

Action Statement

Flora and Fauna Guarantee Act 1988

Revised edition

No. 15

Spot-tailed Quoll *Dasyurus maculatus*

Description

The Spot-tailed Quoll (or Spotted-tailed Quoll or Tiger Quoll, *Dasyurus maculatus*) is the largest marsupial carnivore on mainland Australia. Males have a head and body length of 380-760 mm, a tail length of 370-550 mm and weigh up to 7 kg (average 3 kg), while females have a head and body length of 350-450 mm, a tail length of 340-420 mm and weigh up to 4 kg (average 2 kg). Fur colour ranges from light to very dark brown, with conspicuous white spots over the body and tail. No other quoll species in Australia has a spotted tail. The Spot-tailed Quoll has a relatively large head with a wide jaw gape and characteristic large dentition of a carnivore, including long, curved canine teeth (Edgar and Belcher 1995).

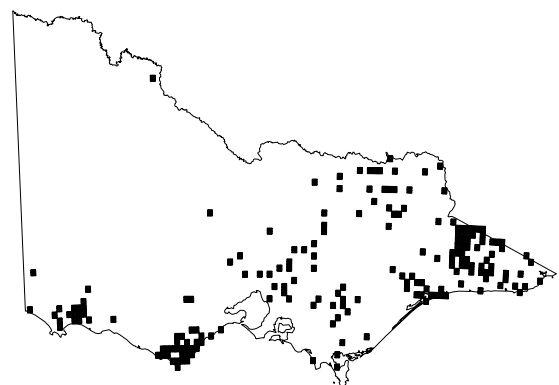


Spot-tailed Quoll (*Dasyurus maculatus*)

Distribution

Australia

The Spot-tailed Quoll occurs in eastern Australia, including Tasmania. There are two described subspecies: *D. maculatus gracilis*, which is confined to northern Queensland; and *D. maculatus maculatus*, which occurs in south-eastern Queensland, New South Wales, Victoria and Tasmania, and formerly occurred in South Australia (Edgar and Belcher 1995). Recent molecular analysis (Firestone *et al.* 1999) indicates that the Tasmanian population of the Spot-tailed Quoll is genetically quite distinct from mainland populations, suggesting that it should be regarded as a separate subspecies.



Distribution in Victoria (DSE 2002)

Distribution (cont.)

Victoria

At the time of European settlement, the Spot-tailed Quoll had a broad distribution in southern, central, eastern and north-eastern Victoria, at altitudes ranging from sea level to at least 1100 metres (Atlas of Victorian Wildlife – AVW, DSE).

The inland limit of its distribution broadly coincided with the 600 mm rainfall isohyet, although the species also occurred along riverine woodland in drier areas (Mansergh 1984). Due to extensive clearing and fragmentation of habitat in parts of the Quolls' range, and subsequent declines in its distribution and abundance since European settlement, the Spot-tailed Quoll now survives in several discrete areas of Victoria, including:

- Eastern Victoria, from the foothills and ranges north-east and east of Melbourne through to the Victoria-New South Wales border (and likely to be contiguous with NSW populations adjacent to the border), including north-eastern Victoria and lowland East Gippsland.
- South Gippsland, in the Strzelecki Ranges. There are also two unconfirmed sight records from Wilsons Promontory, dating from 1908 and the 1960s, but no confirmed records (AVW, DSE).
- Otway Ranges.
- South-western Victoria, including Mt Eccles National Park

There are also recent (1991) records from the Macedon Ranges in central Victoria, and a single record from near Swan Hill in north-western Victoria.

Within Victoria, the Spot-tailed Quoll is now confined largely to public land, mostly in parks, reserves and State forest.

Habitat

The Spot-tailed Quoll is a species of forested habitats and can occur in many forest types particularly including lowland, foothill and montane moist and dry forests and woodlands (AVW-DSE, Mansergh and Belcher 1992; Edgar and Belcher 1995; Belcher 2000a). As male Quolls can move over large distances, animals can occasionally be encountered in 'non-typical' habitats including heathland, coastal dunes, farmland and even outer urban residential areas bordering on forested land.

The structural complexity of the habitat appears to be particularly important, with the species favouring areas with a dense overstorey and understorey and with abundant rocks, large hollow-bearing trees, rocky escarpments and/or

fallen logs for den sites. Areas with a high density of mammal prey items are also utilised. Within these areas, Spot-tailed Quolls apparently preferentially occupy drainage lines, gullies, flats and escarpments, but avoid mid-slopes, and use saddles to cross between catchments (Belcher 2000a). Prey densities and den site availability appear to be key features influencing habitat utilisation (Belcher 2000a).

Life history and ecology

Spot-tailed Quolls are generally solitary animals (Belcher 1994), usually occur at low densities (Jones and Rose 1996) and occupy large home ranges, from 2000 – 4500 ha for males, and 600 – 1200 ha for females, with size of home range related to habitat quality, particularly the availability of den sites and the density of mammal prey items (Belcher 2000a). The home range of a male Spot-tailed Quoll may cover the territories of several females.

Spot-tailed Quolls are carnivorous and will prey upon a wide range of mammals (including possums, rodents and rabbits), birds (including domestic poultry), reptiles and invertebrates, and will scavenge the carcasses of larger mammals such as wombats, wallabies and dogs (Jones 1923; Fleay 1948; Belcher 1995). The species is terrestrial and arboreal, and is an adept climber, hunting for prey in tree hollows and the canopy. Although generally nocturnal or crepuscular, Quolls will hunt during the day, especially for possums in tree hollows. Spot-tailed Quolls shelter and rear young in dens, and individual animals use a number of dens. Den sites include caves, rock crevices, hollow logs, tree hollows, rabbit and small wombat burrows (Belcher 2000a).

The Spot-tailed Quoll has a relatively short life-span for an animal of its size, with a maximum of 5-6 years observed in captivity (Belcher 2000a), and perhaps only 4-5 years in the wild. Maximum weight is attained at about three years of age (Belcher 2000a). Mating occurs during winter, with an average litter size of five, born after a gestation period of about three weeks (Settle 1978). The young become independent at weaning, at about 18 weeks of age, and mature at the age of one year (Fleay 1940; Edgar and Belcher 1995). In captivity, female Quolls will breed at one year of age, and most females breed every year (Brad Walker, Featherdale Wildlife Park pers. comm.). In the wild, female Spot-tailed Quolls generally do not breed until two years of age, and a proportion of females breed only every second year, while the number of young weaned may be lower than the number born (Belcher 1997, 1998), so reproductive output may be linked to available resources.

Spot-tailed Quoll scats have a strong and distinctive odour, and are deposited as isolated single scats, or in communal defecation sites, called 'latrines', often in exposed areas like rock ledges. It is believed that these latrine sites are an important means of communication, indicating territory and perhaps reproductive status (Kruuk and Jarman 1995).

No population or density estimates are available for Spot-tailed Quolls in Victoria. In Tasmania, Spot-tailed Quoll density ranged from an estimated 1 per 300 ha to 1 per 1700 ha, with an average of 1 per 400 ha, and the total population was estimated at about 3600 animals in 1.25 million ha of habitat (Jones and Rose 1996). This figure, although preliminary, illustrates two points: 1) the relatively low density at which Spot-tailed Quolls exist; and 2) the large areas required for Spot-tailed Quoll conservation.

Although the Spot-tailed Quoll is rarely seen, in some circumstances individuals can be readily trapped, if traps are placed near rocky outcrops, latrines, saddles and in heavily utilised habitat during the breeding season (Chris Belcher pers. comm., Andrew Murray, DSE, pers. comm., Jenny Nelson DSE pers. comm.). Individual Quolls can also become habituated to the presence of humans, such as around camping sites and rubbish dumps, and may be readily visible in these circumstances (Jones and Rose 1996). However, in some targeted surveys in Victoria in areas known to be inhabited by Spot-tailed Quolls, only very low detection rates were achieved (Belcher 2000a), including only three detections in over 4000 trap nights at several sites in the Otway Ranges (Belcher 2000a).

Conservation status

The Spot-tailed Quoll is considered Endangered in Victoria (NRE 2003) and is listed as Threatened under the **Flora and Fauna Guarantee Act 1988** (FFG Act).

The south-eastern subspecies (*D. m. maculatus*) is listed as 'Vulnerable' nationally under the **Environment Protection and Biodiversity Conservation Act 1999** while the northern subspecies (*D. m. gracilis*) is listed as 'Endangered'.

Decline and threats

Spot-tailed Quolls were probably always a rare species in Victoria (Mansergh 1984). Since European settlement however, there has been a decline of the species from about 50% of its former range in Victoria, suspected to be due to clearing and fragmentation of habitat, direct or indirect persecution including poisoning and trapping, competition from introduced predators, inappropriate fire regimes and disease (Mansergh

1984, 1995; Mansergh and Belcher 1992; Maxwell *et al.* 1996).

Despite this decline, the Spot-tailed Quoll still remains widely distributed across Victoria. Since 1999, the species has been recorded from south-western Victoria, the Otway Ranges, South Gippsland (the Strzelecki Ranges), north-eastern Victoria and East Gippsland (AVW, DSE). However, the current status of remaining Quoll populations appears to vary substantially throughout Victoria, and Quolls are thought to be still declining in at least part of their current range. In south-western Victoria for instance, there has been a substantial decline in reporting rates in the last 30 years (Belcher 2000c), and extremely low detection rates from targeted surveys in the Otway Ranges, once considered a stronghold for the species (Belcher 2000b). It is not known if any Quolls survive in north-western Victoria or the Macedon Ranges. In contrast, Quolls are still regularly reported in East Gippsland, with 2-11 records per year between 1990-2000 (AVW, DSE), and this region now appears to be the stronghold of the species in Victoria.

Conservation status of the Spot-tailed Quoll varies across its distribution in mainland eastern Australia. It is considered Vulnerable in south-eastern Queensland (DNR 1998), where its range has contracted by at least 30%. It is considered uncommon to rare in south-eastern New South Wales (Edgar and Belcher 1996; Maxwell *et al.* 1996), although 21 Quolls were captured on a total of 100 occasions over 608 trap nights during a survey within the Byadbo Wilderness area of Kosciuszko National Park (Andrew Murray, DSE, pers. comm.). It is still locally common in parts of north-eastern New South Wales; for instance, Körtner and Gresser (2002) captured 78 Quolls at two locations near Armidale between June 2000 and December 2001. The species is extinct in South Australia (Maxwell *et al.* 1996). In Tasmania, it is still widespread but occurs at low densities (Jones and Rose 1996). Changes in population size there since European settlement are not known, although Quoll numbers were reported to have increased after an apparent large decline in the early 1900s, attributed to epidemic disease (Edgar and Belcher 1995). About 50% of the Quoll's core distribution in Tasmania has been cleared for agriculture, and areas of its remaining habitat are subject to timber harvesting. It has become extinct on both King Island and Flinders Island since European settlement (Jones and Rose 1996).

The Spot-tailed Quoll is thought to be facing a range of threats, including primary and secondary poisoning from pest animal baiting programs, competition and predation from introduced predators, and timber harvesting (Mansergh and Belcher 1992; Edgar and Belcher 1995; Jones and

Rose 1996; Maxwell *et al.* 1996; Belcher 1998, 2000a, b). Spot-tailed Quoll populations may also be still experiencing the long-term effects of previous habitat fragmentation and clearing for agriculture and plantations. At least some populations of Spot-tailed Quoll are likely to be so small and isolated that they may be facing general extinction processes affecting all small populations, such as the effects of stochastic events (eg. fire, drought, fluctuating prey abundance, disease) and inbreeding depression, greatly increasing their vulnerability to local extinction.

However, while a range of factors is suspected to contribute to the ongoing decline of some Quoll populations, there is very little direct evidence of current threats, with the evidence for most threats being circumstantial, indirect or anecdotal. What does seem apparent is that Quolls can survive in relatively high numbers in some areas (eg. parts of NSW, Tasmania) where sufficient habitat remains and foxes are in very low numbers or absent, despite these areas having a history of disturbance such as logging and pest animal baiting programs. In other areas however, (eg. south-eastern Queensland and much of Victoria except for East Gippsland), Quoll populations have apparently declined substantially and may still be declining.

In its final recommendation on the nomination of the Spot-tailed Quoll for Listing under the FFG Act as Threatened, the Scientific Advisory Committee (SAC 1991) determined that the Spot-tailed Quoll is:

- in a demonstrable state of decline which is likely to result in extinction;
- significantly prone to future threats which are likely to result in extinction, and
- is very rare in terms of abundance or distribution

In addition to the Spot-tailed Quoll, there are another three species of quolls occurring in Australia - Western Quoll *Dasyurus geoffroii*, Eastern Quoll *Dasyurus viverrinus* and Northern Quoll *Dasyurus hallucatus*. All four quoll species have declined substantially in range and abundance since European settlement. The Western Quoll was once the most widespread species, occurring across 70% of Australia, in all mainland States and the Northern Territory, but has disappeared from about 90% of its former range and is now confined to a small area in Western Australia (Serena and Soderquist 1995; Maxwell *et al.* 1996). The Eastern Quoll is extinct on mainland Australia but is still reasonably common in Tasmania (Godsell 1995; Maxwell *et al.* 1996). The Northern Quoll has declined in or disappeared from at least 50% of its former range in northern Australia (Braithwaite and Begg 1995;

Maxwell *et al.* 1996). Both the Eastern and Western Quolls formerly occurred in Victoria but are now extinct there.

Habitat Clearing, Fragmentation and Disturbance

Historically, substantial areas of probable Quoll habitat have been cleared, contributing to the species' decline in Victoria (Mansergh 1984). In recent decades, Spot-tailed Quolls apparently deserted sites that were cleared for plantations in the Otway Ranges (Belcher 2000a). Some areas of public land where Quolls still occur (eg. in the Strzelecki Ranges and south-western Victoria) are now effectively isolated, a legacy of historical clearing and fragmentation of habitat. Permanent loss of forested habitat is now substantially reduced, and is likely to be an issue mostly on private land, where potentially suitable habitat may still exist in some regions, such as south-western and eastern Victoria, especially where this is adjacent to forested public land.

There are some community perceptions (eg. 'The Standard' January 2001, Environment Victoria 2001) that habitat fragmentation and disturbance through timber harvesting in State forests is a major threat to Quolls, but the evidence for this is not clear. Spot-tailed Quolls appear to prefer mature forest, unlogged forest or forest that is less disturbed from timber harvesting than intensively harvested forest (Belcher 2000a). In selectively logged forest (40-60% canopy cover retained after logging) in south-eastern NSW, Spot-tailed Quolls avoided forest that had been recently logged, but used logged forest that had grown sufficiently to provide ground cover and a dense overstorey, particularly those areas with many logs left lying on the ground after logging, providing abundant den sites (Belcher 2000a). The impact of logging seems to be related to the intensity of logging, the amount of unlogged forest remaining, and the amount of logs left on the ground (Belcher 2000a).

In considering any impact of logging on Spot-tailed Quolls, the amount of protected and retained habitat across the landscape is important. Substantial areas of potentially suitable habitat throughout its range in Victoria are already protected, both in the parks and reserves system and in areas of State forest unavailable to logging. Across virtually all of the Quoll's current range in Victoria, the area of public land totals about 4.9 million ha, essentially all with native vegetation cover. Of this area, 2.1 million ha is in parks and reserves, 1.2 million ha is protected through exclusions from timber harvesting (SPZ, Code of Forest Practices exclusions) and a further 0.6 million ha is considered unproductive forest, totalling 3.9 million ha of protected habitat within the total area. Of the area available for timber harvesting, less than 1 million ha is suitable. In

East Gippsland, of the 1.1 million ha of public land, approximately 440 000 ha (40%) is in parks and reserves, 231 000 ha (21%) is protected through exclusions and 110 000 ha (10%) is considered unproductive for timber harvesting, totalling about 781 000 ha of protected habitat (71% of East Gippsland) (NRE 1995). If Quolls were threatened by timber harvesting alone, then the species should be secure and common in the substantial area of protected habitat established throughout its range, especially considering the broad habitat range the species utilises. That Quolls are apparently not secure even in the large areas of protected habitat suggests that factors other than timber harvesting are threatening Quolls. This is also supported by the status of Quolls in Tasmania, where they are still considered relatively common, despite a similar level of long-term loss of habitat (about 50%) and timber harvesting occurring in part of their remaining range (Jones and Rose 1996).

Timber harvesting and forest management activities may also increase accessibility of the forest by foxes. Extensive disturbance in logged forest in south-eastern NSW appeared to play some part in the distribution and abundance of foxes and the demise of medium-sized ground-dwelling mammals there (Catling and Burt 1995; Catling *et al.* 1998), while foxes were absent or far less abundant in less disturbed forest in north-eastern NSW (Catling *et al.* 2000), where Quolls are still locally common in some forests (Maxwell *et al.* 1996; Körtner and Gresser 2002). Similarly, Quolls are still considered relatively common in Tasmania, which was, until recently, free of foxes.

Poison Baiting Programs

Sodium monofluoroacetate (compound 1080) is toxic to mammals and is used widely in Australia to control a variety of pest mammals including rabbits, wild dogs, dingos, foxes, feral pigs, possums, wallabies and kangaroos. It is highly toxic to dogs and foxes but is relatively less toxic to native marsupial carnivores including the Spot-tailed Quoll (McIlroy 1981).

There is considerable debate on the risk to and impact on Quolls from 1080 baiting programs for pest animal control, and the issue has received substantial attention (eg. McIlroy 1981, 1992, 1999; Belcher 1994, 1998, 2000a; Murray 1998, 1999, undated; Fisher 2000; Murray *et al.* 2000; Körtner and Gresser 2002). Some authors believe that certain 1080 baiting practices pose a severe risk to Quolls in some circumstances (eg. Belcher 1994, 1998; Murray *et al.* 2000), while others (eg. McIlroy 1999; Fisher 2000) indicate the risk is less severe, especially if guidelines to minimise the chances of Quolls taking baits are implemented.

The risk to Quolls from poison baiting programs depends upon several factors, including the accessibility and palatability of baits to Quolls, the intensity of the baiting program, the placement of baits, the amount of 1080 ingested and the size of the Quoll. How these factors relate to each other and the threat they pose to Quolls in the wild are poorly understood. The higher tolerance of Spot-tailed Quolls to 1080 is offset by the smaller body size relative to dogs and foxes (McIlroy 1981). A dose of 3-4.5 mg of 1080 (the amounts used in fox and dog baits in Victoria, respectively) ingested from a single bait is potentially lethal to juvenile, many female and some male Quolls (Belcher 1998; Murray 1998). A large male animal consuming two baits (and ingesting 6-9 mg of 1080) within a short period is also potentially at risk. Spot-tailed Quolls will consume a variety of meat baits prepared for pest animal control, taking baits on the surface, and excavating and consuming baits buried to at least 8 cm depth, but are less likely to excavate baits buried 10 cm or deeper (Murray 1998; Belcher 2000a). In Victoria, poison baits are legally required to be buried to a minimum depth of 8 cm, with a recommended depth of 8 - 10 cm.

There is some anecdotal evidence of the loss of Spot-tailed Quolls coinciding with aerial baiting, hand and mound baiting for wild dogs in New South Wales, and buried baiting for foxes and baiting for rabbits in eastern Victoria (Belcher 2000a). However, in some parts of NSW, Spot-tailed Quoll populations have apparently persisted in areas subjected to aerial and ground baiting for many years. Direct evidence of poisoning is generally not available, although one male Quoll in NSW may have been killed by consuming a poison bait set for wild dogs (Belcher 2000a). Baits for wild dogs in NSW contain 6 mg of 1080 (Belcher 2000a), a higher dose rate than that used in Victoria. Male Quolls may be more likely to come into contact with poisoned baits than female Quolls, because of the much larger areas over which males roam, especially during the breeding season. The sublethal effects of 1080 on native marsupials are not known, but may include impaired cell function or organ damage (McIlroy 1981). Belcher (2000a) also considered Spot-tailed Quolls to be susceptible to secondary poisoning from consuming poisoned rabbits killed using 1080 in rabbit control programs, although Fisher (2000) estimated a comparatively reduced risk of secondary poisoning.

In a landmark study, Körtner and Gresser (2002) examined the impact of baiting with commercially-prepared toxic Foxoff® baits (containing 3 mg of 1080) on Spot-tailed Quolls at two sites in north-eastern New South Wales. A total of 56 Quolls were captured, fitted with mortality radio-transmitters and released, then toxic Foxoff® baits

were laid at about 400 metre intervals through the area where the Quolls were originally trapped. The baits were made readily accessible to Quolls by covering with only a light cover of soil (to avoid removal of baits by birds), and were not buried to the recommended 8-10 cm depth. While Quolls detected and removed baits from bait stations on at least 37 separate occasions, all except one bait were subsequently rejected and not ingested by the animals. Importantly, although there were 15 recorded mortalities amongst their study population of Quolls (from apparent starvation, predation, competition etc), there was not a single record of death due to poisoning by 1080, despite Quolls clearly being able to detect and remove the poison baits. The conclusion by Körtner and Gresser (2002) was that, in their experiments ‘...fox baiting clearly did not threaten...quoll populations...’, primarily because ‘...quolls find toxic Foxoff® baits unpalatable...’.

Several points do seem clear from the information on the risk to Quolls from pest animal baiting programs:

- Baiting for foxes using commercially-prepared toxic Foxoff® baits appears to pose a negligible threat to Quolls, especially if buried to the required or recommended depth.
- Individual Quolls may potentially be at risk from dog baiting programs, and there may be some local population effects, especially in small, isolated populations (but this still needs to be verified).
- Management prescriptions are in place to reduce the risk of baiting to Quolls while maintaining the original aim of the program to reduce pest animals.
- 1080 is an indispensable tool in the conservation of many threatened wildlife species through the control of pest animals (eg. Robley and Fairbridge 2001), and control of fox numbers may be important for Quoll conservation (see next section).

Predation and Competition

Predation and competition from introduced predators, particularly the Red Fox *Canis vulpes*, are suspected to be major current threats to Quolls (Edgar and Belcher 1996; Maxwell *et al.* 1996), although again there is little direct evidence to support this. The diets of foxes, feral cats and wild dogs were found to overlap with Spot-tailed Quolls, indicating the potential for competition for food resources (Belcher 1994, 1995). The Spot-tailed Quoll also falls within the ‘Critical Weight Range’ (CWR) of mammals known to be severely affected by fox predation (Burbidge and McKenzie 1989). Foxes are implicated in the decline of at least eight such CWR species of threatened fauna

in Victoria (Mansergh and Marks 1993). There is indirect evidence from Tasmania that fox predation may be an important factor in Quoll conservation. There, the species is still considered relatively common, despite substantial clearing of habitat and timber harvesting occurring in part of their current range, but foxes were, until recently, absent. The picture is less clear in north-eastern NSW, where Quolls are still locally common in some places (Maxwell *et al.* 1996; Körtner and Gresser 2002). Foxes are generally considered absent or in low numbers in the region (Catling and Burt 1995), although Körtner and Gresser (2002) found foxes to be ‘reasonably common’ at one of their Quoll study sites. Despite this, during the 18 months of the study by Körtner and Gresser, only two animals out of 15 that died over that time were probably killed by foxes (other causes of mortality were probably dog-1, intra-specific aggression from other Quolls-2, roadkill-1, starvation-5, trapping-related hypothermia caused by advanced debilitation-2 and unknown causes-2: Körtner and Gresser 2002). This appears to be the first study that provides some insight into the relative importance of different causes of mortality in Quolls.

In Western Australia, fox control across large areas of the landscape (rather than small specific locations) has resulted in substantial increases in the populations of several species of CWR mammals including Western Quoll (Morris 1992; CALM 2002).

Summary of Threats

In summary, despite many reports and studies, there is still conflicting opinion and little clear unequivocal evidence of current threats to Quolls. It is possible that Quolls may be facing a combination of threats, and different threats may be operating in different areas of the State. Therefore, identification and control of threats remains a priority to address in Quoll conservation in Victoria.

Existing conservation measures

A number of initiatives for Spot-tailed Quoll conservation have been instigated. These include:

- DSE has commissioned and supported research on the Spot-tailed Quoll in Victoria and New South Wales, and a number of reports on its conservation and management have been produced (see References).
- Habitat around post-1980 records of Spot-tailed Quolls in State forest is protected where existing reserves are not adequate. In East Gippsland and Midlands Forest Management Areas and the Central Highlands Regional Forest Agreement (RFA) region, the species is

protected by establishing a 500 ha Special Protection Zone (SPZ). In the North East, Gippsland and West Victoria RFA regions, protection measures comprise a 500 ha SPZ and an adjacent Special Management Zone (SMZ). Within the SMZ (which is approximately 1000 ha) an additional 500 ha is maintained as suitable habitat for Quolls, so that approximately 1000 ha of suitable habitat is protected for each record. Under these prescriptions, 45 records have resulted in a total of an additional 33 100 ha of habitat being protected in SPZ and 9 825 ha in SMZ in State forests in Victoria.

- Spot-tailed Quoll habitat around records on private land in East Gippsland has also been protected through overlays in the local planning scheme.
- Surveys for Spot-tailed Quolls in the Otway Ranges, south-western Victoria and north-eastern Victoria have been undertaken or are underway.
- A “Southeast Forests Spotted-tailed Quoll Working Group”, comprising representatives from forest and wildlife agencies in New South Wales, Australian Capital Territory and Victoria, has been formed to coordinate conservation activities for the species in south-eastern Australia (East Gippsland, south-eastern NSW and the Australian Capital Territory).
- The community-based Threatened Species Network (Victoria) has had a major focus on the Spot-tailed Quoll, running information and training days, and organising and supporting community group surveys for the species in the Otway Ranges, Macedon Ranges, central Gippsland and south-western Victoria.
- A national threat assessment was undertaken and a conservation program prepared in the Action Plan for Australian Marsupials and Monotremes (Maxwell *et al.* 1996).
- DSE has established a strategic fox control research initiative that includes ‘Project Deliverance’ (Murray 1999), an experimental fox control program in East Gippsland designed to determine the response of CWR native mammals to fox control.

Despite these and other conservation measures being initiated, their effectiveness in achieving Spot-tailed Quoll conservation in Victoria is not known. It seems likely that, in some parts of Victoria, isolated Quoll populations may be critically small and perhaps facing local extinction.

Conservation objectives

The difficulties in searching for and monitoring Quolls, predicting within the landscape where Quolls are likely to occur, and the uncertainty over

current threats to Quolls pose considerable hurdles in preparing and implementing a successful conservation program. Nonetheless, with the occurrence of Quolls confined largely to public land, the suspected major threats are largely within the ambit and responsibility of DSE to control and manage. It is within this framework that a conservation program for the Spot-tailed Quoll needs to be developed.

There are three key issues to address in the short-term for conservation of the Spot-tailed Quoll:

- Developing a reliable detection and survey methodology for Spot-tailed Quolls.
- Applying this to Victoria to determine habitat use by Spot-tailed Quolls.
- Determining and controlling threats to Spot-tailed Quolls.

Long-term Objective

To ensure a viable population of Spot-tailed Quolls survives and flourishes in Victoria.

Objectives of this Action Statement

- To develop a reliable standardised method for detecting Spot-tailed Quolls.
- To investigate habitat use by Spot-tailed Quolls, and develop a predictive habitat model to ensure sufficient habitat is protected in Victoria to ensure that a viable population of Quolls can survive.
- To investigate the threats to Quolls, and develop and implement threat control procedures to ensure that a viable population of Quolls can survive.

Intended management actions

The intended management actions listed below are further elaborated in DSE’s Priority Actions Information System. Detailed information about the actions and locations, including priorities, is held in this system and will be provided annually to land managers and other authorities.

Survey

1. Develop a detection model to assess the presence of, and habitat use by, Spot-tailed Quolls. The model will be based on determining the probability of detection of a Quoll within an animal’s home range, and developing a sampling and analytical framework to assess Quoll habitat. The project will initially be based on a known population of Quolls in south-eastern New South Wales. Once the model is developed, it will be applied in Victoria to implement Actions 2.1 and 3.1.

2. Undertake surveys for Spot-tailed Quolls in north-eastern Victoria as part of the North East Forest Management Plan (NRE 2001).
3. Investigate any Quoll sightings in areas with few recent records eg. south-western Victoria, south Gippsland, central Victoria.
4. Encourage the reporting of all Spot-tailed Quoll records by DSE and Parks Victoria staff and the public, properly document and verify each record, and include these in the DSE Atlas of Victorian Wildlife. Where required, these records will initiate any habitat protection/land management processes triggered by the presence of Spot-tailed Quolls (see Action 3.1).
5. Continue to collect biological and ecological data on Spot-tailed Quoll as opportunities arise, to help compile information on the species for more effective conservation management.
6. Investigate the feasibility of conducting extensive surveys for Spot-tailed Quolls in Victoria, especially in areas of potential habitat currently with few records.
7. Assess the impact of the fires of early 2003 on Spot-tailed Quoll habitat in key areas such as the Mt Stradbroke-Suggan Buggan area and Tingaringy National Park.

Habitat Use and Modelling

8. Investigate habitat use by Quolls across a range of land tenure types, to develop a predictive habitat model for Quolls and to determine the contribution of protected areas for Quoll conservation. These protected areas include parks and reserves, and Special Protection Zones and Special Management Zones in State forest established for Quoll conservation. This work is likely to be conducted at several sites in East Gippsland and the Otway Ranges and is dependent upon the successful development of a detection model for Quolls (Action 1.1).

Predation and Competition

9. Determine the impact of broad-scale fox control initiatives (including 'Project Deliverance': Murray 1999; Robley and Fairbridge 2001) and the Adaptive Experimental Management project with Parks Victoria (Choquet and Robley 2001) on Quoll populations at experimental sites. This action relies on the successful completion and subsequent application of the Quoll detection model (Action 1.1), and will assist in determining the impact of fox predation and/or competition on Quolls.

10. Dependent on the outcomes of Action 9, develop plans to apply fox control prescriptions across broader areas of Quoll habitat, especially where small or isolated Quoll populations exist.

Poison Baiting

11. Ensure all pest animal control activities in areas of known Quoll populations comply with current best practice prescriptions to minimise the risks of baiting programs to Quolls. This will include holding information sessions and training days for DSE/DPI staff and others involved in wild dog and fox control (Action 7.3).
12. Investigate the use of Pindone rabbit poison as an alternative to 1080 for rabbit control in areas with isolated or small Quoll populations that may be at risk from secondary poisoning from consuming poisoned rabbits.

Habitat Protection

13. Implement a standard habitat protection prescription of a 500 ha Special Protection Zone (SPZ) and a 1000 ha Special Management Zone (SMZ) for all confirmed Quoll records in State forest throughout Victoria, up to targets specified in individual FMPs. The location of the SPZ and SMZ will be based on protecting preferred habitat features for Quolls. The SPZ will include known den and latrine sites (protected by at least a 200 m radius), and may include other detection sites, based on habitat quality and the proximity of existing protected habitat. Detection sites not included in the SPZ will generally be included within the SMZ, unless there are compelling reasons for excluding them (eg. a record in a clearly unsuitable location for habitat protection, proximity of existing protected habitat etc). Site protection for Quolls will be prioritised according to habitat quality, current reservation status of the site, linkage to other reserves and the presence of complementary values. Records within 2 km of each other will be generally regarded as the same animal unless proved otherwise. In East Gippsland (the area covered by the FMP), there will be a target of 75 Quoll sites in protected habitat (ie. parks, reserves and State forest SPZ/SMZ). Currently, there are 71 sites of Quoll records protected in East Gippsland, including 21 in State forest (note that this prescription exceeds the target of 50 protected records specified in the East Gippsland FMP). In the North East FMP and Gippsland FMP, there are targets of 10 records in State forest triggering habitat protection.

14. Periodically review the selection of Quoll records to be afforded protection by the standard prescription outlined in 5.1 in each FMP to which targets apply, to ensure that, once targets are reached and as new records accrue or other information becomes available, the network of protected habitat in each FMA is optimal for Quoll conservation. To assist this review, develop guidelines for the substitution of protected Quoll sites based on the extent and quality of habitat and on the currency, reliability and type of record.
15. Develop Quoll habitat management guidelines for Special Management Zones, using available information on Quoll and prey habitat preferences and use.
16. Facilitate the protection of potential Spot-tailed Quoll habitat and sites with or near Quoll records on private land, within existing mechanisms for protection of native vegetation (eg. zoning under local government planning schemes, development of Regional Management Plans by Catchment Management Authorities, Bioregional Plans, regional vegetation plans, voluntary conservation agreements - eg Land for Wildlife, Conservation Covenants). State Government policy restricting the clearing of native vegetation has been in operation for some time, and the shift to a 'Net Gain' of native vegetation for Victoria (NRE 1997) is a useful tool for protecting remaining potential habitat on private land.
20. Ensure the provision of regular information updates on Quoll conservation to appropriate DSE/DPI staff, land managers and others with an interest in Quoll conservation (including Biodiversity & Natural Resources Division, Parks and Forests Division, Catchment and Water, Parks Victoria, Forestry Victoria, Catchment Management Authorities, Threatened Species Network). Hold information and training sessions, including Quoll detection methods, habitat identification and protection, Quoll ecology and preferred baiting techniques in and around known Quoll populations.
21. Provide information on Spot-tailed Quoll conservation, threat control, suitable pest animal baiting techniques and habitat management to landowners with potential Spot-tailed Quoll habitat.
22. Contribute to regional and national conservation initiatives for the Spot-tailed Quoll as required.

Community Participation

17. Where practical, include community involvement with Quoll conservation efforts, such as in surveys using hair tubes, and community fox control efforts on private land near Quoll populations and/or with Quoll habitat. These activities could continue to be coordinated through the Threatened Species Network (Victoria).

Project Management

18. Establish a Spot-tailed Quoll recovery program, managed by DSE, to initiate and coordinate actions under this Action Statement, including appointment of a project manager to be responsible for the program.
19. Maintain involvement with the 'Southeast Forests Spotted-tailed Quoll Working Group' to ensure continued information exchange and co-ordination of conservation initiatives for Quolls in south-eastern Australia, such as cross-border predator control programs and Quoll surveys.

References

- ANZECC 2000. List of Threatened Australian Fauna. Australian and New Zealand Environment and Conservation Council, Canberra.
- Belcher, C.L. 1994. Studies on the diet of the Tiger Quoll (*Dasyurus maculatus*). MSc Thesis, La Trobe University.
- Belcher, C.L. 1995. Diet of the Tiger Quoll (*Dasyurus maculatus*) in East Gippsland, Victoria. *Wildlife Research* 22: 341-57.
- Belcher, C.L. 1997. Targeted Assessments of Key Threatened Vertebrate Fauna in Relation to the North East and Benalla-Mansfield Forest Management Areas, Victoria: Spot-tailed (or Tiger) Quoll (*Dasyurus maculatus*). ECOsystems Environmental Consultants, Timboon: Report to NRE.
- Belcher, C.L. 1998. Susceptibility of the Tiger Quoll (*Dasyurus maculatus*) and the Eastern Quoll (*Dasyurus viverrinus*) to 1080-poisoned baits in control programs for vertebrate pests in eastern Australia. *Wildlife Research* 25: 33-40.
- Belcher, C.L. 2000a. The Ecology of the Tiger Quoll, *Dasyurus maculatus* in south-eastern Australia. PhD Thesis, Deakin University.
- Belcher, C. 2000b. The Range, Status and Distribution of the Spot-tailed Quoll (*Dasyurus maculatus*) in the Otway Ranges. ECOsystems Environmental Consultants, Timboon: Report to NRE.
- Belcher, C. 2000c. Spot-tailed Quoll Survey of Mount Eccles National Park. ECOsystems Environmental Consultants, Timboon: Report to Parks Victoria.
- Braithwaite, R.W. and Begg, R.J. 1995. Northern Quoll *Dasyurus hallucatus*. Pp 65-6 in: Strahan,

- R. (ed). *The Mammals of Australia*. Australian Museum and Reed Books, Sydney.
- Burbidge, A.A. and McKenzie, N.L. 1989. Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications. *Biological Conservation* **50**: 143-98.
- CALM 2002. 'Western Shield'. Department of Conservation and Land Management (Western Australia) website www.calm.wa.gov.au
- Catling, P.C. and Burt, R.J. 1995. Why are foxes absent from some eucalypt forests in eastern New South Wales? *Wildlife Research* **22**: 535-46.
- Catling, P.C., Burt, R.J. and Forrester, R.I. 1998. Models of the relationship between distribution and abundance of ground-dwelling mammals in the forests of south-eastern New South Wales and habitat and environmental variables. *Wildlife Research* **25**: 449-66.
- Catling, P.C., Burt, R.J. and Forrester, R.I. 2000. Models of the distribution and abundance of ground-dwelling mammals in the eucalypt forests of north-eastern New South Wales in relation to habitat variables. *Wildlife Research* **27**: 639-54.
- Choquenot, D., and Robley, A. 2001. Proceedings of a workshop on Adaptive Experimental Management of Fox Control for Parks Victoria: Optimising fox control through adaptive experimental management. Held on 13 July 2001 Brimbank Park, Melbourne. Unpublished report. Arthur Rylah Research Institute, Department of Natural Resources and Environment, Melbourne.
- DNR 1998. *Dasyurus maculatus maculatus* Spotted-tailed Quoll Information Sheet. Department of Natural Resources, Queensland.
- Edgar, R.J. and Belcher, C. 1995. Spotted-tailed Quoll *Dasyurus maculatus*. Pp 67-9 in: Strahan, R. (ed). *The Mammals of Australia*. Australian Museum and Reed Books, Sydney.
- Environment Victoria 2001. 'Keeping a Public Eye on NRE'. EV website www.envict.org.au
- Firestone, K.B., Elphinstone, M.S., Sherwin, W.B. and Houlden, B.A. 1999. Phylogeographical population structure of tiger quolls *Dasyurus maculatus* (Dasyuridae: Marsupialia), an endangered carnivorous marsupial. *Molecular Ecology* **8**(10): 1613-25.
- Fisher, P. 2000. Factors affecting the risk of poisoning to Spotted Tailed Quoll (*Dasyurus maculatus*) from 1080 baits laid for pest animal control. Department of Natural Resources and Environment, Victoria: Internal report.
- Fleay, D. 1940. Breeding of the Tiger Cat. *Victorian Naturalist* **56**: 158-63.
- Fleay, D. 1948. Australia's marsupial Tiger Cat: a creature of increasing rarity and extreme pugnacity. *Wildlife* **10**: 459-64.
- Godsell, J. 1995. Eastern Quoll *Dasyurus viverrinus*. Pp 70-71 in: Strahan, R. (ed). *The Mammals of Australia*. Australian Museum and Reed Books, Sydney.
- Jones, F.W. 1923. *The Mammals of South Australia*. Government Printer, Adelaide.
- Jones, M.E. and Rose, R.K. 1996. Preliminary assessment of distribution and habitat associations of spotted-tailed quoll (*Dasyurus maculatus*) and eastern quoll (*D. viverrinus*) in Tasmania to determine conservation and reservation status. Parks and Wildlife Service Tasmania: Report to Tasmanian Regional Forest Agreement Environment and Heritage Technical Committee.
- Körtner, G. and Gresser, S. 2002. Impact of fox baiting on tiger quoll populations. Project ID 00016505. Final report to Environment Australia and the New South Wales National Parks and Wildlife Service. NSW National Parks and Wildlife Service, Sydney.
- Kruuk, H. and Jarman, P.J. 1995. Latrine use by the spotted-tail quoll (*Dasyurus maculatus*: Dasyuridae, Marsupialia) in its natural habitat. *Journal of Zoology* **236**: 345-9.
- Mansergh, I. 1984. The status, distribution and abundance of *Dasyurus maculatus* (Tiger Quoll) in Australia with particular reference to Victoria. *Australian Zoologist* **21**: 109-22.
- Mansergh, I.M. 1995. Spot-tailed Quoll *Dasyurus maculatus*. Pp. 51-2 in Menkhorst, P. (ed). *Mammals of Victoria*. Oxford University Press, Melbourne.
- Mansergh, I. and Belcher, C. 1992. Action Statement No. 15: Tiger Quoll *Dasyurus maculatus*. Department of Conservation and Environment, Melbourne.
- Mansergh, I. and Marks, C. 1993. Action Statement No. 44: Predation of native wildlife by the introduced Red Fox *Vulpes vulpes*. Department of Conservation and Natural Resources, Melbourne.
- Maxwell, S., Burbidge, A.A. and Morris, K.D. 1996. *The 1996 Action Plan for Australian Marsupials and Monotremes*. Wildlife Australia, Canberra.
- McIlroy, J.C. 1981. The sensitivity of Australian animals to 1080 poisoning II. Marsupial and eutherian carnivores. *Australian Wildlife Research* **8**: 385-99.
- McIlroy J.C. 1992. The effect on Australian animals of 1080 poisoning campaigns. Pp 356-9 in J. Borrecco and R. Marsh (eds) *Proceedings of the 15th Vertebrate Pest Conference*. University of California, Davis.
- McIlroy, J.C. 1999. Species Impact Statement: Aerial Baiting with 1080 Poison for wild dog control in New South Wales National Parks and Wildlife Service Reserves. Report to New South Wales National Parks and Wildlife Service.
- Morris, K. 1992. Return of the Chuditch. *Landscape* **8**: 10-15.
- Murray, A. 1998. Tigers and 1080: The Threat Posed by Buried Poison Baits to Spotted-tailed Quolls in the Australian Alps National Parks. Department of Natural Resources and Environment, Victoria: Report to Natural Heritage Working Group of the Australian Alps Liaison Committee.

- Murray, A. 1999. Overview of Recent Research into the Threat that Various Forms of Canid Control in Forested Habitats Pose to Spotted-tailed Quolls *Dasyurus maculatus*. Department of Natural Resources and Environment, Victoria: Internal report.
- Murray, A. (undated). The Risks Posed to Spotted-tailed Quolls by Current Baiting Practices on Public Land in Victoria. Department of Natural Resources and Environment, Victoria: Internal report.
- Murray, A.J., Belcher, C.A., Poore, R.N. and Darrant, J. 2000. The Ability of Spotted-tailed Quolls to Locate and Consume Meat baits Deployed During a Simulated Aerial Baiting Program. Report to the Australian Alps Liaison Committee and the New South Wales National Parks and Wildlife Service.
- NRE 1995. Forest Management Plan for East Gippsland. Department of Natural Resources and Environment, Melbourne.
- NRE 1997. *Victoria's Biodiversity: Directions in Management*. Government of Victoria, Melbourne.
- NRE 2000. *Threatened Vertebrate Fauna in Victoria 2000*. Department of Natural Resources and Environment, Melbourne.
- NRE 2001. North East Forest Management Plan. Department of Natural Resources and Environment, Melbourne.
- Robley, A. and Fairbridge, D. 2001. The Use of 1080 for Biodiversity Conservation Benefits in Victoria. Department of Natural Resources and Environment, Melbourne: Internal report.
- SAC 1991. Final Recommendation on a Nomination for Listing: *Dasyurus maculatus* Tiger Quoll. Nomination Number 146. Scientific Advisory Committee. Department of Conservation and Natural Resources, Melbourne.
- Serena, M. and Soderquist, T. 1995. Western Quoll *Dasyurus geoffroii*. Pp 62-4 in: Strahan, R. (ed). *The Mammals of Australia*. Australian Museum and Reed Books, Sydney.
- 'The Standard' Newspaper January 2001. Quolls' Otway Ranges kingdom in crisis. Newspaper report 9/1/2001.

Compiled by Gary Backhouse, Biodiversity & Natural Resources Division, Department of Sustainability and Environment.

Further information can be obtained from Department of Sustainability and Environment Customer Service Centre on 136 186.

Flora and Fauna Guarantee Action Statements are available from the Department of Sustainability and Environment website: <http://www.dse.vic.gov.au>

This Action Statement has been prepared under section 19 of the Flora and Fauna Guarantee Act 1988 under delegation from Professor Lyndsay Neilson, Secretary, Department of Sustainability and Environment, September 2003.

© The State of Victoria, Department of Sustainability and Environment, 2003

Published by the Department of Sustainability and Environment, Victoria. 8 Nicholson Street, East Melbourne, Victoria 3002 Australia

This publication may be of assistance to you but the State of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

ISSN 1448 9902