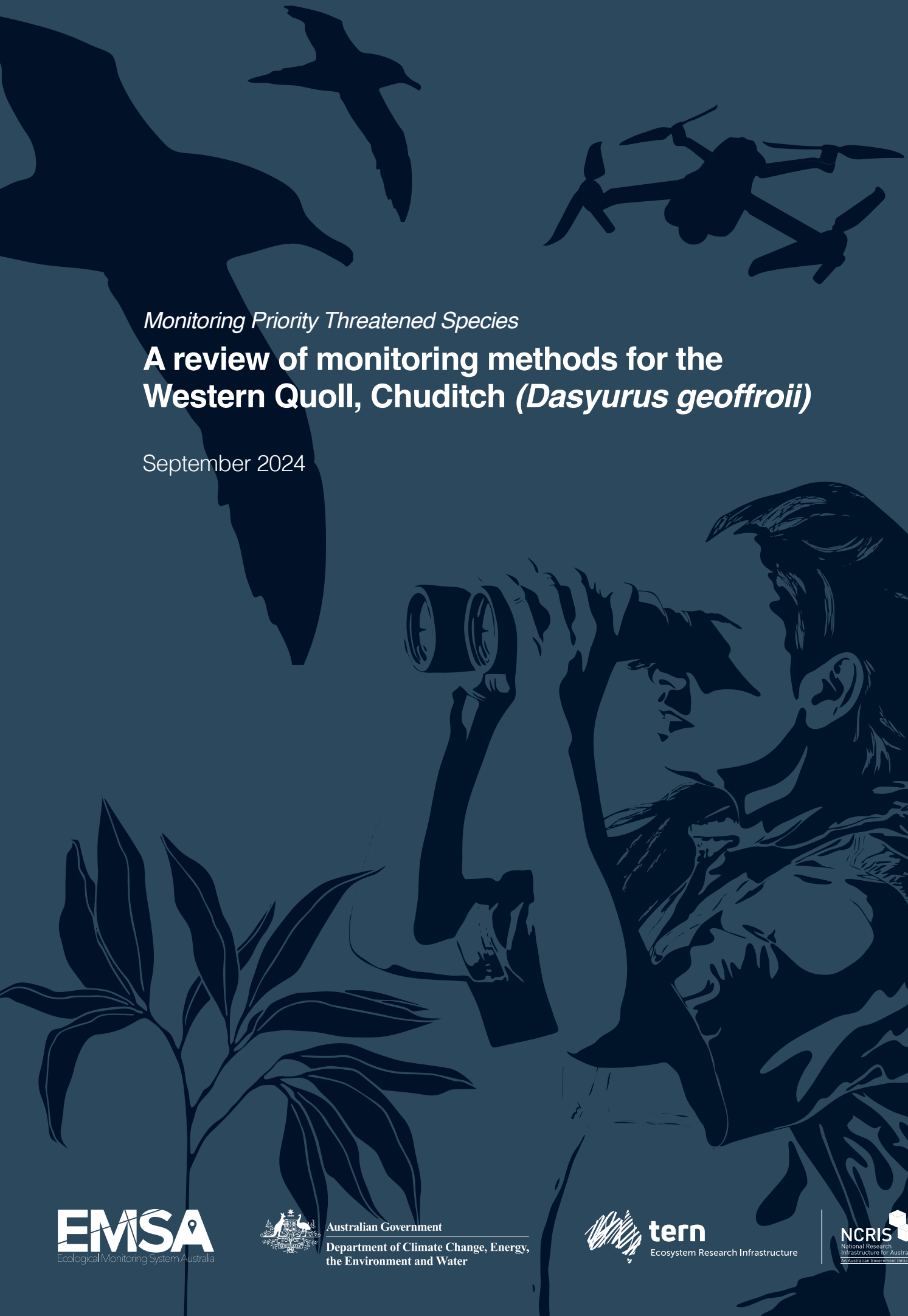

*Monitoring Priority Threatened Species*

# A review of monitoring methods for the Western Quoll, Chuditch *(Dasyurus geoffroii)*

September 2024

EMSA
Ecological Monitoring System Australia

Australian Government
Department of Climate Change, Energy, the Environment and Water

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Ecosystem Research Infrastructure

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## Acknowledgement of Country

We acknowledge the Traditional Custodians of Australia and their continuing connection to land and sea, waters, environment and community. We pay our respects to the Traditional Custodians of the lands we live and work on, their culture, and their Elders past and present.

## Copyright



## Disclaimer

# About

This literature review collates information on one of the 110 priority threatened species identified in the *Threatened Species Action Plan 2022-2032* and has been reviewed by invited practitioners experienced in monitoring the species.

The *Survey Guidelines for Monitoring Threatened Species* project, a collaboration of the Department of Climate Change, Energy, the Environment, and Water (DCCEEW) and the Terrestrial Ecosystem Research Network (TERN), aims to improve our knowledge of threatened species by enhancing accessibility and sharing of quality scientific threatened species data. By developing best practice field survey guidelines and recommendations, practitioners will be better equipped to conduct standardised, repeatable surveys.

By identifying the monitoring methods typically implemented by practitioners, documenting and assessing the techniques known to work, and identifying opportunities to standardise the methods, we can move towards ensuring all monitoring is species-appropriate, comparable between practitioners and populations, and repeatable over time. Further, together with consistent terminology, guidelines, instructions, and data collection, we can refine efforts and resources to measure and share information. Data collected using robust, standardised methods will improve our knowledge of threatened species and underpin threatened species recovery at scale. This project is essential to establishing monitoring protocols and data repositories to enhance the accessibility and sharing of threatened species data.

TERN has prepared the literature reviews for the Department of Climate Change, Energy, the Environment, and Water. For further information, please visit the EMSA Threatened Species Survey Guidelines website. Additional information, particularly monitoring methods and techniques not included that should be considered, can be brought to the author's attention by emailing tern@adelaide.edu.au for consideration for future updates.

# Contents



## Tables

# 1 Background

## 1.1 Species name

The Western Quoll (*Dasyurus geoffroii*) is known as the Chuditch in the Noongar language and as Idnya in the Adnyamathanha language (Abbott 2013).

## 1.2 Conservation status

The species is nationally listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act* 1999 (Cth). Table 1 identifies the species conservation status under Commonwealth, state and territory, and the International Union for Conservation of Nature (IUCN) listings.

Table 1. National, international and state conservation status for the Western Quoll

| Jurisdiction | Conservation status | Legislation |
|---|---|---|
| Commonwealth | Vulnerable | *Environment Protection and Biodiversity Conservation Act 1999* |
| South Australia | Endangered | *National Parks and Wildlife Act 1972* |
| Western Australia | Vulnerable | *Biodiversity Conservation Act 2016* |
| IUCN | Near Threatened | IUCN Red List of Threatened Species (2012) |

## 1.3 Summary of data held in the Threatened Species Index

The Threatened Species Index (TSX) provides reliable and robust measures of change in the relative abundance of Australia's threatened and near-threatened species at national, state and regional levels. Understanding these changes in species populations is crucial for monitoring Australia's conservation progress and allows users to measure and report on the benefits of conservation investments and to justify and design targeted management responses. Currently, the index is restricted to birds, plants and mammals, with new groups to be added in the near future.

Table 2 below summarises Western Quoll data held in the TSX. More information on the TSX, including how to contribute threatened species monitoring data to the index, can be found at tsx.org.au

Table 2. Summary of Western Quoll data held in the Threatened Species Index

| TSX information | Western Quoll data held in the TSX |
|---|---|
| Data held in the TSX? | Yes |
| Number of data sources | 2 |
| Number of unique sites | 29 |
| Average time series length (years) | 18.4 |
| Average number of sampling years | 16.3 |

## 1.4 Distribution and abundance

The Western Quoll was relatively abundant at the time of European settlement, and once occurred across approximately 70 % of the continent, with its range extending into every mainland state and territory (Burbidge et al. 1988; Collett 1887 as cited by Serena et al. 1991; Johnson & Roff 1982; Whittell 1954). More recently, there has been a steep decline in numbers and a range contraction, with the species considered extinct in NSW, Victoria, Qld and the NT, occupying only approximately 5 % of its former range (DEC 2012). In the arid zone of SA, before recent reintroductions, the quoll was last

reported in the mid-1950s (Finlayson 1961). The quoll was abundant in the wheatbelt of WA in 1907. However, by this time, it had disappeared from the coastal region north of Geraldton (Shortridge 1909; Thomas 1906).

The extant distribution of the species is in south-west WA, which by no coincidence overlaps with the primary distribution of *Gastrolobium* (a genus of plant species known for containing a toxin that is commonly used in feral cat and fox baiting). (Chandler et al. 2002; Short et al. 2005). Since 1987 Western Quolls have been translocated to reserves in south-west WA, in 2000 to Kalbarri National Park in the mid-west region of WA (Morris et al. 2003), in 2014-16 to the semi-arid Ikara-Flinders Ranges National Park in SA (Moseby et al. 2021b), in March 2022 and 2023, further north to the Vulkathunha-Gammon Ranges National Park in SA and this population was supplemented in November 2022 with additional WA quolls and quolls bred at Taronga Zoo Dubbo, NSW (T. Moyle pers. comm.).

## 1.5 Habitat requirements

Having been formerly distributed across approximately 70% of Australia, comprising a vast array of habitats ranging from high rainfall jarrah (*Eucalyptus marginata*) forests and woodlands in south-west Western Australia (DEC 2012; Morris et al. 2003), semi-arid Flinders Ranges region in SA (Tunbridge 1991) to the arid deserts of central Australia (Johnson & Roff 1982), the Western Quoll can utilise a broad range of habitats. Primary habitat requirements are den sites (tree hollows, burrows, hollow logs, rock crevices), food resources and protection from predating foxes, cats and dingoes (DEC 2012; Morris et al. 2003). Some of the known habitats include:

- Jarrah (*Eucalyptus marginata*) forests and woodlands in south-west WA (DEC 2012; Morris et al. 2003).
- Salmon gum and morrel woodland and *Melaleuca* heath habitats near Forrestania in semi-arid Western Australia (Rayner et al. 2011).
- *Callitris glaucophylla* and *Eucalyptus intertexta* woodlands, and rocky gorges and ranges often dominated by low mallee, *Allocasuarina* and *Acacia* shrublands in SA's Ikara-Flinders Ranges National Park (Moseby et al. 2021b).
- Central Australian *Triodia* spp. and *Plectrachne* spp. grasslands interspersed with rocky hills and ranges, low open shrublands and open *Acacia aneura*, *A. estrophiolata*, *Casuarina* and *Eucalyptus* woodlands, with *E. camaldulensis* lined ephemeral creek lines (Johnson & Roff 1982).

## 1.6 Biology and ecology

The primarily nocturnal Western Quoll has a largely solitary lifestyle except when breeding, with home ranges containing a core area around den sites, which do not overlap other quolls (Serena & Soderquist 1989). Home ranges reflect the availability of resources and population densities, which are significantly influenced by the abundance of competing and predating feral cats and foxes. In SA's semi-arid Ikara-Flinders Ranges National Park, where foxes have been extirpated and cats reduced by annual baiting, female Western Quolls have average home ranges of 2.45 km$^2$ and males 27.78 km$^2$ (Moseby et al. 2021b). In the presumably unbaited Lane-Poole area of WA the species was recorded with home ranges of 3.37 km$^2$ (0.9 km$^2$ core area) for females and a mean core area of at least 4.15 km$^2$ for males (Serena & Soderquist 1989).

Western Quolls have a broad, opportunistic diet, predominantly eating mammals and invertebrates, but also reptiles, birds, carrion and vegetation (Johnson & Roff 1982; Moseby et al. 2022; Rayner et al. 2011; Serena et al. 1991; Soderquist & Serena 1994). Primary prey items reflect availability, as per a localised mouse plague in Rayner et al. (2011) and abundant rabbits in Moseby et al. (2022).

Breeding commences in late April (Morton et al. 1989) with young born from May to August (Moseby et al. 2021b). Average adult lifespan is only two years (Soderquist 1988).

## 1.7 Threats

Both juveniles (Glen et al. 2010) and adults, especially females (Moseby et al. 2021b), are very vulnerable to feral cat (Glen et al. 2009; Moseby et al. 2021b; Moseby et al. 2015) and fox predation (Glen et al. 2009; Mathew 1996; Morris et al. 2003). Significant recoveries in abundance were found with 1080 fox baiting in Batalling Forest, WA (Morris et al. 2003), and similarly with annual aerial 1080 cat baiting (Moseby et al. 2021a). In south-west WA additional threats to quolls include starvation, raptors and vehicles (DEC 2012).

# 2 Existing monitoring

## 2.1 Overview of monitoring methods

Western Quolls are easily cage-trapped, enabling them to be collared and monitored using telemetry. They are also readily detected by remote cameras. Indirect techniques such as hair traps, tracks and scats, although often not needed, can be beneficial in detecting presence in the area. The primary survey technique to assess the Western Quoll diet is the microscopic analysis of their scats (Moseby et al. 2022; Soderquist & Serena 1994). Additional insights, especially for dietary components that leave minimal, if any, macroscopic fragments, would be obtained from the much more costly and sensitive DNA analysis of scats, as per Bannister et al. (2021).

Direct indicators of the presence of Western Quolls include their images on remote cameras, or quolls being directly observed (e.g. road mortality) or trapped (Morris et al. 2003; Moseby et al. 2021b). Indirect evidence of their presence including scats and tracks.

Some key population monitoring indices for the Western Quoll include:

- trap success rate (e.g. number caught per 100 trap nights; Morris et al. 2003)
- site occupancy
- population density
- survival rates (translocations; Moseby et al. 2021b).

## 2.2 Monitoring resources

Key resources for monitoring the Western Quoll are listed below.

- Chuditch (*Dasyurus geoffroii*) Recovery Plan, Department of Environment and Conservation, Western Australia (2012). This plan suggests:
  - Establishment of reference sites for monitoring population abundance in response to fox and cat control (DEC 2012).
  - Carry out translocations to increase distribution and monitor success (DEC 2012).
  - Standardised protocols for monitoring be employed where possible to improve accuracy of population density estimates (DEC 2012).

- Standard Operating Procedure: Cage Traps for Live Capture of Terrestrial Vertebrates. Department of Biodiversity, Conservation and Attractions, Western Australia (2018)
  - Covers animal welfare, trap types, setting and positioning traps, baiting traps, checking traps and removing animals from traps.
  - Standard method involves a minimum of four consecutive trapping nights along transects comprising 50 small cage traps spaced at 200 m intervals for a total length of 10 km (DBCA 2018).

## 2.3 Survey methods

### 2.3.1 Cage trapping

Being very trappable, especially with meat bait, the primary survey method for the distribution, abundance and dispersal of Western Quolls is cage trapping. As such, the primary measure of population recovery and persistence was established to be a 1% cage trapping success rate, being one quoll per 100 trap nights (DEC 2012; Morris et al. 2003). Cage trapping is also used to capture

animals for subsequent radio-collaring and then monitoring using VHF or GPS telemetry (Rayner et al. 2011; Serena & Soderquist 1989).

One of the established primary measures of success of a Western quoll population recovery is the maintenance of cage trap success rate above 1% (DEC 2012; Morris et al. 2003). For example, for the translocated Ikara-Flinders Ranges National Park population, trap success between December 2014 and April 2019 ranged from 2.6 to 6.7% (Moseby et al. 2021b), but peaked in March 2022 at 15.1% (T. Moyle pers. comm.). This trapping data can be used for trap-mark-recapture analyses to estimate population size (Moseby et al. 2021b). A quoll-specific bait can be required where off-targets such as bettongs can fill traps and prevent effective capture and monitoring of quolls (Table 1; Morris et al. 2003; Wayne et al. 2008).

Table 3. Methods overview of key studies using cage trapping surveys

| Survey type | Study design | Survey effort | Location | Reference |
|---|---|---|---|---|
| Cage trapping | • Traps spaced at 250 m intervals<br>• Surveys conducted in March and December (outside breeding period) | • 152–172 traps set each trapping period<br>• Trapping period lasts 4-5 nights | Ikara-Flinders Ranges National Park, SA | Moseby et al. (2021b) |
| Cage trapping | • Current DBCA protocol<br>• Traps spaced every 500m<br>• Smelly chicken bait (aged raw chicken wings) | • 5 nights of trapping | South-west WA | Brent Johnson pers. comm. (2022) |
| Cage trapping | • Recommended DBCA protocol (to account for smaller home range of female Western Quolls)<br>• Traps spaced every 400m<br>• Smelly chicken bait (aged raw chicken wings) | • 5 nights of trapping | South-west WA | Brent Johnson pers. comm. (2022) |
| Cage trapping | • Former DBCA protocol<br>• Traps spaced at 200 m intervals<br>• Transects consisting of 50 small cage traps (total 10 km)<br>• Surveys conducted between January and June (outside breeding period) | • 5 nights of trapping | South-west WA | DBCA (2018); Morris et al. (2003) |

### 2.3.2 Camera trapping

The second primary method is utilising camera traps. These can be active, utilising a lure such as tuna oil to actively attract and photograph any quolls in the area, or passive, where no lure is used. There is no established protocol, however, Moseby et al. (2021b) deployed passive camera traps 1 km apart according to the camera setup methodology of Meek et al. (2012).

Infrared motion-activated cameras can be used to assess quoll occupancy and any relationship with associated habitat features and pest animal detections (Table 2; Moseby et al. 2021b). Facing cameras towards a lure placed somewhat off the ground, as per the survey technique for Northern quolls (Hohnen et al. 2013), improves Western quoll spot pattern identification of individuals for assessing abundance and distribution (M. Jensen pers. comm.).

Table 4. Methods overview of key studies using camera trap surveys

| Survey type | Study design | Survey effort | Location | Reference |
|---|---|---|---|---|
| Camera trapping (reintroduction monitoring) | • Study site separated into the release site and a buffer zone around the release site<br>• Release site: 30 x infrared motion activated cameras spaced at a minimum 1 km apart and set at a height of 50 cm and a 22-degree | • Release site: Four to 4.5 years continuous monitoring<br>• Buffer zone: Almost 3 years continuous monitoring | Ikara-Flinders Ranges National Park, SA | Moseby et al. (2021b); (Meek et al. 2012) |

| Survey type | Study design | Survey effort | Location | Reference |
|---|---|---|---|---|
| | angle to linear features such as creeks and vehicle tracks<br>• Buffer zone: 14 x cameras set between 1 and 10 km from the release sites<br>• Cameras checked monthly | | | |

### 2.3.3 Radio-tracking

Radio-tracking Western Quolls, generally when they have been reintroduced to a new location, is the primary survey technique to assess individual quoll movements and dispersal, den sites, survival and causes of mortality, including after management actions such as controlled burns (Bilby 2021; Mathew 1996; Morris et al. 2003; Moseby et al. 2021b; Rayner et al. 2011; Table 3; Serena & Soderquist 1989).

Monitoring the survival of adults or sub-adults can be achieved by collaring a significant number/proportion of quolls. The impact of fuel reduction burns on Western Quoll survival was assessed by collaring 10 (Morris et al. 2003) and 13 (Mathew 1996) individuals. Monitoring the survival and cause of mortality of individuals translocated in south-west WA involved collaring the following proportions of released animals: 9 of 9 (100%) quolls released at Lane-Poole Conservation Park in 1987; 20 of 24 (83%) quolls released at Julimar Conservation Park in 1992; 20 of 31 (65%) quolls released at Lake Magenta Nature reserve in 1996; 10 of 20 (50%) quolls released at Cape Arid National Park in 1998; and 8 of 48 (17%) quolls released at Mt Lindesay State Forest in 1999 (Morris et al. 2003). Monitoring the movements, den sites, survival, and cause of mortality of the translocated Ikara-Flinders Ranges National Park population involved collaring 37 of 41 (90%) quolls released in 2014, 37 of 37 (100%) released in 2015 and 10 of 15 (67%) released in 2016.

Table 5. Methods overview of key studies using radio-tracking surveys

| Survey type | Study design | Survey effort | Location | Reference |
|---|---|---|---|---|
| **Radio-tracking** | • Monitoring movements, den sites, survival and causes of mortality | • 37 of 41 (90%) released in 2014<br>• 37 of 37 (100%) released in 2015<br>• 10 of 15 (67%) released in 2016<br>• 11 adult quolls in 2017 prior to aerial 1080 cat baiting being undertaken for the first time<br>• 17 subadults in 2014<br>• 22 subadults in 2020 | Ikara-Flinders Ranges National Park, SA | Bilby (2021); Moseby et al. (2021b) |
| **Radio-tracking** | • Assessing the impact of fuel reduction burns on chuditch survival | • 10 individuals in spring 1994<br>• 13 individuals in autumn 1994 | South-west WA | Mathew (1996) |
| **Radio-tracking** | • Monitoring the survival and causes of mortality of translocated chuditch | • 9 of 9 (100%) quolls released at Lane-Poole Conservation Park in 1987<br>• 20 of 24 (83%) quolls released at Julimar Conservation Park in 1992<br>• 20 of 31 (65%) quolls released at Lake Magenta Nature reserve in 1996<br>• 10 of 20 (50%) quolls released at Cape Arid National Park in 1998<br>• 8 of 48 (17%) quolls released at Mt Lindesay State Forest in 1999 | South-west WA | Morris *et al.* (2003) |
| **Radio-tracking** | • Monitoring movements, den sites, and survival | • 8 adult females and 7 adult males in 1986-87 | Lane-Poole Conservation Reserve and adjoining State Forest and | Serena and Soderquist (1989) |

| Survey type | Study design | Survey effort | Location | Reference |
|---|---|---|---|---|
| | | | private land, south-west WA | |
| **Radio-tracking** | • Locating den sites and assessing home ranges | • 4 males and 2 females, obtaining up to 38 fixes from up to nine weeks effort | Forrestania, WA | Rayner et al. (2011) |

# 3 Key agencies and organisations involved in the species research and recovery

Key agencies, organisations or individuals identified as having been previously or currently actively involved in monitoring the Western Quoll include:

- Katherine Moseby, University of NSW/Ecological Horizons
- Keith Morris (Chair of the recovery team)
- Brent Johnson (Western Australian Department of Biodiversity, Conservation and Attractions)
- Tali Moyle (SA Dept of Enviornment and Water)
- Rob Brandle (SA Department of Environment and Water)
- Tracy McNamara (Foundation for Australia's Most Endangered species Inc)
- Steven Kleinig (Taronga Western Plains Zoo).

# 4 Survey guideline recommendations gathered from the literature

The literature review of the monitoring methods relating to the Western Quoll has identified some key points that must be addressed when developing species-specific survey guidelines. These points are listed below and in Table 6.

- Cage trapping, camera traps, radio-tracking and scat analysis are well-established monitoring methods that are highly efficient and applicable to monitoring the Western Quoll.
- There is room for standardisation of methods, such as spacing of cage and camera traps, noting that this is primarily driven by quoll home ranges, which can vary depending on habitat, fox/cat control, sex, age-class and breeding. Hence, a 200 m spacing for cage traps may be appropriate for the abundant reintroduced Ikara-Flinders Ranges National Park population and for smaller female home ranges, but it would likely be too much for a more arid/resource-poor location.
- Standardising trap bait to smelly chicken wings may offer some advantages for intra- and inter-site comparisons, especially where trap bycatch such as Woylies is a major confounding issue. However, a preliminary review of trapping results from the Ikara-Flinders Ranges National Park has found the universal bait and rabbit bait had comparable results (K. Moseby pers. comm.). Hence, where bycatch is not a major confounding issue, bait type may not greatly impact quoll trapping results.
- The length of time cage trapping and camera traps set in an area could be standardised. Cage trapping for five nights appears to be accepted in WA and SA. However, both regions report new animals still being caught after five nights of trapping. Five nights, therefore, is a compromise between the guidelines of capture-mark-recapture population assessment and cost.
- For camera traps, 2-4 weeks is often the minimum recommended, and 30 days should be considered where possible to provide strong confidence in presence/absence (Meek et al. 2014).
- Radio-tracking is an established monitoring method to help assess specific Western Quoll demographics, home range and den site attributes, and the timing and causes of mortality. It is much more sensitive than cage trapping and camera traps and can be critical to identifying causes of quoll mortality and achieving reintroduction success (Moseby et al. 2021b; Moseby et al. 2015). An area for possible standardisation is the percentage of a translocated Western Quoll population that should be monitored by radio-collaring to assess best survival, home ranges, dispersal and causes of mortality, noting though that this is predominantly driven by cost and available funds, and the human resources available to monitor the collared quolls effectively.

Table 6. Monitoring method summary

| Monitoring method | Details | Key gaps and considerations |
|---|---|---|
| Cage trapping | Cage spacing varies from 200 m to 500 m.<br>Three most common baits, often inter-mixed, are smelly chicken, rabbit portion, or the universal bait. | Optimum spacing of cage traps for habitats/home ranges?<br>Standardising bait?<br>Traps using a treadle versus those using a hanging hook – quoll safety versus keeping bait away from ants. |
| Camera trapping | Detectability of fauna can vary with camera.<br>Quoll individuals can be identified by spot patterns. | Spacing and setup of camera traps – as per Meek *et al.* (2012) or modified to optimise capture of spot patterns as per Hohnen et al. (2013)? |
| Radio-tracking | Proportion of translocated population monitored to assess survival etc. has varied between 17% and 100%. | What percentage of released animals should be monitored?<br>How long released animals should be monitored? |
| Scat dietary analysis | Higher resolution and accuracy with DNA analysis but at a much higher cost. | Macroscopic and/or DNA analysis? |

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