Ecological Field Monitoring Protocols Manual

Using the Ecological Monitoring System Australia

Vertebrate Fauna Module

tern
Ecosystem Research Infrastructure

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

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

Citation

O'Neill S, Laws M, Bignall J, and Sparrow B, (2023) Vertebrate Fauna Module. In 'Ecological Field Monitoring Protocols Manual using the Ecological Monitoring System Australia'. (Eds S O'Neill, K Irvine, A Tokmakoff, B Sparrow). TERN, Adelaide.

Version

Readers are advised that all modules of the Ecological Field Monitoring Protocols Manual regularly undergo revision. Readers should check the website tern.org.au/emsa-protocols-manual/ to ensure they are viewing the current version.

Version 1

Last updated: 21 Jully 2023

Acknowledgements and contributors

This publication is the result of a body of work funded by the Australian Government Department of Climate Change, Energy, the Environment and Water to develop standardised ecological monitoring standards.

Key components of this module were developed, written, and field tested by the TERN Ecosystem Surveillance team, including by Julia Bignall, Beth Cox, Ellen Kilpatrick, Mark Laws, Kimberly McCallum, Rhys Morgan, Tamara Potter, and Carly Steen. Technical components, including the development of the accompanying app, were developed by the team led by Andrew Tokmakoff, including Luke Derby, Matthew, Jin Zhou, Ho Hai Huy Vo, Walid Al Naim, Muhummad Khan, and Michael Doroch. Aspects of the protocols that have been built on by this project are the result of the extensive and ongoing body of work conducted by the TERN Ecosystem Surveillance team, as part of TERN's field-based ecosystem monitoring program. A full list of team members who have contributed is available on the TERN eSupport Services website.

This module builds on previous work undertaken by TERN under the National Emerging Research Priorities project funded by the Australian Government 2013-2015. This work included development of a candidate draft fauna manual designed for implementation by TERN alongside the ecosystem monitoring (AusPlots) program. The national working group who contributed to this project included: David Armstrong, Megan Barnes, Marcus Baseler, Peter Cale, Rebekah Christensen, Mark Cowan, Chris Dickman, Mark Eldridge, Teresa Eyre, Mike Flemming, Alex Kutt, Samuel Luccitti, Pete Lyon, Nikki Thurgate, Erin Turak, Jeff Turpin, Stephen van Leeuwan, Glenda Wardle, Dominic Wundke, Ben Sparrow and Sally O'Neill.

TERN is funded by the National Collaborative Research Infrastructure Strategy.

Copyright

Disclaimer

The information contained in this document comprises information and instructions for implementing ecological monitoring field surveys. The reader is advised that TERN has made best efforts to ensure instructions are comprehensive enough to fulfil the tasks required to the standards required at the time of publication. All field surveys must be carefully planned to ensure the safety of personnel is paramount and that the required scientific permits and wildlife licences are obtained from the appropriate jurisdictions and conditions strictly adhered to. Such requirements may go above and beyond those listed in this manual. TERN, including the project personnel, are excluded from all liability to any person for the consequences, including but not limited to all losses, damages, costs, expenses and any other compensation arising directly or indirectly from using this publication (in part or in whole) and any information or material contained in it.

Photographs presented in this report are provided by TERN unless otherwise indicated.

Main cover photograph: Pale Field Rat (*Rattus tunneyi*), Edel Land, Western Australia.

Version control

Readers are advised that all modules of the Ecological Field Monitoring Protocols Manual regularly undergo revision. Readers should check the website tern.org.au/emsa-protocols-manual/ to ensure they are viewing the current version.

The version history of this module is identified below. The version history of the Ecological Field Monitoring Protocols Manual, the methods and data implications, both historical, current and future interpretations of data, are available from the TERN website. Enquiries should be directed to tern@adelaide.edu.au

Version	Date	Version update overview
1	21 July 2023	First published version

About the Ecological Field Monitoring Protocols Manual

This module is one of many that form the *Ecological Field Monitoring Protocols Manual* using the *Ecological Monitoring System Australia* (EMSA), available at tern.org.au/emsa-protocols-manual/. EMSA has been developed by the Terrestrial Ecosystem Research Network (TERN) in collaboration with the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) to support the National Landcare Program (NLP). The protocols included in the modules build on previous work by numerous ecologists throughout the country (acknowledged in the text) and have been refined with the help of Australia's natural resource management (NRM) community. They provide users with a clear set of protocols to measure and monitor most Australian ecosystems quantitatively and repeatably to enable the reliable quantification of environmental change.

The system addresses many limitations evident in previous NRM programs that have made this change quantification difficult. These included measuring or estimating environmental occurrences with disparate and often incompatible methods, particularly over a range of geographic scales, along with previous inefficiencies in data provision and analysis. The EMSA protocols presented in the modules provide clear and proven methods (built upon previous method/s where appropriate) to accurately measure environmental change for many variables of interest in Australian terrestrial environments. The modules are supported by a toolset to collect and deliver data to the Australian Government's Biodiversity Data Repository, which will see various management, policy and research outcomes informed by the data collected.

The current set of 24 modules is not an exhaustive list, and TERN and DCCEEW may develop additional modules in the future as gaps are identified. We intend these modules and the supporting Monitor app to be widely accessible, with little assumed knowledge, using methods that NRM practitioners and ecologists can easily adopt. To support the uptake of the protocols, we are also developing a series of education and guidance materials and an in-person training course. We anticipate that users outside of the NLP may be interested in utilising these protocols. The team plans to make a version available in the near future that will be independent of the NRM project management system - the monitoring, evaluation, reporting and improvement tool (MERIT), to enable that widespread use.

We acknowledge, value and respect the experiences, perspectives and cultures of Indigenous Australians. We recognise the importance of combining Indigenous and western environmental knowledge systems to improve ecological monitoring in Australia. The EMSA protocols are designed to be implemented alongside First Nations protocols, procedures and policies, and we look forward to working in partnership with Indigenous land managers on future versions of these protocols.

The protocols detailed here are freely available for widespread use by acknowledging their source. The protocols will be refined over time, so we encourage you to download the latest version before using them. We look forward to continuously improving these protocols in the same way as we utilise an adaptive management framework on the environments we monitor. We know that the data collected and supported by this program will enable analyses in novel ways and at previously impossible scales. We thank you for joining us on that journey and look forward to working with you to implement the EMSA system to benefit all Australians.

We also welcome you to provide feedback to tern@adelaide.edu.au

Ben Sparrow
Associate Professor and Program Lead, TERN Ecosystem Surveillance

Contents

Figures

Tables

Appendices

1 Module overview

1.1 Available protocols

This Vertebrate Fauna Module covers the procedures and guidelines to conduct five survey protocols. The protocols are:

- **Trapping survey set-up and closure protocol** (optional) sets up the Fauna Plot and positions the various trap types (pitfall, funnel, box, and cage traps) in a standard array. All trap details are recorded. Traps are left open for five (standard) or seven (enhanced) consecutive nights, checked at least twice daily, and closed at the end of the trapping session.
- **Identify, measure and release protocol** (mandatory when trapping is conducted) collects the capture details from the trapping conducted, including the species identification, morphology measurements, body condition and health status, and collects are series of photographs from all individuals (recommended) or a representative sample of each species.
- **Bird survey protocol** (recommended, mandatory when trapping is not conducted) surveys the 2 ha Biodiversity Plot following standard BirdLife Australia 2 ha, 20 minute surveys, or 500 m (radius) area searches, recording all bird species observed (seen or heard), and sex, age-class and behaviour details where possible.
- **Active and passive search protocol** (optional) records all fauna observations whilst actively searching for fauna and signs of fauna and conducts passive nocturnal searches.
- **Acoustic and ultrasonic recordings protocol (optional)** establishes acoustic recorders at the Biodiversity Plot for 14 consecutive days (recommended) or at least 7 consecutive days. All device details are captured, including microphone and recording time intervals, targeted microhabitat and habitat elements. Acoustic recorders can be set to record acoustic calls (birds, frogs, invertebrates) and or ultrasonic calls (bats), depending on the devices and microphones used.

1.2 Relationships to other modules

1.2.1 Mandatory related modules

Mandatory modules to be completed prior to or in unison with Vertebrate Fauna Module:

- Plot Selection and Layout Module – needs to be undertaken before any fauna surveys can be conducted to mark the location of the Fauna Plot where survey activities will be conducted. The Monitor app is used to establish the plot location and to flag the outer to provide a visual cue of the outer boundary for bird surveys. The end locations of the trap lines are also marked if undertaking a trapping survey. Trapping surveys are conducted on a Fauna Plot, established immediately adjacent, or within 50 m, to a Core Plot where many other EMSA modules are completed. This ensures habitat and ecosystem data is also being obtained. The trapping module must not be conducted within a Core Plot, as the disturbance will interfere with long-term monitoring.
- Plot Description Module – describes the plot using standardised methods and terminologies, including the landform, slope, aspect and disturbance, and a vegetation structural formation description.
- Photopoints Module – captures the physical state of the plot at the time of the survey in a series of panoramic photos. The photos can be used as static photos but can also be analysed, and data on standing carbon extracted. The Photopoints Module needs to be completed when implementing the fauna survey, particularly for each trapping event. There is no need to repeat the photopoints more often than seasonally. For example, suppose a trapping survey is conducted annually, but bird surveys are conducted monthly. In that case, the Photopoints

Module should be conducted seasonally (or once per quarter), and there is no need for monthly photopoints.

1.2.2 Optional complementary related modules

Optional complementary modules to gather additional information relating to the Vertebrate Fauna Module:

- Opportune Module – enables the recording of opportunistic direct sightings of fauna species and indirect signs of fauna (i.e. tracks, scats etc.) captured in a standardised way. Opportune sightings anywhere within the project area whilst undertaking any survey, or non-survey activity, can be recorded. Data collected via the Opportune Module can assist in identifying if fauna species present in the project area are being missed through the other modules being implemented.
- Invertebrate Fauna Module – utilises the Fauna Plot to conduct several survey methods targeting different invertebrate groups. Information obtained contributes to understanding the invertebrate fauna community and linkages to vertebrate fauna food item availability.
- Camera Trapping Module – captures information on fauna species present in the project area and can be useful for confirming occupancy of locations and habitat, particularly of cryptic species, trap-shy species, and species not otherwise detected via the other fauna survey methods. The Camera Trapping Module enables cameras to be set and left in situ for many weeks (or longer, depending on battery life).
- Targeted Surveys Module – allows for specific species-specific techniques and methods that do not align with the methods of the Vertebrate Fauna Module to be implemented.
- Interventions Module – records any management actions specific to fauna and provision of fauna refuges and resources (nest boxes, artificial cover, removal of artificial water sources).
- Condition Module – collects an array of information relating to key habitat attributes. The Condition Module (and associated pre-requisites) is beneficial in understanding food, refuge and habitat resources available to fauna populations.
- Fauna Ground Counts Module – allows for off-plot surveys within the project area. Survey transects are walked or driven during the day or night, recording observations. The module also contains a protocol for vantage point surveys. Surveys undertaken are beneficial for understanding the distribution of medium and large fauna within the project area.
- Signs-based Fauns Surveys Module and Herbivory and Physical Damage Modules – collect information on the presence of fauna, particularly useful for identifying the distribution and relative abundance of large pest fauna species of the project area. Selected protocols of these modules can be conducted within the Fauna Plot, or Core Plot, or elsewhere off-plot within the project area.
- Pest Fauna Control Activities Module – records activities relating to the control of pest fauna species, including trapping, baiting, shooting, poisoning, warren ripping etc., conducted to reduce pest fauna abundance.

Fauna surveys can be completed either as trapping or non-trapping surveys. For trapping surveys, the protocols establish the survey plot, layout the traps, and record the trap specifications in the Monitor app. The Monitor app is also used when traps are checked to ensure all traps are checked to meet animal ethics requirements. The Identify, measure and release protocols must be completed for all trapping surveys, and the details of captures are recorded in the Monitor app. For a trapping survey, the Active search protocols, Bird survey protocols, and Acoustic and ultrasonic recording protocols are recommended, either completing all three protocols or just one.

For non-trapping surveys, the minimum requirement is the Bird survey protocols. Ideally, bird surveys should be combined with at least one other protocol, Active and passive searches or the Acoustic and ultrasonic recordings protocol, where possible. Completing only the Acoustic and ultrasonic recordings protocol or only the Active and passive protocols is inappropriate. Table 1 highlights the preferred module combinations.

Table 1. Vertebrate Fauna Module trapping and non-trapping protocol combinations

Protocol	Trapping survey module combination	Non-trapping survey module combination
Trapping survey set-up and closure protocol	▪ Complete	▪ Do not complete
Identify, measure and release protocol	▪ Complete	▪ Do not complete
Bird surveys	▪ Recommended	▪ Complete
Active and passive searches	▪ Recommended	▪ Recommended
Acoustic and ultrasonic recordings	▪ Recommended	▪ Optional

All Vertebrate Fauna module protocols are conducted within or centred around a 2 ha biodiversity plot (plot naming conventions start with the IBRA/bioregion name, followed by a B for 'biodiversity'). The biodiversity plot extends the 100 x 100 m 1 ha core survey plot to be a 200 x 100 m plot. Trapping activities must be conducted outside of the 100 x 100 m Core Plot to avoid significant disturbance to the Core Plot. Bird surveys are conducted across the 2 ha biodiversity plot.

Table 2 provides an overview of the different Fauna Module protocols.

Table 2. Overview of the Fauna Module Protocols

Protocols	Details	Data captured
Trapping survey set-up and closure protocol	▪ Trapping grid layout consists of 2 lines of 6 pitfalls and 4 funnels along each ~60 m drift fence, plus 4 lines of 10 box traps and 8 cages ▪ Trap for either 5 consecutive nights (standard) or 7 consecutive nights (enhanced), checking traps morning and afternoon, monitor weather conditions and other animal ethics concerns, temporarily close trap if necessary, close the trapping grid at the conclusion, remove all traps and ground disturbance. ▪ Ensure all scientific permit and ethics permit conditions are adhered to, including trap type, trap set-up (provision of weatherproof materials), duration between checking the traps, temporary closure of traps if traps take longer to check, or weather conditions become unfavourable, putting caught animals at risk.	▪ Records survey effort and specifications of the traps used, and trap success rates (by trap type).
Identify, measure, mark and release protocol	▪ Record species, weight, head-body length (mammals), head-vent length (reptiles and amphibians), and tail length. Where possible, record measurements of other identifiable/characteristic features and record sex, reproductive status, body condition and health metrics. ▪ Allows individuals to be permanently marked (microchips, tags) for repeat surveys, or temporarily marked (i.e. texta markings) to ensure accurate capture rates of the survey. ▪ Note this module does not include whole animal or tissue vouchering. Any vouchering must be conducted under guidance from the state/territory jurisdictional museum. ▪ Ensure all scientific permit and ethics permit conditions are adhered to.	▪ Records species and population demographics (age-class and sex), recapture rates, recapture of previously marked individuals (survivorship, site fidelity), and capture details (trap type, trap location) of all individuals caught.
Active and passive searches protocol	▪ Active searches are conducted either during daylight (diurnal) or night time (nocturnal), for a minimum of 60 minutes of observer time (ideally 2 observers for 30 minutes), with surveyors actively moving and looking under coarse woody debris, leaf litter, rocks and tree bark to discover individuals. ▪ Passive searches are conducted either during daylight (diurnal) or night time (nocturnal), for a minimum of 60 minutes of observer time (ideally 2 observers for 30 minutes). Surveyors conduct a passive survey, whereby rocks, debris, leaf etc, are not disturbed, and there are no attempts to flush animals from refuges.	▪ Records observations of species encountered, aimed at identifying species present that may not be readily captured in the traps. Any animals caught by hand may be measured, weighed etc.

Protocols	Details	Data captured
	▪ Nocturnal search (night time hours) minimum 60 minutes of observer time (ideally 2 observers for 30 minutes) traversing the Biodiversity Plot. Nocturnal searches can be either active (looking under coarse woody debris. rocks, leaf litter, and tree bark etc.) or passive, with surveyors remaining quiet to minimise disturbance and merely walking through the plot with spotlights or torches to observe animals. This activity must not be conducted whilst trapping is conducted (i.e., conduct an alternative night before or after trapping).	
Bird survey protocol	▪ Conduct 1-2 morning 20 minute search, and 1-2 afternoon 20 minute search of the 2 ha Biodiversity Plot, recording all birds observed or heard. ▪ Conduct an optional untimed area search of the Biodiversity Plot and wider area (the permitted area is 500 m radius from the centre of the Biodiversity Plot, so long as the same habitat is covered), recording all birds species observed or heard, and where possible, recording activity, behaviour, sex and age-class.	▪ Bird species presence, use of available habitat, breeding and behaviour information.
Acoustic and ultrasonic recordings protocol	▪ Establish acoustic and/or ultrasonic recorders within the Biodiversity Plot. Record the device settings, location and microhabitat details. The recorders must be in situ for a minimum of 14 nights.	▪ Call files, and metadata associated with the device set-up.

2 Introduction and background

The Vertebrate Fauna Module covers the background, procedures and guidelines on when, where and how to conduct a fauna survey for small and medium-sized mammals, reptiles and birds. Some techniques are also suitable for frogs and observing larger mammals. The module has been developed to incorporate several different types of protocols to document different taxa, including trapping, active and passive diurnal and nocturnal searches for fauna and signs of fauna, bird observation surveys, and acoustic and ultrasonic recordings for birds, frogs, bats (and invertebrates).

Vertebrate fauna surveys can be used for baseline surveys and ongoing monitoring surveys to collect valuable data on how the fauna biodiversity of an ecosystem may be changing over time in response to natural fluctuations in resource availability, changes to land management regimes, and responses to land management interventions. The Vertebrate Fauna Module has been developed primarily to obtain an understanding of the native vertebrate fauna present within a project area but can equally be used to understand the exotic pest fauna, particularly when used in unison with the Aerial Fauna Surveys Module, Fauna Ground Counts Module, and Signs-based Fauna Surveys Module.

The key purpose of the Vertebrate Fauna Module is to obtain meaningful, time-series datasets on the vertebrate fauna of the project area and link this data to the other data collected through the other modules that have obtained detailed data on the vegetation communities, structure, composition, and condition, and progress towards restoration. Together, this not only provides detail of the available habitat, but also a comprehensive understanding of the entire ecosystem. Repeated over time, including before, during, and after management interventions have been conducted, provides an insight into trends over time in response to the management.

As with most other modules, the Vertebrate Fauna Module is plot-based, establishing a 1 ha that is 100 m x 100 m, however, the Fauna Plot is adjacent to the Core Plot where vegetation measures are mostly taken from in order to avoid significant disturbance to the Core Plot (i.e. pitfall trapping should never be conducted within the Core Plot). The module specifies standard requirements and prescriptive guidelines for implementing surveys for vertebrate fauna. Sometimes, these standards may not suite a project's needs, which is when the Targeted Surveys Module may be more appropriate. The fauna protocols within the Targeted surveys module offer flexibility that may suit some project's aims and objectives when the methods do not align with the standard requirements of the Vertebrate Fauna Module. Typically the Targeted Surveys Module allows for exceptional circumstances, for example, trapping using different trap types, different trap arrangements, and covering much larger areas. For example, cage traps over a linear transect or track network to target a medium-sized mammal, can be conducted using the Targeted Surveys Module.

The Vertebrate Fauna Module must be conducted with the appropriate approvals from state/territory jurisdictions responsible for administering scientific research involving wildlife. The module has been written with the governing principles of the *Australian Code for the Care and Use of Animals for Scientific Purposes* (NHMRC, 2013 (NHMRC 2013)) in mind. Surveys conducted as part of the Vertebrate Fauna Module is considered a form of environmental studies, and the Code applies to the protocols of this manual. The Code's principles of replacement, reduction and refinement, the 3R's, have been applied:

- the replacement of animals with other methods
    - i.e. acoustic and ultrasonic recordings, and observational surveys (bird surveys, active and passive searches) rather than trapping, see also Camera Trapping Module rather than trapping
- the reduction in the number of animals used
    - only taking animals that the museum deems necessary and for other captures taking morphological measurements and photos and releasing them at the point of capture

- the refinement of techniques used to minimise the adverse impact on animals
    - the instructions, guidelines, and several facets of the app have been deliberately incorporated to refine the fauna survey techniques to minimise adverse impacts.

Key features of the Vertebrate Fauna Module have been included explicitly to aid in meeting scientific permits and animal ethics requirements, including detailed recording of trap status in the Monitor app to prompt surveyors to efficiently and accurately check and record all trap checks, including traps that may have been temporarily closed, as well as documenting trap closure and removal, with photos taken of permanent pitfalls left in situ when permitted to show that they were left secure.

1.3 Key definitions and terminology

Table 3. Common terms used in the Vertebrate Fauna Module.

Term	Definition
Biodiversity Plot	The 200 x 100 m, 2 ha survey plot, that encompasses the 100 x 100 m, 1 ha plot, where additional biodiversity protocols are conducted – including the Vertebrate Fauna protocols. The biodiversity plot is positioned adjacent to the core survey plot, sharing the entire length of one boundary, in any direction.
Core Plot	The 100 x 100 m, 1 ha survey plot where most EMSA activities are conducted. Ideally located directly adjacent to the Fauna Plot where activities of the Vertebrate Fauna Module are conducted.
Fauna Plot	The 100 x 100 m, 1 ha survey plot located adjacent to the core plot, where fauna protocols that cause disturbance are conducted (i.e., including pitfall, funnel, box, and cage trapping, and selected invertebrate surveys).
Monitor app	Field data collection app for Ecological Monitoring System Australia. Collects data using the Australian Biodiversity Information Standard for delivery to the Australian Biodiversity Data Repository managed by the Department of Climate Change, Energy, the Environment and Water.
Opportune observation	A documented record of a species collected without standardised field protocol and without explicit sampling design (van Strien et al. 2013), associated with a geographic location, date and time; may be accompanied by a voucher specimen (whole plant or animal, part thereof, or a tissue sample), photos, video or audio recording.
Voucher specimen	A preserved specimen of an expertly identified taxon deposited in a permanent and accessible storage facility that may later be obtained for examination and further study. This may comprise of a whole plant or animal, part thereof, or a tissue sample. See also vouchering protocols in the Floristics Module, Plant Tissue Vouchering Module, Opportune Module and Invertebrate Modules.
Vouchering	The process by which a voucher is collected and retained through preservation with a view to provide a specimen for later reference or examination. Vouchering permits independent verification of results and allows further study (Department of Parks and Wildlife 2013).
Standard mammal bait	Mix of rolled oats and honey
Tissue sample	A sample of tissue taken from a live or deceased animal that includes ear clip/notch, toe clip, tail clip, skin, skin scrape (cetaceans), muscle, liver, heart, blood, hair, feather, egg shell, scale, faecal sample, egg or semen (Wildlife Ethics Committee 2020). See also tissue vouchering protocols in Vertebrate fauna module.
Trap effort	The total number of nights or days all combined traps are open during a trapping session
Trap nights	The combined total number of traps multiple by the number of nights the traps are left opened for

1.4 Rationale

The protocols presented in this Vertebrate Fauna Module are partly the result of a project funded by the Australian Government whereby a fauna monitoring manual was drafted by a national working group of scientific and management organisations engaged in fauna monitoring across Australia (participates are acknowledged in this module). A discrete component of this project was to develop fauna survey protocols to complement the existing AusPlots Rangelands Protocols (White *et al.* 2012), with the aim to:

- improve our understanding of the distributions, abundance and richness of fauna species across Australia's rangelands

- build an understanding of the relationship between habitat dynamics and fauna species population dynamics
- provide a baseline against which future change can be assessed
- fill a key gap in our ability to understand and report trends in Australian biota
- develop an improved understanding to the degree to which vegetation and condition attributes can be used as surrogates for fauna in biodiversity monitoring.

The working group defined surveillance monitoring for fauna purposes, identified and reviewed methods to achieve fauna monitoring, identified the differences to targeted fauna monitoring, identified jurisdictional and ecosystem differences in standard fauna surveys for inventory purposes, and reviewed and discussed the types of information for collection.

The following details were agreed to clarify exclusions from the scope of the fauna survey protocols.

- Targeted monitoring, particularly at the species level, is not the focus. Targeted monitoring includes specialised survey techniques (including trap types) necessary to adequately species of interest.
- Inventory data is essentially a byproduct of the surveys and not the primary focus.
- Morphological measurements of captured individuals other than measurements to aid identification and categorise age classes is not the focus of the protocols but are seen as additional data to be taken advantage of since the animal is in the hand.

Whilst the original intent of the national working group and the fauna survey manual differs slightly from the intent of fauna monitoring for NRM management, many of the key decisions remain applicable.

to achieve fauna monitoring, identified the differences to targeted fauna monitoring, identified jurisdictional and ecosystem differences in standard fauna surveys for inventory purposes, and reviewed and discussed

1.4.1 The role of NRM in monitoring fauna populations

NRM organisations have an essential role to play in monitoring fauna populations due to their local area knowledge, expertise, understanding of underlying mitigating factors, relationship with landholders and land managers, profound knowledge of community, conservation and NRM drivers in the region, and their on-ground regional proximity, enabling rapid response (given the resources). NRM also play a role in providing on-ground support, motivation, and facilitation of citizen science, an important component in both regional areas and peri-urban areas alike.

1.5 Activities not included in the Vertebrate Fauna Module

The fauna survey techniques and activities not included in the Vertebrate Fauna Module are listed below.

- Use of traps other than pitfall, cage, box and funnel traps, or use of these traps in a non-standard array – see Targeted Surveys Module for available options.
- Use of traps (including Felixer grooming traps) to control pest fauna species – refer to the Interventions Module and Pest Fauna Control Activities Module.
- Hair tubes traps – see Targeted Surveys Module.
- Sand plots and trackpads – see Signed-based Fauna Surveys
- Water body searches for frogs and tadpoles (and other water taxa) – see Targeted Surveys Module.
- Harp and mist netting for birds and bats– see Targeted Surveys Module.
- Active microbat echolocation call detection – see Targeted Surveys Module.

- Vehicle spotlight surveys – see Fauna Ground Counts Module for available options.
- Collection of tissue samples, DNA, and eDNA samples (may be covered in future additional EMSA modules.

3 Fauna survey general guidelines

3.1 Objectives and survey planning

Pre-survey planning tasks should include:

- Desktop assessment
  - Collation of existing information and review of the literature to understand the fauna species that may be present in the project area. This step should include the collation of all previous records, surveys undertaken, and a review of methods conducted.
- Survey design and selection of the protocols to implement
  - Selection of the protocols should be based on the expected fauna community and the relevance to the project.
  - Survey aims and objectives will need to be defined.
  - Survey area, boundaries and extent will need to be identified.
  - Target areas will need to be identified (this may include targeting optional fauna habitat or obtaining a representation of the project area and management zones).
- Identification of jurisdictional requirements regarding scientific permits and wildlife ethics, including liaison, permit application submission and review
- Liaison with museum and other experts to assess requirements for vouchering, and advice regarding species identifications.
- Reconnaissance visits, site inspections, and landholder and land manager negotiations.

Some of these steps are covered in more detail for each applicable protocol presented.

Survey objectives are typically project specific and can focus on:

- Priority areas, ecosystems, habitats and management zones within the project region
- Best-on-offer (BOO) locations
- Survey comprehensiveness (number of Fauna Plots conducted, number of Fauna Plots and Bird Survey Areas paired with Core Plots) to maximise the usefulness of the data collected
- Survey activities (maximising the range and intensity of protocols conducted).

With the aim and objectives in mind, decisions can then be made based around:

- The required skills and expertise of the personnel involved in the activities
- Review of the existing data (initiated through the desktop assessment)
- Reconnaissance visit to identify the suitable survey locations
- Selection of the protocols to implement and survey intensity (i.e. 5 or 7 consecutive nights trapping and one or two morning/afternoon bird surveys).

3.1.1 Permits

Each jurisdiction will have different requirements and approvals before a fauna survey can be conducted. These must be investigated by Project Coordinators as part of the survey planning phase. The types and names of the permits differ between each State/Territory/Commonwealth authority and may include:

- Accessing Indigenous Protected Areas
- Accessing defence land
- Accessing national parks, reserves and other protected areas

- Accessing private land
- Accessing co-managed land, including land lease for mining operations and pastoral activities
- Conducting scientific permits
- Collecting specimens and samples
- Interfering with wildlife
- Ground disturbance (including digging), particularly in relation to known/potential Aboriginal artefacts
- Biosecurity (using digging equipment and moving samples/specimens across management zones)
- Handling and transporting of euthanasia drugs and preserving chemicals (if vouchering is a jurisdictional requirement).

3.1.2 Personnel

All fauna survey personnel must have an understanding of:

- Relevant legislative requirements (including environmental, animal ethics and workplace health and safety)
- Animal ethics requirements, particularly familiarity with the Australian Code for the Care and Use of Animals for Scientific Purposes (NHNRC, 2013).
- Organisational requirements regarding field work, remote area work, communications, animal handling, hygiene, biosecurity hygiene, manual handling, and first aid.

Each protocol identifies additional specific personnel requirements.

3.1.3 Survey timing

The timing of the fauna survey needs to consider:

- optional environmental conditions specific to the region to maximise the species detected and capture rates
- optional weather conditions during the survey, avoiding excessive heat and cold extremes that would influence animal movements and thus capture rates, and potentially lead to animal ethics issues
- phase of the moon, where possible avoiding full moon where nocturnal animal movements may be minimised, thus impacting capture and detection rates
- Logistical constraints that may impede access to the area.

Vouchering of vertebrate animals, as whole animals or tissue samples (including liver, skin, toe or hair) has not been included in any EMSA module, except for roadkill/carcass returns permitted under the Opportune Module. It is acknowledged that animal vouchering may be a mandatory requirement under some state/territory jurisdictional scientific permits. Instructions are not included in this module. Museum vouchering must follow local jurisdictional requirements specific to the local museum, scientific permit and animal ethics committee conditions. Data collected in this Vertebrate Fauna Module does allow for the recording of voucher numbers and voucher types, but the instructions on how to prepare vouchers are not included.

3.2 Survey plot locations

All Vertebrate Fauna Module protocols are conducted adjacent to a Core Plot within a Fauna Plot. The rationale of the pairing of Fauna Plots with Core Plots is so that habitat information from the Core Plot,

where other EMSA modules are conducted, can be extended to the Fauna Plot to link habitat and ecosystem features to the fauna presence (and abundance and absence where possible). Most fauna survey activities are not conducted at the Core Plot to avoid disturbing the Core Plot.

Fauna Plots can either be:

- Adjacent - whereby the Core Plot and Fauna Plot share a common boundary (preferred positioning). The shared boundary may be any boundary (i.e. N/E/S/W. The Core Plot and Fauna Plot combine to make the Biodiversity Plot, where the 2 ha bird surveys are conducted.
- Non-adjacent – whereby it is not possible to have the Core Plot and Fauna Plot immediately adjacent sharing a common boundary, so the two plots are permitted to be a maximum of 50 m apart (in any direction). The combined area is still referred to as the Biodiversity Plot. However, adjustments must be made when conducting the 2 ha bird surveys – always encompassing the entire Fauna Plot and as much as the Core Plot required to make the 2 ha area.

In addition, a Distant Bird Survey Areas can be established a maximum of 200 m from the boundary of the Core Plot. In this case, the 2 ha bird survey area may not overlap with the Core Plot at all (or it may partly overlap). A Distant Bird Survey Area does not need to be paired with a Fauna Plot, but it must be paired with a Core Plot (within 500 m) and the habitat must be uniform. Distant Bird Survey Areas specifically cater for establishing multiple bird survey areas surrounding a Core Plot. For example, a Core Plot may have 4 associated Bird Survey Areas within 500 m.

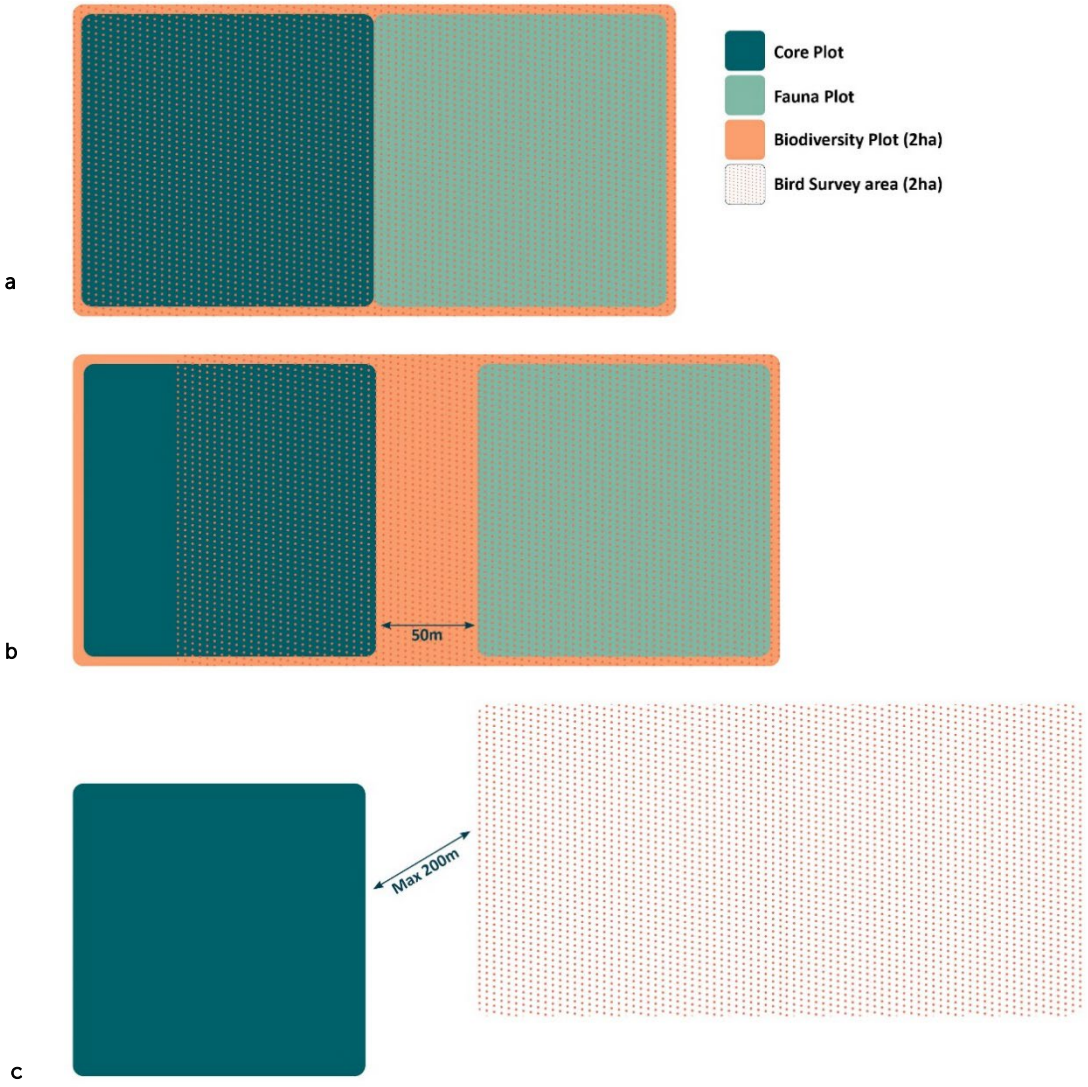

Figure 1. Indicative location of Fauna Plots in relation to Core Plots.

(a) Adjacent Core and Fauna Plots, (b) Non-adjacent Core and Fauna Plots, both creating the Biodiversity Plot and (c) the Bird Survey Areas within 500 m of the Core Plot.

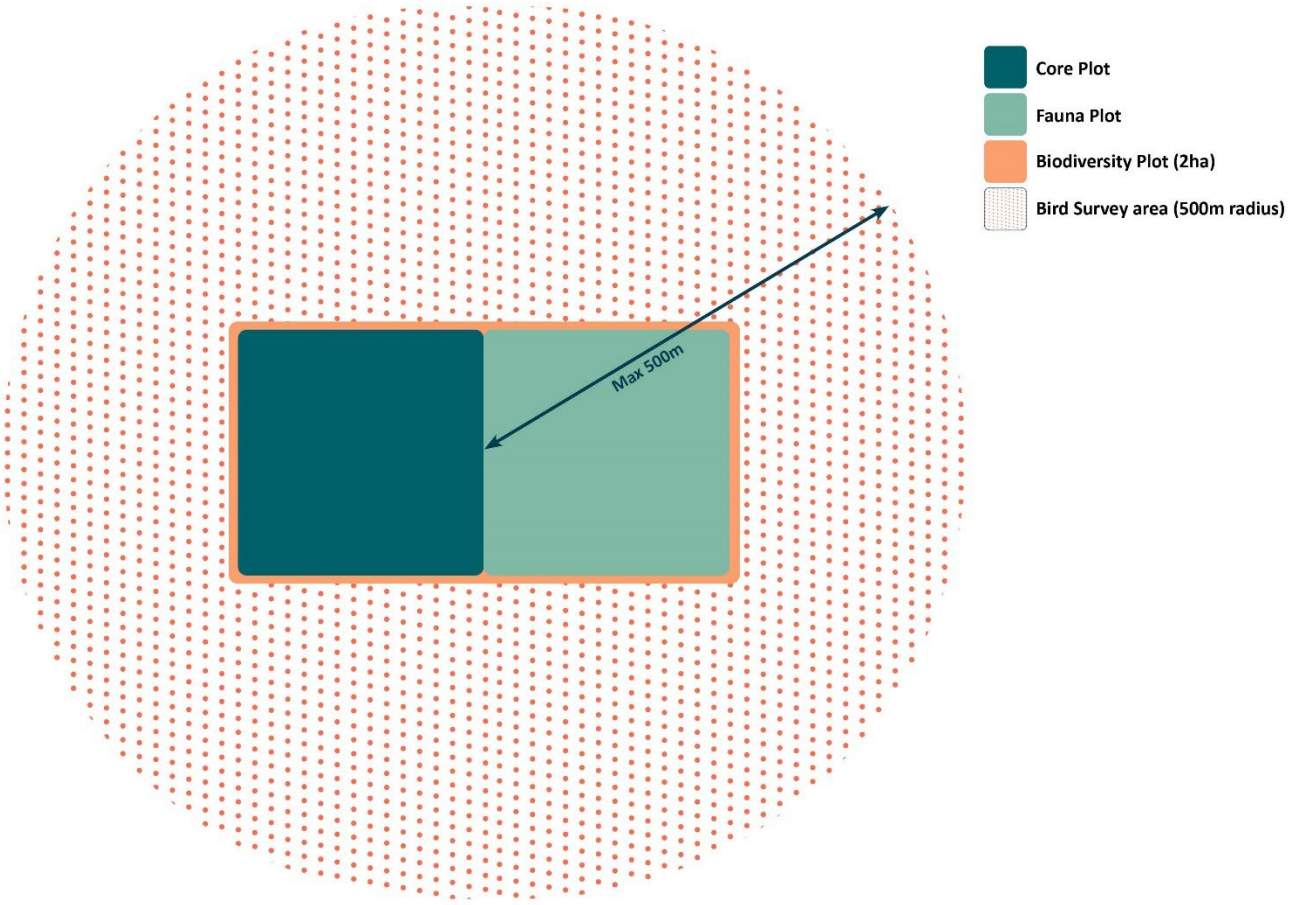

Figure 2. Indicative location of a 500 m area search area used for bird surveys, and placement around the centre of the Biodiversity Plot.

(a) Adjacent Core and Fauna Plots, (b) Non-adjacent Core and Fauna Plots, both creating the Biodiversity Plot and (c) the Bird Survey Areas within 500 m of the Core Plot.

4 Trapping survey set-up and closure protocols

4.1 Field collection

4.1.1 Pre-requisites

Pre-requisites for completing this protocol:

- Before commencing the survey, the fauna plot must be established using the Plot Layout and Selection Module. This can either be done during the reconnaissance visit or on the day before installing the traps.
- The Plot Description Module must be completed before, during or immediately after a trapping survey. The enhanced protocol should be done at least on the first trapping survey, and the standard protocol should be completed on subsequent visits during different seasons/years. This module is best completed by personnel familiar with describing the landforms and vegetation communities.
- Appropriate scientific permits and animal ethics approvals must be obtained before the Trapping survey set-up and closure protocols can commence.

4.1.2 Time requirements

- Allow sufficient time for scientific permits and animal ethics applications to be prepared and approved prior to the intended survey dates.
- Allow 1 - 2 days for survey planning and scheduling.
- Allow 2 - 4 hours to complete reconnaissance visits (plus travel time).
- Allow 2 – 6 hours to discuss museum requirements with curation personnel, including mammal and reptile curation staff.
- Allow 1 – 3 days to prepare survey equipment, pack vehicles (and trailers).
- Allow 3 - 6 hours to install and set-up the traps for each plot. This manual task depends on the ease of digging, density of vegetation, number and experience of personnel assisting, and the equipment used. Allow longer if collapsible pitfalls will need to be constructed on site.
- Allow 20 – 40 minutes to complete the survey set-up in the Monitor app.
- Allow 20 - 60 minutes per site per trap check session (i.e. morning and afternoon) to enter check data into the Monitor app, conduct any maintenance, fix fallen drift fences (does not include time to removal animals from traps, refer to the Identify, measure and release protocol).
- Allow 1 – 3 hours to close and pack-up the traps on the final day. This manual task depends on the ease of digging, density of vegetation, number and experience of personnel assisting, and the equipment used. Allow longer if collapsible pitfalls will need to be de-constructed on site.

4.1.3 Personnel requirements

Number of personnel and skills:

- Scientific permits and wildlife ethics approvals are mandatory for the Trapping survey set-up and closure protocols. Personnel must meet the jurisdictional requirements.
- All components of the Trap set-up and close protocols are best done with a small team of personnel to share the manual labour workload. However, a minimum of two can complete the tasks.
- An ecologist, ideally a fauna ecologist, must be involved in the site selection process and reconnaissance to ensure the plot meets the requirements and is homogenous with the adjacent core plot.

- The Trapping survey set-up and closure protocols are primarily labour-intensive, and general labour personnel can complete much of the work if supervised by an Ecologist to oversee trap positioning.

4.1.4 Equipment

The following equipment is required for each plot:

- Pitfall equipment:
  - 12 pitfall traps, either: 20 L buckets, PVC sheets with side inserts, aluminium flywire bottoms and tape, PVC stormwater pipes, with aluminium flywire bottoms securely in place (dimensions can vary, but must be a minimum depth of 400 mm, and width of 220 – 280 mm, with dimensions must be recorded in the app)
  - 2 rolls of 60 m aluminium or fibreglass drift fence (minimum width recommendation ~50 cm)
  - 40 - 60 wire pins: approximately 400 mm high, for holding the drift fence upright. The number will depend on substrate, quality of the drift-fence, skills and effort of the survey team setting-up the site), allow at least 20 per pitfall line
  - 100 m tape measure.
- For installing/un-installing the pitfalls and drift fence:
  - Long-handled shovels, 2-4, depending on the number of personnel
  - Crow bar
  - Mattocks or picks
  - Petrol-operated auger with post-hole digger attachment (not essential but recommended in heavy/rocky soils)
  - Rakes
- Funnel traps:
  - 8 funnel traps: ~750 mm long x 180 mm wide x 180 mm wide
  - 4 hessian bags
  - 32 pins for securing funnels and bags in place
- Box traps:
  - 40 box traps: Elliott Scientific (Victoria) are recommended, size A, 33 cm long, 10 cm high, 90 cm wide, or any other similar closed box style collapsible trap
- Cage traps:
  - 8 cage traps: treadle plate operated, and ~56 cm long x 20 cm x 20 cm
  - 1 hessian bag per cage trap
- For marking trap locations assigning trap unique QR codes:
  - flagging tape
  - QR code printed on thermal sticker or similar (optional)
- For animal ethics requirements:
  - animal shelters to be placed in the bottom of the pitfalls – may be toilet rolls, drink cooler holders, or a natural insulation
  - 12 sponges, to be wetted and placed in the bottom of the pitfalls should frogs be captured and weather conditions pose a risk to them drying out (optional, if required)
  - insect surface spray or permethrin insecticide, such as Baygon or Coopex (if required)

- Standard mammal bait:
  - Rolled oats, peanut butter. Note other additional ingredients often added to bait mixture, including honey, vanilla essence, sardines, tuna and/or cat biscuits, are not recommended, but if they are used the details must be recorded in the Monitor app
  - Small bucket(s) to store the bait
  - Equipment to mix the bait (large bowl/bucket, large spoon)
- For checking traps (refer to the Identify, measure and release protocol):
  - jiggers or short snake poles (useful for checking the bottom of pitfall traps and reducing having to repeatedly bend down)
  - snake pole (for removing snakes from pitfalls and funnel traps)
  - capture bags
- For closing sites:
  - Long-handled shovels
  - Rakes
  - Drift fence roller (typically custom-made).
- For entering data into the Monitor app:
  - Mobile device with the Monitor app installed
  - GNSS, such as a Trimble R1 or DA2 receiver, a hand-held GPS or device built-in GPS (least preferred), capable of achieving <30 cm accuracy

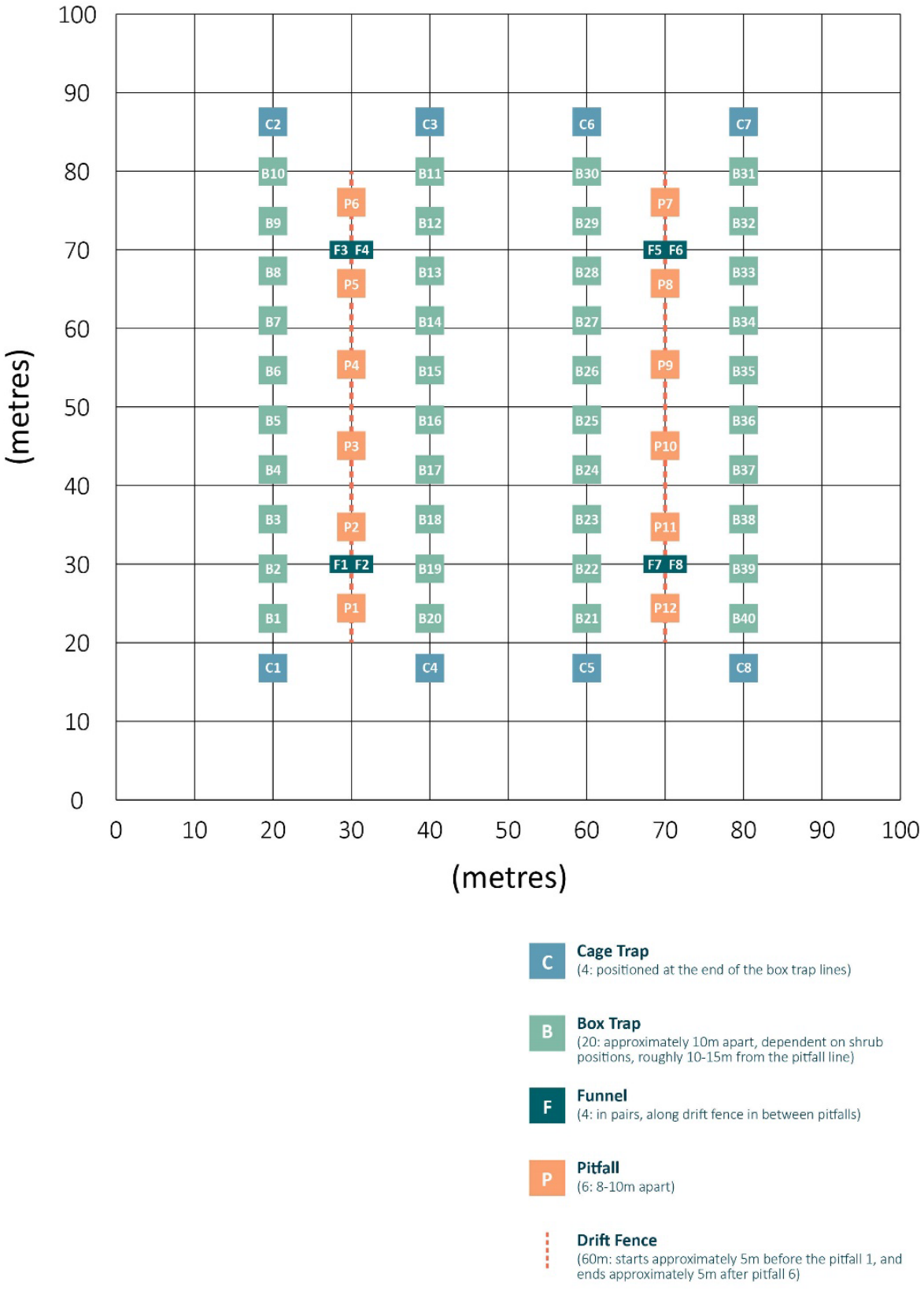

Figure 3. Trap layout diagram,

4.1.5 Instructions and procedures

Pre-survey planning

1. Review the project requirements and consider:
   - the needs of the project, and the reason vertebrate fauna information is required
   - priority ecosystems and habitats within the project area
   - best-on-offer localities, acting as controls whereby species composition and abundance should be relatively stable, and any fluctuations are likely to reflect natural conditions as a response to resource availability, i.e. responses to rainfall
   - localities undergoing intervention, whereby species composition and abundance would be expected to change in response to the management interventions, i.e. responses to pest management, grazing regimes, improvements to vegetation structure and composition, improving resource availability
   - opportunities to maximise the survey effort and efficiently use personnel and equipment.
2. Conduct a desktop assessment and review existing information on fauna species of the project area.
   - Collate existing information to identify what information is already available and identify what survey effort has been conducted.
   - Review literature to determine the findings of previous surveys, what species and habitats are present, identify the preferred habitats and key resource needs of the species expected and likely to occur in the project area, and identify appropriate survey methods and survey timings necessary.
3. Select areas where fauna plots could be established.
   - Consider any existing Core Plots and determine if they are suitable for establishing an adjacent Fauna Plot, remembering that a fauna plot needs to be directly adjacent to the Core Plot, and is also 100 x 100 m and 1 ha in area, making a combined 200 x 100 m 2 ha Biodiversity Plot. Trapping activities must not be undertaken on Core Plots as they create too much disturbance and will interfere with the long-term monitoring of the core plot.
4. Decide on the most appropriate survey design, consider the trapping options, and determine the survey requirements, the availability of equipment, and personnel requirements to implement the survey, including:
   - trap details
     - dimensions (width and depth) and construction material of pitfalls, and pitfall drift fence
     - use of temporary or permanent pitfalls
     - types of traps to include – by default and unless explicitly not suitable, box traps, cage traps and funnel traps are recommended in the standard configuration
   - duration of the survey
     - number of consecutive trap nights, either 5 nights or 7 nights
     - number of plots to be surveyed concurrently or consecutively.
5. Determine the survey frequency (i.e. twice per year, one per year, every second year), and the preferred season to survey in (i.e. autumn, spring, or early summer) depending on the target fauna species. Check that the intended fauna plot location will be accessible at that time of year (weather conditions and other access restrictions).
6. Ensure all jurisdictional scientific permits and licences are held and appropriate animal ethics approvals have been obtained. Conditions will need to be clearly understood by all personnel involved in the survey.
7. Ensure access permissions from the relevant landholder/land manager have been obtained.
8. Ensure suitably experienced field staff and all necessary equipment is available and operational.

9. Discuss the intended survey with local museum personnel (i.e., this may include both the mammal curator and reptile curator) and ensure all jurisdictional scientific permit and licence conditions will be met. This may include the whole animal or tissue vouchering requirement, which must meet the local museum specifications.
    - If vouchering is required, ensure all specifics are understood and all materials, preservation procedures, voucher labels, equipment, drugs, permits to carry drugs, and workplace requirements to undertake such activities are understood and obliged.
    - Personnel conducting the survey must be familiar with euthanasia techniques, have appropriate animal ethics approvals, and be fully confident that museum specifications can be achieved. This Vertebrate Fauna Module does not include instructions on euthanasia or preparing voucher specimens (whole animal or tissue samples).
    - If the museum requires vouchering, ensure voucher requests are understood and make a list for reference during the survey. Make sure to clearly understand which species are required and which are not required, and the specific requests are documented (i.e. typically an adult male and non-breeding female, but curation personnel will be able to provide instruction).
    - Ensure personnel responsible for identifying species in the field are confident of species identifications, including distinguishable features to tell similar species apart. Discuss with museum curation and subject matter experts, and view example museum vouchers where possible.
10. Schedule the survey, considering optimal environmental conditions specific to the region to maximise the species detected and capture rates, optimal weather conditions during the survey, avoiding excessive heat and cold extremes that would influence animal movements and thus capture rates, and cause animal ethics issues, phase of the moon, where possible avoiding full moon where nocturnal animal movements may be minimised, thus impacting capture rates, and logistical constraints that may impede access to the area.
11. In the days before the intended survey start, assess the weather forecast to ensure conditions are suitable for the survey duration. If unfavourable weather conditions are forecasted, post-pone the survey where possible. A survey conducted in less-than-ideal weather conditions is not desirable.

Reconnaissance visit

1. Arrive at the intended Fauna Plot and traverse the plot to assess vegetation cover, density, substrate, and signs of fauna. Ensure the plot is homogenous to the adjacent core plot, with landforms, vegetation, and similar disturbances.
2. Confirm the plot is suitable and desirable to conduct a trapping survey.
3. Use the Plot Layout and Positioning Module to establish the Fauna Plot for the first time. This can be done as part of the reconnaissance or on the day of survey set-up when traps are installed.
4. Use the Plot Description Module to describe the plot. Keep in mind this module is best completed by personnel familiar with describing the landforms and vegetation communities, ideally to species level. This can be done as part of the reconnaissance or on the day of survey set-up when traps are installed.
5. If planning to survey multiple fauna plots concurrently, travel to subsequent plots, ensure driving routes and time requirements are suitable and allow sufficient time for traps to be checked.

Survey set-up

Suggested workflow

The following workflow is recommended:

1. If not already completed, layout the Fauna Plot using the Plot Selection and Layout Module and describe the plot using the Plot Description Module.
2. Locate where the pitfall lines will be installed (see Installing the pitfalls and drift fence lines below).
3. Commence digging the trench where the drift fences for Line B and Line E will be positioned.

4. Dig the location of each pit and install the pitfalls in place.
5. Erect the drift fence.
6. Position the funnels in place (see Installing funnel traps below).
7. Position in place the box traps (see Installing the box traps below).
8. Position the cages traps (see Installing cage traps below)
9. Record trap set-up in the Monitor app once all traps are in place (see Entering the Pitfall Line details in the Monitor app below).

Note the instructions below assume that pitfalls and traps will be open and set and the time of installation. Once everything is in place, the last step is to 'set' the traps in the Monitor app. The app allows the traps to be set up and left closed (i.e., the trapping has not commenced yet) if the survey design prefers traps in place for 1-2 days prior to setting (further information is provided in the Guidelines below).

Installing the pitfalls and drift fence lines

1. Once the Fauna Plot has been positioned using the Plot Layout and Positioning Module, and the corners and centre point marked, locate where the two pitfall lines will be positioned.
   - Pitfall Line A is located 30 m in from the shared (or closest) boundary and Pitfall Line E is located 70 m in from the shared (or closest) boundary.
   - Figure 2 shows the trap placements along Line A and Line B.
2. Mark where the six pitfalls will be positioned along Pitfall Line A, taking note of any ant nests or key ant activity areas that need to be avoided. Ideally, pitfalls should be 8 – 10 m apart. Reposition the pitfall, or entire line, if necessary. Locations of each pit, and the start and end of the drift fence will be marked in the Monitor app later.
3. Dig the pitfalls holes, ensuring the holes are deep enough so the top is level flush with the ground. Leave the soil removed from the hole to the side (ideally about 0.5 m) so it can be used to fill the hole after the trapping.
4. Using mattocks and shovels, dig in the drift fence trench line to approximately 10 cm deep, minimising ground disturbance where possible and avoiding damage to mature shrubs. Ideally, the drift lines should be straight, but weaving around shrubs, trees, and other natural obstacles is appropriate. If weaving is required, aim for sweeping bends rather than tight corners.
5. Erect the drift fence by securing the loose end with a pin and placing it firmly into the ground. Roll the drift line out along the trench. Ensure the bottom few centimetres are buried in the trench, and stand the fence up, placing pins as required along the drift fence to help stand it up.
6. Clean up the drift fence area, removing branches and twigs that may deter animals from moving along the length of the fence.
7. Clean up the area immediately adjacent to each pitfall, flattening soil, removing twigs and rocks, and anything that may deter funnelling the moving animal into the trap.
8. Place a small amount of soil about 1 cm deep (i.e., what was removed to make way for the pitfall) in the bottom of each pitfall.
9. Place a refuge in the bottom of each pitfall, following the guidelines below.
10. If considered appropriate (i.e., if frogs are expected), place a sponge the bottom of each pitfall.
11. Repeat for Pitfall Line E.

Installing funnel traps

1. Position one funnel trap on either side of the drift fence between the first and second pitfall.
2. Drape a hessian bag over the funnel pair to protect any animals caught.
3. Place pins alongside each funnel trap and the hessian bag to secure them against the fence.

4. Position one funnel trap on either side of the drift fence between the fifth and sixth pitfall. Drape a hessian bag over the funnel pair. Place pins alongside each funnel trap and the hessian bag to secure them against the fence.
5. Repeat for Pitfall Line E.

Installing the box traps

1. Locate where Trap Line A will start (approximately 10 m to the left of Pitfall Line B).
2. Bait the box trap with a small (1 – 2 cm diameter) ball of standard mammal bait.
3. Position the box trap at the first location.
    - Set the trap door to open by making sure it clicks into place.
    - Ensure the trap is on level ground and the bait is behind the treadle plate mechanism and will not roll forward.
    - Place the trap in a shaded position, ideally under or amongst a shrub.
    - Avoid ant nests and high ant activity areas.
    - Ensure no twigs or leaf litter are protruding through the door entrance, which will obscure the door from closing once the treadle plate is set off.
    - Flag the trap location (2 strips side by side at eye height are recommended to indicate the start of the line clearly).
4. Move 10 m to the next location, bat the trap, position, and flag the location. Continue to the end of the line.
5. At box trap 10, flag the location with flagging tape (2 strips side by side are recommended to mark the end of the line).
6. Move to the start of Trap Line C, and position box trap 11 in place. Continue to the end of the line, placing the last box trap 20 in place and leaving the empty container at the end of the line.
7. Mark the location of box trap 20 with 2 strips of flagging tape.
8. Repeat for Trap Line D, and Trap Line E.

Installing cage traps

1. Walk to the where Cage 1 will be positioned (approximately 10 m from the box trap), as shown in Figure 2. This should be approximately 15 m from the boundary.
2. Place the cage trap inside a hessian bag or lay a hessian bag over the trap and secure it.
3. Position the cage at the first location.
    - Bait the cage trap with a small (1 – 2 cm diameter ball) of standard mammal bait, ensuring the bait is behind the treadle plate and will not roll forward.
    - Ensure the trap is on level ground, in a shaded position, ideally under or amongst a shrub. Avoid ant nests and key activity areas.
    - Set the trip plate by securing the door mechanism, ensuring the door is not obscured from closing by any twigs, leaf litter etc. You may need to test the door closure several times to get it right.
    - Flag the cage traps location.
4. Move to the end of Trap Line A and repeat for cage 2, and continue for cage 3 and cage 4 on Trap Line C, cage 5 and cage 6 for Trap Line D, and cage 7 and cage 8 on Trap Line F.

Entering the Pitfall Line details in the Monitor app

1. Once all traps have been positioned, flagged, and baited (box traps and cages) open the Monitor app and select *Vertebrate Fauna Module > Trapping Survey Protocol > set-up trapping survey.*
2. Select the applicable *fauna plot code*.

3. The *survey start date* and *survey start time* will be populated, tap to adjust.
4. Traverse to the start of the Pitfall Line B, select *start pitfall line:*
   - select the *pitfall line name* (Pitfall Line B)
   - and select the *drift fence type* (fibreglass/shade cloth, plastic sheet, rigid plastic, other)
   - enter the *drift fence height* in cm (ground to top, i.e., not including the buried depth).
5. Walk along the Pitfall Line B, when you arrive at the first pitfall, select *mark trap* and complete the details.
   - Select the *trap station number.*
   - If using QR codes, tap *scan trap QR code* to bring up the device camera and scan the QR code next to the pitfall to link pitfall 1 to the unique QR code.
   - The app will record the date, time and location automatically.
   - From the *trap type* list, select *pitfall*
     - the *number of traps per station* will be automatically entered as 1
     - select the *trap specifics* (i.e. pitfall – PVC pipe, plastic bucket or temporary plastic sheet)
     - enter the *trap depth* and *trap width* (cm)
     - select *set as default* if the remainder of the pitfalls for the plot will be the same trap type and dimensions.
   - Select *take trap photo* and take a photo of the pitfall approximately 1 m above the surface looking down and showing an overview of the microhabitat surrounding the trap. Add up to 3 photos per trap (optional)
   - Add any *trap comments* (optional)
   - Set the *trap set status* to open (note if the pitfalls/traps are not opened at this stage, select *pitfall closed – lid secured*)
   - Complete the *trap set status set by* field to identify the person responsible for setting/marking the trap.
6. Continue walking along Pitfall Line B, when you arrive at the first funnel pair, select *mark trap* and complete the details.
   - Select the *trap station number,* or trap number will automatically populate (edit if different).
   - Tap *scan trap QR code* to bring up the device camera and scan the QR code next to the funnel to link funnel to the unique QR code.
   - The app will record the date, time and location automatically.
7. From the trap type list, select *funnel trap*
     - confirm the *number of traps per station* (1 – note each funnel is entered separately).
     - select the *trap specifics* (i.e. funnel – shade cloth, funnel - shade cloth with hessian/other bag, or funnel – other and enter details in the *trap specifics comments* field
     - enter the trap length, trap width, and trap height (cm)
     - select *set as default* button if the remainder of the funnels for the plot will be the same trap type and dimensions.
   - Select *take trap photo* and take a photo of the funnels approximately 1 m above the surface looking down and showing an overview of the microhabitat surrounding the trap. Add up to 3 photos (optional).
   - Set the *trap set status* to open.
8. Repeat for the adjacent funnel 2.

9. Continue walking along Pitfall Line B drift fence, setting and entering the trap details for pitfalls 2-5, funnel 3 and 4, pitfall 6. If using QR codes, make sure to scan each pitfalls QR code into the app, and take at least one photo from above of each trap.
10. Walk to the end of the Pitfall Line B drift fence and select *end drift fence*. The app will record the GPS location.
11. Walk to the start of Pitfall line E and select *start drift fence*.
12. Continue walking along the drift fence, setting and entering trap details for pitfalls 7-12, funnel 5, 6, 7 and 8, and once complete, select *end drift fence*.

Entering the Trap Line details in the app

1. Traverse to the start of the Trap Line A, select *start trap line, and* select the *trap line name* (A).
2. Select *mark trap* and complete the details.
   - Select the *trap station number,* or trap number will automatically populate (edit if different)
   - tap *scan trap QR code* to bring up the device camera and scan the QR code next to the trap to link the trap to the unique QR code.
   - confirm the *number of traps per station* (typically 1). If setting 2 traps per station, select the 'a' number from the trap station number list first (see below for guidelines if increasing to 2 traps).
   - select the *trap type* (i.e. box or cage) and enter the *trap length, trap width*, and *trap height* (cm) and select the *trap specifics* (trap construction details). Select *set as default* button if the remainder of the traps of that type for the plot will be the same trap specifics and dimensions.
   - Select *take trap photo* and take a photo of the box trap approximately 1 m above the surface looking down and showing an overview of the microhabitat surrounding the trap. Add up to 3 photos (optional).
3. If setting 2 traps per trap station, repeat the process and select the 'b' from the *trap station number* list.
4. Continue along the trap line marking each trap.
5. When at the end of Trap Line A, select *end trap line*.
6. Traverse to the start of Trap Line C, select start trap line, select the *trap line name* (C).
7. Select *mark trap* for each trap along Trap Line C, and when at the end, select end trap line.
8. Repeat for Trap Line D, and Trap Line F.
9. Once all traps have been marked, select *end trap set-up*.

Delayed start

1. Pitfalls and traps can be positioned, marked in the app, but the trap status set to alternative options other than *trap open*. To delay the start of the trapping:
   - use the instructions above in Entering the Pitfall Line details in the Monitor app and Entering the Trap Line details in the app, but when reaching the trap set status, select an alternative:
     - trap closed – temporarily
     - trap closed – wired shut
     - pitfall closed – lid secure.

Ending the survey

Ending the trapping session in the Monitor app

1. Once the survey has been completed and the number of trap nights planned has been achieved, the traps can now be removed, and 'closed' in the app. This function is completed as the traps are removed.
2. Open the Monitor app and select *Vertebrate Fauna Module > Trapping Survey Protocol > end trapping survey*.
3. Select the applicable *fauna plot code*.
4. The *survey end date* and *survey end time* will be populated, tap to adjust.
5. Standing at the start of the Pitfall Line B, select the *Pitfall Line name* (B), and select *close*
6. Walk along the Pitfall Line B, when you arrive at the first pitfall, scan the QR code, and select *close*.
   - Change the *trap set status* to trap closed (pitfall removed or pitfall filled in and secured)
   - Select *take closed pitfall photo* to take at least one photo of where the trap was positioned, and now removed (temporary), or filled in and secured (permanent).
7. Continue walking along Pitfall Line B, and scan each trap QR code, and close all pitfalls and funnels along the line, and indicate the *trap closed status* (trap closed/removed, pitfall – filled in, pitfall – lid secured, trap – wired shut).
8. When at the end of Pitfall Line A, select, *take closed drift line photo* to take at least one photo of where the drift fence was position and now removed. Take a photo looking back down the line, showing that the drift fence has been removed, substrate brushed over and all equipment removed.
9. Complete the process for Pitfall Line E, and Trap Lines A, C, D, and F until all traps are closed. Only photos of pitfalls and end of drift lines are required.
10. Once you complete the last trap (i.e.. C8) select *all traps closed and removed*.

4.1.6 Additional guidelines

Trap design and construction of pitfall traps and drift fences

Pitfall traps – general

- Ensure the conditions of scientific permit and animal ethics approvals are understood and met.
- Chose a pitfall depth and width that best suits the target fauna species. Ideally pitfalls will be 40 cm deep, and 22 – 29 cm wide (see below). Keep in mind that species such as hopping mice will generally need quite deep pitfalls.
- Chose a pitfall type that is available and suits the project needs, as well as survey logistics. For example, PVC stormwater pipes can be difficult to transport, and 20 L buckets or temporary plastic sheets folded into tubes may be a better option.
- Pitfall traps are not baited.

Permanent pitfalls – left in place between survey periods

- There may be specific requirements scientific permit and animal ethics requirements regarding permanent pitfalls, especially lid requirements. This may include the need for a screw top lid held in place with two tek screws.
- Ideally, permanent pitfalls should be constructed from PVC stormwater pipe, and should be a minimum 40 cm deep, and 22 cm – 28 cm wide in diameter. The bottom of PVC stormwater pipe pitfalls must be secure to stop animals digging out underneath. A piece of cut flywire mesh must be secured to the bottom.
- If scientific permits and animal ethics approvals allow 20 L plastic buckets to be used as permanent pitfalls, keep in mind that the bucket lids may not be sufficient to seal the permanent pit as they may become dislodged, damaged over time, or vandalised. Bucket pitfalls should be filled with soil.

- Once secure, a shallow level of soil should be placed over the lids so that they are not visible to the public.

Temporary pitfalls

- Temporary pitfalls must be removed at the conclusion of the trapping session.
- Bucket pitfalls are typically 20 L plastic buckets and are generally 40 cm deep and 28 – 28.5 cm wide in diameter.
- Temporary collapsible pitfalls are constructed from plastic sheets, and when rolled to form a tube they should form a pitfall a minimum 40 cm deep and 22 – 28.5 cm wide in diameter. Collapsible pitfalls have the advantage in that they can be transported flat and constructed in the field. A piece of aluminium fly-wire mesh is secured to one end with tape (or strong elastic bands), and if necessary (and depending on the width and strength of the side plastic strip), an additional piece of tape may be required half way up the pitfall.

Drift fences

- Drift fences are erected using a ~60 m roll of flywire, ideally aluminium but fibreglass may be used, ~50 cm wide, to stand 30 – 40 cm high with ~5-10 cm buried underground (see Figure 3).
- Drift fences are held up-right with pins, typically metal wires partially folded over. The number of pins required per drift fence will vary depending on the material of the drift fence, soil substrate and experience of the personnel installing the fence.
- If a hard substrate is encountered when installing pitfalls, and digging the hole is slow and overly time-consuming, pits can be cut to a shorter size, or soil can be mounded up around them to enable the top to be flush with the top of the soil surface.

Figure 4. Pitfall (20 L bucket) buried flush to ground level, with drift fence and pin.

Trap design and construction of funnel traps

- Funnel traps are collapsible traps constructed from shade cloth with an internal spring wire frame to maintain shape when open. Funnels are typically ~75 cm long x 18 cm wide x 18 cm high. A ~4 cm wide entrance is located at either end enabling animals to enter the trap. A zip is located along the top of the trap enabling surveyors to empty the trap.
- Funnel traps are relatively light and will easily blow away. Ensure funnels are anchored to the ground by placing a pin either side of the pair wedging them together, or through the flip hook at one end.
- Although made from shade cloth, additional protection from the sun must be placed over the funnel trap. A hessian bag (or similar) should be placed over the funnel trap pair, with pins in place to ensure the bag does not blow away.
- It is not necessary to bait funnel traps.

- When placing funnels along the drift fence, ensure the funnel is placed flush against the drift fence, ensuring animals cannot move between the fence and the funnel (see Figure 4).
- Take care when removing animals (particularly snakes) from inside the funnel trap, ensuring the internal wires and fishing lines are not damaged (Figure 5).
- Be sure to check the funnels carefully as small reptiles can easily hide in the folds of the shade cloth.
- When placing funnels in position, extra soil can be placed in front of the entrance, providing a ramp of soil substrate up to the entrance hole.
- Maintain funnel traps and wipe the zipper clear of soil and leaf material.

Figure 5. Pair of funnel traps positioned along the drift fence showing poor funnel placement.

Note: The funnel on the left shows poor placement. The gap between the funnel and the drift fence enables animals to pass rather than direct them into the funnel entrance. The funnel on the right shows correct placement, with the funnel flush against the drift fence, and a smooth soil layer helping direct the animal into the funnel entrance.

Figure 6. Funnel trap showing the internal wiring, with a snake being removed.

Trap design and construction of box traps

- 20 folding box traps with a treadle release mechanism are used at each site. Elliott traps made by Elliott Scientific (Upwey, Victoria) are recommended (Elliott size A), 33 cm long, 10 cm high, 9 cm wide), however similar traps by alternative manufactures may be used.
- Ensure scientific permit and animal ethics requirements are understood and met. If cool overnight weather is expected, a small piece of insulation should be placed inside all box traps, ensuring it does not impede the trip plate mechanism. If overnight rain is expected in addition to cool temperatures (<10°C) consider partially wrapping the box trap in plastic to minimise seepage.
- Box traps should be micro-sited, selecting a location that is protected by some cover (i.e., next to a shrub). Box traps should be placed amongst or alongside natural cover, i.e., under or alongside shrubs, to aid protection from direct sunlight. If the weather is hot, and traps are closed during the day, place traps ideally amongst cover or at best on the western side of shrubs to limit direct morning sunlight. If shade from the available cover is limited, consider placing hessian bags over each trap.
- Take care to identify and avoid potential ant nest locations or areas of high activity. This may mean moving the trap several metres from the ideal the trap line alignment.
- Box traps must be placed on flat ground to ensure the bait does not roll under the mechanism. If a flat position cannot be located, ensure the front of the trap is higher than the back (i.e., so the bait rolls back away from the mechanism). Clear debris from under the trap to ensure stability.
- Flag the location of the Elliott trap with flagging tape to aid finding it, ensuring the flag is clearly visible, particularly from the angle of which it will be approached during trap checking. A good technique is to double flag (2 strips of flagging tape, ~20 cm apart) the start and end of each trap line, providing a quick visual cue for the surveyor.

Trap design and construction of cage traps

- Cage traps are typically constructed from galvanised wire mesh and ~56 cm long x 20 cm x 20 cm, but larger cages may be used. Ensure the trap specifics, including the trip mechanism (foot plate, or hook mechanism) are recorded in the app. Other trap specifics can be noted in the comments section (this could include door position of cages).
- Cage traps must be partially covered with a hessian bag or placed amongst dense vegetation to provide protection from the sun and wind.

Standard bait for box and cage traps

- Box and cage traps are baited, typically with a small ball (roughly 1-2 cm in diameter) of standard mammal bait consisting of rolled oats and peanut butter. Other ingredients, such as honey, vanilla essence, sardines, tuna and/or cat biscuits, may be added depending on the target fauna species. Ensure bait type is recorded in the app.
- Box and cage traps are baited with a small ball (roughly 15 mm in diameter) of standard mammal bait consisting of rolled oats and peanut butter. Other additional ingredients often added to the bait mixture, including honey, vanilla essence, sardines, tuna and/or cat biscuits, are not recommended and must be noted if they are used.
- Bait should be replaced as needed when depleted. There is no need to replace bait with fresh bait daily (or every second day) as a scent attractant if there is enough bait to feed the captured animal overnight. If bait remnants are removed from the trap, ensure they are removed from the plot or placed inside a pitfall to avoid attracting animals to areas other than the trap location.
- When setting the box traps and cages care must be taken to ensure the bait does not impede the plate mechanism, thus rendering the trap useless for capturing animals. Ensure twigs and leaf litter are not impeding closure of the door.

Trapping commencement

Consecutive nights

- Each site is trapped for five (minimum) to seven (recommended) consecutive nights. The duration of the survey is dependent on logistical considerations. If five nights are planned, but the weather is less than optimal, consider extending for the additional nights.
- Trapping can commence either in the morning or afternoon of the first day. If set-up in the morning, traps must be checked in the afternoon or early evening that day.

Delayed starts

- Delaying the start of surveys can be useful in some circumstances, for example if different personnel are on site to establish the trapping set-up before ecologists arrive, and if multiple sites are being established at once, before commencing the survey on the same date.
- Delayed starts may also be beneficial if species known to be particularly sensitive to disturbance occur in the region, and traps are best positioned, and left for a few days before setting.
- Ensure the trap setup date (and time) reflect the date the traps were installed, and record the *trap set status* appropriately (i.e. trap closed, trap closed – wired shut, pitfall closed – lid secured) and updated once opened for the trapping to commence.
- Check with scientific permits and animal ethics approvals before assuming delayed starts are permitted.

Trap type and the number of traps per trap station

- The recommended trap layout has one trap per trap station, except for funnel traps, where one funnel is placed on either side of the drift fence line.
- The number of box and cage traps can be increased to two, and combining trap types, i.e., one box trap and one cage trap, is permitted but must be recorded in the Monitor app.
- If no fauna species suitable for requiring cage traps over smaller box traps (i.e., medium mammals such as bandicoots and possums) are known to occur in the region, the number of cage traps can be reduced to aid the logistics of carrying cage traps to and from the project area.
- Setting two traps in close proximity at the same trap station is beneficial when fauna is in high abundance, or 'trap happy' individuals are repeatedly being caught, as this gives additional opportunities for other individuals to also be caught.

Checking traps

General

- Ensure scientific permit and animal ethics requirements are understood and achieved. All traps must be checked at least every 12 hours under normal average weather conditions, or more frequently under hot/cold/raining conditions.
- Traps should be checked in sequence to minimise the risk of missing a trap, and thus prolonging the time a captured animal is held.
- Ensure all surveyors avoid walking through the Core Plot to access the fauna plot during both the installation, and morning and afternoon trap checks. All foot traffic must go around the core plot. This is important to minimise disturbance maintain the integrity of the Core Plot.
- Take care to assess the possible capture of a snake before picking up the funnel. If a venous snake is captured, use of a snake catching hook is recommended to carefully lift it from the funnel trap.
- All traps must be accounted for at the end of each trap checking session. Surveyors must ensure that all traps are checked. Use of the app during all trap checking sessions will assist ensuring all traps are checked, with the surveyor alerted to any missed data entry and therefore possible missed traps.

Pitfalls and drift fences

- Ensure the bottom of the pitfall is checked carefully, this includes turning over the soil and lifting any refuge material. Some reptiles, particularly legless lizards and blind snakes are exceptionally good at burying into the soil and hiding.
- Remove any invertebrates, including spiders, scorpions, ants and beetles that are often caught in pitfall traps (consider keeping for invertebrate samples).
- Conduct any maintenance of the drift fence during each trap checking session, ensuring there are no gaps dug under, or branches laying across.

Funnels

- After unzipping the funnel ensure the entrance material is lifted up to check for any small animals hiding, and the entire inside is searched carefully. Small reptiles, such as *Morethia* sp. lizards are easily missed.

Box traps and cages

- When checking, both in the morning and afternoon, ensure the traps are well positioned out of direct sunlight. Re-position if necessary (and also re-position the flagging tape).
- Ensure traps remain in good working order throughout the survey.
- Ensure traps are checked in sequence. Using the app will assist ensuring all traps are checked.
- Replenish bait once consumed. Note there is no need to replenish bait daily. The aim of the bait is to supply any captured animals with enough food to survive the night in the trap, not to act as a scent attractant.

Ethical considerations

Shelter and refuges

- Shelter, such as a handful of leaf litter and either a toilet roll or section of an egg carton, must be placed inside all pitfalls (refer to your animal ethics and scientific permit conditions as they may specify what must be used).
- If cool overnight weather is expected, a small piece of insulation can be placed inside all pitfalls (refer to your animal ethics and scientific permit conditions as they may specify what can/must be used).
- If frog captures are anticipated, or possible (i.e. rainfall expected in a dry arid environment), a wet sponge (~taking up no more than ¼ of the pitfall bottom to enable other animals to stay dry) should be placed inside all pitfalls and re-wet each afternoon.
- All trap deaths must be documented. Ensure the trap type, date, time, species and any comments relevant to the cause are recorded. This information will be required for animal ethics and scientific permit report returns, as well as a specific reporting mechanisms required by the relevant jurisdiction. Assess the suitability of the carcass for whole specimen vouchering if permitted.

Weather conditions, intervals between checking and trap closures

- All conditions and guidelines of the animal ethics approval and scientific permit must be adhered to. The below guidelines are recommended if animal ethics conditions are not specific.
- During typical normal weather conditions for the location (<34°C without significant rainfall), all traps must be checked, and animals removed a minimum of twice per day, i.e. every 12 to 14 hours, typically during the morning (within 2 hours of sunrise) and late afternoon.
- On days of high temperatures (>34°C):
  - box traps and cages should be closed during the day (closed during the morning check and re-opened in the late afternoon), unless sufficient cover is provided to ensure traps are shaded all day and temperatures do not exceed 38°C

  - pitfalls can remain open during hot days >34°C, but must also be checked in the middle of the day as well as the morning and afternoon checks (i.e., 6-7 am, 12-1 pm, 5-6 pm or similar depending on sunrise/set times)
  - all traps must be checked and cleared (i.e., the last trap checked) within 3 hours of first light before temperatures have become warm to hot. Consequently, the survey team should discuss such details the night before as departure times may need to be earlier than usual.
- On days of extreme high temperatures (>38°C):
  - box and cage traps must be closed if the forecasted maximum temperature is expected to reach or exceed 38°C, i.e., closed during the morning check and re-opened late afternoon.
- If high rainfall is expected (the definition of high will depend on the local environment), trapping must cease and all traps closed (or removed) if high rainfall is expected and there is a risk that traps may not be checked at the scheduled time due to access restrictions.
- If low overnight minimum temperatures are expected, all pitfall, box, cage and funnel traps must have insulation provided to aid animals maintaining body temperature. If trap deaths occur and thought attributable to low minimum temperatures, the surveyors must consider closing all traps until warmer temperatures are experienced.
- If the number of captures is high, and the time taken by the surveyors to check and clear traps is excessive and resulting in animals potentially being left in traps for longer than 12 hours, the surveyors must consider:
  - closing some sites and recommencing later and staggering the number of sites concurrently surveyed
  - closing some traps, i.e. box traps and focusing on pitfall and funnel traps – noting in the app which traps were closed to ensure trap effort is accurately recorded, as a last resort
  - removing animals from the traps and releasing them immediately without full processing (i.e. recording where possible the species only, but no other measurements).

Ant attack

- If ants are present in high numbers (i.e., attacking the bait or captured animals) effort must be made to remove the threat and risk of attack. Firstly, the box traps should be re-positioned to a better location, such as several metres from the ideal trap line alignment (remember to re-flag the new location). Application of an insecticide, such as Baygon and Coopex, may be required. If ant attack or the risk of ant attack continues, consider closing the trap (ensuring the trap status is updated in the app).

Additional permit requirements

- Some permit conditions require all fauna survey equipment that is used to capture animals to be clearly labelled. Check your permit conditions for any details that may be required, this may include your organisations name and contact phone number, and/or permit number. Ideally this feature will later be added to the QR code.

Trapping conclusion and site pack-up

- All box, cage and funnel traps must be removed at the conclusion of the survey.
- Permanent pitfalls may be left in situ following the conditions specified in the scientific permit and animal ethics approvals. All lids must be secure.
- Pitfall holes must be filled in as not cause a hazard for wildlife.
- Drift fence lines will need to be raked over, and debris replaced to at least improve visual amenity of the disturbance caused.

4.2 Post-field survey tasks

4.2.1 Sample curation

No samples or specimens are collected in the Trapping survey set-up and closure protocols.

6 Identify, measure and release protocol

6.1 Field collection

6.1.1 Pre-requisites

Pre-requisites for completing this protocol:

- Before commencing the survey, the fauna plot must be established using the Plot Layout and Selection Module and the Plot Description must have been completed.
- The Trapping survey set-up and closure protocol must have been completed to set the traps.
- Appropriate scientific permits and animal ethics approvals must have been obtained before the trapping survey set-up commenced.

6.1.2 Time requirements

- Allow 20 – 60 minutes to check each trapping plot. The duration is dependent on the number of captures. As a minimum, 20 minutes is required to check each trap (full plot), enter the check into the Monitor app, and inspect the drift fences for any maintenance required.

6.1.3 Personnel requirements

Number of personnel and skills:

- Scientific permits and wildlife ethics approvals are mandatory for the Trapping survey set-up and closure protocols. Personnel must meet the jurisdictional requirements and, where necessary, be listed as nominated personnel approved to conduct trapping surveys.
- All personnel handling animals as part of the Identify, measure and release protocol must be aware of relevant legislation (including environmental, animal ethics and workplace health and safety), animal ethics requirements, particularly familiarity with the *Australian code for the care and use of animals for scientific purposes* (NHNRC, 2013), have current animal ethics training.
- All personnel handling animals or survey equipment must be aware of hygiene procedures and be familiar with how to temporarily house, transport, and care for animals in a humane manner.
- The Identify, measure and release protocol is best completed with at least two people. However, three or four personnel can be beneficial, especially if each brings a different taxa/species expertise.
- All personnel handling animals must be confident in removing animals from traps and be experienced in handling terrestrial mammals, reptiles and frogs to obtain basic measurements.
- The personnel responsible for identifying species must be experienced and competent in identifying terrestrial mammals, reptiles and frogs, distinguish identifiable features, and use field guides and taxonomic keys when necessary.
- Only personnel trained, experienced and confident in venomous snake identification and handling should remove snakes from the traps and handle snakes for morphological measurements and identification. Personnel handling venomous snakes must not work alone.

6.1.4 Equipment

For removing animals from the traps:

- Mobile device installed with the Monitor app
- capture bags (calico, cotton, breathable; various sizes - small to fit over the door of a box trap, large to fit over the door of a cage trap; with ties to secure the bag closed), 20+ per site

depending on expected capture rates and the likelihood of animals being measured, marked and released immediately rather than retained for identification, processing and later release)

- masking tape and textas (to label capture bags)
- jiggers or short snake poles (useful for checking the bottom of pitfall traps and reducing having to repeatedly bend down)
- snake pole (for removing snakes from pitfalls and funnel traps)
- bait for re-baiting box traps and cage traps
- refuges (toilet rolls, sections of egg cartons, or neoprene stubby holders) for replacing any in the pitfalls.

For processing animals:

- Mobile device with the Monitor app installed
- plastic zip-lock bags (small size)
- masking tape
- textas (low-toxic)
- callipers
- scales – digital or spring scale (i.e. Pesola) of various increment ranges
- 300 mm clear plastic ruler
- scale cards
- camera
- hand lens
- various field identification field keys, books and apps suitable for identifying species of the local region
- field species list (as developed during the pre-survey planning).

For transporting animals back to the field station or camp (if required for further processing, or holding until suitable release conditions):

- secure containers, such as an eksy, insulated box or ventilated plastic crate (for placing capture bags containing animals inside) for transporting animals from the fauna plot to the field station/camp.

6.1.5 Instructions and procedures

Checking the traps

1. Arrive at the plot and decide who will check which line of traps. If only two personnel are checking the traps, they should work together, with one person checking the traps and the second person entering information in the Monitor app.
2. Traverse to Pitfall Line A, and pitfall 1. Open the Monitor app and select *Vertebrate Fauna Module > Trapping Survey Protocol > check traps.*
3. Select the applicable *fauna plot code*.
4. Select the *trap check interval* (morning, afternoon, midday, other: give details). The app will record the date and time.
5. Complete the *trap checked by* entering first name and surname of personnel checking the traps.
6. Check the traps in the recommended order.
    - Trap Line 1, starting at C1 to C2, including the 10 box traps in between.

- Pitfall Line A, starting at P6 to P1, including the pitfalls and funnels in between.
- Trap Line 2, starting at C4 to C3, including the 10 box traps in between.
- Trap Line 3, starting at C5 to C5, including the 10 box traps in between.
- Pitfall Line B, starting at P7 to P12, including the pitfalls and funnels in between.

7. When arriving at each trap, *scan the QR code* (if using), or *select the trap number*, and record the *trap check status:*
   - capture (see below for further instruction)
   - empty, false trigger - for box traps and cages only
   - not functioning). If the trap is disturbed, a comment can be added (optional), and 1- 3 photos taken (optional).
8. Confirm the *trap set status*, i.e., if the trap was checked and left open, select trap open. If the trap was closed but will be opened again later that day, select trap closed - temporarily.
9. As traps are checked, complete any maintenance required, fix drift fences, replace shelters in pitfalls, replace bait in box traps and cages, and manoeuvre funnels to ensure they are snug against the drift fence.
10. Once all traps have been checked, select *trap check complete.*
11. If any traps have been missed, the app will alert you to which trap has not been checked/entered. If unsure, return to the trap, scan the QR code, and confirm it has been checked.

Record captures

1. A new section is displayed when a capture is selected in the *trap check status*.
2. The app will populate the date, time, GPS location, and trap name (when the user scanned the QR code or selects the trap number from the list). Check these details are correct.
3. The app will able to link the trap type, trap measurements, and trap specifics to the capture (this information will not be displayed).
4. Remove the animal from the trap and securely contain it in a capture bag (see guidelines below for tips).
5. Complete the following in any preferred order (noting that the order will vary between class, species, and personnel preferences) and enter the information in the app.
6. Select the *class* (mammal, reptile, frog, bird or invertebrate).
7. Identify the animal to species level, if required using field guides and/or keys. Start typing the species or common name in the species name box. If the species is uncertain, enter the species field name in the field name box, and re-assess later and update details.
8. Enter the name of the person who made the identification in the *ID made by field.*
9. Enter the primary person processing the animal in the *processed by field*, and an additional person in the *assisted by* field (optional).
10. Check the animal and determine if it is new (never been captured before) or a recapture from a previous day or previous trapping session. Check for temporary texta marks (i.e. recapture from the days prior), check for ear-tags (numbered, coloured, or bluetooth), or ear-tag loss (indicated by ears in the ear margin) and scan for microchips.
    - When no signs of previous markings, select *new capture*, then enter the new individual fields.
        - When temporarily marking, select temporary from the *ID mark type*, and select the *temporary texta colour* allocated, and mark the animal, by drawing line on the upper-side of the base of the tail (see Figure 7), or under-side if tail has black markings and a black texta is being used (see Figure 8).
        - When permanently marking, select *permanent ID type* select microchip, ear-tag or Bluetooth tag, and enter the *ID code* assigned, and mark the animal.

- When previously marked with a texta mark, select *recapture* > *temporary* > *texta mark* > and select the *texta mark colour*.
- When previously marked with a microchip, select *recapture* > *permanent* > *microchip* and enter the microchip number in the *ID code*.
- When previously marked with an ear tag, select *recapture* > *permanent* > *ear tag* and enter the *tag type*, and *tag ID number*. Add *ear tag comments* if needed.
- When previously marked with a Bluetooth tag, select *recapture* > *permanent* > *Bluetooth tag* and enter the *tag type*, and *tag ID number*. Add *ear tag comments* if needed. (Future versions of the app may be able to read the Bluetooth tag directly).
- When previously marked with a band, select *recapture* > *permanent* > *band* and enter *band number*. If the bands are coloured (not numbered), add the left and right leg colour band order starting from the top down to the foot, in *band comments*.

11. For new animals, determine if the animal should be temporarily marked or permanently marked. Select *assign unique ID* and complete the details. Note frogs are not temporarily marked with texta.
    - For texta marked reptiles and mammals, indicate the colour off texta used (red, blue, black, green), and draw a short line in an appropriate area of the body, i.e. top or underside of tail.
12. For recaptures, the app will populate recaptured individuals from the current survey session. If the animal is not listed, proceed to record all details. If the animal is listed from a previous day(s), release the animal (optional, record the animal's weight, check any pouch young etc, but morphological measurements or photographs should not be necessary).
13. If the animal is not to be vouchered continue with the instructions below. If the animal is to be vouchered:
    - scroll to *animal fate*, and select the appropriate option (i.e., held for museum vouchering)
    - keep the animal in the capture bag, place a piece of masking tape on the bag, and label the bag with the required details, and take the animal to the vehicle for return to the field station/camp. On the bag, record:
        - site number
        - date and time (am or pm)
        - trap location collected from
        - species
        - ID made by (first and surname)
        - Processed by (first and surname).
14. For new animals, or animals previously marked but not caught during the current trapping survey, measure and record:
    - *total weight* (animal inside the bag, including the bag weight)
        - for small animals (<20 g) remove the animal from the capture bag and place it in a plastic zip-lock bag, and collect the total weight measurement
        - for animals >20 g keep the animal in the calico bag and collect a weight measurement.
    - remove the animal from the bag and record the *bag weight* (leaving any bait or other objects in for the total weight)
    - the app will calculate and display the *animal weight* (g).
15. Securely hold the animal using any preferred method, including removing the animal from the bag, or holding it in the bag, and exposing the underside.
16. For mammals, using callipers measure and record:
    - *head length*
    - *body length*

- *tail length*
- *hind-foot length*
- *for arm length* (bats only)
- *tibia length* (bats only)
- *ear width* (only use for species where the ear width is an identifiable feature)
- *ear length* (only use for species where the ear width is an identifiable feature)
- ***sex*** (if it can be determined with confidence) or select *unknown* if it cannot be determined.
- *age class* (juvenile, immature - sub-adult, or adult) leave blank if not certain). Note: the animals weight and morphological measurements will also aid in determining if it is a sub-adult post-processing.
- *Female mammal* reproductive signs (optional):
    - *teat condition* (lactating, distended or button, unknown if unsure)
    - *breeding status* (yes, no, unknown)
    - *young present*, *number of young,* and *pouch young head to body length estimate* (note a visual estimate, do not measure as this may dislodge the young), and enter any *young comments*.
- *reproductive status male* mammals (optional):
    - *testes position* (scrotal, abdominal, or unknown if unsure)
    - *testes size category* (not enlarged, enlarged, unknown)
    - male reproductive comments (free text field).
- Comments – add any other additional measurements of morphology descriptions.

17. For mammals, inspect and record:
    - *body condition score* optional) and *body condition comments* (optional)
    - *skin condition* (optional)
    - *clinical scoring – chemosis of eyes* (optional, recommended for koalas)
    - *clinical scoring – proliferation of eyes* (optional, recommended for koalas)
    - *clinical scoring – rump* (optional)
    - note if *clinical swabs* are taken and enter the *swab code* and *swab comment* (for each swab taken).
18. For reptiles, using callipers or a clear plastic ruler measure and record
    - *body length*
    - *tail length*
    - *sex* (if it can be determined with confidence) or note 'unknown' if it cannot be determined.
    - *age class* (juvenile, immature - sub-adult, or adult) leave blank if not certain). Note: the animals weight and morphological measurements will also aid in determining if it is a sub-adult post-processing.
    - *reproductive status female* (optional) (gravid, non-gravid, unknown)
19. For reptiles, inspect and record:
    - *body condition score* optional) and *body condition comments* (optional)
    - *skin condition* (optional)
    - note if *clinical swabs* are taken and enter the *swab code* and *swab comment* (for each swab taken).
20. For frogs, using callipers or a clear plastic ruler measure and record
    - *body length*

- *tibia length* (optional)
- *sex* (if it can be determined with confidence) or note 'unknown' if it cannot be determined.
- *age class* (juvenile, immature - sub-adult, or adult) leave blank if not certain. Note: the animal weight and morphological measurements will also aid in determining if it is a sub-adult post-processing.
- *reproductive status female* (gravid, non-gravid, unknown, in amplexus) (optional)
- *reproduction status for male* (vocal sac obvious, unknown nuptial pads inconspicuous, nuptial pads obvious but not fully developed, nuptial pads fully developed, in amplexus) (optional)

21. Select *take photo series* and follow the prompts to take a photo of the animal from each angle listed. Include a scale card (or ruler, calliper) in each photo where possible. The photos will assist to confirm species identification, individual identification, reproductive status, and clinical observations of individual condition. Remember to include photos of any identifiable features of the species (i.e., underside of hind-foot for mammals and geckos, front foot for geckos and frogs, reproductive markings and colouration, pores, sites of parasites and lesions, and any unusual characteristics.
22. If using an alternative camera (i.e., of better resolution than a tablet), ensure photo numbers are entered into the app, and add the photos later.
23. Select the *animal fate* and indicate if the animal was released at point of capture, withheld for observation, withheld for museum vouchering, or if died as result of trap death or handling death.

Figure 7. Mammal showing texta mark on the upper side of the base of the tail to clearly indicate it has been processed, and if subsequently caught it would be considered a recaptured.

Figure 8. Juvenile reptile showing texta mark on the underside base of the tail to clearly indicate it has been processed, and if subsequently caught it would be considered a recaptured.

6.1.7 Additional guidelines

General

- Animals should only be handled for as long as it takes to identify the species, take and record body and weight measurements, assess reproductive status, photograph, temporarily mark, take a tissue specimen (if permitted and under museum guidance, not covered in this module), and find a suitable location for release.

Ethical considerations

- Animals are to be released unharmed at the point of capture within 24 hours of capture.
- All animals caught in traps should be processed at the point of capture to minimise the time the animal spends in the trap from capture to release.
- If necessary, transport animals back to the field station or camp for processing and identification confirmation. Ensure animals are held securely in a climate-controlled environment (such as an esky). Slightly wet the bags of reptiles and frogs.
- If transporting venomous snakes, ensure the bags are held securely, in at least two tightly knotted calico bags. It is also recommended the bags and snake are placed in a spare cage trap (for extra security), and clearly labelled.

Removing animals from the traps

- Experienced fauna ecologists will generally have their own specific techniques and methods for removing animals from the traps. There is no right or wrong technique, so long as the animal is not harmed and the time is minimised.
- When checking the box traps, a closed door is the best indication that the mechanism has been triggered. Carefully lift the trap up. The weight of the trap will provide an indication of the potential captor. Face the door end towards you, and the mechanism end away from you. Gently tilt the trap so that the door end is higher than the mechanism end, and slightly push the door downward until you can see inside.
- Determine if the animal is potentially venomous, i.e., is it a snake? If it is a snake, ensure that the trap is only checked by someone experienced in snake identification and venomous snake handling.
- If the animal is not a snake, place a calico bag over the door end, folding it and holding it firmly in place, tilt the trap upwards to a vertical position so that the door end is upward, and the mechanism end downward. This should move the animal to the bottom of the trap. Quickly, yet carefully tip the trap upside down, maintaining a firm grip of the calico bag held around the trap. This movement should tip the animal into the calico bag. The animal may avoid entering the calico bag by holding onto the sides of the trap. If this occurs, continue to hold the trap upside down and gently shake the trap until the animal falls into the bag. Once in the bag, ensure the animal is at the bottom, change your grip and grab around the centre of the bag. Remove the trap with one hand and continue holding the calico bag closed in the other hand. If processing at the point of capture, secure the bag by folding the first ~10 cm of the bag over a few times, and tying the string around the bag. Get your measuring equipment, camera etc. out ready for processing.
- Once processed release the animal in a safe location amongst suitable refuge, where possible under a shrub that has cover at ground level, amongst leaf litter. The release location should be at least 15 m from the pitfall line to reduce the chances of immediate recapture.

Species identification

- Discuss with the local museum the recommended field guides, taxonomic keys, and additional resources to use.

Taking morphological measurements

- For medium and/or active animals, it may be easier if one person is holding the animal, and one person is using the callipers and doing the measurements. For smaller animals, it is often easier for

one person to be doing both the holding with one hand and measuring with their other hand. The second person can be entering data into the app.

- Use callipers for mammals where possible. Clear plastic rulers may be best for small reptiles and frogs.
- Ensure the animal is fully stretched and not hunched up when taking head-body and snout to vent measurements.
- Record body measurements in millimetres not centimetres.
- Only record the sex and reproductive status if confident, if unsure select unknown.
- Take care when handling animals with pouch young, ensuring that the young are not dislodged.

Taking photographs

- A series of photographs is recommended for each animal to assist verification of identifications, and document taxonomic and appearance differences between populations. If a species identification is changed during the survey, i.e., a species identified as species x at the start of the survey is further investigated and realised to in fact be species y, the photographs can potentially be used to make corrections.
- It is up to the survey coordinator to determine if excessive photographs are being collected, especially if it proves time consuming due to high capture rates. The taking the photographs could potentially cease once all surveyors are certain of all identifications, and little variation between individuals caught is being observed.
- If photos are not taken using the app, make sure to record camera/SD card/photo numbers in the app for each record.
- Using a scale card or rule in all photographs is strongly recommended. Examples are shown in Figure 11 - Figure 12.

Figure 9. Surveyor using callipers to take a head measurement of a Kowari after feeling for the back of the skull.

Note nose tip measurement can be estimated to avoid damaging the nose with metal calipers. Photo: Tali Moyle.

Figure 10. Field photograph of a medium reptile showing use of a 10 mm increment scale card.

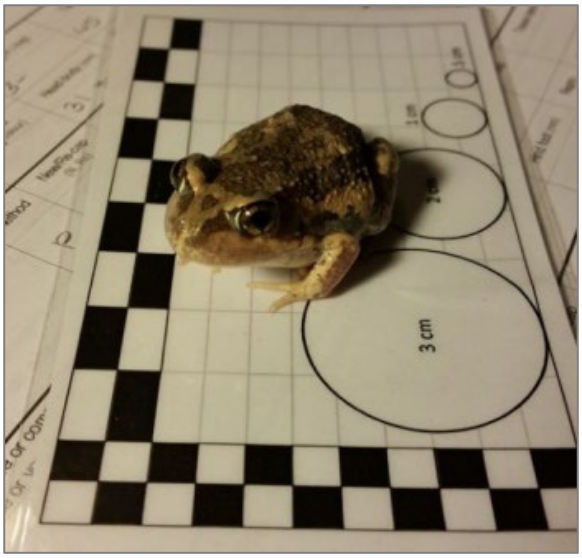

Figure 11. Field photograph of a frog on a scale card.

Figure 12. Active and fragile animals, including frogs, can be temporarily held in clear zip-lock bags and manoeuvred to take photos showing any characteristic markings.

Snakes

- Only surveyors fully trained in snake handling and who are confident should attempt to remove snakes from the traps and take measurements.
- If no confident personnel are present at the time (i.e. checking traps elsewhere), secure the trap and notify additional personnel that may be able to check the trap later, discuss timeframe to rendezvous, and determine if the snake should be held in the trap or released immediately at the point of capture. If no personnel are available, take care and open the trap using a long-handled snake pole. Have a second surveyor available to take photographs from a far and release the animal without processing.

Hygiene

- Always follow strict hygiene precautions when handling all animals, and especially frogs, and all animal processing equipment.

Non-target fauna

- Non-target species (i.e., birds) should be identified and released at the capture site. There is no need to take morphological measurements.

Releasing animals

- Find a suitable location for immediate release within 20 m of the capture location, ensuring the animal is placed near a shrub or woody debris for refuge, ensure it is released in the shade where possible, and that no predators (i.e. birds of prey) are in the vicinity.
- After processing, it may be appropriate to temporarily return the animal to the calico bag whilst a suitable release location is found, or if needing to consult with other personnel at the site. When ready, place the bag into position and gently open it and allow the animal to depart when ready.

6.2 Post-field survey tasks

6.2.1 Sample curation

No samples or specimens are collected in the Identify, measure and release protocol (directly). Any samples taken as additional activities must be managed and curated as per local jurisdiction/museum requirements.

7 Bird survey protocols

7.1 Field collection

7.1.1 Pre-requisites

Pre-requisites for completing this protocol:

- Before commencing the bird survey, the plot must be established using the Plot Layout and Selection Module to record the location of the plot in the Monitor app. Pegs and star-droppers do not need to be installed to mark the boundary of a Fauna Plot, but the outer boundary of the 2 ha plot should be marked with flagging tape to aid as a visual cue. Marking the plot in the Monitor app, and physically with flagging tape can either be done during a reconnaissance visit or the day before conducting the bird survey. It should not be done immediately before the survey commences to avoid disturbing any birds present. The plot only needs to be marked once on the first visit to establish the plot.
- The Plot Description Module should be completed before, during or immediately after a bird survey. The enhanced protocol should be done at least on the first visit of the plot, and the standard protocol completed on subsequent visits during different seasons/years.
- Appropriate scientific permits and animal ethics approvals must be obtained before the Trapping survey set-up and closure protocols can commence.

7.1.2 Time requirements

Survey time requirements will vary depending on the location and habitat complexity of the survey location.

As a general rule:

For a 20 minute 2 ha survey

- Allow 15 minutes to initially set-up the bird survey area (once off)
- ~5 minutes to enter the survey details (surveyor, weather etc) (each survey)
- 20 minutes to conduct a 2 ha, 20 minute survey (each survey)
- ~5-10 minutes to complete notes and ensure all data has been successfully entered (each survey)

500 m area search:

- 15 minutes to initially set-up the bird survey area (once off)
- ~5 minutes to enter the survey details (surveyor, weather etc) (each survey)
- ~60 minutes to conduct a 500 m area search (survey time is not restricted, but recommended 60 minutes, ensure time is recorded in the app)
- ~5-10 minutes to complete notes and ensure all data has been successfully entered (each survey).

7.1.3 Personnel requirements

Number of personnel and skills:

- Bird surveys are observational in nature, and therefore risk to disturbing wildlife is low. Scientific permits and wildlife ethics approvals may not apply, but always check with location jurisdictional requirements.

- The personnel responsible for identifying species must be experienced and competent in identifying birds, be able to distinguish identifiable features in both physical appearance and call, and be able to use field guides when necessary.

7.1.4 Equipment

The following equipment is required to conduct the bird observations protocols:

- Mobile device (tablet/phone) with the app installed
- GNSS, such as a Trimble R1 or DA2 receiver, a hand-held GPS or device built-in GPS (least preferred), capable of achieving <30 cm accuracy
- Binoculars
- Field guides (books or apps)
- Flagging tape (or paint for marking trees).

7.1.5 Instructions and procedures

2 hectare 20 minute survey

Survey set-up

1. Arrive at the Fauna plot location and conduct an assessment to familiarise with the Biodiversity Plot boundaries. If necessary, flag the boundaries of the 2 ha survey area, considering the configuration of the Fauna Plot and Core Plot. It may be useful to flag the corners / boundary of the survey area as a visual aid, but this is no necessary, especially if the survey area is already marked in the app.
2. Open the app and select *Vertebrate fauna > Bird survey > 2 ha 20 minute survey.*
3. Select the applicable *Plot ID*. A map will show.
4. Traverse to any corner of the plot where the survey will begin.
5. Select *survey details*.
6. Enter the *number of observers*, and for each observer, enter the *observer name* and *observer role* (spotter – naked eye, spotter – binoculars, data entry, data entry only). Multiple roles can be selected for each observer, except for *data entry only* (this assumes this person is primarily using the app and not actively spotting), i.e., spotters can be only observing, whilst another person may be both spotting and entering data. Spotter – binoculars, does assume the observer is using their naked eyes as well as binoculars.
7. Enter the *weather conditions*, including *temperature*, *rainfall*, *duration of rainfall*, *cloud cover*, and *wind speed*, and moon phase (optional). Note the weather conditions can be adjusted at the completion of the survey.

Conduct the survey

1. Once all observers and equipment are ready, and the target time (and light conditions) are ideal, select *start survey*. A timer will show at the top of the screen.
2. Commence a slow walk meander around the 2 ha Biodiversity Plot area, stop often to listen for movement, and bird calls. Aiming to cover most of the 2 ha in the 20 minute timeframe.
3. Once a bird is observed, select *record observation*.
    - In the *species name* field start typing the common name and once the name populates, tap it to select.
    - Enter the *number* observed, type the number seen (a keypad will appear). The default will be '1', tap and edit if required.
    - Enter the *observation type* (seen, heard, seen and heard).
    - Select the *location* (within survey plot is the default, or select outside plot - same habitat, or outside plot - different habitat.

- Enter the *activity type* (optional).
- Select the *sex* (unknown, male, female) (optional).
- Select the *age-class* (unknown, adult, immature or juvenile).
- Enter the *breeding activity* (categories as defined by BirdLife Australia, 2015):
    - nest with eggs
    - nest with young
    - young out of nest, precocial chicks of any age or altrical species which have left the nest but which are still dependent on adults (not yet fledged)
    - recently fledged young, juveniles no longer dependent on adults. This is weak evidence of actual nesting having occurred at the plot/time of observations as juveniles often move quickly from natal territories after fledging
    - diagnostic behaviour– confirms an active nesting attempt, includes distraction displays, dive bombing, brood patch evident, carrying food repeatedly to nest or hollow
    - suggestive behaviour – suggests a nesting attempt, but evidence cannot be used as confirmation, includes nest building, courtship or copulation, single observation of carrying food.

4. Select *save record*.
5. If additional observations of the same species are made
    - and all other field details (i.e. same gender, location, activity, gender, maturity, breeding activity) are made, click on the + button to add new records. The tally will be added automatically.
    - but not all the field details, are made, click on the *copy* 🗐 button to make an exact copy of that record, that can then be quickly edited (i.e. different gender, behaviour). A new record will be made. Tap on the species name to bring up the record screen, and edit the fields that need updating. I.e. the original observation was of a New Holland Honeyeater male, the new observation is the same, but a female, so on the copied record, select male from the gender field instead of female, and select save record.
6. At the conclusion of the 20 minutes, the timer will stop to alert you to stop recording any new observations.
7. If continuing the survey, and extending the survey, select 'pause'. Please spend just a few minutes checking over your records.
8. Select *records*. Tidy up any incomplete fields, revise the weather information if necessary.
9. Optional: add in field notes in the free text field. This may include photo reference numbers if applicable (see guidelines, taking photos is discouraged during the survey).
    - Note, taking photos of birds is discouraged during the survey as it can mean the observer spends more time trying to get a good photo, rather than looking for new birds and collecting valuable data. However, if photos are taken, they can be attached to the record. Select the record, and 'add photo' button, and the app will allow you to select photos from your camera roll/device (including linked cloud storage accessible from your device).
10. If continuing, and you have already selected 'pause' on your survey page, make your way to the edge of the 2 ha survey area, and select 'continue with 500 m area search'.
11. The map will now show you the centre point of the 2 ha area, with a 500 m radius.
12. Continue with the survey, repeating the 'add records' as you encounter new observations.
13. Note: if you do remain in the survey area and would like to add additional bird observation records, use the opportune observations module of the app.

500 m area search

1. Arrive at the Fauna plot location, and conduct an assessment to familiarise with the plot boundaries. If necessary flag the boundaries of the 2 ha survey area, considering the configuration of the fauna plot and vegetation and soils plot. It may be useful to flag the corners / boundary of the survey area as a visual aid, but this is no necessary, especially if the survey area is already marked in the app.
2. Open the app, and select 'Vertebrate fauna, 'Bird survey', then '500 , area search bird survey'.
3. A map will show, identifying your location with the surrounding terrain, and any known plots in the area, and any previously marked bird survey areas.
4. If available, select the 500 m search area you want to survey. If there are no previously marked bird survey areas, follow the instructions
5. Select 'survey details'.
6. Select the applicable 'plot name', or type it in if it is not listed.
7. Enter the number of 'observers', the default will be 1, tap and enter if different.
8. Enter the weather conditions (these can be reviewed at the conclusion of the survey if you feel conditions changed from that noted at the start).
9. The app will populate todays date (tap to edit).
10. Select 'start survey', and a timer will show at the top of the screen.
11. Commence a slow walk meander around the 500 m search area, stop often to listen for movement, and bird calls. You should be aiming to cover 'most' sections of the search area in a 60 minute timeframe.
12. Once a bird is observed, select 'record observation', in the 'species name' field start typing the common name and once the name populates, tap it to select.
13. In the 'number' field, type the number seen (a keypad will appear). The default will be '1', tap and edit if required.
14. The 'observation type' default is 'seen', if the bird was only 'heard', select 'heard', if both seen and heard, select both options.
15. The 'location' default is 'within survey plot', select 'outside plot, same habitat', or 'outside plot, different habitat' if applicable.
16. Optional - enter the 'activity type' by selecting from the drop-down list. The default is blank.
17. Optional - the 'sex' field default is 'unknown', if you are certain, tap and select 'male' or 'female'.
18. Optional - the 'maturity' default is 'unknown', if you are certain, to select 'adult', 'immature' or 'juvenile'.
19. Optional – the 'breeding activity' default is 'none'. If applicable, note if the bird fits into a breeding category (as defined by BirdLife Australia, 2015):
    - nest with eggs
    - nest with young
    - young out of nest, precocial chicks of any age or altricial species which have left the nest but which are still dependent on adults (not yet fledged)
    - recently fledged young, juveniles no longer dependent on adults. This is weak evidence of actual nesting having occurred at the plot/time of observations as juveniles often move quickly from natal territories after fledging
    - diagnostic behaviour– confirms an active nesting attempt, includes distraction displays, dive bombing, brood patch evident, carrying food repeatedly to nest or hollow
    - suggestive behaviour – suggests a nesting attempt, but evidence cannot be used as confirmation, includes nest building, courtship or copulation, single observation of carrying food.
20. Select *save record*, and the screen will return to your 'sightings'.

21. If additional observations of the same species, and all other field details (i.e. same gender, location, activity, gender, maturity, breeding activity) are made, click on the '+' button to add new records. The tally will be added automatically.
22. If additional observations of the the same species, but not all the field details, are made, click on the 'copy 🗐' button to make an exact copy of that record, that can then be quickly edited (i.e. different behaviour).
23. A new record will be made. Tap on the species name to bring up the record screen, and edit the fields that need updating. I.e. the original observation was of a White-browed babbler that was seen and heard, the new observation is the same species, but was only heard, so on the copied record, select heard from the 'observation type' field, and select save record.
24. At the conclusion of the 60 minutes, the timer will stop to alert you to stop recording any new observations. (note the time can be stopped prior to this). Select 'end bird survey'.
25. Please spend just a few minutes checking over your records. Select 'records'. Tidy up any incomplete fields, revise the weather information if necessary.
26. Optional: add in field notes in the free text field. This may include photo reference numbers if applicable.
    - Note, taking photos of birds is discouraged during the survey as it can mean the observer spends more time trying to get a good photo, rather than looking for new birds and collecting valuable data. However, if photos are taken, they can be attached to the record. Select the record, and 'add photo' button, and the app will allow you to select photos from your camera roll/device (including linked cloud storage accessible from your device).

Note: if you do remain in the survey area and would like like to add additional bird observation records, please use the opportunistic observations module of the app.

7.1.6 Additional guidelines

- Do not conduct the bird surveys if weather conditions are likely to compromise the detectability of birds:
    - wind velocity exceeds about 10 km/hour (grass, leaves, or twigs constantly moving), especially for species that are usually detected by soft or high frequency calls
    - rainfall intensity is above a drizzle
    - conditions are misty or foggy
    - temperatures are either well below or above the seasonal average.
- Do not use call playback (emitting a bird call from a device encouraging the bird species to respond and therefore make it's presence known). Call playback techniques are only permitted in targeted surveys (and nocturnal observations).
- Try and configure your survey start location so that you will have the sun behind you rather than in front of you. Early morning / late afternoon low sun position can make seeing birds difficult, especially colours, and particularly in shady habitats.
- If multiple observers are completing the survey, make sure they are listed in the survey details. Observers must stay in close proximity and work together (we recommend staying <10 m apart).
- If there the study area has multiple bird plots in relatively close proximity (<1 km), we recommend the plots are simultaneously surveyed by multiple surveyors to ensure independence of the observations.
- Record all birds you see or hear, but only record birds you can identify to the species level with certainty. Do not record unidentifiable species, or 'little brown birds'. However, if the bird has distinguishing features, and you are certain you willl be able to get to an identification after the survey by consulting field guides, field apps, or colleagues, enter a field name, and include the

description details in the free text comment box. At the completion of the survey, records marked with field names only will not be submitted.

- Beware of species that mimic other species, and if you are in close proximity to a dwelling etc., do not record captive birds that you may hear.

- For activity type:
  - The activity of observations that are flying overhead - over the plot (FO) and flying overhead circling (FC) – must be noted as it is important that birds flying over but not utilising the plot can be excluded from certain analyses
  - The remainder activity types, flying within the survey area at strata level (FW), resting on a tree (ROT), resting on ground (ROG), resting on shrub (ROS), foraging on a tree (FOT), foraging on ground (FOG), foraging on shrub (FOS) – are optional and considered useful to understand how the birds are utilising the plot, but not mandatory.

7.2 Post-field survey tasks

7.2.1 Sample curation

No samples or specimens are collected in the Bird surveys protocols.

8 Active and passive search protocols

8.1 Field collection

8.1.1 Pre-requisites

Pre-requisites for completing this protocol:

- The plot must be established using the Plot Layout and Selection Module prior.
- The Plot Description Module must be completed prior to, or during the survey the Active and passive search protocol.

8.1.2 Time requirements

Survey activity time estimates will vary depending on the number and variety of signs encountered, the number of measures recorded, and if scats are being collected and removed or merely recorded. As a general guide:

- Allow 1–2 hours hour for survey planning.
- Allow 20–60 minutes per plot to complete the reconnaissance visit and set up the plot.
- Allow 15 minutes for the survey set-up before commencing each survey to enter the information.
- Active searches should be conducted for a minimum of 60 minutes active surveyor time per ha (i.e. two surveyors for 30 minutes per ha, for a Fauna Plot allow 1 hour and for a 2 ha Biodiversity Plots allow 2 hours). Add additional time if time is spent identifying hand captures and observations or watching animals behaviour.
- Passive searches should be conducted for a minimum of 60 minutes active surveyor time per ha (i.e. two surveyors for 30 minutes per ha, for a Fauna Plot allow 1 hour and for a 2 ha Biodiversity Plots allow 2 hours). Add additional time if time is spent watching animals behaviour.

8.1.3 Personnel requirements

Personnel number and skills:

- Active and passive searches are best conducted with two personnel.
- Surveyors should be familiar with and experienced in identifying the characteristic identifiable features of the species observed and signs encountered and how to distinguish these signs from other species. If surveyors are not confident, time should be dedicated to practising, using field reference guides, and seeking advice before conducting this protocol.
- Active searches do involve interference with wildlife. Therefore scientific permits and wildlife ethics approvals are may be required, but remember to always check with your local authority. Access permissions are required.

8.1.4 Equipment

The following equipment is required:

- Mobile device with App installed
- R1 GNSS
- Hand tools, such as a jemmy bar
- Rakes
- Scale cards
- Camera
- Hand lens

- Head-torches (for viewing inside hollows and diurnal searches)
- Hand-held spotlights (if conducting nocturnal searches with spotlights rather than head-torches)
- Various field guides or field apps
- Capture bags (with masking tape and texta to label bags if necessary)
- Mobile phone/speaker etc., loaded with bird calls to play bird calls *(optional)*
- Bird whistles (to encourage call-back) *(optional).*

8.1.5 Instructions and procedures

Reconnaissance and survey set-up

1. Arrive at the plot prior to the intended survey starte time. Ensure the Plot Selection and Layout Module has been completed to mark out the plot boundary and define the current visit in the Monitor app.
2. Ensure the Plot Description Module, Standard protocol (minimum), or Enhanced protocol has been completed.
3. Open the Monitor app and select *Vertebrate Fauna Module > Active search protocol*.
4. Indicate if *survey intent* is a once-off measure, repeated measure, repeated measure with previous scat removal, or linked to a pre-control activity or post-control activity (optional).
5. Enter the *number of observers*, *observer name* and *observer role* (spotter, data entry, data entry only) for each observer.
6. Enter the *weather conditions*, including *temperature*, *rainfall*, *rainfall duration, cloud cover, wind speed*, and *moon phase* of the previous night. Note the weather conditions can be adjusted after the survey.
7. Enter the *tracking surface* information.
8. Enter the *search type* – active techniques or passive techniques only.
9. Indicate if *call-play back* techniques will be used.
10. Identify if *site information* will be completed after the survey has been conducted or if other modules are being conducted in unison, whereby site information such as floristics and habitat condition will be collected elsewhere (refer to guidelines for further information).

Conduct the survey

1. Determine which direction to commence traversing the plot, ideally walking into the sun to use shadows cast by tracks, and identify which corner of the plot to start the survey at (either of the 4 corners).
2. Select *record start location* and select the corner you are standing at to commence the survey. The app will record the location, start date and time automatically. For subsequent re-surveys, make sure the survey starts at the same corner so that start location photos are the same.
3. Select *start location photo* and face towards the centre of the plot to take a representative photo.
4. Select *start active sign search* to commence the timer, then begin surveying by zig-zagging across the plot looking for signs. Your position within the plot will be shown, and the app will record a location every minute until the survey is completed, creating a trail across the plot. Ensure the entire plot is covered by checking the map intermittently, even when no signs are observed.
5. For active searches only, rake small areas of leaf litter, lift rocks and coarse woody debris, remove sections of tree bark, sift through vegetative matter and soil, carefully search for animals, particularly legless lizards. Return of refuges (rocks, leaf litter, logs etc, as found).
6. For each sign observed, select *add sign record*:
   - select the sign type (scat, track, dig, burrow, warren, etc, see Appendix)
   - select the attributable fauna species (select unknown if not certain)
   - indicate the sign age (fresh 1-2 days, old 3-7 days, very old 7+ days) (optional field)

- indicate the age class of the individual responsible for the sign (optional field applicable to scats and tracks only based on size)
- add photo (representative photos should be taken for each species/sign type for the plot – i.e. not all signs observed need to be photographed, ideally a scale card should be used in all photos (optional, up to 3 photos per sign record)
- if warrens, burrows or dens are observed, count and record the number of entrances and record if any are considered active or not active (optional)
- add any additional comments in the observation comments field. Recording the gait length and width may be of interest, particularly of feral cats and foxes to assist distinguishing individuals.

7. For each animal observed, select *add sign record*:
   - enter the *species*
   - indicate the *age-class*, *sex* and *reproductive status* (optional)
   - if hand-caught, complete and any *morphological measurements* relevant to the species, and any individual ID details (i.e. microchip numbers, tag number etc)
   - enter the *activity type*
   - release the animal at the point of capture, and indicate the *animal fate*.
8. Traverse the entire plot area recording all signs observed.
9. The active search is complete when the surveyors are confident the entire plot has been searched, and there has been a minimum of 60 minutes survey effort. Remember to check the app screen to identify any areas missed. There is no time limit (see below for recommendations).
10. Once the active search is complete, select *end active search*. Edit any key information (i.e. adjust the weather conditions, particularly if wind or light conditions changed during the survey).

8.1.6 Additional guidelines

Diurnal active search

- Diurnal active search effort must be a minimum of 60 minutes surveyor time. Increased effort is recommended for non-trapping Fauna Plots. The effort can be increased by repeating the search on different days and time periods (i.e. morning and afternoon sessions under different weather and cloud cover conditions).
- Diurnal active searching may be conducted whilst the Fauna Plot is being trapped (i.e. you do not need to wait until the conclusion of the trapping).
- Destructive methods, i.e. ripping bark of trees, lifting logs etc., must be restricted to the outer edge of the Fauna Plot to limit disturbance. All rocks and timber, especially hollow logs, must be put back into place. Do not remove fauna refuges, or move them so they no longer provide refuge.
- Destructive methods within 20 m of the plot boundary, and not within an adjacent Core Plot.
- Minimise noise when actively searching.
- Diurnal active searching can be conducted at any time during daylight hours. If sandy surfaces are present, mid-mornings are recommended (after trap checking is completed as a priority), before tracks blow away. However, avoid cold weather conditions as animal movements will be limited, thus chance of observation will be low.
- Where possible, for scat records, note the approximate age of the scat in the comments section - noting if it is considered fresh or old).
- For track observations, note the approximate age of the track in the comments section, noting the track is considered fresh (i.e. overnight), or old – such as tracks left in heavy or previously wet soils.

- Record burrows, to species level where possible, based on the shape, and scats that may be present (use appropriate field guides (Triggs 1996) (Moseby et al. 2012). Remember to look up trees and amongst shrubs for bird nests.

Nocturnal passive searching

- Nocturnal passive search effort must be a minimum of 60 minutes surveyor time. Increased effort is recommended for non-trapping Fauna Plots. The effort can be increased by repeating the search on different nights (rather than extended the search time for one session).
- Where possible, schedule the nocturnal searches to avoid nights surrounding a full moon (all surveys should avoid a full moon where possible) if cloud cover is sparse.
- Nocturnal passive searching may be conducted whilst the Fauna Plot is being trapped (i.e. you do not need to wait until the conclusion of the trapping). Ideally the search should commence between 1 and 2 hours after dark. Surveyors should take care to minimise noise and disturbance.
- For safety reasons, nocturnal searches should not be conducted alone.

8.2 Post-field survey tasks

8.2.1 Sample curation

No samples or specimens are collected in the Active and passive search protocols.

9 Acoustic and ultrasonic recordings protocols – coming soon

The Acoustic and ultrasonic recordings protocol is currently undergoing expert review, and will be provided when available (expected by Friday, 4th August 2023).

10 Data curation

Data from the Vertebrate Fauna Module is collected in the field using the Monitor app. Data entry is completed in the app, photos are taken using the app (or later linked if taken on other devices). All data is checked for correctness and completeness in the app before it is submitted.

Once all data is finalised and marked as complete, the data is submitted from the Monitor app to the staging server by an explicit user action. If the device is offline at the time, the data will be pushed as soon as it is reconnected to a network (i.e. either back in mobile phone range or a wi-fi network). Once data reaches the staging server it is prepared in an export interface for delivery to the Biodiversity Data Repository. DCCEEW is then responsible for managing the data. In the future, it is anticipated that data curation tools will be made available to project personnel.

12 Data use and reason for collection

12.1 Data use to date

Results of vertebrate fauna surveys are typically provided to state/territory jurisdictional databases Data provided is typically capture details, of a biological inventory format (location, date, species, age-class, sex, morphological measurements, and voucher numbers) and observation details (species, age-class, activity and behaviour). Monitoring data, including survey effort, survey results (capture rates etc), is more typically held in local databases and is less readily available. Species occurrence data is often submitted to national datasets, including the Atlas of Living Australia, as occurrence data (species, location, date, data source).

Bird survey data can be readily provided to BirdLife Australia, and is particularly easy to do if using the Birdata app. The Birdata database holds results of 1.5 million surveys, from over 9000 contributors (including amateurs, citizen scientists and experts from across the country), making it a vital dataset to understand Australian bird occurrences over time (Birdlife Australia, 2023 (BirdLife Australia 2023)).

12.2 Future use of the data

In addition to the results of the surveys informing ecological monitoring, and landcare improvement programs, the future data set that becomes available will provide opportunities to refine the Vertebrate Fauna Module and protocols, and other related modules including the Targeted Surveys Module, Invertebrate Fauna Module, Camera Trapping Modules, Fauna Ground Counts Module, Signs-based Fauna Surveys Module. This could include an investigation into the robustness of the data collected from the observational techniques, particularly active diurnal and passive searches, when trapping is not completed, and when trapping is completed. Identifying and providing clear evidence on true value of these non-invasive methods in providing accurate data that is still robust, standardised, and non-biased will further help clarify minimum survey effort requirements to suite different project needs.

The robustness of the data collected from observational techniques, particularly diurnal and passive searches where surveyor bias is likely to play a significant factor. The true value of these techniques when implemented with a trapping survey needs to be considered, particularly when assigning personnel and resources.

The vertebrate fauna data collected present the opportunity for a wide range of applications, such as:

- Inventory of vertebrate taxa present, including a comparison to historical distributions and results of biological surveys
- Monitoring:
  - spatial and temporal changes in vertebrate populations and communities, including distribution and dispersal in fragmented ecosystems e.g. (Stenhouse and Moseby 2023); (McAlpine et al. 2023), and after alternation to management regimes, interventions
  - response to development
  - response to catastrophic events, e.g. response to fire, (Dickman and Happold 2022); (Abom and Schwarzkopf 2016), see (Legge et al. 2022)
  - response to climate driven resource availability
- Detecting:
  - new, and previously undescribed species
  - species though locally extinct from the project area
  - occurrences of threatened species, and species in low abundance
  - morphologically indistinct species

  - vertebrate pest incursions/ biosecurity
- Knowledge of vertebrate:
  - taxonomy, morphology, and systematics e.g. (Hutchinson et al. 2009); Aplin et al. (2015)
  - population demographics, e.g. (Braithwaite and Griffiths 1994); (Major et al. 1999)
  - landscape refuges
  - habitat preferences, resource availability, and the impact of pest fauna damaging critical refuges
  - food resources, resource availability, and the impact of other species competing for resources
  - community ecology and sympatric species
- Identifying:
  - the paths by which vertebrates influence ecosystem services, as well as how climate change will affect those ecosystem services by altering vertebrate populations
  - the influence of sampling biases, which could facilitate improvement in future sampling protocol and design
  - the factors that influence population dynamics and abundance (e.g. season, climate, rainfall, microhabitat conditions)
- Informing:
  - artificial refuge requirements to support significant habitat alternation, post-catastrophic bushfire events, and reintroductions, e.g. (Quin et al. 2020, Best et al. 2022)
  - the relative effectiveness of different sampling methods for inventory and monitoring
  - state of the environment reporting
  - species trajectories
  - conservation decision models, management strategies, action plans and recovery efforts, e.g. see (Addison et al. 2013)
  - predictions of response under different disturbance, management and climatic regimes
  - efforts required for effective monitoring of threatened vertebrates, e.g. (Crates et al. 2022)
  - decisions on environmental impact assessments (e.g. impact on matters of environmental significance)
  - effectiveness of management strategies, including evidence based off-set benefits.

13 References

Abom, R., and L. Schwarzkopf. 2016. Short-term responses of reptile assemblages to fire in native and weedy tropical savannah. Global Ecology and Conservation **6**:58-66.

Addison, P. F. E., L. Rumpff, S. S. Bau, J. M. Carey, Y. E. Chee, F. C. Jarrad, M. F. McBride, and M. A. Burgman. 2013. Practical solutions for making models indispensable in conservation decision-making. Diversity and Distributions **19**:490-502.

Aplin, K. P., S. G. Rhind, J. Ten Have, and R. T. Chesser. 2015. Taxonomic revision of Phascogale tapoatafa (Meyer, 1793)(Dasyuridae; Marsupialia), including descriptions of two new subspecies and confirmation of P. pirata Thomas, 1904 as a 'Top End'endemic. Zootaxa **4055**:1–73-71–73.

Best, K., A. Haslem, A. C. Maisey, K. Semmens, and S. R. Griffiths. 2022. Occupancy of chainsaw-carved hollows by an Australian arboreal mammal is influenced by cavity attributes and surrounding habitat. Forest Ecology and Management **503**:119747.

BirdLife Australia. 2023. Birdata.

Braithwaite, R. W., and A. Griffiths. 1994. Demographic variation and range contraction in the northern quoll, Dasyurus hallucatus (Marsupialia: Dasyuridae). Wildlife Research **21**:203-217.

Crates, R., L. Rayner, D. Stojanovic, B. Scheele, A. Roff, J. MacKenzie, and R. Heinsohn. 2022. Poor-quality monitoring data underestimate the impact of Australia's megafires on a critically endangered songbird. Diversity and Distributions **28**:1-9.

Department of Parks and Wildlife. 2013. Standard Operating Procedure No: 8.1 Vouchering vertebrate fauna specimens. The Government of Western Australia.

Dickman, C. R., and D. C. Happold. 2022. Demographic and dietary responses of small mammals to high severity fire. Australian Zoologist **42**:256-277.

Hutchinson, M. N., P. Doughty, and P. M. Oliver. 2009. Taxonomic revision of the stone geckos (Squamata: Diplodactylidae: Diplodactylus) of southern Australia. Zootaxa **2167**:25–46-25–46.

Legge, S., L. Rumpff, J. C. Z. Woinarski, N. S. Whiterod, M. Ward, D. G. Southwell, B. C. Scheele, D. G. Nimmo, M. Lintermans, H. M. Geyle, S. T. Garnett, B. Hayward-Brown, M. Ensbey, G. Ehmke, S. T. Ahyong, C. J. Blackmore, D. S. Bower, D. Brizuela-Torres, A. H. Burbidge, P. A. Burns, G. Butler, R. Catullo, D. G. Chapple, C. R. Dickman, K. E. Doyle, J. Ferris, D. Fisher, R. Gallagher, G. R. Gillespie, M. J. Greenlees, R. Hohnen, C. J. Hoskin, D. Hunter, C. Jolly, M. Kennard, A. King, D. Kuchinke, B. Law, I. Lawler, S. Lawler, R. Loyn, D. Lunney, J. Lyon, J. MacHunter, M. Mahony, S. Mahony, R. B. McCormack, J. Melville, P. Menkhorst, D. Michael, N. Mitchell, E. Mulder, D. Newell, L. Pearce, T. A. Raadik, J. J. L. Rowley, H. Sitters, R. Spencer, R. Valavi, M. West, D. P. Wilkinson, and S. Zukowski. 2022. The conservation impacts of ecological disturbance: Time-bound estimates of population loss and recovery for fauna affected by the 2019–2020 Australian megafires. Global Ecology and Biogeography **31**:2085-2104.

Major, R. E., F. J. Christie, G. Gowing, and T. J. Ivison. 1999. Age structure and density of red-capped robin populations vary with habitat size and shape. Journal of Applied Ecology **36**:901-908.

McAlpine, C. A., J. Callaghan, D. Lunney, J. R. Rhodes, R. Goldingay, W. Goulding, C. Adams-Hosking, K. Fielding, S. B. Hetherington, A. Brace, M. Hopkins, L. Caddick, E. Taylor, L. Vass, and L. Swankie. 2023. Influences on koala habitat selection across four local government areas on the far north coast of NSW. Austral Ecology **48**:928-951.

Moseby, K., T. Nano, and R. Southgate. 2012. Tales in the sand: a guide to identifying Australian arid zone fauna using spoor and other signs. Government of South Australia, Adelaide.

NHMRC. 2013. Australian Code for the Care and Use of Animals for Scientific

Purposes. Canberra.

Quin, B. R., R. L. Goldingay, D. G. Quin, E. Collins, N. Bartlett, R. Jerome, T. Murnane, T. Marsh, and S. Jessup. 2020. Long-term monitoring of nest boxes and nest logs in a tree-hollow depleted box–ironbark forest in north-eastern Victoria. Australian Journal of Zoology **68**:150-166.

Stenhouse, P., and K. E. Moseby. 2023. Patch size and breeding status influence movement patterns in the threatened Malleefowl (Leipoa ocellata). Austral Ecology **48**:904-927.

Triggs, B. 1996. Tracks, scats and other traces. A field guide to Australian mammals. Oxford University Press Australia, Melbourne.

van Strien, A. J., C. A. van Swaay, and T. Termaat. 2013. Opportunistic citizen science data of animal species produce reliable estimates of distribution trends if analysed with occupancy models. Journal of Applied Ecology **50**:1450–1458.

Wildlife Ethics Committee. 2020. Collection of voucher specimen policy.*in* D. f. E. a. Water, editor. Government of South Australia.

14 Appendices

Appendix 1. Key data collection fields from the Vertebrate Fauna Module

Complete lists are provided in the Monitor app, as well as the TERN website

Trapping set-up and closure

Trap specifics
▪ Pitfall - PVC pipe
▪ Pitfall - plastic bucket
▪ Pitfall - temporary plastic sheet folded
▪ Box trap - foldable aluminium or galvanised steel (i.e. Elliott and Sherman style)
▪ Funnel - shadecloth
▪ Funnel - shadecloth with hessian/other bag
▪ Cage - wire mesh, foot plate mechanism
▪ Cage - wire mesh, hook mechanism
▪ Other: text describe

Trap measurements
▪ Trap depth
▪ Trap height
▪ Trap width
▪ Trap length

Trap set status
▪ Trap open
▪ Trap closed - permanently
▪ Trap closed - temporarily
▪ Trap closed - wired shut
▪ Trap closed and removed
▪ Pitfall closed - filled in
▪ Pitfall closed - lid secured

Trap check result
▪ Empty
▪ False trigger
▪ Capture
▪ Comments

Capture records

Capture status
▪ New
▪ Recapture
▪ Unknown

ID mark type
▪ Temporary
▪ Permanent

Permanent ID type

▪ Microchip
▪ Ear tag
▪ Bluetooth tag
▪ Band

Temporary ID type
▪ Texta - red
▪ Texta - blue
▪ Texta - black
▪ Texta - green
▪ Other

Individual measurements
▪ Total weight
▪ Bag weight
▪ Animal weight

Age-class
▪ Adult
▪ Immature (sub-adult)
▪ Juvenile
▪ Unknown

Sex (all classes)
▪ Female
▪ Male
▪ Unknown

Individual measurements - mammals
▪ Head length
▪ Body length
▪ Tail length
▪ Hind foot length
▪ Forearm length (bats only)
▪ Tibia length (bats only)
▪ Ear width

Mammal reproduction – female: teat condition
▪ button/un-developed
▪ lactating
▪ distended/post-lactating
▪ button
▪ unknown

Mammal reproduction – female: breeding status
▪ pregnant
▪ not pregnant
▪ unknown
▪ dependent young
▪ pregnant

Mammal reproduction – female: pouch young present
▪ pouch young present
▪ no pouch young present
▪ unknown
▪ not applicable
▪ young on back

Mammal reproduction – male: testes position
▪ Scrotal
▪ Abdominal
▪ Unknown

Mammal reproduction – male: testes size category
▪ Not enlarged
▪ Enlarged
▪ Unknown

Individual measurements - reptiles
▪ Body length
▪ Tail length
▪ Other

Reptile breeding status - female	
GR	▪ Gravid
NG	▪ Not gravid
UK	▪ Unknown

Individual measurements - frogs
▪ Body length
▪ Tibia length
▪ Other

Frog breeding status - female	
GR	▪ Gravid
NG	▪ Not gravid
UK	▪ Unknown
BM	▪ In amplexus

Frog breeding status - male	
VS	▪ Vocal sac obvious
UK	▪ Unknown
N1	▪ Nuptial pads inconspicuous
N2	▪ Nuptial pads obvious but not fully developed
N2	▪ Nuptial pads fully developed
BM	▪ In amplexus

Body condition score	
1	▪ Emaciated - backbone, ribs and pelvis easily felt without applying pressure, no fat layer between bone and skin
2	▪ Poor - slightly dishing or concave muscle on either side of scapula, scapula spine very obvious on palpation, edges of scapula bone palpable
3	▪ Fair - flat to slightly convex muscle on either side of scapula, scapula spine prominent on palpation
4	▪ Good - scapula spine is easily palpable
5	▪ Excellent - good covering of fat, hard to fee backbone and pelvis when applying light pressure, muscle mass on either side of the scapula
6	▪ Emaciated - backbone, ribs and pelvis easily felt without applying pressure, no fat layer between bone and skin

Adapted from Jackson (2003)

Skin condition - mammals
▪ Hair loss
▪ Scruffy or matted coat
▪ Fleas or mites
▪ Ticks
▪ Wart-like growths
▪ Lesions
▪ Thickened red skin
▪ Wounds

Skin condition - reptiles
▪ Fleas or mites
▪ Ticks
▪ Wart-like growths
▪ Lesions
▪ Thickened red skin
▪ Wounds
▪ Tail loss

Skin condition - frogs
▪ Fleas or mites
▪ Ticks
▪ Wart-like growths
▪ Lesions
▪ Thickened red skin
▪ Wounds

Clinical scoring - chemosis of eyes	
0	▪ Normal
1	▪ Mild
2	▪ Moderate
3	▪ Severe

Clinical scoring - proliferation of eyes	
0	▪ Normal
1	▪ Mild
2	▪ Moderate
3	▪ Severe

Clinical scoring - chemosis of eyes	
0	▪ Normal
1	▪ Slight discolouration of fur around cloaca; evidence of mild urine leakage and slight odour
2	▪ Slight discolouration of fur around cloaca/tail area; occasional urine dribble; mild odour
3	▪ Discolouration of the tail area fur more evident; stronger odour; urine discharge, greasy texture evident on cloaca/tail
4	▪ Fur stain, greasy, darkened; Strong, pungent 'wet bottom smell'; inflammation of cloacal margins, clitoris, vestibule; discharge containing urinary debris
5	▪ Stained, greasy fur covering a large area; very strong pungent acidic smell; blood in urine; coat brown, dry and lustreless; cloaca and tail area swollen; grinding teeth
6	▪ Stained, greasy, wet matted fur around rump/cloaca area; ulcerated oedematous cloaca/tail area; constant purulent discharge; crying, straining, distressed, flat, ear flicking, teeth grinding
7	▪ Progressive decline; myiasis

Adapted from Flanagan (2015)

Clinical swab taken	
0	▪ Normal
1	▪ Mild
2	▪ Moderate
3	▪ Severe

Clinical swab taken
▪ Yes
▪ No

Animal fate
▪ released at point of capture
▪ held for observation
▪ held for museum vouchering
▪ trap death
▪ handling death
▪ other

Observation survey (birds, active and passive searches)

Weather conditions
▪ Temperature
– Actual BOM/weather station °C
▪ Rainfall
– Showers
– Rain
– Drizzle
– Frost
– Mist
– Thunderstorm
▪ Rainfall duration
– Intermittent
– Occasional
– Frequent
– Continuous
– Periods of rain
– Brief
▪ Cloud cover

– Sunny
– Mostly sunny
– Partly cloudy
– Cloudy
– Overcast
▪ Wind
– Calm
– Light winds
– Moderate winds
– Fresh winds
– Strong winds
– Near gale
– Gale
▪ Moon phase
– New moon
– First quarter
– Full moon
– Third quarter
▪ Weather comments
– Free text description

Observer role
▪ Spotter - binoculars
▪ Spotter - naked eye
▪ Data-entry
▪ Data-entry only
▪ Spotter - binoculars

Equipment used
▪ Binoculars
▪ Spotting scope
▪ Rangefinder
▪ Spotlight
▪ Torch/headtorch
▪ Thermal device
▪ Camera - still
▪ Camera - video
▪ Vehicle
▪ Other

Observation method
▪ Seen
▪ Heard
▪ Seen and heard

Breeding activity - birds
▪ Nest with eggs
▪ Nest with young
▪ Young of out nest
▪ Recently fledged young
▪ Diagnostic behaviour
▪ Suggestive behaviour

Activity type - birds	
CO	▪ Calling only
FO	▪ Flying overhead
FC	▪ Flying overhead circling
FW	▪ Flying within at strata level
ROT	▪ Resting on tree
ROS	▪ Resting on shrub
ROG	▪ Resting on ground
FOT	▪ Foraging on a tree
FOS	▪ Foraging on shrub
FOG	▪ Foraging on ground

Breeding activity - birds
▪ Nest with eggs
▪ Nest with young
▪ Young of out nest
▪ Recently fledged young
▪ Diagnostic behaviour
▪ Suggestive behaviour

As part of its Ecological Monitoring System Australia (EMSA), the Australian Government has partnered with Australia's Terrestrial Ecosystem Research Network (TERN) in the co-design of a suite of ecological monitoring protocols and a data exchange system. The protocols build on TERN's long-established data aggregation systems and well-tested survey protocols.

The primary purpose of the standardised monitoring protocols is to support natural resource management (NRM) programs that benefit the environment, agriculture and communities, as well as making the protocols freely available for use by other environmental land managers and environmental consultants.

The Australian Government and TERN protocols ensure NRM service providers and ecologists collecting field data:

- have ready access to comprehensive instructions for each of the standardised collecting protocol modules
- are able to use mobile-based applications in the field to enter data and images
- and can easily submit and share data.

Data collected from the application of the standardised collecting protocol modules will help evaluate the current NRM program and support research on changes to Australia's ecosystems and biodiversity.

TERN acknowledges the traditional owners and their custodianship of the lands on which TERN operates. We pay our respects to their ancestors and their descendants, who continue cultural and spiritual connections to country.