A Strategic Framework for the Reconstruction and Conservation of the Vertebrate Fauna of Dirk Hartog Island 2017 – 2030

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Cover photograph: Dirk Hartog Island looking south from Quoin Bluff, by Keith Morris (Parks and Wildlife).

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1 Acknowledgements

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The fauna reconstruction and conservation project is largely funded by the Gorgon Barrow Island Net Conservation Benefits Fund. This fund is administered by Parks and Wildlife and approved by the Minister for Environment after considering advice from the Gorgon Barrow Island Net Conservation Benefits Advisory Board.

2 Executive Summary

The Gorgon Gas Development Project on Barrow Island Nature Reserve was approved by the Western Australian and Federal Governments in 2009 and subject to several conservation undertakings relating to compensation for environmental disturbance on this valuable conservation area. In addition, a Net Conservation Benefits fund was established by the Western Australian Government, with agreement from Chevron Australia. This was to provide support to programs that will restore and protect previously degraded habitats, and undertake biodiversity conservation research to better inform initiatives to conserve and manage terrestrial ecosystems, and achieve a net conservation benefit. The Dirk Hartog Island National Park Ecological Restoration Project was considered a flagship project for the NCB to fund and Stage One commenced in 2011. This has successfully removed all sheep from Dirk Hartog Island, and feral goats will be eradicated by early 2017. Feral cats will be eradicated by September 2018. Stage Two of this project will commence in 2018 and will involve the reintroduction of 10 species of native mammal and one species of bird that formerly occurred on the island, and the introduction of two other threatened mammal species for conservation reasons, over a 12 year period. Additional mammal and bird species may be reintroduced if appropriate, depending on an ecological assessment of potential risks and benefits. This strategic plan provides the framework and direction for this ambitious program to occur. It covers the criteria used to select species for translocation, translocation planning, founder population monitoring, transport logistics, criteria for release site selection, and post-release monitoring. It also identifies opportunities for collaborative research programs that will add value to this project and assist in future large-scale fauna translocation projects. This plan will be supported by more detailed species-specific translocation plans. This fauna reconstruction project is the largest of its kind in Australia, and arguably the world.

3 Introduction

The Australian vertebrate fauna, particularly mammals, has undergone a significant decline since European settlement. Over the last 200 years, 29 mammal species have become extinct, and another 89 taxa are threatened with extinction (Woinarski *et al*. 2014). Many of these declines and extinctions have occurred in the semi-arid and arid areas of Australia (Burbidge and McKenzie 1989, Burbidge *et al*. 2008). Offshore islands have provided refuge for several mammal species that otherwise have declined or become extinct on the Australian mainland (Abbott and Burbidge 1995).

Dirk Hartog Island (DHI) is WA's largest island (58,640 ha) and lies within the Shark Bay World Heritage Area. From 1860 - 2009 it was a pastoral lease supporting up to 20,000 sheep (*Ovis aries*) at a time. Goats (*Capra hircus*) were introduced to the island in the early

1900s following the construction and operation of a lighthouse at Cape Inscription, and they became feral soon after. Cats (*Felis catus*) are believed to have been introduced to DHI several times over the last 150 years and are now feral (Koch *et al.* 2015). House mice (*Mus domesticus*) have also become feral on the island, and horses (*Equus caballus*) and camels (*Camelus dromedarius*) were present on DHI as part of the pastoral operations (Burbidge and George 1978).

Thirteen species of native terrestrial mammal are known to have occurred on DHI (Baynes 1990, McKenzie *et al*. 2000), however all but three, smaller species have become extinct over the last few hundred years. This project proposes to reconstruct the island's fauna assemblage by reintroducing 10 species of native mammal and one species of bird, and introducing two other threatened mammal species for conservation reasons, over a 12 year period. Six of the species that are proposed for translocation to DHI are listed as threatened under the WA *Wildlife Conservation Act 1950* and Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*, and another two species are Conservation Dependent. Many of these species are now restricted to a few offshore islands, or fenced conservation enclosures.

The value of DHI to mammal conservation has been recognised for several decades. In 1975 the Conservation Through Reserves Committee (CTRC 1975) recommended that DHI be included in the conservation estate, but this was not achieved until 2009 when most of DHI became a National Park. In 1995, the pastoral lessee developed an environmental management plan that proposed the eradication of sheep, feral goats and feral cats, and the reintroduction of the native mammals that once occurred on DHI (Saunders 1995). In 2003, the Environmental Protection Authority (EPA) supported the use of Net Conservation Benefits (NCB) funds derived from the Gorgon Gas Development on Barrow Island to be used for the restoration of DHI and reconstruction of its mammal fauna. DHI is also within the Shark Bay World Heritage Property. One of the four criteria for which the Shark Bay area was listed as a World Heritage site was that the area supported important and significant natural habitats where threatened species of animals of outstanding universal value still survive. Reconstructing DHI's mammal fauna will further enhance the values of the World Heritage Property in respect of threatened fauna conservation.

NCB funding has allowed realisation of the vision of restoring DHI to a similar ecological condition to that which existed when the Dutch navigator Dirk Hartog landed on the island in October 1616. A proposal for the DHI National Park Ecological Restoration Project (DHINPERP) was submitted by the then Department of Environment and Conservation (now Parks and Wildlife) to the NCB Board in 2011 and proposed a two stage process for achieving this (DEC 2011). Stage One (2011-2018) has focussed on the eradication of sheep, feral goats and feral cats, the management of weeds, and implementing a biosecurity program for the island. This was to be followed by Stage Two (2018-2030) that would restore the native mammal species to the island. The DHINPERP was funded by the NCB in 2012 and work on commenced immediately. With the successful implementation of Stage One, planning is now underway for Stage Two to commence. This project will contribute significantly to the long-term conservation of several threatened species. In addition, by returning the mammal species that were once known on DHI, the ecosystem services provided by their digging, burrowing, grazing and browsing activities will assist in re-establishing the ecological processes to support plant communities. It will be the largest ecological restoration project undertaken in Australia, and possibly the world.

Stage One of the DHINPERP has progressed well and since 2010 over 7,000 sheep and feral goats have been removed from the island. Fourteen radio-collared 'Judas' goats remain and these will all be removed by February 2017. The island was split into two management areas by a cat-proof fence to facilitate effective cat eradication. Following baiting and

trapping programs since 2014, good progress has been made with removing feral cats and eradication will be confirmed by September 2018. No black rats (*Rattus rattus*) have been detected, either on DHI, or in the broader Shark Bay area. Weed management is ongoing. Vegetation assessment by Landsat imagery has shown that there has been a 35% increase in vegetation cover, predominantly in the south part of DHI, since sheep and goat removal began (van Dongen and Huntley 2016).

In anticipation of Stage Two of the DHINPERP proceeding, this plan sets out a strategic framework to guide the fauna reconstruction and conservation program on DHI 2017 - 2030. The plan's start date of 2017 reflects the planning that has been undertaken prior to the fauna translocations commencing in 2018.

4 Vision

The vision for the ecological restoration of Dirk Hartog Island National Park is:

A special place with healthy vegetation and ecosystem processes supporting the full suite of terrestrial native mammal species believed to have occurred there prior to 1616, which is highly valued and appreciated by Western Australians (DEC 2012).

This clearly identifies the central role that the proposed fauna translocations have to the overall ecological restoration program.

5 Gorgon Barrow Island Net Conservation Benefits Fund

In 2001, Chevron Australia commenced discussions with the Western Australian State Government about the potential to site the Gorgon Gas Project on Barrow Island Nature Reserve, and in 2003 an environmental, social and economic review of the Gorgon Gas Development was completed (ChevronTexaco Australia 2003). During the assessment phase, and development of approval conditions should the gas development proceed on Barrow Island, the concept of Net Conservation Benefits was developed. This program would add to, or improve biodiversity conservation values targeting, where possible, the biodiversity conservation values affected or occurring in similar bioregions to Barrow Island was developed (Lagdon and Moro 2013). The EPA recommended to Government that a "NCB decision of substance" was required, commensurate with the scale of the proposed project and the high and unique conservation values on Barrow Island. A value of $40 million was subsequently agreed but increased to $60 million following an increase in project size from two to three gas trains.

In mid-2003 the Conservation Commission of WA reported to the Government on this proposed development and included advice on the NCB proposal. They identified the need for a "substantial icon project together with a substantial annual program over the life of the project". As a reference case for the substantial icon project, the Commission considered the creation of a national park on Dirk Hartog Island given that inclusion of Dirk Hartog Island into the conservation estate has been recommended since the 1975 Conservation through Reserves Red Book report (CTRC 1975). In their advice, the Conservation Commission supported the use of NCB funds for the removal of introduced fauna, destocking, revegetation, fauna reintroductions, visitor facility establishment and other costs depending on the actual makeup of the island reserve and any other land uses on the island.

The Gorgon Gas Development project was approved by the State and Commonwealth governments in 2009, subject to a number of environmental commitments, including the establishment of a Net Conservation Benefit Fund (Lagdon and Moro 2013). The DHI ecological restoration project was regarded as the flagship project for NCB because of the opportunity it presented to create another important mammal conservation area, similar in scale and conservation value to Barrow Island. The biodiversity conservation values of Barrow Island (the second largest island in WA) derive predominantly from its status as an

island that has remained free of many of the threatening processes that have affected the Australian mainland, particularly introduced mammalian predators and competitors (such as foxes, cats, goats, rabbits and rodents). The biodiversity values of Barrow Island are considered to be largely intact and the island is home to a range of fauna that is threatened on the mainland and/or endemic to Barrow Island. With adequate support from the NCB fund, Dirk Hartog Island could be restored and provide a safe haven for threatened and other priority fauna species.

6 Objectives

Conservation translocations will usually comprise a) improving the conservation status of focal (threatened) species locally or globally, and / or b) restoring natural ecosystem function or processes (IUCN 2013). The DHI ecological restoration project offers the opportunity to both improve the conservation status of eight species of threatened or conservation dependent mammal, and to reconstruct the previous vertebrate fauna and restore ecological function. The objectives of the DHI fauna reconstruction and conservation program are therefore to:

1) To improve the *conservation* status (reduce the risk of extinction) of several species of threatened and conservation dependent fauna.
2) To *reconstruct* a suite of terrestrial fauna, and contribute to the ecological restoration and function of the island.

7 Administrative Framework

This strategic framework sits within a nested framework of documents that underpin the conservation of terrestrial fauna in Western Australia. Parks and Wildlife is responsible for the administration and implementation of the *Wildlife Conservation Act 1950* (which will be replaced by the *Biodiversity Conservation Act 2015*) and the *Conservation and Land Management Act 1984* (CALM Act) that together provide the legal basis for the biodiversity conservation in Western Australia. One of the department's goals is to conserve and manage the State's native plants and animals and achieve habitat, ecosystem and landscape scale conservation and protection based on best-practice science (Parks and Wildlife 2014). The Conserving Habitats, Species and Ecological Communities Service within Parks and Wildlife has primary responsibility for implementing this goal. The DHINPERP and particularly the fauna translocation component contributes to Objective 3 *Threatened, significant and iconic species have viable populations and important ecosystems, including wetlands, are intact and healthy, and use of flora and fauna is sustainable* and Objective 4 *Reduce the impacts of key threatening processes, including altered hydrology and priority pest animals, weeds and plant diseases on biodiversity, ecological processes and sustainable land uses* (Parks and Wildlife 2015).

There are a number of Corporate Policies and Guidelines that direct wildlife conservation actions, including:

- Corporate Policy Statement No. 12 (2015) *Management of Pest Animals*.
- Corporate Policy Statement No. 35 (2015) *Conserving Threatened Species and Ecological Communities.*
- Corporate Guideline No. 35 (2015) *Listing and recovery of Threatened Species and Ecological Communities.*
- Corporate Guideline No. 36 (2015) *Recovery of Threatened Species through Translocations and Captive Breeding or Propagation*.

These Policy Statements and Guidelines will be followed in the planning and implementation of this project. Corporate Guideline No. 36 is most relevant, and this is based on the IUCN (2013) *Guidelines for Reintroductions and Other Conservation Translocations.* The intent of this Guideline is to provide direction on the movement of threatened flora and fauna for

conservation purposes. It establishes the principles and the processes by which translocations of threatened flora and fauna are to be planned, approved and implemented.

The Strategic Plan for Science and Conservation Division 2014-2017 (Parks and Wildlife 2014) identifies goat and cat eradication on DHI as a priority in preparation for the fauna reconstruction project. The Framework for Fauna Conservation (Parks and Wildlife 2016a) identifies the DHINPERP as an important landscape scale fauna conservation program for the State. The Midwest Region Nature Conservation Service Plan (DEC 2008a) pre-dates the creation of the DHI national park and the commencement of the ecological restoration project. However it does include a 'new' action to undertake a fauna reconstruction program on Peron Peninsula and DHI.

The Shark Bay World Heritage Property Strategic Plan 2008-2020 (DEC 2008b) recognises the value of acquiring DHI to facilitate improved protection and management of the World Heritage values through the establishment of additional populations of threatened mammal species such as banded hare-wallaby (*Lagostrophus fasciatus*), rufous hare-wallaby (*Lagorchestes hirsutus*), boodie (*Bettongia lesueur*) and western barred bandicoot (*Perameles bougainville*). Similarly, the Shark Bay Terrestrial Reserves Management Plan (DEC 2012) recognises that the "proposed ecological reconstruction of DHI provides an opportunity to improve the conservation status of several Shark Bay threatened fauna, showcase wildlife management on a relatively large scale, and add to the value of Shark Bay as a premier wildlife conservation area."

There are recovery plans and active recovery teams for eight of the 12 mammal species proposed for translocation to DHI: chuditch (*Dasyurus geoffroii*) (Dunlop and Morris 2012), woylie (*Bettongia penicillata*) (Yeatman and Groom 2012), western barred bandicoot, banded hare-wallaby and burrowing bettong (Richards 2012 a), rufous hare-wallaby (Richards 2012 b), dibbler (*Parantechinus apicalis*) (Friend 2004) and djoongari (Shark Bay mouse, *Pseudomys fieldi*) (Morris *et al*. 2000). While all the recovery plans make some reference to the value of translocations for species recovery, only Richards (2012 a, b) make reference to translocations to Dirk Hartog Island specifically. Recovery teams will be involved in the planning of the translocations to DHI. There is also an interim recovery plan approved for the western grasswren (*Amytornis textilis textilis*) (Cale 2003).

The fauna reconstruction project will be undertaken in an active adaptive management framework (McCarthy *et al.* 2012) and this will be reflected in the preparation of a Science Project Plan covering the planning, implementation and monitoring phases of the project.

8 Planning the Translocations

Translocation Proposals will be prepared for each species to be translocated to DHI. Animal Ethics approvals will be obtained prior to commencement of any activity associated with the translocations, including source population monitoring and genetic audit surveys. The translocations will be undertaken by competent staff following Parks and Wildlife Standard Operating Procedures (SOPs) for fauna trapping, handling, processing, transporting and monitoring. Transport of people, animals, vehicles and equipment to DHI for the translocations will be undertaken following the DHI biosecurity implementation plan (Asher and Morris 2014) and broader biosecurity guidelines prepared for visitors and Parks and Wildlife staff undertaking work on islands (Parks and Wildlife 2016b).

8.1 Potential species for translocation

At least 13 species of terrestrial native mammals and three bat species are known to have occurred on DHI in historic times (Baynes 1990, Baynes 2008, McKenzie *et al.* 2000). Only three small species of terrestrial native mammal and two bat species now occur there (Table 1). Six of the locally extinct terrestrial mammal species are listed as threatened and another

two species are regarded as Conservation Dependent (*Wildlife Conservation* (*Specially Protected Fauna*) *Notice* 2015). Another two species of terrestrial mammal possibly occurred on DHI. Vlamingh recorded a dingo (*Canis lupus*) swimming in the water near DHI in 1697, and St Allouarn in 1772 reported a dog like animal eating turtle hatchlings at the north end of DHI (Christensen 2008). There are also early reports of what could have been banded hare-wallabies on DHI by Dampier in 1699 (Dampier 1981) and King in 1827 (King 1827), although Baynes (1990) did not record this species in sub-fossil bone deposits. Based on current distribution patterns it is likely that another two species of mammals existed on DHI; the rufous hare-wallaby and water rat (*Hydromys chrysogaster*) occur on Bernier and Dorre Islands just north of DHI (Baynes 1990, Friend and Thomas 1990), and the rufous hare-wallaby previously occurred on the Peron Peninsula, just east of DHI (Baynes 1990). In the absence of definitive evidence based on specimens, for the purposes of this project, the banded hare-wallaby and rufous hare-wallabies are not being considered as part of the original mammal fauna of DHI.

Three threatened bird species and two threatened reptile species still persist on DHI. The DHI rufous field-wren (*Calamanthus campestris hartogi)*, DHI (southern) emu-wren (*Stipiturus malachurus hartogi*) and white-winged fairy-wren (*Malurus leucopterus leucopterus*) are regarded as Vulnerable, although recent genetic analysis indicates that the rufous field-wren probably does not warrant differentiation as an endemic sub-species (AH Burbidge *pers com*). Two bird species, the western grasswren (regarded as a priority species that requires monitoring) and rock parrot (*Neophema petrophila*), are also thought to have become locally extinct on DHI in the last 100 years (Johnstone *et al.* 2000). The vulnerable western spiny-tailed skink (*Egernia stokesii badia*) occurs on DHI, and the endangered loggerhead turtle (*Caretta caretta*) nests on the northern most beaches of DHI.

8.2 Selection of species for translocation

8.2.1 Species for translocation to DHI for species conservation purposes were selected using the following criteria:

- Listed threatened or conservation dependent species in WA or Commonwealth (EPBC).
- Considered to have formally existed on DHI, or in the Yalgoo Bioregion.
- Suitable habitat available on DHI.
- Threats causing extinction on DHI have been mitigated.
- Source animals available from the wild, or can be captive bred.
- Establishment on DHI will assist in improving species' conservation status.
- Likelihood of success is high.

Based on knowledge of what species once occurred, or likely occurred on DHI, the following eight species / sub-species were selected for translocation primarily to improve their conservation status (mammals in taxonomic order following Van Dyck and Strahan 2008):

- Dibbler *Parantechinus apicalis* (Dasyuridae)
- Chuditch *Dasyurus geoffroii* (Dasyuridae)
- Western barred bandicoot *Perameles bougainville bougainville* (Peramelidae)
- Woylie *Bettongia penicillata ogilby* (Potoroidae)
- Rufous hare-wallaby *Lagorchestes hirsutus bernieri* / un-named mainland sub-species *NTMU2430** (Macropididae)
- Banded hare-wallaby *Lagostrophus fasciatus fasciatus* (Macropididae)
- Heath mouse *Pseudomys shortridgei* (Muridae)
- Shark Bay mouse *Pseudomys fieldi* (Muridae)

* Two sub-species of rufous hare-wallaby are recognised. To maximise genetic diversity of founders, both may be used for translocations to DHI.

8.2.2 Species for translocation to DHI for fauna reconstruction purposes were selected using the following criteria:

- Evidence the species previously occurred on DHI based on historic collections and sub-fossil survey results.
- Suitable habitat available on DHI.
- Threats causing extinction on DHI have been mitigated.
- Source animals available from the wild, or can be captive bred.
- Establishment on DHI will contribute to restoring ecological processes.

Using these criteria the following five species / sub-species were selected primarily for translocation to reconstruct the fauna of DHI:

- Brush-tailed mulgara *Dasycerus blythi* (Dasyuridae)
- Boodie *Bettongia lesueur lesueur* (Potoroidae)
- Greater stick-nest rat *Leporillus conditor* (Muridae)
- Desert mouse *Pseudomys desertor* (Muridae)
- Western grasswren *Amytornis textilis textilis* (Maluridae)

The species listed for translocation to improve their conservation status will also contribute to the fauna reconstruction aim of this project.

In addition to the species listed above, consideration may also be given to translocating water rats and rock parrots to complement the fauna reconstruction of DHI. If undertaken, these would occur within the budget and timeframe for translocating the 13 priority species outlined above.

8.3 Translocation timing and order

Translocations of the 12 priority mammal species and the western grass-wren are planned to start in August / September 2018. This will be following confirmation that feral cat eradication has been successful. Prior to this, a pilot translocation of 10 rufous hare-wallabies and 10 banded hare-wallabies will be undertaken in September / October 2017 to an area south of the cat management fence where cats have not been detected since November 2015. This pilot translocation will be used to trial founder capture and holding techniques, transport logistics, release and monitoring procedures, and suitability of habitat.

The proposed order of the translocations (Table 2) is indicative only and has been based on the following variables/factors:

- Conservation status – highest conservation value earlier.
- Availability of founders.
- Efficiency of collection/sourcing – all Shark Bay island species in consecutive years.
- Time required to successfully establish – slower breeding species earlier.
- Potential interspecific competition - predators translocated after other species established, competitors initially separated.

It is proposed that two species will be translocated in August / September each year, with a re-stocking occurring in April / May the following year (providing the initial translocation was successful in the short-medium term, and adequate numbers of animals from source populations are still available). If adequate numbers are not available for re-stocking in the second year, it will be undertaken at a later date when monitoring shows that the source population has recovered sufficiently. A second re-stocking may be required to consolidate numbers if there is excessive dispersal and/or animals establish home ranges in isolation to each other. This second re-stocking will only occur subject to meeting short to medium term success criteria and availability of a suitable number (up to 30) at the source site/s.

Augmentation translocations 5 – 10 years after establishment may be required for some or all proposed translocated species. These translocations will be undertaken to reduce the potential risk of loss of genetic potential of the translocated populations as augmentation helps to enhance genetic diversity, reduce inbreeding depression and maintain evolutionary potential in the long term. Augmentation translocations will only be undertaken subject to

meeting medium to long term success criteria and numbers required will be guided by results from the genetic assessment of the original founders and subsequent progeny.

8.4 Selection of source populations

The identification of where to source founder animals will be guided by the following principles:

- Where possible, founders will be taken from wild, free-ranging populations.
- Sourcing will be from wild populations in preference to translocated populations (likely to have the greatest genetic diversity, robustness etc.).
- Captive breeding only when wild founder populations are unlikely to be able to sustain harvesting the required numbers for translocation.
- Logistical constraints, e.g. distance from DHI, ease of access.
- Requirement to monitor/survey likely source populations.
- Recognising that the same species are likely to be, or have been proposed for other fauna recovery and conservation projects, there is a need to coordinate with other projects to optimise access to founders and prevent over-harvesting from any one population.

The locations of naturally occurring (wild) and translocated populations of the species proposed for translocation to DHI are shown in Table 3. There are several potential source populations available for most species and the intention is to maximize the number of founders available and the genetic diversity of the translocated populations on DHI by sourcing animals from a mix of populations (where feasible). It is anticipated that only two species, the dibbler and heath mouse will require captive breeding as their numbers in the wild are probably too low to support a wild to wild translocation.

Monitoring of potential source populations is required prior to the removal of founders to assess the size and health of the populations, temporal population fluctuations and inform when removal of individuals would have the least impact on the source population. The numbers of founders available for capture from wild populations is likely to be influenced by climatic variables, particularly rainfall in the preceding 12-18 months for Bernier and Dorre Islands (Chapman *et al.* 2015). The number of founders required and best source location will also be informed by knowledge of the genetic diversity available in source populations. For a number of species, further work is required to understand the extent of genetic diversity of potential founder populations and inform the source site selection and optimal number of founders. Where such knowledge gaps exist, a field program will be undertaken to collect the necessary tissue samples for genetic analysis prior to translocations taking place, which will then be used to inform the selection of appropriate source populations and estimate the number of founders required to obtain genetic representativeness. An assessment of the genetic diversity issues for each species to be translocated is shown in Table 4. Also included is a priority for further genetic work to ensure that genetic diversity in the DHI translocated populations is maximised. There are also opportunities to learn from previous genetic studies and previous translocations to inform this aspect of the project.

Where full knowledge of the potential source population is not available, a set of criteria will guide the selection of the source site and number of founders based on the following principles:

- Harvest from wild population is preferable to harvest from a translocated population.
- Source from a variety of geographic locations where available.
- A minimum of 40 - 50 founders for the initial translocation in August / September and up to another 30 for re-stocking in May of following or subsequent years. If required, an additional (second) re-stocking will be undertaken in subsequent years.

- Examine rainfall records for potential founder sites for the 12-18 month period before translocations are planned.

8.5 Selection of Dirk Hartog Island release sites

Species will be translocated into areas on Dirk Hartog Island considered suitable based on the following criteria:

8.5.1 Suitable habitat – knowledge of the species habitat requirements based on previous and current distributions will be used to select suitable habitat for release on DHI. Several of the species for translocation will likely be sourced from nearby Bernier and Dorre Islands. Beard (1976) has broadly mapped the vegetation of Bernier and Dorre, and DHI and their vegetation communities are similar, although DHI has a more diverse flora. The four vegetation communities mapped by Beard (1976) on DHI, were increased to five communities by Burbidge and George (1978), who split off the “hummock grasslands” from the “mixed heath and spinifex” of Beard. Most of the grazing activity on DHI occurred in the southern part of the island due to easier access from the homestead and other infrastructure, and it is in this area that the most noticeable vegetation recovery has been observed since grazing pressure by goats and sheep has been removed (van Dongen and Huntley 2016). Having an adequate sized area of suitable release habitat is also required to allow for population expansion.

8.5.2 Species interaction and competition – species that are known to detrimentally impact on each other will not be released into the same areas. For example, boodies are capable of outcompeting woylies in captive situations so initially these two species will be separated geographically, as well as by the cat management fence.

8.5.3 Distance to support infrastructure – release areas will be selected taking into account facilities that would be available to support staff involved in the releases and monitoring program. Travel distances can be significant on DHI and the condition of some tracks is poor. Throughout the program, several species will need to be monitored at once so consideration of distance to infrastructure will be important. From south to north there are four nodes of existing infrastructure on DHI: the DHI homestead and resort, Herald Bay Shark Bay District and cat team infrastructure, Sandy Point temporary infrastructure, and the restored lighthouse keeper’s quarters at Cape Inscription (Figure 1).

8.5.4 Track access – vehicle access to release and monitoring sites will be required, and only a limited track network is available on DHI. The cat eradication program has installed quad bike tracks at approximately two kilometre intervals and a number of these will be required for access during the fauna translocation program. Adequate vehicle access will also be required to the points where animals may be landed on DHI from vessels, helicopters or fixed-wing aircraft. Ideally, release areas should also be within a few kilometres (up to 10km) of where animals are going to be landed, but this may not always be possible.

8.5.5 Physical barriers to reduce animal initial dispersal – native animals released into new environments will often move large distances initially, most likely searching for familiar land marks or refuges. These movements often reduce as the animals adjust to their new environment and establish new refuges and home range areas. It can be an advantage to select release sites that may have some physical boundary (e.g. fence, or unconsolidated sand dunes) to restrict the initial movements of released animals. This will help animals to stay in close proximity to each other for breeding and assist in the efficiency of monitoring.

8.5.6 Elevated areas for radio-tracking - DHI is dominated by a series of consolidated and unconsolidated sand dunes that can reach 30m in height. Having some of these higher areas in the release areas will assist in detecting signals from radio-collars fitted to some of the released animals for monitoring purposes.

8.5.7 Management of potential hazards – there are at least 18 old pastoral well sites on DHI, and many of these are uncovered and can act like large pit traps for native fauna. These are potentially hazardous for released (and local) fauna and need to be covered or fenced in areas where animals are to be released. Ultimately all open wells on DHI should be covered or fenced to prevent fauna (and visitors) falling into them. Another potential hazard that will need to be managed once animals have been released on DHI is night driving and the risk of road-kills. Education and speed limits could be used to minimise this risk.

8.5.8 Freehold land – as part of the negotiations for the creation of the DHI national park in 2009, several blocks of freehold land in the Sunday Bay area were allocated to the Wardle family. These are now for sale and private dwellings are being erected on them. While these areas will not be targeted for releases of native fauna, landowners will need to be aware that over time some species may occupy uncleared freehold blocks. If clearing of these is required for dwelling construction the EPBC Act might be triggered if the species affected is a Matter of National Environmental Significance (MNES) species (threatened fauna).

9 Undertaking the translocations

All the translocations will be undertaken in an adaptive management framework, where a ‘learning by doing’ approach will be adopted (Walters and Holling 1990). It is possible therefore that some procedures may change to improve outcomes.

9.1 Capture / collection of founder animals

Translocations will be undertaken in the order discussed in 8.3 above, with the initial 40-50 founders being captured / collected in August – September, and individuals for restocking (assuming the initial translocation is successful) captured / collected in April the following year/s, providing adequate source numbers remain.

Founder mammals from wild populations will be captured, usually by trapping and/or hand netting, measured, weighed, marked (using Passive Integrated Transponder implants), tissue taken (for genetic work) and held as stipulated in the Translocation Proposal and Animal Ethics approval. Depending on species and suitability of fitting radio-transmitters, a proportion of founders (up to 50%) may be fitted with radio-tracking devices for post-release monitoring purposes.

Founder birds will be captured using appropriate traps and mist nets operated by accredited personnel and following the Parks and Wildlife Standard Operating Procedure (DEC 2013). Each individual will be weighed, measured and marked with uniquely numbered metal bird bands from the Australian Bird and Bat Banding Scheme by an accredited bird-bander. Feathers and / or a blood sample will be taken from each individual for genetic analysis. Birds will be held and transported as stipulated in the Translocation Proposal and Animal Ethics approval. A proportion of founders (up to 50%) may be fitted with radio-tracking devices for post-release monitoring.

9.2 Transport to Dirk Hartog Island

Founder, restocking and augmentation animals will be transported as quickly and efficiently as possible using whatever combination of charter vessels, helicopters and fixed winged aircraft is necessary to ensure animals are released within 24 hours of capture.

9.3 Release on Dirk Hartog Island

Mammals will be released at, or soon after, dusk at the selected release sites on DHI (Section 8.5) to reduce the risk of translocation shock, to reduce dispersal and potential predation by birds of prey. Birds will be released in the morning to reduce the risk of translocation shock and allow individuals plenty of daylight time in which to find food and adequate shelter sites.

9.4 Monitoring of founder populations

Monitoring of wild source populations after the removal of founders is required under Parks and Wildlife corporate guidelines (No 36) and IUCN (2013) translocation guidelines to ensure that there is minimal detrimental impact on the founder population. This is particularly important for populations on arid and semi-arid islands where populations can fluctuate significantly due to climatic influences and removal of additional animals could have a large impact.

9.5 Monitoring of translocated populations

Monitoring of a proportion of the released individuals is also required under Parks and Wildlife corporate guidelines and IUCN translocation guidelines. Translocation proposals will include species-specific short, medium and long term criteria against which the success or failure of the translocation will be measured. Monitoring initial survivorship, recruitment, genetic diversity and spread of the translocated population are important to assess the translocation against these criteria. Typically, monitoring becomes less intensive over time, providing the translocation achieves the specific success criteria.

10 Measures of success

This project aims to be effective in terms of achieving outcomes that increase the distribution and abundance of the species that once occurred on DHI and to improve the ecological conditions of DHI by restoring fauna and the ecological processes they contribute. Ultimately, measuring the success of the program will be based on the achievement of the species conservation and fauna restoration objectives identified above (Section 6), and within budget. The operational success of the DHI restoration project will be assessed through monitoring and the use of short, medium and long-term success criteria identified in translocation proposals, along with assessment of their contribution to the overarching objectives of the project. Assessment and reporting whether outcomes are being met will be provided through an annual report. Each outcome will be categorized as being 1) not achieved, 2) partially achieved / underway / ongoing, or 3) achieved. Through this evidence-based assessment the DHI Management Committee and the Steering Committee will be able to assess whether the project objectives are being met and to identify changes to management strategies early-on as part of an adaptive management framework.

The program also needs to be efficient in achieving these outcomes within the budget available. Efficiencies can be gained through the program adding to existing or overlapping projects (for example NESP, Oz Mammals Genome Initiative), and by forming partnerships with communities and industry to achieved shared goals. Stage Two funding will cease in 2030, however some level of monitoring and potentially augmentation translocations for some species will need to be maintained by Parks and Wildlife past this time.

The short, medium and long-term criteria for success of translocations will be included in Translocation Proposals. These are based on the objectives or purpose of the translocation, the life history of the species and the ability to monitor / measure appropriate parameters. Monitoring for success usually includes initial survivorship of founders, establishment in the release area (or adjacent areas), evidence of breeding, survivorship of progeny, and

expansion away from the release area. Genetic monitoring will be used to assess the genetic integrity of established populations (i.e. how they maintain genetic diversity, whether inbreeding is a problem). Long-term persistence, population growth and maintaining genetic potential of the established populations is the ultimate aim.

11 Reporting

Annual reports will be provided to the DHI Management Committee, Steering Committee, NCB Board and Recovery Teams. A publication schedule will be developed and peer reviewed journal papers and popular articles will be prepared, and presentations made at conferences and workshops. The current DHINPERP Community Engagement Strategy will be reviewed and updated.

12 Research opportunities

This scale of fauna translocation has not been attempted in Australia before and an adequate preparation period provides the opportunity for research by third parties into the planning, implementation and monitoring phases to be undertaken to complement departmental research activities. Topics of interest could include modelling the numbers of founders required to maximise translocation success, monitoring the recovery of founder populations after founders have been removed, assessing the impact of the translocated fauna on the vegetation and soil characteristics of DHI, and assessing the trajectory of genetic diversity in translocated populations. One of the Parks and Wildlife scientists working on this project will have a proportion of their time allocated to promoting research and collaborative opportunities.

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Glossary

CALM	WA Department of Conservation and Land Management (now Department of Parks and Wildlife)
CEO	Chief Executive Officer
CTRC	Conservation Through Reserves Committee
DEC	WA Department of Environment and Conservation (now Department of Parks and Wildlife)
DHI	Dirk Hartog Island
DHINPERP	Dirk Hartog Island National Park Ecological Restoration Project
EMB	Environmental Management Branch
EPA	Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act
IUCN	International Union for the Conservation of Nature
MNES	Matters of National Environmental Significance
NCB	Net Conservation Benefit
NESP	National Environmental Science Program
Parks and Wildlife	WA Department of Parks and Wildlife
PICA	Public Information and Corporate Affairs Division, Department of Parks and Wildlife
PVA	Population Viability Analysis
PVS	Parks and Visitor Services Division, Department of Parks and Wildlife
SCD	Science and Conservation Division, Department of Parks and Wildlife.
SOP	Standard Operating Procedure
SSC	Species Survival Commission
UWA	The University of Western Australia.

Table 1. Status of native mammal fauna of Dirk Hartog Island.

Species	Conservation status (WCA)	Status on DHI	Evidence of presence
Mulgara *Dasycercus blythi*	Priority 4	Extinct	Burbidge and George (1978), Baynes (1990)
Chuditch *Dasyurus geoffroii*	Vulnerable	Extinct	Burbidge and George (1978), Baynes (1990)
Dibbler *Parantechinus apicalis*	Endangered	Extinct	Burbidge and George (1978), Baynes (1990)
Little long-tailed dunnart *Sminthopsis dolichura*	Not threatened	Extant	Prince 1977 (*pers com*), Baynes (1990)
Western barred bandicoot *Perameles bougainville*	Vulnerable	Extinct	King (1821), Burbidge and George (1978), Baynes (1990), Denham (1858)
Rufous hare-wallaby / mala *Lagorchestes hirsutus*	Vulnerable / Endangered	No record	Burbidge and George (1978), Baynes (1990)
Banded hare-wallaby *Lagostrophus fasciatus*	Vulnerable	Possibly Extinct	Dampier (1699), King (1827), Dampier (1981), Burbidge and George (1978)
Boodie *Bettongia lesueur*	Conservation Dependent	Extinct	Quoy and Gaimard (1824), Denham (1858), Burbidge and George (1978)
Woylie *Bettongia penicillata*	Critically Endangered	Extinct	Burbidge and George (1978), Baynes (1990)
Greater stick-nest rat *Leporillus conditor*	Conservation Dependent	Extinct	Burbidge and George (1978), Baynes (1990)
Heath mouse *Pseudomys shortridgei*	Vulnerable	Extinct	Burbidge and George (1978), Baynes (1990)
Desert mouse *Pseudomys desertor*	Not Threatened	Extinct	Burbidge and George (1978), Baynes *pers comm*. (2008)
Shark Bay mouse *Pseudomys fieldi*	Vulnerable	Extinct	Burbidge and George (1978), Baynes (1990)
Sandy inland mouse *Pseudomys hermannsburgensis*	Not Threatened	Extant	Burbidge and George (1978)
Ash-grey mouse *Pseudomys albocinereus*	Not Threatened	Extant	Burbidge and George (1978)
Water rat *Hydromys chrysogaster*	Priority 4	No record	
Dingo *Canis lupus*	Not Threatened	Extinct	Christensen (2008)
Ghost bat *Macroderma gigas*	Vulnerable	Extinct	Baynes *pers com.* (2008)
Finlayson's cave bat *Vespadelus finlaysoni*	Least Concern	Extant	Burbidge and George (1978)
Lesser long-eared bat *Nyctophilus geoffroyi*	Least Concern	Extant	Burbidge and George (1978)

Table 2. Indicative timing and order of fauna translocations to Dirk Hartog Island.

Year	Species to be translocated (primary purpose C = conservation, R = fauna reconstruction)	Species to be re-stocked
2017	Rufous hare wallaby (C)*, Banded hare-wallaby (C)*	
2018	Rufous hare wallaby (C), Banded hare-wallaby (C)	
2019	Western barred bandicoot (C), Boodie (C)	Rufous hare wallaby, Banded hare-wallaby
2020	Shark Bay mouse (C), Greater stick-nest rat (R)	Western barred bandicoot, boodie
2021	Western grasswren (R), Woylie (C)	Shark Bay mouse, Greater stick-nest rat
2022	Heath mouse (C), Desert mouse (R)	Western grasswren, Woylie
2023	Mulgara (R), Dibbler (C)**	Heath mouse, Desert mouse
2024	Chuditch (C)	Mulgara, Dibbler
2025		Chuditch

* Trial translocation.

** It is likely that the dibbler translocation will occur earlier than 2023 to accommodate the captive breeding program at Perth Zoo.

Table 3. Potential source populations for Dirk Hartog Island founders (actual source populations will be determined following assessments of genetic diversity and abundance).

Species	Translocation years	Naturally occurring populations	Translocated populations	Captive breeding required?	Comments
Mala / rufous hare-wallaby	2017, 2018, 2019	Bernier and Dorre Islands	Trimouille Island, Matuwa enclosure, Uluru enclosure (NT) - all central Australian mala stock).	No	Potential to mix Trimouille Is. / NT mala with Bernier and Dorre RHW
Banded hare-wallaby	2017, 2018, 2019	Bernier and Dorre Islands	Faure Island, Wadderin enclosure.	No	Genetic health of F1 population to be investigated.
Western barred bandicoot	2019, 2020	Bernier and Dorre Islands	Faure Island, Arid Recovery enclosure (SA).	No	Confirm disease risk is addressed adequately. Translocated populations require genetic health assessments before confirmed as suitable source.
Boodie	2019, 2020	Bernier and Dorre Islands	Faure Island, Scotia enclosure (NSW), Arid Recovery enclosure (SA), Yookamurra enclosure (SA)	No	Propose to use only the Shark Bay form, not Barrow island form. Translocated populations unlikely to provide founders due to genetic bottlenecks. Potential issue of boodies outcompeting woylies, put boodies north of cat fence (more rocky ridges), woylies south of fence (more shrubland).
Shark Bay mouse	2019, 2020, 2021	Bernier Island	North West Island, Faure Island.	No	Genetic health of North West Is population requires assessing. Any SBM trapped during capture of boodies and WBB on Bernier Is in 2019, 2020, will be translocated, other sources could be

					used at later dates.
Greater stick-nest rat	2020, 2021	Franklin Islands (SA)	Salutation Island, Mt Gibson enclosure, Arid Recovery enclosure (SA).	No	Need genetic audit to determine best founder population(s). Arid Recovery is an unlikely source due to small founder size and bottlenecks.
Western grasswren	2021, 2022	Shark Bay mainland	None	No	Two potential source populations, one on Peron Peninsula, one in the Hamelin /Woodleigh/Carbla area (Cale 2003).
Woylie	2021, 2022	Upper Warren, Dryandra	Perup Sanctuary, Dryandra enclosure, other SW sites (Batalling?)	No	Translocate south of the cat fence to minimise interaction with boodies.
Heath mouse	2022, 2023	Lake Magenta NR, South Coast reserves, Victoria	None	Yes	Heath mouse has not been recorded in the wild in WA since 2012, need to survey / monitor for potential harvest sites. Possibly mix WA and Vic populations.
Desert mouse	2022, 2023	Matuwa, other rangeland / Pilbara sites	None	Probably not	Need to survey / monitor.
Mulgara	2023, 2024	Matuwa, other rangeland / Pilbara sites	None	No	Need to survey / monitor.
Dibbler	2023, 2024	Boullanger and Whitlock Islands, Fitzgerald River NP	Peniup, Gunton Island, Escape Island, Waychinicup enclosure.	Yes, existing program at Perth Zoo	Mid-west islands or mainland stock? May need to start translocations to DHI earlier (2018?) and drip feed dibblers into DHI over several years.
Chuditch	2024, 2025	Upper Warren, Fitzgerald River NP, salvaged animals from mine clearing?	Julimar, Lake Magenta, Kalbarri.	No	Large predator, needs to be translocated last. Abundances of potential source populations need to be assessed.

Table 4. Genetic issues in potential source populations.

Species	Translocation years	Naturally occurring populations	Translocated populations	Genetic issue	Genetics priority
Mala / rufous hare-wallaby	2017, 2018, 2019	Bernier and Dorre Islands	Trimouille Island, Matuwa enclosure, Uluru enclosure (NT) - all central Australian mala stock).	Bernier and Dorre Island animals are a subset of central Australian mala: 2 options – mix Shark Bay and Trimouille founders, or use only Trimouille founders.	High
Banded hare-wallaby	2017, 2018, 2019	Bernier and Dorre Islands	Faure Island, Wadderin enclosure.	Genetic diversity and differentiation of Bernier and Dorre Is animals. Resolved (P Spencer), no differences.	Low
Western barred bandicoot	2019, 2020	Bernier and Dorre Islands	Faure Island, Arid Recovery enclosure (SA) Dryandra enclosure.	Confirm that disease is no longer an issue on Bernier and Dorre Is. Diversity and differentiation of Bernier and Dorre animals resolved, no differences.	Low
Boodie	2019, 2020	Bernier and Dorre Islands	Faure Island, Scotia enclosure (NSW), Arid Recovery enclosure (SA), Yookamurra enclosure (SA)	Potential to mix Barrow and Shark Bay forms (cf Matuwa). Diversity and differentiation of Bernier and Dorre animals resolved, no differences (Elf)	High: if Barrow and Shark Bay animals are to be used – need to assess if Barrow has > or < diversity compared to Shark Bay. Low: if only going to use Shark Bay founders.
Shark Bay mouse	2019, 2020, 2021	Bernier Island	North West Island, Faure Island.	Have NW and Faure Island populations retained genetic	High: important to know if NW Island

				diversity compared to Bernier Island.	animals are to be used as founders, more abundant and easier to trap compared to Bernier Is (no non targets).
Greater stick-nest rat	2020, 2021	Franklin Islands (SA)	Salutation Island, Mt Gibson enclosure, Arid Recovery enclosure (SA).	Have the translocated populations retained genetic diversity? SA project underway	High: to inform role of Salutation Is in translocations (easier access than other GSNR populations)
Western grasswren	2021, 2022	Shark Bay mainland	None	There have been suggestions that DHI birds were subspecifically different from mainland birds, and slightly divergent genetically (Austin *et al.* 2013, Black 2011).	Medium: Degree of genetic variation between potential source populations (Peron Peninsula and Hamelin area) is unknown.
Woylie	2021, 2022	Upper Warren, Dryandra	Perup Sanctuary, Dryandra enclosure, other SW sites (Batalling?)	Genetics well documented (Pacioni *et al.* 2010)	Low
Heath mouse	2022, 2023	Lake Magenta NR, South Coast reserves, Victoria	None	Should the captive colony be established using WA and Vic animals?	High: WA founders may have to be supplemented by Vic stock.
Desert mouse	2022, 2023	Matuwa, other rangeland / Pilbara sites	None	None, but should maximise number of founder collection sites.	Low

Mulgara	2023, 2024	Matuwa, other rangeland / Pilbara sites	None	None, but should maximise number of founder collection sites. Ensure that founders are *D blythi*.	Low.
Dibbler	2023, 2024	Boullanger and Whitlock Islands, Fitzgerald River NP	Peniup, Gunton Island, Escape Island, Waychinicup enclosure.	Should the founders be a mix of island / mainland stock?	High if mainland and island stocks are to be mixed. Low if only using a single stock.
Chuditch	2024, 2025	Upper Warren, Fitzgerald River NP, salvaged animals from mine clearing?	Julimar, Lake Magenta, Kalbarri.	None, founder populations have retained genetic diversity of source populations.	Low.

Figure 1. Map of Dirk Hartog Island showing place names and location of infrastructure.