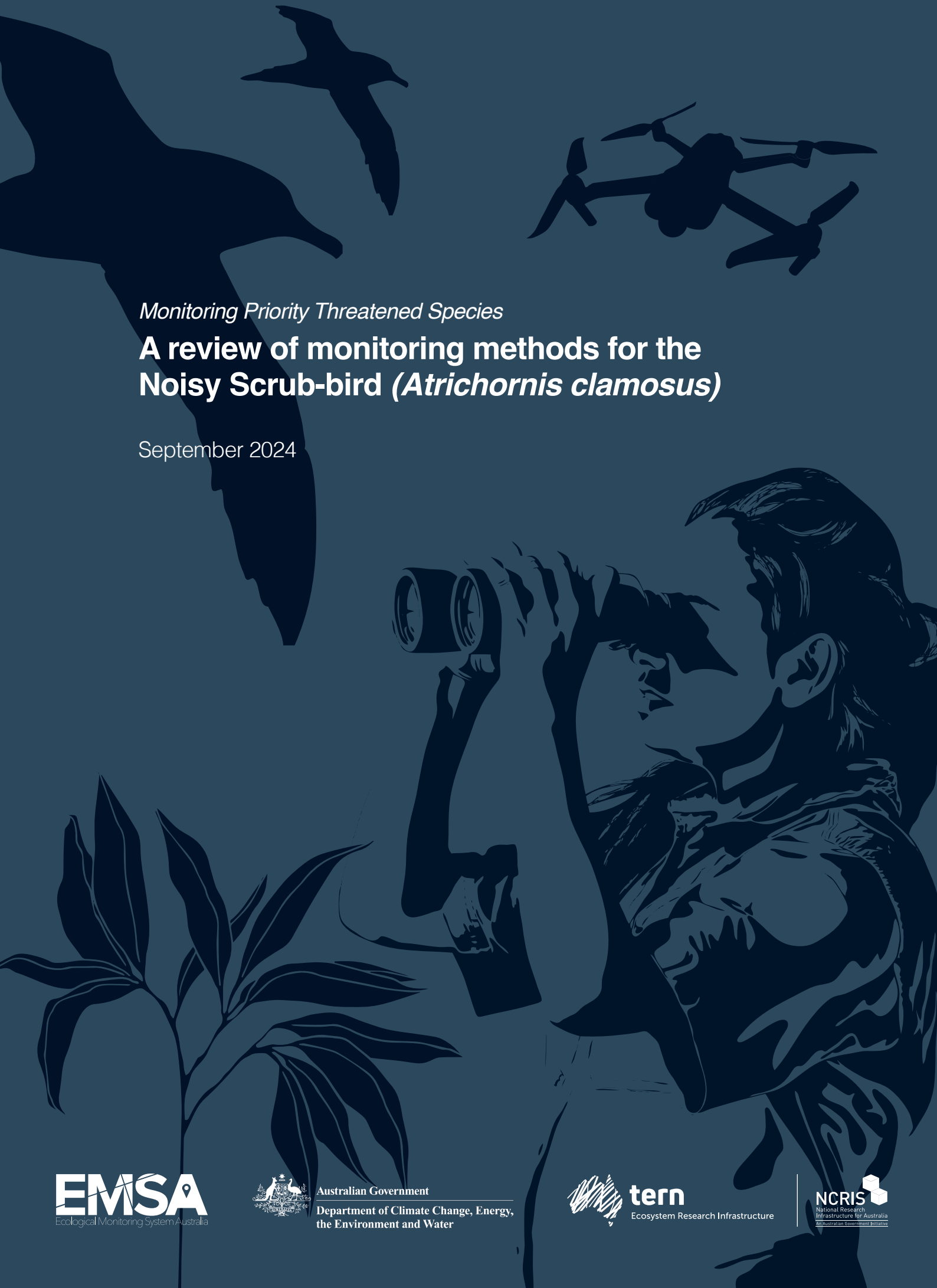


Monitoring Priority Threatened Species

A review of monitoring methods for the Noisy Scrub-bird *(Atrichornis clamosus)*

September 2024

EMSA
Ecological Monitoring System Australia

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

tern
Ecosystem Research Infrastructure

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

Citation

TERN Australia (2024) Monitoring Priority Threatened Species: A review of monitoring methods for the Noisy Scrub-bird (Atrichornis clamosus) Version 1 Report to Department of Climate Change, Energy the Environment and Water. TERN, Adelaide.

Version

Version 1.

Last updated: 2 September 2024

Acknowledgements and contributions

This work was funded by the Australian Government Department of Climate Change, Energy, the Environment and Water.

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. Developing best practice field survey guidelines and recommendations will better equip practitioners 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

Figures

Tables

1 Background

1.1 Species name

The Noisy Scrub-bird (*Atrichornis clamosus*)(Gould 1844) is also known as 'Tjimiluk' by the Minang people of Albany (Comer et al. 2018a).

1.2 Conservation status

The Noisy Scrub-bird is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act; DCCEEW 2023) and according to the International Union for Conservation of Nature (IUCN Red List of Threatened Species: 2022.2 list). The IUCN cites restricted range and continuing decline in habitat quality and mature individuals as reason for this listing (BirdLife International 2022). The Noisy Scrub-bird is one of 22 priority bird species listed in the Australian Government Threatened Species Action Plan 2022-2023 (DCCEEW 2022). Table 1 outlines the species conservation status under Commonwealth, state and IUCN listings.

Table 1. National, international and state conservation status for the Noisy Scrub-bird

Listing type	Status	Legislation or listing
Commonwealth	Endangered	*Environment Protection and Biodiversity Conservation Act 1999*
Western Australia	Endangered	*Biodiversity Conservation Act 2016*
IUCN	Endangered	IUCN Red List of Threatened Species

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.

The TSX does not hold data on the Noisy Scrub-bird. More information on the TSX, including how to contribute threatened species monitoring data to the index, can be found on the TSX website.

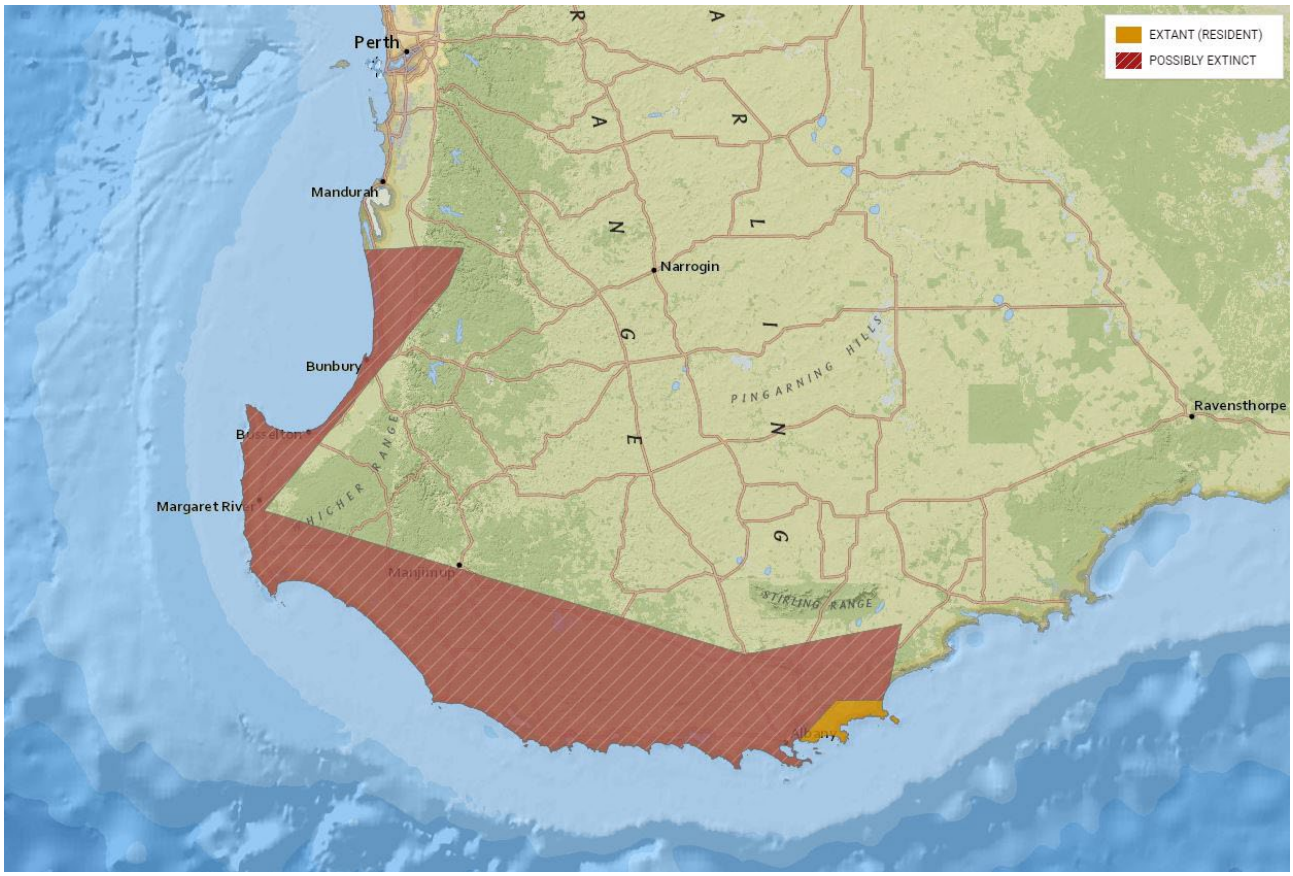
1.4 Distribution and abundance

Initially more widespread across southern Western Australia, the Noisy Scrub-bird's known population is now restricted to a small area just east of Albany between Two Peoples Bay Nature Reserve and Cheyne's Beach, with an additional outlying subpopulation on nearby Bald Island (Comer et al. 2010; DPaW 2014). Since its rediscovery in 1961, there have been several successful translocations: 31 founder individuals to Mt Manypeaks between 1983-1985, 10 individuals to Mermaid between 1992-1994 and 11 individuals to Bald Island in 1992-1993 (Comer et al. 2010). Translocations to other areas in south-west Western Australia have been attempted but have been unsuccessful to date (Comer et al. 2010).

The mainland subpopulation encompasses several local populations which are connected by corridors of suitable habitat enabling movement of birds between locations (Danks 1991; DPaW 2014). These sites include Moates Lake-Gardner Lake, Mount Gardner, Angove River-Normans Inlet,

Mount Manypeaks, Waychinicup and Mermaid Point. The most recent population estimate is ~1380 mature individuals (Burbidge et al. 2018; Comer et al. 2021).

Figure 1. Distribution of the Noisy Scrub-bird



Source: Birdlife International 2022.

Notes: Areas shaded red/brown indicate where the species is possibly extinct. Areas shaded yellow indicate the extant distribution.

1.5 Habitat requirements

Historically, Noisy Scrub-birds were likely limited to wetter sections where jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) systems occur, such as the ecotone between swamp and forest communities (Danks 1997; DPaW 2014; Smith 1985). Within their current distribution, vegetation communities are generally associated with gullies and drainage lines between the granite peaks and surrounding hills, as well as adjacent to lakes and streams and in overgrown swamps within the lowland areas (DPaW 2014). Noisy Scrub-birds prefer dense vegetation with abundant leaf litter (Comer et al. 2010; DPaW 2014). This includes low forest and scrub thicket, and seldomly, heathland (Danks 1997; DPaW 2014).

Noisy Scrub-birds are found in habitat which has been long unburnt, particularly areas greater than ten years since fire (Danks 1997; DPaW 2014). However, depending on the vegetation type, areas four to ten years post fire may be suitable for re-establishment (DPaW 2014).

1.6 Biology and ecology

The Noisy Scrub-bird is a small bird with powerful legs, short, round wings, and a graduated tail. They are brown dorsally with a paler underside which transitions from buff to rufous around the vent (DPaW 2014). They have dark cross-barring from the head to the tail tip. Noisy Scrub-birds are sexually dimorphic with females exhibiting a cream-coloured throat and lacking the blackish triangle across

the throat that males possess (DPaW 2014). During the breeding season, males weigh around 51 g while females have an average weight of only 34 g (DEC 2011).

They are semi-flightless, in that they are only able to sustain flight for a few metres, and therefore have poor dispersal ability (DPaW 2014). They are agile climbers, leaping from shrub to shrub and they run along the ground in rapid short bursts (Danks 1997; DPaW 2014). Noisy Scrub-birds typically feed on or near the ground, foraging for invertebrates predominantly. The species will sometimes consume lizards and small frogs (Danks 1997; Smith & Calver 1984).

Noisy Scrub-birds are sedentary, with limited dispersal of young birds during the breeding season (Danks 1991). Males produce a loud, conspicuous, song when defending their non-overlapping territories (DPaW 2014; Portelli 2004). Territories range from 6 - 9 ha and consist of a core area (0.75 - 2.25 ha) where males sing 80% of their calls and distances between core areas range from 200 - 500 m (Smith 1985). They call all year round but more frequently during the breeding season (April to October, although can extend into November; DPaW 2014; Portelli 2004). A group of up to ten males can form a 'song group' with a collective repertoire of territorial songs which differ to neighbouring groups (Berryman 2007). Noisy Scrub-birds are relatively slow breeders with females producing only one chick per year (Cowen et al. 2021; Danks 1997). Females build the nest and are responsible for incubating and feeding the young (DPaW 2014). Nests are dome shaped with a side entrance and composed of leaves, twigs, bark and decaying plant matter. They are situated low to the ground usually in a clump of sedges or rushes or in a tangle of shrubs (Danks 1997). Females can breed within their first year but males only reach sexual maturity after three years (Smith 1996).

1.7 Threats

Increase in the scale, frequency and intensity of bushfires are considered a significant threat to the survival of Noisy Scrub-birds (Comer et al. 2021)as they have a restricted distribution, occur in fire-prone vegetation communities, and have a limited ability to disperse (Danks 1991). In 2004, the population in the Mount Manypeaks area was reduced by almost two-thirds by wildfires (Comer et al. 2010; Roberts et al. 2020). Despite this event, the population at Mount Manypeaks has slowly recovered (Comer et al. 2010; Roberts et al. 2020). The core populations on Mount Gardner were also impacted by fire in late November 2015, with approximately 90% of habitat occupied by Noisy Scrub-birds burnt (Comer et al. 2018b). Increasing frequency of droughts and heatwaves in the Noisy Scrub-bird's distribution are likely to increase the probability of fire in the region (Di Virgilio et al. 2019; Dowdy et al. 2019).

As Noisy Scrub-birds forage and nest close to the ground, they are at risk of predation by feral predators such as foxes, cats and black rats (Gilfillan et al. 2007; Kemp et al. 2015), however, the exact impact on population numbers is unknown. Foxes may be less of a concern as they prefer more open habitats, while cats may be more of a threat due to their "stalk and ambush hunting tactics" (DPaW 2014). Feathers from a Noisy Scrub-bird were found in the stomach of a feral cat from Two Peoples Bay Nature Reserve (DPaW 2014). Assessments of predator density and vegetation composition revealed the success of reintroductions was influenced by fire history and exotic predators (Kemp et al. 2015). Other potential threats include introduced herbivores, weed invasion and climate change.

2 Existing monitoring

2.1 Overview of monitoring methods

Noisy Scrub-birds are difficult to see and are therefore identified primarily from their calls (DPaW 2014; Portelli 2004). Only males sing and will call throughout the year (Portelli 2004). However, calls are more frequent during the breeding season (May-November; Portelli 2004; Roberts et al. 2020), and in the period two to three hours after sunrise (Smith & Forrester 1981).

Key population monitoring measures for the Noisy Scrub-bird include:

- Distribution
- Relative abundance (estimate based on the number of territorial males singing)
- Extent of occurrence
- Area of occupancy

2.2 Monitoring resources

Key resources with information for monitoring the Noisy Scrub-bird include:

- DEWHA (2010) Survey guidelines for Australia's threatened birds. Department of the Environment, Water, Heritage and the Arts.
  - Provides recommendations on survey methodology and effort (for areas less than 50 ha) including:
    - Area searches or transect-point surveys early in the morning in suitable habitat with an effort of 4 days of 8 hours.
    - Broadcast surveys - proposed for when birds are in low densities if area searches or transects are unsuccessful. Suggests 3 days of 6 hours.
  - Recommends surveys are conducted early in the morning before and during the breeding season.

- DPaW (2014) South Coast Threatened Birds Recovery Plan. Department of Parks and Wildlife, Western Australia. This plan replaces the previous national recovery plan for the Noisy Scrub-bird (Danks et al. 1996). Key actions include:
  - Refining, locating and mapping areas of critical habitat for the survival of the Noisy Scrub-bird.
  - Developing survey and monitoring protocols to increase the ability to detect population changes.
  - Continued monitoring at known locations and to survey new sites.

- DCCEEW (2023) *Atrichornis clamosus* in Species Profile and Threats (SPRAT) Database. Department of Climate Change, Energy, the Environment and Water, provides some comments regarding survey guideline such as:
  - The Noisy Scrub-bird is easy to detect using the characteristic male territorial call which can be heard up to 1.5 km away in good weather.
  - The species is shy and elusive and therefore difficult to observe.

2.3 Survey methods

2.3.1 Call-based survey

Noisy Scrub-bird populations are censused through call-based surveys and a relative abundance is estimated based on the number of singing territorial males (Comer et al. 2010; Danks 1997; Portelli 2004; Roberts et al. 2020). The primary method for determining the distribution and occupancy of the Noisy Scrub-bird is by using call-based surveys. This includes targeted listening or call playback for male territorial songs (Comer et al. 2010; Danks 1997; DPaW 2014; Portelli 2004; Roberts et al. 2020).

Monitoring by counting the number of singing males has been undertaken since 1966 (Comer et al. 2018a; Roberts et al. 2020). A systematic population census has been undertaken at intervals of yearly to several years, between 1970 and recently (Burbidge et al. 2018; Roberts et al. 2020; Smith & Forrester 1981). However, these surveys only provide an index of the true population trend as only breeding males produce a territorial song. Therefore, counts of singing males do not account for the number of subadults, non-breeding males, or females (Roberts et al. 2020; Smith 1985). Nonetheless, it is the only existing metric of population size (Comer et al. 2010; Danks et al. 1996; Roberts et al. 2020; Smith 1985).

The relationship between the number of calling males and the total population is unknown (Burbidge et al. 2018), and estimations can be variable as there are two types of Noisy Scrub-bird territories (Smith & Forrester 1981). Long-term territories are generally small areas (1000 m^2) occupied continuously by males which sing throughout the year and are located in optimal breeding habitat with abundant food, while short-term territories are situated in sub-optimal habitat, or on the periphery of long-term territories, where food and breeding habitat is poor (Smith & Forrester 1981). These are characterised by males who call only during the breeding season, sometimes only for a few weeks. A ratio of 2.5 individuals for each territorial male has been used previously to provide a population estimate(Comer et al. 2021; Danks et al. 1996).

Monitoring using auditory methods can be conducted at any time as males will call throughout the year (Portelli 2004). However, calls are more frequent during the breeding season (May-November; Portelli 2004; Roberts et al. 2020). Calling rates begin to increase in April until they peak in May/June and this high song output is maintained until October when calling frequency decreases (Smith & Forrester 1981). The highest frequency of songs are in the period two to three hours after sunrise and calls can be heard up to 1.5 km away on a calm day (Smith & Forrester 1981). More information on call-based survey design and effort can be found in Table 2

Table 2. Methods overview of key studies using call-based surveys.

Survey type	Study design	Survey effort	Location	Reference
Census of singing males	▪ Study focus translocation post-release monitoring ▪ Annual census of territorial males and the number of days taken for a territory to be re-occupied used to monitor effects of removal of birds for translocations	▪ Annual surveys. ▪ Further details not provided.	Two Peoples Bay Nature Reserve – Mt Gardner, WA	(Comer et al. 2010)
Call-based	▪ Study focus was recording of songs ▪ Scrub-birds recorded using a Sony WMD6C Walkman and Sony PBR400 or Sony ECMMS907 microphone from a distance of 5-100 m, but mostly between 20-50 m.	▪ All scrub-bird territories in each area visited for 1-2 hrs. ▪ May, July, September 2004 and July 2005. ▪ Total of 71 songs from 131 occupied territories in 2004.	Two Peoples Bay Nature Reserve – Mt Gardner, WA	(Berryman 2007)

Survey type	Study design	Survey effort	Location	Reference
Call-based	▪ Study focus was locating singing males and mapping territories ▪ Singing birds located during morning and afternoon ▪ Walks along tracks. ▪ At least 15 min per walk spent listening in all areas for scrub-birds. ▪ GPS and compass used to take 2 bearings for triangulation. ▪ Locations mapped on aerial photos.	▪ Surveys carried out during July, August, September and October ▪ Surveys undertaken in the 3 hrs post-sunrise and 3 hrs pre-sunset ▪ At least 15 min walked transects ▪ All locations visited on at least 10 occasions.	Two Peoples Bay Nature Reserve - Tick Flat, Mt Gardner Headland, WA	(Berryman 2007)
Call-based	▪ Study focus: recording of songs ▪ Calls from males in 12 distinct territories recorded opportunistically ▪ Calls recorded between 0530-1830 hrs ▪ Sony Walkman WMD6C and Sennheiser ME67 or Beyer Dynamic M88N(C) microphone.	▪ Surveys conducted on 1-17 days in December 2001	Two Peoples Bay Nature Reserve, WA	(Portelli 2004)
Call-based	▪ Study focus translocation post-release monitoring ▪ Monitoring involved listening for territorial songs of males at release sites Annual counts of singing males with observations of territories and nest sites conducted in source populations.	▪ Annual counts ▪ Further details not provided.	Two Peoples Bay Nature Reserve, WA	(Danks 1997)
Census of singing males	▪ Study focus: translocation post-release monitoring ▪ Methods involve walking marked trails. ▪ Monitoring included recording the location of singing males. ▪ Areas of suitable vegetation also visited at least 3 times during the census period.	▪ 5 marked trails surveyed 28 km total length) ▪ Monitoring on at least three occasions ▪ Monitoring in the early morning between May and Oct ▪ This census technique was followed in 1979, 1980, 1982 and 1983.	Two Peoples Bay Nature Reserve – Lake Gardner, WA	(Smith 1985)
Census of singing males	▪ Study focus: population index and establishing survey methodology ▪ Trail transects walked at sunrise ▪ Between 1962-1966 some known territories were visited once while others were visited a number of times.	▪ In 1970, 14-man days during July and September were spent surveying territories ▪ 5 walking trails were established covering all potential scrub-bird habitat. ▪ 1971-76 trails were walked between May-October at sunrise with ~10 min spent within hearing distance of each territory. Trails were walked variable times each year.	Two Peoples Bay Nature Reserve, WA	(Smith & Forrester 1981)

2.3.2 Direct observations, capture and tracking

Noisy Scrub-birds are particularly challenging to observe directly due to their cryptic nature, small size and preference for dense vegetation (Portelli 2004; Smith & Forrester 1981). They are also difficult to capture and the process takes lots of time and effort, particularly outside of the breeding period (Danks 1994, 1997; Portelli 2004). However, capture has been necessary for translocations and radio-tracking studies. Males are considerably easier to capture than females and can be caught using mist nets, or modified versions, and song playback (Berryman 2007; Comer et al. 2010; Danks 1997; Kemp et al. 2015; Morris et al. 2015). Females on the other hand are best captured from nest sites with

the use of small mammal live traps (Danks 1994, 1997). Wind speed and direction, and cloud cover should be considered when mist netting as wind and sun make the net more visible thus decreasing the possibility of capture (Berryman 2007). More information on direct observations and capture survey design and effort can be found in Table 3.

Table 3. Methods overview of key studies using direct observation, capture and tracking surveys.

Survey type	Study design	Survey effort	Location	Reference
Radio-tracking	▪ Study focus: translocation post release monitoring ▪ Movements of translocated birds were monitored using radio-telemetry ▪ Provided data on survival rates.	▪ Birds monitored for 4-6 weeks post release ▪ Further details not provided.	Translocation sites in SW WA	(Comer et al. 2010)
Radio-tracking	▪ Study focus: call analysis and home range size ▪ Scrub-bird males (3 in total) were captured using modified mist nets and playback to lure them to the net. ▪ Playback songs were from the individual itself or neighbouring birds. ▪ Backpack harness with transmitter weighing <2g fitted within 5-10 min of capture. ▪ Locations triangulated from 2 bearings. Any vocalisations recorded with each location.	▪ Surveys undertaken in 2005 ▪ Birds tracked for various lengths of time (2 birds total). ▪ During radio-tracking sessions, locations were recorded at least 30 min apart. Bird 1: 112 fixes over 12 days, Bird 2: 204 fixes over 24 days.	Two Peoples Bay Nature Reserve - Tick Flat, Mt Gardner Headland, WA	(Berryman 2007)
Radio-tracking	▪ Study focus: translocation ▪ Adult males captured using modified mist nets and song playback and females captured by nest trapping with small mammal traps. ▪ Some radio-tracking undertaken to provide data on survival and post-release behaviour.	▪ Further details not provided.	Two Peoples Bay Nature Reserve, Mt Gardner, Mt Manypeaks, WA	(Danks 1997)
Direct observations	▪ Study focus: diet of nestlings ▪ Observation hides 3-4 m from the nest. ▪ Prey items from females' bill identified and recorded. ▪ Faecal sacs (718 in total) collected from 22 nests and examined for animal remains. ▪ Invertebrates were collected from leaf litter and sorted by hand for macroinvertebrates.	▪ Feeding and brooding of females was directly observed at 12 nests between 1972-1975 ▪ Each week from hatchling to chick leaving, 4 x 2 hr watches were made in the morning and late afternoon ▪ Invertebrate surveys undertaken in one territory during July-Oct 1975 and in 5 x 400 m^2 survey areas in 1976	Two Peoples Bay Nature Reserve, WA	(Smith & Calver 1984)

2.3.3 Habitat assessment

Habitat assessments have been predominantly undertaken to evaluate site suitability for translocations. Initially, only a visual assessment of vegetation structure was performed, but habitat assessments evolved in the mid-1990s to include sampling of leaf-litter invertebrates and available digestible biomass (Comer et al. 2010; Danks 1997). From the early 2000s, assessments of habitat began to include vegetation structure, composition (floristics) and density (Comer et al. 2010). Considerations of fire history, land tenure and purpose and potential interactions with other species have also been included in appraisals of suitable translocation sites (Danks 1997). Habitat suitability is confirmed through short-term (4 - 6 week) radio-tracking of individuals post-release (Comer et al. 2010; Danks 1997). More information on habitat survey design and effort can be found in Table 4.

Table 4. Methods overview of key studies using habitat surveys.

Survey type	Study design	Survey effort	Location	Reference
Habitat	▪ Study focus: translocation site suitability ▪ Initial method involved visual assessment of vegetation structure, more recently site selection includes sampling leaf litter invertebrates and considering fire history, land tenure and species interactions.	▪ Further details not provided	Two Peoples Bay Nature Reserve, Mt Gardner, Mt Manypeaks, WA	(Danks 1997)
Invertebrate sampling	▪ Study focus diet analysis ▪ Litter collection, pit trapping, bush beating and opportunistic invertebrate to provide a reference collection for diet analysis from faecal droppings.	▪ Collecting was carried out in June-July 1990 ▪ Further details not provided	Two Peoples Bay Nature Reserve – Mt Gardner, WA	(Danks & Calver 1993)
Habitat	▪ Study focus broad classification ▪ Vegetation for core ranges of each territorial male classified based on simple structural formations: heath, thicket, low forest A and low forest B.	▪ Further details not provided	Two People Bay Nature Reserve and Lake Gardner, WA	(Smith 1985)

2.3.4 Other methods

Other monitoring methods that have been used, but have not been widely implemented include:

- DNA sampling (Cowen et al. 2021)
- acoustic recording devices (Comer et al. 2018a).

Additional methods that may have future applications include:

- eDNA (e.g., from soil samples).

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 Noisy Scrub-bird include:

- Sarah Comer, Department of Biodiversity, Conservation and Attractions (DBCA), South Coast Region
- Alan Danks
- Abby Berryman, DBCA, Western Ground Parrot recovery program
- Saul Cowen, DBCA, Dirk Hartog Island.

4 Key survey guideline recommendations gathered from the literature

The literature review of the monitoring methods relating to the Noisy Scrub-bird has identified some key points that must be addressed when developing species-specific guidelines. These points include:

- Noisy Scrub-bird are highly cryptic and most commonly monitored by census of calling males during periods in their breeding season. The relationship between calling male numbers and the true population is not known (Burbidge et al. 2018), therefore monitoring only provides an index of the true population (Comer et al. 2010; Danks et al. 1996; Roberts et al. 2020; Smith 1985)
- Standardising the methods in which monitoring occurs will add reliability to inferences drawn from trends in the population index.
- Surveys are typically undertaken during the Noisy Scrub-bird's breeding season (April – October) (Portelli 2004; Roberts et al. 2020) in the three hours after sunrise or three hours before sunset (Smith & Forrester 1981) when the birds are likely to be most active.
- Monitoring could be undertaken using formal transects but existing monitoring has be done by mapping occupied territories in winter.
- Providing standards for transect length/ distance between sample sites, duration of surveys, how call playback may be utilised as well as standardising the weather, climate, location and vegetation observations recorded will benefit the reliability of the data collected. Allow for repeat surveys and robustness of inferences made from the data collected.
- Monitoring using permanent or semi-permanent acoustic monitoring devices has not been well documented for the Noisy Scrub-bird, however, it is mentioned, without detail in at least one document reviewed in this literature review (Comer et al. 2018a). It is therefore likely that monitoring is currently occurring but the documentation is not publicly available. Monitoring using permanent acoustic monitoring devices is cost effective and practical, enabling large amounts of data t to be recorded, however this also means a lot of post recoding processing and unlike in-person surveys, the direction of calls cannot be determined (Pickering 2018).
- Live capture is not recommended as a standard approach to monitoring the Noisy Scrub-bird population, as they are difficult to capture and the process takes a lot of time and effort (Danks 1994, 1997; Portelli 2004), and males and females require different modes of capture (Berryman 2007; Comer et al. 2010; Danks 1997; Kemp et al. 2015; Morris et al. 2015). Capture has however been utilised for translocation and radiotracking studies, but not standard population monitoring.
- Ecological Field Monitoring System Australia (EMSA) standard protocols include modules for vertebrate fauna and vegetation mapping that may be relevant to surveying the Noisy Scrub-bird.

5 References

Berryman, A 2007, 'Song sharing and repertoire change as indicators of social structure in the noisy scrub-bird', PhD thesis, Murdoch University, Perth, WA.

BirdLife International 2022, *Atrichornis clamosus*, The IUCN Red List of Threatened Species 2022.

Burbidge, A, Comer, S & Danks, A 2018, 'Collaborative commitment to a shared vision: recovery efforts for noisy scrub-birds and western ground parrots', in S Garnett, J Woinarski, D Lindenmayer & P Latch (eds), *Recovering Australian threatened species: A book of hope*, CSIRO Publishing, Melbourne, pp. 95-104.

Comer, S, Burbidge, AH, Danks, A & Garnett, ST 2021, ' Noisy scrub-bird *Atrichornis clamosus*', in ST Garnett & GB Baker (eds), *The Action Plan for Australian Birds 2020*, CSIRO Publishing, Melbourne, pp. 480–483.

Comer, S, Danks, A, Berryman, A & Cowen, SJ 2018a, 'Living on the edge: the survival of the noisy scrub-bird', *Landscope*, vol. 33, pp. 28-33.

Comer, S, Danks, A, Berryman, A & Cowen, SJ 2018b, ' Living on the edge: the survival of the noisy scrub-bird', *Landscope*, vol. 33, pp. 28-33.

Comer, S, Danks, A, Burbidge, AH & Tiller, C 2010, 'The history and success of noisy scrub-bird re-introductions in Western Australia: 1983-2005', in *Global re-introduction perspectives: 2010 - additional case-studies from around the globe*, IUCN/SSC Re-Introduction Specialist Group and Environment Agency, Abu Dhabi, pp. 187-192.

Cowen, SJ, Comer, S, Wetherall, JD & Groth, DM 2021, 'Translocations and their effect on population genetics in an endangered and cryptic songbird, the noisy scrub-bird *Atrichornis clamosus*', *Emu*, vol. 121, no. 1-2, pp. 33-44.

Danks, A 1991, 'The role of corridors in the management of an endangered passerine', in DA Saunders & RJ Hobbs (eds), *Nature conservation 2: the role of corridors*, Surrey Beatty, Sydney, pp. 291-296.

Danks, A 1994, 'Noisy scrub-bird translocations: 1983–1992', in M Serena (ed.), *Reintroduction biology of Australian and New Zealand fauna*, Surrey Beatty, Sydney, pp. 129-134.

Danks, A 1997, 'Conservation of the noisy scrub-bird: a review of 35 years of research and management', *Pacific Conservation Biology*, vol. 3, no. 4, pp. 341-349.

Danks, A, Burbidge, AA, Burbidge, AH & Smith, GT 1996, *Noisy scrub-bird recovery plan, wildlife management program no. 12*, Department of Conservation and Land Management, Perth, Western Australia.

Danks, A & Calver, MC 1993, 'Diet of the noisy scrub-bird *Atrichornis clamosus* at two peoples bay, south-western Western Australia', *Emu*, vol. 93, no. 3, pp. 203-205.

DCCEEW 2022, *Threatened species action plan 2022–2032*, Department of Climate Change, Energy, the Environment and Water,, Canberra, ACT.

DCCEEW 2023, *Atrichornis clamosus in species profile and threats database*, Department of Climate Change, Energy, the Environment and Water, Canberra, ACT, viewed 11 May, <www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=654>.

DEC 2011, *Noisy scrub-bird capture database*, Albany, WA.

DEWHA 2010, *Survey guidelines for Australia's threatened birds: guidelines for detecting birds listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999.*, Department of the Environment, Water, Heritage and the Arts, Canberra, ACT.

Di Virgilio, G, Evans, JP, Blake, SAP, Armstrong, M, Dowdy, AJ, Sharples, J & McRae, R 2019, 'Climate change increases the potential for extreme wildfires', *Geophysical Research Letters*, vol. 46, no. 14, pp. 8517-8526.

Dowdy, AJ, Ye, H, Pepler, A, Thatcher, M, Osbrough, SL, Evans, JP, Di Virgilio, G & McCarthy, N 2019, 'Future changes in extreme weather and pyroconvection risk factors for Australian wildfires', *Scientific Reports*, vol. 9, no. 1, 2019/07/11, p. 10073.

DPaW 2014, *South coast threatened birds recovery plan*, Department of Parks and Wildlife, Perth, WA.

Gilfillan, S, Comer, S, Burbidge, AH, Blyth, J & Danks, A 2007, *South coast threatened birds recovery plan western ground parrot Pezoporus wallicus flaviventris, western bristlebird Dasyornis longirostris, noisy scrub-bird or Tjimiluk Atrichornis clamosus, western whipbird (western heath subspecies) Psophodes nigrogul*, Perth.

Kemp, L, Norbury, G, Groenewegen, R & Comer, S 2015, 'The roles of trials and experiments in fauna reintroduction programs', in DP Armstrong, MW Hayward, D Moro & PJ Seddon (eds), *Advances in reintroduction biology of Australian and New Zealand fauna*, CSIRO Publishing, Melbourne, pp. 73-89.

Morris, K, Page, M, Kay, R, Renwick, J, Desmond, A, Comer, S, Burbidge, A, Kuchling, G & Sims, C 2015, 'Forty years of fauna translocations in Western Australia: lessons learned', in DP Armstrong, MW Hayward, D Moro & PJ Seddon (eds), *Advances in reintroduction biology of Australian and New Zealand fauna*, CSIRO Publishing, Melbourne, pp. 217-235.

Pickering, R 2018, *Technology used to survey the endangered Australasian bittern*, BirdLife Australia, , Youtube Video, 15 August 2018, <www.youtube.com/watch?v=Z30Vb-zkurl>.

Portelli, DJ 2004, 'The singing behavior of the noisy scrub-bird, *Atrichornis clamosus*: congeneric comparisons and the feasibility of using individual variation in song as a census tool', *Emu - Austral Ornithology*, vol. 104, no. 3, pp. 273-281.

Roberts, JD, Danks, A, Berryman, A, Sidhu, N, Burbidge, AH & Comer, S 2020, 'Population decline of the noisy scrub-bird is not correlated with territory size, marginal declines in rainfall or fire impacts', *Pacific Conservation Biology*, vol. 26, no. 3, pp. 230-238.

Smith, GT 1985, 'Population and habitat selection of the noisy scrub-bird, *Atrichornis clamosus*, 1962-83', *Wildlife Research*, vol. 12, no. 3, pp. 479-485.

Smith, GT 1996, 'Habitat use and management for the noisy scrub-bird *Atrichornis clamosus*', *Bird Conservation International*, vol. 6, no. 1, pp. 33-48.

Smith, GT & Calver, MC 1984, 'The diet of the nestling noisy scrub-bird, *Atrichornis Clamosus*', *Wildlife Research*, vol. 11, no. 3, pp. 553-558.

Smith, GT & Forrester, RI 1981, 'The status of the noisy scrub-bird *Atrichornis clamosus*', *Biological Conservation*, vol. 19, no. 4, pp. 239-254.

EMSA
Ecological Monitoring System Australia

emsa.tern.org.au