

## A REAPPRAISAL OF THE DISTRIBUTION AND DISPERSAL OF FEMALE HIMALAYAN THAR IN NEW ZEALAND

**Summary:** The breeding ranges of thar are described as they were in 1976 and 1984 and compared with previously described ranges in 1936, 1946, 1956 and 1966. Commercial hunting during 1972-1976 harvested about 32000 thar and along with habitat limits in some areas this slowed the rate of dispersal into new areas and eliminated thar from the periphery of their range in other areas. The rate of thar dispersal from the time of their liberation in 1904 until 1936 was non-linear and recalculation of their breeding ranges from 1936-1966 shows rates of dispersal consistent with an exponential curve. The implications of this to a threshold-pressure and to a diffusion model of dispersal and their implications to thar management are discussed.

**Keywords:** Himalayan thar; *Hemitragus jemlahicus*; Bovidae; distribution; breeding range; dispersal; New Zealand.

### Introduction

Himalayan thar (*Hemitragus jemlahicus*) are social caprids native to the southern flank of the Himalayas from Kashmir to Bhutan (Caughley, 1967; Schaller, 1973). Thirteen animals from a captive herd at Woburn in England were released near Mt Cook in the Southern Alps of New Zealand - three females and two males in 1904, and two females and six males in 1909 (Donne, 1924). Their descendants spread along the Alps, passing through an eruptive oscillation in each new area colonised (Caughley, 1970a). For the first 30 years their spread was largely unimpeded by man, but by the 1930s the damage they caused to alpine vegetation became apparent and attempts were made to limit their numbers.

The history of control campaigns, which began in 1937, of commercial exploitation of thar for game meat, which began in 1971, and of recreational hunting in some areas, has been summarised by Tustin (1980) and Douglas (1984), and is updated in this paper. The advent of helicopter-based hunting for control or commercial exploitation had a dramatic effect on the numbers of thar, with reductions of over 90% being recorded (Tustin and Challies, 1978). In August 1983, a moratorium was declared on the commercial hunting of thar for meat and other products and on New Zealand Forest Service (NZFS) control hunting, except in Mt Cook and Westland National Parks and around the Hunter and Dingle Rivers (the southern boundary of thar breeding range) and in the Rakaia River catchment (the northern boundary). The purpose of this moratorium was to allow thar numbers and ranges to be determined while the animals were less

disturbed, and in November 1984, the Minister of Forests called for submissions on the potential of thar for recreational and commercial safari hunting and the need to protect National Parks and soil and water conservation values.

Caughley (1970b) published distribution maps of female thar in 1936, 1946, 1956 and 1966 and calculated dispersal rates from these. Our paper describes the distribution of female thar in 1976 and 1984, recalculates their dispersal rates, and discusses the application of dispersal models to them.

### Methods

Caughley (1970b) defined two ways of mapping the distribution of thar; gross range, being the area enclosing the extreme locations at which thar of either sex were recorded, and breeding range, being the area inhabited by adult female thar. Caughley arbitrarily included in the breeding range intervening areas between two groups of females which were separated by less than 3.2 km. However, the distance between groups of females has generally increased since the large decline in numbers caused by helicopter hunting in the mid-1970s, and we have expanded this distance to 10 km for the mapping of the 1976 and 1984 breeding ranges.

We have assumed a breeding range of 1 km<sup>2</sup> in 1904 for convenience in calculating dispersal rates. This area is about the size of an individual female thar's home range (Tustin, unpubl. data).

Caughley established the 1936, 1946, and 1956 breeding ranges by talking to government and recreational hunters, mountain climbers, and others and by searching government files and reports. The 1966 breeding range was established more accurately by inspecting many areas during 1963-1966

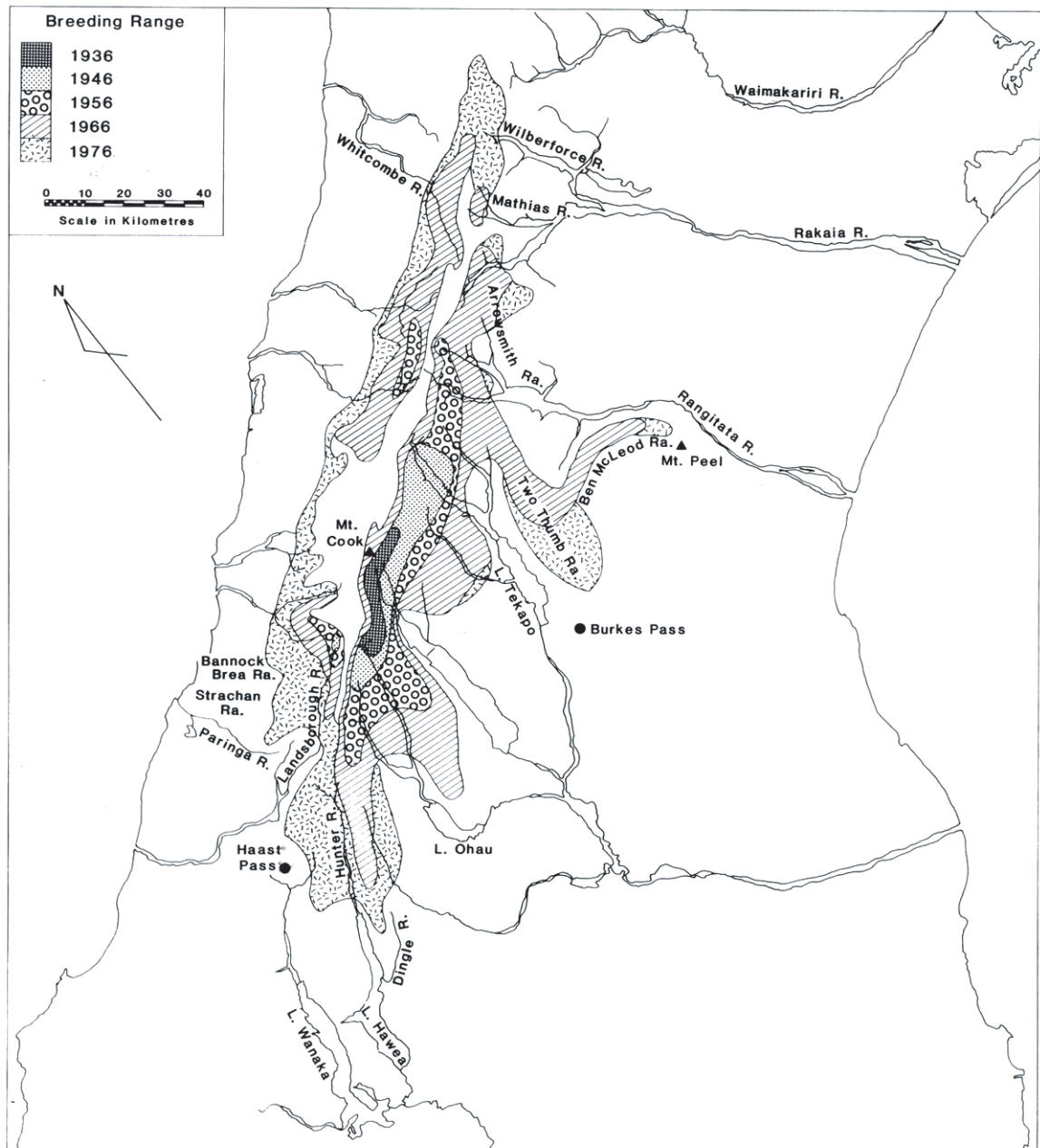


Figure 1: Breeding range of female Himalayan thar in South Island, New Zealand in 1936, 1946, 1956, 1966 (after Caughley, 1970b) and 1976.

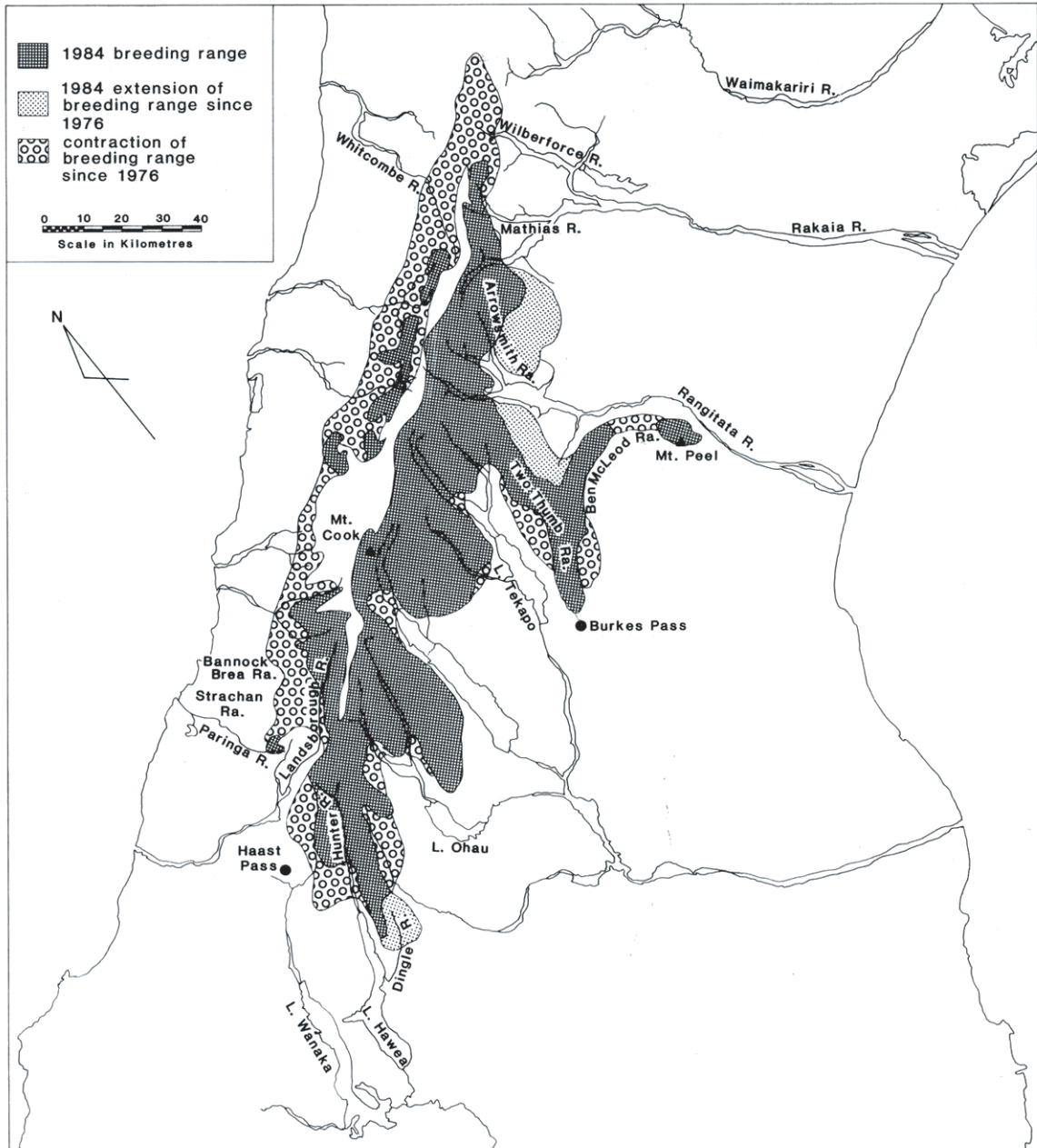


Figure 2: Breeding range of female Himalayan thar in South Island, New Zealand in 1984 showing areas of contraction and extension since 1976.

(Caughley, 1970b). KGT determined the 1976 breeding range from data provided mostly by commercial helicopter-based hunters over the period 1972-1976, a time of considerable change in the thar populations. JPP determined the 1984 breeding range from reports by NZFS staff involved with thar control, commercial helicopter-based hunters, and land owners during 1983 and until March 1984.

Breeding ranges were drawn with smoothed boundaries around the extreme locations of female thar on 1:500000 maps and areas were calculated using an area programme on a DECLAB 11/03 digitizer. These areas were compared with those calculated by a cut and weigh method used by Caughley (1970b), and both were converted to radial equivalents, being the radius of a circle of equal area.

## Results

### Distribution

Until the mid-1970s, female thar continued to expand their breeding range (Table 1, Fig. 1). Between 1966 and 1976 the range boundary moved northwards from the Whitcombe and headwaters of the Mathias catchments as females colonised the headwaters of the Wilberforce River and were on the margin of the southern catchments of the Waimakariri catchment. Female thar closed the gap in their range in central Westland (within Westland National Park), and colonised the country along the

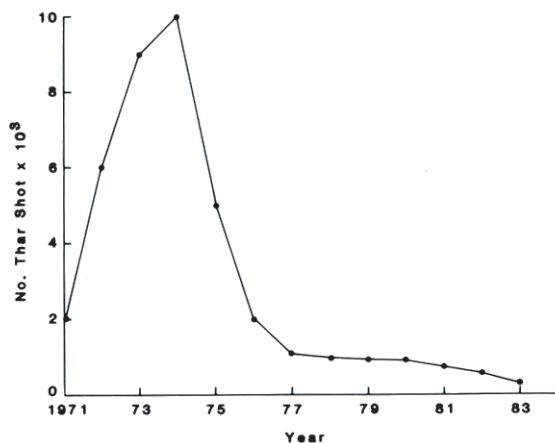


Figure 3: Estimated total annual harvest of Himalayan thar shot 1971-1983. Figures are provided from the records of game packing factories and N.Z. Forest Service records (after Tustin 1980).

eastern edges of Bannock Brae and Strachan ranges to the heads of the Paringa River in south Westland. In the southern part of their range, they reached Lake Hawea in the Hunter River to the west, and the headwaters of the Dingle River to the east. Female thar moved more slowly into new areas to the east. They colonised some new range in the Rakaia catchment, along the Ben McLeod Range to Mt Peel, and southwards down the Two Thumb Range almost to Burkes Pass. In much of the eastern range from Lakes Tekapo to Ohau thar had reached the limits of suitable range by 1966.

After 1976, breeding range continued to expand, particularly north-east into the Arrowsmith Range and Ben McLeod Range, and south into the Dingle River. However, in many areas, breeding range

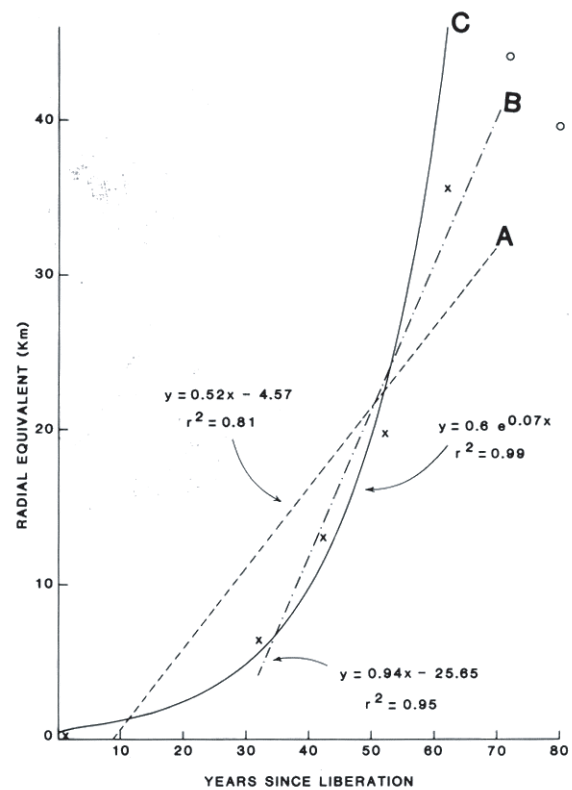


Figure 4: Radial equivalents of female Himalayan thar breeding ranges in 1904, 1936, 1946, 1956, 1966(X) and in 1976 and 1984(O). The three fitted lines are: (A) linear fit 1904-1966; (B) linear fit 1936-1966; (C) exponential fit 1904-1966.

contracted as female thar were eliminated during the intensive commercial harvesting by helicopter operators in the 1970s (Figs 2, 3). This contraction was most marked in the more recently colonised areas in the north and west (the northern catchments of the Rakaia and down the length of the alpine fault in the west from the Whitcombe River to the headwaters of the Landsborough River).

#### Dispersal

Our estimates of breeding range areas calculated by digitizer differ from Caughley's (1970b) estimates, particularly in the three earliest decades (Table 1). We were confident in the estimates obtained from the digitizer and concluded that Caughley's (1970b) estimates were wrong. Examination of his published data showed discrepancies between the areas in his Figure 4 and the calculated areas in his Table 2 (Caughley, 1970b). G. Caughley (pers. comm.) points out that the errors lie in the calculations from the maps, not in the maps themselves.

The recalculated radial equivalents best fit an exponential curve ( $y = 0.6 e^{0.07x}$ ,  $r^2 = 0.99$ ) over the period 1904 to 1966 (Fig. 4). Between 1936 and 1966 a case for a linear increase in radial equivalent over time can still be advanced ( $y = 0.94x - 25.65$ ,  $r^2 = 0.95$ ) c.f. Caughley (1970b) but again the data are more consistent with an exponential increase.

The rate of dispersal slowed in the decade after 1966 and became negative after 1976 as females were eliminated from some areas on the edge of their range.

#### Discussion

Two factors have affected the distribution of female thar since 1966; removal by helicopter-based hunters and habitat limitations.

About 32 000 thar were killed between 1972 and 1976, i.e., when the 1976 breeding range shown in this paper was being collated. This, and later

harvests, had profound effects on the distribution and density of thar. The greatly reduced density of animals can be inferred from a series of counts taken in one small catchment - Carneys Creek in the Rangitata catchment (Tustin and Challies, 1978), from the decreasing annual harvests after 1974, and from the declining success of recreational hunters (Tustin, 1980; Douglas, 1984). This reduced density means that a range map in 1984 is not equivalent to a range map drawn up in 1966 because the areas within the range boundaries not containing thar have increased (presumably those areas where thar were particularly vulnerable to helicopters and / or the habitat was less favourable).

The harvest eliminated female thar from some areas on the perimeter of the range, particularly in the north and west, less so in the east probably because commercial helicopter access to the leasehold properties in the east was more restricted than access to the Crown lands in the west. Despite the hunting pressure, female thar did colonise two new areas, east of the Arrowsmith Range and the Dingle River. In the latter they are still subject to NZFS helicopter-hunting every winter and have not spread further down the eastern shore of Lake Hawea (P. Honderlink, pers. comm).

Lack of suitable habitat has limited the dispersal of thar beyond the periphery of the 1966 range. For example, by 1966 they had reached the limits of potential habitat to the east between Lakes Tekapo and Ohau unless they could cross large areas of low altitude, unsuitable country, to reach the high country in Central Otago. Caughley's (1970b) predictions on the future breeding range of thar are in part confirmed. Female thar did colonise new range to the north (but only as far as the Wilberforce River), to the south (but only as far as Haast Pass), they did close the Westland gap and continue the

Table 1: *Breeding ranges ( $\pi R^2$ ) and radial equivalents (R) of female thar in 1904 (Area assumed = 1 km<sup>2</sup> in 1936, 1946, 1956, 1966, 1976 and 1984.*

Year	Caughley (1970b)		Parkes and Tustin	
	Area (km <sup>2</sup> )	Radial equivalent (km)	Area (km <sup>2</sup> )	Radial equivalent (km)
1904			1	0.56
1936	355	10.63	129	6.41
1946	860	16.55	542	13.13
1956	2010	25.29	1237	19.84
1966	3610	33.90	3998	35.67
1976			6138	44.20
1984			4937	39.64

predicted colonisation of the ranges east of the main divide.

Caughley (1970b, 1977) tested two models of animal dispersal to describe the rate of colonisation of female thar. The threshold-pressure model envisages that after some threshold density is reached, some factor such as food supply becomes limiting and individuals are induced to disperse, the proportion dispersing being density dependent. This model predicts that as the population increases exponentially but density remains constant at the threshold, so the area occupied, and the radial equivalent, also increase exponentially with time. The diffusion model envisages the causes of dispersal being innate. The proportion of the population that disperses is constant, irrespective of density and shows no lower density threshold. It predicts that the increase in radial equivalent over time will be linear.

Caughley (1970b) concluded that the relationship between radial equivalent and time from 1936-1966 was linear but he recognised that from 1904-1936 the relationship must be non-linear (Caughley, 1977). Correction of the 1936-1966 data in this paper has shown that an exponential curve better explains the relationship over the whole period from liberation in 1904 until 1966. We therefore conclude that the threshold-pressure model, rather than the diffusion model, best describes the dispersal of female thar.

The decreased rate of dispersal between 1966 and 1976 has been explained by limitations of habitat and the effects of hunting. During the period of intensive hunting, the net rate of dispersal was actually negative as thar were eliminated from some areas on the periphery of their range.

The management implications of the two dispersal processes are different. In the diffusion model female thar will move from areas set aside for recreational or safari hunting into adjacent areas such as National Parks irrespective of their density. However, in the threshold-pressure model such emigration will not be a problem so long as the thar are held at a density below the threshold.

We have shown that the dispersal of female thar is consistent with this latter model, but the threshold

density, the limiting factors which induce dispersal at this threshold, and the different dispersal behaviour of male thar (Caughley, 1970b) are all unknown.

### Acknowledgements

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