

# Camera-trap surveys of the northern Spotted-tailed Quoll (*Dasyurus maculatus gracilis*) in the Cairns to Innisfail hinterland

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## Abstract

The northern subspecies of the Spotted-tailed Quoll, *Dasyurus maculatus gracilis*, is confined to rainforests and adjacent habitats in Queensland's Wet Tropics, where it was estimated to number 540 individuals and to be in on-going decline. Using motion-sensor cameras equipped with a flash and set at chicken baits, we surveyed eight rainforest areas from which the subspecies has previously been recorded. Survey areas ranged from Barron Gorge National Park south to Mt Bartle Frere, with cameras set at elevations from 400 to 1,600 m ASL. A total of 740 camera days of effort yielded eleven images of the Spotted-tailed Quoll from four cameras in two areas – the Bellenden Ker Range and Mt Bartle Frere. From these, five individuals are identifiable on the basis of spot patterns. Given the proven record of this technique in detecting the species, our failure to detect quolls at two other high-elevation areas is cause for concern. Twenty-one other species, including the Endangered Southern Cassowary (*Casuarius casuarius johnsonii*), were also detected in camera images.

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## Introduction

All of Australia's four species of quoll (*Dasyurus* spp.) have suffered major range contractions since European settlement (Menkhorst & Knight 2001). The Spotted-tailed Quoll (*D. maculatus*; also known as the Tiger Quoll) has disappeared from the extremities of its south-east Australian range and become uncommon in much of its remaining mainland range, remaining widespread only in Tasmania. The species is listed as Endangered nationally and in Queensland, and as Near Threatened by the IUCN (Burnett 2012).

The northern subspecies of the Spotted-tailed Quoll, *D. m. gracilis*, is considerably smaller than its parent subspecies and is confined to Queensland's Wet Tropics. It is isolated from its parent subspecies by a gap of more than 1,000 km, the northernmost occurrence of the latter being

formerly near Rockhampton and currently probably the vicinity of Gympie in south-east Queensland (Burnett & Meyer-Gleaves 2012). The northern subspecies thus forms a discrete Management Unit (Firestone *et al.* 1999; Burnett & Marsh 2004) which meets IUCN criteria as Endangered because it is estimated to number only 540 individuals, has contracted from many lowland areas, and is now mostly found in fragmented populations above 600 m ASL (Burnett 2001). Its decline is attributed to habitat loss and persecution, and it may also be threatened by the toxic effects of ingesting Cane Toads (*Rhinella [Chaunus, Bufo] marina*) and accidental poisoning (Burnett 2012).

Within Queensland's Wet Tropics, the northern Spotted-tailed Quoll is now known from scattered

localities from Mt Finnegan (south of Cooktown) in the north, south to just south of Lake Koombooloomba (Burnett 2001). The subspecies also occurred near Paluma, further south, with last reported sightings there in 1945 (in Burnett 2001) and 1971 (Alan Gillanders pers. comm. to Luke Jackson). Within this general range, it occurs in rainforest and adjacent wet sclerophyll forest mostly above about 900 m ASL and much less frequently above 600 m ASL (Burnett 2001). It is a medium-sized (c. 1–2.5 kg) predator that consumes mostly small- and medium-sized mammals but also invertebrates, reptiles birds and carrion (Burnett 2001). It is one of two quoll species to occur in north Queensland, the other being the smaller Northern Quoll (*D. hallucatus*) which, in the vicinity of the Wet Tropics, occurs mainly in dry and moist sclerophyll forest surrounding the northern Spotted-tailed Quoll's range (Woinarski *et al.* 2008).

As part of recovery efforts for the northern Spotted-tailed Quoll, *Research directions* recommended by Burnett (2012) include *Gather data on the distribution and population sizes of quolls* and *Investigate the most effective quoll census techniques*. In eastern Victoria, baited camera 'traps' have proven an effective technique for detecting the species (Nelson *et al.* 2014), these authors recommending widely-spaced traps (>500 m) with effort to maximise the number of sites surveyed rather than the intensity (no. of traps) of effort at individual sites. In north Queensland, a similar method has been used with great success to detect the species in areas outside of our study area for several years (Burnett pers. comm.). In this paper, we report a survey of eight areas (Fig. 1) in, or within 500 m of the Cairns Regional Council municipal boundary using motion-sensor cameras. Spotted-tailed Quoll have been recorded in the general vicinity of these areas mostly within the last two decades (Table 1), and our aim was to verify the persistence of populations there. We also provide a list of other vertebrate faunal species detected in motion-sensor camera images during this survey.

## Methods

Eight survey areas were selected (Fig. 1, Table 1) on the basis of prior reports of Spotted-tailed Quoll in the general vicinity. The most recent prior reports vary among areas from 1993 to 2016. All

survey areas were in rainforest and at elevations from 400 to more than 1,500 m ASL, thus including the elevations of recognised core areas (mostly more than 900 m, but also 600–900 m ASL; Burnett 2001) but also lower elevations.

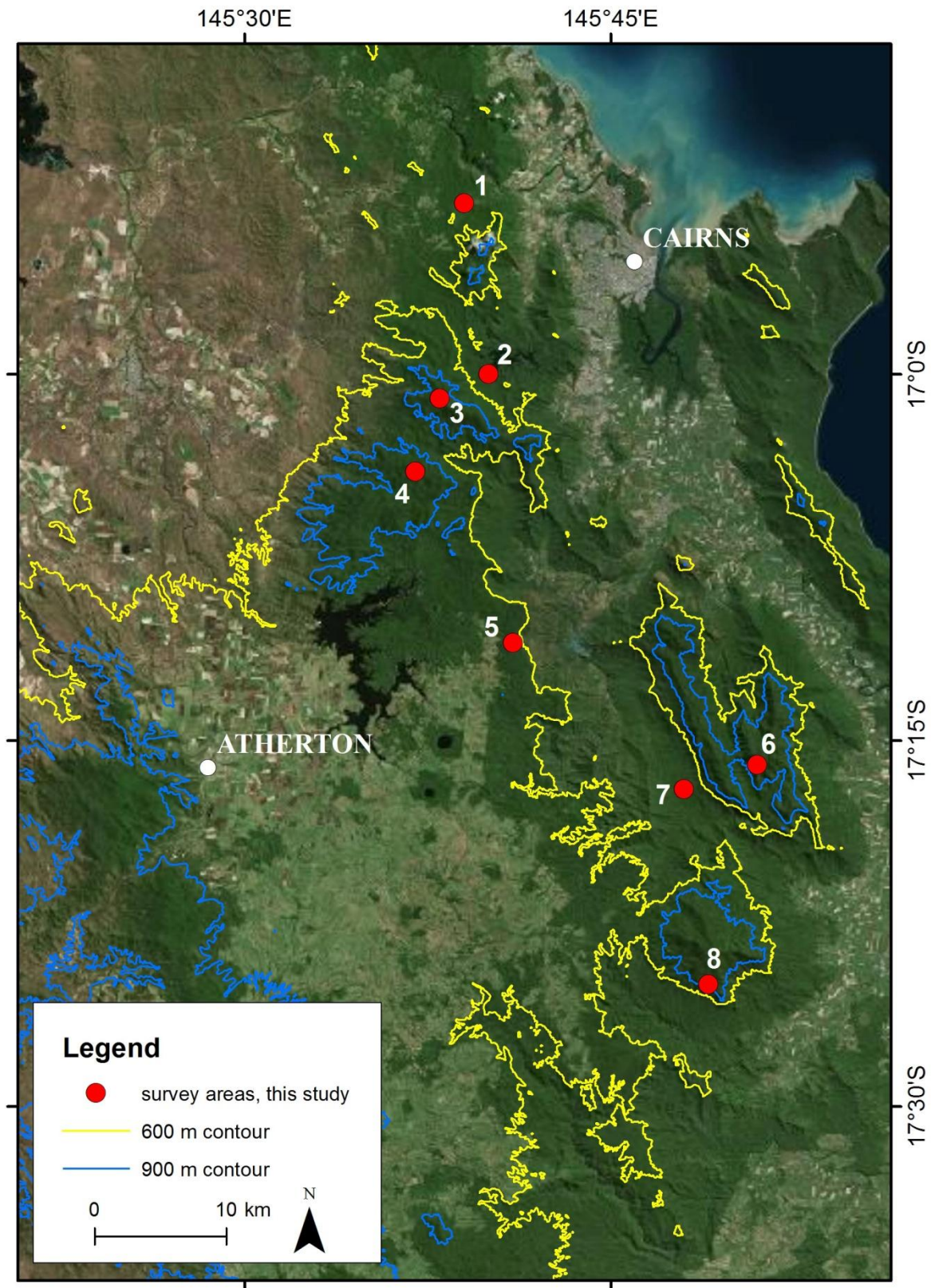
Within each survey area, camera sites were generally spaced from 500 m to 1 km apart but at times at lesser spacings of practical necessity. Camera sites were selected to have a two metre clearing and suitable trees on which to mount equipment, and to be out of view from walking tracks and roads for reasons of animal safety and security of equipment. At each camera site, a chicken carcass was placed in a lattice bag and either attached to a tree with a strap/zip tag c. 1.5 m above the ground, or tied inside a cage trap which was secured open. A motion-sensor camera equipped with flash (BestGuarder SG-990V) was set and tied to a tree (Fig. 2) generally between 0.5 and 1.5 m above the ground and level with the bait (the ground was often steeply sloping) and about 2 m from, and directed toward the bait. Cameras were deployed for 14–15 days continuously at each camera site to allow time to overcome the sensitivity of quolls to human scent. Further detail of areas, camera sites and methods is available in Jackson & Vale (2016).

Individual quolls were distinguished in photographs by their unique spot patterns, overall size and body shape, and facial features.

## Results

A maximum of ten cameras were deployed 52 times for a total of 740 camera days (Table 1). These yielded eleven images (e.g. Fig. 3) of five individual quolls from four cameras, two cameras in each of two areas, Bellenden Ker (three individuals) and Mt Bartle Frere (two individuals). These comprise a return for effort of one or more detections at 7.7% of camera sites and 1.49 quoll images per 100 camera-days.

A total of 22 wildlife species were photographed, comprising eleven mammals, nine birds, one reptile and one insect (Fig. 4; Table 2). The mammals included two non-native species, and it is of concern that feral House Cats (*Felis catus*) were detected in remote rainforest on the Mt Bartle Frere massif, though only at camera sites below 900 m ASL. There was considerable variability in detection and success between survey areas, with the number of species detected ranging



**Figure 1. Survey areas for the Spotted-tailed Quoll, north Queensland, Australia.**

Survey area nos. correspond to those in Table 1. Elevation contours are those described as relevant to the Spotted-tailed Quoll by Burnett (2001) with Spotted-tailed Quolls preferring rainforest at higher elevations (see Methods). Dark green areas are dense forest – mostly rainforest. Data sources: contours = GEODATA TOPO 250K Series 3 ([www.ga.gov.au](http://www.ga.gov.au)); imagery = ESRI/DigitalGlobe ([www.digitalglobe.com](http://www.digitalglobe.com)).

**Table 1. Field survey areas and their attributes.**

Areas are arranged from north to south, and area nos. correspond to those in Fig. 1. NP = national park. Unattributed historical records are from the files of the Australian Quoll Conservancy. STQ = Spotted-tailed Quoll.

Area descriptor	Latitude / longitude	Elevation (m ASL)	Recent records	Month of survey	No. of cameras deployed	No. of camera days	No. of STQ cameras (images)
1. Speewah (Barron Gorge NP)	16°53' S, 145°39' E	420 to 500	most recent are 1989 & 1993	March 2016	3	42	0
2. Lake Morris	17°00' S, 145°40' E	408 to 425	1993; second-hand report since 2000	Aug.-Sept. 2015	10	140	0
3. Lambs Head (Dinden NP)	17°01' S, 145°38' E	912 to 1,316	sightings 1995, 2000; scats c. 2011	Sept.-Oct. 2015	7	98	0
4. Varch Trail (Dinden NP)	17°04' S, 145°37' E	850 to 1,200	c. 1994 (Burnett 2001)	Nov.-Dec. 2015	5	70	0
5. Gillies Lookout	17°11' S, 145°41' E	450 to 700	Gillies Hwy, most recent is 2016	July 2015	3	42	0
6. Bellenden Ker	17°16' S, 145°51' E	1,520 to 1,593	photos 2016	April 2016	9	138	2(3)
7. Goldsborough Valley	17°17' S, 145°48' E	100 to 300	ranger reports, c. 2013	February 2016	9	126	0
8. Bartle Frere	17°25' S, 145°49' E	813 to 1,604	photos 2016	December 2015	6	84	2(8)

from one to eleven, the number of images obtained ranging from two to 24, and the return for effort ranging from 4.8 to 28.6 images per 100 camera-days. The Varch Trail in Dinden National Park and the Mt Bartle Frere massif in Wooroonooran National Park were the most productive areas by a considerable margin (Table 3).

**Figure 2.**  
A motion-sensor camera  
deployed in this study.  
Photo: Alberto Vale.





Figure 3. Motion-sensor camera image (cropped) of a Spotted-tailed Quoll at a chicken bait, Mt Bartle Frere, December 2015.



Figure 4. A sample of non-target species detected during this survey: A. Musky Rat-kangaroo, *Hypsiprymonodon moschatus*; B. Pig, *Sus scrofa*; C. Dingo, *Canis lupus dingo* or Dingo-Dog hybrid; and D. House Cat, *Felis catus*.

**Table 2. Camera-trap records of Spotted-tailed Quoll and non-target species during the surveys detailed in Table 1.**

\* indicates a non-native species. Numbers are: no. of cameras(no. of images); x = photographed. Names and order of species follow Menkhorst & Knight (2001) for mammals and Christidis & Boles (2008) for birds apart from Spotted-tailed Quoll (Spot-tailed Quoll in Menkhorst & Knight 2001).

Species	Speewah	Lake Morris	Lambs Head	Varch Trail	Gillies Lookout	Bellenden Ker	Golds- borough	Bartle Frere
<i>Mammals</i>								
Spotted-tailed Quoll, <i>Dasyurus maculatus (gracilis)</i>						3(3)		2(8)
<i>Antechinus</i> sp.			1(1)					
Long-nosed Bandicoot, <i>Parameles nasuta</i>		3(3)						1(1)
Bandicoot sp.					x			
Musky Rat-kangaroo, <i>Hypsiprymnodon moschatus</i>			1(1)	1(1)	x			1(1)
Red-legged Pademelon, <i>Thylogale stigmatica</i>				1(1)	x			
Giant White-tailed Rat, <i>Uromys caudamaculatus</i>		2(3)	1(1)	1(2)	x		3(3)	
Water Rat, <i>Hydromys chrysogaster</i>		1(3)				2(2)		
Bush Rat, <i>Rattus fuscipes</i>		3(3)	1(1)	3(3)				4(4)
Dingo, <i>Canis lupus dingo</i> <sup>A</sup>		1(1)					2(2)	
* House Cat, <i>Felis catus</i>								3(4)
* Pig, <i>Sus scrofa</i>		1(1)					4(4)	
<i>Birds</i>								
Southern Cassowary, <i>Casuarius casuarius</i>		1(2)						
Australian Brush-turkey, <i>Alectura lathami</i>		1(1)		3(3)		2(2)	3(3)	1(1)
Orange-footed Scrubfowl, <i>Megapodius reinwardt</i>							2(2)	
Grey Goshawk, <i>Accipiter novaehollandiae</i>				1(2)				
Noisy Pitta, <i>Pitta versicolor</i>							1(1)	1(1)
Spotted Catbird, <i>Ailuroedus melanotis</i>				1(1)				
Pied Currawong, <i>Strepera graculina</i>				2(2)		1(1)		1(1)
Grey-headed Robin, <i>Heteromyias cinereifrons</i>			1(1)	1(1)				1(1)
Bassian Thrush, <i>Zoothera lunulata</i>				1(1)				
<i>Other</i>								
Lace Monitor, <i>Varanus varius</i>	2(2)	1(1)		1(1)			1(1)	
Giant White-kneed King Cricket, <i>Penalva flavocalceata</i>								2(2)
<i>Summary data</i>								
No. of species	1	9	5	11	4	4	7	10
No. of 'captures'	2(2)	14(18)	5(5)	16(18)	n.a.	8(8)	16(16)	17(24)
No. of camera days	42	140	98	70	42	138	126	84
Camera days per image	21.0	7.8	19.6	3.9	n.a.	17.3	7.9	3.5

<sup>A</sup> or hybrid Dingo by Domestic Dog, *Canis familiaris*

## Discussion

Our survey is the first published systematic application of motion-sensor cameras for detection of northern Spotted-tailed Quolls. We have shown that the technique is capable of detecting the subspecies, as also demonstrated by Scott Burnett (pers. comm.) and by our prior unpublished surveys. Nelson *et al.* (2014) detected the southern subspecies of the Spotted-tailed Quoll at eight of 52 sites and modelled a detection rate of c. 70% after two weeks using a single camera at sites where the species is present, with camera type but not the number of cameras at a site influencing the rate. It is unclear how the subspecies might differ in detectability, nor how small differences in technique might have influenced results, and these differences may be worthy of further investigation. We used a different brand of camera (BestGuarder) to either of those (TrailMac, PixController) evaluated by Nelson *et al.* (2014).

We have verified persistence of populations in two areas – the Bellenden Ker Range and Mt Bartle Frere. These are both at elevations (>900 m ASL) identified by Burnett (2001) as recent core habitat for the species. However, we failed to detect quolls in two other high-elevation areas (Lamb's Head and Varch Trail), the latter a study site of Burnett (2001) at which the species was present in the period 1993 to 1995. Given the high level of detectability demonstrated by Nelson *et al.* (2014), this suggests that our failure to detect the species in these two areas is of concern, especially so given evidence of the small and fragmented nature of the populations of the subspecies (Burnett 2001). Further surveys are required. These may also include other techniques including searches for scats and footprints. These alternatives, however, have the limitation of being most effective along roads: "Quoll scats ... are highly visible on maintained gravel roads" and distinguishable from cats by their "ropy appearance", while footprints are detectable in dried mud or dried surface of dirt roads (Burnett 2001, pp. 53-54). They are perhaps also less easily quantifiable as detection rates than are motion-sensor camera surveys.

That we failed to detect the species at four lower-elevation sites (Speewah, Lake Morris, Gillies Lookout and Goldsborough Valley) is less surprising because it is consistent with Burnett's (2001) evidence that the species has retracted to high-

elevation sites. It is possible that most-recent previous sightings in these areas have been of males that had dispersed from higher-elevation populations, and thus not of residents at these lower elevations. Male Spotted-tailed Quolls move further than females and one telemetered male moved over 6.5 km (straight-line distance) (Burnett 2001).

It remains little more than guesswork which processes threaten the persistence of the northern Spotted-tailed Quolls in remaining suitable habitat. Practical management actions might include pest management (cats, pigs, toads) and the placement and design of roads to minimise mortality. We have received a number of reports of road-killed quolls. Given that the subspecies is endangered, these management actions require urgent implementation in an adaptive-management (learning by doing) framework (Walters & Holling 1990) in which monitoring with motion-sensor cameras is likely to play a key role.

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