Report

Night Parrot (*Pezoporus occidentalis*) Research Plan

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Fortescue
The New Force in Iron Ore

	Night Parrot *Pezoporus occidentalis* Research Plan CB-RP-EN-1048		
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1. INTRODUCTION

1.1 The Night Parrot

Night Parrots (*Pezoporus occidentalis*) are small to medium-sized nocturnal parrots that are endemic to Australia's arid zone. Along with a suite of medium-sized desert-dwelling mammals, the distribution and density of Night Parrots has reduced dramatically over the 20th century, and indeed they may be locally extinct over much of their former range (Murphy 2012; Murphy *et al.* 2009). Under various State and Commonwealth legislation they are listed as:

- Endangered (and Migratory) under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
- Critically Endangered under the *Territory Parks and Wildlife Conservation Act 2000* (Northern Territory)
- Endangered under the *Nature Conservation Act 1992* (Queensland)
- Endangered under the *National Parks and Wildlife Act 1972* (South Australia)
- Rare Or Likely To Become Extinct under the *Wildlife Conservation Act 1950* (Western Australia)
- Presumed Extinct under the *Threatened Species Conservation Act 1995* (NSW)
- Regionally Extinct under the *Advisory List of Threatened Vertebrate Fauna in Victoria 2003* (Victoria)

Little is known about the biology of the Night Parrot. There is no reliable information about basic attributes such as preferred habitats and use, breeding biology, movements, diet, social interactions and threatening processes. Gaining this knowledge is being hindered by the lack of robust, repeatable detection methods. A comprehensive review of Night Parrot biology appears in Murphy (2012). Knowledge gaps that are relevant to this proposal appear in the backgrounds to the sections below.

In May 2013, at the Queensland Museum, Queensland naturalist John Young presented the findings of his search for the Night Parrot, complete with the first photographs of living birds. Importantly, John revealed that he had been repeatedly visiting a location for a year or more, during which time Night Parrots were present and he made sound recordings of their calls. Prior to this, the only other time a site seemed to be reliably occupied by Night Parrots was in the 1870-80s at the Gawler Ranges in South Australia, where the majority of museum specimens were collected. John's discovery presents a critical, possibly unique, opportunity to collect systematic data about Night Parrots, and provides the basis for much of the proposed research presented here.

1.2 Scope

This research plan has been developed by Fortescue Metals Group (Fortescue) to satisfy Condition 10 of EPBC 2010/5696, which states that:

> *To compensate for any unavoidable impacts on habitat for the Night Parrot, a Night Parrot Research Plan must be prepared and submitted to the Minister for approval within 12 months of the date of this approval. The research activities much be funded to a value of no less than $1 million (GST Exclusive). The Night Parrot Research Plan must include, but not be limited to:*
>
> *a) funding of a suitably qualified expert/s to (undertake) research which contributes to understanding the field ecology/biology of the Night Parrot. The research must investigate and develop a repeatable survey methodology that provides for the detection of the species*
>
> *b) upon completion of the research identified by (condition 10 a) and no more than 4 years from the date of this approval, conduct or fund comprehensive targeted surveys for the Night Parrot in at least 3 sites in areas where confirmed sightings or specimens of Night Parrot have been recorded since 1 January 2000. The surveys must be informed by the outcomes of the research identified at (condition 10 a) and undertaken by a suitably qualified expert; and*
>
> *c) indicative timeframes for funding, and completion of all research activities required under the Night Parrot Research Plan. The Night Parrot Research Plan must include timeframes for reporting the outcomes of the research.*
>
> *The results of any research funded under the Night Parrot Research Plan must be provided to the department within 12 months of completion. During the implementation timeframe for the Night Parrot Research Plan, research results and annual progress of research activities must be reported annually in the Environmental Performance Report required at (condition 13). The approved Night Parrot Research Plan must be funded and implemented.*

1.3 Development of the Research Plan

Steve Murphy has been engaged by Fortescue as the “suitably qualified expert” to prepare and implement the Night Parrot Research Plan as defined under the condition above. Prior to this engagement, Steve assisted John Young with implementing systematic research at the SW QLD site so as not to miss the opportunities presented by that situation. Once approved, the proposal presented here will form the basis of all research that occurs at the SW QLD site, and John will be involved in its implementation.

In preparing this research plan, a Night Parrot Research Advisory Panel (RAP) was established to provide advice and feedback. Members were selected based on their knowledge of the Night

Parrot, arid zone ecology (especially threatening processes), and the recovery planning process. They were:

- Allan Burbidge (RAP Chair; Principal Research Scientist, WA Department of Parks and Wildlife)
- Julian Reid (Fenner School of Environment and Society, Australian National University)
- Leo Joseph (Director, Australian National Wildlife Collection, CSIRO)
- Rachel Paltridge (Director, Desert Wildlife Services, Alice Springs)
- Stephen Garnett (Professor of Conservation and Sustainability, Research Institute for the Environment and Livelihoods, Charles Darwin University)
- Wolf Sievers (Director Threatened Species Unit, Queensland Department of Environment and Heritage Protection).

The RAP met face to face in Perth on 21st October 2013 to discuss research priorities.

1.4 Support during the life of the research program

Given the uncharted nature of this work, and the high likelihood of unforseen changes in the direction the work will take, it is suggested that an advisory group be developed that allows experts to provide advice and feedback as the research plan is implemented. The RAP was designed only to provide advice about the development of the plan and will cease to exist once the plan is approved by the Commonwealth. Sometime after this, it may be optimal to form a new advisory group (Night Parrot Recovery Team) that can provide the support for the research program. Membership would include some or all RAP members along with other key stakeholders (NRM groups, Indigenous groups, pastoralists etc.). The responsibility of convening this may be best placed with the Commonwealth as it will be independent of Fortescue's Research Plan obligations.

1.5 General Approach in developing the plan

To better understand the biology and field ecology of the Night Parrot a three-year time frame is proposed for completing this research program. Potential areas of research were drawn from the Night Parrot Interim Recovery Plan (Blyth 1996), the Approved Conservation Advice for the Night Parrot (Australian Government 2008), the Night Parrot Workshop held in Perth on 22/08/2013, and a long history of discussions among colleagues. These were prioritised according to their importance in contributing to the species' long-term survival, given the current state of knowledge. The priority scale extends from "critical → high → nice to know → not important". The potential research areas and their priorities are shown in Table 1.

Table 1: Potential areas of research, priority, description and rationale

Research Area	Priority	Brief description and rationale
Detection Strategies	Critical	Some information exists based on recent work. Developing and testing strategies is critical to locate new populations or to monitor existing populations. Some strategies will not be tested due to specific limitations or high risk of failure versus investment (e.g. detector dogs). **INCLUDED IN THIS PLAN.**
Habitat preferences and use	Critical	Little existing information. Understanding what habitats are important and why underpins successful management and guides survey effort. **INCLUDED IN THIS PLAN.**
Distribution	Critical	Limited existing information. Underpins successful management. Additional (invasive) research depends on locating new populations. Would also allow replication thus strengthening results. **INCLUDED IN THIS PLAN.**
Threatening Processes	Critical	Some existing knowledge inferred. Understanding may help define preferred habitat model. Critical for long-term conservation. **INCLUDED IN THIS PLAN.**
Human and social aspects and communications strategy	High	Complex issue involving stakeholder attitudes and engagement, managing biosecurity threats from illegal collecting and developing a communications strategy to manage interest in the project and potential visitor pressure at important sites. Discussed at length during RAP meeting, but it was decided to **NOT INCLUDE IN THIS PLAN.** However, discussions are underway with Desert Channels Queensland NRM group to develop a complimentary program dealing with these issues that will integrate with the research program outlined here.
Diet and drinking	High	Little existing information about either. Detailed study would involve time budgets, energetics, water balance etc. in addition to basic descriptions of resources. This level of detail on diet is not likely to help locate new populations. Basic information collected during study of habitat preferences. Detailed studies **NOT INCLUDED IN THIS PLAN.**
Nomadism and landscape-scale movements	High	Practically no existing information about either. Detailed knowledge not likely to help locate new populations, at the moment but could be important for long-term management. Difficult question to tackle. Priority may be elevated depending on other results e.g. if study population disappears. **NOT INCLUDED IN THIS PLAN.**
Breeding biology and life history	Nice to know	Little existing information. Breeding biology *per se* not considered high priority given other knowledge gaps and context. Proper study involves detailed, well replicated, potentially invasive work (regular nest checks etc.). Data collected opportunistically about basic aspects (site, season, vocalisations etc.) when possible. Detailed studies **NOT INCLUDED IN THIS PLAN.**
Population structure	Nice to know	No existing information. Potentially some management implications. Some genetic work possible now based on museum samples. Feathers will be collected for analyses if birds handled. Considered low priority given context. **NOT INCLUDED IN THIS PLAN.**
Captive Breeding	Nice to know	No existing information. Information would underpin breed and release program and act as insurance against extinction. May be considered necessary once better picture of distribution emerges, but not considered high priority given context. **NOT INCLUDED IN THIS PLAN.**

When prioritising the nature and timing of research activities, the degree to which proposed activities caused disturbance to individual Night Parrots or habitat was considered. At the time of writing this plan, there is only one reliable location known that supports an unknown number of birds. Invasive research methods that might cause birds to abandon the site cannot be applied at this stage. Accordingly, an overarching principle of the plan is to first apply passive methods before applying progressively more active and potentially invasive ones. At the extreme end of this spectrum is handling individual Night Parrots and it is proposed to attempt this only when additional occupied locations and populations are identified.

As discussed above, there exists a paucity of reliable information about nearly all aspects of Night Parrot biology and ecology. Even though there is the opportunity to conduct some systematic work at a site where Night Parrots can be reliably detected, the low sample size means that a heuristic approach for much of this work is appropriate, especially initially. As sample sizes increase, it may be possible to work with more robust statistical frameworks.

Finally, given that so little is known about Night Parrots and that this will be the first systematically recorded information about their biology, it is not possible to fully or accurately anticipate which direction various aspects of the research will head. Subsequently, what is presented here is an initial program that is intended to answer research questions deemed to be critical at this time. The program will remain flexible depending on findings and context, and the yet-to-be-formed advisory group will play an important role in supporting this adaptability.

1.6 Program framework

A schematic of how the research will be developed is provided in Figure 1. It illustrates how the data collected (using non-invasive methods) at the single known site will be used to find additional sites that will allow more invasive research to be conducted. It also shows how results from the invasive research at additional sites will be used to refine knowledge of habitat preferences and detection methods to ultimately locate more populations. Elements in the research program presented here are inter-dependent and by applying this framework in an iterative way, an ever-increasing level of refinement and confidence in the knowledge about Night Parrots can be assured. The surveys that will be conducted to locate additional populations will partly satisfy part 10(b) of the EPBC Condition (see ‘Background and Relevance’ section of ‘Increasing Knowledge of Night Parrot Distribution’).

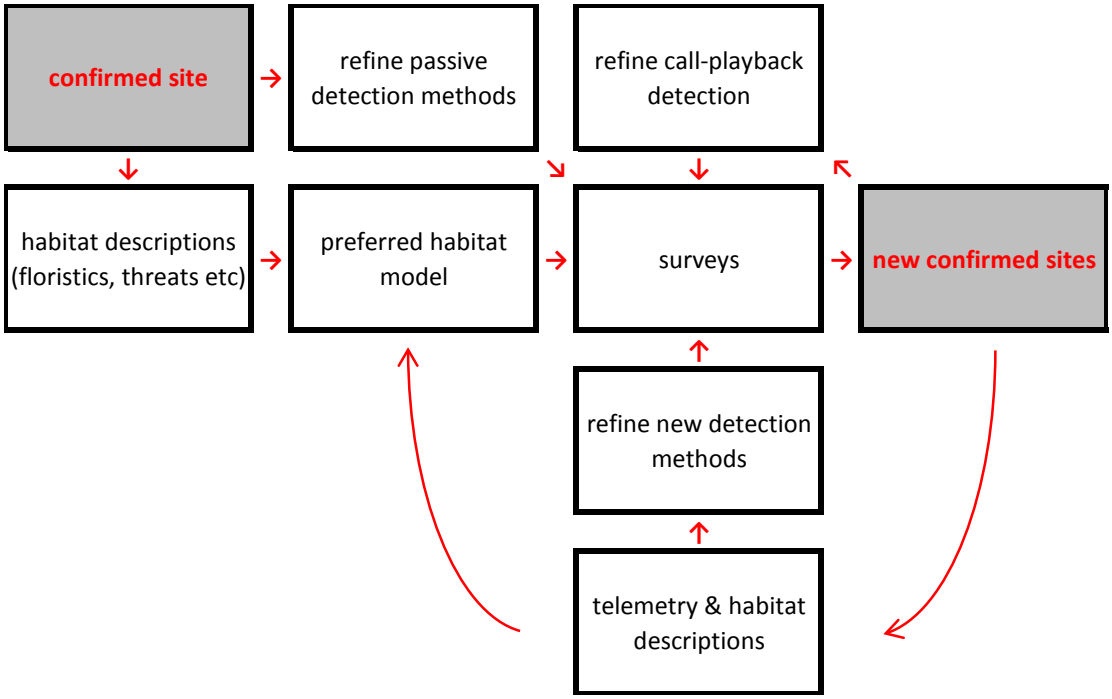


Figure 1: Research program framework

2. PROPOSED RESEARCH

2.1 Developing Detection Strategies for Night Parrots

2.1.1 Background and relevance

For cryptic species, such as the Night Parrot, developing robust, repeatable survey methodology is critical for locating populations for active management and research. This is also the primary intent of the Commonwealth's Condition 10(a) that states the "research must investigate and develop a repeatable survey methodology that provides for the detection of the species."

Night Parrots are difficult to detect, even when they are known, or suspected to be in an area (Murphy 2012). Many attempts have been made to find Night Parrots using a variety of techniques without success. However it is unknown whether the lack of detection is a failure of the techniques used or whether Night Parrots were not present at the time surveys were conducted. The SW QLD location provides a critically important opportunity to develop and test detection strategies because there is a degree of certainty surrounding occupancy.

Until recently, there have been no recordings of Night Parrot calls and this has prevented the development of useful survey techniques. Sound data recorded initially by John Young, and then subsequently during preliminary systematic work at the SW QLD site, provides a promising new detection tool. The research program proposes to invest heavily in testing and refining sound-based detection strategies. This aligns with recommendations outlined in the Interim Recovery Plan (Blyth 1996) and the Species Profile and Threat statement for Night Parrots (Australian Government 2013).

Historically, the most common strategy employed for the Night Parrot was to survey at isolated water during dry spells (Blyth and Boles 1999; Blyth et al. 1997a; Blyth *et al.* 1997b; Butler 1977; Maher 1995). This is an intuitive strategy, especially in the context of information recorded by authorities who observed Night Parrots drinking (Andrews 1883; Bourgoin in Wilson 1937). However, given its limited success, the strategy needs to be tested systematically and it is proposed to do this using camera traps. Additional detection methods may be developed and tested once more information about Night Parrot habitat use and associated behaviours emerges, such as active searches for feeding signs or tunnels through *Triodia*, camera traps set is particular ways in specific feeding habitats etc.

2.1.2 How this relates to other parts of the research plan

Developing survey methods underpins most other aspects of this research proposal.

- It will be combined with the 'preferred habitat model' (see below) to locate new populations and thus refine knowledge of the species' distribution

- Finding new populations will allow more invasive research methods (e.g. telemetry) to be adopted
- An understanding of detection probability is essential in the formulation of a credible monitoring protocol.

2.1.3 Aims

To develop and measure quantitatively detection techniques on reliable populations, starting with:

- Sound-based detection, both passive and using call-playback
- Camera traps in drinking, roosting and feeding habitats.

2.1.4 Detection using sound

Listening for bird calls is a widespread survey method (e.g. Allen *et al.* 2004; Burbidge *et al.* 2007; Kubel and Yahner 2007). For aural surveys to be conducted and interpreted properly, an understanding of factors that influence detectability is required. These factors include understanding the frequency of calling, whether detectability changes seasonally or due to other factors (e.g. wind), the distance over which calls can be detected, and whether or not detectability is increased in response to call-playback, and the context in which playback is done (e.g. breeding season, distance of respondent to speaker etc.). Ultimately, some form of a detection function is calculated using these and other variables that allows robust statistical interpretation of survey results using distance sampling or occupancy modelling (Buckland *et al.* 2008; MacKenzie *et al.* 2006) – although see Welsh et al. (2013) for a discussion about the vagaries of trying to adjust occupancy models to account for non-detection.

As mentioned elsewhere in this research plan, because of limited sample sizes it is necessary to adopt a heuristic approach when developing and refining survey methods for Night Parrots. At least initially, this will be an exercise in data collection and description, rather than being strictly inferential. However, this will not preclude collecting quantitative data about factors that affect detectability using Night Parrot calls.

Passive call detection using automated recording units

Recent advances in electronics and digital memory storage has allowed for the development of commercially available products capable of autonomous operation for extended periods. In mid-August 2013, 8 of these units were deployed at the SW QLD site to collect data while the opportunity existed. ‘SM2+’ units were deployed (Wildlife Acoustics Inc., Massachusetts) with a configuration that is power unlimited and capable of recording every night for 42 nights (i.e. they are not triggered by target frequencies) before memory reaches capacity. Preliminary analyses shows that these units are very capable of detecting Night Parrots. It is proposed to continue to use multiple SM2+ units at sites known to be occupied to investigate the following:

- What is the full repertoire of Night Parrot calls?
- What time of night do Night Parrots call?
- How frequently do they call?
- Over what distance can calls be detected, and under what conditions?
- Does calling change according to environmental factors, such as rainfall?

Answers to these questions will directly inform the design of Night Parrot surveys. To answer them adequately, it is proposed to maintain the 8 existing SM2+ units, with several more to be permanently deployed in a set array at all sites where Night Parrots are confirmed. Rain and wind logging instruments will be installed so these variables can be considered in calculating detection probabilities. Recording will continue even if it appears that Night Parrots have abandoned the site because seasonal occupancy of the site cannot be ruled out. Each unit will be placed at pre-determined distances so the effect of distance on detectability can be considered.

This high level of data collection requires a site visit approximately every 40 days to retrieve data and replace memory cards. Such an extensive array of equipment recording more or less continuously will generate a vast amount of data (130 gigabytes per SM2+ every 42 days). 'Song Scope' (Wildlife Acoustics Inc.) and 'Sound ID' (Boucher *et al.* 2008) software will be trialled, which both employ an automatic sound-file processing function, based on sample of reference calls. Preliminary use of Song Scope indicates that it is possible to detect Night Parrot from sound files automatically, with about 80% success. As the library of reference calls increases and the sound 'recogniser' algorithms are refined, it is expected that the performance of this software will improve markedly.

Maintaining SM2+s at confirmed Night Parrot locations serves an additional benefit of monitoring occupancy of sites (as distinct from collecting data about calling and/or testing this as a detection method).

Call detection using call-playback

Call-playback is used commonly in bird surveys to elicit a vocal response thereby improving detection probability. Gaining a proper understanding of the effect of playback on detection probability requires knowledge of variables such as season, time of day/night, the distance of the target bird to the speaker at the time the call is broadcast etc. (Allen *et al.* 2004; Buckland *et al.* 2006; Kubel and Yahner 2007). With respect to speaker-respondent distance, investigation of birds wearing radio transmitters will be considered, although only if there is certainty that it will not unduly disrupt the main purpose of telemetry (i.e. investigating habitat preferences and use).

Even if the distance between respondent and speaker in unknown, call-playback experiments will still yield important information about detection probability. It is proposed that an automated system be developed using a combination of SM2+s and custom-built automatic playback devices. Broadly, this will involve broadcasting a Night Parrot call at realistic volume, time of

night and frequency (based on preliminary data) over a 2 week period, with an SM2+ unit set up to record responses. As with testing other detection methods, it will be important to conduct this work at sites known to be occupied by Night Parrots. This system can also be used in an opportunistic way for surveying new areas in the region from early-on in the life of the project (see also section on Night Parrot distribution below).

To avoid excessive disturbance at the only known site, it is proposed to undertake call-playback work only at sites that are additional to the currently known occupied site.

2.1.5 Detection using camera traps

Similar to sound equipment, the capabilities of infra-red triggered camera traps have improved dramatically in recent years, with a concomitant reduction in price. It is now possible to undertake extensive fauna surveys using this technology, and there are many examples of programs that have successfully detected rare and/or cryptic bird species (reviewed in O'Brien and Kinnaird 2008). There has also been an increasing amount of attention paid to developing robust methods of analysing camera trap data (O'Brien and Kinnaird 2008; Rowcliffe *et al.* 2008 - see also the discussion below about estimating predator densities). While it may be a long-term objective to apply such analytical frameworks to the Night Parrot data collected as part of this research plan, initially (and in-line with the recurring heuristic theme), the focus will be on developing methods for detection using camera traps on known birds.

As described previously in this section, surveying for Night Parrots at water points is an intuitive and commonly adopted strategy that is intended to be investigated using the currently known location in SW QLD. A combination of local knowledge, spatial data and ground searches will be used to identify all surface water points within 10 km of the site. This approach aligns with Andrews (1883) who described birds as flying “four or five miles” to water. Camera traps and SM2 sound units will then be installed at each point in an attempt to detect Night Parrots. This work will be repeated under dry and wet conditions to test whether there is a seasonal effect of surface water dependency. It is possible that Night Parrots switch to a seed-based diet in wet periods during which time they are dependent on surface water (inferred from comments in Andrews 1883). During wet conditions there may be an issue of too many water points to survey, in which case there will be a need to survey the transition period between wet and dry when surveys become more feasible but while Night Parrots may still be feeding on seeds. Another possibility is to attempt to detect Night Parrots at artificial water that is provided during dry spells. However, caution will need to be applied if this is attempted due to the risk of attracting mammalian predators to occupied sites. Further caution will be needed so that important details about how Night Parrots obtain their water requirements naturally are not obscured by providing artificial water supplies.

In addition to detection at water, we also propose to deploy camera traps among the day-time roosting habitat at the known location to test this as a detection method. This would integrate with the proposed study on assessing the potential impacts of mammalian predators at the site (see below).

Additional strategies using camera traps may become more apparent once Night Parrot habitat use is better understood. For example, if birds feed in a predictable way in specific habitats, then it may be possible to use camera traps to detect them.

2.1.6 Timeline and anticipated outcomes

Passive call detection

- It is proposed to deploy SM2+ units for continual recording at all confirmed locations. This is necessary to understand whether there are seasonal effects of call detection.
- This work can begin immediately and, in fact, will be a continuation of the preliminary work already being done. This will be repeated at all sites where Night Parrots are confirmed to build adequate sample sizes for analyses. Consequently, this work will continue throughout the life of the research project.

Call detection using play-back

- The efficacy of call-playback will be tested using the systematic approach described above once Night Parrots have been discovered at additional sites. The automated call-playback system will be used opportunistically beforehand to assist in finding new sites (see section on distribution).

Detection using camera traps

- It is proposed to identify surface water points near the current SW QLD site and install camera traps immediately, to take advantage of the present unseasonably dry conditions in the region. Water points will be surveyed using camera traps when wet conditions return, but at a time when surveying an adequate and appropriate sample of water points is feasible (see above).
- Camera traps in roosting habitat will be installed immediately at the SW QLD site. This will integrate with work on assessing the potential impacts of mammalian predation. This will be repeated once Night Parrots are detected at other sites.

New detection methods will be tested using camera traps once there is a clearer picture of habitat use.

Upon completion of this component of the research project, survey methods for the Night Parrot will have been designed, refined and tested. This will include the use of passive call detection and call-playback, and various strategies using camera traps. Refinement and testing of detection methods will occur at locations of known Night Parrot occupation. Therefore, there will be opportunity to assess quantitatively the performance of various detection strategies. This knowledge will be used to inform further surveys, both as part of this research program and also by others conducting dedicated Night Parrot surveys as part of environmental impact assessments. The knowledge will also be used to develop robust monitoring protocols that could be used to assess the impact of management actions.

2.2 Understanding Night Parrot habitat preferences and use

2.2.1 Background and relevance

Understanding species' habitat preferences is central to understanding the biology and field ecology of any species, and is critical for managing threatening processes. It also underpins the selection of sites for surveys that aim to determine distribution. Both of these objectives are highly relevant for the conservation of Night Parrots. It has particular relevance for habitat-based assessments for the presence of Matters of National Environmental Significance during development proposals, such as mining.

Effective habitat management also requires some understanding about what, specifically, Night Parrots are doing in various habitat types and if there is a seasonal (temporal) component. This includes the identification of:

- Feeding habitat
- Sites used for drinking (if indeed they do drink)
- Breeding habitat
- Roosting habitat
- Temporal changes in each of these, according to seasonality or other factors

2.2.2 How this relates to other parts of the research plan

Understanding habitat preference and use relates to other parts of the proposed research program. With respect to the components to be investigated, understanding habitat use relates directly to:

- Developing detection methods for Night Parrots, because some behaviours in some habitats may offer new methods of detection (e.g. feeding in particular parts of the landscape)
- Increasing knowledge of Night Parrot distribution, because it will allow the identification of areas with similar habitat for surveys
- Understanding the threats to Night Parrots, because it enables better understanding of the processes that may be specific to particular habitat types (e.g. grazing may impact some habitats more than others). Particular threats may be important variables in defining preferred Night Parrot habitat.

Though not a priority of this research plan, there may be an opportunity to collect basic information about Night Parrot breeding. This would include nest site, season, recording breeding-related vocalisations etc.

2.2.3 Aims

- To identify key habitats used by Night Parrots for feeding/drinking, roosting and breeding
- To describe these habitats in terms of vegetation structure and floristics, and position in the landscape, in order to define Night Parrot habitat preferences

2.2.4 Identifying key habitats

To ensure the full range of habitats used by Night Parrots is understood, it is proposed to track individuals using telemetry. This involves fixing small devices to individual birds so their location can be recorded. While a lot can be gained from such studies, this is an invasive procedure that carries potentially significant risks relating to individuals abandoning sites or sustaining injuries. Therefore this component of the research will only be conducted once additional occupied sites are located.

Capture

Standard mist-netting is a proven safe way of capturing birds (Spotswood *et al*. 2012). The nominated lead researcher holds a current A-Class mist netting endorsement from the Australian Bird and Bat Banding Scheme (Bander ID 2289, issued 1997) and has extensive experience capturing small-medium sized parrots (e.g. *Cyanoramphus* spp., *Psephotus* spp., *Neophema* spp., *Melopsittacus undulatus*, *Barnardius zonarius, Trichoglossus* spp.). Handling protocols will be streamlined to ensure restraint time is minimised. Handling will include recording limited morphometric data (weight), collecting a small number of feathers for DNA analyses, photography for aging and transmitter attachment.

Telemetry devices and attachment

There are two main types of telemetry devices potentially relevant for the study: (1) radio telemetry units that transmit a signal that is followed in the field using hand-held receivers, and (2) GPS units that store satellite-derived location data that is retrieved at a later date.

GPS tracking data is superior in that location information is accurate, regularly obtained and collected without interference to the birds by field workers. The main downside is weight (the smallest unit currently available weighs 2.5g). Most workers advocate that telemetry devices should be no more than 2-5% of body weight, with recommendations tending towards 2% for studies involvement individual movements (Barron *et al.* 2010; Murray and Fuller 2000). No data exist for Night Parrot weight, although judging by their general size, they are not likely to be more than 90-100g. This means that current GPS telemetry devices are probably not suitable to use with Night Parrots (applying a 2% rule of thumb).

Given uncertainties about Night Parrot weight, how they move through their habitat (which probably has implications for transmitter bulk), how they will respond behaviourally to wearing a relatively large device and sensitivities surrounding their capture and handling, we propose to at

least start the telemetry work using very small traditional VHF transmitting units. GPS units will be considered for deployment at a later date once accurate weight data is collected and an assessment is made of how individuals respond to wearing VHF transmitters. Key specifications of the unit intended to be used are: 0.31g, 13-22 day lifespan (21 day nominal), and 8mm long x 5.3 mm wide x 2.8 mm high (http://www.holohil.com/lb2x.htm).

It is proposed to glue transmitters to trimmed feathers just above the synsacrum (on the back, between the hips), which is the location least likely to affect flight performance or behaviour because it is nearer the centre of gravity and does not interfere with the movement of the wings (Raim 1978; Rappole and Tipton 1991). In a recent review comparing attachment methods, dorsal gluing was the attachment method least likely to affect behaviour and breeding (Barron *et al.* 2010).

Tracking

Studies on other nocturnal birds of similar size have attempted to locate individuals wearing transmitters using triangulation from multiple fixed-point receiving stations (e.g. plains wanderer *Pedionomus torquatus* (Baker-Gabb *et al.* 1990)). However, the error ellipses (up to several hundred metres) produced by triangulation are likely to be too large for the purpose of this (Murphy, unpubl. data). Additionally, as one of the research objectives is to determine why birds are visiting particular parts of the landscape, it will be necessary to make direct observations. Considering all this, it is proposed to track individuals on foot as much as possible while transmitters remain on individuals. To avoid causing excess disturbance birds will be observed from a distance using night vision equipment. Behaviours and associated details (e.g. feeding and food items, drinking, social interactions, breeding etc.) will be recorded. Once birds have moved away from their location, accurate location data will be recorded using handheld GPS units, and associated details will be confirmed with close-up inspections.

There is the potential that locating birds wearing transmitters on foot will not be possible all of the time. If birds cannot be located after two nights, it is proposed to locate them from the air using a helicopter using suitably qualified, instrument-rated pilots .

Analyses of telemetry data

In the first instance, the tracking data will simply be used to identify those habitats used by Night Parrots. As the number of recorded point locations increases, it will be possible to answer questions relating to home-range size and the relative importance of areas using kernel density estimation. Assuming individuals will carry transmitters for the nominal 21-day period at least four fixes each night (separated by at least one hour) and two each day will be attempted to reach the minimum number of fixes required for analysis (a minimum of 30 per individual but preferably >50, Seaman *et al.* 1999). Refining home range estimates by considering movement behaviour, and barriers and/or areas that are never traversed will also be attempted (Benhamou and Cornélis 2010).

2.2.5 Habitat descriptions and preferences

To describe habitats, National Vegetation Information System Level V protocols will be used, because this is the national standard and will ensure habitat data are consistent and comparable across state boundaries. Level V includes collecting information about dominant growth form, height, cover and species (3 species) for the three traditional strata i.e. Upper, Mid and Ground (Executive Steering Committee for Australian Vegetation Information 2003) . Additionally, information will be collected that is specific to Night Parrots that may not be part of the standard NVIS Level V protocols, such as size and spaces between *Triodia* clumps and a measure of greenness in key species (e.g. chenopods).

During habitat surveys, information about potential threatening processes will also be collected (e.g. herbivore and predator scat recording and collection). Habitat descriptions at the same or similar times that Night Parrots are detected will be conducted to assess potential resource availability i.e. habitat assessments will not be undertaken during wet periods if birds were detected during dry spells.

Defining Night Parrot habitat preferences (i.e. building a preferred habitat model) will incorporate both qualitative and quantitative variables. Some variables that are likely to be important will be investigated in other parts of the plan – namely, threatening processes (fire, grazing history etc.). Broadly, the variables that are likely to be used in describing preferred habitat are:

- Floristics and structure of roosting, feeding and breeding habitats
- Spatial configuration of these habitat types
- Fire history of the site and the availability of long-term fire refugia
- The effect of season on habitat use
- Grazing impacts in particular habitats

2.2.6 Timeline and anticipated outcomes

- The capture and tracking of individual Night Parrots using telemetry will only be attempted once new confirmed sites are identified.
- Habitat assessments will be conducted at known sites soon after discovery. For the currently occupied site this will be undertaken as soon as possible. These data will be incorporated into understanding preferred Night Parrot habitat in an iterative way (i.e. will be continually refined as new data are recorded).

This section will define where Night Parrots spend their time and why, in terms of vegetation floristics and structure, and position in the landscape. It will form the basis of defining preferred Night Parrot habitat, which will underpin site selection for subsequent surveys and increase understanding of the potential threatening processes.

2.3 Increasing knowledge of Night Parrot distribution

2.3.1 Background and relevance

At present only one site occupied by Night Parrots is known, which is in SW QLD. Together with the discoveries of dead birds in 1990 and 2006 (Boles *et al.* 1994; McDougall *et al.* 2009), this suggests an extant population in this region, perhaps extending into north-eastern South Australia. There is a consistent record of Night Parrot sightings from the Pilbara region, Western Australia, suggesting that there may also be an extant population there (Murphy 2012). In contrast, Night Parrots seem to have retracted from the southern portion of their former range (Murphy 2012).

It is critical that the knowledge about the distribution of Night Parrots is refined because this underpins practically all aspects of conservation management and research. This importance is reflected in Condition 10(b) of EPBC 2010/5696, which states:

> *"upon completion of the research identified by (condition 10 a) and no more than 4 years from the date of this approval, conduct or fund comprehensive targeted surveys for the Night Parrot in at least 3 sites in areas where confirmed sightings or specimens of Night Parrot have been recorded since 1 January 2000. The surveys must be informed by the outcomes of the research identified at (condition 10 a) and undertaken by a suitably qualified expert."*

Exactly how these surveys integrate into the research plan was discussed at the Night Parrot Research Advisory Panel meeting in October 2013, where it was unanimously agreed that the surveys should be integrated into the research plan rather than delaying until the research has been completed. However, it is important to note that it is not proposed to conduct surveys only at locations where Night Parrot sightings have been made by third parties. Areas will also be selected on the basis of current knowledge of preferred habitats. The benefits of this approach are that:

- Conducting surveys will allow us to test learnings about preferred Night Parrot habitat.
- Similarly, surveys in new areas may be a good test of the detection strategies
- Following up on high veracity sightings quickly, rather than after the research is completed, increases the chances of detecting Night Parrots

2.3.2 How this relates to other parts of the research plan

As mentioned above, conducting surveys to determine distribution will test detection strategies and understanding of preferred habitat. Also, identifying additional locations will allow some of the more invasive aspects of this proposal to be undertaken, and will increase the opportunity to

increase samples sizes, generally. This will allow transition from a heuristic research approach to one based on more rigorous, inferential analyses.

2.3.3 Aims

- To combine knowledge of detection methods and habitat preferences to locate additional Night Parrot populations both within SW QLD and interstate.
- To follow-up high veracity, third-party sightings during the research program using refined detection methods, thus satisfying Condition 10(b) of EPBC 2010/5696.

2.3.4 Finding additional Night Parrot populations

As mentioned elsewhere, there will be no attempt to conduct invasive research at the confirmed occupied site. Additional sites will need to be found before some critical information can be collected that will improve understanding about the best ways to search for Night Parrots. The circularity of this situation may not be as constraining as it first appears because two important tools are available to locate additional sites immediately. Firstly Night Parrots are known to roost in long unburnt *Triodia* sp. Secondly, there is evidence that Night Parrots call relatively frequently in the first two hours after sunset from these roosting areas, and that this call can be detected using automated recording devices. Related to this, methods have already been developed to screen these sound data automatically for Night Parrot calls.

To identify long unburnt *Triodia* (and indeed other habitats as they become known) a combination of on-ground site inspections and spatial analyses will be used. The latter will allow systematic identification of likely areas to survey using supervised classification of multispectral LANDSAT imagery. Generally, this involves mapping sample areas of known habitat, and then classifying an entire image based on these 'training areas'. Subsequently, field data are normally collected to verify and refine the classification. This approach has been applied commonly in similar situations (Debinski *et al.* 1999; Gottschalk *et al.* 2005; Grace 2003; Leyequien *et al.* 2007; Saxon 1983; Wallin *et al.* 1992).

One potential problem is that it may not be possible to identify the small habitat patches that are important to Night Parrots using LANDSAT (30m resolution). In this case, suitable habitats will be mapped from other sources, such as Google Earth imagery or archived aerial photographs. This has also been used successfully in other situations (Franklin and Steadman 1991; Harvey and Hill 2001; Lauver *et al.* 2002; Robertson *et al.* 1990).

Using these tools, surveys of new likely areas can commence immediately and will be maintained throughout the life of the project with an ever-increasing level of refinement about when, where and how to look, as information becomes available.

2.3.5 Following-up third party sightings

Areas with previous Night Parrot sightings of high veracity may also be surveyed. Preliminary analyses of a relatively large database of Night Parrot sightings suggests that there is a high probability of misidentifying a Night Parrot (Murphy *et al.* 2009). As part of that analysis, a protocol was developed to give individual sightings a score related to how likely the observation was of a Night Parrot. The protocol used elements of the observation, such as the physical description of the bird and the habitat, and details about the observer and the conditions under which the observation was made. It is proposed to adapt this scoring protocol to assess whether or not effort should be invested in following up on new third-party sightings. It is also proposed to assess the habitat based on knowledge assembled during this research. Once a decision to follow up a sighting has been made, new detection strategies that have been developed will be applied.

An example of a location where high veracity Night Parrot sightings have been made recently is Lorna Glen – a conservation reserve in Western Australia managed by the Department of Parks and Wildlife (Burbidge and Hamilton 2013). A Night Parrot sighting was reported by DPaW (then DEC) staff in 2009, and despite follow-up surveys, no further evidence has been discovered. As part of this proposal, it is intended to collaborate with DPaW staff to apply some of the detection and analytical methods being developed as part of this project at Lorna Glen in 2014.

2.3.6 Timeline and anticipated outcomes

- As soon as possible, opportunistic surveys will be conducted using the tools already developed in likely areas identified by on-ground inspection and spatial analyses.
- As knowledge of detection strategies and habitat preferences improves, a more refined and systematic approach in the selection of survey sites will be applied.

The main outcome of this component of the research plan will be completed surveys in areas that (a) have been identified systematically using spatial analyses and (b) have been identified from Night Parrot sightings from third parties. This will satisfy point 10(b) of the EPBC Condition. If surveys are successful in detecting Night Parrots, it will allow other, more invasive parts of the research plan to proceed. It will also potentially increase the sample size of some aspects of the research, therefore allowing a shift toward more rigorous inferential analyses.

2.4 Understanding the threats to Night Parrots

2.4.1 Background and relevance

Based on historical accounts suggesting high densities of Night Parrots at some places and times (Andrews 1883; Ashby 1924) and the lack of confirmed sightings from about 1912 (Murphy 2012), it seems clear that the species has suffered a major range contraction and/or reduction in population density in most places. Over the same period and in the same general area, a suite of medium-sized mammals became either wholly or functionally extinct, with changed fire patterns and introduced predators and herbivores identified as the main drivers (Burbidge *et al.* 1988).

It is intuitive that these same threatening processes, acting either alone or synergistically, probably affected Night Parrots, and there is some anecdotal or circumstantial evidence that supports this. Recent work in SW QLD and high veracity historical records demonstrate clearly that Night Parrots rely on long-unburnt *Triodia* spp. Analyses of contemporary fire patterns in central Australia show that *Triodia* is prone to large-scale disturbance by mismanaged fire (Edwards et al. 2008) and this is most likely impacting on Night Parrots. This is not to advocate fire exclusion, rather that there will be optimal fire patterns that maintain Night Parrot habitat. Night Parrots appear to rely on chenopod systems (although it is not known exactly why), and other birds dependent on these systems have declined due to grazing pressure (e.g. some Grasswrens – reviewed in Skroblin and Murphy (2013)). Anecdotal evidence also suggests that feral and domestic cats prey upon Night Parrots (Ashby 1924; McGilp 1931; Whitlock 1924). In one case, a single domestic cat is thought to have been responsible for killing several Night Parrots ("several picture frames were covered by the wings and tails of the 'Porcupine Parrot' which had been caught by a cat last summer" (Ashby 1924, p. 179). Also, Keartland claims to have frequently found "the remains of those (Night Parrots) recently killed by dingoes…" (quoted in Ashby 1924, p. 179). Although there are no reports of foxes (*Vulpes vulpes*) preying upon Night Parrots, it is a reasonable proposition that they do so.

With regards to dingoes, irrespective of whether they are classed as native or not, they occupy an important ecological position that is potentially relevant to Night Parrots. It is possible that dingoes prey upon Night Parrots, although there is considerable evidence to suggest that dingoes regulate cat and fox populations (Glen *et al.* 2007; Kennedy *et al.* 2012; Letnic *et al.* 2011), and could reduce the potential impact of these predators.

Clarifying the potential for these threats to impact Night Parrots and understanding their dynamics (e.g. optimal fire patterns) is important for long-term management.

2.4.2 How this relates to other parts of the research plan

Understanding processes that may be threatening Night Parrots relies on identifying what parts of the landscape Night Parrots are using. The presence of threatening processes and history of fire patterns are likely to be important variables in defining preferred habitat.

2.4.3 Aims

- To investigate the fire history at areas occupied by Night Parrots
- To assess the potential impacts of predation by invasive species (cats/foxes) on Night Parrots
- To assess the potential impacts of grazing on Night Parrot habitat

2.4.4 Fire history of Night Parrot habitats

It is proposed to create a fire history for areas occupied by Night Parrots, using the free LANDSAT image archive (www.glovis.usgs.gov). Images extending back to the mid-1970s will be processed to highlight and map fire scars using supervised classification techniques in remote sensing and GIS software (e.g. ER Mapper/Imagine and ArcMap). It is anticipated that fire frequency will be quite low, and this process may not be as arduous as it first appears. Vectorised fire scars will be attributed with date and image ID.

Importantly, the fire history will be extended into the area surrounding occupied sites in order to better understand fire patterns at a landscape scale. This is necessary to investigate the importance of fire refugia when core habitat areas are disturbed. In a sense, it is testing a hypothesis that Night Parrots now only occur where landscape features ensure reliable long-term fire refugia. This information will be incorporated into understanding Night Parrot habitat preferences developed during other parts of the research plan.

2.4.5 Potential impacts of mammalian predators on Night Parrots

It is unlikely that the level of cat or fox predation on Night Parrots can be assessed directly. Instead, it is proposed to assess the density of these predators (and dingoes) in the habitats that are being used by Night Parrots, as defined by the section on habitat preferences and use. In doing so, it will enable the potential impacts of these species on Night Parrots to be estimated.

Assessing mammalian predator density is fraught with issues such as low densities (and thus low statistical signals) and violations of non-independent sampling for some commonly used methods such as counting foot prints along roadways (Wilson and Delahay 2001). Additionally, the rocky surfaces in and around the SW QLD study area preclude the use of track-based methods, and to import sand etc. for plots is not recommended due to the risk of inadvertently attracting predators to the area. Instead, it is proposed to use arrays of passive infra-red triggered cameras. This approach has been applied successful in estimating feral cat densities using a capture-mark-recapture analytical framework where individuals were identifiable from coat patterns (Bengsen *et al.* 2012). Camera traps have also been used to estimate densities without relying on individual identification, and it is proposed to use one such method developed by Rowcliffe *et al.* (2008). They combined information about individual daily movements and group size, with camera-trap specifications relating to detection distance and angle to provide

reliable density estimates. Reliable information exists about daily movements for cats, foxes and dingoes in arid environments (Edwards et al. 2001; Marsack and Campbell 1990; Molsher et al. 2005; Moseby *et al.* 2009b; Thomson 1992). Assumptions of the approach are that (i) the movements of individuals with respect to conspecifics and landscape features is random and independent (although the model was robust to some violation of this) (ii) animal movements are largely independent of the cameras and (iii) the population is closed (i.e. migration, recruitment and mortality are negligible).

Most studies of predator activity using camera traps employ attractant lures to increase the probability of detection. In the context of this research proposal, the use of lures risks attracting predators to occupied sites and therefore it is proposed to use camera traps without lures. If the statistical signal is too low without lures, an attempt will be made to determine predator density/activity and the potential impacts on Night Parrots by systematic scat surveys within 2 ha area (Moseby *et al*. 2009a). Scats will be analysed using standard protocols (Paltridge 2002). Although more labour-intensive, such surveys have been used previously to investigate predator-prey dynamics successfully (Paltridge 2002).

2.4.6 Potential impacts of grazing on Night Parrot habitat

Observations in the only habitat known to be used by Night Parrots suggest that grazing impacts are low and are likely to remain low given the nature of the habitat (long-unburnt *Triodia*). However, once a clearer picture of the full range of habitats used by Night Parrots emerges from other components of this research plan, the potential impacts of grazing can be better assessed. This is proposed by generating an index of grazing pressure based on herbivore (cattle, horse, camel, rabbit and macropod) scat densities recorded during habitat descriptions (see above). Alternative quantitative measures of grazing impacts using remote sensing (LANDSAT) data will be considered for some areas where grazing pressure seem to be particularly important. (Bastin *et al*. 1993). Given that the LANDSAT archive extends back to the mid-1970s, this opens the possibility of examining historical grazing pressure also.

2.4.7 Timeline and anticipated outcomes

- A fire history using archived LANDSAT imagery for all sites known to be used by Night Parrots will be created. This will begin immediately for the currently occupied site in SW QLD.
- It is proposed to install camera traps at the SW QLD site as soon as possible, and at other sites as they become known.
- Data on potential herbivore impacts will be collected during the habitat descriptions of confirmed sites. This will be done as soon as possible for the currently known SW QLD site.

The combined elements of this part of the research project will provide estimates of the level of potential threat in various habitat types posed by feral predators and grazing animals. It will also describe the fire history in and around sites occupied by Night Parrots, which will inform both the optimal habitat model and practical fire management guidelines.

Budget and schedule

2.5 Budget estimate

A budget estimate for the Research Program is provided in Table 2.

Table 2: Budget Estimate

Research Program Reference	Item	Yr 1 ($,000)	Yr 2 ($,000)	Yr 3 ($,000)	Justification
Detection	SM2+ sound units and Accessories	53.2	0	0	For passive and call-playback detection. (20SM2+ units).
Detection/Threat. Process	Camera trap and Accessories	39	0	0	For detection strategies and threating processes (50 cameras).
Habitat Preferences	Telemetry, capture equipment etc	32.8	0	0	For defining habitat use, including night vision and helicopter hire.
Distribution	Aerial Photos	3.6	1.8	1.8	For habitat mapping and site history analyses.
Distribution	Interstate field work	22	24	24	Airfares, interstate vehicle hire etc.
All	Misc. field gear and supplies	6	2	2	For field supplies including food allowance and general field equipment.
All	Equipment repairs and maintenance	4	4	4	Approximately 10% of capital expenditure on equipment over three years.
All	Project coordination and analyses	132	132	132	Equivalent to approval ARC Post-doc salary; includes on-costs
All	Vehicle running costs	35	35	35	Including 25,000 km/yr @ RACQ rates for 4WD; quad bike/trailer for remote work.
All	Field technician support	60	60	60	Essential for effective and safe field work.
All	Freight	1	0.5	0.5	
All	Admin	5.8	3.9	3.9	1.5 % of subtotal
Year Total		394.4	263.2	263.2	
TOTAL		**$920,808 EX GST**			

2.6 Timeline summary and milestones

As discussed, several key parts of this research plan rely on finding additional populations for study. There is some risk associated with not being able to do this, although the probability of finding additional occupied sites is considered very high. However, if after 12 months of comprehensive surveys in likely habitats in the region no additional birds have been found, contingency plans will be discussed with the yet-to-be-formed advisory group. A likely contingency plan will be attempting to do some of the invasive research (e.g. call-playback

work) at the known site. If birds vacate the known site, investment in identifying areas of suitable habitat and conducting surveys will be increased.

Given the uncertainty around when additional populations will be located that will enable several key parts of the proposed research to proceed, it is difficult to be specific about the timing of much of the proposal. Figure 2 shows a predicted timeline considering this uncertainty.

Figure 3 shows proportion of time analysing various parts of the proposed research plan. The sound data is anticipated to take up 40% of analysis time, possibly more in the first year. It is also anticipated that the ratio of field work to analyses and project management is 30:70.

Additionally, as a result of uncertainty it is not possible to provide precise dates for milestones for the full duration of the research program. Having said this, the following indicative milestones are proposed (assuming the program can commence in January 2014):

June 30, 2014:

1. All permits (including ethics) for invasive research granted (or at least submitted)
2. Methods for automated sound recording refined or at least at an advanced stage of development
3. Preliminary analyses of passive call detection data collected to date completed
4. Preliminary analyses of camera trap data collected to date completed (both for threatening processes and Night Parrot detection)
5. Habitat assessment of known site completed
6. Fire history of known site completed
7. At least 5 new areas identified from aerial photos and surveyed using SM2 units, and data analysed

December 15, 2014:

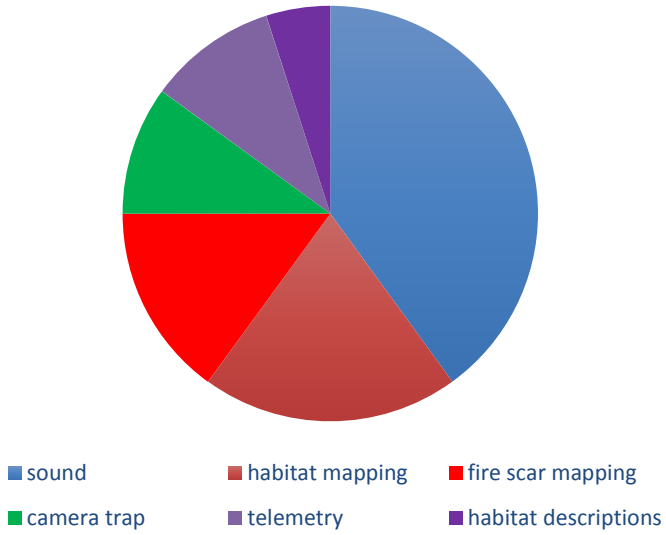
8. Preliminary analyses of passive call detection data collected during subsequent sampling period completed
9. Preliminary analyses of camera trap data completed (both for threatening processes and Night Parrot detection)
10. At least 5 new areas identified from aerial photos and surveyed using SM2 units, and data analysed
11. Annual report completed presenting progress to date.

Figure 2: Proposed timeline.

Part	Research activity	2014												2015												2016											
		jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
Detection	passive call detection	permanent monitoring at all confirmed locations																																			
	detection using call-playback	as soon as Night Parrots detected at additional locations, then ongoing until adequately sampled																																			
	detection using camera traps	at currently known site until adequately sample												then, as additional information about habitat use becomes known until adequately sampled																							
Habitat preferences	identifying key habitats using telemetry	as soon as Night Parrots detected at additional locations, then ongoing until adequately sampled																																			
	habitat descriptions			then, as additional sites become known																																			
Distribution	identify & survey likely areas	ongoing, once we begin to define preferred habitat model																																			
	follow-up third party sightings	as high veracity sightings become known																																			
Threatening processes	Fire history of habitats		at known site	then, as additional sites become known																																	
	Potential impacts of mammalian predators	at known site, until adequately sampled												then, as additional sites become known																							
	Potential impacts of grazing	"		then, as additional sites become known																																		

NB: Green blocks indicate estimated timing of those activities that are not dependent on finding Night Parrots at additional locations.

Figure 3: Projected proportion of time analysing various research components



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