A summary of recovery effort and future direction for Coxen's fig-parrot *Cyclopsitta diophthalma coxeni* 

May 2018
Executive summary

Coxen’s fig-parrot, one of the rarest birds in Australia, is restricted to south-east Queensland and north-east New South Wales. It is listed as Endangered in Queensland and nationally. Although confirmed records and credible sighting reports of Coxen’s fig-parrot continue to be made in both states, tangible proof of the bird’s existence in the form of photographs or video and sound recordings has yet to be obtained.

Through its lead conservation agency, the Queensland Government has been involved with the recovery effort for Coxen’s fig-parrot since 1993, when the first recovery plan was prepared. Queensland has led the national Coxen’s Fig-Parrot Recovery Team since its formation in that same year.

To date, the main aims of the recovery effort for Coxen’s fig-parrot have been to establish the bird’s population size and distribution, to improve the quality and extent of suitable habitat and to refine captive husbandry techniques on the closely related red-browed fig-parrot for potential application to Coxen’s fig-parrot if and when required.

Locating extant populations of Coxen’s fig-parrot has proved challenging for all stakeholders involved with recovery efforts over the last two decades. While several confirmed records of the birds have been made, most sighting reports received, usually from members of the public, remain unverifiable because of a lack of tangible evidence. It is hoped that recent advances in remote acoustic recording technology and signal detection software for call matching will finally provide irrefutable proof of the Coxen’s fig-parrot’s existence, as well as the means to establish definitively the distribution and temporal usage of habitat of this highly enigmatic bird. Acoustic remote sensing has the potential to provide inexpensive, dawn-to-dusk, year-round, remote monitoring of fig-parrot habitat without causing disturbance to these birds or other forest fauna. Current progress achieved using this advanced monitoring approach, as well as future directions, are described.

In south-east Queensland, past efforts by the Department of Environment and Science (DES), recovery team partners and various external collaborators to increase the extent, quality and connectivity of Coxen’s fig-parrot habitat have been considerable. Mostly, these have focused on the Sunshine Coast hinterland, where some of the most recent and reliable sightings of the bird have been reported. It is hoped that success with the acoustic monitoring methodology, along with sighting information received from the general public, will enable locations utilised by Coxen’s fig-parrot to be identified, thereby facilitating better targeting of future habitat restoration work for this endangered bird.
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1 Introduction

Coxen’s fig-parrot is conventionally considered to be the largest of the three Australian subspecies of the double-eyed fig-parrot *Cyclopsitta diophthalma* (e.g., Higgins 1999). Recently, del Hoyo et al. (2014) raised the taxon to species level as *Cyclopsitta coxeni* on the basis of the bird’s large size compared to the two north Queensland fig-parrots (Marshall’s *C.d. marshalli* and Macleay’s or red-browed fig-parrot *C.d. macleayana*). Although this taxonomic change has been adopted by some authorities (e.g., BirdLife International, 2017 and 2018), it has not yet received universal acceptance.

Coxen’s fig-parrot is restricted to south-east Queensland and north-east New South Wales. It is listed as Endangered in Queensland (under the *Nature Conservation Act 1992*) and nationally (under the Commonwealth’s *Environment Protection and Biodiversity Conservation Act 1999*) and is listed as Critically Endangered in New South Wales (under the *Biodiversity Conservation Act 2016*). It is also ranked as a critical priority under DES’s Back on Track species prioritisation framework.

Following the preparation of the first recovery plan for Coxen’s fig-parrot (Davidson 1993), a national recovery team was formed to initiate action to improve the conservation status of the bird. The Queensland Government (through the then Department of Environment and Heritage) was a foundation member of the team and lead agency. Early recovery efforts are summarised by Romer and Gynther (1997). Subsequently, a second national recovery plan *Coxen’s fig-parrot Cyclopsitta diophthalma coxeni recovery plan 2001-2005* was adopted in 2003, with the overall objective of preventing extinction of Coxen’s fig-parrot from human-induced causes and ensuring the stability of wild populations (Coxen’s Fig-Parrot Recovery Team 2001). The main aims of the national recovery effort to date have been to establish the bird’s population size and distribution, to improve the quality and extent of suitable habitat and to refine captive husbandry techniques using the red-browed fig-parrot as an analogue. However, because the status of Coxen’s fig-parrot is so poorly known, it is difficult to predict if these measures are sufficient to secure its long-term survival (Coxen’s Fig-Parrot Recovery Team 2001). Currently, this situation remains unchanged.

1.1 Background

Coxen’s fig-parrot has been recorded between the Rockhampton area of Queensland and the Richmond River in northern New South Wales, west to the Bunya Mountains, Main Range, Richmond Range and Koreelah Range (Garnett et al. 2011). Additional plausible but unconfirmed records have been reported from further south in New South Wales. Figure 1 depicts the Queensland locations of selected records of Coxen’s fig-parrot during from the period 1990 to 2000. The Sunshine Coast and hinterland continue to be a focus of reports of this bird (Figure 2).

Surveys by ornithologists to locate individuals by visual means have had some success but are hampered by the critically small population size of Coxen’s fig-parrot (estimated at only 100-250 individuals – Garnett et al. 2011; BirdLife International, 2017), compounded by the bird’s small size, cryptic colouration and highly mobile nature. To date, most sightings of this parrot have been fortuitous, with observers simply being in the right place at the right time.

Records have come from rainforests of all types, spanning elevations from sea level to approximately 900m (Coxen’s Fig-Parrot Recovery Team 2001; Gynther 2012). In addition, recent sightings have been made in coastal open forest comprising *Melaleuca, Corymbia* and *Livistona* north of Bundaberg, as well as riparian corridors through woodland, open woodland or cleared land where food resources (especially fig trees) exist (Gynther 2012). Coxen’s fig-parrot is also known to visit fruiting trees in gardens and farmland (e.g., Forshaw 1969; Morris and McGill 1980; Fisher in Holmes 1990; Gynther et al. 1998).

The apparent decline in Coxen’s fig-parrot numbers around the turn of the 20th century was probably due to loss of habitat through the clearing of lowland rainforest for residential and agricultural purposes and logging of rainforest trees (Illidge 1924; Cayley 1938; Martindale 1986).

Current threats to Coxen’s fig-parrot include the inadequate extent, quality and connectivity of habitat, which makes foraging more difficult and increases the risk of predation when birds move between stands of habitat; probable seasonal gaps in food availability; degradation of habitat by exotic invasive trees, shrubs and vines, particularly in gallery rainforests and other lowland riparian corridors; and disturbance to breeding areas from inappropriate burning, logging or clearing (Gynther 2012). Potentially, the illegal collection of birds or eggs for the avicultural trade (Holmes 1990; Coxen’s Fig-Parrot Recovery Plan 2001) also remains a threat.
Figure 1. Confirmed and credible records of Coxen’s fig-parrot in Queensland from 1990–2000
Source: Holmes (1994 and 1995), Gynther et al. (1998), Coxen’s Fig-Parrot Recovery Team (2001)
1.2 Strategies for conservation action

1.2.1 Ecological assessment and monitoring

An important component of the Coxen's fig-parrot recovery program is to locate birds in the wild to establish where surviving populations occur and to gather information about temporal usage of occupied habitat.

Nest site surveys, as identified in the recovery plan, were undertaken by DES staff in conjunction with other recovery team members and a consultant (e.g., Gynther 1996a and 1996b, Gynther et al. 1998; Gynther 2000) with a focus primarily on locations of confirmed records, preferred habitats at localities of recent, credible incidental sightings or localities judged to be potentially important based on knowledge of the bird's distribution.

Investigating novel, remote survey methodologies is identified in the recovery plan as one of the actions with potential for providing critical data on distribution and biology of this poorly known bird (Coxen's Fig-Parrot Recovery Team 2001). Over the last two decades of investigations and trials, acoustic remote sensing has been identified as the most cost-effective method to monitor sites with a history of Coxen's fig-parrot observations. It has the potential to provide inexpensive, dawn-to-dusk, year-round, remote monitoring of fig-parrot habitat without causing disturbance to the birds or other forest fauna. Critically, recent years have seen significant improvements in the quality and performance of hardware and software associated with acoustic remote sensing and signal detection.

1.2.2 Habitat protection and enhancement

Protection and enhancement of habitat is an identified action of the both the national and New South Wales recovery plans (Coxen's Fig-Parrot Recovery Team 2001; New South Wales National Parks and Wildlife Service 2002). This has involved the development of management guidelines for logging operations in areas of identified fig-parrot habitat, the regulation of land-use by state and local authorities, the rehabilitation of habitat, and the implementation of programs to assist with the propagation of food trees. While much of this work has been implemented, maintaining such efforts will continue to provide conservation benefits for Coxen's fig-parrot.
To improve the quality and extent of Coxen's fig-parrot habitat, efforts have been focussed on fig tree and rainforest planting programs in Queensland and New South Wales, and funding projects to rehabilitate and revegetate remnant stands of rainforest on the Sunshine Coast of south-east Queensland (e.g., Coxen's Fig-Parrot Recovery Team 2001; Gynther 2000 and 2006).

### 1.2.3 Captive breeding

Currently no captive populations of Coxen's fig-parrot exist, although the establishment of a captive-breeding program has been advocated in all three published recovery plans (Davidson 1993; Coxen's Fig-Parrot Recovery Team 2001; New South Wales National Parks and Wildlife Service 2002). An inability to locate active nests of the subspecies from which breeding stock could be acquired (Gynther 2000) has, so far, impeded a captive-breeding population being founded.

Captive husbandry techniques and protocols have been developed since 1987 at Currumbin Wildlife Sanctuary in Queensland on the closely related red-browed fig-parrot in case the opportunity to secure Coxen's fig-parrot in captivity arises (Hibbert 1988; Romer and Spittall 1994; Romer and Gynther 1997). These techniques continue to be refined on this captive population today. To better prepare for the potential location of a breeding pair of Coxen's fig-parrot in south-east Queensland and north-east New South Wales, husbandry trials have also included transferring eggs and chicks of wild red-browed fig-parrots into the captive population at Currumbin Wildlife Sanctuary for both hand-raising and rearing by foster parents (I. Gynther and C. Hall, unpublished data). A three-part document outlining a proposed captive-breeding protocol for Coxen's fig-parrot has been drafted by the recovery team ahead of an opportunity arising for founder stock to be acquired. Further development of, and agreement on, this protocol will be required before considering its implementation.

Joseph (1988) suggested that captive breeding may warrant being given a higher priority than conserving existing habitat or populations of Coxen's fig-parrot. Resolving these priorities and deciding on an appropriate time for active intervention are important responsibilities of the recovery team and will be undertaken in full consultation with relevant government and scientific authorities, ethics committees, as well as acknowledged experts in the avicultural and general communities.

### 1.3 Objectives

In implementing elements of the national recovery program, the main objectives of the current DES project are to:

- develop a call reference library for call matching using a north Queensland subspecies (Macleay's or red-browed fig-parrot) as a proxy for Coxen's fig-parrot;
- develop an automated call-detection system for fig-parrots for application to survey and monitoring efforts for Coxen's fig-parrot;
- following the successful development of an automated call detection system, deploy remote sound recorders at selected south-east Queensland monitoring sites known or thought to be visited by Coxen's fig-parrot to detect and monitor the bird's presence in the wild;
- locate individuals of Coxen's fig-parrot and gather data on the bird's distribution and ecology, including patterns of seasonal movement, to support future conservation efforts;
- if Coxen's fig-parrot is detected during the breeding season, conduct targeted surveys of surrounding habitat to locate active nests, thus providing an opportunity to advance ecological knowledge of the bird rapidly;
- should nest surveys prove successful, consider securing Coxen's fig-parrot eggs or chicks in captivity to establish a captive breeding population, where possible, maximising the genetic diversity of founders;
- at all locations where Coxen's fig-parrot presence is confirmed, wherever possible, implement programs to improve the extent, quality and connectivity of habitat for the bird;
- document all reliable Coxen's fig-parrot records and share this information with the Coxen's Fig-Parrot Recovery Team and other relevant parties; and
- manage and store all data relating to confirmed fig-parrot records in the Queensland Government’s wildlife database, WildNet.
2 Methods

The methods detailed below are from previous and current projects.

2.1 Ecological assessment and monitoring

2.1.1 Survey protocols and incidental record collection

In 1996 and 1997, an important strategy adopted to survey for Coxen's fig-parrot was to conduct nest site searches instead of simply monitoring food trees. The general approach used during all nest site surveys was to scan trees in areas of suitable habitat by eye and with binoculars in an effort to locate nest holes belonging to the bird. Rather than using existing hollows, fig-parrots excavate a nest chamber inside a dead tree trunk or branch using their bills, with the shape and size of the entrance aperture, and the position of the nest in the tree, all being highly characteristic (Gynther et al. 1998). Certain features also enable old holes to be distinguished from freshly excavated ones. The authenticity of all holes found was confirmed or rejected after close scrutiny with binoculars or a spotting scope. The search effort was concentrated along roads, walking tracks, watercourses and forest edges.

To document information about all Coxen's fig-parrot records (both survey records and incidental sightings by members of the public), a sighting report form was designed by the Coxen's Fig-Parrot Recovery Team in 1996 (Appendix 1). Guidelines were also formulated for the establishment and operation of a Coxen's Fig-Parrot Records Appraisal Committee to assess incidental sightings (Coxen's Fig-Parrot Recovery Team 2001). All reported sightings of Coxen's fig-parrot are followed up with the observer by phone and, in cases assessed as being worthwhile, a sighting report form is provided for completion. In this way, the details of all reports are captured as thoroughly as possible to enable the veracity of observations to be assessed and to build a pattern of the bird’s geographic, temporal and seasonal patterns of occurrence.

2.1.2 Monitoring via remote acoustic recording and call recognition

2.1.2.1 Recording of the red-browed fig-parrot’s acoustic repertoire in the wild

No known audio recordings of Coxen’s fig-parrot currently exist and so survey and monitoring techniques involving call recognition must rely on the vocalisations of this bird’s closest relatives, namely the red-browed and Marshall’s fig-parrots from north Queensland. To gather a high quality set of acoustic recordings of the red-browed fig-parrot's vocal repertoire (as a proxy for Coxen’s fig-parrot) and to generate a visually validated set of sound recordings for the subsequent development and testing of an automated call matching system (an acoustic ‘recogniser’), it was necessary to visit locations in Queensland’s Wet Tropics known to be frequented by red-browed fig-parrots. This field work was made possible by crowd-sourced funding raised by Noosa and District Landcare Group Inc. (Noosa Landcare). A team of four observers visited selected locations in the Cairns, Gordonvale and Mission Beach areas of north Queensland in September and October 2017. The team consisted of Ian Gynther, Ted Pedersen (bioacoustics expert, Central Queensland University), Ilana Kelly (Noosa Landcare) and Allison Beutel (Currumbin Wildlife Sanctuary). At each location, the team captured:

- Information about the time of arrival, departure, numbers, range and behaviour of fig-parrots;
- High quality digital recordings (using handheld studio-grade equipment) of vocalisations, annotating behaviour for each bout of calling (Figure 3);
- Routine field-grade recordings using a standardised acoustic remote sensing system as used by the team during field trials in south-east Queensland over the past two years. This sophisticated sound monitoring equipment is called a Bioacoustic Audio Recorder (BAR), developed by Brisbane company, Frontier Labs (Figure 4). The BAR is a professional-grade audio recorder designed specifically for bioacoustic studies. It is highly sensitive and produces excellent sound quality.

This approach provided two data sets:

Data set A – a high quality set of acoustic recordings with corresponding detailed annotated behavioural notes; and

Data set B – a field quality set of acoustic recordings with observer-validated presence, numbers and visitation times of red-browed fig-parrots.

In addition, a BAR was installed for an extended period (two months) at a site on private property in Redlynch (Cairns) where red-browed fig-parrots frequently visit (Figure 5). At regular intervals during the deployment and at the end of the recording period, the property owner replaced or removed the Secure Digital (SD) card in the BAR and mailed the full cards to Ted Pedersen for subsequent analysis. At the conclusion of its field deployment, this recording device and the associated equipment will be shipped back to Brisbane.
Figure 3. Allison Beutel using a handheld parabola and digital sound recorder to capture vocalisations of red-browed fig-parrots in Cairns (Image: Ian Gynther, DES)

Figure 4. A Bioacoustic Audio Recorder (BAR) fitted with a boundary layer microphone being used to capture red-browed fig-parrot calls in Cairns (Image: Ian Gynther, DES)
2.1.2.2 Development and testing of acoustic recognisers for fig-parrot vocalisations

All analysis and application of acoustic data will be undertaken by Ted Pedersen. Data set A (from 2.1.2.1 above) should provide a comprehensive call repertoire as a foundation for establishing a preliminary automated call recogniser, and will allow a comparison to be made with recordings of wild individuals from other subspecies of double-eyed fig-parrot (i.e., in Australia, *C.d. marshalli*) to provide insight into how signals from the larger-bodied *C.d. coxeni* may vary from the proxy red-browed fig-parrot. Data set B, the visually validated data set, will be used to compare this preliminary recogniser’s performance against visual detection by the skilled human observers.

The digital sound recordings from the BAR left deployed for two months in north Queensland (see 2.1.2.1 above) will subsequently be divided into two data sets, as follows:

- **Data set C** – half the data set will be used to develop an applied suite of acoustic recognisers. Recogniser performance will be critically tested on Data set B (the visually validated data set) and subsequently, in a robust, applied situation, on Data set D.

- **Data set D** – the remaining half of the data set will be quarantined and used solely to test the veracity of the recogniser in an applied context.

Applying acoustic recognisers to the task of identifying fig-parrot vocalisations from within long-term recordings of environmental sound will require the application of call recognition software that was specifically developed for this purpose (SoundID, Maleny, Qld; [http://www.soundid.net/](http://www.soundid.net/)). Observed call repertoire variations between Coxen’s fig-parrot and other subspecies of double-eyed fig-parrot will be quantified and qualified. Depending on how much and what scope of variation is observed, a subset of the successful proxy recognisers might be replicated and adapted to accommodate any anticipated variation between the acoustic repertoire of Coxen’s fig-parrot and the proxy subspecies, the red-browed fig-parrot.

Despite these precautions, the nature of the acoustic repertoire of Coxen’s fig-parrot will remain in conjecture until birds can be located and recorded in south-east Queensland. With this in mind, sensitivity of recognisers will be set inclusively as a precautionary measure. Inclusive settings will inevitably result in the SoundID software detecting a range of false positives. Typically, the bulk of false positives will arise from a small number of species with call repertoire elements overlapping those of the anticipated repertoire of Coxen’s fig-parrot. Over time, recognisers can be developed for these false positive species to create ‘negative’ recognisers. Latest developmental versions of the recogniser software can use negative recognisers to reduce the incidence of false positives, training software over time for increased efficacy.
2.1.2.3 Deployment of acoustic remote sensors at selected Coxen’s fig-parrot monitoring sites

Once automated signal detection software is perfected, it will be feasible to scale up Coxen’s fig-parrot acoustic monitoring efforts into an applied project with wider site coverage across south-east Queensland. Remote sound recorders (BARs) will be deployed at ground level in rainforest at selected monitoring sites known to be visited by Coxen’s fig-parrot, including sites near Maleny (Sunshine Coast), Cunninghams Gap (Main Range National Park) and locations adjacent to Borumba Dam (Wide Bay–Burnett). To enhance the capacity of this acoustic monitoring system to record calls from the rainforest canopy, it will be used in conjunction with a purpose-built boundary layer microphone (Figures 4 and 5). All calls recorded by the system will be stored on replaceable 128 or 256GB SD cards. This will necessitate regular (approximately monthly) visits to the monitoring sites to exchange batteries and SD cards, with digital sound files then being provided to Ted Pedersen for analysis (see 2.1.2.4 below). If credible records of Coxen’s fig-parrot are reported by others from additional locations during the course of the project, consideration will be given to deploying BARs for an appropriate period of time at these sites too, with the aim of obtaining confirmation of the original reports.

2.1.2.4 Analysis of acoustic data from selected Coxen’s fig-parrot monitoring sites

Analysis of the anticipated large volumes of data collected at the monitoring sites will involve Ted Pedersen utilising the SoundID software in conjunction with the newly developed fig-parrot recognisers in an effort to detect the occurrence of Coxen’s fig-parrots via automated call matching. If and when positive fig-parrot call matches are detected, the veracity of these call detections will be confirmed by listening to the relevant sound files. This will determine the need for a follow-up site inspection or the instigation of a visual monitoring program.

2.1.2.5 Follow-up inspection and monitoring of sites where Coxen’s fig-parrot is positively detected

Should the recent presence of fig-parrots be detected at a site through the call-monitoring approach, a brief visit will be made as soon as possible afterwards to attempt to observe the birds, gather important ecological data such as the presence and abundance of food resources and to search the immediate area in an effort to locate the fig-parrot’s highly distinctive nest excavations. If this initial site inspection ascertains that fruiting fig trees or other known food resources for fig-parrots are present, arrangements will be made for a longer term, observer-based monitoring program involving students and/or citizen scientists in an effort to obtain visual confirmation of the bird’s presence, capture photographic or video evidence, and determine the number, age and sex of individuals visiting the site.

2.1.3 Data management

All records of Coxen’s fig-parrots made in the field or derived from acoustic data sets will be managed appropriately. At the earliest opportunity, they will be entered into the WildNet database, where they will be treated as confidential records due to the endangered status of the bird.

2.2 Habitat protection and enhancement

2.2.1 Restoration of degraded habitats project

2.2.1.1 Site selection

Between 2001 and 2005, the locality within south-east Queensland from which the majority of credible sightings of Coxen’s fig-parrot had been reported was the Blackall Range in the Sunshine Coast hinterland. Most of these sighting reports came from the southern end of the Range, centred on the township of Maleny and an area to the south-west along the Maleny–Stanley River Road. This area contains numerous small rainforest remnants on the plateau and escarpment edges, some of which are protected in reserves. Many remnants occur on private land.

In 2005, a project was implemented (under a Commonwealth grant through the Natural Heritage Trust) to undertake specific habitat restoration programs at key sites in the Sunshine Coast hinterland where Coxen’s fig-parrot was either known or suspected to occur (Gynther 2006). The project aimed to contribute to the re-establishment of the spatial and temporal continuity and diversity of food resources available to the bird, by expanding the area of suitable habitat and by providing interconnecting habitat corridors. Priority sites for on-ground works were selected using a multi-pronged approach. Reference was made to information about previous known and credible sightings, accumulated as a component of the recovery planning program for Coxen’s fig-parrot. This was used in conjunction with mapping generated during the Biodiversity Planning Assessment for the South East Queensland Bioregion. Key contacts in local government and Landcare were consulted to refine the list of possible sites for targeted action. Six sites were chosen for on-ground works and included a combination of public and private land. All sites selected were either known fig-parrot locations or were in close proximity to such locations (Figure 6). Furthermore, all possessed locally significant remnants of rainforest or were strategically
positioned between important remnants so that rehabilitation efforts would assist in creating habitat corridors.

Figure 6. Location of habitat restoration project sites in the Sunshine Coast hinterland (Gynther 2006)

2.2.1.2 Implementation

Barung Landcare Association Inc. (Barung Landcare), a Maleny-based group with a proven track record in carrying out habitat rehabilitation work within short timeframes, was chosen as the lead partner organisation to implement the on-ground actions. A formal Deed of Agreement was drawn up between the Department (at the time, Environmental Protection Agency) and Barung Landcare, officially contracting the group to undertake the on-ground works for the collaborative project.

Barung Landcare had previously had considerable involvement with both the Coxen’s fig-parrot recovery program and the SEQ Rainforest Recovery Project (a project coordinated by World Wide Fund for Nature Australia). This enabled the subcontractor to quickly and efficiently provide the required services without the need for any familiarisation or training. The group already had a good knowledge of key contacts and responsibilities associated with the project and were known by local government and relevant landholders. This enabled the necessary approvals from local government and landholders to implement conservation works on public and private property to be obtained quickly. Barung Landcare was also able to utilise a broad range of volunteers and work crews to ensure that the project’s in-kind labour component was sufficient to assist in matching the level of funding received from the Commonwealth.

Due to the organisation’s track record in revegetation and habitat rehabilitation projects in the local area, Barung Landcare already had personnel experienced with propagating plants on a relatively large scale. They managed a native plant nursery with a diverse mix of tube stock (of local provenance) appropriate for the selected sites. Seed collection was also undertaken on an ongoing basis throughout the project implementation phase to bolster the quantity of tube stock available for the revegetation work. Specific tasks undertaken during this project included manual weeding, spraying/poisoning of weeds, maintaining pre-existing plantings, erecting cattle-exclusion fencing and conducting revegetation activities.
3 Results

3.1 Ecological assessment and monitoring

3.1.1 Site surveys and incidental records

Nest site surveys conducted in 1996 and 1997 (Gynther 1996a, Gynther and O'Reilly 1998, Gynther et al. 1998) yielded a sighting of a pair of Coxen’s fig-parrots at Cunninghams Gap (Main Range National Park) and detected evidence of current or past Coxen’s fig-parrot breeding activity in the form of completed or partially excavated nest holes at eight localities. In Queensland, nesting signs were discovered in Kenilworth State Forest, Lamington National Park and Main Range National Park (all August 1996) and in Conondale National Park (October 1998). In New South Wales, breeding evidence was found in Mebbin State Forest, Tooloom National Park and the Tyalgum area in August 1996 and in Toonumbar National Park in September 1997. Signs of post-1995 nesting activity were present at four sites. In Lamington National Park, nest excavations were probably made less than a week prior to their discovery in 1996, although the site was not subsequently used. To date, no active nest has been found.

The most recent reliable records from Queensland have been two sightings made on 28 November 2013 and 21 November 2014 in a Sunshine Coast Council-managed reserve near Maleny. The first of these was made by Kieran Aland, a Queensland Museum staff member and environmental consultant, who was conducting a fauna survey at the time. This sighting was reported by Sunshine Coast Council (2014 and 2015 – see https://www.sunshinecoast.qld.gov.au/Council/News-Centre/A-Levy-well-spent and https://www.sunshinecoast.qld.gov.au/Council/News-Centre/The-long-arm-of-the-Environment-Levy).

In addition to these sites, an array of other sightings or call-based records have come to the attention of the recovery team. Some are from experienced observers. The records for Queensland made during the last decade and considered by experts to be most credible include:

- 8 September 2008 – Mooloolah Valley – calls only heard, involving birds in flight
- During 2009 and in several years since then – Daguin (Mary River Valley) – birds seen and/or heard on multiple occasions
- 28 July 2009 – Lamington National Park (Green Mountains Section) – 2 birds heard feeding in/seen leaving crown of strangling fig
- 22 October 2010 – Mt Mellum – 2 birds seen and heard flying along creek (in an area in which sightings have been reported previously by three separate observers)
- 7 October 2012 – Lamington National Park (Green Mountains Section) – 2 birds seen and heard flying off in rainforest
- 10 January 2013 – Forest Glen (Sunshine Coast) – 1 bird seen in fruiting fig near edge of rainforest stand (this location was subsequently monitored for several days by Ian Gynther and members of Birds Queensland without obtaining confirmation)
- 18-19 November 2014 – Tuchekoi (Mary River Valley) – 4 birds seen in crown of large fig tree in paddock
- 5 June 2017 – Kin Kin (Noosa hinterland) – 2 birds observed flying above road in area supporting patchy remnant vegetation.

A cluster of sighting reports has become evident from the Lake Borumba area of the Mary River Valley over the period between 2010 and 2013. Site visits to the report locations with project partners have shown high quality habitat with the potential to support fig-parrots. This is also in the same general vicinity as a sighting report made by ornithologist Greg Czechura (Queensland Museum) in 1997.

The above records indicate that the Mary River Valley, Blackall Range and its foothills, Sunshine Coast lowlands and Lamington National Park continue to be important areas for Coxen’s fig-parrot in Queensland. To this list of areas can be added Main Range National Park (Cunninghams Gap), where Conrad Hoskin and Megan Higgie (both James Cook University) confirmed birds were present in August 2004, and the Bellthorpe area (between the Blackall and Conondale Ranges), where Ian Gynther located an old nest excavation in 2007.

Incidental records of Coxen’s fig-parrot have also been reported from New South Wales over the past decade. Although no tangible evidence of these records is available for the purposes of substantiation, credible observations by experienced birdwatchers include the following:

- February 2009 – Cougal (western side of Border Ranges National Park) – 2 birds seen and heard flying over on two occasions
- February 2011 – Dunoon (Big Scrub region, south of Nightcap National Park) – 1 bird seen and heard for a period of two minutes
3.1.2 Acoustic remote sensing trials

When the recovery team began investigating acoustic remote sensing technologies in 2008, the recorders, signal detection software and expertise were inceptive and, although the method showed promise, technological obstacles hindered the project.

Preliminary trials of an autonomous recording unit (ARU) and an early version of the SoundID software at Mary Cairncross Scenic Reserve, Maleny (a known Coxen's fig-parrot location) was first scheduled in 2010-11; however the ARU developed a fault with its hardware (the mini-PC that ran the system). Difficulties sourcing a replacement part for this particular model proved insurmountable, stalling progress until 2013.

In 2013, the use of greatly improved acoustic monitoring equipment, namely the Song Meter II (Wildlife Acoustics, Massachusetts, USA), was investigated in collaboration with Ted Pedersen. In December 2014, one of these units was installed at the site managed by Sunshine Coast Council near Maleny, where reliable fig-parrot records were made in Nov 2013 and 2014 (Figure 7). Monthly visits to this monitoring site were conducted to swap batteries and exchange SD cards containing sound files (Jan & Feb 2015).

Importantly, equipment advances trialled during 2014-15 (e.g., the use of a boundary layer microphone) significantly extended the acoustic catchment area of the sound-recording unit and improved signal-to-noise ratio. The latter is a key factor in automating the signal detection process and will prove imperative to the application of this acoustic recording system to long-term and multi-site monitoring. Power usage and data storage, however, proved problematic with the equipment used over the 2014-15 recording season.

In 2015-16, the BARs developed by Frontier Labs became available, representing a new generation of acoustic monitoring equipment. One of these recording devices, which possessed a more reliable and manageable power supply than the Song Meter II, was sourced and deployed earlier in the season (October/November rather than December 2015) and left in place to monitor sounds for several months.

A substantial amount of acoustic data was recorded over the two years that the passive sound monitoring units were deployed. These data have been stored for subsequent analysis, but this must await the development of a reliable call recogniser to allow the task to be conducted efficiently (see 4.1 Future project directions and priorities).
3.1.3 Call reference library and acoustic recogniser for the red-browed fig-parrot

Field work conducted in north Queensland in September–October 2017 yielded a vast array of high quality digital recordings of red-browed fig-parrot calls, involving birds engaged in a broad range of behaviours. These behaviours included flying, feeding, preening, perching, interacting in courtship situations, begging for food from mates, and arriving at/departing from nest holes (Figure 8). Call-recording with both handheld audio equipment and a BAR, while simultaneously observing the behaviour of the birds, enabled the context of the various vocalisations to be documented and will assist the performance of the BAR to be critically examined. This approach allowed a near-complete acoustic repertoire for the red-browed fig-parrot to be obtained, thereby producing a call reference library that will provide the basis for developing a preliminary acoustic recogniser for fig-parrots (see 4.1 Future project directions and priorities).

Call recordings retrieved from the BAR that had been installed for two months on private property at Redlynch (Cairns) are still being analysed. To date, this has confirmed that the acoustic data contain fig-parrot vocalisations (Figures 9 and 10) and these are of sufficiently high quality to enable the recorded calls to be used for the development of an automated call matching system (Ted Pedersen, in litt.). For this task, half the acoustic data set from the field-installed Redlynch BAR are currently being employed to develop a suite of acoustic recognisers. The performance of these recognisers will then be tested on the acoustic data set acquired via hand-held recordings made while simultaneously observing fig-parrots (i.e., the recordings that were visually validated as being from the target bird). Finally, the performance of the recognisers will be tested and validated in an applied context by using them to detect fig-parrot vocalisations from the remaining half of the data set recorded by the Redlynch BAR. This will establish whether the recognisers work successfully. If so, they can then be applied to the analysis of the existing acoustic data sets from south-east Queensland that potentially contain vocalisations of Coxen’s fig-parrot (see 4.1 Future project directions and priorities).
Figure 8. An adult female red-browed fig-parrot at the entrance to its nest hole at Brinsmead, Cairns in October 2017 (Image: Ian Gynther, DES)

Figure 9. Two sonogram traces of the same red-browed fig-parrot flight call sequence recorded with the BAR deployed at Redlynch in October 2017. The upper trace plots call intensity (signal strength) against time; the lower trace shows the frequency of calls against time, i.e., a spectrogram (Image: Ted Pedersen)
3.2 Habitat protection and enhancement

The scheduled tasks for the 2005 habitat restoration project in the Sunshine Coast hinterland were completed on time at five of the six project sites, with on-ground works delayed for five months at the remaining site (Gynther 2006). Weed control was successfully undertaken at all sites and cattle-exclusion fencing installed at two of the sites. Initial plantings following the wet spring storm season had excellent outcomes. Later planting, however, experienced some setbacks due to extreme UV and heatwaves. Some tree losses were also experienced due to grazing by the introduced European brown hare *Lepus europaeus*.

Comprehensive flora lists for all sites were compiled and the presence of all significant (e.g., threatened) plant species was noted.
Figure 11. Installation of barbed-wire fencing to exclude cattle from rainforest remnants and areas being revegetated at Maleny (Image: Barung Landcare 2006).

Figure 12. Cat’s claw creeper vines on mature trees cut and painted with Glyphosate 450. Left, during treatment; right, after treatment (Image: Barung Landcare 2006).

3.3 Lessons learnt

3.3.1 Remote acoustic recording and call recognition

By replacing the BAR’s standard microphone with a purpose-built boundary layer microphone, the catchment area over which sounds can be recorded and the signal-to-noise ratio of the recordings were both greatly enhanced. This makes it possible for a ground-based acoustic monitoring unit to effectively capture bird calls in or above the canopy of cluttered rainforest environments, where Coxen’s fig-parrot is most likely to occur when in flight or feeding in the crowns of fig trees. Employing boundary layer microphones during field deployments of BARs will be a boon to the project.
From work conducted to date, it is evident that prolonging battery life and increasing the data storage capacity of the BARs would also be greatly beneficial because it would demand less frequent visits to remote recording stations to replace batteries and SD cards, thereby reducing overall staff time and costs for the project. Currently, efforts are being made to obtain a new model of the BAR from Frontier Labs that possesses an extended battery pack and four SD card slots.

Analyses of fig-parrot call recordings from north Queensland conducted to date indicate that the calls of birds made in flight are likely to be the most useful vocalisations for call-matching using acoustic recognisers (Ted Pedersen, in litt.). These calls are loud (far-carrying) and acoustically distinctive and so should be the primary target for automated detection techniques because they are likely to provide the best return on investment of time and effort in conducting analyses. This finding will greatly benefit the processing of acoustic data already amassed from south-east Queensland, as well as the analysis of data collected from future monitoring efforts.

### 3.3.2 Restoration of degraded habitats

With respect to the habitat restoration project conducted in collaboration with Barung Landcare at Maleny, short project timelines created some difficulties because the project necessitated negotiations with different stakeholders and was partly reliant on favourable weather conditions. Due to 18 months of drought and poor seed production at the time, there was a limited availability of local provenance plant stock. Drought conditions would have also influenced the success of weed control as weeds are less responsive to chemical treatments when stressed. Initial plantings during the wet spring storm season had excellent outcomes; however, later planting experienced some stock losses due to extreme UV and heatwaves. Having greater flexibility to carry funding over may have improved the success of this Coxen’s fig-parrot habitat restoration project.

### 3.4 Measures of success

#### 3.4.1 Sightings data

Nest surveys conducted in 1996 and 1997 resulted in a pair of Coxen's fig-parrots being sighted by three Recovery Team members and evidence of current or past Coxen's fig-parrot breeding activity in the form of completed or partially excavated nest holes at eight localities across the two range states (four localities in south-east Queensland and four in north-east New South Wales), including the discovery of past nesting activity at a new NSW site (Gynther 1996a and 1996b; Gynther et.al. 1998). In addition, many of the localities searched were assessed as having suitable habitat for Coxen's fig-parrot.

Two of the most recent reliable records of Coxen's fig-parrot near Maleny in November 2013 and 2014 are very significant because they are immediately adjacent to the location of a documented 1970s record, indicating that the area may have a long history of use by the birds.

Other reliable sightings records indicate that the Mary River Valley, Blackall Range and foothills, Sunshine Coast lowlands and Lamington National Park continue to be highly significant areas for Coxen’s fig-parrot in Queensland. Additional sites of importance include Main Range National Park (Cunninghams Gap), and the Bellthorpe area (between the Blackall and Conondale Ranges).

#### 3.4.2 Acoustic monitoring data

Several months’ worth of dawn-to-dusk audio recordings have been amassed over the late spring to early autumn period of 2015 (as well as a smaller set from a pilot installation in late 2014/early 2015). The current project to develop a comprehensive fig-parrot call reference library and construct a fully functional acoustic recogniser for fig-parrots will finally provide the means to analyse all of the digital recordings that have been accumulated. It is possible that this will produced evidence of the recent occurrence of Coxen’s fig-parrot via positive call detection.

#### 3.4.3 Restoration of degraded habitats

Habitat restoration work undertaken in the Sunshine Coast hinterland as part of the Natural Heritage Trust project improved the quality of important rainforest remnants at key sites where Coxen's fig-parrot was either known or suspected to occur. This project also assisted with the creation of habitat corridors between four private properties and two local government reserves.

### 3.5 Publicity and community awareness efforts

Heightened public awareness that will trigger the immediate reporting of future sightings of Coxen’s fig-parrot is considered to be critical to advancing the recovery program and improving knowledge of this enigmatic bird (Gynther 2000). Prompt reporting of observations by the general community has the potential to confirm the
presence of populations, enable vital data on morphology, ecology, behaviour and breeding biology to be gathered, and identify new areas for habitat rehabilitation.

Past efforts to inform and educate the public about Coxen's fig-parrot and its status have been considerable. Initiatives have included the publication of articles in ornithological and natural history periodicals, the distribution of more than 10,000 information brochures to improve recognition of the bird and encourage sightings to be reported, coverage in the media in both Queensland and New South Wales, and presentations to various interest groups (Coxen's Fig-Parrot Recovery Team 2001).

The results of the 2005 habitat restoration project at Maleny were promoted through the published articles below:


Where relevant, the results of the current monitoring project will be communicated widely, i.e., to the Minister, Departmental staff, the Coxen's Fig-Parrot Recovery Team, the scientific community and the general public. Existing information about Coxen's fig-parrot and the results of this project will be updated periodically on the DES website, as required.

4 Discussion and recommendations

4.1 Future project directions and priorities

4.1.1 Monitoring via remote acoustic recording and call recognition

The various interconnected components of the current fig-parrot acoustic recording project are illustrated diagrammatically in Figure 13. The different colours denote separate procedural groupings. For example, green boxes represent the remote acoustic monitoring work already conducted at Redlynch, the pink boxes in the central columns indicate the targeted acquisition tasks of the field project recently undertaken in north Queensland, whereas the pale blue boxes represent the desktop work currently being conducted by project collaborator, Ted Pedersen to create an acoustic recogniser. The preceding stages are all necessary to enable a concerted Coxen's fig-parrot acoustic monitoring project to be designed and implemented (dark blue box; see 2.1.2.3), which it is hoped will lead to individuals being located in the wild in south-east Queensland (red boxes). Should this occur, the newly acquired calls from the endangered target bird will then be added to the call reference library, thus refining the recogniser so that it may better detect Coxen's fig-parrot (rather than the proxy fig-parrot from north Queensland). All project stages are of equal priority and critical, except for the detailed call repertoire and behavioural work (pink boxes at top right), because this will only be relevant after a population is actually located and a detailed study proposed (e.g., by an external researcher from a tertiary institution).

Although not identical to those of Coxen's fig-parrot, the vocalisations of the closely related red-browed fig-parrot recorded during the field work in north Queensland should allow a functional call recogniser to be constructed. By keeping the call-matching parameters in the SoundID software reasonably broad, it should then be possible for the reference library of red-browed fig-parrot calls to be applied successfully to the detection of vocalisations of any Coxen's fig-parrot individuals in the recordings that have been amassed to date. Similarly, this acoustic processing methodology will also be used to analyse the considerable data set of sound recordings already gathered by project collaborators, Noosa Landcare from the Upper Pinbarren area of the Noosa hinterland (see 4.2.1) in search of a positive call matches. All calls identified by the software as matching those of fig-parrots will then be listened to and verified by ear.

In future, inclusion of a call playback feature in the BAR system (to periodically broadcast a selection of fig-parrot calls through a speaker mounted in the wall of the unit as a potential method of attracting Coxen's fig-parrot individuals) will provide a cheaper, lower maintenance and more effective means of implementing another survey strategy from the national recovery plan.
4.1.2 Field investigation of confirmed or credible Coxen’s fig-parrot records

All locations at which positive call detections of Coxen’s fig-parrot are made through application of the acoustic monitoring methodology or where credible records of sightings or call records are reported by members of the public should be inspected in an effort to sight the birds and obtain photographic proof of existence. Where very recent sightings are reported, consideration will be given to deploying acoustic monitoring equipment at the relevant site over the short term in an attempt to obtain call recordings. Acquiring such tangible evidence will greatly assist future promotion of Coxen’s fig-parrot and its recovery program to the scientific and general communities. Visually locating birds during follow-up field inspections will potentially provide an opportunity to establish the current distribution of the bird and gather important ecological data, including habitat usage, food preferences, foraging behaviour and patterns of seasonal movement, to support future conservation efforts. Should a longer term monitoring program be deemed worthwhile at particular sites, a pool of skilled citizen scientist volunteers will be called upon to extend the period over which observations are made, thereby improving the likelihood of gathering photographic evidence and other valuable information.

In situations where confirmed or highly credible records are made or received during the known Coxen’s fig-parrot breeding season (August to January), targeted nest site searches should be conducted within surrounding habitat with the aim of locating active nests. Identification of a nest hole that is currently in use would offer an opportunity to advance knowledge of the bird and its breeding ecology significantly through the implementation of a long-term monitoring program. As stated in 4.1.1, this program and any associated ecological research would best be undertaken by an external project partner, such as a postgraduate university student.

All confirmed records of Coxen’s fig-parrot and those assessed as being credible will be documented comprehensively for sharing with the Coxen’s Fig-Parrot Recovery Team and other relevant stakeholders. The information will also be entered into the WildNet database, in which the records will be treated as ‘confidential’.

4.1.3 Potential instigation of a captive-breeding program for Coxen’s fig-parrot

Locating an active nest of Coxen’s fig-parrot may offer the opportunity to meet another objective of the national recovery program, namely the instigation of a captive-breeding program through the collection of eggs or chicks as founders. Securing Coxen’s fig-parrot in captivity would provide insurance against the future loss of the wild population (due either to slow decline or a catastrophic event) and the potential for breeding individuals for eventual release to the wild. As discussed in 1.2.3 Captive breeding, considerable effort has already been made to develop
and refine field acquisition and husbandry techniques for double-eyed fig-parrots, especially by Currumbin Wildlife Sanctuary, and the national recovery team has previously drafted a proposed captive-breeding protocol for Coxen’s fig-parrot. If concrete evidence of extended occupation of a site by Coxen’s fig-parrot is obtained as a result of acoustic or visual monitoring programs or from ongoing public sighting reports, this captive-breeding protocol should be revised and circulated to relevant authorities for consideration and approval in principle, prior to any opportunity arising for founder stock to be acquired. Subsequently, should an active nest of Coxen’s fig-parrot be located, a decision about whether to implement the protocol and initiate captive breeding can then be made with minimal delay. As with any captive breeding program, genetic diversity of the founders will need to be carefully considered and managed, with founder individuals being obtained from geographically distant locations wherever possible.

4.1.4 Habitat protection and enhancement

4.1.4.1 Prioritisation of sites for future actions

Future measures to protect and enhance habitat should be prioritised to locations where Coxen’s fig-parrot is currently either known or strongly suspected to occur based on sighting reports and survey data previously obtained. As additional records are gathered from the results of monitoring work conducted during this project or from sightings reported by the general public, these should be used to further refine site selection for on-ground habitat restoration and fig tree planting activities to increase the extent and quality of available fig-parrot habitat, and improve overall connectivity with surrounding areas likely to be utilised by the bird. A particularly high priority should be assigned to locations where clusters of sightings or call records of Coxen’s fig-parrot have been made.

In addition, all sites where previous restoration work has occurred should be followed up to assess the need for further funds to maintain and extend works in significant corridors and remnants. The declaration of these areas as nature refuges should also be considered to protect significant habitat.

4.1.5 Future staffing and resource requirements

Although Noosa Landcare’s crowd-sourced funding provided the opportunity to acquire the equipment and conduct the field work necessary to compile a call reference library to develop an acoustic recogniser for fig-parrots, additional funds will be required to establish a dedicated acoustic monitoring program for Coxen’s fig-parrot in key localities in south-east Queensland and to enable the ad hoc deployment of a sound recorder where recent sightings are reported. Most of this funding will be needed to purchase acoustic monitoring equipment. Items required to establish a single acoustic monitoring station and which are available from Frontier Labs are:

- One Bioacoustic Audio Recorder (BAR LT) Upgraded Kit (with 4 x SD card slots, 2 audio channels, 2 microphones, 12V external input and cable)
- Two sets of 5 x 3400mAh 18650 protected cells (10 batteries in all)
- One Xtar WP6II 18650 6 cell battery charger
- Four SD storage cards (Sandisk 256GB Extreme Pro)
- One boundary layer microphone

At present and in the immediate future, no additional staff are required for this recovery project. Should the methodology being developed prove to be successful in detecting positive call matches for Coxen’s fig-parrot, this would warrant a more concerted monitoring project being rolled out. In this situation, more of the existing staff member’s time (i.e., a greater full time equivalent contribution) may be justifiable to implement the project satisfactorily. As described in 4.1.2, a long-term visual monitoring program instigated in response to obtaining positive call matches or sightings would be conducted by volunteers. Any ongoing behavioural and ecological research project stemming from a confirmed Coxen’s fig-parrot detection would be not be conducted by DES staff but rather by external institutions or individuals, perhaps under a partnership agreement.

4.2 Complementary conservation actions

4.2.1 Monitoring via remote acoustic recording and call recognition

In 2017, Noosa Landcare obtained funding from the June Canavan Foundation to conduct a 24-month survey and monitoring program for Coxen’s fig-parrot in the Upper Pinbarren Creek area of the Noosa hinterland, a site long established as being important for this bird based on multiple reported sightings. The funds were used to acquire state-of-the-art acoustic monitoring units (BARs) and remote cameras for installation in fig trees on private properties throughout the Upper Pinbarren Creek valley, where many landholders are supportive of the project. This work is ongoing and being conducted in collaboration with DES and Ted Pedersen.
4.2.2 Habitat protection and enhancement

Over the past two decades, numerous non-government organisations in both Queensland and New South Wales have undertaken project work that has benefited Coxen’s fig-parrot by the supplementary planting of fig trees to bolster food resources, the rehabilitation of degraded rainforest remnants to improve existing habitat or the revegetation of areas of land to recreate habitat and restore connectivity between remaining patches of rainforest. These projects have been undertaken using funding obtained from a variety of sources, including Commonwealth grants (e.g., Natural Heritage Trust, Threatened Species Network Grants), local government grants, natural resource management groups, private foundations and corporate donations. Some examples of such habitat restoration work in key areas of south-east Queensland known to be utilised by Coxen’s fig-parrot include:

- The restoration of habitat undertaken as part of the SEQ Rainforest Recovery Project, including in the Sunshine Coast hinterland.
- Barung Landcare’s 4-year ‘Barung Revegetation/Remnant Protection in Upper Mary Catchment Project’ in the early 2000s, which resulted in the successful re-establishment of 42 000 local native plants on 17 ha of degraded riparian land, with 15 ha linking existing areas of native habitat.
- A 3-year ‘Corridors of Green’ partnership between Barung Landcare, Greening Australia and Tiaro, Noosa and Gympie Landcare groups in the early 2000s to link isolated stands of remnant vegetation, resulting in more than 100 local landholders cooperating to establish 46,000 local native trees, shrubs, groundcovers and grasses over 25 ha in critical areas and approximately 9 km of riparian revegetation.
- The widening of the gallery rainforest corridor along Kin Kin Creek and habitat restoration and augmentation along Upper Pinbarren Creek by the conservation group Save Today Our Parkland (2002–4).
- A joint local area recovery project on the Blackall Range undertaken in 2004 by Wildlife Preservation Society Queensland, Wildlife Land Fund and Barung Landcare, which included giving away 4 000 assorted fig trees to landholders with the aim of increasing potential food plants for the fig-parrot.
- A partnership between Hinterland Bush Links and Barung Landcare to eradicate cat’s claw creeper, madeira vine and Dutchmans pipe in the Upper Mary Valley from 2015–2016.
- Between 2016 and 2018, Noosa Landcare’s contribution to the national ‘20 Million Trees Program’ through broad-scale replanting to recreate habitat across the Sunshine Coast, including the planting of 16 880 native trees over 4.22 ha of private freehold and Noosa Council land to recreate EPBC-listed, critically endangered lowland rainforest of subtropical Australia in the Kin Kin Creek catchment, and another project to establish a total of 13 900 plants over 3.5 ha to restore lowland subtropical rainforest along Six Mile Creek and Pinbarren Creek in the Mary River catchment.

In addition, the Queensland Government’s nature refuge program has ensured the protection of many rainforest remnants across south-east Queensland, and provided funding for on-ground works to improve habitat quality on these important parcels of land. As an example, a nature refuge on Kin Kin Creek at Cootharaba is known to contain significant habitat and food resources for Coxen’s fig-parrot and has been the focus of previous (in this case, federally-funded) habitat restoration work to benefit fig-parrots.

4.3 Potential impacts of future climate change

The majority of known habitat for Coxen’s fig-parrot in Queensland falls within the East Coast North sub-cluster of NRM regions in Australia (Dowdy et al. 2015). According to CSIRO climate change predictions for this sub-cluster (http://www.climatechangeinaustralia.gov.au/), average temperatures will continue to increase in all seasons with very high confidence (CSIRO and Bureau of Meteorology, 2017).

Extreme temperatures are projected (with very high confidence) to increase at a similar rate to mean temperature, with a substantial increase in the temperature reached on hot days, the frequency of hot days, and the duration of warm spells. Some parts of the sub-cluster could experience around two to three times the average number of days above 35°C under intermediate emission scenarios by late in the century.

Currently, the fragmented state of the Coxen’s fig-parrot’s preferred lowland rainforest habitat represents a serious threatening process for the bird because it makes locating food resources difficult. The severity of this threat is likely to be exacerbated by climate change impacts because increases in temperature and CO₂ are anticipated to influence the fruiting and seeding seasons, altering the seasonal availability of food.

Climate change is expected to increase the severity and extent of wildfires. A higher fire risk under climate change could retard rainforest expansion, but seems unlikely in most coastal bioregions to reverse it, except where flammable weeds contribute high fuel loads (Low 2011). Fires are most obviously damaging to rainforest where weedy pasture grasses and lantana Lantana camara increase fire intensity at edges with cleared or disturbed land.
Weeds are likely to benefit from climate change impacts, further increasing their competitive edge (Low 2011). An increase in growth rates of weeds of concern, e.g., cat’s-claw creeper *Macfadyena unguis-cati*, which is highly invasive on rainforest edges and along riparian corridors where fig-trees and other food resources for Coxen’s fig-parrot often occur, will reduce the quality of remaining habitat in south-east Queensland.

### 4.4 Characteristics of Coxen’s fig-parrot making it amenable to recovery

Currently available information is inadequate to predict the subspecies’ ability to recover; however, indications from other parrot species are that recovery will take some time even after threatening processes are mitigated (Coxen’s Fig-Parrot Recovery Team 2001). Nevertheless, the ongoing reporting of sightings since the 1990s suggests that the Coxen’s fig-parrot’s population, although small, cannot still be declining or it would have already become extinct over this timeframe (Garnett et al. 2011; BirdLife International, 2017; I. Gynther, unpublished data). From this it can be inferred that the bird possesses a degree of resilience, having persisted despite the numerous threats to which it has been subjected since European settlement. Furthermore, there is some cause for optimism because the significant extent of recent habitat restoration and revegetation work conducted or funded by government agencies, natural resource management groups, Landcare organisations, conservation bodies and private landholders can only be improving the recovery prospects for Coxen’s fig-parrot.

The considerable captive husbandry work (including trial acquisitions from the wild) conducted to date using the surrogate subspecies *C.d. macleayana* indicate that fig-parrots are amenable to captive breeding. This approach, if it can be applied to Coxen’s fig-parrot, would offer potential for augmenting wild populations to contribute further to the bird’s recovery.

### 4.5 Project partnerships

Current and previous partnerships established with other government, non-government groups and external organisations include the following:

- Coxen’s Fig-Parrot Recovery Team, of which DES is the lead agency.
- Ted Pedersen, Central Queensland University, who is a biologist and bioacoustics expert, and an integral project partner.
- Noosa Landcare, which has been a key contributor to the development of a fig-parrot acoustic recogniser through sourcing of funds for a joint field project. It is conducting a parallel acoustic monitoring program in the Noosa hinterland.
- Sunshine Coast Council, which is responsible for management of a number of conservation reserves and allows access to these sites for fig-parrot survey and monitoring work.
- Currumbin Wildlife Sanctuary, which has a long history of involvement with the Coxen’s fig-parrot recovery program. It maintains a captive surrogate population of red-browed fig-parrots and is a potential project partner for any future captive-breeding project that may be initiated for Coxen’s fig-parrot.
- NSW Office of Environment and Heritage, which is also a member of the recovery team and manages parallel conservation programs for Coxen’s fig-parrot in New South Wales.
- O’Reilly’s Rainforest Retreat, which is a long-term recovery team partner and has provided considerable in-kind support to the survey and monitoring program for Coxen’s fig-parrot.
4.6 Risks
A number of risk factors may hinder or prevent aspects of the recovery program being implemented which, in turn, may impact negatively on the overall level of success achieved. These risks are discussed briefly below, along with suggested means for diminishing or negating each of the issues involved.

4.6.1 Project partnerships
The success of the current monitoring project is largely reliant upon strong partnerships with key collaborators. Foremost among these is the close working relationship and mutual dependency between DES staff, Ted Pedersen and Noosa Landcare. Regular, open communication about the project’s objectives, methodology and results should ensure close cooperation from these project partners is maintained and that satisfactory project outcomes are delivered within anticipated timeframes.

4.6.2 Habitat protection and enhancement
Climate change impacts are a chief concern for the maintenance and enhancement of habitat for the Coxen's fig-parrot. There is a risk that responsibility for climate change actions will continue to be stalled by political debate. Collaboration between Federal, State and local governments in partnerships with local conservation groups will be essential for the planning and implementation of future habitat conservation projects. Good communication between members of the Coxen's Fig-Parrot Recovery Team and project partners will provide unified support and purpose for future project funding submissions.

4.7 Summary of recommendations

4.7.1 Monitoring via remote acoustic recording and call recognition
With a comprehensive fig-parrot call reference library now compiled from the vocalisations of north Queensland birds, the development and testing of an acoustic recogniser for fig-parrots, based on the application of special sound recognition software, is the immediate priority. This will hopefully enable the calls of Coxen's fig-parrot to be detected from among the months of acoustic data currently amassed so that additional survey and monitoring efforts, as well as habitat rehabilitation programs, may be better targeted.

4.7.2 Habitat protection and enhancement
Programs to reduce threats to Coxen’s fig-parrot by augmenting the amount, quality and connectivity of habitat and the availability of food resources should continue. To have meaningful conservation benefits, such programs will require a considerable and long-term collaborative effort by all project partners. While information currently available about locations that are known and likely to support Coxen’s fig-parrot can already be used to select sites for habitat restoration efforts, it is hoped that the analysis of acoustic monitoring data will help to refine where these projects are optimally targeted. The protection of sites can also be supported through declarations as nature refuges under the Nature Conservation Act 1992, with the added benefit of possible future grant funding to support habitat conservation and restoration.

4.7.3 Increasing and maintaining awareness
Observational records remain vital to the national Coxen’s fig-parrot recovery program. Consequently, increasing the awareness of ornithologists and the wider community about Coxen's fig-parrot, enhancing skills to recognise the bird and encouraging all sightings to be reported (e.g., to BirdLife Australia, State conservation agencies or the recovery team) would improve existing knowledge of the extant population. The importance of documenting all records with photographs or sound recordings, wherever possible, will be a key message stressed.
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Appendix 1

Coxen’s fig-parrot sighting report form

Coxen’s Fig-Parrot
Records Appraisal Committee

Sighting Report Form

Please use this to document details of any Coxen’s Fig-Parrot Cyclopsitta diaphanae coxeni record. Mail to: Ian Gynter, Threatened Species Program, DES, PO Box 64, Bellbowrie Qld 4070.

Name:
Address:

Contact phone: (H) (W) (Fax)

Other observers present (include addresses and phone nos):

Date of observation:

Location (be as precise as possible, e.g. include park or state forest name, distance and bearing from named point features, road/track name, latitude/longitude etc.):

Habitat description (e.g. broad vegetation type, dominant tree species, topography, altitude etc.):

Sighting conditions (time of day, weather, visibility, duration of observation):

Optical or other aids used (e.g. binoculars, telescope, tape recorders):

Number of birds observed:

Distance from bird/height of bird above ground:

Prior experience with this species:

How confident are you of your identification (e.g. 90%, 100%):
Description of bird (describe what you saw/heard, e.g. size, shape, comparative size of body parts, plumage, colour of eyes and bill, age, sex, calls etc. Attach copies of any sketches or field notes made. Use extra pages if required):

Behaviour of bird (What was the bird doing when observed? What alerted you to its presence?)

How was it distinguished from similar species?

Reference books used:

Other comments:

[Office Use Only] Received: Case No.: Recommendation: