# Dirk Hartog Island Invasive Rodent Survey Number 3 - 2016; with notes on the detection of Black Rats in the Shark Bay World Heritage Area near Carnarvon


Camera trap image of a black rat (*Rattus rattus*) at New Beach south of Carnarvon (Gary Hearle)

Prepared by Russell Palmer

Science and Conservation Division, Department of Parks and Wildlife, Locked Bag 104 Bentley Delivery Centre, Western Australia, 6983.

March 2017

Department of Parks and Wildlife

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# Acknowledgments

The survey was funded by the Gorgon Barrow Island Net Conservation Benefits Fund. I am grateful for the field assistance provided by volunteer Dorian Moro in setting the camera traps. Sean Garretson retrieved the camera traps with help from Neil Thomas. Shane Heriot transported teams safely across to the island. The feral cat eradication team on the island were very welcoming and allowed us to share their camp. Neil Hamilton, Allan Burbidge, Mark Blythman and Michael Johnstone collected barn owl pellets for the project. Mark Cowan provided the black rat distribution map and Hannah Anderson helped produce this report.

# 1 Purpose

A key ecological objective under the Dirk Hartog Island National Park Ecological Restoration Project is to confirm presence/absence of introduced black rats (*Rattus rattus*) and eradicate/control these, if found.

The first survey for black rats on Dirk Hartog Island under the Restoration Project was done in August 2011. It focused on areas and buildings associated with human inhabitation, mostly the Dirk Hartog Island Eco Lodge (Johnson 2011). A second survey followed in 2013, this was an island–wide survey that primarily utilised camera trapping as the key detection method for rats (Palmer & Morris 2014). Both surveys failed to detect any evidence of black rats on the island.

# 2 Introduction

Dirk Hartog Island has a long European maritime and settlement history that is consistent with the invasion and establishment of black rats on many of Australia's other islands (see Palmer & Morris 2014 for review). For instance, ship wrecks, guano mining and pearling activities brought black rats to numerous islands along the Western Australian coast to the north and south of Shark Bay (Burbidge & Morris 2002; Burbidge 2004a; Burbidge 2004b; Morris 2002). In addition, Dirk Hartog was used for pastoralism for over 150 years and the transportation of livestock fodder to islands is a known vector for invasive rodents.

Even with this history, black rats have never been detected during general biological surveys or targeted surveys on Dirk Hartog Island (Baynes 1990; Baynes 2006; Burbidge & George 1978; Johnson 2011; Palmer & Morris 2014). The Wardle family have not identified a rat or rat-like animal in over 20 years of residence on the island (Johnson 2011). While it seems possible that black rats may have found their way to Dirk Hartog Island in the past, they have either failed to establish or if a population did establish, it was relatively short-lived.

The arid and hot Mediterranean summers experienced on the islands in Shark Bay appear to pose a severe physiological challenge for black rats. They lack the renal performance of similar sized native rodents, such as *R. villosissimus*, which occur in the arid zone and northern Australia (Collins & Bradshaw 1973; Collins 1978). Black rats also rely upon large amounts of water for evaporative cooling when exposed to moderate temperatures and their ability to compensate by maintaining a high level of food intake (water in green vegetation) during the dry summer months on islands in Shark Bay would be limited (Collins & Bradshaw 1973; Collins 1978). Furthermore, they lack the ability to utilise undiluted sea water when freshwater is absent (Norman & Baudinette 1969).

In spite of the above, there is a remote possibility that small populations of black rats could exist undetected on a large island like Dirk Hartog. For example, a long established population of black rats evaded detection on Barrow Island (23 590 ha) off the Pilbara coast until 1990 (Morris 2002). In the subsequent program to

eradicate black rats from the island, it was found they only occupy ~245 ha on the southern tip of the island (1.0% of the island). Morris (2002) speculated that black rats originated from pearling luggers that used the area in the 1890s but competition with members of the diverse native fauna assemblage on this large island restricted them from invading other parts of Barrow Island.

A similar situation could conceivably have existed on Dirk Hartog Island, but predation by feral cats and/or competition for water–bearing plants in summer from introduced livestock could have been factors maintaining possible rat populations in 'predation and/or competition pits'. The relatively dry conditions on the island leading into the period when the first two targeted surveys for black rats were undertaken may also have limited the chances of detecting any localised black rat populations restricted to mesic refuges (Figure 1).

The DHI Restoration Project is now well advanced, with populations of feral cats, sheep and feral goats, either eradicated or very close to elimination. In March 2015, tropical cyclone Olwyn passed near to Dirk Hartog Island and heavy rains also occurred in June (Figure 1). Total rainfall for 2015 was more than double that of the long–term average. These conditions gave rise to extensive plagues of small rodents on Dirk Hartog Island in 2016, suggesting the circumstances were ideal for triggering the release of black rat populations if they were present anyway on the island. Such conditions were not that dissimilar to those described by Short et al. (2017), whereby the native pale field-rat (*Rattus tunneyi*) irrupted from relict populations in Edel Land at Shark Bay to then invade the nearby Heirisson Prong in ~1996.

This report documents the results of the third targeted survey for black rats on Dirk Hartog Island undertaken in 2016.

# 3 Methods

## 3.1 Rainfall

The climate of the island is 'semi-desert Mediterranean', averaging ~230 mm precipitation annually (Figure 1; Australian Bureau of Meteorology 2017). Rainfall leading into the first two surveys in 2011 and 2013 was less than average. Well above average rainfall was received in 2015 prior to this survey.

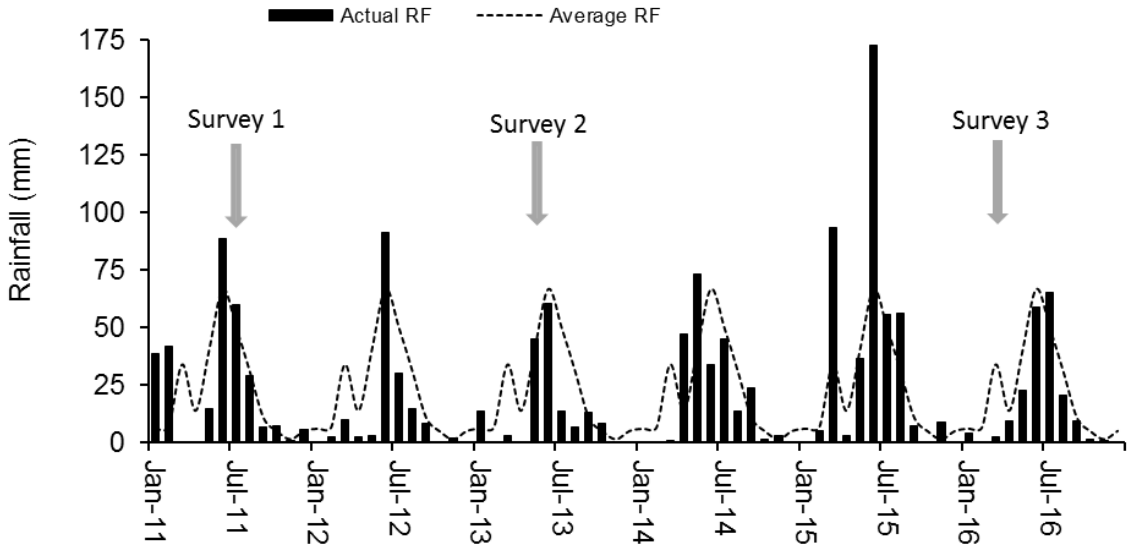


*Figure 1 Mean monthly rainfall for nearby recording station at Steep Point (113.22°E, 26.18°S) and long-term average rainfall (RF=rainfall).*

## 3.2 Rodent surveys

As with the 2013 camera trap survey (Palmer & Morris 2014), likely sites to harbour black rats were predicted to be in association with artificial water points (wells and bores) due to the lack of fresh water on the island, or living in commensal association with humans either around buildings (inhabited or abandon) or the higher-quality coastal habitats on the sheltered eastern side of the island. The barge landing site at Cape Ransonnet is also a potential entry point for rats to the island.

We selected 22 sites that provided wide coverage of such locations across the island to place camera traps (Table 1; Figure 1). One or two camera traps were set at most sites and four cameras were placed in the vicinity of the Dirk Hartog Island Eco-Lodge. Twenty cameras were set at the same sites used in 2013 (Palmer & Morris 2014). Nine cameras were set in new locations, targeting the richer marine sites at Withnell Point, Long Tom Bay (mangroves), Turtle Bay (hatching loggerhead turtles *Caretta caretta*) and Notch Point cormorant colony (old nests only; Table 1). Survey effort was lacking in such sites in 2013 (Palmer & Morris 2014).

### 3.2.1 Camera traps

The camera traps (HyperFire™ PC900; Reconyx, Wisconsin, USA) were set between 8-11$^{th}$ March 2016 and retrieved 12-13$^{th}$ April (Table 1, Figures 2). Each camera was set horizontally, attached to a plastic peg approximately 30 cm above the ground and oriented to face south, away from direct sun. They were programmed on ‘Aggressive’ to take three pictures at up to two frames per second upon a trigger. There was no quiet period between triggers unless signs of small rodent activity at the site was high. For the latter sites the quiet period was set to 1 minute. A PVC bait capsule (60 mm wide and 120 mm high), containing a mixture of universal bait

(peanut butter and rolled oats) was secured to a tent peg anchored in front of the camera trap (2–3 m away). Vegetation was trimmed from the detection zone of the camera to minimize false triggers caused by moving vegetation.

Black rats can be distinguished from the extant species of small rodent (Sandy Inland Mouse *Pseudomys hermannsburgensis* 9-14.5 g; Ash Grey Mouse *P. albocinereus* 14-40 g; House Mouse *Mus musculus* 10-25 g) known to occur on Dirk Hartog due to their large size (body length 165-245 mm; weight 95-340 g) and distinctive tail that is longer than their head-body length (Front cover image). The bait capsule present in the centre of each camera image was used as a scale. Accurate identification of small rodent species that are morphologically similar, such as the three species found on the island using camera trap imagery is difficult (Meek et al. 2013). For the purposes of this survey, I did not attempt to identify images of small rodents to species level. These images were pooled as 'small rodents'. We used the date- and time-stamp on each image from individual cameras to calculate the number of trap–days each animal species was detected.

### 3.2.2 Barn owl pellet collections

Owl-pellet analysis is a highly effective method for detecting the presence of rodents in survey areas (Heisler et al. 2016). We searched abandoned buildings, sheds and other structures (e.g. concrete tanks) for recent owl pellets. Members of the feral cat eradication team were also asked to collect any barn owl pellets they encountered on the island.

The barn owl located in the Herald Bay outcamp (shed) during the May 2013 survey continued to use this roost into 2014 (Palmer & Morris 2014). Neil Hamilton collected ~50 pellets in April 2014, of which a sub-sample of 22 were analysed. The barn owl was no longer present when Allan Burbidge and Mark Blythman re-visited the shed in September 2014, and only 7 pellets were found. A further deposit of 'modern' barn owl pellet material (rodent skulls and bones but rodent hair was no longer present) was collected from a coastal limestone cave on the eastern side of the island north of Herald Bay by Mike Johnston in September 2014 (25°50'42"S 113°06'52"E). Owl pellets were analysed by Georgeanna Story of Scats About (www.scatsabout.com.au).

In an attempt to enhance further collections of barn owl pellets, home-made timber barn owl nest boxes were installed in the huts at Herald Bay and Bore Well, and another was placed in an old freezer trailer in the outer dump near the Ecolodge during the March 2016 camera setting trip.

*Table 1 Description and location of the 29 camera traps set on Dirk Hartog Island March–April 2016. Bolded camera numbers denote new survey sites.*

| Camera No. | Site Type | Description | Latitude | Longitude |
|---|---|---|---|---|
| **YP001** | Artificial waterpoint | Mystery Beach well | -25.6323 | 112.9357 |
| **YP002** | Marine | Whitnel Point – limestone | -25.5842 | 113.0234 |
| YP003 | Buildings | Lighthouse Hut | -25.4817 | 112.9723 |
| YP004 | Artificial waterpoint | Sandy Point Mill | -25.7202 | 113.0648 |
| YP005 | Buildings | Sandy Point Shearing quarters | -25.7181 | 113.0593 |
| YP006 | Artificial waterpoint | Louisa Bay Mill | -25.7795 | 113.0843 |
| YP007 | Artificial waterpoint | Hawknest Mill | -25.5256 | 112.9381 |
| YP008 | Marine | Turtle Beach | -25.4985 | 113.0114 |
| YP009 | Buildings | Borewell Outcamp hut | -25.6094 | 112.9447 |
| YP010 | Artificial waterpoint | Fitzy's Bore (bananas) | -25.9838 | 113.1535 |
| **YP011** | Marine | Whitnel Point marine flats and pools | -25.6394 | 113.0411 |
| **YP012** | Marine | Turtle Beach - limestone over hang | -25.4992 | 113.0079 |
| YP013 | Artificial waterpoint | Bottom Ten Mile Well | -25.9033 | 113.1128 |
| **YP014** | Marine | Long Tom bay – mangroves | -26.1062 | 113.2260 |
| YP016 | Artificial waterpoint | Yabara Well | -26.0064 | 113.1697 |
| YP017 | Buildings | Clough's shed | -26.1382 | 113.2243 |
| **YP018** | Homestead Complex | Wardle Dump - outer dump | -26.0023 | 113.1897 |
| **YP019** | Marine | Notch Point old cormorant colony | -25.9434 | 113.1678 |
| YP020 | Marine | Tetrodon Loop – sampfire | -25.9767 | 113.1367 |
| YP021 | Buildings | Wardell Homestead - shed | -26.0023 | 113.1982 |
| YP022 | Artificial waterpoint | Two Wells | -26.0445 | 113.1876 |
| YP023 | Marine | Cape Ransonnet - barge landing | -26.1609 | 113.2156 |
| YP024 | Homestead Complex | Wardell Dump - shearing shed | -26.0029 | 113.1961 |
| YP025 | Marine | Cape Ransonnet - barge landing | -26.1609 | 113.2164 |
| **YP026** | Marine | Long Tom bay – mangroves | -26.1041 | 113.2278 |
| **YP027** | Marine | Long Tom bay – mangroves | -26.1089 | 113.2249 |
| YP029 | Marine | Mangroves Tetrodon Loop | -25.9761 | 113.1465 |
| YP030 | Homestead Complex | Wardell Dump - burn pit | -26.0033 | 113.1960 |
| YP032 | Buildings | Herald Bay Outcamp | -25.8722 | 113.1095 |


*Figure 2 Location of camera trap sets on Dirk Hartog Island.*

# 4 Results

All 29 cameras traps were functional for a period of 33 to 37 days. Data was analysed from a total of 1013 camera trap–days, which represents 24 303 hrs of field observations. No black rats or feral cats were detected on any of the cameras. Small rodents were detected on 20 (69%) of the camera traps, birds at 19 (66%, 10 species) and reptiles at 8 (28%, 4-5 species). Small rodent numbers were highly variable across the island with some cameras recording them in every 24 hour period, with up to 20 animals visible in a single image. Plague numbers of small rodents were detected on the three cameras in the dump area of the Wardell land (YP018, 21, 24 and 30), Tetrodon Loop (YP020) and the artificial waterpoints to the north and south of the Wardell Homestead (YP010, 16 and 22).

The bone material from a barn owl deposit recovered from the cave did not contain any rat remains (Table 2). No remains of black rats were detected in the additional 27 fresh barn owl pellets collected from the Herald Bay hut in 2014 (Table 3). The three smaller rodent species known from the island and geckos were the main prey of barn owls.

*Table 2 Prey of barn owls (Tyto alba) identified from material collected from a coastal cave located to the north of Herald Bay, Dirk Hartog Island.*

| **Prey type** | **Minimum number of individuals per sample** | **Percent of individuals** |
|---|---|---|
| *Mus musculus* | 27 | 23.9 |
| *Pseudomys hermannsburgensis* | 34 | 30.1 |
| Unknown Rodent | 14 | 12.4 |
| Microbat | 1 | 0.9 |
| Gecko | 21 | 18.6 |
| Frog | 1 | 0.9 |
| Bird | 2 | 1.8 |
| Beetle | 11 | 9.7 |
| Grasshopper | 2 | 1.8 |
| Totals | 113 | |

*Table 3 Diet composition of the barn owl (Tyto alba) at Herald Bay Outcamp, Dirk Hartog Island based on collections from May 2013 to September 2014.MNI = minimum number of individuals per pellet. Biomass of prey types were estimated.*

| | May 2013 (n=44) | | | June 2013 (n=9) | | | October 2013 (n=39) | | | April 2014 (n=22) | | | September 2014 (n=7) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Prey type** | **MNI** | **Mean # individuals per pellet** | **% biomass** | **MNI** | **Mean # individuals per pellet** | **% biomass** | **MNI** | **Mean # individuals per pellet** | **% biomass** | **MNI** | **Mean # individuals per pellet** | **% biomass** | **MNI** | **Mean # individuals per pellet** | **% biomass** |
| *Mus musculus* | 115 | 2.61 | 64.2 | 26 | 2.89 | 56.5 | 53 | 1.36 | 51.0 | 32 | 1.45 | 58.5 | 14 | 2.00 | 46.0 |
| *Pseudomys hermannsburgensis* | 20 | 0.45 | 9.3 | 12 | 1.33 | 21.7 | 18 | 0.46 | 14.4 | 5 | 0.23 | 7.6 | 9 | 1.29 | 24.7 |
| *Pseudomys albocinereus* | 5 | 0.11 | 7.0 | 1 | 0.11 | 5.4 | 9 | 0.23 | 21.7 | 1 | 0.05 | 4.6 | 1 | 0.14 | 8.2 |
| *Pseudomys* spp./ Rodent unknown | 1 | 0.02 | 0.9 | 3 | 0.33 | 10.9 | - | - | - | 2 | 0.09 | 4.6 | 2 | 0.29 | 8.2 |
| Microbat | 1 | 0.02 | 0.4 | - | - | - | 1 | 0.03 | 0.6 | - | - | - | - | - | - |
| Skink | 8 | 0.18 | 1.5 | - | - | - | - | - | - | - | - | - | - | - | - |
| Dragon | 2 | 0.05 | 0.9 | 1 | 0.11 | 1.8 | 3 | 0.08 | 2.4 | - | - | - | - | - | - |
| Gecko | 44 | 1.00 | 6.1 | 2 | 0.22 | 1.1 | 11 | 0.28 | 2.6 | 33 | 1.50 | 15.1 | 13 | 1.86 | 10.7 |
| Bird | 9 | 0.20 | 8.4 | - | - | - | 2 | 0.05 | 3.2 | 2 | 0.09 | 6.1 | - | - | - |
| Beetle | 10 | 0.23 | 0.5 | 14 | 1.56 | 2.5 | 30 | 0.77 | 2.4 | 19 | 0.86 | 2.9 | 6 | 0.86 | 1.6 |
| Grasshopper | 7 | 0.16 | 0.7 | - | - | - | 10 | 0.26 | 1.6 | 2 | 0.09 | 0.6 | 1 | 0.14 | 0.5 |
| Spider/Centipede /Scorpion | 2 | 0.04 | 0.1 | - | - | - | - | - | - | 1 | 0.05 | 0.1 | - | - | - |
| **Totals** | **224** | **5.09** | | **59** | **6.56** | | **137** | **3.51** | | **97** | **4.41** | | **46** | **6.57** | |

# 5 Discussion

## 5.1 Black rats

No black rats were detected on Dirk Hartog Island. Twenty of the camera trap survey sites used during the 2013 survey were resampled and a further nine new sites were surveyed. The sites selected for the camera sets provided a wide coverage of sites where black rats may potentially occur, including buildings (used and abandoned), artificial watering points and potential entry sites, such as the barge landing and Tetrodon Loop (once a Pearling camp area). No black rat remains were recovered from barn owl pellet deposits collected from the island during this survey or the previous survey (Palmer & Morris 2014). All of the rodent species known from the island were detected using this approach.

A further dietary study based on the analysis of the contents of 14 feral cat stomachs and intestines collected from Dirk Hartog between March and April 2013 found few mammal remains (Deller et al. 2015). The only mammal identified was a single house mouse. The remains of two other small mammals were detected but these prey items could not be identified to species level.

As mentioned above, conditions were ideal for rodents living on Dirk Hartog Island to outbreak into plague numbers in 2016. There was almost a total absence of competition from introduced livestock or predation pressure from feral cats, and a strong pulse in plant production following the high rainfall in 2015. Populations of all three species of extant rodents on the island responded, increasing into plague numbers. If black rats were present in isolated mesic refuges on the island somewhere, they too would have almost certainly increased in numbers and expanded their ranges on the island (see also Short et al. 2017). Under these circumstances, a large–sized rodent would have become highly conspicuous on the island and easily detected by the camera traps set during this survey or by the feral cat survey team with their 160 camera traps located in grid formation across the entire island. Black rat tracks would also have been visible to these teams combing the island for feral cat sign.

Importantly, the only other extant native terrestrial species of mammal known from Dirk Hartog Island, the little long-tailed dunnart (*Sminthopsis dolichura*), was detected on the cat camera traps (Michael Johnstone pers. comm. March 2017). This species was not detected during the three targeted black rat surveys (Johnson 2011; Palmer & Morris 2014). The methods used for these surveys (baited camera traps and analysis of barn owl pellets) were not suited for detecting this species but the above example highlights the extent and thoroughness of the various current monitoring programs on Dirk Hartog Island.

## 5.2 Other fauna observations

Despite the small rodent plagues on Dirk Hartog in 2016, no barn owls have taken up residence in the three nest boxes placed in shelters on the island (Michael Johnstone pers. comm., February 2017). This suggests barn owls are vagrants on Dirk Hartog.

Four to five species of reptiles known to the island were detected by the cameras. The sand goanna (*Varanus gouldii*) accounted for most of the detections. Also detected was a stimson's python (*Anateresia stimsoni*), a large *Ctenotus* skink and several larger sized elapid snakes (*Pseudechis australis* and/or *Pseudonaja mengdeni*).

Images of birds (usually a series of pictures captured in a single day) were readily identifiable to species level. The bird detections from the two camera trap surveys (2013 and 2016) were combined and uploaded onto NatureMap by Paul Gioia (Science and Conservation Division). In total there were 246 daily species records from 40 camera locations representing 19 species. All species of bird found were common species for the island.

## 5.3 Conclusion

I conclude that black rats are not present on Dirk Hartog Island and there is no further requirement to undertake targeted surveys for this species. Continued general surveillance and enforcement of island quarantine measures is recommended to ensure that Dirk Hartog Island remains free of black rats.

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# Appendices

## Appendix 1 Detection of Black Rats in the Shark Bay World Heritage Area near Carnarvon

**Russell Palmer and Gary Hearle** (Operations Officer, DPAW Carnarvon)

A native of the Indian sub-continent, the black rat (*Rattus rattus* complex) has now spread throughout the world. In Australia, they occupy most of the agricultural land, watercourses and coastal environments around the entire mainland, frequently in association with human settlement. They have failed to penetrate into the arid interior, possibly due to their high water requirements.

Mapping of the black rat voucher specimens held by the Western Australian Museum shows a large gap in their distribution along the arid section of the west coast from Kalbarri National Park to Cape Range (Figure 3). The lack of records of black rats from the coastal fringes of the Shark Bay World Heritage Area (SBWH) and the main communities of Denham, Monkey Mia and Useless Loop suggest that the biosecurity risk of black rats to Dirk Hartog Island via transportation vectors (i.e. vehicles and vessels) from the adjacent mainland is minimal (Palmer & Morris 2014).

While the museum holds no vouchers of black rats from Carnarvon and none were detected during the Carnarvon basin biological survey (Burbidge et al. 2000), they are widespread in the town and surrounding farmland (Gary Hearle, pers. obs.). Subsequent DNA analysis of ear tissue by the South Australian Museum from three rats collected in Carnarvon on the 1st December 2014 has confirmed the identity of these black rats.

To determine if black rats had invaded the mangrove communities to the north and south of Carnarvon, Gary Hearle set eight camera traps in the mangroves from Miaboolya Beach 9 km to the north, down to New Beach, which is 31 km to the south of the town. Camera traps were set in four different locations with two cameras at each site for three nights, 10-13$^{th}$ May 2016. They were baited with a punctured tin of tuna and a smear of peanut butter.

Although these cameras were set for a short time, both the cameras at the most distant site from Carnarvon, New Beach, detected black rats (cover image and Plate 2).

While black rats at Carnarvon pose little direct risk to Dirk Hartog Island, this is the first confirmed record of black rats inside the SBWHA. It appears likely that rats are associated with the fringing mangroves in this northern section of the SBWHA, with New Beach located towards the southern limit of the continuous mangrove fringe (Rule et al. 2014). Additional surveys of the coast strip south of Carnarvon are required to determine if black rats have invaded further into the SBWHA where mangrove stands become intermittent.

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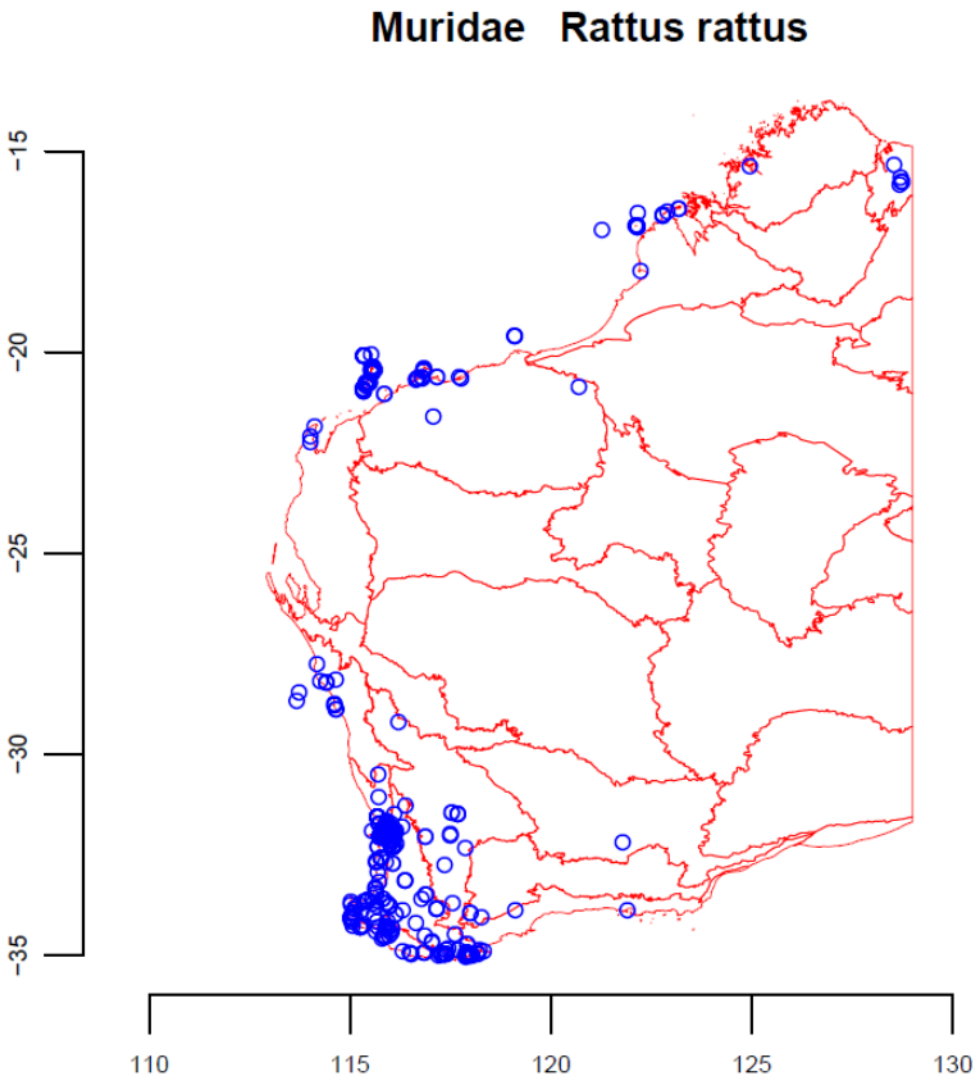


*Figure 3 Distribution of black rats in Western Australia according to voucher specimens held by the Western Australian Museum. Map produced by Mark Cowan.*

Camera 075 New Beach 1, 25.14245°S 113.77666°E.

Camera 080 New Beach 2, 25.14159°S 113.77592°E.

*Plate 1 Coastal mangrove sites and locations where black rats were detected on camera traps at New Beach south of Carnarvon*


*Plate 2 Black rat on Camera trap 80A at New Beach south of Carnarvon*