Home Ranges of Feral Goats in a Pastoral Area in Western Australia

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Abstract
Home ranges of feral goats studied by radio-telemetry in a pastoral area in Western Australia were much larger than those found in most other studies. Home ranges of males were larger (ranging from 139.2 to 587.7 km²) than those of females, which ranged from 15.0 to 190.2 km². Excursions outside the normal (90 percentile) home ranges were common. The home ranges of females were smaller during summer than during winter. Male home ranges were of similar size in both seasons. Group structure and composition was highly variable. Implications of goat movements on management and control programmes are discussed.

Introduction
The movements or sizes of home ranges of feral goats have been studied in several areas outside Australia (Riney and Caughley 1959; Yocom 1967; Williams and Rudge 1969; Coblenz 1974, 1978; Gould 1979). The only studies of goat movements within Australia are those of McRae (1984) and O'Brien (1984). Most of these studies involved tagging goats and recapturing or resighting them on infrequent and irregular occasions.

This study used radiotelemetry, which has the advantages of enabling the animals to be relocated frequently at predetermined times, and providing data on the short- and long-term movements of individual animals over lengthy periods.

Knowledge of home-range size and movements of feral goats is useful in managing them for agricultural production, pest control or in the event of an outbreak of exotic disease.

Materials and Methods
The study site was on Yerilla Station (29°28'S., 121°49'E.) in the Eastern Goldfields pastoral region of Western Australia. The climate is arid with unpredictable rainfall and a possibility of precipitation in all months (Milewski 1988). The annual average rainfall at the nearest official meteorological station, approximately 80 km away (Menzies), is 239 mm (Bureau of Meteorology 1975). Rainfall was 24% below average during the first 12 months, but was 15% above average during the remaining 12 months of the study. While rain did fall in all but 1 month, amounts greater than 20 mm fell in only 7 of the 24 months of the study. Heavy rain fell in June 1986 and January 1987. The vegetation is low mulga woodland and chenopod shrubland (Milewski and Keighery 1988) on five major land systems (mulga plain, mineral plain, lake plain, lake and hills). The station is used for grazing sheep.

Adult and subadult goats were randomly selected from a large number that had been captured in July 1985 by mustering with motorcycles and dogs. The 10 males and 10 females used for telemetry were weighed, and their ages were estimated on the basis of tooth eruption. Goats with four, six or eight permanent teeth (full mouths) were classed as adults; subadults had two permanent teeth.
Radiocollars were attached to six adult and four subadult females and five adult and five subadult males. All adult females weighed over 30 kg and all adult males weighed over 50 kg (Table 1). The mean weight of subadults of both sexes was 23.5 kg.

Goats were fitted with collars containing 164-MHz transmitters (AVM, U.S.A.) and released near their point of capture. One adult female, one subadult and two adult male goats were shot by poachers or died of unknown causes during the study, and replacement collars were placed on three additional animals in December 1985.

The study began in August 1985 and ended in June 1987. The study site was visited for 4-5 days at variable intervals of 17-41 days, except during the summer of 1986, when the intervals between 3 trips were 62 and 109 days. Attempts were made to locate each goat several times during each trip. Short-term movements were examined during 7 days of more intense tracking during 2 periods between 9 and 20 December 1985.

The goats were located one or more times each trip, from a Cessna 182 aircraft fitted with directional antennae (Whitehouse and Steven 1977) and an AVM receiver. Coordinates were recorded and locations were plotted on gridded maps. Convex polygons were plotted and home ranges (mean ± s.d.) and 90-percentile core areas (Messier and Barette 1982) were calculated from them.

This trial was approved by the Animal Experimentation Ethics Committee of the W.A. Department of Agriculture.

Results

Substantial data (located more than 20 times each) were obtained from nine female and seven male goats. Three of the females were designated at the beginning of the study as subadults and six as adults, and four of the males were classed as subadults and three as adults. Subadults would not have attained adult status until shortly before the end of the study.

Each female was located 27-40 times over periods of 20-23 months and each male 21-35 times over periods of 18-23 months. Goats were sighted frequently when they were located by telemetry, and the number of their companions could then be counted or estimated.

Home range sizes of both sexes were highly variable (Table 1). All animals made occasional excursions over long distances outside of the core (90 percentile) area of their home ranges, and were located there on from one to seven occasions. They generally returned from these to their normal activity areas. The one exception was an adult female which, on her final two locations, was found several kilometres from her normal home range. This may have been an uncompleted excursion. The reason for these excursions is unknown.

Core areas varied in a fashion similar to the total sizes of home ranges (Table 1). Rankings of animals with the largest to the smallest core areas were similar to those for total home ranges.

Between 9 and 20 December 1985, short-term movements of 13 animals were studied. Each individual (eight females, five males) was located on 3-6 occasions during that period. All but two goats moved over very small portions (mean = 4.1%, range = 1.5-16.2%) of the home ranges used during the first 12 months of the study. The exceptions were a juvenile female that moved over an area of 32.3% of her home range for that year and a juvenile male that moved over 24.3% of his home range. The longest distances between any two locations during this period ranged from 0.8 to 3.7 km for females and from 3.1 to 7.8 km for males.

The home ranges of all but one goat were larger during the second half of the study than in the first half. The areas of the home ranges of males increased by up to 7-fold while those of females generally increased by less than twice their size, although one increased by over five times its former size. Home ranges of females were significantly (t = -2.354, d.f. = 8, P < 0.025) smaller in summer (October-March, mean = 17.1±9.5 km², range = 4.0-37.8) than in winter (April-September, mean = 58.7±56.2 km², range = 7.2-189.2),
while those of males were similar \((t = 0.558, \text{ d.f.} = 6, P < 0.375)\) in winter \((\text{mean} = 229.8 \pm 129.0 \text{ km}^2, \text{range} = 25.7 \text{ to } 385.0 \text{ km}^2)\) and summer \((\text{mean} = 201.0 \pm 97.8 \text{ km}^2, \text{range} = 101.0 \text{ to } 380.6 \text{ km}^2)\). The longest distance between any two locations within the home ranges of females ranged from 7.1 to 33.8 km, and for males it ranged from 24.3 to 47.0 km (Table 1). The means of the longest distances between consecutive locations \((\text{often over 4-6 week})\) were 11.3 ± 4.2 km \((\text{range} = 7.6 \text{ to } 17.4 \text{ km})\) for females and 17.2 ± 6.5 km \((\text{range} = 11.2 \text{ to } 29.7 \text{ km})\) for males.

Home ranges of the females overlapped extensively (Fig. 1). Only one of the radio-collared males was regularly \((23 \text{ of } 35 \text{ locations})\) seen in the company of radio-collared females, and his home range extended well beyond those of most females. Home ranges of males also showed considerable spatial overlap (Fig. 2).

The goats concentrated their activities within a core area which extended only a few kilometres from watering points (Fig. 3). Approximately 80% of the locations of females were on the lake plain or lake systems and only about 12% were on the mulga plain or mineral plain. Only about 30% of the locations of the males, however, were on the lake plains or on dry lakes and almost 70% were on mulga plain or mineral plain. There was little use of hills, except by adult females (approximately 8% of their locations).

The composition of groups was very fluid. Individuals joined with and separated from groups frequently, and stayed together for variable periods. Group sizes were variable throughout the year. Small groups of 2–5 goats, as well as those of more than 30 animals, were sighted at all times of year.
Discussion

Feral goats occur in a variety of climates and habitats (Coblenz 1978). Small home ranges are to be expected in environments where water, food and shelter are readily available (McRae 1984). Most studies of home ranges of goats have been done on small islands or in forested areas (Riney and Caughley 1959; Yocom 1967; Williams and Rudge 1969; Coblenz 1974, 1978; Gould 1979; O’Brien 1984), where the home ranges were much smaller than those determined in this study. In his study at Fowlers Gap, N.S.W., McRae (1984) observed the movements of six tagged goats in an area with similar climate and vegetation to Yerilla Station, and found that their home ranges were larger than those previously
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Fig. 3. Map of Yerilla Station. Dashed lines, interior fences; ⋄, water points; ○, Yerilla Homestead.

reported (Riney and Caughley 1959; Yocom 1967; Williams and Rudge 1969; Coblenz 1974, 1978; Gould 1979; O'Brien 1984). Although no figures for individual home ranges were given, it was speculated that they might be as large as 100 km² (McRae 1984). In this study, the home-range sizes of 4 of 9 females approximated or exceeded that value, and all males occupied home ranges larger than 100 km², and up to almost six times that size. The home ranges of females were significantly smaller than those of males, as has been reported by others (Riney and Caughley 1959; Yocom 1967; Coblenz 1974, 1978; Gould 1979; O'Brien 1984; McRae 1984).

Short-term movements occurred within small areas. Focal points within the home range were around permanent water sources. Longer movements (up to 47 km) did occur during the study, and goats often crossed interior fences or station boundaries (Figs 1 and 2). McRae (1984) reported a move by a male of 87 km in 10 months. Movements of this length make any attempts at managing goats in pastoral areas, either to reduce or to increase their numbers, very difficult.

The home ranges of females were significantly larger in winter than in summer. This difference may have been related to the extent to which they rely on fixed water sources when it is hot and dry. O'Brien (1984) also found that female's home-range areas differed seasonally, and were larger in winter. The home range sizes of males in this study did not differ between seasons. The home ranges of goats in this study were larger in the second 12 months than in the first 12 months. This may also be related to their greater reliance on fixed water sources during dry periods: rainfall was below average during the first half of the study, and above average in the second half. Green food was much more abundant during the second half, and because of the water content of the green feed, goats were probably less reliant then on free water, which was only available during dry periods at the fixed waterpoints they visited. McRae (1984) also found that the longest movements occurred during periods of good seasonal conditions.

Home ranges of individual females overlapped extensively (Fig. 1), as reported by others (Riney and Caughley 1959; Yocom 1967; Williams and Rudge 1969; Coblenz 1974; Gould 1979; O'Brien 1984; McRae 1984). Home ranges of males also overlapped those of other males, and several groups of females, as found by McRae (1984) and O'Brien (1984).

Group size was variable and fluid, as groups coalesced and divided frequently (McRae 1984). No seasonal trend in group size was apparent. Females were most frequently located in the lake plains or the lake system, whereas males were commonly located in the mulga.
plains and mineral plains. On most occasions, males were in the company of other goats whose identity and sex were not known. Little use was made of rough hilly terrain, which McRae (1984) found to be favoured habitat.

Some pastoralists have proposed establishing managed populations of feral goats for cashmere and meat production in the semiarid pastoral regions of Western Australia. Recent trials have shown that because of the high capital inputs required and low fibre yields, cashmere production in pastoral areas is not viable (W. Fletcher, personal communication). Neither is the meat of young feral goats suitable for the high-paying domestic market; it is only acceptable for carcass export (an unstable market) or smallgoods products (W. Fletcher, personal communication). As it is very difficult to totally exclude feral goats from an area, upgrading of stocks of captive goats in the pastoral areas would be almost impossible.

Feral goats are regarded as a serious problem in the pastoral regions of Western Australia (Fletcher 1991). They can easily negotiate fences intended for containing sheep. Much more substantial fences, or well-constructed electrified fences, are required to restrict the movements of goats, which often cross station boundaries.

The dietary overlap between goats and sheep is considerable and although goats at low stocking levels cause less damage to the vegetation than sheep, goats at high stocking rates and in combination with sheep can result in land degradation (Fletcher 1991). The current return from grazing goats does not make them economically viable in the pastoral areas of Western Australia, and Fletcher (1991) suggests that feral goats in an uncontrolled state should be eliminated.

An Australian Veterinary Emergency Plan (Ausvetplan) for controlling feral goats in the event of an exotic disease outbreak was written in 1990. The plan relies heavily on use of the Judas goat method and shooting from helicopters. The applicability of such a plan in an area where goats are as mobile, and travel such distances (Table 1), as those in the present study is questionable. Current plans involving shooting from the ground or fencing also seem unsuitable in pastoral regions. The logistics of any control programmes applicable to pastoral areas will make them both difficult and costly.

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References


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