Dirk Hartog Island National Park Ecological Restoration Project:

Stage Two – Year Two

Translocation and Monitoring Report

Saul Cowen, Kelly Rayner, Colleen Sims, Tony Friend, Fiona Knox, Kym Ottewell and Lesley Gibson

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GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

Department of Biodiversity, Conservation and Attractions
Locked Bag 104
Bentley Delivery Centre WA 6983
Phone: (08) 9219 9000
Fax: (08) 9334 0498

www.dbca.wa.gov.au

This report was prepared by Saul Cowen, Kelly Rayner, Colleen Sims, Tony Friend, Fiona Knox, Kym Ottewell and Lesley Gibson.

Questions regarding the use of this material should be directed to:
Research Scientist – DHINPERP Fauna Reconstruction
Biodiversity and Conservation Science
Department of Biodiversity, Conservation and Attractions
Locked Bag 104
Bentley Delivery Centre WA 6983
Phone: 08 9405 5119
Email: saul.cowen@dbca.wa.gov.au

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Cover photo: Shark Bay bandicoot (*Perameles bougainville*) released on Dirk Hartog Island. (© T. Duselli/DBCA).

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Acknowledgments

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Summary

The Dirk Hartog Island National Park Ecological Restoration Project (DHINPERP) or “Return to 1616” aims to translocate 12 species of mammal (ten known to be locally extinct) and one species of locally extinct bird to Dirk Hartog Island (DHI) in an effort to improve their conservation status and help restore ecological processes to the island. Following a successful trial translocation in 2017 of banded hare-wallabies (*Lagostrophus fasciatus*) and rufous hare-wallabies (*Lagorchestes hirsutus*), sourced from Bernier and Dorre Island Nature Reserve, a full-scale translocation of both species of hare-wallaby in September/October 2018 ensued. A total of 90 banded hare-wallabies and 50 rufous hare-wallabies were released on the island, again from Bernier and Dorre Islands.

Here we report on the second year of translocations, and associated monitoring, undertaken in 2019/20. In August/September 2019, an additional 50 rufous hare-wallabies were translocated from Bernier and Dorre Islands, along with 72 Shark Bay bandicoots (*Perameles bougainville*). In October 2019, 26 dibblers (*Parantechinus apicalis*) from a captive-breeding program at Perth Zoo were also released. Post-release monitoring was conducted using radio-tracking, live-capture trapping and remote cameras up until March 2020. However, follow-up monitoring on DHI was suspended after this date, due to the COVID-19 pandemic, which prevented any further field work up until the end of this reporting period (June 2020).

1 Background

The vision for the ecological restoration of Dirk Hartog Island National Park (DHI) is "to create a special place with healthy vegetation and ecosystem processes that support the full suite of terrestrial native mammal species that occurred there at the time of Dirk Hartog's landing in 1616, and that this is highly valued and appreciated by the community" (DEC 2012). Successful eradications of sheep (*Ovis aries*), goats (*Capra hircus*) and cats (*Felis catus*) were completed by 2018 (Algar *et al.* 2019, Heriot *et al.* 2019). Stage Two of the project officially commenced in July 2018 and focuses on the translocation and establishment of 12 species of mostly threatened native mammal, and one bird species. A strategic framework has been prepared to guide the implementation of this stage of the project (Morris *et al.* 2017).

In 2017 and 2018, translocations of banded and rufous hare-wallabies to DHI were undertaken and these have currently met the majority of short- and medium-term success criteria. A total of 102 banded hare-wallabies were released, representing the full quota of animals for this translocation. Here we report on a supplementation to the 62 rufous hare-wallabies already released and the translocation of two more species, Shark Bay bandicoot and dibbler, to the island.

1.1 Site description

Dirk Hartog Island is located in the Shire of Shark Bay in Western Australia at approximately -26° S and 113° E, and forms part of the Shark Bay UNESCO World Heritage Area. It falls within the DBCA Parks and Wildlife Service's Shark Bay District in the Midwest Region. The island is approximately 80km long and up to 12km wide with a total area of 63,300 ha, making it the largest island in Western Australia (Figure 1). The island contains a range of terrestrial habitats, including *Acacia*-dominated shrubland communities, *Triodia*-dominated grasslands, *Thryptomene dampieri* heath, consolidated and mobile dune-systems with large areas of *Spinifex longifolius* and many small 'birrida' clay-pans vegetated by chenopods (Beard 1976).

The island was a pastoral lease from the 1860s to 2009, when most of it became a National Park. Some existing and additional small areas of freehold and leasehold were granted to the former lessee at this time. Maritime lighthouse facilities and areas for the purpose of recreation are also under leasehold at the north end of the island and additional areas have been classified as heritage reserves. Following 150 years of sheep and feral goat occupancy, the island's vegetation had been heavily affected by grazing and has become degraded in many parts. Since destocking commenced in 2005, vegetation cover has increased significantly over 38% of the island (van Dongen *et al.* 2019).

Dirk Hartog Island has a semi-arid climate, characterised by winter rainfall and dry summers with a mean annual rainfall of approximately 230mm. Occasional heavy falls of rain may occur in summer and autumn, particularly when associated with cyclones moving down the west coast of Western Australia. Figure 2 shows rainfall events and maximum daily temperatures over the reporting period from June 2019 to May 2020.

Note the main rainfall events occurred in late autumn/early winter at each end of the period. Peak temperatures over summer were between early November and mid-March.

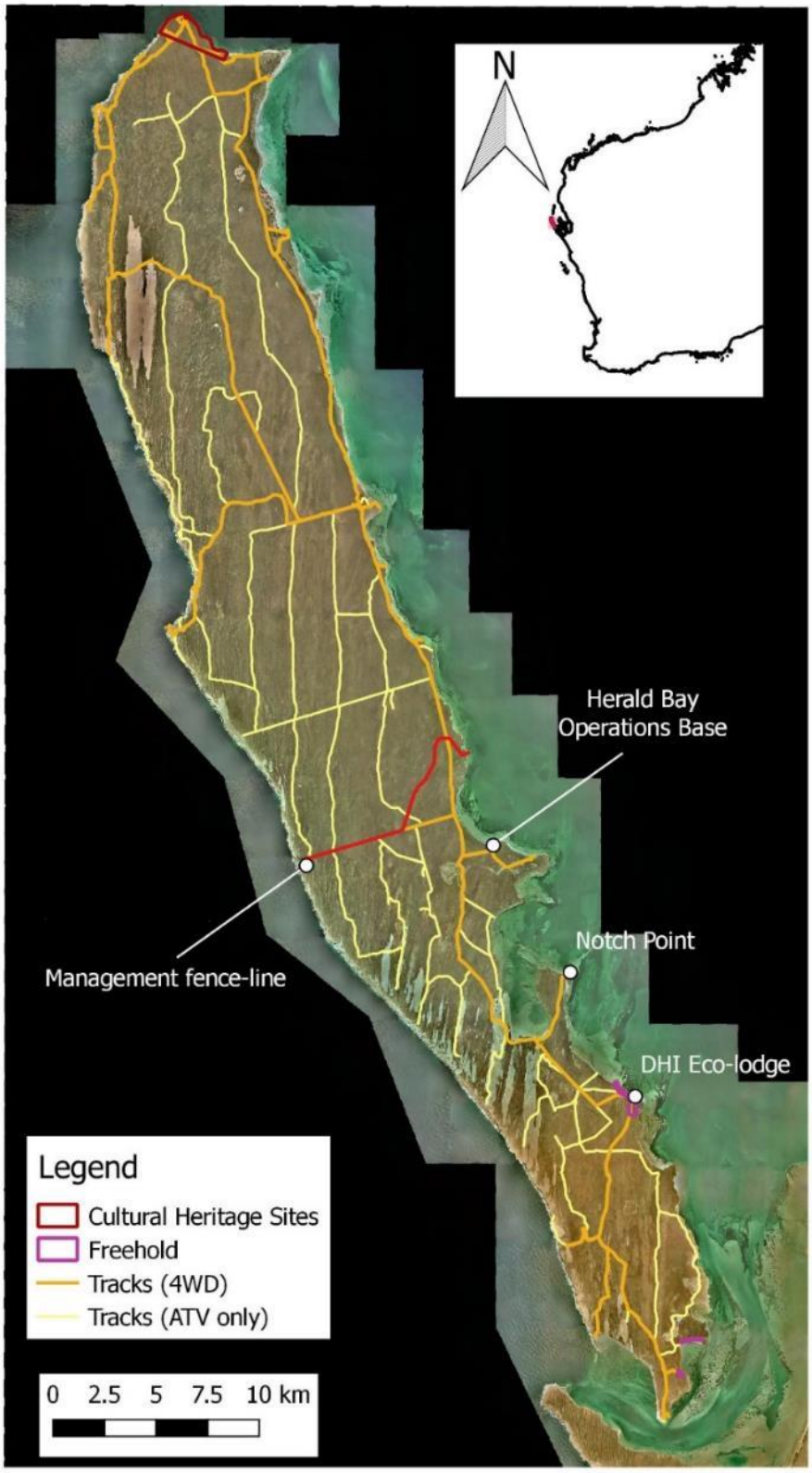


Figure 1. Map of Dirk Hartog Island, indicating important areas and 4WD and ATV track network.

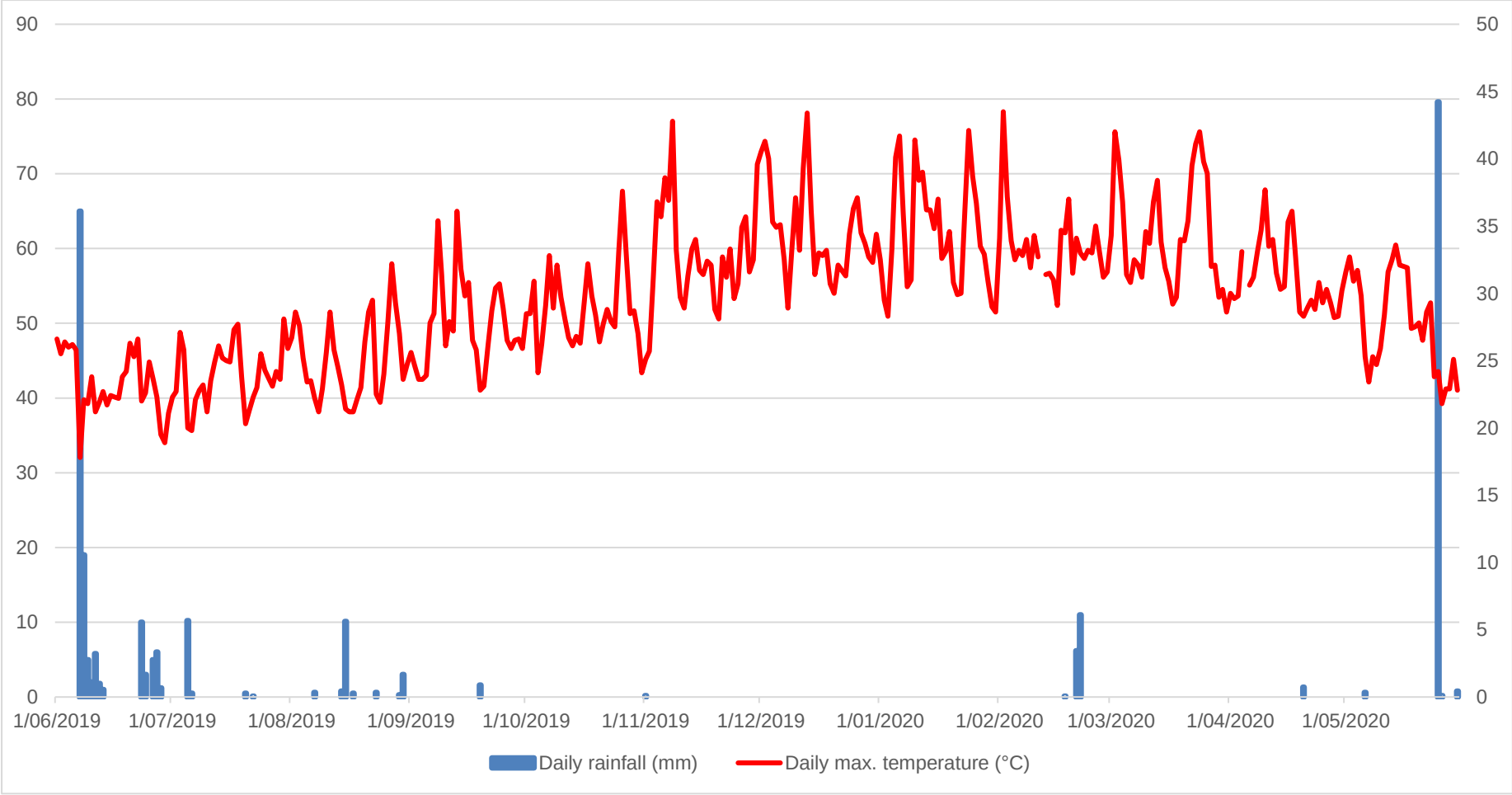


Figure 2. Total daily rainfall for Steep Point (left y-axis) and maximum daily temperature (right y-axis) for Shark Bay Airport from June 2019 to May 2020

1.2 Species descriptions

1.2.1 Rufous hare-wallaby

The rufous hare-wallaby (*Lagorchestes hirsutus*) is described in Cowen *et al.* (2019).

Compared with other mainland populations, the Bernier and Dorre Island populations of rufous hare-wallaby are highly inbred with low genetic diversity, but each island has retained unique variation (Eldridge *et al.* 2019). By the admixture of these two populations on DHI, it is hoped to boost the genetic diversity of the translocated population, whilst incurring minimal risk of outbreeding depression from mixing with the mainland subspecies or 'mala'.

1.2.2 Shark Bay bandicoot

The Shark Bay bandicoot is the smallest member of the bandicoot family Peramelidae, weighing between 100 and 375g (Short *et al.* 1998) and measuring approximately 200mm (Friend 2008). This species is the sole surviving member of the 'western barred bandicoot' complex which was recently split into five separate species (Travouillon and Phillips 2018). The original complex was once widespread across western and southern Australia (Friend 2008, Richards 2012) but the taxon found in Shark Bay appears to have been restricted to the north-west of Western Australia (WA), from Shark Bay and adjacent islands to the western Pilbara region near Onslow (Richards 2012). Today, the Shark Bay bandicoot is confined to two remnant populations on Bernier and Dorre Island Nature Reserve in Shark Bay, as well as a reintroduced population on nearby Faure Island. The species has also been translocated to predator-proof enclosures on the mainland at Heirisson Prong in Shark Bay (WA), Mt Gibson Sanctuary (WA) and Roxby Downs/Arid Recovery Project (South Australia), with only the latter two populations persisting. Consequently, the conservation status of the Shark Bay bandicoot is listed as Endangered under the EPBC Act (1999) and Vulnerable (Schedule 3) under the Western Australian Wildlife Conservation (Specially Protected Fauna) Notice (2018) and IUCN criteria.

Shark Bay bandicoots appear to have broad habitat preferences (Friend 2008, Jensen 2012, Richards 2012) and on Bernier and Dorre Islands they can be found in any habitat or landform including dunes, heathland and travertine limestone (Short *et al.* 1997, Short *et al.* 1998, Friend 2008). This diversity is also apparent in the other Shark Bay population on Faure Island, where they can be found in *Acacia* shrubland, saltbush and buffel-grass (*Cenchrus ciliaris*) dominated communities (Australian Wildlife Conservancy, *in litt.*). It has been suggested that Shark Bay bandicoots prefer dense cover and leaf litter that provide refuge from predators (Richards 2012). The impact of drought and rabbits (*Oryctolagus cuniculus*) on their preferred habitat were thought to be involved in the local extinction of the reintroduced population at Heirisson Prong (Short 2016). They are an omnivorous species with a diet of seeds, roots and herbs, invertebrates and small vertebrates (Visser 2000).

Shark Bay bandicoots are nocturnal and shelter in nests during the day in leaf litter or dead seagrass under shrubby or dead vegetation (Richards 2004, Friend 2008, Jensen 2012). They are generally solitary but males may share nests with females

during oestrous (Richards 2004) and females have also been observed sharing nests with young (Friend 2008). Home range size is highly variable between locations, but males generally have much larger home ranges than females (Richards 2004, Friend 2008, Jensen 2012). Home ranges can overlap considerably, including between the sexes, potentially indicative of a promiscuous mating system (Jensen 2012). Longevity in the wild has been found to be up to four years (Friend 2008), increasing to eight in captivity (Richards 2012). Breeding in Shark Bay appears to coincide with periods of peak rainfall (March to November; Short *et al.* (1998), Friend (2008)). Gestation is very short (12.5 days; Richards (2012) and the mean litter size is 1.8 (1-3) which increases with the size of the mother. Young leave the pouch at around 60-70 days and are weaned at around 1-2 weeks (around 100g). Sexual maturity is reached at 3-5 and 4-6 months in females and males respectively (Short *et al.* 1998).

As with the rufous hare-wallaby, non-native predators are a key threat to the Shark Bay bandicoot and were implicated in their extirpation at Heirisson Prong (Woinarski *et al.* 2014, Short 2016). Subfossil remains of Shark Bay bandicoots were found on DHI by Baynes (1990), indicating their previous existence there and predation by cats may have directly contributed to their extinction on the island. However, another potential threat to this species is the pathogen Bandicoot Papillomatosis Carcinomatosis Virus 1 (BPCV1), which has been infecting the Shark Bay bandicoot for millions of years (Bennett *et al.* 2008). The disease usually manifests in the development of papilloma and carcinoma on the head, limbs and genital areas and is usually fatal, although this is mainly through secondary causes (e.g. starvation, predation or infection) (Woolford *et al.* 2009). BPCV1 is species-specific and has not been shown to have infected any other species. To date infected Shark Bay bandicoots have only been recorded on Bernier Island (or captive animals sourced from Bernier); there are no recorded infections on Dorre Island. However, Shark Bay bandicoots have amongst the lowest genetic diversity found in Australian marsupials (Smith and Hughes 2007), which may also contribute to their susceptibility to BPCV1 (Woolford *et al.* 2009). The admixture of Bernier and Dorre populations in new translocated populations, to maximise the available diversity (as has been achieved at Arid Recovery (White *et al.* 2018)), is a high priority.

1.2.3 Dibbler

The dibbler (*Parantechinus apicalis*) is a small (40-120g) dasyurid marsupial with silver-grey fur, a white ring around its eye and a short, hairy tail that tapers to a point. It is the only member of the genus *Parantechinus* and, despite some morphological similarities to other Australian dasyurids, it is most closely related to the *Myoictis* spp. dasyures of New Guinea (Westerman *et al.* 2016, Woolley 2019). It was once patchily distributed throughout the south-west of Western Australia from Shark Bay to Israelite Bay, with fossil remains also found on Eyre Peninsula in South Australia. Once thought to be extinct, it was rediscovered at Cheynes Beach near Albany in 1967 (Morcombe 1967) but its present-day distribution is currently confined to natural populations in the Fitzgerald River National Park and on Boullanger and Whitlock Islands off Jurien Bay, both in Western Australia (Woolley 2008). In addition, translocated populations have been successfully established on the south coast of WA at Peniup Nature Reserve

and Gunton Island in the Recherche Archipelago Nature Reserve, as well as Escape Island in Jurien Bay on the west coast. Dibblers are currently listed as Endangered under the EPBC Act (1999) and IUCN criteria and under Schedule 2 of the Western Australian Wildlife Conservation (Specially Protected Fauna) Notice (2018).

Dibblers are crepuscular, being active mainly at dawn and dusk (Moro 2003). Habitat on the Jurien Bay islands varies between islands, but dibblers can be found in heathland, scrubland (including that dominated by *Nitraria billardierei*) and sedge (*Lepidosperma gladiatum*) thickets (Bencini *et al.* 2001). Dibblers will forage both on the ground and in shrubs (Lambert and Mills 2006) and there are examples of dibblers being observed foraging on *Banksia media* flowers (Hartley and Cowen 2005), including the capture of an individual on a *Banksia attenuata* flower resulting in the species' rediscovery (Morcombe 1967). Dibblers have been shown to have a generalist diet. On the Jurien Bay islands, their diet largely consists of invertebrates, particularly arthropods, across a range of orders. However, they will also feed on berries (e.g. *Rhagodia baccata*) when available and up to 40% of dibbler scat may comprise vegetable matter. There is limited evidence that dibblers prey on other small mammals, for example the house mouse (*Mus musculus*) in Jurien Bay (Dickman 1986, Bencini *et al.* 2001, Miller *et al.* 2003).

Female dibblers are monoestrous and generally come into oestrous in autumn (March-April; Mills and Bencini (2000)) with young being weaned at 16-18 weeks. Gestation in Jurien Bay is 38 days but on the mainland is significantly longer at 45 days (Mills *et al.* 2012). Semelparity has been observed in male dibblers, as it has in some other smaller dasyurids (Dickman and Braithwaite 1992). However, such events appear to be facultative and dependent on resource availability and so far have only been observed in one population (Boullanger Island; Mills and Bencini (2000), Mills *et al.* (2012)). Dibblers from populations on the Jurien Bay islands are approximately 40% smaller than mainland individuals. The island populations exhibit lower genetic diversity and higher levels of inbreeding than mainland populations (Mills *et al.* 2004) and high differentiation between islands (Aisya 2018). There is recent evidence of a population bottleneck on Boullanger Island but not Whitlock, which may reflect the facultative male die-off that has been observed on the former but not the latter (Mills *et al.* 2004).

2 Methods

2.1 Translocation proposals

The translocation proposal for the rufous hare-wallaby was approved in August 2017; the Shark Bay Bandicoot and dibbler translocation proposals were both approved in August 2019. Animal Ethics applications were approved for the rufous hare-wallaby translocation in August 2018 (AEC 2018/14A), Shark Bay bandicoots in August 2019 (AEC 2019/23) and dibblers also in August 2019 (AEC 2018/44G). Success criteria listed under the translocation proposals for the species can be found in Appendix 6.1.

2.2 Timeline

Source population monitoring of rufous hare-wallabies and Shark Bay bandicoots on Bernier and Dorre Islands took place in March and April 2019 (Sims *et al.* 2020).

The timing of the translocations of bandicoots and hare-wallabies were set for early spring, as this was the best compromise between when sea conditions and wind strength/directions were most favourable to work on the eastern side of Bernier and Dorre Islands, and when environmental temperatures were still mild enough to avoid excessive physiological stress for translocated animals. The former was an important safety consideration for vessel-based capture teams. The translocation of dibblers was not dependent on weather, but rather when young, captive-bred at Perth Zoo, were mature enough for release, which was predicted to be early October.

The translocation of these two species commenced on 27 August 2019 with the first capture of Shark Bay bandicoots from Dorre Island, followed by captures each night between 28 August to 1 September 2019. Bernier Island captures took place on 2 and between 10 to 13 September 2019. This translocation was followed by a two-month period of intensive ground monitoring of Shark Bay bandicoots only. Twelve radio-collars were deployed on release and removed by 16 October 2019. Two trapping grids were established for monitoring purposes in the release areas and were implemented in November 2019 and March 2020.

Source population monitoring of dibbers took place on Boullanger and Whitlock Islands in Jurien Bay in May and October 2019 (Sims *et al.* 2020). Additional animals were also collected from Boullanger Island to supplement the captive colony in October 2019. Translocation of dibblers from the captive colony at Perth Zoo (comprising Escape and Whitlock Island animals) occurred on 7 October 2019. Intensive ground monitoring by radio-tracking occurred for the first ten days post release. Two trapping grids were established for monitoring purposes in the release area and implemented in November 2019 and a camera grid was established over the release sites (see 2.5.5).

The Gantt chart in Figure 3 shows the relative timing of monitoring and translocation activities.

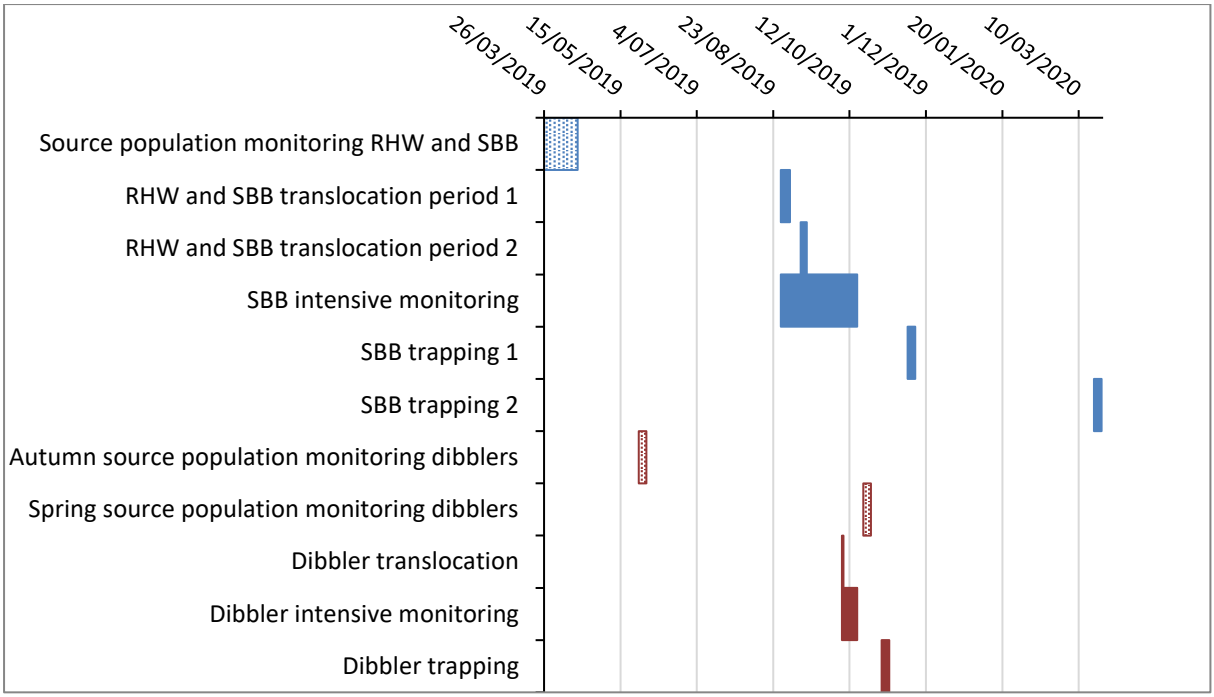


Figure 3. *Timeline of activities for translocation of rufous hare-wallabies (RHW), Shark Bay bandicoots (SBB) and dibblers between March 2019 and March 2020*

2.3 Translocation site selection

Selection of translocation sites on DHI was based on availability and condition of suitable habitat and proximity to the operations base (i.e. Herald Bay). Habitat suitability involved an assessment of the vegetation as both a food source and refuge for all species. Specific features that were considered include:

1. For grazing rufous hare-wallabies, important shelter includes *Triodia* hummocks, and small, dense stands of *Thryptomene, Beaufortia* and *Melaleuca* species.
2. For omnivorous Shark Bay bandicoots and dibblers that consume a large portion of ground-dwelling invertebrates, release sites needed to have substantial (deep) leaf litter. Shark Bay bandicoots also refuge in leaf litter. Dibbler release sites were, in particular, selected based on their similarity to sites shown to have high biomass of invertebrate prey (John 2018), i.e. presence of dense cover and abundant leaf-litter.

Inspections of release sites were completed in March 2019 with two general areas selected: Quoin Bluff (south and east of the Herald Bay Operations base) and the weather station (west of Herald Bay). Exact release locations within these areas were selected on a daily basis resulting in 19 release points for rufous hare-wallabies, 23 release points for Shark Bay bandicoots and two release points for dibblers (Figure 8).

2.4 Capture, transport and release

2.4.1 Rufous hare-wallabies and Shark Bay bandicoots

2.4.1.1 Capture on Bernier and Dorre Islands

Spotlights and hand-nets as per the DBCA standard operating procedure (SOP) Hand capture of wildlife (Department of Biodiversity Conservation and Attractions 2017) were used to capture all rufous hare-wallabies and most Shark Bay bandicoots from Bernier and Dorre Islands. Hand-netting required a team of six, with one member to locate target animals in the beam of a 35W spotlight, one to carry field-processing equipment and three to four others with hand-nets to catch the animal. Chases were minimised to <100m to mitigate risk of capture myopathy (Paterson 2007). Live-capture traps are not appropriate for trap-shy hare-wallabies (Richards *et al.* 2001). However, box (Elliott) traps baited with “universal bait” (peanut butter and oats) were employed for Shark Bay bandicoots in addition to hand netting.

Once animals were captured, they were immediately assessed for suitability for translocation, considering sex, age, weight, body condition and breeding status (i.e. presence and size of pouch young or young-at-foot). All Shark Bay bandicoots were also closely inspected for signs and symptoms (i.e. warts, lesions or other abnormalities) of BPCV1 (and other diseases such as chlamydia, identified as risks in Vaughan-Higgins *et al.* (*in review*)), with any symptomatic animals omitted from translocation and released at their point of capture. Lesions of potentially symptomatic animals were swabbed and sent off for testing. Animals deemed suitable for translocation were weighed and had Passive Integrated Transponders (PIT), (Allflex ™ FDX-B Microchip, ca.11 x 3mm and Global Ident ™ Microchip, ca. 12 x 2.1mm) inserted at the rear of the neck.

To mitigate the risk of capture myopathy in the rufous hare-wallabies, individuals selected for translocation were treated with selenium/vitamin E (0.2ml/kg). Selenium and vitamin E are thought to play a role in reducing the likelihood of capture myopathy, particularly if the animal is likely to be subject to further stress. In addition, some hare-wallabies were sedated using diazepam (1.0mg/kg) and azaperone (2mg/kg) to maintain the animal in a calm state during transport and handling. While sedation with diazepam only lasts a few hours, azaperone sedation may last up to eight hours. However, the effect of azaperone sedation is more predictable if diazepam is administered prior. Handling was kept to minimum under all circumstances, since this is another stressor that may potentially exacerbate the risk of capture myopathy in rufous hare-wallabies (Paterson 2007). To minimise fluid loss (often resulting from stress in the form of hypersalivation) during the holding period, some hare-wallabies received atropine (0.04-0.05mg/kg) upon capture.

Females with pouch young were selected for translocation only if the crown-rump length of the pouch young was ≤60mm (rufous hare-wallabies) or ≤15mm (Shark Bay bandicoots). Females with pouch young larger than 20mm (rufous hare-wallabies) or 12mm (Shark Bay bandicoots) crown-rump length had their pouches secured with Fixomull® tape (BSN medical, Hamburg Germany) (as per DBCA SOP: Care of Evicted Pouch Young (Department of Biodiversity Conservation and Attractions 2017).

2.4.1.2 *Transfer and holding procedure*

After capture, animals selected for translocation were held in a dark cotton bag inside a pet-pack (PP30 62 x 43 x 45 cm) and then transferred by Robinson R-44 helicopter to Dirk Hartog Island. Whilst every attempt was made to minimise noise during transport, it was impossible to eliminate all noise. Hence sedation of the hare-wallabies was vital to minimise stress levels during transport. Transfer time to Dirk Hartog Island was 20-30 minutes. Time in transit is linked to levels of chronic stress in translocated wildlife, necessitating the most direct means of transport possible (Dickens *et al.* 2010).

On arrival at Dirk Hartog Island, all animals were re-weighed and morphometric measurements taken. Small punches of ear-tissue were collected for subsequent DNA analysis and radio-telemetry collars were fitted to twelve Shark Bay bandicoots. Animals were selected for collaring based on weight (≥200g) and reproductive status (only females with inactive pouches). RI-2DM transmitters (Holohil Systems, Carp, Ontario) with 5 months battery life at a pulse rate of 60bpm (80bpm mortality), weighing 7.5g were fitted to animals under general anaesthesia. This step was taken to ensure that the correct collar fit was obtained (Sims *et al.* in press), as previous efforts collaring this species have resulted in adverse outcomes including entanglement and neck ulceration (Moseby 2001, Richards and Short 2003, Moseby *et al.* 2018). The collar design consisted of a natural cotton embroidery thread inside clear, soft silicon tubing (2.5mm inner diameter) with the thread, designed as a weak link to allow eventual collar drop should animals fail to be recaptured for collar removal.

General anaesthesia was administered via a table mount Advanced Anaesthesia Specialists Stinger™ anaesthetic machine with low flow vapourisor and Darvall NRB (non-rebreathing) zero dead space (ZDS) mask and T-circuit. Induction was by mask using oxygen and isoflurane at 3-5% and maintained at 1-2%, with an oxygen flow rate of 2L/minute, for a duration of 6-25min. Once animals had been fully processed, they were again held in a cool, quiet area in clean dark cotton bags until after sunset.

Collars were not fitted to rufous hare-wallabies, as information collected from radio-telemetry in 2017/18 indicated a high likelihood of survivorship.

2.4.1.3 *Release procedure*

Animals were transported in pet-packs by vehicle and released after dark at designated release sites. Prior to release, Shark Bay bandicoots were checked again for collar-fit and to ensure fore-limbs were not caught. Animals were observed at the time of release to ensure they had not sustained any injuries during translocation or displayed signs of incapacitation. Once this was established, staff and volunteers departed the area calmly and quietly to minimise additional disturbance to the animals.

Females with pouch young were released in their holding bags away from people and other animals with strings loosened off to allow them to depart when ready (‘soft-release’). Pouches were taped to prevent pouch young being ejected as part of a fear ‘flight’ response by the female. These bags were checked collected the following day.

2.4.2 Dibblers

2.4.2.1 Captive-breeding

Eight pairs of dibblers were available for the 2019 breeding season. Four females failed to produce offspring without any clear reason (Mantellato and Lambert 2019). Three of these were from Whitlock Island but three of the four males that did breed were also from Whitlock. One female may have been greater than two years old which may explain why she did not produce young.

The remaining four females produced a total of 28 young between 16 and 27 April 2019 (Table 1), with three females producing full litters of eight young. Of these, 24 offspring were made available for release on DHI, with four held back for inclusion in the 2020 breeding program. Two adults previously used in the breeding program were also included in the cohort for translocation, with an equal sex ratio of 13 males and females.

Table 1. Summary of successful pairings and resulting offspring from dibbler captive-breeding program at Perth Zoo (from Mantellato and Lambert (2019)).

Litter No.	Pairing	Origin	Total offspring	Total for release
1	M – 1166 or 1170 F – 1176	Whitlock x Whitlock	4	4
2	M – 1164 F – 1177	Whitlock x Escape	8	7
3	M – 1168 F – 1178	Whitlock x Escape	8	7
4	M – 1179 F – 1180	Escape x Escape	8	6

2.4.2.2 Radio-collaring

Ten dibblers were fitted with radio-collars while still in captivity at Perth Zoo, three days prior to translocation to DHI. This allowed for animals to be observed and checked while wearing the collars, to confirm suitability and fit. Pip3 transmitters (Lotek Wireless, Newmarket, Ontario) with four weeks battery life and no mortality option, weighing 0.8g were fitted to conscious animals. Collared animals were checked for adverse occurrences (e.g. entanglement, rubbing) daily by zoo staff until they were translocated, with those that were having an adverse impact on the animal being removed.

2.4.2.3 Transfer and holding procedures

Dibblers were caught by Perth Zoo staff and examined on the morning of the translocation to confirm that they were fit for translocation. Dibblers ready for transport were placed individually into Elliott traps containing shredded paper, and these placed into pet-packs, with nine traps in each. Pet-packs were transferred to Jandakot Airport

via air-conditioned vehicle (30 minutes), flown to Denham by Beechcraft Bonanza fixed-wing light aircraft (three hours) and finally flown to DHI by Robinson R-44 helicopter (15 minutes), arriving mid-afternoon. A helicopter transfer to the island, as opposed to light aircraft, was chosen to allow direct delivery to the operations base.

Once dibblers arrived on DHI, they were examined to confirm general health status and the six radio-collared animals checked for any adverse occurrences. Any collars that were ill-fitting were adjusted: none required removal due to adverse impact on the animal. Once animals had been checked, they were returned to their Elliott trap and held in a cool, quiet location until release.

2.4.2.4 Release procedure

Dibblers were transported to pre-designated release sites (see section 2.3) in 4WD vehicles and were released approximately half an hour before sunset. The rest of the release procedure was as for hare-wallabies and bandicoots (see 2.4.1.3).

2.5 Post-release monitoring

2.5.1 Ground radio-tracking

The primary method of post-release monitoring of Shark Bay bandicoots and dibblers was regular ground tracking of radio-telemetry collars (radio-tracking). The main objective was to determine survivorship of animals with collars, as an indication of overall survivorship. The importance of determining survivorship and the cause of any mortalities is outlined in previous reports (e.g. Cowen *et al.* (2019)). This was relatively straightforward for Shark Bay bandicoots, as the collars were fitted with a mortality sensor. If a collar was detected in mortality mode, staff would locate the collar and retrieve either the slipped collar or the carcass as quickly as possible. Dibbler collars were not fitted with a mortality sensor (due to the additional weight of these components) and confirmation that the animals were still alive relied on checking that individuals were moving locations daily. If collars were tracked to the same location on two consecutive days, a careful inspection of the refuge was completed to determine if the animal was deceased or not. Radio-tracking was carried out almost daily (except for one weekend (per species) during staff changeovers) from the first day after release until collars were removed.

A secondary aim of radio-tracking was to collect data on behaviour, movement and habitat use. Shark Bay bandicoots and dibblers were radio-tracked to their refuges every other day, to determine if the release sites selected were indeed suitable for these species. Radio-collars were intended to remain on Shark Bay bandicoots for five to six weeks following release, with a check-up at two weeks; and removal of dibbler collars was planned for three weeks post release (Figure 3).

2.5.2 Aerial radio-tracking

For the purpose of locating animals that could not be found using ground radio-tracking, we chartered a Cessna 172 fixed-wing light aircraft and fitted telemetry antennas underneath both wings (CASA engineering order number EO TDE5788-01-R1). The aerial search pattern consisted of flying east-west transects at 2km intervals, then once a signal was detected the location of the collar was homed in on by alternating between right and left antennas until the signal reached a null (as outlined by Seddon and Maloney (2004)), the location was recorded using a GPS unit.

2.5.3 Radio-collar checks and removal

Shark Bay bandicoots were captured for collar checks and collar removal using similar methods as employed for hare-wallabies (Cowen *et al.* 2019). Refuges were located during daylight hours and fenced off using soft 'cat netting' mesh (Diamond Networks, Kardinya, WA) and light-weight plant stakes (Figure 4). The animal was left in-situ until last light when the following capture techniques were attempted preferentially in the order listed:

1. The animal was removed by hand directly from its nest and transferred into a handling bag; or
2. The animal was purposefully flushed directly from its nest into a hand net; or
3. If the animal had already emerged from its nest or was flushed from it, the animal was hand captured using the mesh fencing with which to envelop and restrain it.

Figure 4. Soft 'cat-netting' fence used to facilitate captures of Shark Bay bandicoots from their refuge or nest (© K. Rayner/DBCA).

On nights when captures of multiple animals were attempted, two cage (Sheffield) traps baited with universal bait were set within selected fenced areas immediately prior to sunset. These were then checked once captures of other animals had been attempted. The combination of techniques helped to increase capture efficiency, and thereby kept stress levels to a minimum.

Once animals were captured, they were weighed, examined for signs of BPCV1 and females were checked for pouch condition. The fit of the collar was checked, as was the condition of the skin around the neck and other areas associated with the transmitter. Collars were only left on the animal if the fit of the collar was still appropriate and there was no open skin or swelling. Otherwise, the collar was removed, and any open wounds were treated with antiseptic ointment. Collars were removed by carefully cutting through the string that formed the collar band. Once the animal was processed, the fence was removed and the animal released at the point of capture.

2.5.4 Trapping

2.5.4.1 Shark Bay bandicoots

One 50m trapping grid and one transect was established at each of the two main Shark Bay bandicoot release areas for monitoring purposes (Figure 5). The grid at the weather station was set up in a six by six configuration (36 trap points) and the second grid was set up in a five by six configuration (30 trap points). Transects at both sites consisted of ten traps at 50m intervals. Both grids were first run for four nights from 19 November 2019 using a single Elliott trap at each point. Grids were opened again for the same period in March 2020, with a Sheffield trap added to each trap point. In addition, this second trapping session was immediately preceded by three nights of pre-baiting; cage traps were wired open and rebaited daily.

Trapped Shark Bay bandicoots were first checked for PITs; any new animals were implanted with a PIT and tissue was taken. Animals were weighed, morphometrics measured (head length and long pes), body and pouch condition recorded. All animals were also examined for signs of BPCV1. All processing equipment and hands of handlers were cleaned with F10 (F10 Products, Loughborough, England) after bandicoots were processed and released. Any by-catch (non-target species) was temporarily marked with black marker at the base of the tail (mammals) or abdomen (reptiles). All animals trapped were released at the point of capture once processing was complete.

2.5.4.2 Dibblers

Two trapping grids, 400m apart, were established in the dibbler release area for monitoring purposes (Figure 5). Both grids consisted of six transects at 100m spacings, each with ten trap points at 50m intervals (60 trap points). These grids were open concurrently, for four consecutive nights from 2 November 2019. Two Elliott traps were set at each trap point, baited with universal bait. Trapped dibblers were first checked for PITs, animals were then weighed, tail width measured (as an indication

of body condition) and pouch condition of females inspected (to confirm age as opposed to reproductive status). Any by-catch from these sessions was temporarily marked and released as above.

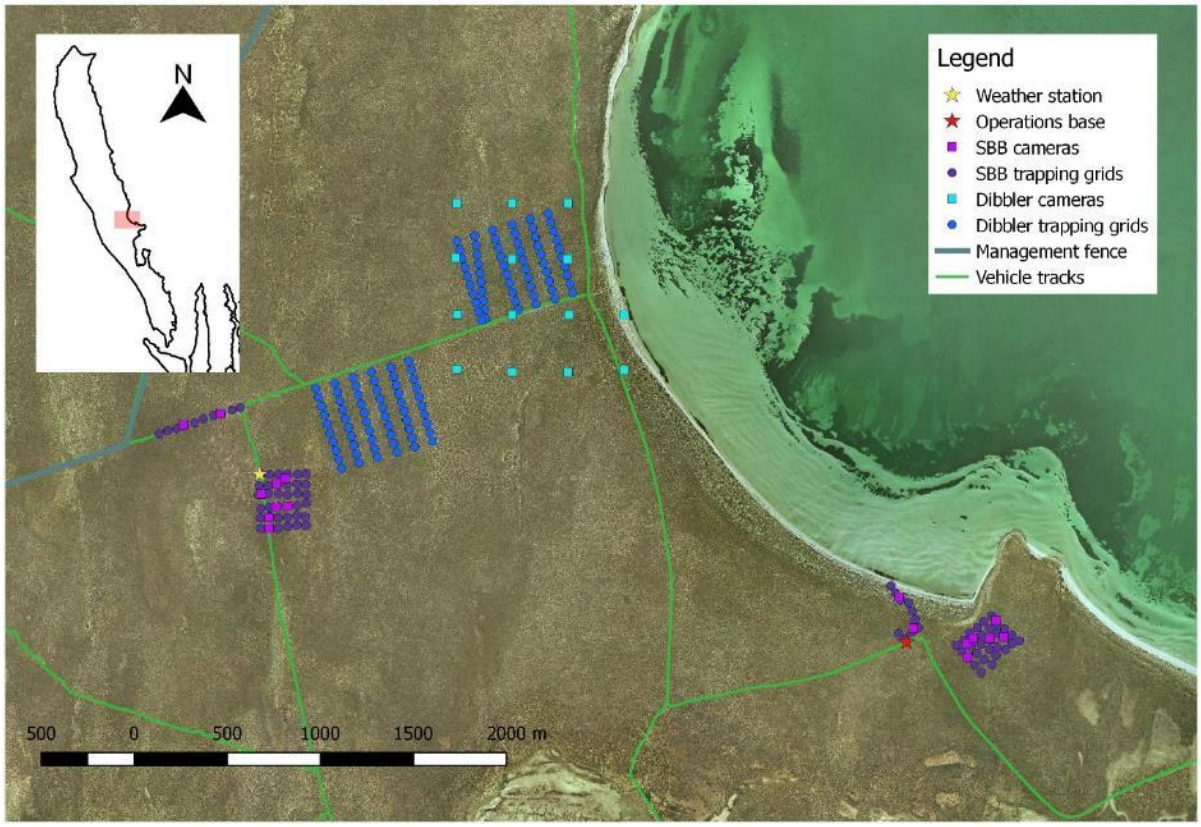


Figure 5. Map of camera and trapping grid locations in Herald Bay area at Shark Bay bandicoot and dibbler release areas.

2.5.5 Remote cameras

Establishing a long-term monitoring protocol for all species translocated to DHI is a high priority for the project. Since not all species have a propensity to enter live-capture traps, equipment such as remote cameras presents a potentially valuable monitoring tool for species that are difficult to trap and may be relatively economical compared to other techniques such as conducting spotlighting or scat/track surveys (Bondi *et al.* 2010). A passive (i.e. no lure) remote camera grid (32 cameras on a 2 km grid) employed in 2017 and 2018 (Cowen *et al.* 2018, Cowen *et al.* 2019) was maintained until November 2019, when cameras were collected. Camera images were downloaded, databased and prepared for additional analysis in CPW Photo Warehouse (Colorado Parks and Wildlife). The analysis of detection rates and counts across camera sites was conducted in R (R Core Development Team) using an online application developed by M. Cowan (DBCA).

Grid arrays were also established at both Shark Bay bandicoot and dibbler release sites (Figure 5). Eight cameras were placed at randomly selected sites within the

trapping grids established at each of the bandicoot release sites. These cameras were also passive. The dibbler grid array comprise 12 cameras spaced 300m apart (Figure 5) in the vicinity of their release sites (Figure 8). These cameras were lured with "universal bait" (a mixture of peanut butter, oats and sardines) held within perforated PVC pipes positioned 1.5m from the camera.

2.5.6 Hare-wallaby faecal DNA monitoring

In 2018, an experiment to test the feasibility of extracting DNA from hare-wallaby faecal pellets (scats) for monitoring purposes was undertaken, including a trial to quantify the rate of DNA degradation in ambient environmental conditions on DHI (Cowen *et al.* 2019). Results of this study, combined with a parallel study undertaken by the Australian Wildlife Conservancy at their Mt Gibson sanctuary, have shown that obtaining DNA from hare-wallaby scats (up to 21 days) is a promising monitoring alternative to other non-invasive methods such as cameras or spotlighting, and is the subject of a manuscript currently being prepared for peer review (Cowen *et al. in prep.).*

A pilot study was conducted in November 2019 to collect scat samples for DNA analysis from the newly translocated populations of banded and rufous hare-wallabies on DHI to estimate population size using a spatially explicit capture-recapture (SECR) modelling framework (Mills *et al.* 2000, Lukacs and Burnham 2005, Piggott *et al.* 2006, Goode *et al.* 2014, Fuller *et al.* 2016, Morin *et al.* 2016, Woodruff *et al.* 2016, Dziminski and Carpenter 2018). Faecal DNA is potentially a highly cost-effective non-invasive monitoring method for hare-wallabies, since each time a hare-wallaby scat is collected and an individual identity assigned, this represents a single 'trapping' event for an otherwise hard-to-capture species.

A study area of approximately 2.5km^2 was established in the vicinity of release sites for hare-wallabies in the southern-most section of the island, where both species were regularly recorded either on camera or when radio-tracking collared individuals in 2017 and 2018. Fifteen 1.5km transects were designed in Quantum GIS (version 2.18 Las Palmas) and ran east-west each 100m apart, which was predicted to be close enough so that the home range of a hare-wallaby would encompass multiple transects (based on results of modelling done in Cowen *et al.* (2019)). In a SECR-based approach, the survey design should aim to maximise the number of times the same individual is 'trapped' at different locations. Each 1.5km transect was walked in pairs and any fresh scat collected was placed in sample vials containing cotton wool and silica gel desiccant. Scat was assessed as 'fresh' if it still retained a glossy surface (Figure 6a). Less fresh but still intact pellets were also collected (Figure 6b) but any pellets showing sign of loss of integrity and desiccation were rejected (Figure 6c). Collection locations were recorded on a handheld GPS and a waypoint noted on a datasheet.

a) b) c)

Figure 6. Three hare-wallaby faecal pellets of different ages: a) fresh; glossy b) moderately fresh; intact but no gloss c) old, desiccated; losing integrity.

Scats were at -20°C until transfer to the DBCA genetics laboratory at Kensington. DNA was extracted from the scat firstly by scraping the outer surface of the pellet into SLP buffer and centrifuging at 11,000rpm for two minutes to separate coarse material from DNA contained in surface cells. Approximately 300µl of supernatant was extracted using the Omega Bio-tek 96 Mag-Bind® Stool DNA 96 Kit following the manufacturer's instructions. DNA was eluted in 100µl of TE buffer.

As hare-wallaby scats were not able to be identified to species based on appearance, species identification was achieved by screening samples using three microsatellite markers (Me4, Pa593, Y105) that showed consistent size differences between hare-wallaby species. Once scats were identified to species, individual genotypes were determined by polymerase chain reaction (PCR) using 11 microsatellite markers for rufous hare-wallaby samples and 15 microsatellite markers for banded hare-wallaby samples. Rufous hare-wallaby microsatellite multiplexes contained 5 novel species-specific microsatellites (RHW12, RHW10, RHW18, RHW09, RHW24; unpublished data) and 6 microsatellite markers that have previously been cross-transferred from banded hare-wallaby and other macropod species (BHW37, Pa593, Me14, Y105, Me17, Y148). Similarly, banded hare-wallaby multiplexes consisted of 9 novel species-specific primers (BHW01, BHW09, BHW22, BHW36, BHW07, BHW14, BHW19, BHW24, BHW48) and 6 markers cross-transferred (Pa593, Me14, Y105, Pa297, Y148, Y175; detail in Cowen et al. *in prep.*). Samples were amplified using the Qiagen Multiplex PCR Plus Kit (Qiagen Inc, Germany) in 9µl reactions containing 4 µl Qiagen MasterMix, 1µl 2µM primer mix and 4µl scat DNA. Reactions were performed on an Eppendorf Mastercycler using PCR cycling conditions recommended by the manufacturer. Fragment analysis was performed on an ABI 3730XL using a commercial service at the State Agricultural Biotechnology Centre, Murdoch University. Microsatellite genotypes were scored using GENEMAPPER software (v6, Applied Biosystems). Allele size was determined by co-running a Genescan500 standard (Applied Biosystems, Melbourne).

2.5.7 Monitoring of small vertebrates

From 2017-19, surveys were undertaken each year at eight sites across DHI (Figure 7) to monitor diversity and abundance of small vertebrates that were extant on the island prior to reintroductions commencing in 2017. The sites used were established by Shark Bay District in 2005 to monitor small vertebrate fauna and sampled for six years. These now represent a valuable baseline to assess the effect of eradications of sheep, goats and cats and the subsequent reintroductions of locally extinct species.

The trapping methodology consisted of two parallel lines of six pitfall traps (three buckets, three PVC pipes) with a 'drift-fence' made of fly-wire mesh running between the pits. Each drift-fence had two pairs of funnel traps, covered by hessian sacks. Two lines of six Elliott traps were also deployed in the vicinity of each pit-line. The base of the pits were filled with c.2cm of sand for fossorial reptiles (e.g. *Lerista* spp.) to shelter in and other material (e.g. egg-boxes, meat trays, vegetation) was also supplied in each pit to shelter non-fossorial species. In 2019, an extra trial site was established (with just one line each of pits and Elliott traps) to include a *Triodia* spinifex community not adequately sampled by any of the other eight sites.

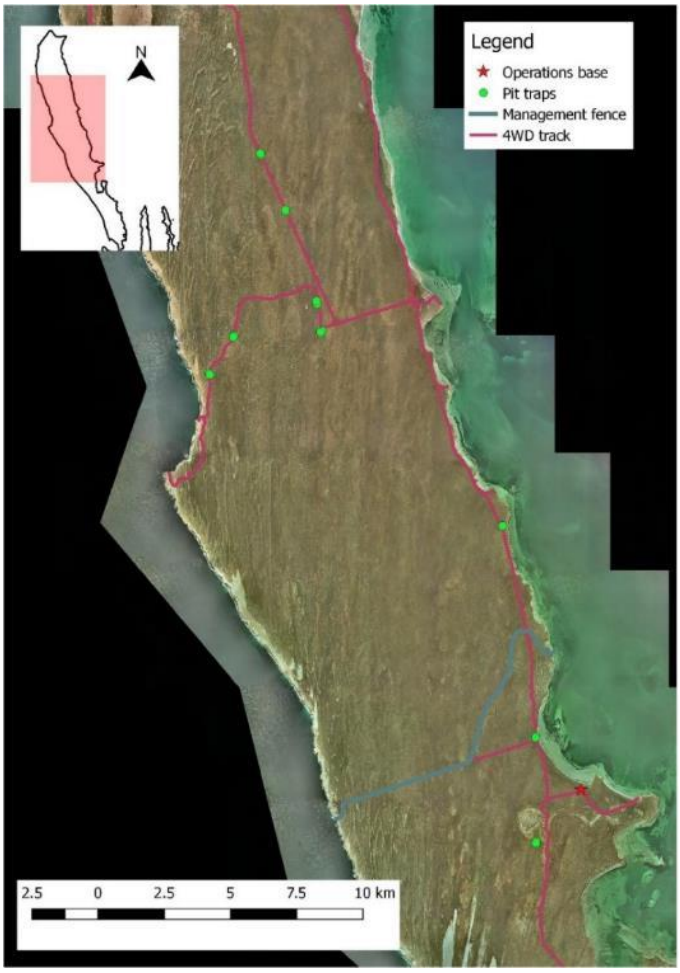


Figure 7. Map of small vertebrate monitoring site locations on Dirk Hartog Island.

Traps were checked once daily within 3-4 hrs after sunrise for seven nights in mid- to late October. The relatively cool temperatures at this time of year allowed checking

only once a day without risk to diurnal species that may be captured between checks. Captures were weighed, measured and, if required, a tissue sample taken for subsequent lodging at the Western Australian Museum. All animals were temporarily marked, usually with a non-xylene marker pen (on ventral surface of reptiles, on base of tail for small mammals), although some species (e.g. bobtails (*Tiliqua rugosa*) and some snakes) were marked through scale-clip tissue sampling.

2.5.8 Scat and pellet collection for diet analysis

As in previous years, scats were collected and stored from processing bags (as per Cowen *et al.* (2019)) from both rufous hare-wallabies and Shark Bay bandicoots for use in future dietary analyses. Dibbler scat was not collected.

Pellets from raptor or owl roost sites continued to be collected, as were scat from sand monitors (*Varanus gouldii*). These samples were dried and stored (frozen) and will be used in future analyses to assess if diet in these predators changes over the course of the ecological restoration.

2.5.9 Monitoring of raptors and owls

As per the recommendations of the 2017-18 annual report (Cowen *et al.* 2018), monitoring of the presence of large carnivorous raptors was undertaken between August 2019 and March 2020. The presence of raptor species was recorded on a weekly basis over 12 survey weeks. Again the main species of interest were the wedge-tailed eagle and white-bellied sea-eagle (*Haliaeetus leucogaster*), which are both potential predators of hare-wallabies (Short and Turner 1992, Richards *et al.* 2001) and other species of medium-sized mammal. Other species of interest included black-shouldered kite (*Elanus axillaris*), spotted harrier (*Circus assimilis*), brown falcon (*Falco berigora*), eastern barn owl (*Tyto javanica*) and Australian boobook (*Ninox boobook*) as these species may all prey on small mammals. These were recorded on an ad-hoc basis as an increase in frequency of occurrence and abundance may potentially relate to the removal of cats and the presumably concomitant increase in populations of mammalian prey species.

2.5.10 Post-mortem of deceased mammals

In the case of any mortalities during the intensive post-release monitoring period, it was important that a post-mortem be carried out as soon as possible to establish the probable cause of death, especially if capture myopathy was suspected. The protocol for this is outlined in Cowen *et al.* (2018).

3 Results

3.1 Translocation and release

3.1.1 Rufous hare-wallabies

A total of 50 rufous hare-wallabies were captured and translocated from Bernier (*n* = 20) and Dorre (*n* = 30) between 28 August and 13 September 2019 (Table 2). Combined with translocations in 2017, there are now 53 individuals that have been translocated from Bernier and 59 from Dorre, representing close to 1:1 between the two islands (Cowen *et al.* 2018, Cowen *et al.* 2019). In 2019, the sex ratio was also equal and over the three years, 57 females and 55 males have been released (this includes the male that died four days post-release in 2017 from presumed capture myopathy). Fourteen females were translocated with small pouch young in 2019. Release sites for all species are shown in Figure 8.

*Table 2. Capture statistics for translocation of rufous hare-wallabies and Shark Bay bandicoots from Bernier and Dorre Islands to Dirk Hartog Island in Aug-Sep 2019 (NB: dates reflect captures occurring before and after midnight; NAR, Native Animal Rescue, Malaga, Perth; * figures include euthanised male Shark Bay bandicoot).*

		L. hirsutus			*P. bougainville*		
Capture date	Source	Female	Male	Total	Female	Male	Total
4 May (released 7 October)	Dorre (via NAR)	0	0	0	0	2	2
27-28 August	Dorre	0	0	0	5	4	9
28-29 August		3	5	8	2	4	6
29-30 August		0	0	0	3	7	10
30-31 August		7	5	12	9	3	12
31-1 September		3	2	5	2	3	5
1-2 September		2	3	5	4	4	8
	Dorre Total	**15**	**15**	**30**	**25**	**27**	**52**
2-3 September	Bernier	2	2	4	3	2*	5*
10-11 September		4	5	9	4	0	4
11-12 September		2	3	5	3	3	6
12-13 September		2	0	2	1	1	2
13-14 September		0	0	0	2	2	4
	Bernier Total	**10**	**10**	**20**	**13**	**8***	**21***
Total		**25**	**25**	**50**	**38**	**35***	**73***

One female hare-wallaby (DR12) was discovered to have a deceased and partially decomposed pouch young on arrival at DHI. The circumstances of this mortality are not known but it was recorded as live during initial processing on capture. It is likely to have occurred soon after this (due to the state of decomposition of the joey) and a result of an elevated stress response in the mother during capture, holding and transfer. The mother was in good body condition, weighing 2.2kg and recorded a

condition score of 4 (out of 5), but was suspected to have been suffering from a pouch infection as the pouch was moist with a brown discharge and malodorous. A single dose (30mg/kg) of long-acting antibiotics (procaine penicillin, 150 mg/mL; benzathine penicillin, 150 mg/mL; procaine hydrochloride, 20 mg/mL; (Troy Laboratories, Smithfield, NSW)) was given intramuscularly prior to soft release.

As in previous years, while every effort was made to minimise stress during the translocation, many animals exhibited some level of stress. One common indication of stress in rufous hare-wallabies is hypersalivation and some degree of salivation was noted in exactly half of individuals processed on DHI. Handling bags were often soaked with saliva and/or urine and one or two changes into fresh, dry bags were required during the course of the translocation. However, most animals remained calm and quiet up to and during release. No problems were noted at point of release, although some were slow to move away.

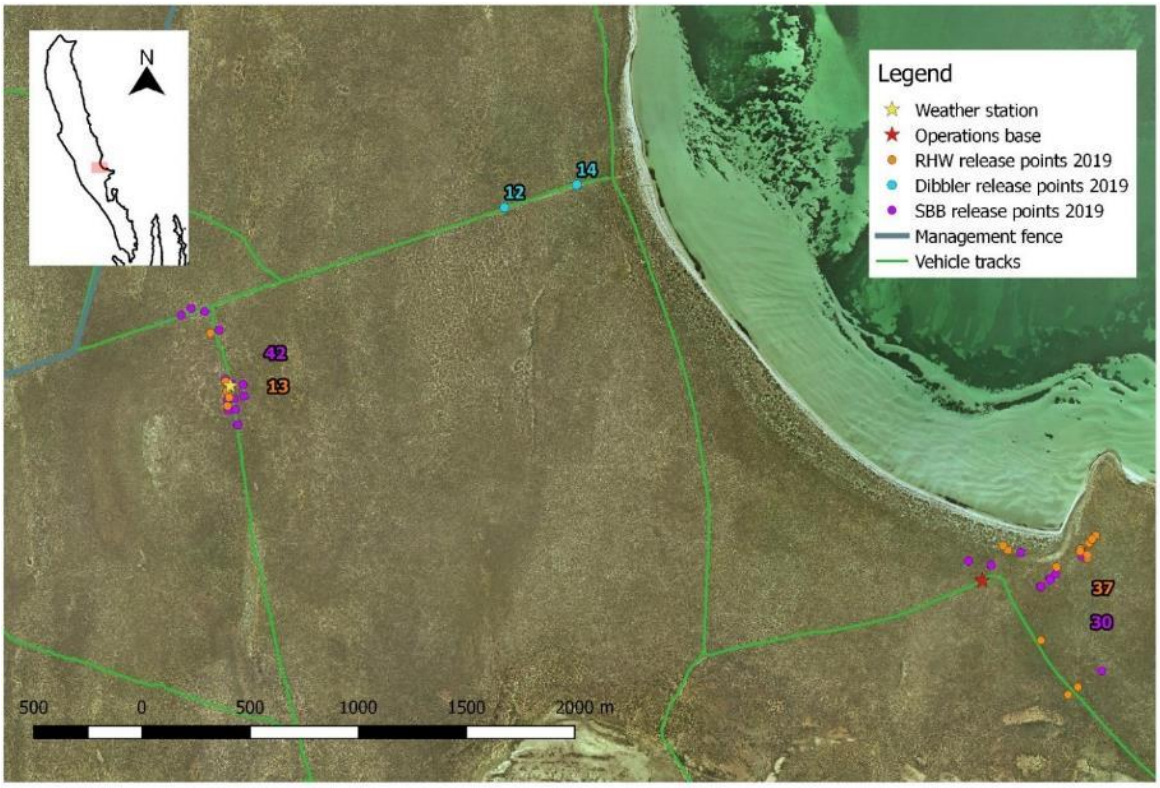


Figure 8. Map of release sites of rufous hare-wallabies, Shark Bay bandicoots and dibblers in spring 2019, showing numbers of animals released at each site.

In 2017, dramatic weight loss was observed in rufous hare-wallabies between capture and release with animals losing up to 18% of their body weight in c.12 hours (Cowen *et al.* 2018). This loss was attributed to manifestations of stress such as hypersalivation and excessive urination, leading to a substantial loss of fluid. Measures such as using a helicopter rather than a vessel to transfer animals and administration of atropine were employed, with some success. Figure 9 shows that since 2017, while some weight loss has been observed in 2018 and 2019, this was not significant.

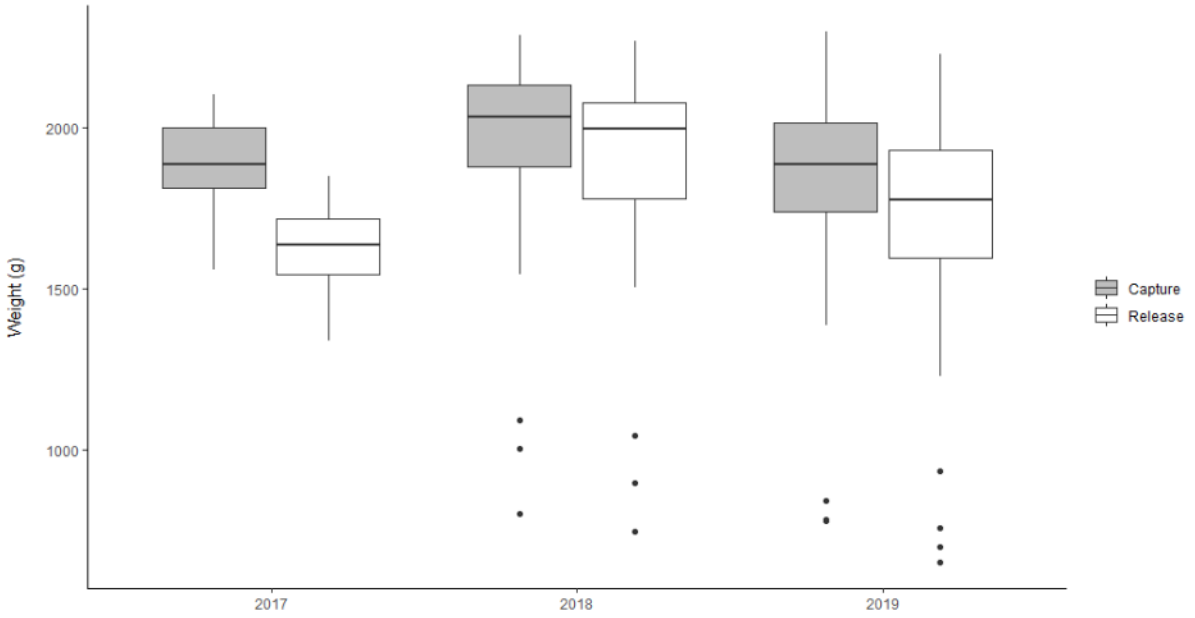


Figure 9. Median weights of rufous hare-wallabies at capture on Bernier/Dorre Islands and release on DHI in 2017 (n = 12), 2018 (n = 50) and 2019 (n = 50).

No mortalities of translocated hare-wallabies were recorded during the post-release period in 2019, as there was no direct monitoring of individuals. However, a deceased individual was discovered close to the Herald Bay camp in February 2020 (Figure 10). This animal was identified as DR12, the same female that was found with a deceased pouch young (see above). Examination of the teeth found that there was not a significant level of wear (as was observed in the deceased male rufous hare-wallaby in 2017 (Cowen *et al.* 2018)), indicating that this was not a particularly old individual. Signs of predation were visible on the carcass (Figure 10) but this was thought to be caused by scavenging activities of *V. gouldii* which were observed in the vicinity (S. Heriot *pers. comm.*). The cause of mortality remains unknown.

Figure 10. Deceased female rufous hare-wallaby (DR12) discovered near Herald Bay Camp in February 2020 (© S. Heriot/DBCA).

3.1.2 Shark Bay bandicoots

The translocation of Shark Bay bandicoots took place between 27 August and 14 September, with a total of 71 animals transferred from Bernier (*n* = 21) and Dorre (*n* = 50) Islands (Table 2). One animal from Bernier Island was euthanised without release (see below), leaving a total of 70 animals released onto DHI at this time. The sex ratio for Dorre was exactly 1:1 but 13 females were translocated from Bernier compared to eight males. Of the 38 females translocated, nine were carrying pouch young. Dorre animals were observed to be more reproductively active during the translocation (Sims *et al.* 2020). Prior to the translocation, two male Shark Bay bandicoots were captured on 4 May 2019 from Dorre Island for a trial of collar attachment methods in captivity (Sims *et al.* in review). These animals were released on 7 October with the cohort of dibblers from Perth Zoo, bringing the total translocated to 72 (Figure 8).

Eight out of 38 captures on Bernier were rejected for translocation due to lesions that were potentially symptomatic of BPCV1 and one animal was rejected from Dorre as a precaution due to presentation of a BPCV1-like lesion symptoms (later testing negative). Swabs were taken and subsequently only one individual tested positive for the virus, although it was suggested that another animal with substantial clinical signs was a false negative (Sims *et al.* 2020). A further 12 animals were rejected for other reasons, including old and recent eye injuries (relatively common finding in wild bandicoots that is likely due to trauma, but may also be related to chlamydia infections – no swabs were taken to screen for this) and large pouch young. Likewise, 43 out of 93 captures on Dorre were also rejected primarily due to reproductive condition of females (carrying large pouch young, or lactating) or young animals below designated minimum weight.

Despite meticulous screening of bandicoots at capture, one individual (male BS03) was found to have a well-defined and raised circular lesion on its left-hind footpad (Figure 11). The lesion itself was not roughened and there was no redness (erythema). The animal was deemed unsuitable for release but could not be returned to Bernier as the helicopter and capture team's vessel had both returned to Carnarvon by the time the wart was discovered. The bandicoot was euthanised following general anaesthetic with an intravascular pentobarbitone overdose, swabbed and necropsied on site in the field-laboratory at Herald Bay camp. Aside from a visibly heavy intestinal helminth infection, no other abnormalities were identifiable on necropsy. Analysis of swabs returned a negative result for BPCV1.

Minor weight loss of bandicoots was observed between capture and release, but this was not significant (Figure 12Figure 12. Median weights of Shark Bay bandicoots at capture on Bernier/Dorre Islands, release on DHI and subsequent recaptures (cohort sizes are shown on x axis).). However, significant weight gains were noted between release and recapture for collar removal, although this was a small cohort of the overall founder group. This weight gain was sustained and further increased by the time bandicoots were recaptured in March 2020.

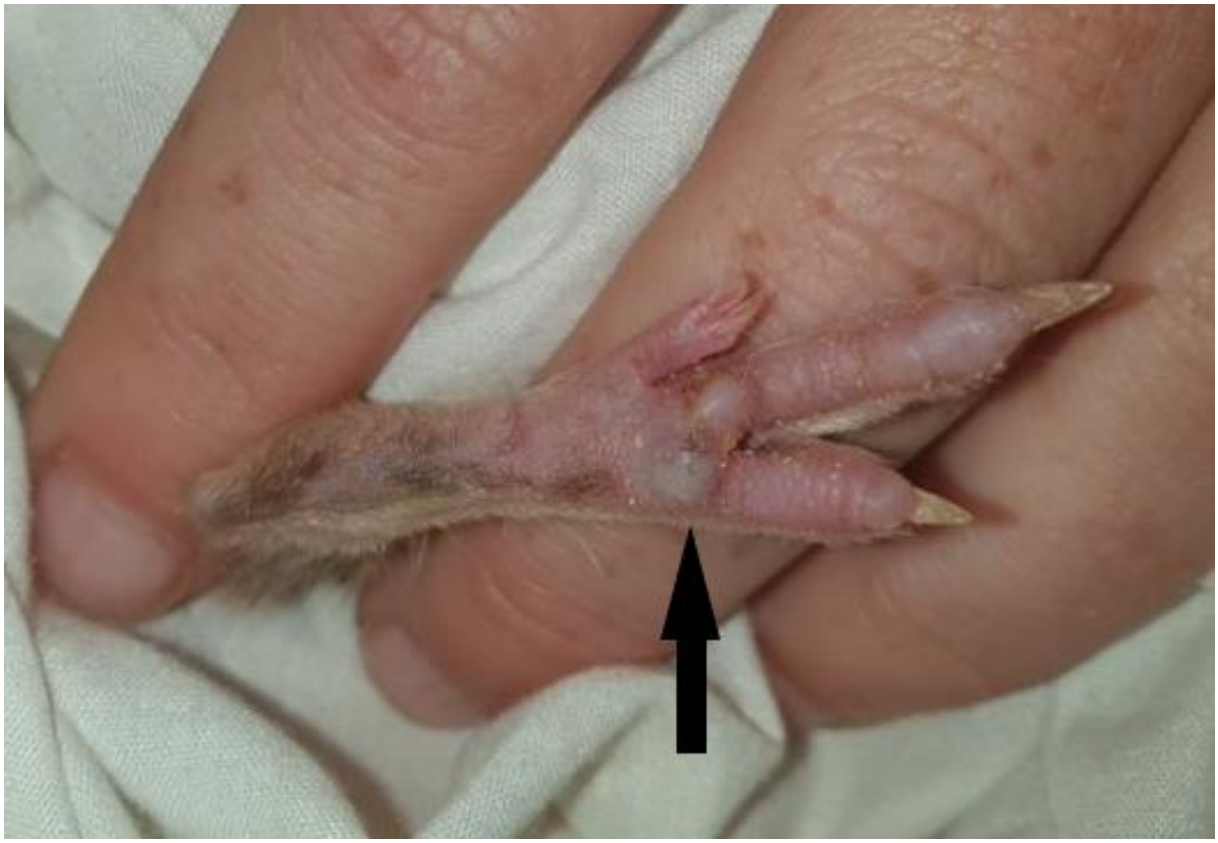


Figure 11. Lesion on left-hind footpad of Shark Bay bandicoot BS03 (© K. Rayner/DBCA).

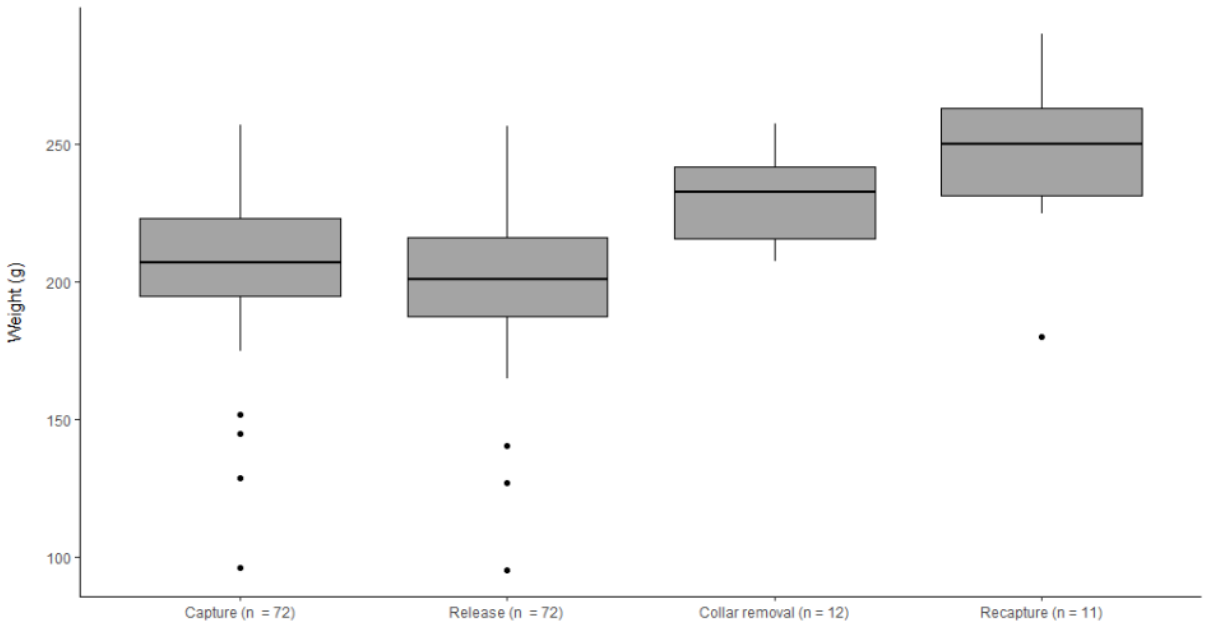


Figure 12. Median weights of Shark Bay bandicoots at capture on Bernier/Dorre Islands, release on DHI and subsequent recaptures (cohort sizes are shown on x axis).

3.1.3 Dibblers

A total of 26 dibblers were made available from the Perth Zoo breeding program, with 24 captive-bred offspring and two adults originally captured on Escape Island forming the cohort for release on DHI (Table 3). The sex ratio was 1:1. Following collar fitting at Perth Zoo on 4 October, four collars were removed due to chafing or because they were a poor fit. All animals were released on 7 October (Figure 8).

Table 3. Capture statistics for translocation of dibblers from captive-breeding program at Perth Zoo to Dirk Hartog Island on 7 October 2019 (PZ, Perth Zoo).

Capture date	Source	Female	Male	Total
24 February	Escape Island via PZ	1	1	2
n/a	Captive bred at PZ	12	12	24
Total		**13**	**13**	**26**

3.2 Monitoring

3.2.1 Radio-tracking and survivorship

3.2.1.1 Shark Bay bandicoots

The 12 collared Shark Bay bandicoots were tracked daily after release and most individuals were successfully relocated, with an average of 94.3% of collars being located each day. Approximately two weeks after release, each collared bandicoot was recaptured and collar and condition checked. The collar of one individual (male DS02) was found to be potentially causing abrasion (due to the coarse sandy substrate that the animal was digging in and getting under the collar) and a further check was scheduled two weeks later. At this check, it was found that due to sustained weight gain (+18g), the exposed portion of cotton thread was pressing into the animal's neck and causing an open sore to develop. The collar was removed and the planned removal of all collars brought forward by one week. One additional injury similar to DS02 was noted but no other collars were found to be causing problems. The average deployment for collars was 34 days, with most retrieved between 28 and 35 days (Table 4). One individual (DS40) could not be relocated on the scheduled recapture date. It was eventually relocated by aircraft (4km from its last location; Figure 13), recaptured and its collar removed 45 days post-release.

All collared bandicoots gained weight between capture and collar removal, with one animal achieving an increase of 50g (female DS36) (Table 4). The average gain for males was 15.6g but for females it was much higher at 31.9g. At least two females were reproductively active during the radio-tracking period, with small pouch young present at collar removal. All collared bandicoots survived the 4-7 weeks monitoring period and there was no evidence of mortalities.

Table 4. Results of recaptures of Shark Bay bandicoots in immediate post-release monitoring period (Aug-Oct 2019) and in trapping session in March 2020 (NB. weight change is from release to last time captured; PY, pouch young; RT, regressing teat).

Animal ID	Sex	Release date	Last recorded alive	Collared (Y/N)	Days elapsed	Method	Weight change (g)	Reproductive status at last capture
DS02	M	28/8/19	25/9/19	Y	28	Captured	+18	
DS06	F	28/8/19	24/3/20	Y	209	Captured	+23	2 PY
DS08	F	28/8/19	3/10/19	Y	36	Captured	+16	1 PY
DS10	M	29/8/19	1/10/19	Y	33	Captured	+24.5	
DS12	M	29/8/19	2/10/19	Y	34	Captured	+8	
DS15	M	29/8/19	1/10/19	Y	33	Captured	+5	
DS17	M	30/8/19	24/3/20	N	207	Captured	+33	
DS20	F	30/8/19	2/10/19	Y	33	Captured	+30.5	1 PY
DS21	M	30/8/19	4/10/19	Y	35	Captured	+14	
DS22	M	30/8/19	4/10/19	N	35	Captured	+27	
DS25	F	30/8/19	1/10/19	Y	32	Captured	+40	RT
DS29	F	30/8/19	23/3/20	N	206	Captured	+100	
DS34	M	31/8/19	4/10/19	Y	34	Captured	+20.5	
DS36	F	31/8/19	3/10/19	Y	33	Captured	+50	RT
DS39	M	1/9/19	22/3/20	N	203	Captured	+39	
DS40	M	1/9/19	16/10/19	Y	45	Captured	+19	
DS41	F	1/9/19	23/3/20	N	204	Captured	+52	RT
BS01	M	3/9/19	22/3/20	N	202	Captured	+58	
BS04	F	3/9/19	23/3/20	N	203	Captured	+53	2 PY
BS07	F	11/9/19	23/3/20	N	194	Captured	+56	
BS15	M	12/9/19	22/3/20	N	192	Captured	+50	
BS17	F	13/9/19	24/3/20	N	193	Captured	+154	Active pouch

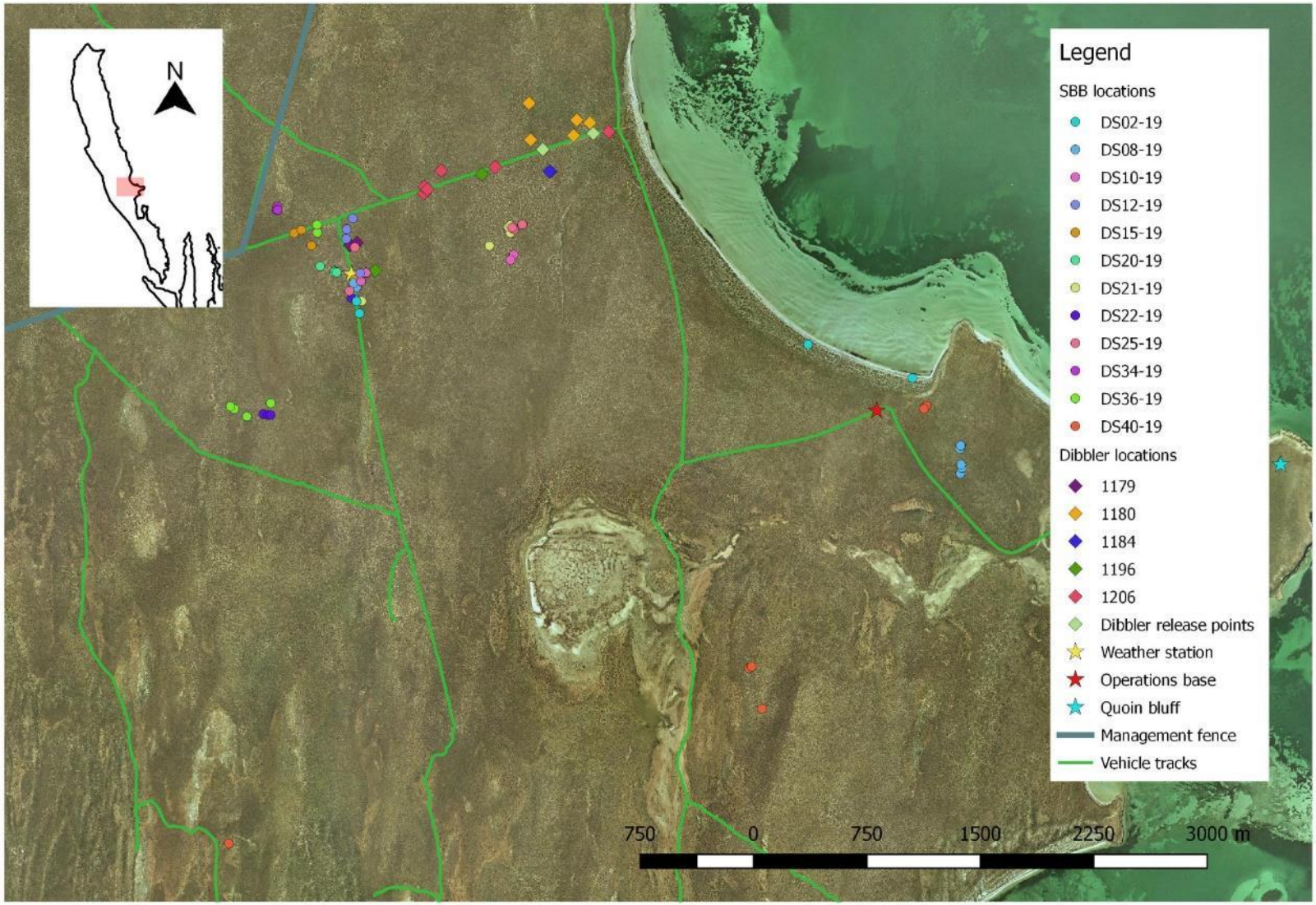


Figure 13. Map of locations of Shark Bay bandicoot and dibbler release points and refuges during post-release monitoring in Aug-Oct 2019.

It was planned that bandicoots would be tracked to their refuges every second day but after a number of individuals were flushed, this was scaled back. New refuges were found on 17 dates between release and collar removal (Figure 13).

3.2.1.2 Dibblers

Six dibblers were released with collars. Collars were retrieved from five of these individuals and a sixth individual was unable to be relocated after five days (Table 5), despite extensive searching from a fixed-wing aircraft. Four individuals slipped their collars between one and six days post-release. When another collar was detected in a *V. gouldii* burrow on the fourth and fifth days, the burrow was excavated and the collar and dead dibbler retrieved. The collar had slipped down to the abdomen and had become caught on a subterranean root (Figure 14).

During the brief monitoring period, dibblers were tracked to their daytime refuges, with individuals moving up to 950m overnight.

Figure 14. Deceased dibbler recovered from sand monitor burrow with slipped collar (© K. Rayner/DBCA).

Table 5. Results of monitoring collared dibblers released on DHI from Perth Zoo captive-breeding program (deceased individual recovered from same location on 12/10/19).*

Animal ID	Species	Sex	Release date	Last recorded alive	Days elapsed	Method	Weight change (g)
1179	*P.apicalis*	M	7/10/19	11/10/19*	4	Refuge located	-
1180	*P.apicalis*	F	7/10/19	4/11/19	28	Captured	-5.5
1184	*P.apicalis*	F	7/10/19	10/10/19	3	Collar found	-
1186	*P.apicalis*	M	7/10/19	8/10/19	1	Collar found	-
1196	*P.apicalis*	M	7/10/19	12/10/19	5	Refuge located	-
1206	*P.apicalis*	F	7/10/19	13/10/19	6	Collar found	-

3.2.2 Trapping

3.2.2.1 Shark Bay bandicoot

Monitoring in November 2019 using Elliott traps failed to capture bandicoots after 343 trap nights, despite. abundant signs of activity. Cameras deployed in the two release areas between November and March 2020 also frequently detected bandicoots, including small individuals that appeared to be new recruits to the population.

Further trapping in March 2020 using both Sheffield traps and Elliott traps over a total of 685 trap nights resulted in the capture of 11 bandicoots, including 10 from the founder group released in 2019 (six females; four males (Table 4)). These individuals had all gained weight and all but one female was reproductively active with pouch young present in two. Weight gains of up to 154g were recorded, but these included individuals that were not fully mature when released. In addition, one new female was captured, representing the first confirmed island-born Shark Bay bandicoot (Figure 15).

Figure 15. The first Dirk Hartog Island-born Shark Bay bandicoot to be captured (March 2020) (© K. Rayner/DBCA).

3.2.2.2 Dibblers

A total effort of 960 trap nights resulted in the capture of one dibbler, 440 individual rodents and four individual reptiles. The dibbler that was captured (1180) was one of two animals originally caught on Escape Island, prior to entering the breeding program at Perth Zoo and subsequently released on Dirk Hartog Island.

3.2.3 Health

Changes in weight of rufous hare-wallabies and Shark Bay bandicoots are discussed above. Ectoparasites were observed on the majority of rufous hare-wallabies, with ticks and fleas noted on 37 and 36 individuals respectively. Ectoparasites were less prevalent on Shark Bay bandicoots, with 13 individuals noted as having ticks, mites or fleas and another seven with general ectoparasites. All ectoparasite loads were noted as either low or moderate.

Median qualitative conditions scores were 3.5 for rufous hare-wallabies and 3 for Shark Bay bandicoots. The median quantitative condition index (see Cowen *et al.* (2019) for methodology) for rufous hare-wallabies was 1.137, which was lower than in both 2017 (1.157) and 2018 (1.150). The median condition index for bandicoots was 1.235.

Dibblers were clear of ectoparasites and in good health before leaving Perth Zoo. Female 1180 weighed 36.5g when recaptured in November, which was 5.5g less than release weight and 7.5g less than its original capture weight on Escape Island.

3.2.4 Remote cameras

3.2.4.1 Banded and rufous hare-wallabies

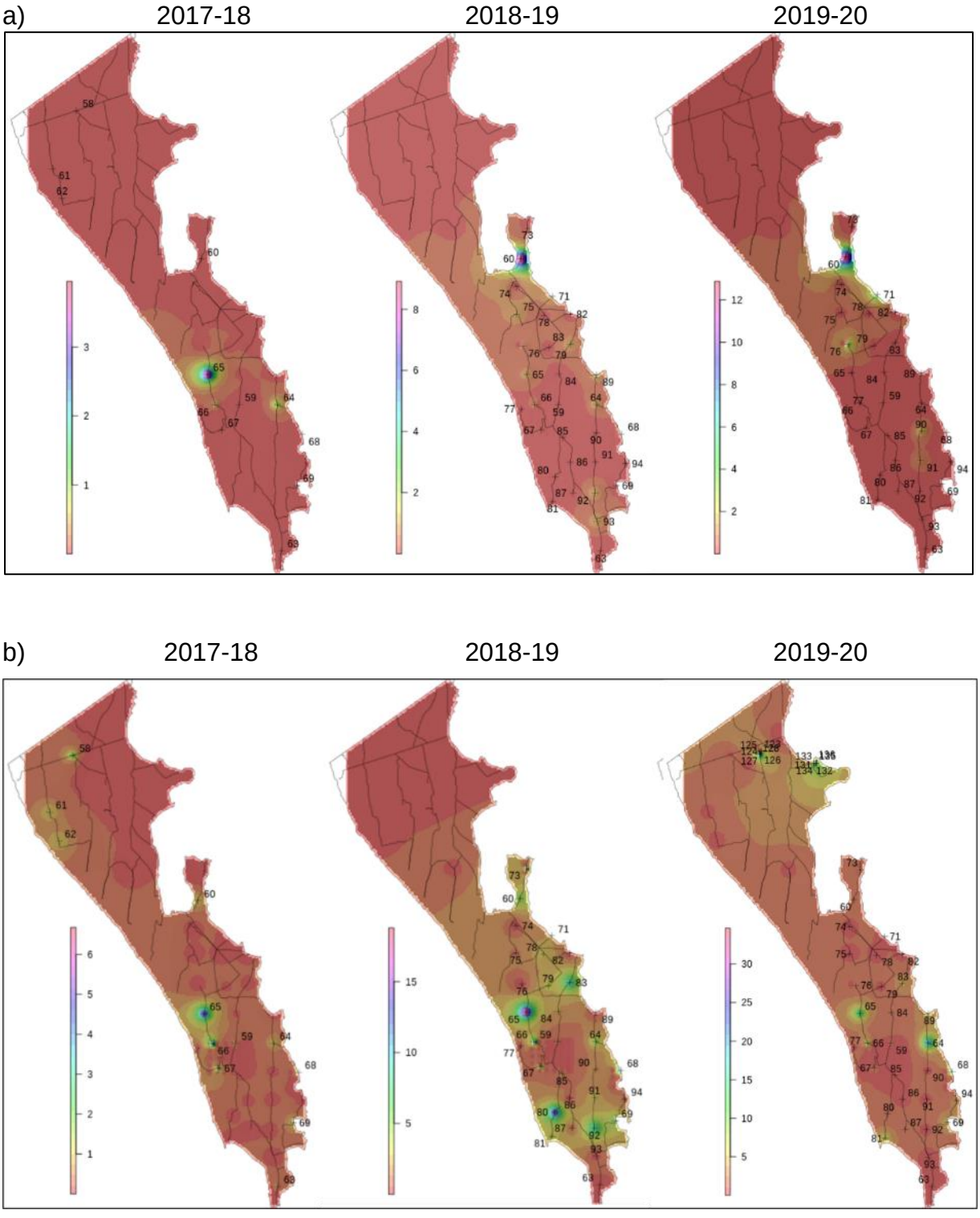
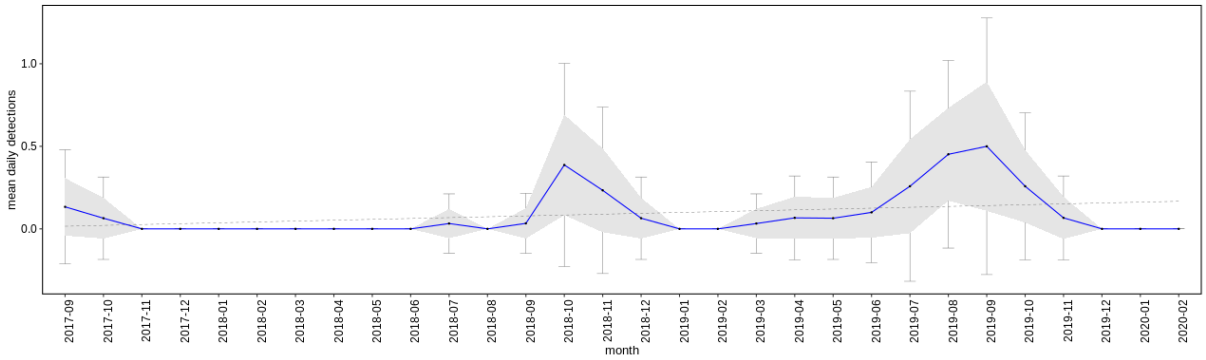


Figure 16. Inverse distance weighted interpolation maps of number of independent detections at each camera site (per 24hr period) of a) banded hare-wallabies and b) rufous hare-wallabies between September and February for each survey period (figures relate to camera site ID numbers; NB. differing scales between years).

The spatial pattern of detections of banded hare-wallabies on remote cameras in 2019-20 was similar to 2018-19 (Figure 16) but there was a clear increase in the rate of detections commencing in winter and peaking in spring in all years (Figure 17). Translocations in 2017 and 2018 may have contributed to a sudden rise in activity, but a similar pattern in 2019 did not coincide with a translocation.

The spatial pattern of rufous hare-wallaby detections differ (Figure 16) between 2018-19 and 2019-20 but this is due to the release of animals in the Herald Bay area (top of map). South of Notch Point, the spatial spread of detections decreased between 2018-19 and 2019-20. Number of detections in other hotspots remained similar between the two periods. Over time there has been a sustained increase in the rate of detections of rufous hare-wallabies since the trial translocation in 2017 (Figure 17).

a)



b)

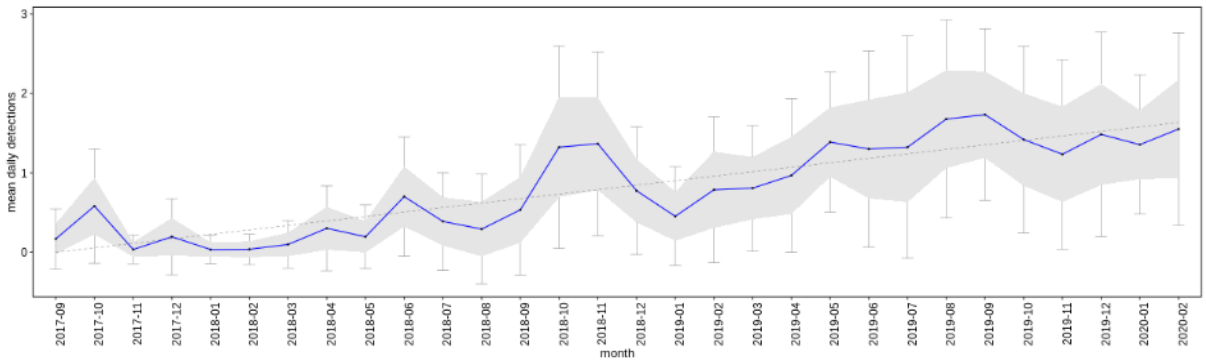


Figure 17. Mean daily detections on camera for a) banded hare-wallaby and b) rufous hare-wallaby between September 2017 and February 2020.

3.2.4.2 Shark Bay bandicoots

Detections of Shark Bay bandicoots on camera were highest at the two release sites, with most detections at the 'weather station' release area (Figure 18). There were also detections on the camera grid array deployed for monitoring dibblers. Mean daily detections increased over time between the translocation in September 2019 and the last monitoring period in March 2020 (Figure 19).

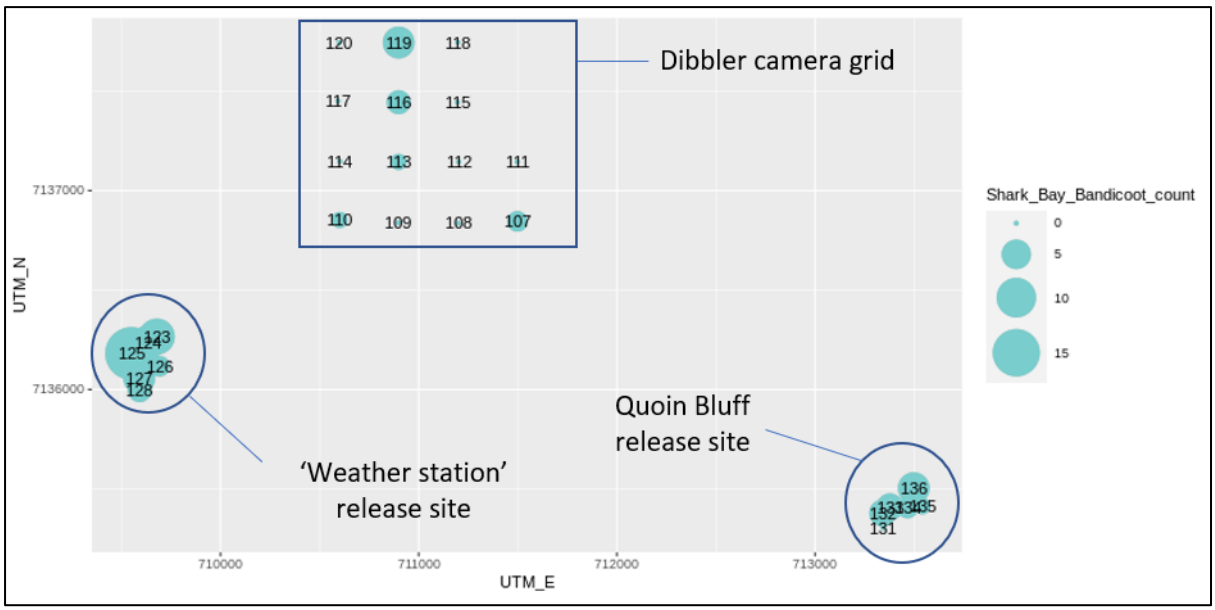


Figure 18. Detections of Shark Bay bandicoots on camera between September 2019 and March 2020 at two release areas and on dibbler camera grid (figures represent camera site ID numbers; major gridlines represent 1000m spacing, minor gridlines represent 500m spacing).

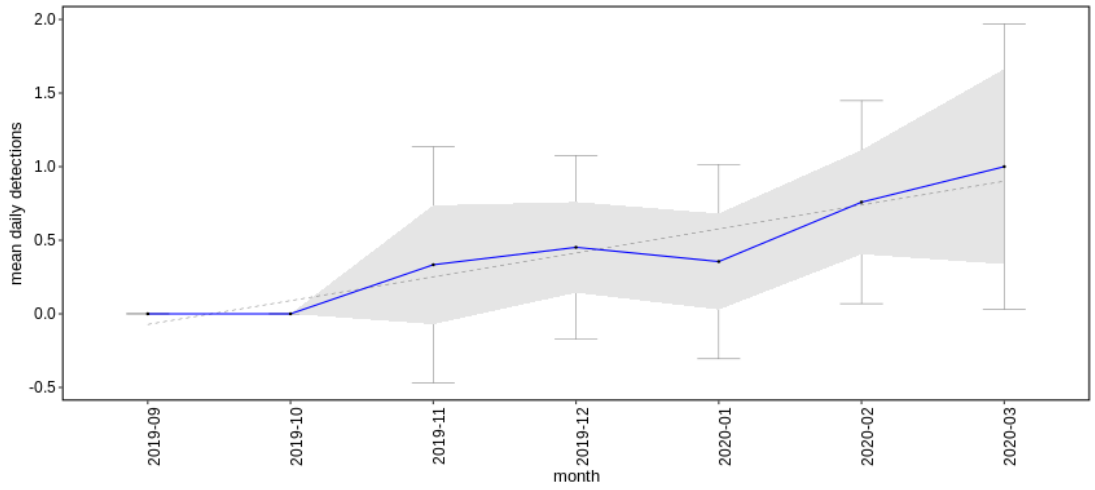


Figure 19. Mean daily detections on camera for Shark Bay bandicoots between September 2019 and March 2020.

3.2.4.3 Dibblers

No dibblers were recorded on camera between the translocation in October 2019 and the last monitoring period in March 2020.

3.2.4.4 Other incidental fauna

Through the use of remote cameras, trapping, and an incidental sightings register (animal seen or heard or tracks and scats observed), 104 terrestrial species were recorded during this reporting period (July 2019 - June 2020). A summary of all incidental fauna records is provided in Appendix 6.2.

Mean daily detections of *V. gouldii* on cameras between October 2017 and March 2020 show clear peaks between November and January (Figure 20), coinciding with the beginning of the warmest period of the year.

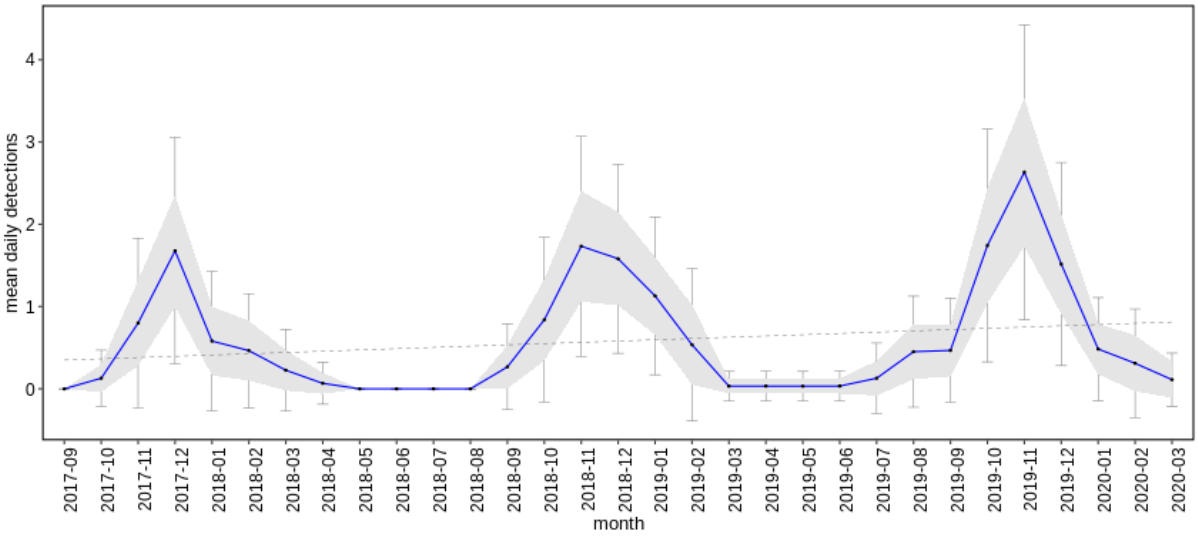


Figure 20. Mean daily detections of sand monitors (Varanus gouldii) on all remote camera sites between October 2017 and March 2020 (NB. no cameras were deployed during the period between June and August 2018).

3.2.5 Hare-wallaby faecal DNA monitoring

Collection of hare-wallaby scat took place between 25 and 27 November 2019, with 190 samples collected. Of these, 153 samples were collected to the west of the main 4WD track where most hare-wallabies were released in 2017 and 2018 (Cowen *et al.* 2018, Cowen *et al.* 2019). DNA was extracted from 190 samples, as per the protocol in 2.5.6, and 168 were confidently identified in the species identification screening step, with 11 samples ambiguous and another 11 failed to amplify (overall amplification success = 94%). Genetic species identification determined almost equal numbers of scats were collected from each species (88 RHW and 80 BHW). Rufous and banded hare-wallabies appear to be exhibiting resource partitioning within the sampled area with very little spatial overlap in the distribution of scats of each species (Figure 21). Individual genotypes are currently being determined for rufous and banded hare-wallaby scats to identify the number of unique individuals detected within the sampling area. Information on the spatial distribution of 'detections' of individuals using scat DNA will be analysed within a SECR framework to estimate population size for each species.

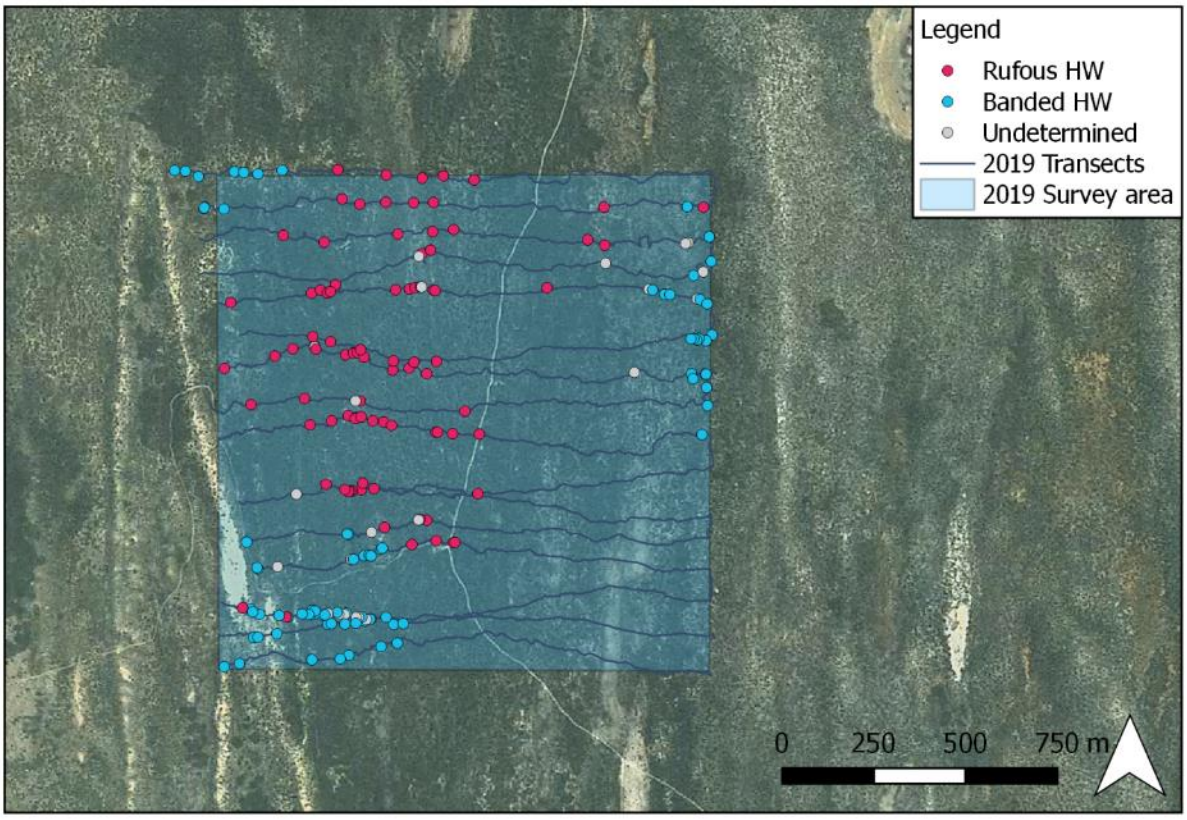


Figure 21. Distribution of genetically-identified rufous hare-wallaby and banded hare-wallaby scats along 2.5 km transects surveyed in November 2019.

3.2.6 Monitoring of small vertebrates

Small vertebrate monitoring consisted of 708 pitfall trap nights and 710 Elliott trap nights between 23-29 October 2019. The total number of individual animals captured was 946, of which 507 were sandy inland mice (*Pseudomys hermannsburgensis*), representing an increase in trap success from 5% in 2017 to 36% in 2019. Trap success for ash-grey mouse (*P. albocinereus*) also increased from the previous two years, from 3% in 2017 and 2018 to 9% in 2019. Figure 22 shows trap success rates since 2017. Thirty-three species were recorded in 2019 (Appendix 6.2) including one species not previously captured in 2017 or 2018 (western brown snake *Pseudonaja mengdeni*).

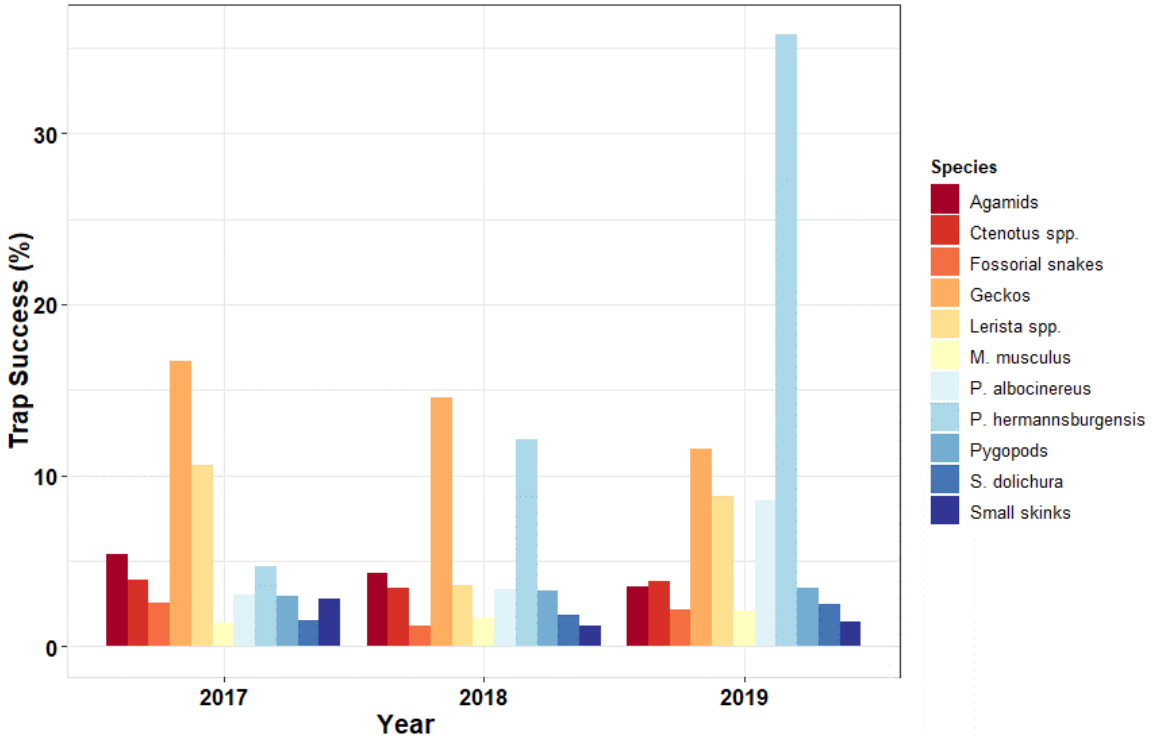


Figure 22. Trap success for small vertebrate taxa between 2017 and 2019.

3.2.7 Monitoring of raptors and owls

The presence of raptor species was recorded over twelve weeks between August 2019 and March 2020 (Figure 23). The most frequently occurring species were the eastern osprey, nankeen kestrel and white-bellied sea-eagle, which are all resident on the island. Five additional species (including wedge-tailed eagle) were recorded during one of the twelve weeks and black-shouldered kites were recorded during two weeks.

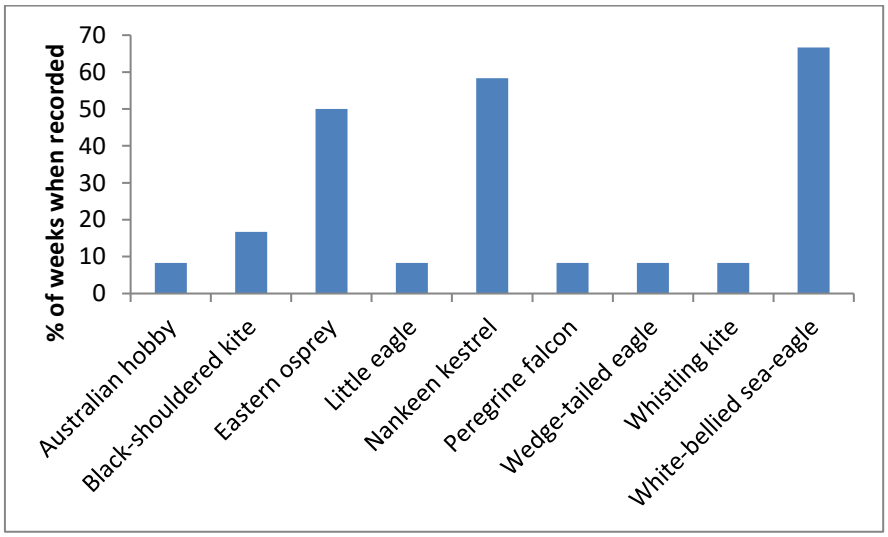


Figure 23. Frequency at which raptor species were observed on DHI between August 2019 and March 2020.

4 Discussion

4.1 Translocation outcomes

4.1.1 Rufous hare-wallabies and Shark Bay bandicoots

Rufous hare-wallabies were successfully translocated for a third year from Bernier and Dorre Island, adding a further 50 adult individuals to the island, as well as 14 pouch young translocated with their mothers. This brings the total of translocated adults to 112 and represents the first translocation of the Shark Bay subspecies *L. h. bernieri*.

The dramatic weight loss observed in this species between capture and release in 2017 appears to have been successfully managed, and while weight loss was evident in both 2018 and 2019, it was not as substantial as in 2017. It is unclear whether this is due to the use of drugs such as atropine or simply the much shorter transfer time from Bernier and Dorre. Unfortunately, a female hare-wallaby was found deceased in February 2020. However, monitoring indicates that there is a high likelihood that most individuals will have survived the first nine months post-release.

The translocation of Shark Bay bandicoots was also successful, with 72 of a quota of 75 being relocated from Bernier and Dorre. Nine females also carried pouch young. Survivorship of collared animals was 100% for the monitoring period and all animals either gained or maintained body weight and condition. Reproductive activity was also noted, with two new pouch young recorded during the tracking period.

Of the Shark Bay bandicoots captured on Bernier Island, eight were rejected due to the presence of potential symptoms of BPCV1. Only one tested positive for the virus, but the capture team exercised the precautionary principal to reject all animals under suspicion of exhibiting signs. An animal euthanised on DHI after arriving from Bernier with a suspicious lesion tested negative. However, the risk of introducing this potentially lethal pathogen to the new DHI population outweighed the value of releasing this one individual.

4.1.2 Dibblers

A total of 26 dibblers were released in October 2019, including two wild-bred individuals (male and female from Escape Island) and 24 offspring from the captive breeding program at Perth Zoo. All were in good health when released. This represents the first translocation of Jurien Bay island dibblers outside of Jurien Bay.

4.2 Monitoring outcomes

4.2.1 Banded and rufous hare-wallabies

Camera monitoring of both species of hare-wallabies showed number of detections of both species increased over time but the spatial spread of detections decreased. This is expected as monitoring in 2018-19 showed that hare-wallaby activity surged immediately after translocation but reduced over time as animals established territories or home ranges (Cowen *et al.* 2019). The pattern of mean daily detections

between the species differed with rufous hare-wallabies showing a constant increase over time, while banded hare-wallaby detections peaked around late winter and early spring in 2019. This may be due to the dispersal of offspring after becoming independent, six months after breeding peaks in autumn (Richards *et al.* 2001, Prince and Richards 2008). Banded hare-wallaby detections have continued to increase since 2017, suggesting that the population is continuing to establish.

Monitoring for of hare-wallabies using faecal DNA techniques demonstrated that hare-wallaby scat could be located and collected along transects and DNA can be successfully analysed, with a very high rate of amplification. This technique was successfully able to discriminate between scats of both hare-wallaby species and work is underway to assign individual genotypes using this method. A high-throughput method for scat analysis using single-nucleotide polymorphism (SNP) markers will be developed for both rufous and banded hare-wallabies in 2020-21. Development of SNP genotyping panels will allow greater species-specificity and provide higher resolution of individual genotypes, as well as providing stable, high-throughput technology for ongoing monitoring.

As for the banded hare-wallaby translocation (Cowen *et al.* 2019), short-term success criteria have now been met for the rufous hare-wallaby and all but one medium-term criteria (Criterion 4) have been met. It is anticipated that once the scat DNA technique is further refined, this method will demonstrate that the final medium-term criteria related to population size has also been met.

4.2.2 Shark Bay bandicoots

The ability to monitor survivorship and movement in the immediate post-release period is important to demonstrate early translocation success. A captive trial with Shark Bay bandicoots provided insight on how to best fit suitable radio-telemetry collars to maximise the effectiveness of the post-release monitoring. That all 12 collared animals survived the four- to seven-week tracking period and either maintained or gained weight is a good indicator of early success. The tracking of individuals also showed some release-site fidelity while others moved up to 4km between locations, and some were detected at both release sites. The recapture of individuals confirmed the ongoing presence of healthy animals, including F1 generation offspring. So far there is no evidence of BPCV1 in DHI bandicoots, but this will continue to be monitored closely.

Based on the radio-collared animals, four of the five short-term success criteria for the Shark Bay bandicoot translocation were met in the first six months (Appendix 6.1). The low recapture rate of the bandicoots compromises an estimate of the survival rate. Of the five medium-term success criteria, three have already been achieved (Criteria 2, 3 and 4) and one (Criterion 5) is also likely to have been achieved, given some of the movements observed in March 2020. Criterion 1 cannot be assessed until 12 months post-release (September 2020).

4.2.3 Dibblers

Unfortunately, the effectiveness of the radio-tracking of the Shark Bay bandicoots was not reflected in the dibblers, which meant it was difficult to establish early translocation success of the 26 dibblers released. Only one of the six animals collared (most others had removed their collar) was recaptured in November and had lost weight. Additionally, no dibblers were recorded on remote cameras between October and March 2020, and none were successfully trapped. Immediately post-release, dibblers moved around the landscape rapidly and travelled relatively large distances and it is possible that individuals may have settled well away from the release sites.

Currently none of the short-term success criteria (≤12 months; Appendix 6.1) can be considered to have been achieved. Ongoing monitoring with cameras and trapping planned for November 2020 may provide more information on the status of the 2019 released dibblers.

4.2.4 Other native fauna

The small vertebrate monitoring conducted in October between 2017 and 2019 shows little change in the abundance of most taxa. Both sandy inland and ash-grey mice show a clear increasing trend, the former increasing in numbers seven-fold since 2017. However, from this short-term dataset it is unclear whether this is a 'boom' response to environmental conditions, or to the removal of cats.

Activity of *Varanus gouldii*, one of the largest terrestrial predators currently extant on the island, tends to consistently peak in early summer and is considerably lower during autumn and winter. This is an important consideration for future translocations, particularly of small mammals, as *V. gouldii* has been implicated in the failure of one translocation of Shark Bay mouse (*Pseudomys fieldi*) (Fletcher and Morris 2003) and were shown to prey upon translocated Shark Bay mice on Faure Island (Rowles 2008), Doole Island (Speldewinde and Morris 1993, Morris and Speldewinde 1995) and Northwest Island (Djoongari Recovery Team 1999, Speldewinde 1999). Bolton and Moseby (2004) recommended that translocations of greater stick-nest rats (*Leporillus conditor*) in the arid zone take place in autumn to avoid interactions with this potential predator. As both these rodents are planned for reintroduction to DHI, careful consideration should be given to the timing of their translocations to mitigate this risk.

Predatory bird species continued to be recorded on an ad-hoc basis. Of the three most frequently recorded species, white-bellied sea-eagles are the most likely to prey upon hare-wallabies and nankeen kestrels the most likely to prey on dibblers. However, mammals are not believed to the preferred prey of either of these species and their continuing presence on the island is not thought to be an important threat to the translocated fauna. Wedge-tailed eagles and black-shouldered kites may primarily prey on mammals, but neither of these species were recorded regularly.

4.3 Recommendations

Based on the results of the 2019 translocations the following recommendations are made:

1. The use of faecal DNA to monitor the two species of hare-wallabies is promising, and once a protocol is established, it may provide an effective monitoring technique that can be implemented with relatively low cost and labour implications. Therefore, future monitoring plans for these species should incorporate this technique and the feasibility of using this method to monitor other reintroduced species (e.g. Shark Bay bandicoot, woylie (*Bettongia penicillata*)) should also be investigated.

2. The monitoring for the presence of BPCV1 and other pathogens such as chlamydia should continue, as asymptomatic Shark Bay bandicoots may have inadvertently been released on DHI. The strict hygiene precautions currently implemented to mitigate the risk of spreading disease between bandicoots should continue to be adhered to until such time as there is a high level of confidence that DHI is BPCV1-free. Disease monitoring in other mammal species present on the island may also be desirable and is the subject of an ongoing Disease Risk Analysis study being undertaken by a Wildlife Population Health resident at Murdoch University.

3. An improved method of fitting radio-telemetry tags to dibblers should be investigated, to maximise the duration of attachment of the transmitter (and therefore monitoring duration), whilst ensuring minimal impact on the animals' welfare. Consideration should also be given to different transmitter devices e.g. coded VHF/UHF tags which can last up to a year but require specialised static receiver towers and decoding hardware.

4. The trapping survey design for Shark Bay bandicoots and dibblers should be refined. Both species appear to have dispersed further from their release sites than expected and the trapping grids used in 2019 and 2020 should be expanded to take in a greater area. Given the close proximity of the bandicoot and dibbler release areas, it should be possible to streamline trapping effort into one program, but with multiple trap types (e.g. Sheffields, Elliotts and cameras).

5. Monitoring of small extant vertebrates should be continued to elucidate changes in abundance and compositional patterns, particularly those of the native rodents. This is important to better understand the potential influence of reintroduced species on this fauna, including the four rodents planned for reintroduction to DHI.

6. The use of remote cameras to monitor populations of translocated and extant fauna has so far provided valuable information. Consideration should be given to how best to expand this monitoring program, to ensure the continued

effective monitoring of these species, without incurring significant additional effort in the subsequent storage and analysis of images.

7. Ad-hoc monitoring of the presence of raptors and owls on DHI should be maintained, as an increase in these predators may potentially affect the success of the translocation program. This is especially relevant in the context of the increasing number of native rodents observed on the island during 2019, which may result in an increased abundance of predatory birds.

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6 Appendices

6.1 Success criteria for rufous hare-wallaby, Shark Bay bandicoot and dibbler translocations.

	Rufous hare-wallaby (*Lagorchestes hirsutus*)	Shark Bay bandicoot (*Perameles bougainville*)	Dibbler (*Parantechinus apicalis*)
Short-term	0-9 months 1. At least 50% of the radio-collared, released hare-wallabies survive for the first four months after release. 2. Any causes of mortality are understood and ameliorated. 3. Founders have maintained or increased bodyweight, condition maintained. 4. Some evidence of successful recruitment of those that may have been larger pouch young when translocated.	0-6 months 1. ≥60% of founder animals known to be alive one-two months after release (based on radio-tracking and/or live-capture) and monitoring indicates continued survivorship of animals for 4-7 months. 2. No cause(s) of mortality which are unidentified and unable to be ameliorated. 3. Founders have maintained or increased bodyweight (after initial weight loss (<15%) expected during translocation process). 4. Founders settle within an area and use daytime refuges/shelter, indicating suitable habitat is being occupied. 5. No evidence of significant founder survival compromised by expression of BPCV1.	0-12 months 1. ≥20% of founder animals known to survive the first 7 months after initial release. Any causes of mortality understood and if possible, ameliorated. 2. Dibblers recorded at baited camera sites at least 6 months after release 3. Maintenance or increase in body weight/condition at 7 and 12 months compared to initial release. 4. ≥50% of trapped founder females produce pouch young 7 months after initial release. 5. Juveniles trapped or recorded by camera traps within 12 months of initial release. 6. Evidence that radio-collared individuals are sheltering in suitable habitat two weeks after release.
Medium-term	10-36 months 1. Population has established and expanded habitat is used. 2. Body weight and condition are maintained. 3. Further evidence of successful reproduction; presence of pouch young, or F1 generation (from females with large pouch young when translocated). 4. Hare-wallabies are recorded during spotlight and/or trapping monitoring sessions.	6-24 months 1. Continued survivorship of founders (<20% identified mortality of founders and >50% of those alive at 7 months still known to be alive at 12 months). 2. Founder population has established and expanded habitat used. 3. Evidence of reproduction (presence of pouch young) and successful recruitment of new F1 individuals into population. 4. Dispersal of new recruits and increasing activity (as measured by trap, track, spotlight or camera surveys). 5. Expansion of the area of occupancy of initial founder group.	13-36 months 1. Island-born individuals in the trapped population at 24 months and 36 months. Minimum number animals known to be alive is ≥50 at 36 months. 2. Body weight and condition maintained within variation observed in initial release data, and taking climatic variation into account. 3. ≥50% of trapped females with pouch young at 19 months and 31 months after first release. 4. Island-born juveniles in trapped population at 24 months and 36 months after initial release. 5. Area of occupancy increased between 12 and 36 months based on trapping/camera trap data.

	Rufous hare-wallaby (*Lagorchestes hirsutus*)	Shark Bay bandicoot (*Perameles bougainville*)	Dibbler (*Parantechinus apicalis*)
Long-term	<u>3-10 years</u> 1. Population size improved from initial release and area of occupancy expanded. 2. Health and condition maintained providing non-drought conditions experienced. 3. Evidence of F2 (and longer) generations, at least 50% of females breeding (depending on climatic conditions). 4. Population recovers area of occupancy and density after first drought cycle. 5. Genetic variability maintained at ≥90% of allelic diversity and heterozygosity of released individuals.	<u>2-10 years</u> 1. Population has increased and continued to expand area of occupancy to at least twice that initially occupied by the founder group and up to 25% of suitable habitat south of management fence. 2. F2 (and longer) generation present and reproducing. 3. Body weight and condition is maintained at levels similar to source populations, >50% of females breeding (as appropriate to prevailing seasonality and variable rainfall). 4. Genetic variability (allelic richness and heterozygosity) maintained at >90% of released individuals at five- and 10-years post-release (alternative criteria may be developed based on deviations of genetic diversity from a mean value. 5. Population persists and recovers their area of occupancy after a first drought cycle.	<u>3-10 years</u> 1. Population size at 3 years maintained or increased at 10 years. 2. Body weight and condition maintained within variation observed in initial release data and taking climatic variation into account. 3. Evidence of young/juveniles in trappable population at 10 years. At least 50% of females breeding (depending on climatic conditions). 4. Area of occupancy increased between 3 and 10 years based on trapping or camera trap data. 5. Genetic variability at 10 years maintained at ≥90% of allelic diversity and ≥95% heterozygosity of released individuals. 6. Frequency of island-specific alleles does not diverge significantly from founder group.

6.2 Incidental species list 2019-20

Common name	Scientific name	Remote camera	Incidental sighting	Trapped
Spiny-cheeked honeyeater	*Acanthagenys rufogularis*		X	
Stimson's python	*Antaresia stimsoni*		X	X
Australian pipit	*Anthus australis*	X	X	
	Aprasia haroldi			X
Little eagle	*Aquila morphnoides*		X	
Eastern reef-egret	*Ardea sacra*		X	
Australian bustard	*Ardeotis australis*	X	X	
Ruddy turnstone	*Arenaria interpres*		X	
Black-faced woodswallaw	*Artamus cinereus*	X	X	
Little woodswallow	*Artamus minor*		X	
Striated heron	*Butorides striatus*		X	
Rufous fieldwren	*Calamanthus campestris*	X	X	X
Red-necked stint	*Calidris ruficollis*		X	
Greater sandplover	*Charadrius leschenaultii*		X	
Red-capped plover	*Charadrius ruficapillus*		X	
Oriental plover	*Charadrius veredus*		X	
Horsfield's bronze cuckoo	*Chrysococcyx basalis*		X	
Shining bronze cuckoo	*Chrysococcyx lucidus*		X	
Banded stilt	*Cladorhynchus leucocephalus*		X	
Black-faced cuckoo-shrike	*Coracina novaehollandiae*		X	
Little crow	*Corvus bennetti*	X	X	
Brown quail	*Coturnix ypsilophora*		X	
Grey butcherbird	*Craticus torquatus*	X	X	
	Crenadactylus ocellatus		X	X
	Cryptoblepharus plagiocephalus		X	X
	Ctenophorus butlerorum		X	X
Spotted military dragon	*Ctenophorus maculatus*	X	X	X
	Ctenotus australis		X	X
	Ctenotus fallens		X	X
	Cyclodomorphus celatus			X
	Delma butleri		X	X
	Diplodactylus ornatus		X	X
Gidgee skink	*Egernia stokesii*		X	X
Black-shouldered kite	*Elanus caeruleus*		X	
White-fronted honeyeater	*Epthianura albifrons*		X	
Nankeen kestrel	*Falco cenchroides*	X	X	
Australian hobby	*Falco longipennis*		X	
Peregrine falcon	*Falco peregrinus*		X	
Buff-banded rail	*Gallirallus philippensis*	X		
Singing honeyeater	*Gavicalis virescens*	X	X	
	Gehyra variegata		X	X

Sooty oystercatcher	*Haematopus fuliginosus*		X	
Pied oystercatcher	*Haematopus longirostris*		X	
White-bellied sea-eagle	*Haliaeetus leucogaster*		X	
Whistling kite	*Haliastur sphenurus*		X	
	Heteronotia binoei		X	X
Welcome swallow	*Hirundo neoxena*		X	
Tree martin	*Hirundo nigricans*		X	
Rufous hare-wallaby	*Lagorchestes hirsutus*	X	X	
Banded hare-wallaby	*Lagostrophus fasciatus*	X		
Silver gull	*Larus novaehollandiae*		X	
Pacific gull	*Larus pacificus*		X	
	Lerista elegans		X	X
	Lerista lineopunctulata			X
	Lerista planiventralis		X	X
	Lerista praepedita			X
	Lerista varia			X
Burton’s legless-lizard	*Lialis burtonis*		X	X
Variegated fairy-wren	*Malurus lamberti*		X	
White-winged fairy-wren	*Malurus leucopterus*		X	
	Morethia lineoocellata		X	X
House mouse	*Mus musculus*		X	X
	Neelaps bimaculatus			X
	Nephrurus levis		X	X
Crested bellbird	*Oreoica gutturalis*		X	
Eastern osprey	*Pandion haliaetus*		X	
Dibbler	*Parantechinus apicalis*			X
Australian pelican	*Pelecanus conspicillatus*		X	
Shark Bay bandicoot	*Perameles bougainville*	X	X	X
Pied cormorant	*Phalacrocorax varius*		X	
	Pletholax edelensis			X
Western bearded dragon	*Pogona minor*		X	X
Baillon's crake	*Porzana pusilla*		X	
Mulga snake	*Pseudechis australis*		X	X
Ash-grey mouse	*Pseudomys albocinereus*		X	X
Sandy inland mouse	*Pseudomys hermannsburgensis*	X	X	X
Western brown snake	*Pseudonaja mengdeni*			X
Wedge-tailed shearwater	*Puffinus pacificus*		X	
Red-necked avocet	*Recurvirostra novaehollandiae*		X	
Willie wagtail	*Rhipidura leucophrys*	X	X	
White-browed scrubwren	*Sericornis frontalis*		X	
	Simoselaps littoralis		X	X
Little long-tailed dunnart	*Sminthopsis dolichura*	X		X
Bridled tern	*Sterna anaethetus*		X	
Lesser crested tern	*Sterna bengalensis*		X	
Crested tern	*Sterna bergii*		X	
Caspian tern	*Sterna caspia*		X	

Roseate tern	*Sterna dougallii*		X	
Fairy tern	*Sterna nereis*		X	
Southern emu-wren	*Stipiturus malachurus*		X	
Laughing dove	*Streptopelia senegalensis*	X	X	
	Strophurus spinigerus			X
Australian gannet	*Sula serrator*		X	
Zebra finch	*Taeniopygia guttata*		X	
Bobtail	*Tiliqua rugosa*	X	X	X
Grey-tailed tattler	*Tringa brevipes*		X	
Common sandpiper	*Tringa hypoleucos*		X	
Common greenshank	*Tringa nebularia*		X	
Painted button-quail	*Turnix varius*	X	X	
	Underwoodisaurus milii		X	
Banded lapwing	*Vanellus tricolor*	X	X	
Sand goanna	*Varanus gouldii*	X	X	X
Finlayson's cave bat	*Vespadelus finlaysoni*		X	
Silvereye	*Zosterops lateralis*		X	