

The conservation status of the yellow-footed rock-wallaby in Queensland

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*A survey of the distribution of the yellow-footed rock-wallaby *Petrogale xanthopus* was carried out in Queensland from 1984 to 1987. The species was found at 44 sites to the north and north-west of Adavale in south-western Queensland, mainly in the rugged country along the edges of low sandstone tablelands and hills. The size of the rock-wallaby population could not be estimated with accuracy, but is considered to be of the order of 5000–10,000 animals. The species is vulnerable because of property development in the area and possibly because of competition from other herbivores. The authors recommend regular monitoring of the population size.*

Introduction

The yellow-footed rock-wallaby *Petrogale xanthopus* was originally described as the yellow-legged rock kangaroo from specimens collected in the Flinders Ranges in South Australia (Gray, 1854). It was first collected in Queensland in 1922 and described as *Petrogale celeris* from specimens collected at Terrachie, north-west of Quilpie (Figure 1) (Le Souef, 1924). It is now considered to be a subspecies of *P. xanthopus* (Maynes and Sharman, 1983; Eldridge *et al.*, in press). Five additional specimens were taken in Queensland between 1922 and 1931, three from Ambathalla and Blackwater Creek (Figure 1) and two from undefined localities. Since the initial collections, the species in Queensland has been reported to be of unknown status due to the lack of recent records (Calaby, 1971) and has been considered rare (Poole, 1979; Briscoe *et al.*, 1982; Maynes and Sharman, 1983) or uncommon and possibly endangered (Archer *et al.*, 1985).

Recent work on the conservation and management of the yellow-footed rock-wallaby has been summarized by Lim *et al.* (1987). A sighting of the species near Adavale in 1973, the first Queensland record since 1931, prompted the Queensland National Parks and Wildlife Service to start surveys for this species. An intensive survey during 1973–74 found that its distribution was limited to an

area north of Adavale (Gordon *et al.*, 1978). Brief visits were made to the area during 1980–84, a second intensive survey was carried out in June 1984 and the survey was completed with further occasional visits during 1985–87. The completed survey is described in this paper.

Methods

Land systems mapping, which uses a combination of physiography, geology, soils and vegetation to describe and map the natural features of a region, was used as a basis for determining the survey area (The Western Arid Region Land Use Study [WARLUS]; see Figure 1). The mapping categories are land units, which are grouped into land systems. In this survey, land units were used to differentiate between different kinds of rock-wallaby habitats, similar units from different map areas being grouped to form habitat types. Data from the land systems maps were also used to calculate the approximate area of habitat types.

The Dissected Residual land systems – ranges of low tablelands, ridges and hills with eroding slopes – include all the more rugged country in the region and all potential rock-wallaby habitat. In June 1984, a search area was defined using known localities, reported

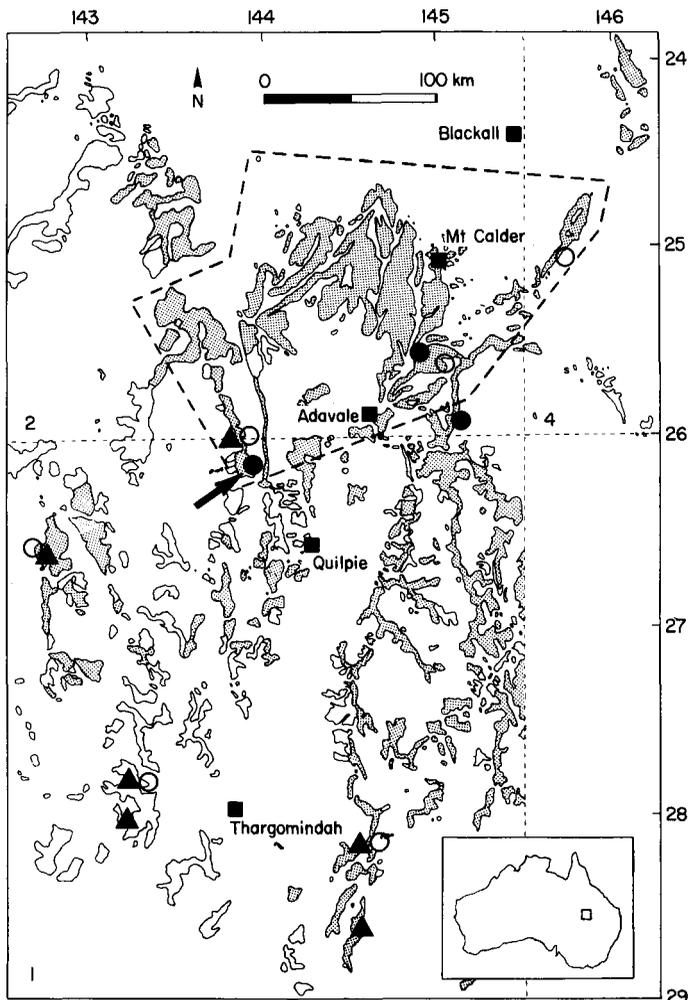


Figure 1. Yellow-footed rock-wallaby study area in south-western Queensland. Outlined areas show Dissected Residual land systems with cliffs (shaded) and without cliffs (open). 1, 2, 4 – WARLUS (Western Arid Region Land Use Study) map sheets. (Map 1, Dawson and Boyland, 1974a, b; Map 2, Mills and Boyland, 1980a, b; Map 4, Turner and Beeston, 1978; Turner *et al.*, 1978.) ●, museum specimens, locations approximate (▲ type locality of subspecies, Terrachie); ○, old unverified rock-wallaby reports from Gordon *et al.* (1978); ▲, sites from Map 1 area inspected in 1973-74; ■, place names; ---, boundary of aerial survey. Inset map shows location of area.

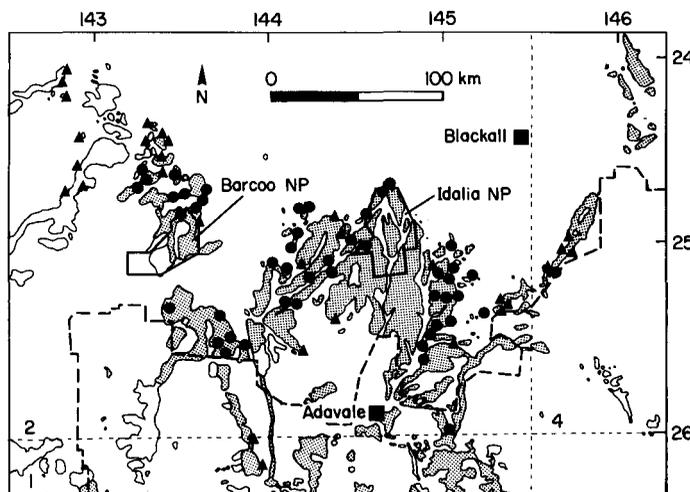


Figure 2. Sites inspected from 1980 to 1987. Outlined areas show Dissected Residual land systems with cliffs (shaded) and without cliffs (open). ●, yellow-footed rock-wallaby or its dung found; ▲, yellow-footed rock-wallabies not found. 1, 2, 4 – WARLUS map sheets. ■, place names; ---, the route of the dingo barrier fence, the area to the south and east of the fence being subject to more intensive dingo-control programmes.

sightings, habitat preference as known by one of the authors (L.L.), and data from the land systems maps (Figure 1). The survey contained aerial and ground components and utilized staff from both the Queensland and New South Wales National Parks and Wildlife Services. The aerial survey in a high wing aircraft (Cessna 206 with a Robertson conversion) was undertaken by L. Lim, who has extensive experience of aerial survey for the yellow-footed rock-wallaby in New South Wales and South Australia (Lim and Giles, 1987; Lim *et al.*, 1987). Potential yellow-footed rock-wallaby habitat was located by low-level aerial reconnaissance. Approximately 25,000 sq km of south-western Queensland (Figure 1) was covered by 27 hours of aerial survey at between 150 and 450 m above ground level. The regions located in the aerial search were investigated by a 12-person ground-survey team with six vehicles. In each region, the more rugged sites were chosen for closer inspection. Not all potential sites were inspected because the aim was to establish the presence of the yellow-footed rock-wallaby in each region rather than to map its distribution in detail. Most sites were visited on the ground in June 1984. Survey of the more westerly sites was completed in May 1987. Between 1973 and 1987, 73 sites (defined as locations 5 km or more apart) were assessed, 51 of them during 1984–1987.

At each site we recorded: broad vegetation type; habitat type using the land unit description (Turner *et al.*, 1978; Mills and Boyland, 1980b); the number of yellow-footed rock-wallabies sighted; abundance of dung; physical features; other grazing animals (presence of the wallaroo *Macropus robustus*, the feral goat *Capra hircus*, the rabbit *Oryctolagus cuniculus*); and disturbance (e.g., clearing of timber, presence of domestic stock). The abundance of the yellow-footed rock-wallaby at each site was assessed as: absent (no dung or sightings); uncommon (maximum density of faecal pellets 1–5 per sq m and no animals sighted); or common to abundant (maximum density of faecal pellets > 5 per sq m or one or more animals sighted). A habitat score (Lim and Giles, 1987) was calculated for each site



A yellow-footed rock wallaby (Queensland Department of Environment and Heritage).

by summing the number of physical features present out of a maximum of five (cliffs or gorges, boulders, rocky terraces, fissures in the cliff face, and caves or overhangs).

In May 1985, a survey was carried out on Mount Calder station south-west of Blackall (Figure 1) in order to locate all yellow-footed rock-wallaby sites on the tablelands and hills of the property. It was undertaken on foot over 4 days by 22 soldiers from the Australian Army, Enoggera Barracks, Brisbane, and staff from the Queensland National Parks and Wildlife Service.

Incidental survey work was also carried out from the Charleville office of the Queensland

Rock-wallaby occurrence	Habitat A			Habitat B Map 2
	Map 1	Map 2	Map 4	
Present 1973+		43	1	
Absent 1973+	8	10	2	9
Museum pre-1973	1	3		
Reports pre-1973	3	2	1	

Table 1. Number of survey sites and reported sites found in each habitat type and map area

Habitat A: upper slopes, cliff-lines and flat tops of low tablelands and hills with slopes of 1–60 per cent and vegetation of *Acacia* woodland or shrubland.

Habitat B: upper slopes and flat tops of low tablelands and hills with slopes of 1–25 per cent and vegetation of mulga shrubland; cliffs absent.

Sites prior to 1973 are from museum specimens and from reports by residents and the habitat type is assumed (see text). Present: the yellow-footed rock-wallaby or its dung was found at the site. Absent: no sign of rock wallabies during survey. Museum: museum records of rock-wallabies. Reports: old unverified reports of rock-wallabies. Map areas are numbered as in Figure 1.

National Parks and Wildlife Service as reports of sightings were received.

Results

Historical records

With the exception of the type locality of the Queensland subspecies, Terrachie, the known localities at which the yellow-footed rock-wallaby was collected in Queensland during the 1920s and 1930s occur within or near the present known distribution of the species (Figures 1 and 2).

Current distribution

Since 1973, the species or its droppings have been found at 44 sites, including 33 sites from 1984–87, all north of Adavale and within an area measuring 250 km from east to west and 160 km from north to south (Figure 2). The yellow-footed rock-wallaby was common or abundant at 33 of the 44 sites; negative sites in the east and the north-west indicated distributional limits (Figure 2).

Population size

We did not attempt to systematically estimate the total population size, but obtained some indication of potential population size.

At Mt Calder station, 228 yellow-footed rock-wallabies were seen during the intensive survey, occurring at 5.7 per sq km in the preferred habitat type (see below), which covers approximately 40 sq km on this property. In the broad-scale survey, 192 yellow-footed rock-wallabies were seen at 44 sites (4.36/site). In the southern Flinders Ranges in South Australia Lim *et al.* (1987) reported sightings of five to six animals in colonies with known populations of 30–40 animals. If it is assumed

Table 2. Relationship of yellow-footed rock-wallaby records to habitat score (no. sites in each category)

Rock-wallaby occurrence	Habitat score				
	1	2	3	4	5
Absent	2	5	6	4	2
Uncommon	1	4	5	1	0
Common/abundant	2	2	5	10	10

Habitat score ranges from least complex topography (1) to most complex (5).

that a similar relationship exists in Queensland, the populations at sites in the more densely vegetated areas may be five to eight times greater than the number of animals sighted. From this, the population size at known sites in Queensland could be 960–1500 animals.

During the broad-scale survey, only a small proportion of potentially suitable habitat was visited and we believe that the number of suitable sites is much greater than 44. If it is assumed that 44 sites comprise 20 per cent of the total sites, then the total population size would be 4800–7680; if 44 sites comprise 10 per cent, the total population size could be 9600–15,360. It is probable, therefore, that there are at least 5000 yellow-footed rock-wallabies in Queensland.

Rock-wallaby habitat

At all yellow-footed rock-wallaby sites the habitat comprised the upper slopes, cliff-lines and flat tops of low tablelands and hills, with gradients of up to 60 per cent and vegetation of low *Acacia* woodland or shrubland (habitat A, Table 1). Although these areas include the physically complex sites described below where wallaby abundance is higher, they usually have simple topography with relatively uniform slopes (lacking boulders or terraces) and 1–2-m-high unbroken cliff-lines. The ranges with such topography, where cliff-lines and eroding scarps are a prominent feature, indicate the area potentially suitable as rock-wallaby habitat (Figure 1).

Statistical analysis showed that the abundance of the yellow-footed rock-wallaby was significantly related to habitat complexity (Table 2). However, rock-wallabies were absent from six sites with a high score for complexity. These were all on the extreme margins of the known distribution and, although physically suitable, they were apparently unoccupied for other reasons. Table 2 also reveals that nine positive sites had low physical complexity, but all contained cliffs and/or large boulders.

Sites with higher abundance included some or most of the following features: cliffs at least

2 m high, fissures and/or caves in the cliff face, and terraces or large boulders on the slope below the tableland.

We also attempted to determine probable habitats for older reports (prior to 1973) where the location is not known accurately (museum records and unverified reports from Gordon *et al.*, 1978) (Figure 1), by allocating them to the nearest range area and reading the potential habitat there from the land system maps. The older reports appear to occur in habitats similar to current records (Table 1).

Rock-wallabies were consistently absent from sites that were less rugged than the positive sites, consisting of the upper slopes and flat tops of residual tablelands with no cliffs, lower gradients (1–25 per cent) and vegetation of mulga shrubland (habitat B, Table 2). Ranges with such topography may form marginal habitat or serve as dispersal routes (Figure 1).

Most positive sites occur in land systems where rock-wallaby habitat is very extensive, comprising 50–70 per cent of the land system, although at 15 sites this habitat comprised only 20 per cent of the land system. In the southern half of the survey area, where the species is thought to be absent (Map 1 area, Figure 1), potential rock-wallaby habitat comprises only 10–35 per cent of the land systems.

Vegetation of rock-wallaby sites

The vegetation of the dissected tablelands occupied by the yellow-footed rock-wallaby consists of open woodland to low open woodland, dominated by a well-defined but discontinuous upper storey of mulga *Acacia aneura* or bendee *A. catenulata* (Mills and Boyland, 1980b). Lancewood *A. petraea* and mountain sandalwood *Eremophila oppositifolia* are frequent co-dominants. A variety of other species may be present. A low shrub layer, dominated by the genera *Acacia*, *Eremophila* and *Cassia*, is present to varying degrees. This shrub layer is generally more developed on the scarps of the yellow-footed rock-wallaby sites than on the tablelands. Ground layer vegetation is sparse and is dominated by the family Malvaceae, particularly *Sida* spp. Grasses

were generally not recorded as a dominant component of the ground layer but the genera *Eragrostis* and *Sporobolus* were frequent.

The yellow-footed rock-wallaby also occupies gorges within the dissected tablelands. These areas may contain rock holes with permanent water and boulder piles formed from broken edges of the tableland. The vegetation may include species representative of much wetter areas: river red gum *Eucalyptus camaldulensis*, Moreton Bay ash *E. tessellaris*, flax-leaved tea-tree *Melaleuca linariifolia*, red ash *Alphitonia excelsa* and the sedge *Gahnia aspera*.

There is no detailed information on the yellow-footed rock-wallaby's diet in Queensland. Casual observations indicated that the small tufted grass *Sporobolus caroli* and the spindly forb *Sida filiformis* are grazed heavily by the species. The rock sedge *Scleria sphacelata*, which occurs in cracks and crevices in and around boulder piles and rock faces, is also frequently trimmed to ground level. The yellow-footed rock-wallaby has been observed eating leaf fall from mulga and bendee and in captivity at Charleville readily takes mulga. At several of the sites reported in this study where more detailed survey work has been conducted, one of the authors (P.M.) observed no browsing on the most abundant mid-stratum shrubs: wilga *Geijera parviflora* and wedding bush *Ricinocarpus bowmanii*.

Geology

The predominant surface rocks at most rock-wallaby sites are silicified Tertiary sandstones (silcrete) overlying Cretaceous sediments (Dawson and Boyland, 1974b; Mills and Boyland, 1980b). At the site in the Map 4 area (Figure 2) the rock types are Cretaceous sediments, including conglomerate, overlying Jurassic sandstones (Turner *et al.*, 1978).

Occurrence of goats

The feral goat was widespread in the area, occurring on 30 of 39 sites assessed for presence or absence, but its presence was not significantly related to habitat score. However, Mahood (1985) and Lim (1987) have shown

that activity of feral goats varies spatially and temporally during the day and between seasons and a more intensive investigation may be necessary to indicate any correlation between feral goats and other factors.

Discussion

The Queensland environment

The habitat of the yellow-footed rock-wallaby in Queensland differs in some respects from that of the southern Flinders Ranges and the more arid areas of its range.

In western Queensland most yellow-footed rock-wallabies occur in areas of silcrete and conglomerate. In the Flinders Ranges and western New South Wales, however, the rock type is predominantly sandstone with marginal colonies of the wallaby, most of which are locally extinct, on smaller areas of minor rock types including granite, conglomerate, and retrograde metamorphics. Limestone-dolomite, conglomerate-tillite and granite-porphry are found in some parts of the Flinders Ranges. At the eastern and western ends of the yellow-footed rock-wallaby's distribution in South Australia it is found on granite outcrops (Copley, 1983; Lim *et al.*, 1987).

In Queensland, yellow-footed rock-wallaby habitat receives most of its rain from the summer monsoon; mean annual rainfall varies from about 324 mm (Quilpie) to 531 mm (Blackall) (Figure 1). In the more arid parts of the species's southern range (the northern Flinders Ranges, the Olary Hills and western New South Wales), the rainfall is unpredictable (Lim *et al.*, 1987). Our observations suggest that this species is found only where the rainfall is higher than 150 mm per annum and in higher densities only when the mean annual rainfall exceeds 200 mm. In the drier parts of its range higher densities occur around permanent waterholes.

Although there are common elements in the vegetation types in yellow-footed rock-wallaby habitat throughout its range, there are also some differences. The shrub layer, which

consists of different species in the widely separated areas of the wallaby's range, often includes closely related species of the same genus (Copley, 1981; Mahood, 1983 in Lim, 1987; Lim *et al.*, 1987). Therefore, although the floristic composition may be different, the structural components are similar. In parts of the habitat in Queensland, however, the shrub layer is denser and the mulga cover is more continuous than elsewhere in the species's range. It is notable that the yellow-footed rock-wallaby is found in the mulga zone in Queensland, in mulga/cypress (*A. aneura/Callitris* spp.) associations in New South Wales (where most of the mulga has now been cleared) and in the cypress/mallee (*Callitris/Eucalyptus* spp.) zone of South Australia (except in the northern Flinders Ranges). This may indicate the dependence of the species on browse like mulga during droughts and the summer months (Lim, 1987). Outside the area where browse is available they are also able to survive where they have access to permanent water (Terrapina Gorge, northern Flinders Ranges). The management of the yellow-footed rock-wallaby is therefore dependent on the protection of these food and habitat resources from over-grazing, destruction and depletion by domestic stock and feral goats.

Habitat utilization

The yellow-footed rock-wallaby occurred at physically complex sites where either cliffs or boulders were present. This is consistent with the habitat preference observed in western New South Wales and South Australia (Lim *et al.*, 1987). However, some physically simple sites were also used, suggesting that habitat utilization is broader than in New South Wales where the species mainly occupies sites with high habitat scores (Lim and Giles, 1987).

Observations made during the survey suggested that the yellow-footed rock-wallaby requires a well-developed mid-stratum structural habitat component, either a shrub layer or complex system of boulders and rocks, or a combination of both. Thus, physically simple sites with a small number of boulders generally supported well-developed shrub layers.

Conversely, areas with a complex system of rocks, boulders, overhangs and crevices often supported only sparse shrub layers, but moderately developed canopy layers. Suboptimal or marginal sites often contain little physical or vegetation complexity and may serve as temporary habitat for dispersing animals.

Limiting factors

Clear limits to distribution are present in the north and north-west where suitable habitat ceases (Figure 2). In the north-east, the species is absent from a large area of habitat that is apparently physically suitable. The distribution here may be limited by some factor that was not measured in detail, for example, a high density of feral goats. Similarly, the species is absent or scarce to the south of Adavale, including at the type locality of the Queensland subspecies.

The habitat to the south of Adavale (Map 1 area, Figure 1) differs in some respects from that where rock-wallabies are now common. Firstly, the Dissected Residual land systems are more attenuated (Figure 1) so that habitat is more dispersed among other land types. This may make the species more vulnerable to disturbance, such as sheep grazing, land clearance, fox predation and competition with feral goats. Secondly, suitable habitat forms a much smaller proportion of the preferred land systems than in most habitat north of Adavale (Maps 2, 4 areas, Figure 1).

A dingo barrier fence runs east and south of the current yellow-footed rock-wallaby distribution, separating areas of predominantly sheep country (south and east of the fence) from areas mainly stocked with cattle (north and west of the fence) (Figure 2). In sheep country, properties are smaller and more intensively developed and are often subject to more intensive dingo-control programmes, which could result in higher populations of feral goats, a factor that has been suggested as being harmful to the yellow-footed rock-wallaby populations (Wilson *et al.*, 1976; Lim *et al.*, 1980). In addition, sheep grazing may have a more harmful impact on the vegetation in rock-wallaby habitat than cattle grazing.

There is also some evidence to suggest that where dingoes are abundant, red fox *Vulpes vulpes* numbers are kept to a minimum. Although dingoes may take small mammals as their predominant prey in some locations, they generally prefer larger prey (Robertshaw and Harden, 1985) and therefore may only take large adult yellow-footed rock-wallabies that venture from the security of the rock outcrops. Most extinctions of Australian mammals have occurred in species with a weight range of 3500–5500 g (Burbidge and McKenzie, 1989). This was attributed partly to predation by introduced predators. Young rock-wallabies of less than 55 kg may suffer considerable predation pressure from red fox in sheep country where dingo numbers are controlled. Kinnear *et al.* (1988) demonstrated the impact of the red fox on the black-footed rock-wallaby *P. lateralis* in Western Australia. In south-eastern Australia, the decline of the brush-tailed rock-wallaby *P. penicillata* has been correlated with a group of factors: the presence of feral goats, rabbits, sheep and the red fox, and the absence of dingoes (Short and Milkovits, 1990). Of these factors, the presence of feral goats and the red fox were considered to be of major importance.

Status

The Queensland population of the yellow-footed rock-wallaby is of major conservation importance because it includes a significant part of the total Australian population. The known distribution, 44 sites spread over a 250-km-wide area, compares well with that of the Flinders Ranges' population, which has 187 known sites spread over an area 408 km wide (Copley, 1983; Lim *et al.*, 1987). The species was rated as common or abundant at 33 of the 44 sites. Although population size was not calculated, available data suggests that a population size of 5000–10,000 is a realistic estimate.

The Queensland population of the species has a much better status than was previously thought. It is probable that its apparent rarity was due to a lack of earlier surveys and the nature of the habitat and land use. The area

mainly consists of large properties with tracts of rugged country that are only lightly grazed. Landowners visit the areas inhabited by rock-wallabies infrequently and the owner of one property and professional kangaroo shooters reported only 1–2 sightings of animals in nearly 12 months of spotlight shooting. Many property owners/managers contacted during the course of this survey were unfamiliar with the species and unaware of its existence on their properties. It is probable, therefore, that the yellow-footed rock-wallaby has always been common in a restricted range in Queensland, but has gone unnoticed.

Gordon *et al.* (1978) suggested that the species had declined greatly in the Map 1 region to the south of Adavale, because a number of old reports had been received from residents in that area (Figure 1). However, L. Lim (pers. comm.) considers that such outlying reports may be interpreted as resulting from dispersing animals establishing temporary colonies in marginal areas. The movements of the yellow-footed rock-wallaby due to prolonged droughts and local rainfall have yet to be investigated. Further investigation of the historical status of the species in this area is therefore warranted. It is probable that at least a minor decline has occurred here because the yellow-footed rock-wallaby is now absent from the type locality of the subspecies and adjacent areas to the west-south-west of Adavale.

Unconfirmed reports to the Queensland National Parks and Wildlife Service also suggest that a small subpopulation may still exist in the region of Thargomindah, south of Adavale.

Management

A number of factors were identified that are potentially harmful and require further investigation. Land-use changes occur continually in the region in the form of intermittent property development. This often takes the form of subdivision of paddocks and provision of extra watering points. Recently, there has been an upsurge in broad-scale clearance of timber, particularly of gidgee *Acacia cambagei* and

mulga. These changes may be harmful to the yellow-footed rock-wallaby populations. More intensive grazing by domestic stock near rock-wallaby habitat is an immediate result. Domestic stock, particularly sheep, are potential competitors for food in areas where rock-wallabies graze away from the more rugged lands. Where residual ranges are more isolated, as in the north-east (Figure 1), clearing between them may affect the dispersal of animals. Perhaps more importantly, changes in the land management may favour the feral goat and the wallaroo. This might occur when the numbers of dingoes are controlled or when there is increased availability of food or water. The feral goat is common in the region (for example, 1000 were removed from one property alone in 1987) and has been identified elsewhere as a potential competitor for food or shelter (Dawson and Ellis, 1979; Copley, 1983; Lim *et al.*, 1987). It was also considered that the wallaroo populations, enhanced by favourable property management, could compete with the yellow-footed rock-wallaby for shelter. The wallaroo is common to abundant in the Dissected Residual land systems. The red fox and the rabbit are present but appear to occur in low numbers only and are not considered to be a threat to the rock-wallabies at present. Rock-wallabies are also better adapted to withstand droughts and are able to survive longer into a drought than these species (L. Lim, pers. obs., Flinders Ranges).

Land use in the region is dynamic and populations of potential competitors may be changing. Thus, it is desirable that the yellow-footed rock-wallaby population size be monitored regularly at selected sites on a biennial basis.

Two national parks have been established in part of the rock-wallaby area, Idalia (144,000 ha) and Barcoo (124,000 ha). The yellow-footed rock-wallaby has, however, shown an ability to survive on grazing properties in this area and thus should be able to persist there if the land is managed appropriately.

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