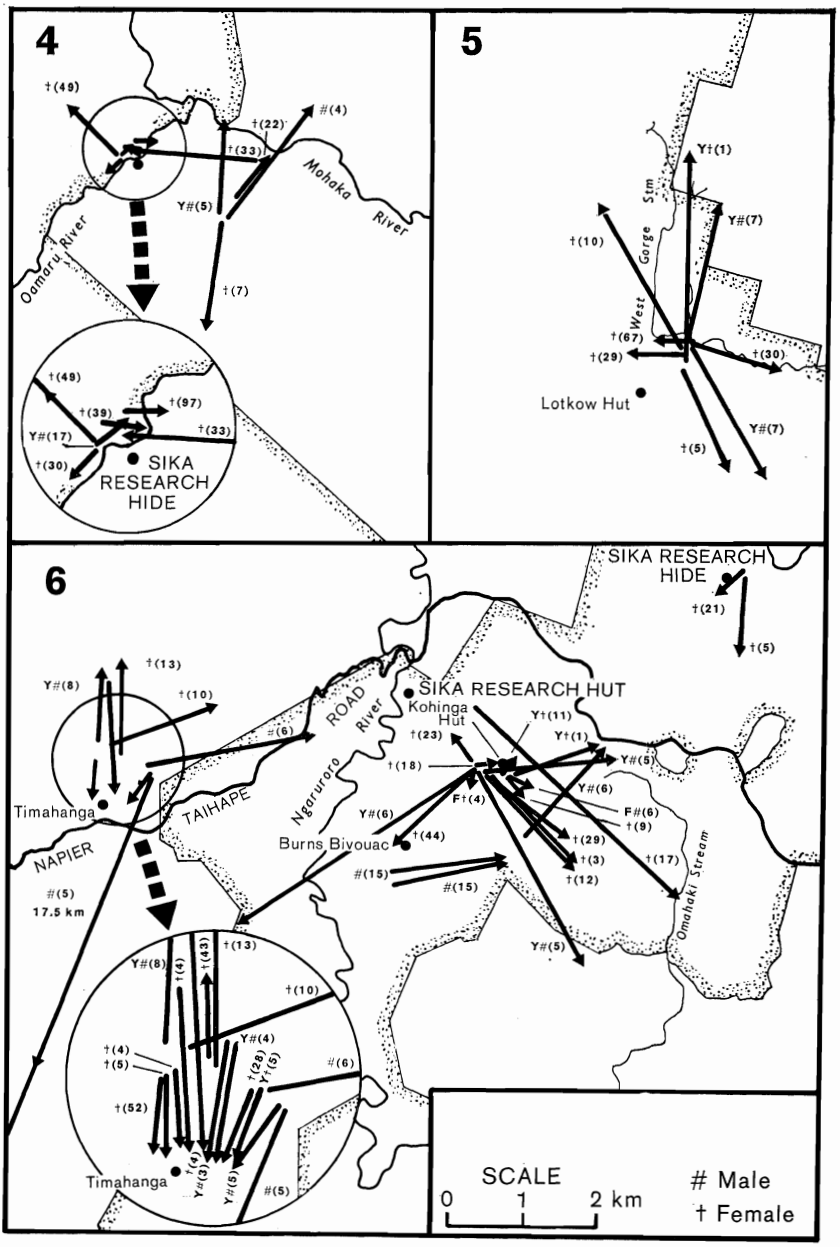

FIG. 4—Sika deer movements.

The category "sprung broken", indicated that collars were missing at the snare site, but a search revealed them lying on the ground in the vicinity. It was assumed that the collar had probably been taken by an antlered stag.

The third category "sprung closed" was thought to be a result of interference by an animal, possibly an antlered stag, or a fawn which had slipped the collar. Category four, "sprung", where the collar had been drawn around the anchor wire but had not been secured in the clip, was possibly occasioned by a passing animal but more likely had been sprung by the wind. The fifth category, "OK", described collars which remained set, except for a few which showed slight disturbance by wind or animals or the breaking of an anchor wire because of weathering. Collars described as "not found" were missing entirely, including the anchor wire, and despite searching could not be found.

Breaking potential of the snares was high, for the anchor wire had to be weakened by filing to enable the deer to break free easily, and undue strain on it before successful closure of the tagging device resulted in the wire breaking too soon. However, many breakages were attributed to three points of weakness in the spring clip, and to the extreme brittleness of some of the anchoring wire. Polythene braid proved more durable than nylon.

Verme (1962) records a success rate for self-tagging by deer of 55%, and possibilities of up to 66%, on snow runways from winter deer yards. A very different situation pertains in central North Island of New Zealand, where the climate is milder, and deer unhampered by deep snow disperse throughout the upper forest in winter (Davidson, 1973a). Table 1 records collar snares set from 1964-74 and Tables 2, 3 their final disposition according to deer species and areas found. Of the 798 "missing" collars (6.5% of all collars set), 496 were taken in the first half of the year, which appeared to indicate greater movement and/or less caution in the autumn "roar" period, than the second half-yearly figure of 302 ($p = 0.05$). The categories of "sprung broken" (4% of all collars set) and "sprung closed" (2.5%), combined with the 6.5% for "missing" collars, suggest for this study an overall potential of only 13% for self-tagging animals. The 1% of "not found" snares represents collars lost through logging operations, storms, snow, action by animals, and regrettably, removal by humans for souvenirs or other reasons.

Marking results for snares set on the Oamaru River flats and observed from the hide (Table 4), suggest different susceptibilities in regard to age and sex of deer. For sika on morning counts, higher proportions of marked adult females than males (7.8% *v.* 2.8%, $\chi^2 = 43.9$) indicate that adult females were significantly more prone to be tagged. On the other hand, yearling males showed greater susceptibility than yearling females, both for morning ($\chi^2 = 46.1$) and afternoon ($\chi^2 = 12.8$); adult red deer females, too, were more susceptible to marking.

RESULTS

Collars were recovered from 84 deer, of which 54 were sika (Table 2) and 30 were red deer (Table 3). Ten sika deer (8 with two collars, 1 with three, and 1 with four), and 4 red deer (2 with two collars, and 2 with three), were tagged with more than one collar, with 103 collars in all for the 84 deer.

TABLE 1—Snare record analysis, September 1964-July 1974

Date	Period	No. Set	Missing	%	Sprung broken	%	Sprung closed	%	Srpung	%	OK	%	Not found	%
1964	2nd ½ yr	1220	28	2	11	1	9	1	18	1	1154	95	0	
1965	1st ½ yr	940	59	6	55	6	7	1	103	11	716	76	0	
1965	2nd ½ yr	945	40	4	44	5	12	1	56	6	793	84	0	
1966	1st ½ yr	1674	61	4	71	4	27	2	84	5	1423	85	8	0
1966	2nd ½ yr	1741	55	3	70	4	23	1	55	3	1527	88	11	1
1967	End 1st ½	810	83	10	72	9	42	5	60	7	532	66	21	3
1967	End 2nd ½	365	23	6	22	6	12	3	19	5	280	77	9	3
1968	End 1st ½	363	36	10	18	5	32	9	26	7	251	69	0	
1968	End 2nd ½	312	14	5	8	3	17	5	17	5	256	82	0	
1969	End 1st ½	348	35	10	23	7	10	3	35	10	244	70	1	0
1969	End 2nd ½	335	35	10	14	4	10	3	16	5	253	76	7	2
1970	End 1st ½	302	42	14	16	5	13	4	25	8	204	68	2	1
1970	End 2nd ½	294	21	7	9	3	1	1	20	7	242	82	1	0
1971	End 1st ½	337	32	10	21	6	19	6	32	9	223	66	10	3
1971	End 2nd ½	319	21	7	8	2	8	2	12	4	268	84	2	1
1972	End 1st ½	374	57	15	15	4	19	5	34	9	236	63	13	4
1972	End 2nd ½	322	29	9	9	3	4	1	11	3	261	81	8	3
1973	End 1st ½	355	34	10	15	4	21	6	28	8	255	72	2	0
1973	End 2nd ½	428	36	9	6	1	3	1	9	2	374	87	0	
1974	End last ½	470	57	12	9	2	20	4	32	7	345	73	7	2
		12254	798	6.5	516	4	309	2.5	692	6	9837	80	102	1

TABLE 2—Distance, d (kilometers), and elapsed time, t (months) from tagging for sika deer

	Kaweka		Lotkow		Kohinga		Castle Rock		Omahaki Burns		Timahanga	
	d	t	d	t	d	t	d	t	d	t	d	t
	2.00	5	3.21	7	6.03	6			2.41	6	1.21	3
SYM	0.40	17	3.21	7	4.83	5					1.21	4
					2.82	5					1.61	8
											0.81	5
SYF			4.43	1	2.01	1					0.81	5
					0.41	11						
SFM					0.41	6						
SFF					0.41	4						
SAM	3.22	4							2.42	15	17.71	5
									2.42	15	3.63	6
SAF	2.42	7	3.63	10	2.82	12	1.61	5			2.42	10
	1.21	22	2.42	5	2.82	3	0.81	21			0.81	4
	2.82	33	1.21	29	0.41	9					2.42	4
	0.41	30	2.02	30	2.02	29					1.61	4
	0.41	39	0.81	67	0.41	18					0.81	43
	1.61	49			0.81	23					0.81	28
					6.04	17						
	0.41	97			2.42	44					0.81	52
											0.81	5
											2.02	13

SYM: sika yearling male
SYF: sika yearling female
SFF: sika fawn female
SFM: sika fawn male
SAF: sika adult female
SAM: sika adult male

The 84 deer, from six areas, were classified according to species, sex, and age (fawn, yearling, and adult). Scattergrams of the data showed no relationship between distance moved and time elapsed. The majority of deer from which collars were recovered appear to have remained in, or had returned to, the area in which they were tagged; even after 97 months (Fig. 4; Table 2) a sika hind was only 0.41 km from the setting point of the collar she was wearing. The Kurskall Wallis test was used to examine the difference of movement by different groups. The only significant difference found was between male (which travelled further) and female sika deer ($p = 0.05$). There was no evidence that this difference could be attributed to age. The short and multiple directions of movement from snaring areas (Figs. 3, 4) did not warrant further work relating to direction of movement from these areas to the Ruahines.

TABLE 3—Distance, d (kilometers), and elapsed time, t (months) from tagging for red deer

	Kaweka Kaimanawa		Lotkow		Kohinga		Castle Rock		Burns Omahaki		Timahunga	
	d	t	d	t	d	t	d	t	d	t	d	t
RYM	7.65	7			0.81	5	7.25	2	1.21	4	1.61	2
RFM					0.41	4						
RFF					0.41	3						
	1.21	25	7.25	30	2.42	5			1.61	2	0.81	4
RAM					1.61	35			8.45	68		
RAF	8.45	17			0.41	3	3.22	7	2.42	23		
	8.45	17			0.41	3	3.22	7	2.42	23		
	2.42	38			2.42	22	1.21	19	6.44	12		
	1.21	59			0.81	11	5.64	51	2.42	21		
RAF					6.04	1						
					6.04	1						
					3.63	4						
					0.41	12						
					1.61	14						

RYM: red yearling male
RFM: red fawn male
RFF: red fawn female
RAF: red adult female
RAM: red adult male

The mean linear distance travelled by 54 sika and 30 red deer from tagging to kill site, and the time taken, were determined on a basis of 6-monthly checks.

		Distance (km)	Time (months)
SIKA	All sika deer	2.2 (0.41-17.71)	16.9 (1-97)
	Yearling males	2.5	6.5 (3-17)
	Yearling females	1.9	4.5 (1-11)
	Adult males	5.9	9.0 (1-15)
	Adult females	1.7	24.5 (3-97)
RED	All red deer	3.0 (0.41-8.45)	17.0 (1-68)
	Yearling males	3.7	4.0 (2-7)
	Adult males	3.3	24.0 (2-68)
	Adult females	3.0	19.5 (1-59)

In analysis of recovery data, distance from the tagging to the kill site (Tables 2, 3) was measured in a straight line (Figs. 3, 4) and rounded to the nearest 0.4 km. A multiple-tagged red hind, carrying three collars when shot, was credited with a distance of 2.42 km in 23 months (Table 3). A greater distance was obtained by calculating the linear distance to the intermediate collar sets, giving legs of 1.5 km, 1.6 km, and 1.3 km, a total of 4.4 km.

TABLE 4—Sika deer. Total numbers of deer seen and those with collars

	Ad. male		Ad. fem.		Y. male		Y. fem.		Fawns		Totals	
	Coll.	Tot.	Coll.	Tot.	Coll.	Tot.	Coll.	Tot.	Coll.	Tot.	Coll.	Tot.
MORNING												
Total	54	1898	124	1589	105	541	39	622	55	852	377	5502
% collared	2.8		7.8		19.4		6.3		6.4		6.8	
χ^2 diff.		43.9				46.1						
AFTERNOON												
Total	62	1874	87	905	75	495	22	321	25	526	271	4121
% collared	3.3		9.6		15.2		6.8		4.8		6.6	
χ^2 diff.		47.8				12.8						

Red deer. Total number of deer seen and those with collars

	Ad. male		Ad. fem.		Y. male		Y. fem.		Fawns		Totals	
	Coll.	Tot.	Coll.	Tot.	Coll.	Tot.	Coll.	Tot.	Coll.	Tot.	Coll.	Tot.
MORNING												
Total	10	269	33	284	0	46	8	92	1	67	52	758
% collared	3.7		11.6		0		8.7		1.5		6.9	
χ^2 diff.		12.0				—						
AFTERNOON												
Total	12	220	32	216	0	45	5	62	0	53	49	596
% collared	5.45		14.81		0		8.1		0		8.2	
χ^2 diff.		10.5				—						

DISCUSSION

Seasonal Movement

Observations from a hide in the Oamaru Valley (Fig. 4; area 4) in the northern part of the study area showed that sika, and red deer also, returned in spring to graze on the tussock-covered river flats, and departed in autumn, but how far they travelled was unknown (Davidson, 1973b).

Collar recovery data (Tables 2, 3; Figs. 3, 4) suggest that some marked deer remain in, or (more likely) return to, the vicinity of the tagging site, the only significant difference being found between the sexes of sika deer. It is usual that males travel further than females (Verme, 1973). The distance of nearly 18 km travelled by a sika stag in 5 months (Table 2; Fig. 4, area 6), however, is suspected of being accelerated movement due to construction of a logging road close to the tagging site. This stag had to cross the Taruarau River to reach the Makirikiri area of the northern Ruahine where it was shot, and is the only *marked* deer in this study to be recovered there. The multiple-kill site shown for sika (Fig. 4, area 6) was on Timahanga Station; deer feeding on a turnip crop were shot by employees.

Also, sightings of marked deer from the Oamaru Valley hide (Table 4) indicate that at least some deer return annually to summer feeding areas. The first marked deer seen on the Oamaru flats (14 October 1965) were a sika hind (2 collars) and her yearling hind (one collar). Hunter information on an adult sika hind shot 0.41 km from the tagging site after 39 months (Table 2; Fig. 4, area 4) indicates that this was most likely the same adult hind; the collars were set on 19 July 1965, and missing on 16 August and 15 September 1965. These two females were observed from October 1965 until March 1966, then once in June, then disappearing until September; thereafter, observed frequently until the end of the Oamaru snaring in December 1966. The longest time recorded (97 months) was for a sika hind (Table 2; Fig. 4, area 4) which was shot on 14 November 1973, again only 0.41 km from the tagging site. This collar was set in September 1965, and was missing the following month. These deer were shot virtually on the tagging site, indicating repeated seasonal movement. This was also found by Verme (1973), in a similar study on white-tailed deer (*Odocoileus virginianus*).

Linear distance measurement, implying movement in a straight line and at a constant rate, is an arbitrary assessment showing only minimal movement of the deer, but was all that was available in this study. Its shortcomings are evident in the case of the multiple-tagged red hind which showed some degree of meandering, but undoubtedly less than the actual distance travelled. A study by Kammermeyer and Marchington (1976), using telemetry, shows the meandering pattern of movement which would be expected.

Dispersal

In addition to seasonal movement of an established herd, there is also dispersal of deer into new country. Davidson (1973a), taking dispersal from the liberation point on the eastern Kaimanawa in 1905 to the Ruahine area in 1962, via the eastern Kaweka, gives elapsed time of 57 years for some 90 km, a yearly average of 1.6 km. Collar recoveries recorded in Fig. 4 show a predominantly southward movement of sika deer, which confirms and extends the earlier records of dispersal gained from personal communications, and "roar" and kill data.

The marked sika stag recovered at Makirikiri, Ruahine Range, was shot on 23 October 1972. A collared sika was also sighted in the same area the previous season (J. H. Dorrian, pers. comm.). Sika appear reluctant to leave the favoured shrubland habitat (Davidson, 1973a) of the southern Kaweka and cross either the Taruarau or the Ngaruroro to the Ruahines. This, along with lack of evidence of antagonism and replacement of red deer by sika, renders unlikely any threat to the stability of the Ruahine highlands because of accelerated deterioration arising from a rapidly increasing rate of infiltration by sika. The conversion of shrublands to exotic forest (not preferred sika habitat but used by red deer) in the Kaweka, however, and also the rehabilitation of deteriorated farmlands, will influence their future movement in a manner difficult to predict.

ACKNOWLEDGMENTS

The writer is indebted to the sika research project staff, P. W. Cook, P. J. George, A. H. Leigh, J. M. Reed, and R. S. Schofield, who established the marking programme in the field; to J. Roberts for permission to snare on Timahanga Station, to E. W. and I. L. J. Powell who served as voluntary assistants from 1967-74; to hunters who returned collars; to A. H.

Aldridge, DSIR, for statistics; to Forest Research Institute officers; D. J. O'Leary and staff for maps, and C. L. Batcheler and A. H. C. Christie for statistics and helpful comment; and for long term support, A. N. Gilmore and W. E. Davidson.

REFERENCES

DAVIDSON, Mavis M. 1973a: Characteristics, liberation, and dispersal of sika deer (**Cervus nippon**) in New Zealand. **N.Z. J. For. Sci. 3(2):** 153-80.

——— 1973b: Use of habitat by sika deer. **In** Assessment and management of introduced animals in New Zealand forests. **N.Z. For. Serv., For. Res. Inst., Symposium 14:** 55-67.

——— 1976: Season of parturition and fawning percentage of sika deer (**Cervus nippon**) in New Zealand. **N.Z. J. For. Sci. 5(3):** 355-7.

HAWKINS, R. D., AUTRY, D. C. and KLIMSTRA, W. D. 1967: Comparison of methods used to capture white-tailed deer. **J. Wildlife Management 31(3):** 460-4.

KAMMERMEYER, K. E. and MARCHINGTON, R. D. 1976: Notes on dispersal of white-tailed deer. **J. Mammalogy 57(4):** 776-8.

KIDDIE, D. G. 1962: The sika deer (**Cervus nippon**) in New Zealand. **N.Z. For. Serv., Information Series 44.**

LOGAN, P. C. 1957: The Japanese deer herd; spread, density and control problems. **N.Z. For. Serv., Report SF 90/1; 16 September** (unpubl.).

McKELVEY, P. J. 1959: Animal damage in the North Island protection forests. **In** Browsing animals in protective vegetation. **N.Z. Sci. Rev. 17(2):** 28-34.

——— and NICHOLLS, J. L. 1957: A provisional classification of North Island forests. **N.Z. J. For. 7(4):** 84-101.

VERME, LOUIS J. 1962: An automatic tagging device for deer. **J. Wildlife Management 26(4):** 387-92.

——— 1973: Movements of white-tailed deer in upper Michigan. **J. Wildlife Management 37(4):** 545-52.