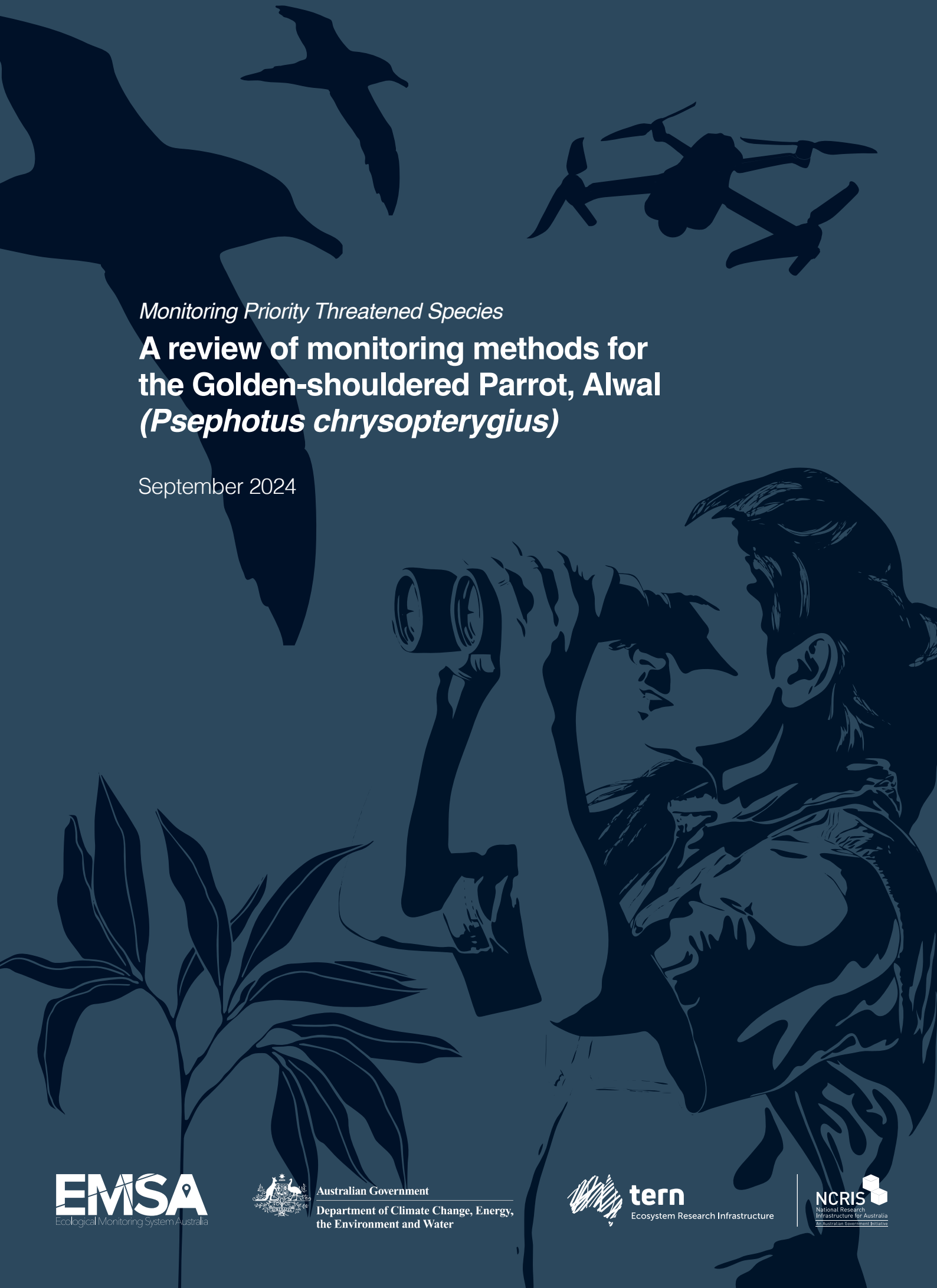


Monitoring Priority Threatened Species

A review of monitoring methods for the Golden-shouldered Parrot, Alwal *(Psephotus chrysopterygius)*

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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.

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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.

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1 Background

1.1 Species name

The Golden-shouldered Parrot (*Psephotus chrysopteryguis*) (Gould 1857), synonym: *Psephotellus chrysopteryguis* is called *Alwal* in Olkola language and has significance to a number of Traditional Owner groups across the species' range including the Olkola, Kokoberrin, Kunjen, Thayoan and Wakaman peoples (Olkola Aboriginal Corporation 2022).

1.2 Conservation status

The Golden-shouldered Parrot was listed as Endangered under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) in 2000 and a recovery plan was adopted in 2002 (Garnett & Crowley 2002). The Golden-shouldered Parrot is one of 22 priority bird species listed in the Australian Government Threatened Species Action Plan 2022-2023 (DCCEEW 2022). The International Union for Conservation of Nature's (IUCN) Red List of threatened species also lists the Golden-shouldered Parrot as Endangered citing the species' very small and decreasing population within which changes in the burning regime and introduction of cattle have resulted in long term population decline(Birdlife International 2022). The conservation status of the Golden-shouldered Parrot is outlined in Table 1.

Table 1. National, international and state conservation status for the Golden-shouldered Parrot.

Listing type	Status	Legislation or listing
Commonwealth	Endangered	*Environment Protection and Biodiversity Conservation Act 1999*
Queensland	Endangered	*Nature Conservation (Animals) Regulation 2020 (QLD)*
IUCN	Endangered	IUCN Red List of Threatened Species

1.3 Summary of data held in the Threatened Species Index

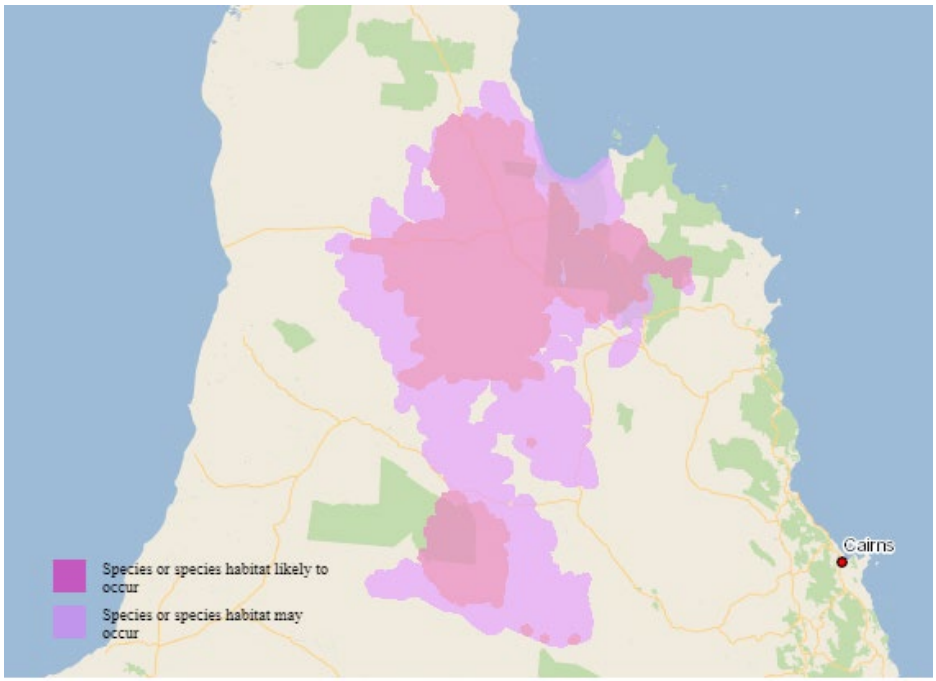
The Threatened Species Index (TSX) provides reliable and robust measures of change in the relative abundance of Australia's threatened and near-threatened species at national, state and regional levels. Understanding these changes in species populations is crucial for monitoring Australia's conservation 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 Golden-shouldered Parrot. More information on the TSX, including how to contribute threatened species monitoring data to the index, can be found at tsx.org.au

1.4 Distribution and abundance

The Golden-shouldered Parrot is endemic to the Cape York Peninsula in far north Queensland (Figure 1) (Collingwood et al. 2020; Crowley et al. 2004; DOE 2022). Once widespread from Croydon in the southwest to near Weipa in the north, they are now restricted to two smaller populations on the Cape York Peninsula (Garnett & Crowley 2002). The Morehead population occurs in the headwaters of the Morehead River and adjacent westward flowing streams covering approximately 1000 km2. As of 2016 the range of the Morehead population is still considered to be contracting along its northern and eastern boundaries (TSSC 2017).

Figure 1. Distribution of Golden-shouldered Parrot



Source: Golden-shouldered Parrot SPRAT

The Statten population extends across approximately 300 km^2 throughout the upper tributaries of the Statten River, west of the Lynd River in the Headwaters of Cockburn, Back and White Horse creeks (Crowley et al. 2004). A third population was previously recorded north of Coen, however, it was last observed breeding in 1922 (White 1922). Sightings of birds in this area persisted until 1970 (Crowley et al. 2004) and occasional sightings continue to be reported outside of their Morehead and Statten ranges, and there is insufficient genetic data to determine if the two populations are genetically isolated (Preece et al. 2009). However, despite searches, no additional populations have been found (Garnett & Crowley 2002). Most of the parrot's current range occurs on Indigenous lands where the Olkola People (National Environmental Science Program Threatened Species Research Hub 2019; Olkola Aboriginal Corporation 2022) now lead their conservation through the recently formed National Recovery Team.

The population size was previously estimated to be fewer than 2500 birds at the start of each breeding season (Crowley et al. 2004). However, recent research suggests that these estimates do not adequately consider the habitat suitability within the parrot's range (Collingwood et al. 2020; Olkola Aboriginal Corporation 2022). Adjusted estimates suggest a total population of around 1000 individuals remaining (Olkola Aboriginal Corporation 2022). These more recent estimates are based on new information and do not indicate any trend or direction of change in the Golden-shouldered Parrot's population over time. With limited surveying, it is unclear if the overall population is increasing, stable or declining (Preece et al. 2009).

1.5 Habitat requirements

Golden-shouldered Parrots occupy various habitats across their range, taking advantage of seasonal food sources in far north Australia during the wet and dry seasons (Crowley et al. 2004). The species' historical range closely matches the extent of the tropical savanna zone on Cape York Peninsula. To the north and east of their range, the availability of fallen seed critical to their diets is limited by shorter and sometimes non-existent dry seasons (Olkola Aboriginal Corporation 2022). To the south, rainfall is unreliable with many wet seasons failing (Olkola Aboriginal Corporation 2022). Much of the vegetation occupied by the parrots is poorly mapped, partially because they habitat units are too small to map and partially because the nesting habitat is difficult to access (Garnett &

Crowley 2002). In broad terms they occur in tropical savanna open woodlands with canopy dominated by *Melaleuca* or *Eucalyptus* species and ground layer dominated by grass species *Schizachyrium*, *Thaumastachloa*, *Sorghum plumosum* and *Eriachne burkitti* (Garnett & Crowley 2002).

These grasses and open woodlands have been maintained for thousands of years by infrequent low-intensity fires occurring naturally at the break of the wet season (storm burning) from lightning strikes or managed by Indigenous people (Bassani et al. 2006). Such fires prevent the recruitment of young woody plants and their suckers into the canopy layer by benefiting grass species to proliferate before suckers re-establish (Crowley et al. 2009; Crowley & Garnett 2001). Changes in these fire regimes since European settlement has resulted in woody thickening in grasslands and grassy woodlands (Crowley et al. 2009). *Melaleuca viridiflora* has explicitly changed the structure of open woodlands within the Golden-shouldered Parrot's nesting range (Crowley et al. 2009) and reduced the native grasslands available for parrots to feed on (Crowley & Garnett 1998).

The monsoonal climate cycles in this region drive the ecological cycles (Crowley & Preece 2019). Many annual and perennial grass species in the monsoonal tropics produce vast amounts of seeds that sit on the soil surface and provide food for the parrots throughout the long dry season (Crowley et al. 2004). A shortage of food occurs annually in the early wet season when most fallen seed has already geminated, this can be worsened by lack of burning and intense grazing by introduced species (Garnett & Crowley 2002). At this time, parrots feed on seeds that have fallen on the gravelly slopes associated with metamorphic and granite rock or in a storm-burnt habitat where patches of roasted seeds that cannot germinate are available (Crowley et al. 2004). Seed germination occurs later on the gravelly slopes as water can drain away more freely than on other substrates (Garnett & Crowley 2002). These habitat features appear to improve the survival of parrots, particularly young, inexperienced birds, through the wet season (Crowley et al. 2004). This suggests that that food supply in the rest of the landscape is often inadequate to support the population (Crowley et al. 2004).

The parrots excavate termite mounds to build their nests in, particularly those of *Amitermes scopulus* in the Morehead population and *A. vitiosus* in the Staaten population. Mounds are rarely occupied more than once and are likely to be at least 30 years old before they reach a suitable size for nesting in (Garnett & Crowley 2002). They primarily occur along grassy drainage flats fringed by woodland, and on gravel slopes where vegetation is open. The open structure allows parrots to be vigilant of predators, however, intense grazing by cattle and pigs and altered fire patterns have resulted in a greater density of woody shrubs (Crowley & Garnett 1998; Crowley et al. 2004) and may increase the vulnerability of nesting parrots (Garnett & Crowley 2002; Preece et al. 2009). Nests are often found in the vicinity of *Artamus cinereus* (Black-faced Woodswallow) nests; whose alarm calls at the approach of predators assist the parrots (Crowley et al. 2004).

1.6 Biology and ecology

The Golden-shouldered Parrot is one of three small (45-55 g) granivorous parrots that nest in termite mounds (TSSC 2017). Like most parrots, it is vividly coloured. The males are primarily turquoise with a salmon-coloured belly, a black crown and a streak of yellow on its wing and forehead. Females and immature birds are mostly green with a turquoise rump (Garnett & Crowley 2002).

After the first wet-season rains, the parrots form flocks associated with breeding Black-faced Woodswallows, to reduce the threat of predation by *Cracticus nigrogularis* (Pied Butcherbird) (Crowley et al. 2004). Black-faced Woodswallows act as sentries alerting parrots to the presence of predators. Black-faced Woodswallows, like the Golden-shouldered Parrot are also open country birds (Higgins 1999) and are less common where vegetation has thickened. A shortage of food occurs early in the wet season and lasts for a period of about six weeks (Crowley & Garnett 1999, 2001) until perennial grasses, particularly *Alloteropsis semialata* (Cockatoo Grass) begin producing seed and

green legumes become abundant (Crowley & Garnett 2001), which initiates egg-laying (Crowley et al. 2004). Parrots alternate food sources continually through the wet season, feeding throughout the daylight hours. Egg laying ceases when green grass seed is no longer available (Garnett & Crowley 2002). Termite mounds of appropriate size are excavated for nests (Figure 2.), generally by the female between March and June. On average, birds lay five to six eggs, of which approximately 75 % hatch and of these 65 % successfully fledge (Garnett & Crowley 2002). Most nestlings have fled by the middle of the dry season (July–August). Young birds stay with their parents within about 2 km of the nest for the first six weeks after fledging and often in a flock with other birds (Crowley et al. 2004). After breeding, the birds disperse through open *Eucalyptus tetrodonta* woodland (Darwin Stringybark), concentrating their feeding activity on the super-abundant seeds of *Schizachyrium* spp. (fire grasses) (Crowley & Garnett 1999), on which they forage for less than 2 hours a day (Crowley et al. 2004). The birds begin breeding after one year and have a maximum longevity in the wild of eight years resulting in a generation time of 4.1 years (TSSC 2017).

Figure 2. Golden-shouldered Parrot nest in termite mound



Source: SBS

Golden-shouldered Parrot nests are the only known habitat for the Antbed-parrot Moth (*Trisyntopa scatophga*) (Cooney 2009; Garnett & Crowley 2002), they occur in nearly all surveyed nests but not nests of other birds in the same area (TSSC 2016). The moth's larvae consume fallen excreta and clean the birds' feet and feathers, resulting in clean nests and nestlings (Turner 1923) potentially benefitting the health of young birds (Cooney 2009). The nature of the association between parrot and moth has not been identified (i.e. mutualistic, commensal or parasitic); however, if the relationship proves to be mutualistic, any plans to reintroduce or relocate Golden-shouldered Parrots to parts of its former range should also include the Antbed-parrot Moth (Cooney 2009). Any decline in parrots or threat to nesting habitat also implies a threat to the moth (Garnett & Crowley 2002).

1.7 Threats

Butcherbirds (*Cracticus* spp. and *Melloria* sp.) and goannas (*Varanus* spp.) were previously thought to be the most significant predators of Golden-shouldered Parrots (Crowley et al. 2004; Preece et al. 2009). Small tree goannas predate the eggs and chicks, and butcherbirds take chicks and adult birds. However, Yellow-spotted Monitors (*Varanus panoptes*), Brown Goshawk (*Accipiter fasciatus*)

and cats (*Felis catus*) where all recorded taking live birds and potentially adults from nests in recent camera trapping (Collingwood et al. 2020; Olkola Aboriginal Corporation 2022).

Vegetation thickening and the encroachment of *Melaleuca viridiflora* into grasslands, caused by altered fire regimes (Crowley & Garnett 1998; Neldner et al. 1997) may contribute to the increased predation of the Golden-shouldered Parrot (Collingwood et al. 2020; Crowley et al. 2004) though it is difficult to attribute this directly, nesting success appears to be more successful where habitats have an open structure (Garnett & Crowley 2002). Indirectly, vegetation thickening appears to result in loss of Black-faced Woodswallows (Crowley et al. 2004) whose alarm calls when predators are nearby greatly benefit the Golden-shouldered Parrot (Crowley et al. 2004). Nesting Black-faced Woodswallow populations appear to be declining across the Golden-shouldered Parrot's range (Garnett & Crowley 2000) although the divers of their decline are not well documented (Olkola Aboriginal Corporation 2022).

Vegetation thickening can also cause termite mounds for nesting sites to grow more slowly (Crowley et al. 2009) due to increased shading and less food availability for termites (Garnett & Crowley 2002). The availability of termite mounds suitable for nesting is decreasing (Crowley et al. 2004). It is estimated that mounds must be at least 30 years old before they are suitable for nesting (Garnett & Crowley 2002), with their growth rates affected by the length and intensity of the wet season and fire regimes (Crowley et al. 2004). Small termite mounds are also vulnerable to trampling by pigs and cattle (Crowley et al. 2004; Garnett & Crowley 2002).

A shortage of wet season food availability can be exacerbated by inappropriate fire regimes (Crowley & Garnett 1999; Crowley et al. 2004) as storm burning at the end of the wet season removes vegetation cover to expose seeds and scorch germinated seeds, increasing food availability during this period (Crowley & Garnett 1999).

2 Existing monitoring

2.1 Overview of monitoring methods

The Golden-shouldered Parrot is one of three Australian parrots known to excavate their nests in termite mounds, they choose mounds in open grassy areas within Melaleuca or Eucalypt savannas that provide them an opportunity to detect predators as they approach. Area searches throughout suitable habitat within their range for nests and opportunistic detection by call and sightings are the most common methods to survey their populations.

Monitoring for the Golden-shouldered Parrot commonly focuses on:

- range (area of occupancy and extent of occurrence)
- population abundance
- vegetation structure and condition in existing and former parrot habitat
- nesting habitat and nest site selection
- dry season feeding activity
- wet season feeding ecology

(Garnett & Crowley 1995).

2.2 Monitoring resources

Key resources with information for monitoring the Golden-shouldered Parrot include:

- Re-assessment of the status of the Golden-shouldered Parrot *Psephotus chrysopterygius* (Preece et al. 2009)
  - Population survey conducted on the Morehead River population.
  - Surveys were conducted on five of the Morehead River area properties known to hold breeding populations of the parrot, including Artemis, Mary Valley, Killarney, Dixie and Kalinga.
  - Transects with a total length of 1500 km were surveyed for the presence of termite mounds being used for nesting.
  - Photos and measurements were taken of all nests, and the location of all parrots, Black-faced Woodswallows and associated species were also recorded.

- Native and exotic nest predators of Alwal (Golden-shouldered parrot *Psephotellus chrysopterygius*) on Olkola Country, Cape York Peninsula, Australia (Collingwood et al. 2020)
  - Monitoring to determine native and exotic predators of the Golden-shouldered parrot.
  - Camera traps were deployed on active nests. One camera was placed in close proximity to the nesting hollow to monitor parrot and nestling activity, with a second camera further away to monitor predator activity.
  - All woody trees were counted and measured within 50 metres of surveyed nests.
  - One of the recommendations from this study was to "improve nest predation monitoring techniques".
- Survey Guidelines for Australia's Threatened Birds EPBC Act Survey Guidelines 6.2 (DEWHA 2010)
  - Recommends area searches throughout suitable habitat.
  - Detection is by call, sightings or observation of nest holes in termite mounds. In the mornings they call frequently when leaving roost sites to feed. Alarm calls when flushed.
  - Targeted searches and watches by waterholes may also be useful in the dry season

(September to November).
  - Holes are similar to but distinguishable from the Red-backed Kingfisher (*Todiramphus pyrrhopugia*)
  - Early in the breeding season (November – January) Black-faced Woodswallow flocks should be surveyed/checked for immature male Golden-shouldered Parrots who form an association.

- Draft Golden-shouldered Parrot Recovery Plan (Olkola Aboriginal Corporation 2022)
  - Outlines the management plan to restore Golden-shouldered Parrot habitat and ecological processes, including dingo interactions and resource availability
  - Aims to manage the recovery program using culturally appropriate and scientifically robust principles
- Recovery plan for the Golden-shouldered Parrot Psephotus chrysopteryguis 2003-2007 (Garnett & Crowley 2002)
  - The recovery plan had specific objectives, including determining population trends, managing habitat at a landscape scale, determining the impacts of pied butcher birds on nest success and determining the impacts of change in vegetation structure on Black-faced Woodswallows.
  - An overall objective of the recovery plan is to see an increase in the number of wild populations of Golden-shouldered Parrots with the result of downlisting the species from endangered to vulnerable.

- Management guidelines for Golden-shouldered Parrot conservation (Crowley et al. 2004)

  Steps in the proposed reintroduction of Golden-shouldered Parrots:
  - Site identification - Assess criteria for habitat suitability
  - Site restoration - Manage site to restore and maintain habitat
  - Site security - Establish a protected area or conservation agreement over reintroduction area
  - Proposal preparation - Develop captive breeding and release program within national and international protocols
  - Apply for appropriate permits - Identify resource and personnel requirements
  - Population assessment - Use population viability analysis to assess whether removal of nestlings will threaten existing population
  - Aviary design and construction - Liaise with amateur bird keepers to develop aviary design
  - Capture of wild birds - Take nestlings from nests in dense vegetation
  - Management of captive birds - Rear birds in aviary at capture sites then transfer birds to release aviaries.
  - Release - Release groups of at least 50 birds at a time during breeding season. Provide supplementary food until the birds are feeding independently, as well as in the early wet season
  - Monitor population success - Monitor nests in the wild and monitor wet season population

2.3 Survey methods

2.3.1 Nest surveys

Nest surveys are used in areas of potential or known parrot habitat within their range to inform population estimates (Preece et al. 2009). They have also been used in areas outside or on the cusp

of their known range in suitable habitat in an effort to locate additional populations and define range boundaries with more confidence (Garnett & Crowley 2002).

Nests are excavated in termite mounds of *Amitermes scopulus* in the Morehead population and *A. vitiosus* in the Staaten population. The termite mounds become a suitable size at around 30 years old though most mounds used for nesting are at least 50 years old (Garnett & Crowley 2002)

Old nests can still be present more than a decade after exploration, though most are built over within a season of use Old nests can still be present more than a decade after exploration, though most are built over within a season of use. Active or fresh nests usually have a fresh pile of dirt below the hole (DEWHA 2010). Nests are excavated in termite mounds between March and June and most nestlings have fully fledged by July/August.

Preece et al. (2009) conducted nest surveys of the Morehead population of Golden-shouldered Parrot to:

- determine trends in the population size, and
- observe nest predation, flock sizes, sex ratios, number of juveniles and presence/absence of Pied Butcher Birds and/or Black-faced Woodswallows.

The surveys occurred in response to objectives outlined in the Recovery Plan for the Golden-shouldered Parrot *Psephotus chrysopteryius* 2003-2007 (Garnett & Crowley 2002) and the methodology used was based ongoing surveys of remote nesting sites in 1996/7 and 2001/2, however, documentation of these methods could not be found to include in this document. Garnett and Crowley (2002) recommend establishing a five year monitoring routine to identify trends throughout the parrot's distribution, however, the Preece et al. (2009) survey occurred eight years previous surveys.

Surveys of termite mounds for active nesting hollows in (Preece et al. 2009) were conducted:

- at five properties known to have breeding populations of the parrot in the Morehead River range (Artemis, Mary Valley, Killarney, Dixie and Kalinga)
- by surveyors on motorcycle and four-wheeler bike
- by at least two people necessary to conduct surveys
- at the end of breeding season; from March to June (this is variable, depending on the duration of the wet season and availability of green seed (Garnett & Crowley 2002)
- using handheld GPS receivers to track the survey transects and to record the locations of nests observed during the surveys
- over a total of 1500 km of survey transects
- for five days by two surveyors.

Data collected included:

- the location of active nests
- tracks of surveyed transects
- opportunistic observations of flock size and makeup (male : female : juvenile) and presence/absence of other species in the flock
- photographs of active nests
- photographs and descriptions of evidence of predation and nest damage
- measurements of termite mounds used for nesting

- measurements of excavated nesting holes
- presence/absence of Pied Butcher Birds (predator) and Black-faced Woodswallows (friend).

Signs of nesting behaviour include:

- excavated hole in termite nests
- fresh piles of dirt below the hole (DEWHA 2010)
- honeycombed patches of spent pupae (Cooney 2009; Garnett & Crowley 2002).

2.3.2 Camera trapping

Camera trapping is conducted as an extension of nest surveys with the purpose of documenting breeding success and nest predation (Collingwood et al. 2020).

A study by Collingwood et al. (2020) aimed to identify nest predators of the Golden-shouldered Parrot, using camera traps. The secondary aims of the study were to examine the relative impacts that predators have on nest success and collect evidence for the relationship between woody vegetation encroachment and nest success.

Camera trapping procedure as described in (Collingwood et al. 2020) included:

- nest searches conducted across known nesting habitat informed by the methodology outlined by Preece et al. (2009) (see section 3.1)
- searches conducted during breeding season over a two year period (April to September 2016 and March to October in 2017)
- nests were inspected following protocols established by Crowley and Garnett (1995) to determine the development stage
- cameras deployed on 28 active nests for 1660 camera-trap nights over two consecutive breeding seasons
- two sets of camera traps were deployed on each active nest identified
- camera one was placed 1-1.5 m from the nest entrance to monitor parent and nestling activity
- camera two was placed 3-4 m from the nest to monitor predator activity.

Signs of the nest development stage include:

- fresh dirt piled below the nest hole indicates a fresh or active nest (DEWHA 2010)
- short tunnels or scrapes in termite mounds but no excavation indicates an abandoned attempt at nest building perhaps due to the uncovering of a previous nest and 'rotten' interior (Garnett & Crowley 1998)
- larvae of the Antbed-parrot Moth indicate an active or recently active nest (Crowley & Garnett 1995).
- nest holes occupied by crickets, spiders and case moth larvae indicate an abandoned nest
- termites begin re-filling nests soon after they have been abandoned.

Other measurements taken included:

- all woody trees counted either side of two perpendicular 50 m transects that ran north-south, and east-west, intersecting at the nest site and categorised as:
  - immature (height <2 m or >2 m with circumference <20 cm at breast height (130 cm)) or,
  - mature (height >2 m with circumference >20 cm at breast height)

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

Key agencies, organisations or individuals identified as having been previous, or currently actively involved in monitoring the Golden-shouldered Parrot include:

- Artemis Nature Fund – long-term monitoring and restoration program for the Golden-shouldered Parrot
- Golden-shouldered Parrot Recovery Team, Olkola Aboriginal Corporation
- Noel Preece, James Cook University
- Stephen Garnett, Charles Darwin University
- Gabriel Crowley, University of Queensland (botanist, technical advice (Preece et al. 2009)).

4 Key survey guideline recommendations gathered from the literature

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

- The presence and abundance of the Golden-shouldered Parrot is often detected by active nest holes excavated in termite mounds (Garnett & Crowley 2002; Preece et al. 2009). This is undertaken as area searches in suitable habitat.
- Vegetation mapping of areas known to be occupied by the parrots that are currently poorly mapped (Garnett & Crowley 2002) may be useful in discerning areas of focus for future searches to better understand extent of occupancy.
- Detection by call sightings, direct observation, and targeted surveys and watches at waterholes during the dry season are recommended in the *Survey guidelines for Australia's threatened birds* (DEWHA 2010). When surveying, consideration should also be taken to account for immature parrots that associate with Black-faced Woodswallow flocks.
- Camera trapping has been effective at nest success surveys and identifying predators (Collingwood et al. 2020).

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5 Appendices

Appendix 1. Alwal Nest Survey Data Sheet – Olkola Aboriginal Land Managers

Alwal Nest Survey Data Sheet

1 CAMERA NUMBER: _____Distance from nest_____

DATE_____ # 2 CAMERA NUMBER _____Distance from nest_____

1. Nest number: _____
2. Property and site/ flat name:_____
3. GPS Waypoint: _____

4. Were the parents present? Record if mum or dad were seen flying, at the nest, or heard nearby.	
5. Height of antbed (cm)? Measure from the ground to the highest point.	
6. Height of nest hole (cm)? Measure from ground to the base of the hole.	
7. Measurements of nest hole entrance (cm)? Measure from the bottom to the top of the hole in cm/ and from one side to the other.	Hole dimensions top to bottom: Hole dimensions side to side:
8. Base of antbed (cm)? Measure girth with measuring tape.	
9. What direction is the hole facing? (North, South, East, West)	
10. Any chicks or eggs? Record number of each and details (just hatched, got coloured feathers already? eggs fresh/ dirty?)	
11. Are there any grubs in the nest? Look for grubs in the bottom of the nest. Record if there are any old 'honeycomb' patches where old nests have been.	
12. Tree density? (0 = very open, 1 = very few large trees, 3 = many large trees, 4 = very thick)	
13. Walk 7 steps back from hole and take a photo	Photo taken? Take a photo of this data sheet after the nest photo.
14. Did you hear or see any Butcher Birds around the nest?	

Any other Notes: (Record here if it was a fresh scrape)



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