Monitoring Source Populations of Fauna for the Dirk Hartog Island National Park Ecological Restoration Project – 2020

Colleen Sims, Saul Cowen, Sean Garretson, Aline Gibson Vega and Tony Friend

Biodiversity and Conservation Science

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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 Colleen Sims, Saul Cowen, Sean Garretson, Aline Gibson Vega and Tony Friend.

Questions regarding the use of this material should be directed to:

Senior Project Officer – Dirk Hartog island National Park Ecological Restoration Project
Animal Science Program, Biodiversity and Conservation Science
Department of Biodiversity, Conservation and Attractions
Locked Bag 104
Bentley Delivery Centre WA 6983
Phone:08 – 9405 5103
Email: colleen.sims@dbca.wa.gov.au

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Contents

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Summary

Monitoring of source populations of four mammal and one bird species was undertaken by the Department of Biodiversity Conservation and Attractions' (DBCA), Biodiversity and Conservation Science in 2020 to obtain information on their distribution and abundance prior to their translocation to Dirk Hartog Island National Park as part of the Dirk Hartog Island National Park Ecological Restoration Project (DHINPERP). Monitoring of these source populations in 2020, also fulfilled the requirements of Corporate Guideline 36 (Sections 1.2 and 5.2.9), to monitor their status post-harvesting in 2019. Monitoring of Shark Bay bandicoots on Bernier Island was also undertaken to inform proposed harvesting activity in spring 2020.

Spotlight and trap monitoring of all species on Bernier and Dorre Islands was planned for March/April 2020. However, delays due to Covid-19 resulted in postponement to August 2020, and ongoing restrictions and weather delays prevented the completion of the spotlight surveys. The trap monitoring program was completed on both islands and allowed for the necessary population assessment of the Shark Bay Bandicoot prior to supplementary harvesting for the DHINPERP translocation which was approved and occurred in September 2020.

Monitoring of dibbler populations on Boullanger and Whitlock Islands (Jurien Bay) occurred in June and October 2020, and monitoring of the Escape Island population (and harvesting of additional animals for the Perth Zoo breeding program) occurred in December 2020.

In addition, preliminary monitoring and capture work of western grasswrens was undertaken at two locations in Shark Bay: Hamelin Station Reserve (owned by Bush Heritage Australia) in July 2019 and Peron Peninsula (including Francois Peron National Park and adjacent Unallocated Crown Land) in June and October 2020. Data collected from this work will be used as part of a doctoral study by A. Gibson Vega on the genetics and behaviour of this taxon, which will inform the proposed translocation to Dirk Hartog Island.

1 Introduction

This report documents the monitoring activities undertaken in August 2020 on Bernier and Dorre Islands in Shark Bay and in June, October and December 2020 on the Jurien Bay islands. Species monitored were the Shark Bay bandicoot (*Perameles bougainville*), boodie (*Bettongia lesueur*) (both Bernier and Dorre), Shark Bay mouse (*Pseudomys fieldi*) (Bernier only) and dibbler (*Parantechinus apicalis*) (Jurien Bay). It presents both qualitative assessments and quantitative analysis of data collected during this monitoring, and a comparison with 2016, 2017, 2018 and 2019 monitoring results where these are available.

We also present the results of preliminary surveys for western grasswrens (*Amytornis textilis*) at Hamelin Station Reserve and on Peron Peninsula, both in the Shark Bay area. All five species covered by this report have either been translocated or are planned for translocation to Dirk Hartog Island National Park (DHI).

2 Methods

2.1 Surveys

2.1.1 Bernier and Dorre Islands

Monitoring of both Bernier and Dorre Islands was undertaken in August 2020. Dorre Island monitoring was undertaken between 6 and 12 August 2020, with a gap of two nights when traps were closed due to a severe storm front. Bernier monitoring took place between 20 and 24 August.

One trapping grid of 64 trap points has been established on each of Bernier and Dorre Islands. Both grids were open for four nights. The total trapping effort was 256 cage and 256 Elliott trap nights for both the main Bernier and Dorre Island grids.

A second, smaller permanent grid of 21 trap points, located in sand dune habitat near Red Cliff Bay on Bernier Island, was also operated together with the larger grid, to specifically target Shark Bay mice (SBM). This grid was also opened for four trap nights concurrently with the larger grid. A full description of permanent trap grid design, locations and methodology are described in previous reports (Sims *et al.* 2020).

Extra Elliott traps (total of 100 trap nights) were placed in the beach area and eastern dune area at Red Cliff Bay on Bernier Island to assist in capture of additional SBM and ash-grey mice (*Pseudomys albocinereus*) for disease surveys to inform the Rodent Disease Risk Analysis being developed by Dr Fiona Knox.

All Shark Bay bandicoots (SBBs) captured on both islands were examined for possible symptoms of active infection with Bandicoot Papillomatosis Carcinomatosis Virus One (BPCV1). Bandicoots were carefully examined for abnormalities of the hair and skin, and any suspicious lesions were photographed and then sampled, along with other potential viral shedding sites on the bandicoots (eyelids, lips, feet and flanks) using sterile saline swabs (Woolford 2017). Swabs were then frozen and sent for PCR assay

for detection of BPCV1 (Woolford *et al.* 2007). See previous reports (e.g. Sims *et al.* (2020)) and the Disease Risk Analysis (Vaughan-Higgins *et al.* 2018) for further information on this disease. In addition, bandicoots showing clinical signs of ocular disease were sampled under general anaesthesia for chlamydia.

2.1.2 Dibblers

Trapping for dibblers on Boullanger, Escape and Whitlock Islands (Jurien Bay) involved medium Elliott traps placed on permanent monitoring transects. Weight, animal ID, sex, reproductive condition, pes length and head length were also measured and recorded for this species, and individuals were marked with a Passive Integrated Transponder (Trovan^{TM} ID-100C, FDX-A Microchip, 11.5mm x 2.12mm).

Autumn trapping on Boullanger and Whitlock Islands normally takes place in late May but due to poor weather, this was delayed to 8 to 12 June in 2020. Again, due to weather conditions, the decision was made to terminate trapping after only two nights. Spring monitoring on Boullanger and Whitlock took place between 26 to 30 October 2020. Monitoring on Escape Island was undertaken between 3 and 7 December 2020 only.

2.1.3 Western grasswren

Surveys by DHINPERP staff for western grasswren territories took place between 22 July and 2 August 2019 at Hamelin Station Reserve (Hamelin) and between 3 and 19 June and 7 to 15 October 2020 on Peron Peninsula (Peron). At Hamelin, initial survey locations were selected based on survey points from M. Brooker and B. Parkhurst, but new locations were recorded based on locating birds by call and sightings. At Peron, survey sites were selected based on appropriate vegetation type and structure. At all sites, birds were located by call and if sighted a capture attempt (for DNA sampling and colour banding) was usually initiated. Additional territories were recorded by A. Gibson Vega during fieldwork undertaken at Hamelin and Peron in 2019 and 2020.

Capture of grasswrens involved the use of mist-nets, modified to include a deep ‘pocket’ at ground level designed to capture birds running or flying low along the ground. Where possible, behaviour of birds would be observed prior to a capture attempt and nets set-up around a favoured refuge or vegetation ‘corridor’. Judicious use of call playback was used to entice birds to approach the net, either using commercially available recordings or recordings of calls by local birds. Captured birds were banded with metal and colour bands and a blood sample taken through a puncture of the brachial (wing) vein for subsequent genetic analysis.

2.2 Data analysis

Trapping data from Bernier and Dorre Islands (and greater stick-nest rats on Salutation Island (see section 4.6) were analysed using the Spatially Explicit Capture Recapture (SECR) package (secr 4.0.6) in ‘R’ version 3.6.3 (R Core Team 2020) to provide density and abundance estimates.

3 Results

3.1 Shark Bay bandicoots

3.1.1 Dorre Island

A total of 62 captures of 24 individuals were recorded on Dorre Island in August 2020, from 512 trap nights. The sex ratio of individuals was 12M:12F and 14 were new individuals. Half of captured females had pouch young (PY) and two more were lactating, indicating they still had independent young-at-foot or had recently weaned. SECR analysis provided a population estimate of 6,445 (4,598-9,833) (Figure 1), representing an 11% increase on the 2019 estimate (see Appendix 1).

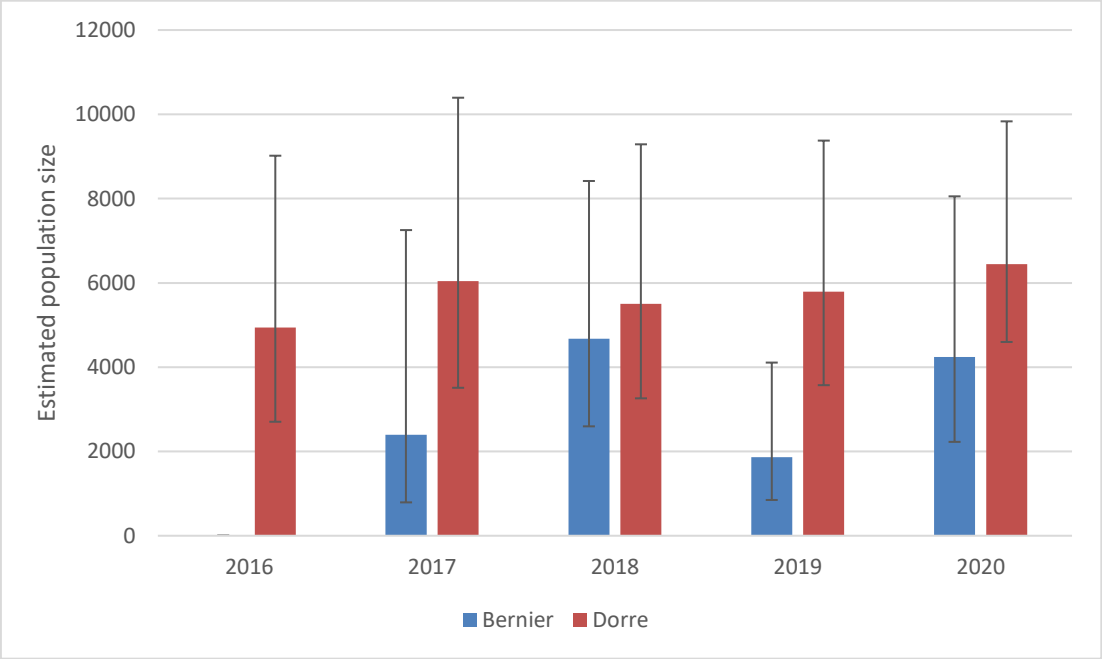


Figure 1. Population estimates for Shark Bay bandicoots on Bernier and Dorre Islands between 2016 and 2020, derived from SECR analysis on trapping data (NB. No data available for Bernier in 2016).

3.1.2 Bernier Island

A total of 24 captures of 14 individuals were recorded on Bernier Island in August 2020, from 512 trap nights. The sex ratio of individuals was 6M:8F and nine were new individuals. Seven out of eight (87.5%) females had PY. SECR analysis provided a population estimate of 4,244 (2,228-8,054) (Figure 1), representing a 127% increase on the 2019 estimate (see Appendix 1).

Based on these results, the harvest of up to 30 individuals from Bernier was permitted for translocation to DHI, following the 72 (52 from Dorre, 20 from Bernier) released in 2019 (Cowen *et al.* 2020). A total of 27 were translocated from Bernier to DHI in September 2020.

Two of the fourteen bandicoots (14%) had definite or probable warts and were swabbed for BPCV1 (both of which were positive on PCR). Five bandicoots (three of which had clinical symptoms of eye problems) were swabbed for chlamydia as part of a disease monitoring project run by Dr Fiona Knox for the rodent DRA. Two of the five returned positive results for chlamydiaecae DNA, albeit at low levels.

3.2 Boodies

3.2.1 Dorre Island

A total of 67 captures of 24 individuals were recorded on Dorre Island in August 2020, from 256 trap nights. The sex ratio of individuals was 13M:11F and 11 were new individuals. Five out of 11 females (45.5%) had PY, with another four reproductively active. SECR analysis provided a population estimate of 5,559 (3,904-8,679) (Figure 2), representing a 22% increase on the 2019 estimate (see Appendix 1).

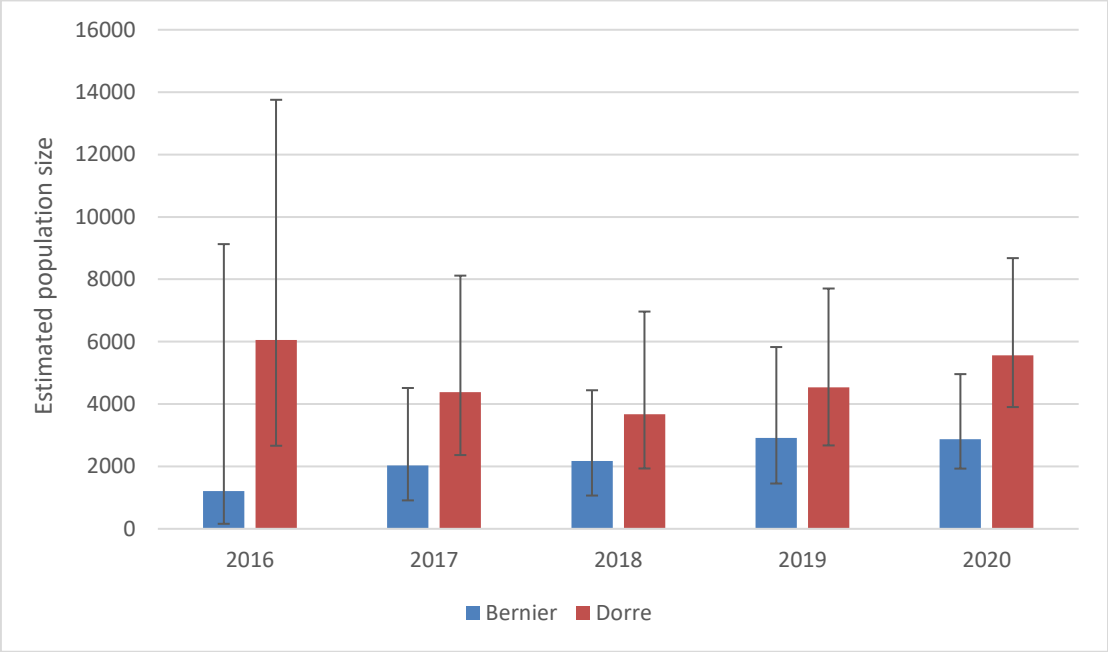


Figure 2. Population estimates for boodies on Bernier and Dorre Islands between 2016 and 2020, derived from SECR analysis on trapping data.

3.2.2 Bernier Island

A total of 37 captures of 14 individuals were recorded on Bernier Island in August 2020, from 256 trap nights. The sex ratio of individuals was 7M:7F and seven were new individuals. One out of seven females (14%) had PY, with another four reproductively active. SECR analysis provided a population estimate of 2,869 (1,931-4,960) (Figure 2), representing a 1% decrease on the 2019 estimate (Appendix 1).

3.3 Shark Bay mice

Five captures of three individual SBM were recorded across both bandicoot/boodie and Shark Bay mouse trapping grids on Bernier Island in August 2020, from 340 trap nights (1.5% trap success). An additional nine captures of 6 individuals (3M:3F) were recorded from the additional trap line established for rodent disease sampling (100 trap nights; 9% trap success). Unfortunately, capture data for the standard monitoring grids was insufficient for SECR analysis and a population estimate was not obtained. Monitoring results for comparison are shown in Appendix 1.

Eight Shark Bay mice were sampled under anaesthesia for possible infection with chlamydia as part of a disease monitoring project run by Dr Fiona Knox for the rodent DRA. Three animals returned positive results for chlamydiaecae DNA, although at low levels.

3.4 Dibblers

3.4.1 Boullanger and Whitlock Islands

Monitoring in June 2020 resulted in five individual dibblers being captured (1M:4F) on Boullanger Island, from 242 trap nights. One male and two females were new individuals and all females had PY, with three litters of eight and one of six. Eight individuals (5M:3F) were caught on Whitlock Island in June, from 80 trap nights. All individuals were recaptures and two females had PY, both having litters of six. Given the reduced trapping period, these results are not directly comparable to autumn 2019, when eight and 18 individuals were captured on Boullanger and Whitlock, respectively (Sims *et al.* 2020).

Monitoring in October 2020 resulted in 13 individuals being captured (6M:7F) on Boullanger, from 496 trap nights. This represented an increase of two individuals (or 18%) compared to October 2019 (Figure 3a). All but one individual were new. Ten individuals (7M:3F) were caught on Whitlock, from 159 trap nights. This represented a decrease of 54% compared to October 2019 (Figure 3b). Only two individuals were new.

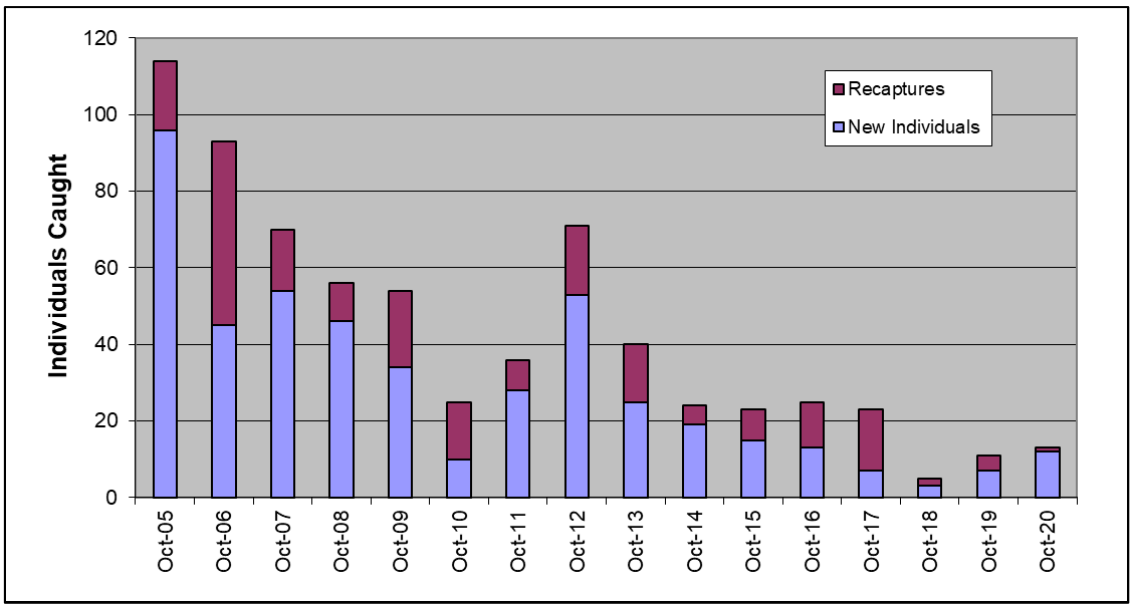
3.4.2 Escape Island

Monitoring in December 2020 resulted in 73 individuals being captured (37M:36F), from 395 trap nights. The last full monitoring of Escape Island took place in 2014, when 26 individuals were caught, and the 2020 result was 60% higher than the highest previous capture total in 2006 (T. Friend, *in litt*.).

3.4.3 Harvesting for captive population

To reinforce the captive population at Perth Zoo, an additional six subadults were taken from Escape Island (3M:3F) in December 2020. For the 2021 breeding season, the breeding program will have 20 individuals available (10M:10F).

a)



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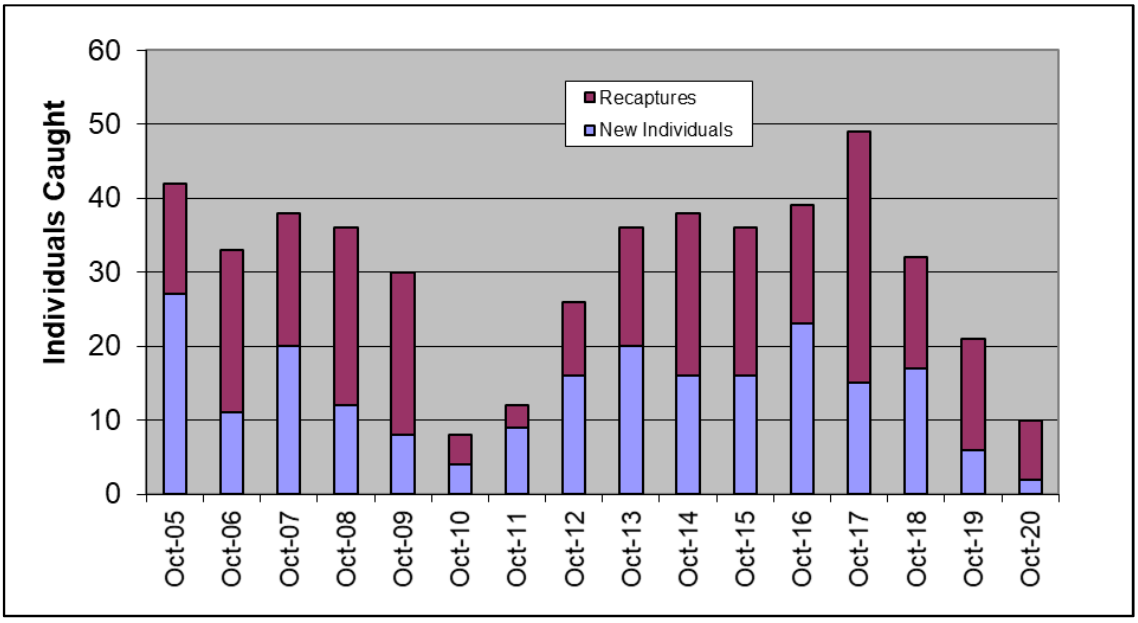

Figure 3. Numbers of October dibbler captures from (a) Boullanger and (b) Whitlock Islands between 2005 and 2020.

3.5 Western grasswren

3.5.1 2019 Hamelin Station Reserve

Survey and capture work for grasswrens in July/August 2019 resulted in 33 adults being captured. Further work (through A. Gibson Vega's PhD field-work) between August and October resulted in an additional 25 adult captures. Approximately 39 territories were located at or in proximity to Hamelin Station Reserve.

3.5.2 2020 Peron Peninsula and Hamelin Reserve

Survey and capture work for grasswrens in June and October 2020 resulted in 33 and 26 adults being captured, respectively. Approximately 71 territories were located in total. A further 27 territories were located, but birds were not captured. Further work by A. Gibson Vega at Hamelin Reserve between June and October resulted in an additional 8 adult captures. In total 125 adults were caught across both sites in 2019 and 2020 combined, plus 40 chicks and juveniles. Blood samples were obtained from 157 individuals. Figure 4 shows the locations of all western grasswren captures in Shark Bay area during 2019 and 2020.

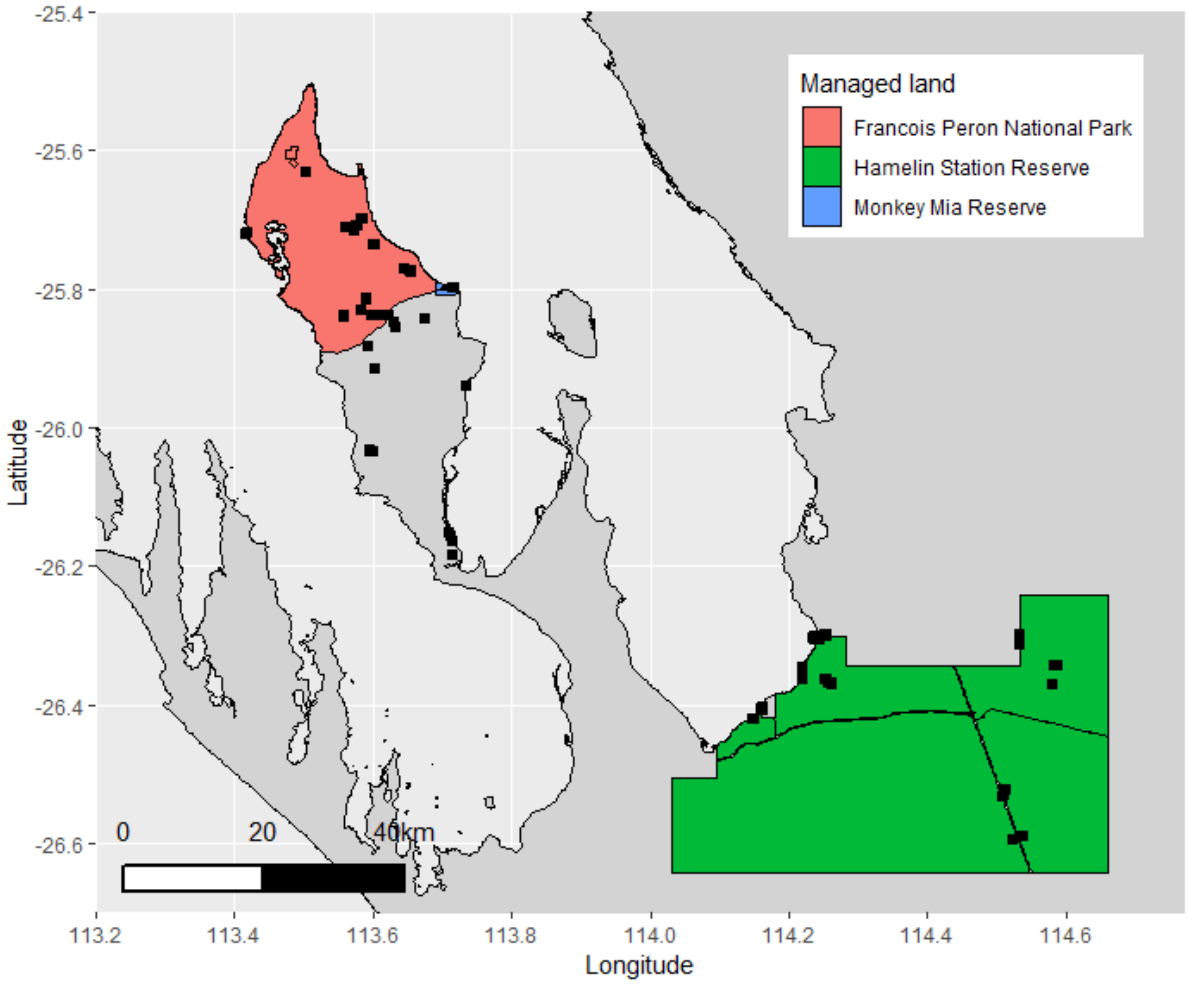

Figure 4. Map of all western grasswrens captures in Shark Bay in 2019 and 2020.

3.6 Rainfall

3.6.1 Shark Bay

Remote weather stations have been established by DBCA on Bernier, Dorre and DHI. Rainfall on Bernier Island in 2020 was 116mm, Dorre received 270mm and DHI received 178mm. In contrast, Carnarvon Airport only received 86mm (annual average 223mm) and Shark Bay Airport received 113mm (annual average 209mm). Dorre

received nearly three times more rainfall in 2020 than in 2019 (93mm) but rainfall on Bernier was comparable to the 128mm received in 2019 (Bureau of Meteorology, 2021).

3.6.2 Jurien Bay

Complete annual rainfall totals were unavailable for the Jurien Bay weather station in 2020. However, rainfall totals for Nambung Station (35km away) and Leeman (39km away) were 406mm and 338mm, respectively, which were both below the annual average of 549mm (Bureau of Meteorology, 2021).

4 Discussion

4.1 Shark Bay bandicoots

4.1.1 Population estimates and dynamics

Since 2017, population estimates for Shark Bay bandicoots (SBBs) on Bernier and Dorre Islands in 2020 were similar to previous estimates, although Dorre appears to be the more stable of the two populations. Since the last monitoring session in 2019, the population estimate for Bernier has more than doubled. There has been no observable impact of the removal of 52 individuals from Dorre and 20 individuals from Bernier for the 2019 translocation to DHI. The 2020 estimate for Bernier Island was also sufficient to permit an additional harvest of up to 30 animals (1.3% of LCL estimate; see Appendix 1) for supplementation of the DHI translocated population, of which 27 were translocated in September 2020. In total, 99 individuals (52 from Dorre, 47 from Bernier) have been released on DHI.

Rainfall fluctuations on Bernier and Dorre Islands have been shown to have corresponding effects on the islands' vegetation (van Dongen *et al.* 2019) and this is understood to play a role on population dynamics of the mammal species that occur there (Short *et al.* 1997, Chapman *et al.* 2015). Based on the results of monitoring on Bernier and Dorre in 2020, populations of SBBs (and boodies) appear to have remained stable since 2016, despite several years of below average rainfall and harvesting of the former species for several translocation programs. However, the exact relationship between rainfall and mammal population dynamics (including lag time) is uncertain and likely to vary depending on the species.

4.1.2 Disease

The relatively high density of bandicoots on Bernier Island in 2020 was accompanied by obvious presence of clinical disease due to BPCV1, which appears to be consistent with previous historical data indicating a higher prevalence of the disease when population density is high. Surveillance swabbing for chlamydia on Bernier Island resulted in positive results for chlamydieacea DNA in all three species sampled (ash-grey mice, Shark Bay mice, Shark Bay bandicoots). However, the three bandicoots with clear clinical signs of eye pathology, proved negative for

chalmydia. Dr Knox believes that another infectious agent (which would not be identified with the chlamydia specific testing) may be responsible, but that would require further investigation.

4.2 Boodies

Since 2016, population estimates for boodies on Bernier and Dorre Islands have been similar, with a minor increase in the mean estimate for Dorre and a minor decrease for Bernier in 2020.

4.3 Shark Bay mice

A low capture rate meant a population estimate for the Shark Bay mouse (SBM) could not be obtained in 2020. It is possible that above average numbers of ash-grey mice were partly responsible for their low capture success. However, variable capture success has been noted for this species in previous years (see Appendix 1) and may relate to other factors. The higher capture success on the extra Elliott trap line may indicate that the habitat where the main grid is situated is sub-optimal for SBMs. The additional traps were in coastal spinifex (*Spinifex longifolius*) dominated habitat, which is understood to be the preferred habitat of the species (Morris *et al.* 2000).

Analysis of swab samples taken from Shark Bay mice were also negative for chlamydia.

4.4 Dibblers

Capture numbers of dibblers on Boullanger Island continue to be relatively low, although numbers have increased slightly since an apparent crash in 2018. This population tends to fluctuate widely, with similarly low numbers in 2009, 2011 and 2014 (Figure 5). However, historically, the population has generally experienced a rapid recovery, something that has not been observed in recent years.

A similar result was observed on Whitlock Island, where the number of captures in 2020 was at a similar level to 2010 (Figure 3b). It is possible that, with below average rainfall between 2017 and 2020 (Sims *et al.* 2020), has reduced productivity. However, the population on Escape Island reached its highest recorded level of captures in 2020. It has also been suggested that low genetic diversity and inbreeding on Boullanger and Whitlock may be playing a role in their poor performance, in contrast to the artificially admixed population on Escape (D. White *pers. comm.*). However, more work is required to investigate this and the declines of the Boullanger and Whitlock populations highlight the importance of establishing a large, admixed population on DHI to preserve this distinct conservation management unit (Mills *et al.* 2004).

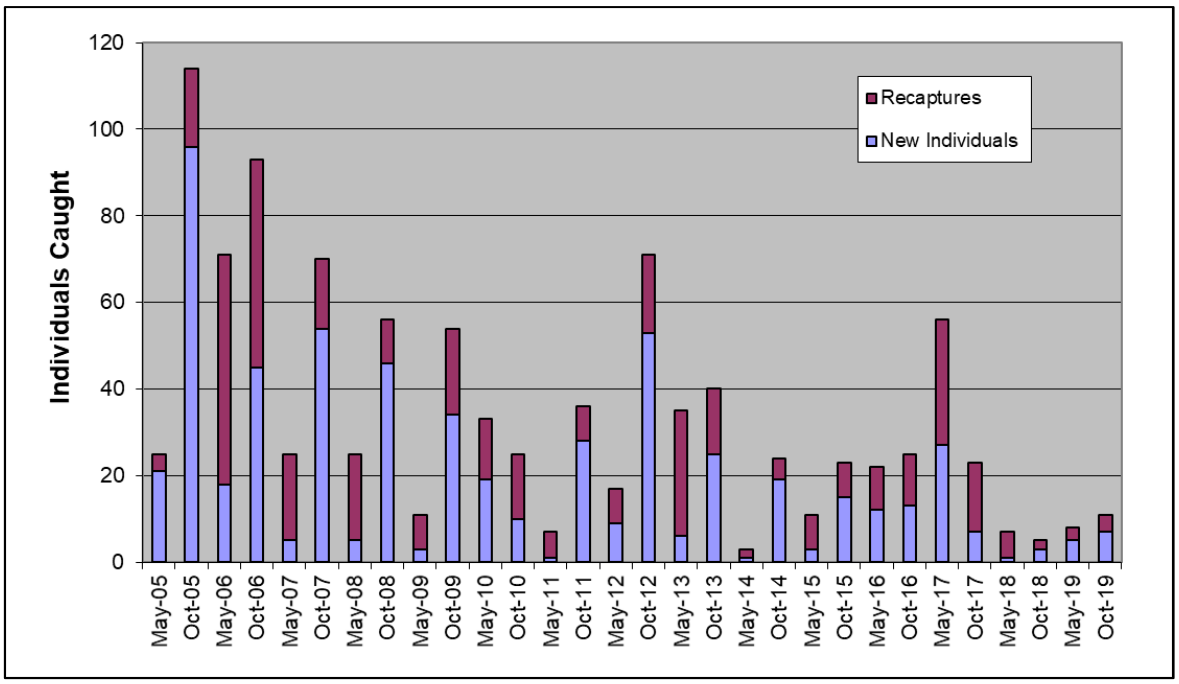

Figure 5. Numbers of dibbler capture on Boullanger Island 2005-2019.

4.5 Western grasswrens

Western grasswrens appear to be widespread in suitable habitat within the two study sites in Shark Bay. At Hamelin Station Reserve there are three apparent clusters in the north-west, north-east and south of the reserve. On Peron Peninsula, grasswrens occur discontinuously throughout the peninsula, with clusters in the north-east, centre and south-east. However, the method of survey used in 2019 and 2020 was not exhaustive and it is likely that grasswrens are more widespread at both locations than indicated here. The results of these preliminary surveys will be useful for designing a more rigorous survey methodology in the future, prior to the proposed translocations to DHI. The research being undertaken by A. Gibson Vega will help clarify a number of questions about these two populations, such as how genetically and behaviourally similar they are and what the levels of genetic diversity are in each population. This information will be invaluable in developing a translocation strategy for this species.

4.6 Future monitoring plans

Table 1 shows the current programmed source population monitoring surveys to be undertaken in 2021.

Monitoring of SBM on Northwest Island (Montebello Islands) is planned for April 2021, ahead of a proposed translocation of up to 80 individuals to DHI.

Monitoring of the greater stick-nest rat (*Leporillus conditor*) population on Salutation Island in Shark Bay has previously been undertaken by Parks and Wildlife Service (PWS) Shark Bay District staff. Analysis (using SECR) of monitoring (Elliott trap) data from May 2020 resulted in an estimated a population size of 2,760 (2,230-3,438). This population experiences irruptive population dynamics (boom-bust) and this relatively high estimate indicates the island was experiencing a boom in 2020. The next monitoring is scheduled for May 2021, with DHINPERP staff assisting, and if numbers remain sufficient for a sustainable harvest, a translocation of up 60 individuals to DHI is planned.

Monitoring for heath mice (*Pseudomys shortridgei*) was led by staff from PWS South Coast and Wheatbelt Regions at a number of sites between the Fitzgerald River National Park and the Great Western Woodlands in 2019 and 2020. Two individuals were recorded at two sites in 2019 but one site was subsequently burned in a bushfire and surveys in 2020 failed to record any heath mice. More surveys are planned for August/September 2021, in collaboration with DHINPERP and regional DBCA staff.

Table 1. Source population monitoring planned for 2021 calendar year (SBB, Shark Bay bandicoot; SBM, Shark Bay mouse; BB, boodie; GSNR, greater stick-nest rat).

Species	Location	Timing
SBB/SBM/BB	Bernier Island	March
SBM	Northwest Island	April
GSNR	Salutation Island	May
Dibbler	Boullanger/Whitlock Islands	May
Heath Mouse	South Coast/Wheatbelt regions	Aug/Sep
Dibbler	Boullanger/Whitlock Islands	October
Dibbler	Escape Island	December

References

Chapman, T. F., C. Sims, N. D. Thomas and L. Reinhold (2015). Assessment of mammal populations on Bernier and Dorre Island 2006-2013. Department of Parks and Wildlife, Perth WA.

Cowen, S., K. Rayner, C. Sims, T. Friend, F. Knox, K. Ottewell and L. Gibson (2020). Dirk Hartog Island National Park Ecological Restoration Project: Stage Two – Year Two Translocation and Monitoring Report. Department of Biodiversity, Conservation and Attractions, Perth WA.

Mills, H. R., D. Moro and P. B. S. Spencer (2004). "Conservation significance of island versus mainland populations: a case study of dibblers (*Parantechinus apicalis*) in Western Australia." Animal Conservation **7**(4): 387-395.

Morris, K., P. Speldewinde and P. Orell (2000). Djoongari (Shark Bay Mouse), *Pseudomys fieldi*, Recovery Plan 1992-2001. Department of Conservation and Land Management, Perth WA.

R Core Team (2020). "'R: A language and environment for statistical computing'. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/."

Short, J., B. Turner, C. Majors and J. Leone (1997). "The fluctuating abundance of endangered mammals on Bernier and Dorre Islands, Western Australia - Conservation implications." Australian Mammalogy **20**: 53-61.

Sims, C., S. Cowen, S. Garretson and J. A. Friend (2020). Monitoring Source Populations of Fauna for the Dirk Hartog Island National Park Ecological Restoration Project – 2019, Department of Biodiversity Conservation and Attractions, Perth WA.

van Dongen, R., S. Cowen and C. Sims (2019). Bernier and Dorre Islands vegetation cover report: 2019, Department of Biodiversity Conservation and Attractions, Perth WA.

Vaughan-Higgins, R., S. Vitali and A. Reiss (2018). Western barred bandicoot (*Perameles bougainville*) proposed translocation: Disease risk analysis (DRA). Perth WA.

Woolford, L. (2017). Protocol for detection of BPCV1 by surface skin or lesion swab.

Woolford, L., A. Rector, M. Van Ranst, A. Ducki, M. D. Bennett, P. K. Nicholls, K. S. Warren, R. A. Swan, G. E. Wilcox and A. J. O'Hara (2007). "A novel virus detected in papillomas and carcinomas of the endangered western barred bandicoot (*Perameles bougainville*) exhibits genomic features of both the Papillomaviridae and Polyomaviridae." Journal of Virology **81**(24): 13280-13290.

Appendices

Appendix 1 Density and abundance estimates for from trapping data at Dorre and Bernier Island 2016-2020

(* Denotes poor model fit (** worse))

1a. 5134ha Dorre Island (habitat area used for calculating abundance ~ 4815ha)

Species	Year	N	Density/ha	SE	LCL density	UCL density	Mean popn	LCL popn	UCL popn
SBB	2016	16	1.03	0.32	0.56	1.87	4939	**2705**	9018
SBB	2017	16	1.25	0.35	0.73	2.16	6041	**3511**	10394
SBB	2018	16	1.14	0.31	0.68	1.93	5503	**3261**	9288
SBB	2019	19	1.20	0.30	0.74	1.95	5788	**3573**	9376
SBB	2020	24	1.34	0.27	0.95	2.04	6445	**4598**	9833
BB	*2016	12	1.26	0.55	0.55	2.86	6053	**2664**	13755
BB	2017	12	0.91	0.29	0.49	1.69	4382	**2365**	8118
BB	2018	14	0.76	0.26	0.40	1.45	3672	**1935**	6966
BB	2019	16	0.94	0.26	0.56	1.60	4539	**2674**	7705
BB	2020	24	1.15	0.24	0.81	1.80	5559	**3904**	8679

1b. 4267ha Bernier Island (habitat area used for calculating abundance ~ 3750ha)

Species	Year	N	Density/ha	SE	LCL density	UCL density	Mean popn	LCL popn	UCL popn
SBB	**2017	8	0.64	0.39	0.21	1.93	2397	**792**	7253
SBB	2018	15	1.25	0.38	0.69	2.24	4675	**2596**	8418
SBB	*2019	7	0.50	0.21	0.23	1.10	1868	**849**	4109
SBB	2020	14	1.13	0.38	0.59	2.15	4244	**2228**	8054
BB	**2016	5	0.32	0.44	0.04	2.43	1213	**161**	9128

BB	*2017	7	0.54	0.23	0.24	1.20	2029	**912**	4515
BB	2018	8	0.58	0.22	0.28	1.18	2177	**1067**	4443
BB	2019	10	0.78	0.28	0.39	1.55	2910	**1453**	5828
BB	2020	14	0.77	0.19	0.51	1.32	2869	**1931**	4960
SBM	**2016	7	1.55	2.28	0.19	12.72	5458	704	47692
SBM	*2018	8	0.33	0.23	0.10	1.13	1251	**369**	4238
SBM	*2019	11	1.42	0.84	0.49	4.16	5335	**1823**	15614
SBM	2020	3	n/a	n/a	n/a	n/a	n/a	**n/a**	n/a