Monitoring Fauna Source Populations for the Dirk Hartog Island National Park Ecological Restoration Project - 2017/18

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Biodiversity and Conservation Science

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GOVERNMENT OF WESTERN AUSTRALIA

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Contents

Appendices

Figures

Tables

Acknowledgments

We acknowledge that the conservation work we do is on the traditional lands and waters, ‘Gutharraguda’ of the Malgana people.

We would like to thank Sean Garretson and John Angus, and the many other Department of Biodiversity, Conservation and Attractions staff and volunteers who worked so hard, in often trying conditions to assist in collection of the data used in this report. We also thank the Mid-west and Pilbara regional Parks and Wildlife staff who assisted with logistics, communications and support from Shark Bay, Carnarvon, Exmouth, Karratha and Jurien Bay offices. The work on the islands of Shark Bay and Montebello group could not be achieved without the skilled and professional services provided by the skipper and crews of the support vessel *KeshiMer II*used during the monitoring program. This work was undertaken with DBCA animal ethics approval 2016/10.

Summary

Monitoring of the island source populations of seven species of mammal was undertaken by the Department of Biodiversity Conservation and Attractions in 2017/18 to obtain information on their distribution and abundance prior to translocation to Dirk Hartog Island National Park as part of the Dirk Hartog Island National Park Ecological Restoration Project. Monitoring of three of these species was also undertaken to inform proposed translocations to the Mt Gibson wildlife sanctuary by the Australian Wildlife Conservancy.

Monitoring of banded and rufous hare-wallabies on Bernier and Dorre Islands in August 2017 provided combined estimates of abundance of 6715 (5176 - 8712)banded and 3415 (2329-5006)rufous hare-wallabies on both islands. Subsequent harvesting of banded and rufous hare-wallabies for the trial translocation to Dirk Hartog Island National Park by the Department, and of banded hare-wallabies by Australian Wildlife Conservancy for the Mt Gibson sanctuary, removed an estimated 1.4% of the banded hare-wallaby population and 0.5% of the rufous hare-wallabies.

Boodie and western barred bandicoot population estimates on Bernier and Dorre Islands were less confident due to the smaller numbers observed during the monitoring, but like the hare-wallabies, appeared to be more abundant than the 2016 estimates. This was despite lower than average rainfall recorded at nearby Carnarvon, for the previous 12 months. Reproductive rates of all species on Bernier and Dorre Islands at this time were lower than for the same period in 2016.The disturbance of Elliott traps by boodies prevented the capture of Shark Bay mice on Bernier Island, although they were known to be present by observations of their tracks and sightings during the spotlight survey. No estimate of Shark Bay mouse abundance was obtained for Bernier Island.

The below average rainfall recorded for Dorre Island through the spring and summer of 2017/18, may significantly impact population numbers of all species in 2018. The next monitoring of these populations will occur in April 2018.

Monitoring of the mala population on Trimouille Island and Shark Bay mouse on North West Island in the Montebello group occurred in October 2017. Population abundance for mala was estimated by Program Distance analysis in ‘R’ to be 1227 (864-1742), a 50% increase on the 2016 estimate. Although trap success rates for Shark Bay mice on North West Island was <50% of 2016 figures, the population is still relatively abundant and distributed across the island. Following monitoring, 42 Shark Bay mice were removed from North West Island for translocation to the Mt Gibson sanctuary.

Plans to harvest 20 dibblers from the Jurien Bay Island populations, for a captive breeding program at Perth Zoo in January 2018, did not proceed due to low capture rates, and high numbers of feral mice. Further monitoring of these populations is planned for May 2018.

1 Introduction

The Dirk Hartog Island National Park Ecological Restoration Project (DHINPERP) aims to return Western Australia's largest island (60,000 ha) to the ecological state it was in when the Dutch navigator Dirk Hartog first visited the island in 1616. With the eradication of sheep and feral goats, and indications that feral cats have also been eradicated, planning for Stage 2, the reconstruction of the island's vertebrate fauna has commenced (Morris *et al*. 2016). Twelve species of mammal (mostly threatened species) and one bird species will be translocated to Dirk Hartog Island (DHI) over a 12 year period, from 2018 - 2030. Department of Biodiversity, Conservation and Attractions (DBCA) Translocations Proposals follow the IUCN guidelines for reintroductions and other conservation translocations (IUCN 2013) and require that monitoring of source populations is undertaken before and after harvesting of founders, to ensure that the viability and health of these populations is not compromised by harvesting.

The DHINPERP Stage 2 plans originally proposed starting translocations of species to DHI in 2018, two years after eradication of feral cats from the island. However after eradication from the southern half of the island (fenced off from the north) in 2015, a trial translocation of a small number of the banded hare-wallaby *Lagostrophus fasciatus fasciatus* and the rufous hare-wallaby *Lagorchestes hirsutus bernieri* was undertaken in August / September 2017 to trial logistics, capture, transport and monitoring techniques. In preparation for this, monitoring of the potential source populations on Bernier and Dorre Islands in Shark Bay, and North West and Trimouille Islands in the Montebello group for the species to be translocated over the first few years was commenced in 2016. In 2017, monitoring of populations of banded hare-wallaby, rufous hare-wallaby, boodie *Bettongia lesueur*, western barred bandicoot *Perameles bougainville bougainville* and Shark Bay mice *Pseudomys fieldi* was undertaken on Bernier and Dorre Islands in August, and mainland rufous hare-wallaby (mala) and Shark Bay mice populations on the Montebello Islands undertaken in October. Dibblers *Parantechinus apicalis* were scheduled for a release on DHI in October 2018 after a program of captive breeding to provide sufficient founders for release. Regular monitoring of the proposed source populations on Boullanger, and Whitlock islands, Jurien Bay, occurred in May and October 2017,and in January 2018 a trip to collect breeding stock for the Perth Zoo was undertaken.

This report documents the monitoring activities undertaken in August 2017 on Bernier and Dorre Islands in Shark Bay, in October 2017 on North West and Trimouille Islands in the Montebello group, and in January 2018 on the Jurien Bay islands. It presents both qualitative assessments and quantitative analysis of data collected during this monitoring, and where possible a comparison with 2016 monitoring results. Monitoring undertaken on Berner and Dorre Islands in April 2018 will be reported separately.

2 Methods

2.1 Logistics and transport

Access to the source populations on Bernier and Dorre Islands in Shark Bay and North West and Trimouille Islands in the Montebello group is a difficult and expensive operation, due to the remoteness, ruggedness and frequent exposure to strong winds and variable tides. None of the islands have infrastructure from which to work and all were accessed for extended field trips of 5-10 days using the 'live-aboard' charter vessel *Keshi Mer II*. Access onto the islands for survey and trapping work was via a semi-rigid inflatable tender and was dependent on favourable weather, wind and sea (including tide) conditions. Judgements and modifications to the program were required at times based on current and forecast conditions for the next 24hours, to ensure the welfare and safety of the animals being monitored, personnel and vessel.

The Jurien Bay Islands are a relatively short distance off the coast adjacent to the mid-west town of Jurien. Consequently personnel stayed in accommodation in Jurien and accessed the islands on a daily basis using a small semi-rigid inflatable boat made available by the Jurien Bay District DBCA office. As with the other islands, access to check and clear traps was dependent on favourable weather conditions.

2.2 Trapping

One trapping grid of 49 trap points in a 7x7 pattern with each trap point spaced at 40m intervals has been established on Bernier and Dorre Islands. Grids were trapped for four nights. Traps were left open during the day, but checked morning and evening. Each trap point had one collapsible small cage trap (~31 x 31 x 70cm – Sheffield Wire) plus one medium Elliott trap (90 x 100 x 330mm aluminium box trap) located at it. The total trapping effort was 196 cage trap nights and 196 Elliott trap nights. All cage traps were covered with individual new hessian bags which are replaced for each trip, and for each island in accordance with quarantine and disease control protocols (Murdoch University 2007; Chapman *et al*. 2011). Elliott traps were also covered with either hessian or plastic film wrap, to provide shade or protection from rain, depending on their positions on the ground. Traps were checked and cleared within three hours of sunrise. Traps were rechecked in the late afternoon and diurnal non-target captures such as birds and reptiles were released, and traps re-set before sunset. All trap points have a permanent short peg in the ground and are re-flagged with fresh flagging tape as required each session. Each is also recorded on a hand-held GPS.

Trapping grids were located at the most accessible and weather-flexible landing points on each island (White Beach on Dorre Island and Red Cliff Bay on Bernier Island).

In addition, a second, smaller grid of 21 trap points, in a 7x3 pattern, spaced at 40m intervals 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. This grid

used only medium Elliott traps. In 2017, no protection from boodie interference was employed on this grid, and almost all traps were rendered unavailable by disturbance. Only one Shark Bay mouse was captured and unfortunately escaped before any information could be recorded. Additional measures will be put in place in 2018 to address this issue and exclude boodies as much as possible.

The grid used to monitor Shark Bay mice on North West Island is a replicate of the one used on Bernier Island, comprising 21 medium Elliott traps set in a 3x7 pattern spaced at 40m intervals. An additional 100 Elliott traps were set for two nights in fore-dune and back of beach areas on the western end of the island in October 2017, to capture individuals for translocation.

All traps were baited with 'Universal bait' comprising peanut butter and rolled oats.

All captured animals were individually identified with either a Passive Implant Transponder (PIT, Allflex^{TM} FDX-B Microchip, ca.11 x 3mm) for larger species or ear punch number for the smaller Shark Bay mice. Ash-grey mice (*Pseudomys albocinereus*) were temporarily marked in the ear with a non-toxic marking pen. Their weight, pes length, head length, and tail length was measured, and their reproductive, body condition and measurements recorded.

Because of previous incidences of the wart like disease in western barred bandicoots, these individuals had their health and skin/coat condition carefully examined for signs of warty/eczema-like lesions that could be indicative of active infection with BPCV1 virus.

All tissue samples collected from ear punches for each new individual (usually two samples, one from each ear, placed in a single vial) were stored in 80% ethanol and labelled with species, sex, date and location. They will be used to contribute to a number of studies on genetic variation, taxonomy and species health.

Additional ear tissue samples were taken from six rufous hare-wallabies, three from each of Bernier and Dorre Islands, which were translocated to DHINP as part of the 2017 trial translocation. Tissue samples were also taken from three mala on Trimouille Island. All these samples were sent to Janine Deakin at the University of Canberra for karyotyping to determine relationship of the different remnant rufous hare-wallaby populations / subspecies.

Trapping for dibblers on Boullanger and Whitlock Islands used medium Elliott traps placed on the permanent monitoring transects, plus additional traps placed on the eastern headland of Boullanger Island.

2.3 Spotlighting

Spotlight surveys for banded and rufous hare-wallabies, boodies and western barred bandicoots were undertaken using three teams each comprising two observers. The primary observer used a Lightforce 'Striker' hand held spotlight (170mm reflector, 12V 35W HID globe with 4200K colour rendering and adjustable focus), powered by 6 or 9 amp hr LiFePO4 batteries, and infra-red range finder. The second person acted as a recorder, navigator and secondary observer, using a Trimble PDA loaded with the TerraSync software program and bluetooth connection to the range finder,

to follow pre-programmed transect lines and record GPS location of, and distance to the target animals observed.

All transect lines were laid out in an east-west orientation across the width of each of Bernier, Dorre and Trimouille Islands and were walked on a single latitudinal line using the UTM 'Northing' which uses a scale in meters that allows estimation of position in relation to transect line. Each team surveys between two and five transects per night with surveys beginning soon after dark and last transects completed before midnight.

2.4 Capture and transport for translocations

All banded and rufous hare-wallabies for translocation to DHINP were captured at night using the Lightforce spotlights described above, head torches and long handled scoop nets with an open soft mesh net and a hoop diameter of 400-500mm. Once captured, each animal was checked for condition, weight and sex and either selected for translocation or released at capture site. Those selected for translocation were put into black cotton handling bag, labelled with an individual identification, weight, species and sex and placed in medium Pet Packs, two animals per pack. Once sufficient animals had been captured, they were carried to the beach and transferred to the main vessel by the tender in dry containers. All hare-wallabies received treatment at capture with Selenium and Vitamin E to protect against stress myopathy, and all rufous hare-wallabies were injected with the sedative diazepam at time and point of capture, and then followed up within 1.5 hours with azaperone on arrival on the vessel prior to departure. Animals were captured and processed between dusk and 2230 hrs, and all were settled in their Pet Packs in the centre of the deck under cover by 2330 hrs. The boat journey from Bernier or Dorre Island took ~4-5.5 hours, and the animals were transferred to shore on Dirk Hartog Island at first light.

2.5 Analysis

Abundance and density estimates were obtained from spotlight survey data using the Distance package (Thomas *et al*. 2010) in 'R' version 3.4.4 (R Core Team 2018).

Trapping data from Bernier, Dorre and North West Islands are in the process of being analysed using the Spatially Explicit Capture Recapture package in 'R' version 3.4.3 to provide density and abundance estimates.

3 Results

3.1 Dorre Island, Shark Bay

Dorre Island monitoring was undertaken between the 2 - 11 August 2017, with four nights trapping from 3 – 7 August and four nights spotlighting from 7 – 10 August.

3.1.1 Trapping

The full four nights trapping were successfully completed and trap results, with comparisons to 2016, are provided in Table 1.

Table 1. Dorre Island trapping results.

Species / Year	No. captures	No. Individuals	No. New individuals	% Females reproductive	Trap rates	Density
WBB 2017	41	16(6:10)	5(2:3)	0/10	10.5%	TBA
WBB 2016	46	17(9:8)	N/A	5/9	11.7%	0.92/ha
Boodie 2017	33	13(5:8)	7(3:4)	2+2?/8	16.8%	TBA
Boodies 2016	20	12(8:4)	N/A	4/4	10.2%	1.04/ha
AGM 2017	6	6(5:1)	N/A		3.1%	N/A
AGM 2016	2	2(1:1)	N/A		1.0%	N/A

WBB= western barred bandicoot; **AGM** = ash-grey mouse (male: female ratio)

A similar number of western barred bandicoots were captured in 2017 as 2016, however no females showed signs of being reproductive compared to 2016, when over 50% were breeding. Of the five new individuals, some appeared to be new recruits from recent (2017) breeding events.

There were 50% more captures of boodies in 2017 than 2016, but this reflected a higher re-trap rate, as the total number of individuals, were almost identical the same as 2016. As with western barred bandicoots, it appears that fewer boodies were in reproductive condition. Two of the females captured in 2017 had pouch young and a further two had moist pouches, suggestive of activity preparatory to giving birth. This is approximately 50% of the females, compared to 2016, when 100% of females were breeding. Several animals were recorded as being in poor body condition. Of the 13 individuals, 2 were sub-adults, indicating some breeding had occurred earlier in the year.

Although three times as many ash-grey mice were captured in 2017 as in 2016, only one of the six individuals was a female.

Density estimates from spatially explicit capture recapture (SECR) analysis for boodies and western barred bandicoots on Dorre Island are yet to be completed.

3.1.2 Spotlighting

All 27 spotlight transects on Dorre Island were completed, but the survey in one block (DP) was disrupted by heavy rainfall part-way through and three of the four transects were not surveyed, leaving 24 transects for the analysis. Total numbers of animals observed for each species, and number per km of transect surveyed are shown in Table 2.

Table 2. Dorre Island 2016 and 2017 spotlighting results.

Species	No. sightings 2017	No. sightings 2016	Rain Adjusted 2017	No. per km transect 2017	PY or clearly 'young' animals (Y/N)
WBB	21	9	19	0.470	N
Boodie	50	43	49	1.261	N
BHW	79	60	78	2.008	Y
RHW	46	39	46	1.184	Y
AGM	1	0	1	0.026*	?

WBB= western barred bandicoot; **BHW** = banded hare-wallaby; **RHW** = rufous hare-wallaby; **AGM** = ash-grey mouse.

The comparison of 2017 to 2016 field data (total numbers observed for each species), in conjunction with 2016 abundance estimates derived from Program Distance analysis, was used to inform the decisions on approval for harvesting of hare-wallabies and western barred bandicoots for the translocations in August and September 2017.

Pouch young, young at-heel and sub-adult individuals of both hare-wallaby species were sighted during the spotlight surveys, indicating that some breeding had occurred during 2017.

3.2 Bernier Island, Shark Bay

Bernier Island monitoring was undertaken between the 18 - 27 August 2017, with three nights trapping from 18 - 21 August and three nights spotlighting from 24 - 26 August.

It should be noted that the monitoring program on Bernier and Dorre Islands was disrupted by very strong winds and heavy rain, resulting in a reduced survey effort for both the trapping and spotlight survey programs.

3.2.1 Trapping

Only three nights trapping was possible on Bernier Island due to strong winds and the loss of the charter vessel's tender. On the third morning, after loss of the tender overnight, three staff had to swim ashore to clear and close all traps. Traps were cleared as soon as possible and animals were released with only species, sex and if N/R/RT (PIT scanned) being recorded. However, no other processing occurred and no new animals had PITs implanted). The results of the trapping on Bernier Island in both 2016 and 2017 are shown in Table 3.

Table 3. Bernier Island trapping results (only 3 nights trapping in each year).

Species/ Year	No. captures	No. Individuals	No. New individuals	% Female reproductive	Trap rates	Density
WBB 2017	8	5(2:3)	5(2:3)	0/3	2.0%	TBA?
WBB 2016	2	2(1:1)	N/A	1/1	0.5%	N/A
Boodie 2017	21	7(3:4)	5(2:3)	0/4	10.7 %	TBA
Boodie 2016	7	5(4:1)	N/A	1/1	3.6%	N/A
AGM 2017	1	1(1:0)	1(1:0)	N/A	0.5%	N/A
AGM 2016	0		N/A			
BHW 2017	2 (both juv.)	2(2:0)	2(2:0)	N/A	1.0%	N/A
BHW 2016	0		N/A			
SBM 2017 (+SBM grid)	1 (escaped)	1	?	?	---	N/A
SBM 2016 (+SBM grid)	8	7(3:4)	N/A	3/4	2.9%	N/A

WBB= western barred bandicoot; **SBM**= Shark Bay mouse; **AGM** = ash-grey mouse.

Again, although the numbers of animals trapped on Bernier Island were higher in 2017 than in 2016 for the same number of trap nights, there was a difference in the number of reproductive females.

The trap success rate for western barred bandicoots in 2017 was four times that recorded in 2016, and there were also more individuals in total. However, the total trapped was still only five animals. No females were reproductive, but at least one of the five animals captured was of sub-adult size, indicating there had been some breeding earlier in the year.

One female western barred bandicoot was recorded as having some suspicious patches on the skin of the hind feet and chin, but there was no equipment for sampling of lesions, so further investigation was not possible.

There were three times as many boodies captures in 2017 as in 2016, and more individuals captured as well. No females were reproductive, but two of the four females were virginal (i.e. although probably 'adult', they were young enough to have not yet bred at all).

Only one Shark Bay mouse was captured on either grid and it unfortunately escaped before any data could be recorded. Disturbance of the Elliott traps at the designated Shark Bay mouse grid by boodies and crows in 2017 did not appear to have been as severe in 2016, based on the capture rates that year.

There were insufficient captures of western barred bandicoots and Shark Bay mice on Bernier Island for analysis.

Density estimates for boodies on Bernier Island are yet to be completed.

3.2.2 Spotlighting

Spotlight surveys were also severely curtailed due to the time lost waiting for the replacement tender and continuing strong winds preventing access to the island and specific transects. Consequently, only 16 of the 27 transects were surveyed over three nights and able to be used for Program Distance analysis. The results of animals observed on the equivalent transects during the spotlight surveys in 2017 and 2016 are compared in Table 4.

Table 4. Bernier Island 2016 and 2017 spotlighting results.

Species	No. sightings 2017	No. sightings 2016 (for same length)	No. per km transect 2017	PY or clearly 'young' animals (Y/N)
WBB	6	15	0.21*	N
Boodie	17	17	0.56	N
BHW	68	54	2.40	N
RHW	38	23	1.34	N
AGM	5	3	0.18*	N
SBM	0	0	0	N/A

WBB= western barred bandicoot; **BHW** = banded hare-wallaby; **RHW** = rufous hare-wallaby; **AGM** = ash-grey mouse; **SBM** = Shark Bay mouse.

The above comparison of 2017 to 2016 raw data for the identical transects (total numbers observed for each species), in conjunction with 2016 abundance estimates derived from Distance analysis, was used to inform the decisions on approval for harvesting of hare-wallabies and western barred bandicoots for translocations in August and September 2017.

Sub-adult rufous and banded hare-wallabies were observed during spotlighting, indicating that there had been some breeding activity earlier in 2017.

3.3 Bernier and Dorre Islands combined population estimates

As a result of the short time-frame to undertake source population monitoring prior to the translocations, there was insufficient time for a full statistical analysis of the resultant survey data. However, a qualitative assessment of the raw survey data (i.e. similarity to numbers of observations from the previous season's data) assisted in the decision to proceed with the translocation. Subsequent abundance estimates obtained using Distance sampling analysis for the 2017 dataset, further vindicated this decision. Table 5 compares the 2011 to 2017 abundance estimates for banded and rufous hare-wallabies, boodies and western barred bandicoots for Bernier and Dorre Islands separately, and the estimates for the two islands combined, along with the upper and lower confidence limits are shown in Table 6. 2017 abundance estimates (with lower and upper confidence limits) for the species on Bernier and Dorre Islands are seen in Figure 1e, and plotted against the recent previous estimates in Figures 1a-d.

Of the species of interest, only banded hare-wallabies were observed in sufficient numbers on both Bernier and Dorre Islands to satisfy the recommended minimum

number (60) for calculating Detection Functions with confidence, in order to calculate separate estimates for each island. However, the combined observations for Bernier and Dorre Islands together were sufficient to derive confident Global Detection Functions and combined population estimates for both boodies and rufous hare-wallabies, as well as for banded hare-wallabies. The estimates derived for western barred bandicoots should be viewed with less confidence, as the recommended minimum sample size of 60 for calculating detection functions was not reached for this species, even when combining data from both islands.

Table 5. Abundance estimates for all species, Bernier and Dorre Island, 2011-2017 (figures in red did not reach recommended minimum samples sizes) (LCL = lower 95% confidence limits, UCL= upper confidence limits)

Bernier: BHW

	N	SE	LCL	UCL
2011	668	262.02	277	1609
2012	2017	526.41	1124	3620
2013	2627	508.65	1717	4020
2016	2790	504.22	1892	4115
2017	**3540**	**586.98**	**2523**	**4966**

Dorre: BHW

N	SE	LCL	UCL
1420	465.48	679	2967
2271	535.85	1342	3844
1729	434.25	986	3033
2440	865.41	1099	5415
3175	**531.59**	**2266**	**4449**

Bernier: Boodie

	N	SE	LCL	UCL
2011	751	324.62	284	1980
2012	1581	349	960	2606
2013	2289	377.55	1586	3303
2016	1221	331.12	668	2232
2017	**1297**	**301.12**	**803**	**2094**

Dorre: Boodie

N	SE	LCL	UCL
2561	898.38	1156	5671
3988	968.81	2298	6921
2871	859.58	1454	5669
1698	619.4	744	3877
2803	**594.22**	**1835**	**4282**

Bernier: RHW

	N	SE	LCL	UCL
2011	669	132.29	434	1032
2012	1535	305.48	992	2374
2013	1203	270.39	731	1978
2016	1683	435.66	955	2966
2017	**1712**	**360.5**	**1105**	**2652**

Dorre: RHW

N	SE	LCL	UCL
1548	417.59	847	2830
1381	391.04	732	2603
1381	412.97	706	2701
1481	563	632	3470
1703	**485.53**	**956**	**3031**

Bernier: WBB

	N	SE	LCL	UCL
2011	381	167.47	147	989
2012	287	122.92	113	726

Dorre: WBB

N	SE	LCL	UCL
1100	322.41	590	2051
695	266.7	304	1591

2013	632	236.74	281	1419	1434	373.18	831	2475
2016	1090	187.64	776	1533	527	159.89	276	1006
2017	**1370**	**311.12**	**837**	**2244**	**2539**	**602.46**	**1570**	**4105**

Notes:

Estimates for each species by island

Distance analysis using Program Distance 6.2

2017 analysis using Distance in 'R' vs 3.4.3

Table 6. Combined abundance estimates for all species, Bernier and Dorre Is. 2011-2017 (figures in red did not reach recommended minimum samples sizes)

Bernier and Dorre: BHW

	N	SE	LCL	UCL
2011	2059	592.48	1138	3727
2012	4219	758.14	2920	6097
2013	4445	806.43	3065	6447
2016	5271	1054.6	3499	7942
2017	**6715**	**882.37**	**5176**	**8712**

Bernier and Dorre: Boodie

	N	SE	LCL	UCL
2011	3265	957.28	1779	5992
2012	5561	1092	3700	8358
2013	5149	894.55	3593	7377
2016	2899	669.13	1799	4672
2017	**4100**	**767.73**	**2831**	**5938**

Bernier and Dorre: RHW

	N	SE	LCL	UCL
2011	2197	466.23	1420	3397
2012	2917	548.92	1985	4288
2013	2589	492.41	1754	3812
2016	3202	740.03	1994	5143
2017	**3415**	**857.66**	**2329**	**5006**

Bernier and Dorre: WBB

	N	SE	LCL	UCL
2011	1464	430.15	811	2644

2012	981	303.3	526	1827
2013	2012	486.5	1241	3262
2016	1676	358.49	1096	2562
2017	**3909**	**781.85**	**2619**	**5834**

Notes:

Observations combined from both island to give a Global estimate

Distance analysis using Program Distance 6.2

2017 analysis using Distance in 'R' vs 3.4.4

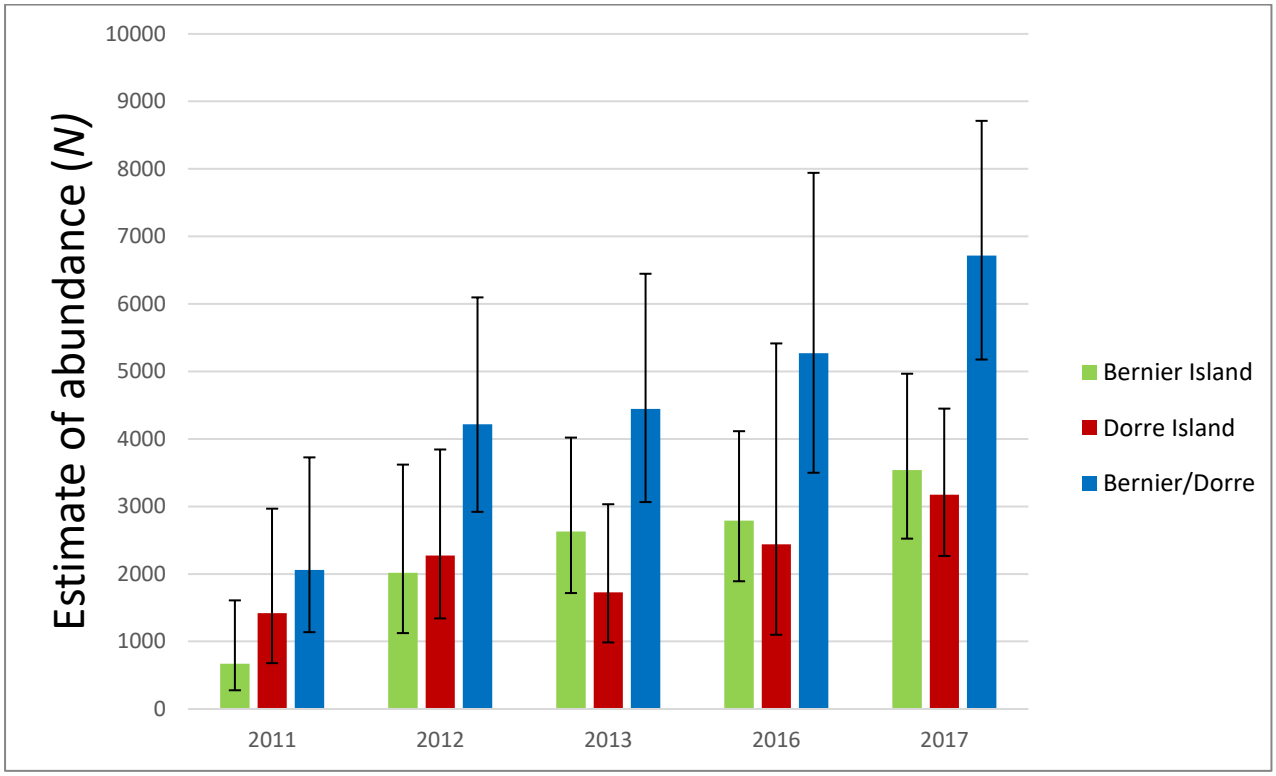

Figure 1a. Abundance estimates for banded hare-wallabies on Bernier and Dorre Islands 2011-2017 (including LCL and UCL bars).

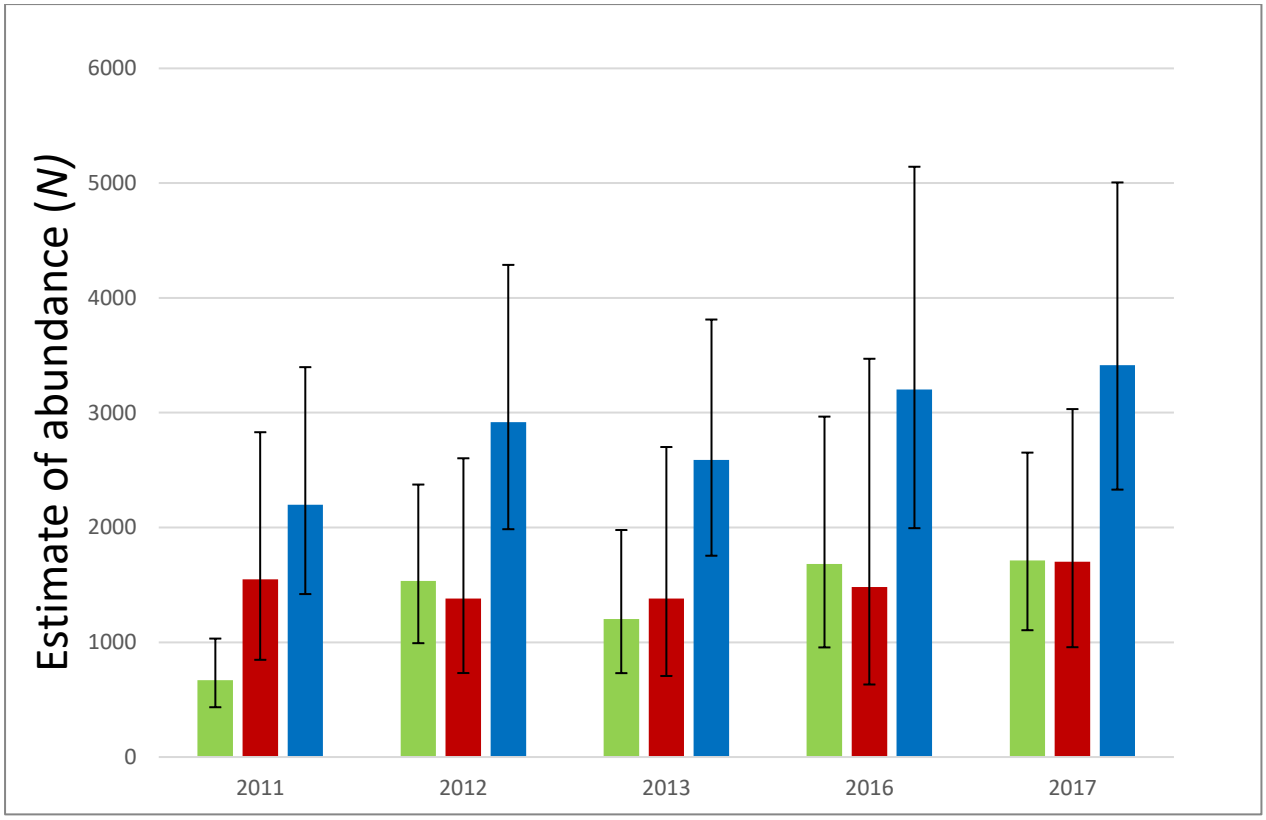

Figure 1b. Abundance estimates for rufous hare-wallabies on Bernier and Dorre Islands 2011-2017 (including LCL and UCL bars).

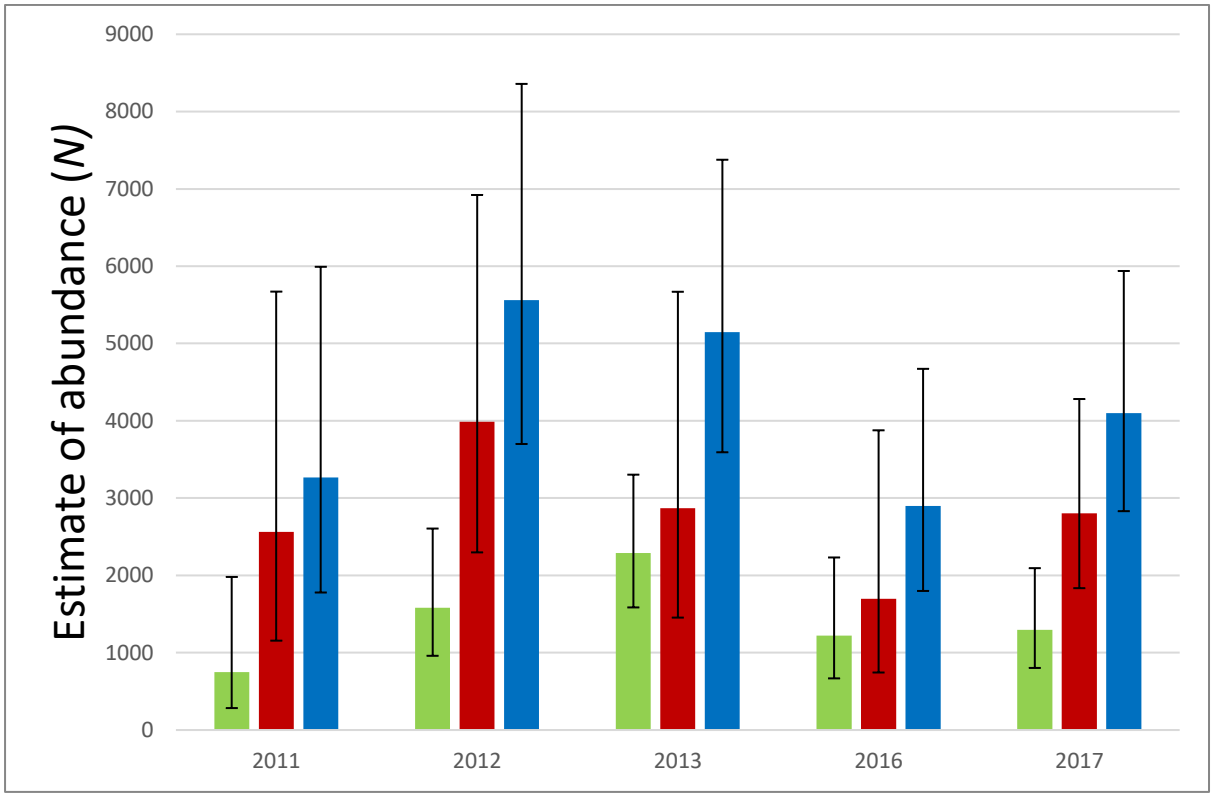

Figure 1c. Abundance estimates for boodies on Bernier and Dorre Islands 2011–2017 (including LCL and UCL bars)

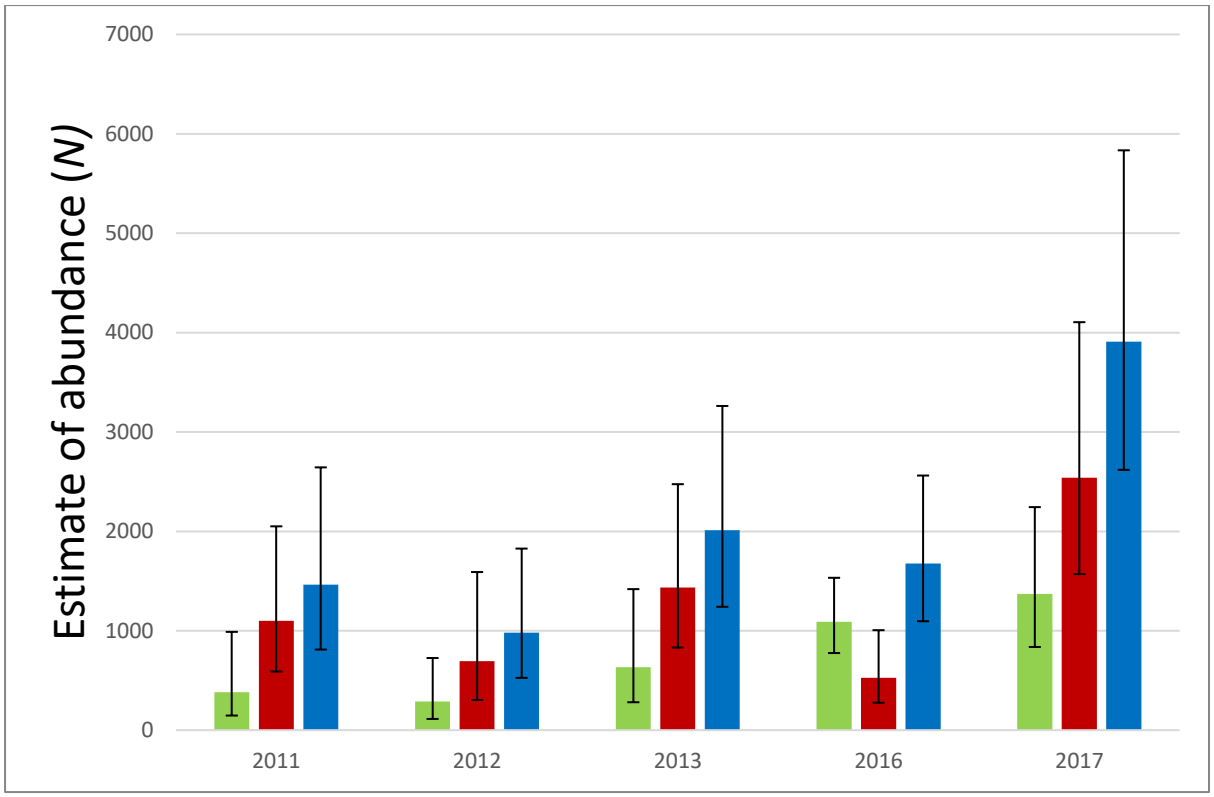

Figure 1d. Abundance estimates for WBB on Bernier and Dorre Islands 2011-2017 (including LCL and UCL bars).

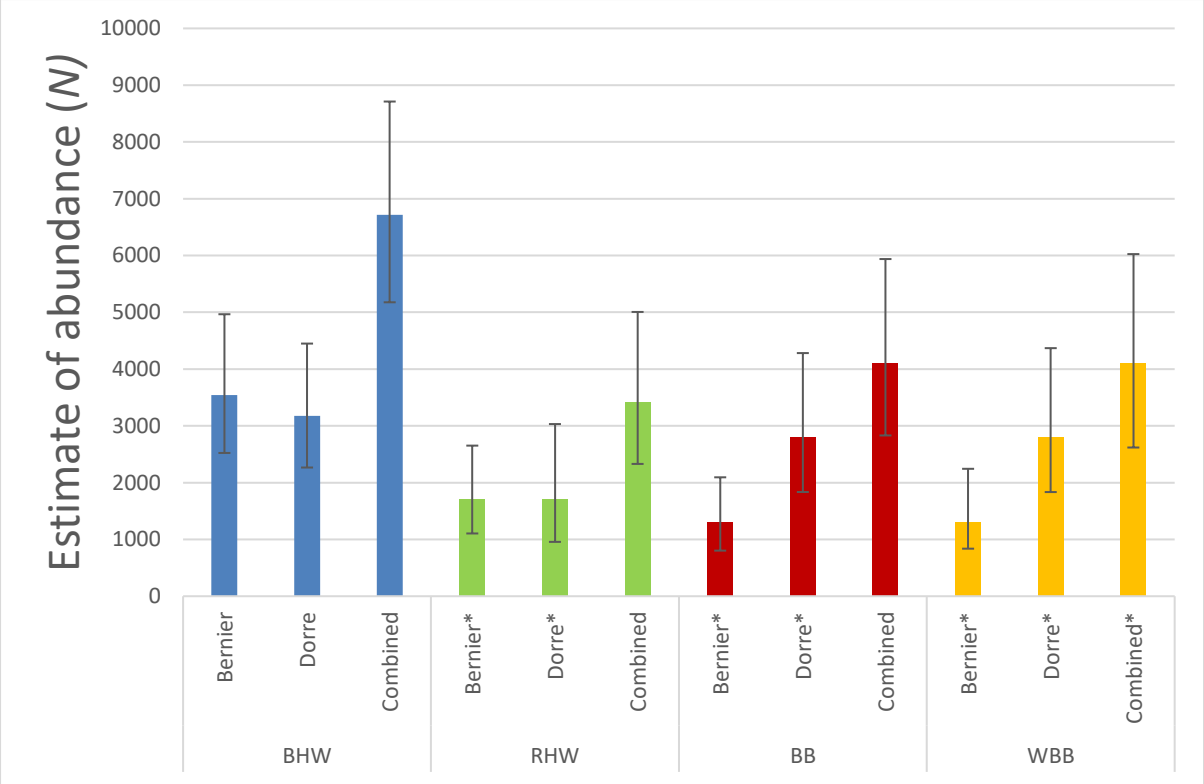

Figure 1e. Abundance estimates for banded hare-wallabies (BHW), rufous hare-wallabies (RHW), boodies (BB) and western barred bandicoots (WBB) on Bernier and Dorre Islands in 2017 (including UCL and LCL bars).

3.4 Translocations from Bernier and Dorre Islands

Translocations of 12 rufous and 12 banded hare-wallabies, comprising six animals (two males and four females) of each species from each island, occurred from 28 - 30 August 2017. One of the eight rufous hare-wallaby females translocated to DHI was carrying a small pouch young. This translocation was followed in September 2017 by removal of a further 61 banded hare-wallabies (28 males: 33 females) from Bernier (23 individuals) and Dorre Islands (38 individuals) by the Australian Wildlife Conservancy (AWC) as part of their translocation program to Mt Gibson sanctuary. None of the female banded hare-wallabies translocated to Mt Gibson were carrying pouch young. At the same time, AWC also translocated 14 western barred bandicoots, comprising seven males and seven females from Dorre Island to Mt Gibson. Three of the seven (43%) females carried pouch young at capture.

These translocations immediately followed the monitoring trip and did not allow time for full analysis and estimates of population abundance before translocations occurred. However, a review of raw observational numbers was sufficient to provide some confidence that use of the abundance estimates from 2016 was an acceptable surrogate for 2017 abundances, which were likely to be at least equal (or slightly higher than) for 2016. Based on this information, approval from the Executive Director of Science and Conservation Division, DBCA, was given for the DHINP and Mt Gibson translocations to proceed.

Due to the considerable variability and large standard errors (SE) associated with the abundance estimates obtained for these populations, harvesting guidelines drafted by DBCA (Page 2017) recommended taking the precautionary principle and using the lower confidence level (LCL) abundance estimates when considering population sizes and appropriate harvesting levels. Using these figures, the total numbers of each species harvested from Bernier and Dorre Island in Aug-Sept 2017, make up only 1.4 % (73/5176) of the banded hare-wallaby population, 0.5% (12/2330)of the rufous hare-wallaby population for the combined Bernier and Dorre Islands in 2016/17, and 0.9% (14/1570) of the Dorre Island population of western barred bandicoots.

3.5 North West Island, Montebello group.

Because of the difficulty capturing significant numbers of Shark Bay mice on Bernier Island, in the presence of the other mammal species which interfere with traps (especially boodies) it has been proposed to source at least some of the founders of this species for DHI from the introduced population on North West Island. This population was established from 47 Shark Bay mice bred in a captive colony at the Perth Zoo and released in 1999-2000. It has persisted for 18 years and now appears to be a robust population spread across most of the island. No regular monitoring had been in place, although observations of tracks across the island and trapping in 2011 and 2012 for translocations to Matuwa (Lorna Glen), indicated that the population was widespread and at a good density across the island.

A monitoring grid was established in 2016 to provide data on the density and abundance prior to potential harvesting of Shark Bay mice for translocation to DHINP and elsewhere.

3.5.1 Trap grid monitoring

Trapping occurred at the monitoring grid for the second year in a row, from 10 - 14 October 2017. Table 7 provides capture results for both 2016 and 2017.

Table 7. Shark Bay mouse trapping results for the North West Island monitoring grid.

Year	No. captures	No. Individuals	No. New individuals	% Female reproductive	Trap rates	Density
2016	63	49(25:24)	N/A	8% (2/24)	75%	12.65/ha
2017	27	21(11:10)	12(6:6)	0	32%	TBA

Capture rates and numbers of individuals in 2017 were less than half those for 2016. Density analysis is yet to be completed for the 2017 data, but it is expected that density will be lower than in 2016. Some of this reduction may be due to a high percentage of traps that appeared to function properly despite bait having been removed, suggesting that the mice may have learned how to access bait without setting traps off (e.g. by putting head underneath the treadle plate to remove it). However, there was no evidence of current breeding activity and island vegetation appeared quite dry, with evidence of only a small amount of recent flowering and seeding of some species.

High rainfall in May, June and July of 2016 probably contributed to a high reproductive response and population increase in the rodents, as observed during the monitoring in October of that year. However, in 2017 there were large falls of rain in the first three months of the year, but little for the rest of the year other than ~ 23mm in June, (probably too little and/or too long before monitoring, to give similar impetus to breeding in October of that year). These findings would suggest that there were poorer environmental conditions in 2017, which may have been reflected by an actual reduction in population size, not just a reduction in 'trappability' of individuals.

3.5.2 Trapping for Shark Bay mouse translocation to Mt Gibson.

Staff from the AWC assisted DBCA in the monitoring of Shark Bay mice and mala on North West and Trimouille Islands respectively, and in the trapping and harvesting of Shark Bay mice from North West Island for translocation to Mt Gibson sanctuary. This additional trapping was carried out for the last two nights (plus one night pre-feeding prior to trap set) using 100 Elliott traps in two roughly parallel trap lines in the back of beach and fore-dune vegetation immediately adjacent to beaches on the southwest and west end of the island. All of these traps were a minimum of 500m from the permanent trapping grid to minimise interference to the monitored

population at the grid. These traps captured a total of 61 (34:27) Shark Bay mice in the 210 ‘trap nights’ (29% trap success rate) and 46 (22:24) individuals were removed and translocated to Mt Gibson sanctuary by helicopter and light aircraft. None of the translocated animals were previously marked animals from the monitoring grid.

3.6 Trimouille Island, Montebello group

There is a translocated population of mainland ‘mala’ *Lagorchestes hirsutus* subsp. (NTM 2430) on Trimouille Island, in the Montebello group. This was established for conservation reason in 1998 and is now the most abundant population of this threatened taxa. It may be used as a source of founders for translocation to DHINP depending on a genetic review of the three sub-populations. Hence the field trip in October 2017 was also utilised to assess the abundance of this population.

3.6.1 Spotlighting

Spotlight surveys were carried out on the ten permanent transect lines across Trimouille Island from 14 -16 October 2017. In 2014 and 2016, all ten transects were surveyed twice each to obtain data analysed in Program Distance to produce abundance estimates. In 2017, all ten transects were surveyed at least once, but three transects were not surveyed a second time due to delays caused by an injury to a team member, which required evacuation to Karratha hospital for medical attention. This did not reduce the total survey effort by a significant amount. Abundance estimates from the three surveys are shown in Table 8 and Figure 2.

Table 8. Population estimates of mala derived from spotlight surveys on Trimouille Island.

Year	Abundance	SE	LCL	UCL	Density
2014	350	46.59	270	455	N/A
2016	838	100.28	660	1064	N/A
2017	1227	211.29	864	1742	2.4/ha

The population of mala on Trimouille Island in 2017, was estimated at 1227 (864-1742) animals, and indicates a nearly 50% increase on 2016 figures and a 250% increase in population size in the three years between 2014 and 2017. See Figure 3.

The population of mala on Trimouille Island was started in 1998 with 30 founders from the ‘Mala Paddock’ in the Tanami Desert, Northern Territory. Prior to 2014, no regular, standardised monitoring had been in place, although surveys for signs of animal’s distribution across the island, and some trapping for translocation of individuals to Matuwa (Lorna Glen) in 2011 and 2012, had taken place.

Since the spotlight surveys were established in 2014, abundance estimates suggest that the population has undergone substantial growth in numbers. The confidence limits have widened for the more recent figures, but even if the LCL values are considered, the pattern of growth holds true. Although this growth rate is surprising, it is not impossible when the potential reproductive capacity of mala is considered. In favourable environmental conditions, mala can produce up to three young per year and could produce a quadrupling of population in three years.

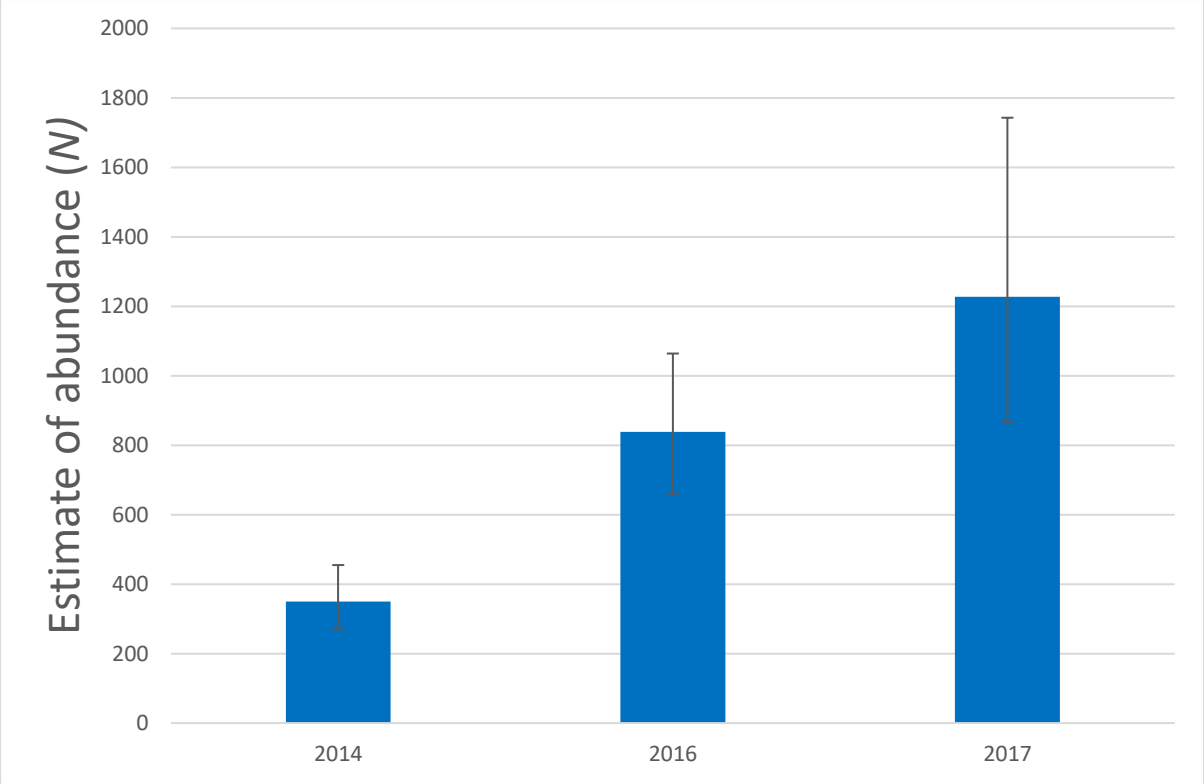

Figure 2. Abundance estimates for mala on Trimouille Island, 2014 to 2017 (LCL and UCL error bars).

3.6.2 Tissue sampling for karyotyping

Tissue for genetic analysis was collected from the Trimouille Island mala in 2016, and is being used in a review of the genetic diversity of the meta-population across its current range. However, there has still been debate about the relationship of the mainland mala to the Shark Bay Islands rufous hare-wallaby and karyotyping is also being used to examine this relationship between the three remnant populations and determine if sub-specific status is valid. To aid in this research, samples were taken for karyotyping from three mala on Trimouille Island. Unfortunately the samples were held up for nearly two weeks in transit by the freight company, and they reached the laboratory in poor condition and were unable to be used.

If samples are not obtained from an alternative mala population in the interim, then the field trip planned to deploy the camera monitoring grid on Hermite Island (Gorgon Offset funds) will provide an opportunity for re-sampling in August 2018.

3.7 Boullanger and Whitlock Islands, Jurien Bay.

The DHINPERP Stage 2 Plan proposed the translocation of dibblers to DHINP in 2018 - 2019, to be sourced from the northern population on the Jurien Bay Islands (Boullanger, Whitlock and Escape). The plan proposed capture of 20 (10:10) founder individuals and captive breeding at Perth Zoo during 2018 to provide larger release numbers for a 2019 release. Monitoring of these populations has been occurring regularly in May and October each year, and 2017 data suggested the populations were robust and capable of support harvesting as planned. Trapping to harvest

founders occurred in January 2018, however capture rates of dibbler were extremely low, and plans to harvest were aborted out of concerns for the viability of the remnant source populations if they were to proceed.

Escape Island could not be safely reached due to adverse weather and sea conditions, so traps were set only on Boullanger and Whitlock Islands. Because of similar access issues to those experienced on this field trip, the reintroduced population on Escape Island has not been monitored in five years.

The trapping occurred over three nights from 8 -11 January 2018, and four dibblers were captured (two from each island) and sent to the Zoo on Day 1. But subsequent failure to capture additional animals from Whitlock Island and still only one sex having been captured on Boullanger Island by Day 2, resulted in a decision to hold off removal of additional animals. By the end of the 3-day trapping session, more animals (including both sexes from each island) had been identified, but numbers were still very low (Table 9.), and considerably reduced from previous 2017 data. The four individuals sent to Perth Zoo were later returned to their islands of origin the following week.

The trapping program resulted in capture (and destruction) of 156 house mice (*Mus musculus*), indicating the islands were experiencing a higher than average abundance at the time, and the opportunity was taken to collect tissue samples for a genetic research project of house mice island populations.

Further monitoring of the Jurien Bay islands dibbler population is planned for the more usual time in May 2018, and will be essential to determine how the populations are faring in comparison to previous years, and remove potential seasonal variation from the calculations.

Table 9. Dibbler captures on Jurien Bay Islands, January 2018.

Island	No. trap nights	No. dibbler Individuals	No. New dibblers	Mice captures
Boullanger	114	7(2:5)	3(1:2)	97
Whitlock	92	6(2:4)	0	59
Totals	206	13	3	156

4 Rainfall and environmental conditions

Fluctuating rainfall in Shark Bay has been shown to be correlated with population abundance of the mammal species on Bernier and Dorre Island (Short and Turner 1992; Chapman *et al*. 2015; Speldewinde and Morris, unpublished.), although the exact relationship and time lag is uncertain and likely to vary depending on the species. Rainfall can be locally highly variable (within a kilometre or two), and although rainfall records for Carnarvon Airport and Shark Bay Airport/Denham have the longest continuous data sets and likely represent the general cycles of low and high rainfall years across the whole Shark Bay area, they may not be accurate representations of the actual falls on Bernier and Dorre Islands. Consequently a rain gauge was put in place on the north end of Dorre Island in 2007. However, this first model had numerous problems with disruptions to data collection and downloads, resulting in interrupted and unreliable rainfall data, until it was replaced with a satellite linked automatic weather station in 2015.

4.1 Shark Bay

Rainfall over the last 21 years in Shark Bay has been recorded at several Bureau of Meteorology (BOM) weather stations, and it is clear that the recorded annual falls are not the same across the Shark Bay area, but the annual pattern of rainfall between the stations is clearly correlated (Figure 3.), and seems to reflect a cycle of four or five years between significantly below average rainfall, which have the potential to affect island mammal population sizes. The last two years has seen one of these cycles of below average rainfall at the two mainland BOM stations, but has been associated with better rainfall figures on the Dorre Island station. However, the 2017/18 summer rainfall has been considerably lower than the previous two years.

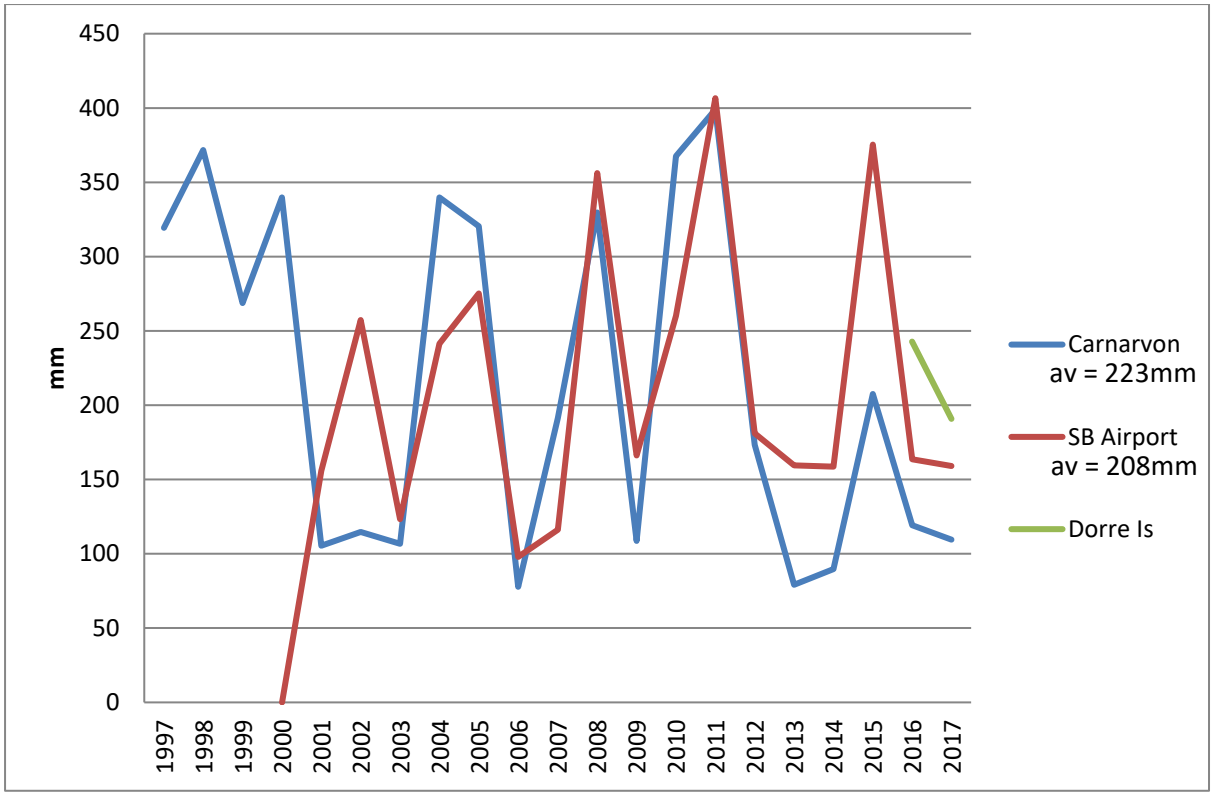

Figure 3. Annual rainfall at Carnarvon, Shark Bay Airports and Dorre Island 1997-2017.

4.2 Montebello group

The annual rainfall as recorded at the Bureau of Meteorology Barrow Island Airport weather station (35 km south of the Montebello group), can be used as a surrogate for rainfall on the Montebello Islands group and also demonstrates the highly cyclic nature of rainfall on Pilbara islands (Figure 4). While 2016 experienced below average annual rainfall, 2017 rainfall was above average..

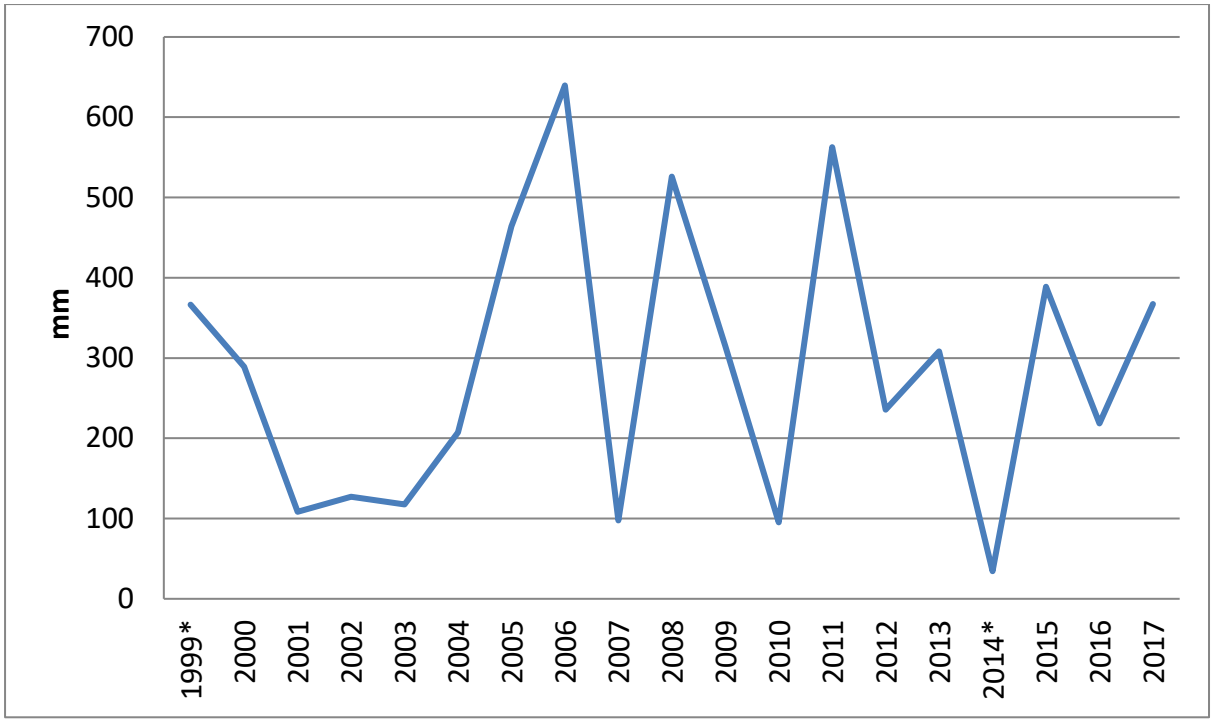

Figure 4. Annual rainfall at Barrow Island Airport 1999-2017 (average = 298mm).

5 Discussion

Despite the logistical challenges associated with accessing these remote islands and monitoring their threatened mammal populations, significant gains in knowledge of the status of these source populations have been achieved and are providing valuable inputs to decision-making frameworks for managing the timing, size and frequency of fauna harvesting activities for these threatened species' last surviving populations, both for the DHINPERP translocation program and those being proposed by other groups across Australia.

5.1 Bernier and Dorre Islands

As with previous monitoring programs on Bernier and Dorre Islands, the 2017 program was affected by adverse weather, and personnel and the charter vessel crew had to be flexible to respond to these challenges.

Weather conditions were not ideal during work on Dorre Island, and prevailing sea and wind conditions required the vessel to relocate to safe anchorages, at Turtle Bay (Dirk Hartog Island), and Pin Bay (northwest side Dorre Island) for three nights, which required travelling between two to four hours after completion of the scheduled task and similar travel time the following morning to get back to undertake the next scheduled task. Despite this, all scheduled tasks were completed on Dorre Island.

More severe weather and sea conditions during the Bernier Island schedule, made it even more difficult to operate on the east side of Bernier Island and in proximity to the main landing points. Conditions required the vessel to relocate to safe anchorage at Koks Island (north end Bernier Island) on one occasion, necessitating additional travel time before and after schedule tasks. The prevailing sea and winds also made it difficult landing on and getting off beaches, particularly with the night landings and pickups. Safety of the personnel and vessel, and welfare of the animals is of paramount importance in these situations, and guide all decisions. The severity of conditions also resulted in loss of the vessel tender, which needed to be replaced before recommencement of activities, and necessitated the vessel returning to the safe harbour at Carnarvon for several nights (with no work able to be completed). As a result, neither the trapping, nor the spotlighting programs for Bernier Island were able to be completed as planned.

The change in trapping grid design instigated in 2016 was aimed at being both directly comparable to monitoring methodology used at Barrow Island for bandicoots, and to provide data suitable for producing density estimates, using SECR (Spatially Explicit Capture Recapture) analysis. The success of this strategy, depends on both capture and recapture rates of individuals in each session. The data generated in 2016 was not sufficient to allow analysis for Bernier Island populations of western barred bandicoots or boodies, and although samples sizes appear higher for both islands for 2017, data may still be insufficient to provide good analysis results. Future trap rates may be further reduced in low population years when environmental conditions are harsher, which could complicate analysis further. In response to these concerns, 2018 trap surveys will look at trying to increase the grid size and

subsequent numbers. However, capacity to increase trap effort will be limited by financial, safety, and welfare considerations which are magnified under these challenging logistical conditions. The second Shark Bay mouse grid on Bernier Island was beset with problems of interference from boodies in 2017, which did not appear to be as significant in 2016. This problem will be addressed in the 2018 surveys by adopting methods used to protect traps from disturbance, which should ensure better capture rates in the future.

Similarly, the spotlight survey design for Program Distance analysis is robust, but low sample sizes for many of the species in some years will make abundance estimates less confident. The solution to this is to survey more transects to increase the sample sizes for each species. But as illustrated in the outcomes of the 2016 and 2017 field trips and discussed above in relation to trap surveys, the financial, safety and welfare considerations of working on these remote and exposed locations, will limit the capacity to increase survey effort with the resources available.

Population estimates for all species in 2017 appear to be good, but low recent rainfall and reduced signs of breeding, maybe early indicators that the populations may be about to fall in 2018, in response to poorer environmental conditions at the end of spring and summer 2017/18.

5.2 North West and Trimouille Islands

Monitoring programs on the Montebello Islands tend to be less affected by adverse weather conditions as options for sheltered anchorages are greater within and around the archipelago. However, severe weather conditions can still disrupt ability for personnel to get on and off islands, and shallow waters and greater tide variations create their own challenges to access. The 2017 program completed all scheduled work activities but one nights spotlighting. This was due to injury to one member of the party, and highlights the inherent risk of working in these environments, but also the value of careful planning and good safety protocols.

Spotlight survey design on Trimouille Island is robust and provides good data for estimation of mala abundance using Distance analysis. Population estimates have increased several-fold since 2014 and density estimates are four or five times that calculated for rufous hare-wallabies on Bernier and Dorre Islands. This is likely a result of lack of competition for this species on Trimouille Island, and to the population reproducing at high rates in response to a string of years with good environmental conditions (only two of the last ten years have had significantly below average annual rainfall). Recently, annual rainfall appears to be returning to average or below average levels, and given the rapid rate of population increase in the last three years, it will remain to be seen if the carrying capacity of the island and population size will be reduced to a lower level in the near future. If this is the case, then it may be worth harvesting mala from this population for translocation programs back onto the mainland in the near future.

The trapping grid design on North West Island was successful in providing sufficient sample size for density estimation of the Shark Bay mice in 2016. Reduced capture rates in 2017 may reduce the reliability of estimates produced from this data. As with

trapping survey designs on Bernier and Dorre Islands, it may be beneficial to increase trapping effort through increased size, or replication of the current grid, but the capacity to do this will be dependent on financial and resource limitations.

Tissue samples collected from the Shark Bay mice from North West Island in 2016 and 2017, and from Bernier Island and Faure Island are being used to investigate the level of genetic diversity in each population and how suitable they are as source populations, identifying if any require supplementation to improve their genetic quality.

There are no plans to repeat population surveys on Trimouille and North West Islands in 2018.

5.3 Jurien Bay Islands

The closer proximity of the Jurien Bay islands to the mainland coast and regional centres, makes fauna monitoring less expensive and difficult. However, access to islands is always dependent on favourable weather and sea conditions, and requires access to suitable vessels and seafaring skills to successfully complete scheduled programs. In January 2018, adverse weather conditions prevented access and monitoring of the dibbler population on Escape Island.

Despite favourable population estimates in 2017, the Boullanger and Whitlock Island populations appear to have reduced substantially by January 2018, and further monitoring in May 2018 is critical to assess whether this is a real phenomenon, or an artefact of seasonal variation and/or trap competition with house mice.

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Appendices

Appendix 1 Field Schedules for monitoring trips

1.1 Dorre Island monitoring.

DATE	Program	Comments
01/08/17	Drive ex Perth o/n Carnarvon	Either pack gear or leave until am, cars to DBCA compound
02/08/17	Steam to Dorre, set trap grid	
03/08/17	Processing day 1	
04/08/17	Processing day 2	
05/08/17	Processing day 3	
06/08/17	Processing day 4	Clean traps, reccon night-time landings and set leads
07/08/17	Spotlight night 1	
08/08/17	Spotlight night 2	
09/08/17	Spotlight night 3	
10/08/17	Spotlight night 4	
11/08/17	Spotlight night 5	Spotlight not required, Return Perth
12/08/17	Fly ex Carnarvon	

1.2 Bernier Island monitoring.

DATE	Program	Comments
18/08/17	Fly ex Perth, steam to Bernier and set traps	
19/08/17	Processing day 1	
20/08/17	Processing day 2	
21/08/17	Processing day 3	Emptied traps
22/08/17	Processing day 4	Aborted due to weather
23/08/17	Spotlight night 1	Aborted due to weather
24/08/17	Spotlight night 2	
25/08/17	Spotlight night 3	
26/08/17	Spotlight night 4	
27/08/17	Spotlight night 5	Aborted due to weather
28/08/17	Animal netting night 1	Red Cliff Bay, Bernier Island
29/08/17	Animal netting night 2	White Beach, Dorre Island
30/08/17	Animal netting night 3	Not required
31/08/17	Animal netting night 4	Not required
01/09/17	Steam ex DHI, pack vehicles, depart	

1.3 North West and Trimouille Islands monitoring.

Day	Date	Activity	Location
Day 1	Mon 9/10	Fly Perth – Exmouth, stay on boat	Perth/Exmouth
Day 2	10/10	Depart Exmouth 6am travel to Montebello Is (Arrive ~ 3pm) Set SBM monitoring grid (3x7 elliots)	Montebello group
Day 3	11/10	Check grid traps am, reset pm. and place traps(50-100 Elliott traps– west end) for capture and translocation (pre-bait 1 night)	North West Is
Day 4	12/10	Check grid traps am, reset pm. Spotlight training Set translocation traps	North West Is
Day 5	13/10	Check all traps am, select, process, and prepare SBM for translocation, transport to Trimouille for helicopter transfer. Reset pm	North West Is North West Is Heli pad
Day 6	14/10	Check all traps am, select, process, and prepare SBM for translocation, transport to Trimouille for helicopter transfer. Close and remove traps. Spotlight transects for mala (night)	North West Is North West Is Heli pad Trimouille Is
Day 7	15/10	Chemical cleanup Spotlight transects for mala (night) *[**Aborted early due to injury]*	Hermite Is Trimouille Is
Day 8	16/10	Chemical cleanup Spotlight transects for mala, net and sample tissue for genetic analysis (night)	**Dampier return* Trimouille Is
Day 9	17/10	Chemical cleanup Spotlight transects for mala (night) finish early	Hermite Is Trimouille Is
Day 10	18/10	Depart early (~4am) to return to Exmouth by 13:00hrs. Catch 3:30pm flight to Perth	Exmouth/Perth