

TEMPORAL AND SPATIAL DISTRIBUTION OF THE TASMANIAN DEVIL,
SARCOPHILUS HARRISI (DASYURIDAE:MARSUPIALIA)

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(with two text-figures and two tables)

ABSTRACT

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The Tasmanian devil *Sarcophilus harrisi* (Boitard), once widespread on continental Australia, probably became extinct there partly due to food competition with dingoes and, possibly, black man and their extinction may have been expedited by a dry climatic change before white man's appearances. Recent reports of wild devils on the continent must be regarded as very doubtful. Devils now are widespread and numerous in Tasmania and have suffered at least one major population cycle since white occupation. The species appears to live well in competition with man.

INTRODUCTION

The Tasmanian devil, *Sarcophilus harrisi* (Boitard), is the largest marsupial carnivore surviving in substantial numbers and since the arrival of white settlers in Australia in 1795 has been known in the wild state only from Tasmania. However, fossil and sub-fossil remains are widely known from continental Australia and it seems appropriate to review information on their past and present distribution and to record the distribution and numbers of the Tasmanian population of *Sarcophilus*.

SPATIAL DISTRIBUTION ON CONTINENTAL AUSTRALIA

A fossil species of *Sarcophilus*, *S. laniarius* Owen, described from Australia was considered by Stephenson (1963) to be synonymous with *S. harrisi*. However, Ride (1964) separated *S. laniarius* and *S. harrisi* statistically but Archer's (1977) results suggest a size continuity in the Late Pleistocene and modern devil populations which supports Stephenson's views. Horton (1977) described a very small fossil devil from the Holocene of Cape York which may be another species. A further fossil species, *S. prior* de Vis, was shown by Bartholomai and Marshall (1973) to be not a member of the Dasyuridae but assignable to *Vombatus*. However, fossil and sub-fossil remains of *S. harrisi* have been found widely in deposits, mainly cave and dune, on the continent of Australia and it is these that provide the distributional data for this study.

Victorian records summarized by Gill (1953) and added to by Wakefield (1964) show that *Sarcophilus* formerly lived in that State, Gill commenting that it was once widely distributed over the Victorian plains. The southern range of the species extended into South Australia (Hale and Tindale 1930; Mulvaney *et al.* 1964) and across the Nullabor into Western Australia (Glauert 1914; Cook 1960, 1963a, b; Lundelius 1963).

Devils were first reported from New South Wales by Owen (1877) and Calaby and White (1967) further enlarged the range to the Northern Territory so that it is now clear that devils were once over most, if not all, of continental Australia, although it is not known whether they were ever present in central Australia. The records suggest that devils may have been confined to the damper coastal regions as well as the mountain ranges where moisture and shade could be found.

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Certain islands off southern Australia have supported former populations of devils, Calaby and White recording remains from Kangaroo Island, whilst Hope (1973) reported sub-fossil remains from Flinders Island. Their presence on Flinders Island might be expected in view of the land bridge across Bass Strait which connected this island with Tasmania and Australia until about 22 500-12 750 years ago (Rawlinson 1974). Their occurrence on Kangaroo Island indicates that devil populations were isolated on other islands connected to the mainland as well. *Sarcophilus* has not been reported from King Island.

The remains of *Sarcophilus* often are associated with or in the same geographical area as those of *Thylacinus cynocephalus* (Lowry and Lowry 1967). In view of the association of these remains it is of interest to note that *Thylacinus* has been reported from New Guinea (van Deusen 1963) so it is possible that *Sarcophilus* may well be discovered there in the future.

TEMPORAL DISTRIBUTION ON CONTINENTAL AUSTRALIA

The more recently discovered deposits from which *Sarcophilus* remains have been identified have been dated by radio-carbon methods and appear to have an age of between 1 300 and 3 800 B.P. which is contemporaneous with fossil thylacine remains from Western Australia (Mulvaney *et al.* 1964; Partridge 1967). However, Gill (1953) reported a date of only 538 ± 200 years for a Victorian site but later corrected this when more accurate techniques yielded a date of 5 000 B.P. (Gill 1971), which is more in keeping with other datings. Lundelius (1963) found devil bones in a Western Australian cave which were accompanied by bones of the introduced rabbit and mouse, but the latter probably were intrusive. Butler (1969) found *Sarcophilus* bones in a Western Australian dune deposit which were associated with both rabbit and fox bones. Dune deposits are unstable and this report may not mean much in chronological terms. It is also unlikely that the other rabbit-devil association is strictly contemporaneous since the invasion of Western Australia by rabbits did not occur until 1894 and they did not reach the coast (at Geraldton) until 1907 (Ratcliffe 1959). Thus if the devils occurred with the rabbits it would have been well within the period of white settlement but there is no record of devils having been seen or believed to have lived there during this time.

Live devils have been captured rarely from continental Australia, mainly from Victoria. Kershaw (1912) recorded a live devil from Tooborac, about 100 km from Melbourne and in spite of considerable efforts was unable to determine whether or not this animal had escaped from captivity. *Sarcophilus* was then an unprotected species and records of exports to mainland zoos or circuses were not kept. He also went on to record *Sarcophilus* bones from the shores of Lake Corangamite (also Victoria) and stated that the bones were unmineralized and had the appearance of being fresh. A further devil was caught in Victoria near Ballarat on 22 May, 1971 but this was believed to be an escaped animal (*The Mercury* 1971). One escapee lived on the Melbourne waterfront docks for some time in the 1960-1965 period.

It would appear from these records that escaped animals can survive for at least some time in the wild in Victoria and it would not be unreasonable to expect them to be successful there since the climate and other conditions there closely resemble those in northern Tasmania.

SPATIAL DISTRIBUTION IN TASMANIA

Early diarists write of devils being found around the camps during the period of the settlement of Hobart and it can be inferred that devils were widespread in Tasmania at that time, but details of numbers are lacking. Stock station records about this time mention only rarely devils in northwestern Tasmania, only one lamb being reported killed by devils at Surrey Hills (Van Diemen's Land Coy 1838) whilst many lambs as well as sheep were killed by dogs, thylacines, vagabonds and aboriginals.

The first evidence on numbers of devils is contained in Meredith (1850) who reported that they were very numerous on the east coast, 143 being caught at Apsley in the course

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of one winter. Gunn (1852) gave no information on the distribution or numbers of *Sarcophilus* but Gould (1863) noted that they were scarce in cultivated areas and were abundant in the "rougher places", but he did not give any indication of a diminution or increase in numbers since Meredith's time.

Lucas and Le Soeuf (1909) largely repeated Gould's comment without any further evaluation of the numbers but Smith (1909) did not find any devils at the Magnet Mine which is situated in an area which surely would be classed as a "rough place". The observations of Smith which were based on field work were supported by those of Flynn (1911) who could find only one female upon which to base his description of the female reproductive system and it is evident that the status of devils had altered and that they were uncommon or even scarce at that time. Lord (1919) noted that devils were in the rougher parts of the State but Flynn (1923) considered that *Sarcophilus* was a disappearing species. Later Lord (1928) reiterated his earlier statement and went on to say that there was every prospect of devils remaining in the more remote parts of the State for some time. It is clear that there was a difference of opinion regarding the status of devils at this time but there does seem to be a rather repetitious use of Gould's "confined to the rougher parts". However, we can be certain that devils were not common in the settled areas, if in fact they occurred there at all.

Lord and Scott (1945) repeated Lord's earlier opinion but qualified it by stating that devils were more abundant than was apparent as few people were in the parts of the country inhabited by them. Fleay (1946) captured 19 devils in the Jane River-Raglan Ranges area in November, 1945 and 10 in March, 1946. The many snares set together with the attractive live and dead bait used in the traps by this expedition during the five months they operated in the area might have been expected to have yielded more devils than were actually caught had they been abundant. It should be noted that at the present time of devil abundance (1977) this area does not support large numbers of devils nor would it be reasonably expected to, especially in view of the results obtained by Hocking *et al.* (1978). At about this time devils were not known in some cultivated areas, a specimen captured in Turners Marsh in 1954 could not be identified in the locality and was sent to the Queen Victoria Museum for identification. Apparently, devils were so uncommon that the public were unaware of their existence or even of their appearance.

Kimberley (1973) collected observations from the owners of "Glenconnel" and "Auburn" properties near Ross and recorded that devils were very unusual in that area in 1946 and their capture was worthy of comment but by 1953 more were being sighted. The number of devils continued to increase in rural areas, so much so that the first complaints about devil numbers and the damage they allegedly caused to livestock came from Kentish Council in 1960 (Guiler 1960; Cox 1961) as well as from Cape Portland and adjoining Icena. In 1964 damage complaints were received from Smithton (Ablitt 1964) and an expedition in that area in 1963-4 substantiated this claim by capturing a number of devils (Guiler 1966).

Since that time newspaper reports spoke of devils in places where they had been unknown for many years, even reaching Hobart suburbs (*The Mercury* 1974). Devil tracks have been seen intermittently on Mount Nelson since 1968 although the animals have not been sighted.

Although devils were common in various places, especially in northeastern Tasmania, they were still sufficiently unusual in other parts of the State for their presence to be specially reported, McIntyre (1961, 1963) recording them from Woolnorth and Georgetown, Hanlon (1962) sighted them at Mt Picton, and Hooper (1962) on the Coles Bay Road.

The alleged depredations by devils led landowners to apply for permits to destroy them, the first being issued on Cape Portland in August 1960 followed by other permits in 1966 (Table 1). In addition to those listed in the table permits also were issued to Bonneys Plains (1974); Avoca (1974); Cullenswood (1976); Ormley and Royal George (1975); Beaufront (1974); Deddington (1973, 1974); Conara (1973, 1976); Blessington (1974, 1975); Lake Leake (1975, 1976); Mt Morriston (1976); Buckland (1974); Kingston (1974); Carlton

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(1975); Georgetown (1975); Relbia (1976); Nunamara (1973); Turners Marsh (1974) (fig. 1). The latter record is of particular interest since it was at this place 21 years earlier that no person in the district could identify a devil.

TABLE 1

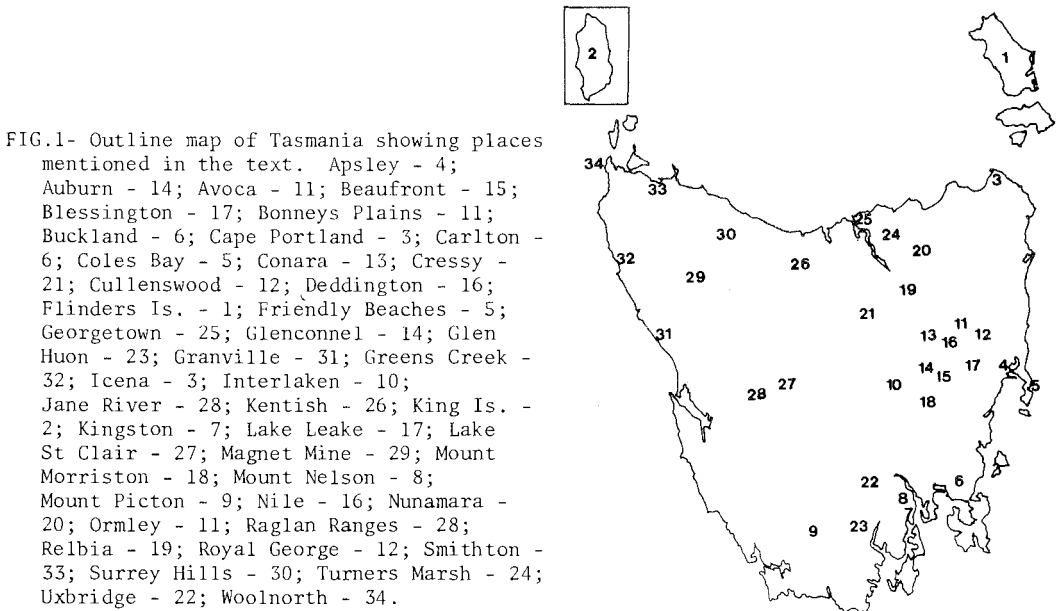
SOME PERMITS ISSUED FOR THE DESTRUCTION OF *SARCOPHILUS HARRISI*.
Only those properties which frequently receive permits are shown.

| Property | Date | Observations |
|---------------|-----------|------------------------|
| Cape Portland | 8/1960 | More than 70 taken |
| | 7-8/1966 | More than 134 taken |
| | 7/1969 | More than 51 taken |
| | 10/1973 | |
| Icna | 7/1966 | 130 taken |
| | 8/1966 | 40 taken |
| | 11/1966 | 10 taken |
| | 9/1968 | 52 taken |
| | 7/1969 | Issued to Rushy Lagoon |
| | 8/1969 | 31 taken |
| Auburn | 3/1968 | |
| | 1-2/1973 | 94 taken |
| | 2-4/1973 | 198 taken |
| | 2/1975 | |
| | 4/1975 | |
| | 7/1975 | |
| Glenconnel | 2-4/1973 | 40 taken |
| | 8-10/1975 | |
| | 1/1976 | |
| Nile | 7/1968 | 11 taken |
| | 8/1969 | 17 taken |
| Cressy | -/1965 | |
| | -/1972 | |
| | -/1975 | |
| | -/1976 | |

No particular distribution pattern can be derived from the above information although it can be concluded that devils are widespread and numerous at the present time throughout the central and northeastern agricultural districts of the State. They are undoubtedly common in other parts of the State, devils having been trapped by the Zoology Department workers at Glen Huon; Friendly Beaches; Greens Creek; Woolnorth; Uxbridge; Interlaken; Silver Plains; Lake St Clair area. Road kills and sightings from many parts of Tasmania over the past five years have confirmed this widespread distribution although devils apparently are not common in the rainforest and wet sclerophyll forests of the western parts of the State. A survey carried out in this area by Hocking *et al.* (1978) found that devils were scarce in the area.

NUMBERS

The evidence presented above shows that there has been an increase in the numbers of devils in Tasmania over the last 25 years. Devils foraging habits have brought them into conflict with farming activities (Guiler 1970a). The depredations can readily be identified and farmers apply for permits to control devil numbers on troubled properties.



The number of devil control permits issued has increased and may be taken as an indication of the impact that these animals are having upon farming properties. Devils are now to be encountered in most parts of the State, especially those which have some farming activity.

Guiler (1970b) estimated the numbers in the devil population at Cape Portland after a two-year investigation to be 136 and the numbers at Granville Harbour were found to range from 14 to 107 over the period 1966-1975, reaching a peak of 107 in 1975 and a minimum of 13 in 1978 (Guiler 1978). Guiler concluded that the Granville population reached a maximum some time after the populations in some other parts of the State such as Cape Portland and Icena where a peak was reached in 1966-69 and the Nile where a peak was attained in 1968-69. No other population estimates have been made except Kimberley's (1973) count of devils taken under permit at the Auburn and Glenconnel properties when 195 animals were taken during a trapping programme which reduced the population almost to local extinction.

Care has to be taken in interpreting the catch per trap per night as an index of relative abundance of devils. It has been shown at Cape Portland that the catch per trap per night declines during a lengthy period of trapping as in 1966 when the catch was 0.366 in May and dropped to 0.064 in October although the number of devils in the area was about the same (Guiler 1970b). However, field returns from Granville show that over a short term the number of animals caught reaches a maximum after three or four nights and then declines. The Granville work was undertaken in short "bursts" to allow for this.

However, if devils are trapped over very short periods and at long intervals of time this trap shyness can be reduced and the catch/trap/night used as an index of relative abundance (fig. 2). This yield of devils reached a peak in 1973-75 with indices from 0.226 to 0.273. Previous to this the indices for 1966-72 (inclusive) varied about a mean of 0.129. Subsequent to 1975 the index dropped very markedly to a mean of 0.065. It may be interpreted that the devil population was fairly stable over the period 1966-70 then rapidly increased in 1973, peaking in 1975 and decreasing rapidly in 1976. This conclusion

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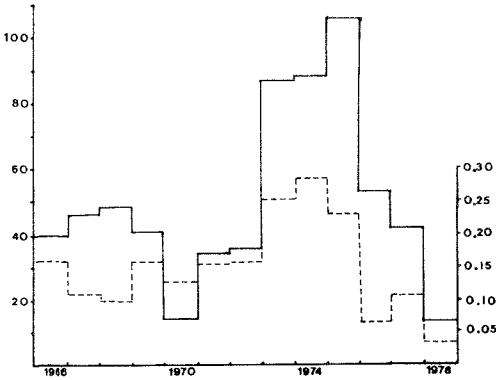


FIG.2- Histograms of the catch of devils per trap per night at Granville, 1966-78, and of total estimated population (solid line). Based on data in Guiler (1978).

is supported by further field evidence such as footprints, droppings and activity around carcasses as well as the trapping results.

The catch does vary from locality to locality as Granville in 1974 yielded 0.421 animals/trap/night; Auburn, 1973 produced 0.102 animals and Friendly Beaches in 1975 gave 0.083 animals. It is known that the population at Cape Portland was more dense than that at Granville and it is clear that the characteristics of each region and its population affect catches, such as availability of food, reproductive status of the females, familiarity of the animals with the traps, trap setting in relation to areas of devil activity, local movement patterns, weather and season.

TABLE 2

CATCH PER TRAP PER NIGHT FOR TASMANIAN DEVILS AT GRANVILLE 1966-78.
The population was estimated by the Petersen Index.

| | Number of traps | Catch/trap | Estimated population |
|------|--------------------|------------|-------------------------|
| 1966 | 396 | 0.157 | 40 |
| 1967 | 586 | 0.111 | 46 |
| 1968 | 331 | 0.093 | 48 |
| 1969 | 778 | 0.116 | 41 |
| 1970 | 233 | 0.124 | 14 |
| 1971 | 244 | 0.151 | 34 |
| 1972 | 296 | 0.152 | 36 |
| 1973 | 726 | 0.248 | 87 |
| 1974 | 1021 | 0.273 | 89 |
| 1975 | 522 | 0.226 | 107 |
| 1976 | 678 | 0.064 | 52 |
| 1977 | 435 | 0.092 | 42 |
| 1978 | 328 | 0.039 | 13 |

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DISCUSSION

Tasmanian devils were once widespread, if not common, over much of continental Australia and the problem of their present restriction to Tasmania should be viewed in relation to their disappearance from the continent rather than seeking reasons why they survived in Tasmania. The climate of Australia in the Late Pleistocene was colder than at present with glaciation in Tasmania and on the Snowy Mountains between 25 000-15 000 years ago, but the climate warmed up from 15 000-10 000 years ago. In the last 10 000 years the climate has been relatively stable but with a period of higher rainfall and warmer conditions between 9 000-6 000 years ago (Bowler *et al.* 1976). It is this latter period that is of concern to this discussion.

The more moist climate some 6 000-9 000 years ago would have suited devils more than the present arid conditions. The climate has changed little since devils have been established as living on continental Australia, say 3 000 B.P. The environment found in some parts of Australia, for example some of the gullies of the eastern mountains of New South Wales and Victoria would appear to offer very suitable habitat for devils, little differing from that which they use extensively in northeastern Tasmania and it is difficult to believe that climatic alterations are responsible for their extinction on Australia. It has been shown that *Sarcophilus* is a competent thermoregulator (Hulbert and Rose 1972; Guiler and Heddle 1974) and it would be capable of living in much of the present Australian environment. Gill (1953) favoured the concept of devils preferring colder climates but their efficient thermoregulation together with the strictly nocturnal habits would permit them to use warmer situations.

Thus, the climate of 6 000 years ago would have suited devils but the drier conditions of the last 5 000 years would not have been sufficiently drastic to have caused the total disappearance of *Sarcophilus* from continental Australia and we must look to other factors such as interspecific competition. The species with which the devil would have competed, either directly or indirectly, are black man, white man, black man's dog and dingoes. Of these three we can eliminate white man as there is no evidence of live devils living in Australia at the time of white settlement.

Sarcophilus occurred on what is now Flinders Island using the land bridge through this area. The species has never been reported alive from the Island (Hope 1973) so that devils must have been extinct there by 1800, probably very much earlier than this. This is of some interest as the introductions which usually are named as interspecific competitors with *Sarcophilus*, the dingo and the fox, have never been found in the Furneaux Group. Food on Flinders Island for a scavenging species such as *Sarcophilus* would have become less abundant as the seas rose and isolated the island and the available sources were not able to sustain a viable devil population. This situation would have been accentuated by the nature of the vegetation of the island in its undeveloped state which was mainly thick forest or scrub which was unlikely to carry much suitable prey.

There is dispute over the date of invasion of Australia by dingoes. Rolls (1969) believed that the dingo came to Australia with aboriginal man, and therefore entered active competition with the devil, about 7 000 years ago. Macintosh (1975) agreed that dingoes did not appear in Australia before 8 000 B.P. and showed that dingoes did not occur in the archaeological context until 3 000 B.P. Assuming these dates of introduction to be correct, then the dingo would have had the advantage of wetter and warmer conditions to expedite its colonization and spread across Australia. Macintosh (1975) went on to suggest that devils were extinct by 3 000 B.P. and deduced that dingoes and devils never were in competition. These dates are not supported by the datings of Mulvaney *et al.*'s (1964) materials.

It is difficult to accept the extinction of the Australian devils as being caused only by direct competition with black man and canids, be they dogs or dingoes. There are many areas with permanent water, and dense vegetation which would offer shelter to devils and where dingoes could not operate successfully. The climate of southeastern Australia offers much the same conditions as northeastern Tasmania where devils abound, and it could be

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expected that devils would thrive there if they were introduced. It may be that the combination of competition and climatic alternatives was sufficient to cause their decline but I feel that some other presently unknown factor or factors may have contributed.

It is clear that *Sarcophilus* whether in competition with dingo or not, has been extinct for a sufficiently long period of time in Australia for its religious, legendary and food significance to have disappeared from the aboriginal tribes. The aboriginal may have had considerable impact on the number of *Sarcophilus* in Australia but it difficult to assess whether this would be in a negative or positive manner. The devil in modern Tasmania makes wide use of human settlement and garbage for food and the presence of aboriginal man may have offered a similar dietary supplement in Australia. On the other hand it may be that devils offered either a source of food to the aborigines or else suffered as a result of food competition with the aborigines.

Gill (1953) noted that *Sarcophilus* was one of the species that disappeared from Australia during the period of the occupation by black man and he went on to make the intriguing point, though this is not supported by fossil evidence which shows them to be contemporaneous about 3 000 years ago (Lowry and Lowry 1967), that the thylacine probably became extinct on continental Australia before the devil. This may well be comparable to the present Tasmanian situation where the thylacine, to say the least of it, is extremely rare although devils are still numerous.

There can be little doubt that white man has not expedited the extinction of this species from Australia in spite of Kershaw's (1912) record. Such a vociferous and flamboyant species as *Sarcophilus* would be expected to be handed down for many years in native song, dance and legend. There is no evidence of this and presumably therefore the species was not known to the natives in the near past.

With even greater certainty it can be said that the fox, introduced about 1868 (Rolls 1969) cannot have been a competitor with *Sarcophilus*.

The Tasmanian devil has experienced at least one major population cycle since the settlement of the island in 1804. Although early records are scanty, it would seem that devils were common in the 1820's and very common in some districts (Meredith 1850). Apparently they suffered a diminution in numbers as Gould and later writers found them only in the remote districts and this situation prevailed for many years, the species reaching its nadir about 1910 and remaining scarce until 1955 or thereabouts. This decline may have been due in part to a distemper-like disease that affected all the dasyures about that time (Burbury quoted by Guiler 1961). Much land clearance was taking place at about this time and the removal of cover, an important prerequisite for devils, would have assisted in confining the species to the mountains but at the same time additional food was supplied in the form of dead livestock and native species together with litter generally. The recent studies of devils have shown (Guiler 1978) that they make full use of these resources and have adapted well to the modern scene, living even in the outer suburbs of cities. It would be unlikely that agriculture would play a major part in the decline in numbers of devils.

Trapping of animals for fur used to be an important part of the Tasmanian rural winter scene and a feature was the setting of traps for devils to remove them from the trapline. Such activity could only have a local effect and would not control the total population.

The present population peak was not reached synchronously throughout the State and it may be that the Cape Portland population, although still high, may have passed its peak. However, the Midlands population currently is very high as is shown by the permit applications from Cressy, Auburn and Glenconnel. The relative abundance of devils cannot be assessed from the return per unit of effort in different places. The return per trap in 1974 at Granville (0.421) was obtained from a smaller number of animals than at Cape Portland (0.366) or Auburn (0.102). The yield of devils is controlled in part by the nutritional status of the population under study and also by the knowledge of the general patterns of devil movements and those of the local population by the workers concerned.

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