INVASIVE RODENT SURVEY OF DIRK HARTOG ISLAND

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Figure 1. Small rodents (house mice) captured on a camera trap at Fitzy's Bore on Dirk Hartog Island

Introduction

Invasive rodents (*Rattus rattus*, *R. exulans*, *R. norvegicus* and *Mus musculus/domesticus*) are arguably amongst the most successful invasive species on the planet. Through their commensal relationship with humans they have spread to almost every corner of the globe, including the Australian mainland and/or its offshore islands (Banks and Hughes 2012). In essentially every habitat invaded, *Rattus* has had severe negative impacts on natural diversity(Jones *et al.* 2008; Towns *et al.* 2006). Of the approximately 123 oceanic island groups worldwide, about 82% have been invaded by invasive rats (Atkinson 1985). The invasion rates by exotic rodents of continental (or landbridge) island groups/archipelagos off the Western Australian coast has been lower, although black rats (*R. rattus*) have been found on more than 40 islands and house mice (*M. domesticus*) on over 20 islands (Abbott and Burbidge 1995; DEWHA 2009).

Given the high conservation values of many of Australia's offshore islands and the negative impacts caused by invasive rodents, "Predation by exotic rats on Australian offshore islands of less than 1000 km^2 (100,000 ha)" is listed as a Key Threatening Processes under the *Environment Protection and Biodiversity Conservation Act* 1999 (DEWHA 2009). Black rats have been successfully eradicated from 30 islands in Western Australia in the past 30 years. Only five house mice populations have been eradicated from islands (Burbidge 2004; Morris 2002).

Dirk Hartog Island is the largest island in Western Australia, covering an area of 62 000 hectares. The island was discovered by Europeans in 1616 and it has a long maritime and settlement history (Abbott 2007; Burbidge and George 1978; Stanbury 1986). This includes numerous visits by early navigators and explorers, various ship wrecks, establishment of pearling base camps at Tetrodon Loop in the 1870s and the extensive guano mining activities on the islands in the surrounding waters of Shark Bay in the 1850s. A military encampment was briefly set up at Quoin Bluff on Dirk Hartog Island in the 1850s to prevent the illegal removal of guano from nearby islands (Stanbury 1986). A permanent human presence commenced after F.L. Von Bibra established Dirk Hartog Island pastoral station in the late 1860s (Abbott 2007). Construction of the lighthouse and ancillary facilities at Cape Inscription was

completed in 1910. The lighthouse residences were vacated in 1917 when the light was automated (Cumming *et al.* 1995).

Many of the ships of these early navigators were infested by rats (e.g. King 1827). The vessels of the pearling fleets and those that brought and supplied the early settlers were also riddled with vermin, including black rats (Bartlett 1954). This brief summary of the history of visitation and settlement suggests there were ample opportunities for black rats to invade Dirk Hartog, particularly as house mice are widespread on the island.

In 2009, the majority of Dirk Hartog Island became a National Park, and an ambitious plan to restore the islands' ecosystems was devised. This included the eradication of the sheep, feral goats and feral cats, and the reintroduction of 10 threatened mammals to the island. In 2011, this project was supported by the Gorgon Gas Project – Nett Conservation Benefit fund, and work on eradicating sheep and feral goats commenced immediately. Because so many other islands that had supported settlements and, in particular pearling operations, in the 18th century had had black rats introduced to them (Morris 2002), it was considered prudent to undertake several annual surveys of Dirk Hartog Island for black rats before fauna reintroductions commenced. In addition, two anecdotal reports of "a small rat sized animal" on the island were made, however these have now been dismissed.

This report documents the results of survey activities undertaken in 2013 on Dirk Hartog Island in search of black rats.

Methods

We predicted that if this large and arid island harboured black rats, we would find them in the richer coastal ecosystems, or living in a commensal association with humans either at the Wardle homestead complex or modified refugia created by humans, such as artificial water points (mills, bores or wells). For this survey, we focused our attention on the Wardle homestead and surrounding sites, other buildings on the island, artificial water points and associated infrastructure, and marine sites that are or were potential incursion sites for rats (barge landing area on the southern tip of the island and Tetrodon Loop – historical pearling camp).

Rodent detection methods

Camera traps

Twenty-eight active camera sets were established between the 7th and 11th May 2013 (Table 1, Figures 1 and 2). Each camera set consisted of a PVC bait capsule with a non-toxic bait or lure (peanut butter and oats) used to attract animals to within the detection zone of a camera trap. Several models of passive infrared Reconyx camera traps (Reconyx, Inc., WI, USA) were used. Cameras were collected on the 11th and 12th July 2013.

Accurate identification of small rodent species that are morphologically similar, such as the three species found on Dirk Hartog Island (*Pseudomys hermannsburgensis*, *P. albocinereus* and *Mus musculus*), using camera trap imagery is difficult (Meek *et al.* 2013). For this investigation images of small rodents were pooled as 'small rodents'.

Trapping

Two trap lines comprising 25 medium sized Elliott traps and 16 small cage traps (Tomahawk skunk traps) were set for three nights at Tetrodon Loop. Elliott traps were baited with universal bait and cage traps baited with a mixture of sardines and oats. Elliott traps (4-8 per night) were also set in the departmental shed, near the airstrip, over five nights.

Predator pellets and scats

Analysis of raptor/predator pellets and scats is a widely used survey tool for detecting the presence of rodents in a location. We searched abandoned buildings, sheds and other structures (e.g. concrete tanks) and several rock overhangs for recent owl and raptor pellets. Members of the survey party also searched for feral cat scats. A barn owl was found roosting in the Herald Bay Outcamp (shed) and Australian kestrels were found to use perches in the Brows Hollow shed and Bore Well Outcamp (shed). During the May trip, 44 barn owl pellets, 63 kestrel pellets, 1 feral cat scat and 1 snake scat were collected. A further 48 barn owl pellets and 14 kestrel pellets were collected by Allan Burbidge and Mark Blythman in October 2013

when they were undertaking threatened bird surveys. All pellets and scats were sent to an expert for analysis (Georgeanna Story, *www.scatsabout.com.au*).

General searches for rodent sign and tracks

Numerous beaches, buildings, artificial water points and other potential sites were inspected for signs of rodents, in particular black rats and the native water rat (*Hydromys chrysogaster*).

Results

Of the 28 cameras traps set, 22 were functional for 60 to 66 nights each and the remaining 6 cameras functioned for between 11 and 49 nights. Data was analysed from a total of 1612 camera trap–nights, which represents ~38 688 hrs of field observations. No black rats were detected on any of the cameras. Small rodents were detected at 23 (82%) of the camera trap sites, feral cats at 17 (61%), birds at 21 (75%, 17 species) and reptiles at 6 (21%, 5 species). In total, images of small rodents were recorded on 362 camera trap–nights (22% of trap–nights), feral cats on 47 days/nights (3%), birds on 212 days (13%) and reptiles on 14 days (<1%).

Nine *Pseudomys hermannsburgensis* and one house mouse were caught in the Elliott traps over the three nights (75 trap nights) at Tretrodon Loop. Ear tissue was collected from two *P. hermannsburgensis.* Nothing was captured in the cage traps (48 trap nights). Numerous house mice were captured in the departmental shed. Four house mice were vouchered and tissue taken. These vouchers and tissue samples were lodged with the WA Museum.

No remains of black rats were detected in the 171 predator pellets/scats analysed (92 barn owl, 77 Australian kestrel, 1 feral cat and 1 snake). The cat and snake had eaten house mice. The barn owl and kestrels preyed on the three species of small rodent and a range of reptiles and invertebrates (Tables 2 and 3). Birds were a minor prey of both raptors and the barn owl took several microbats. The diet of the barn owl showed some seasonal variation between the May and October collections, with more house mice, geckos and birds in the former and more beetles present in the latter sample (Table 3). The diet of kestrels from 2013 (May and October) is

compared to a previous investigation undertaken in October 2009 (Woolley 2009) in Figure 3.

No sign of medium to large rodent activity was detected on the beaches and other sites we inspected. A number of feral cats were seen and their tracks were found on roads. Fresh goat tracks (potentially two small mobs of 3-5 individuals) were observed on the road in the vicinity of Charlies Harbour on the 11th May. A domestic cat and dog, plus chickens, ducks and Guinea fowl were present at the Wardle's homestead.

Discussion

We found no evidence of black rats on Dirk Hartog Island. 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).

The weather during our visit was not conducive to detecting tracks of medium to large sized rodents, as a substantial front crossed the island producing significant rainfall and wind. Seas were also rough and the beaches we inspected were washed of most signs of animal activity.

No black rat remains were found in the 171 raptor/predator pellets/scats collected from Dirk Hartog Island. This diet analysis did show that house mice were a common prey item of the barn owl, and to a lesser degree, the Australian kestrel. Black rats and house mice have been found to be important prey for island populations (Galapagos, Bahamas and Canary) of barn owls in various parts of the world (Taylor 1994). Black rats with a body size of 40-120 g present a more profitable prey to barn owls than the smaller house mouse (<20 g). Optimal foraging theory suggests that the barn owl at Herald Bay should actively select this more profitable species (if available) over less profitable prey such as small rodents, geckos and insects. House mice were found in 94% of barn owl pellets, but it did not specialise on this prey item, with between 1 to 4 individuals found in the pellets. Comparatively, the diet of the barn owl recorded here was more generalist and included a wider range of

smaller prey categories than usually reported for the Australian mainland (Taylor 1994). This would indicate house mice were not overly abundant surrounding the roost at Herald Bay when the pellets were deposited. The diet information recorded for the barn owl and Australian kestrel in this study was consistent, however, with Dickman *et al*. (1991). They recorded diet for both these raptors from three smaller islands off Jurien Bay. House mice were present on two of these islands. Our study of kestrel diet for Dirk Hartog did differ significantly from the earlier October 2009 investigation by Woolley (2009). Woolley found that house mice comprised the bulk of their diet when this rodent was very abundant on the island (Linda Reinhold, pers. comm.). The comparison of these two datasets provides an insight into the influence of house mice on the diet of an opportunistic raptor.

Further collections of barn owl pellets and possibly kestrel pellets will provide a relatively cheap method of investigating the diets of predators on the island and the influence rodent populations have on the foraging behaviours of generalist raptors. Such information may be useful for the planned feral cat eradication. These collections will also provide important baseline datasets of raptor diets prior to the restoration of the mammal fauna to the island. Barn owls do prey on rats and *Egernia* spp. (Dickman *et al.* 1991), potentially providing a means of detecting these species if they are present on Dirk Hartog. Installing barn owl nest boxes in existing buildings on the island may assist in the collection of their pellets.

The remote cameras detected at least five species of reptile, although none were the western spiny-tailed skink (*Egernia stokesii*). The bobtail skink (*Tiliqua rugosa*) was recorded at three sites, suggesting cameras may be useful for detecting western spiny-tailed skinks in areas of suitable habitat. Bird images (usually a series of pictures captured in a single day) were readily identifiable to species level. In total, 211 of the 212 bird records per day were recognised to species. Data derived from daily visits by individual species of birds for all camera sites were provided to Dr. Allan Burbidge. All 17 species of bird found were common species for the island.

Genetic analysis by Dr. H Suzuki, Hokkaido University, Sapporo, Japan, confirmed that the house mice present on Dirk Hartog Island is *Mus domesticus* or *Mus musculus domesticus.* This species originated in western Europe and it is the same

species found on the Australian mainland and British Isles. The Eurasian house mice (*Mus musculus*) is present on Browse Island and Ashmore reef off the north western coast of Western Australia (Suzuki and Palmer unpublished data).

An additional survey (cameras and tracks) for black rats and water rats is warranted in the tidal flats between Withnell Point and Turtle Bay. This area was not effectively surveyed during this investigation. The increased productivity along these coastal flats from the marine environment may favour larger sized rodents. The small islands of Egg (1.0 ha), Meade (0.5 ha) and Sunday (0.3 ha) on the eastern side of Dirk Hartog, which were mined for guano in the past should be surveyed for the presence of invasive rodents. If house mice are present, their eradication is recommended.

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Table 1 Description and location of the 28 remote camera sets on Dirk Hartog Island May-July 2013

Camera No.	Site Type	Description	Latitude	Longitude
5	Buildings	Shed next to Lighthouse	-25.4823	112.9719
HC004	Building	Bore Well Outcamp	-25.6094	112.9445
48	Artificial water point	Hawknest Mill	-25.5256	112.9380
HC010	Buildings	Sandy Point Shearing Shed	-25.7184	113.0589
102	Buildings	Sandy Point Shearing Shed	-25.7181	113.0593
101	Artificial water point	Sandy Point Mill	-25.7188	113.0652
55	Artificial water point	Louisa Bay Mill	-25.7794	113.0843
58	Artificial water point	Eight Mile Well	-25.9301	113.1043
HC003	Building	Herald Bay Outcamp	-25.8723	113.1094
HC006	Artificial water point	Bottom Ten Mile Well	-25.9032	113.1128
HC009	Marine	Tetrodon Loop - samphire	-25.9774	113.1379
PC004	Marine	Tetrodon Loop - mangroves	-25.9763	113.1441
100	Artificial water point	Fitzy's Bore (in bananas)	-25.9838	113.1534
45	Marine	Notch Point road	-25.9750	113.1549
6	Artificial water point	Yabara Well	-26.0065	113.1697
HC005	Artificial water point	Two Wells	-26.0445	113.1875
HC007	Homestead complex	Rubbish dump	-26.0032	113.1960
39	Homestead complex	Shearing Shed	-26.0028	113.1963
50	Homestead complex	Wardle's house	-26.0020	113.1979
46	Homestead complex	Wardle's house	-26.0023	113.1981
38	Homestead complex	Wardle's house	-26.0025	113.1982
57	Homestead complex	Wardle's house	-26.0028	113.1989
41	Homestead complex	Wardle's house	-26.0022	113.1992
56	Homestead complex	Wardle's house	-26.0024	113.1993
51	Marine	Barge Landing	-26.1595	113.2153
42	Marine	Barge Landing	-26.1611	113.2157
44	Building	Clough’s Shed	-26.1382	113.2242
HC001	Building	Clough’s Shed	-26.1381	113.2243

Table 2 Overall diet composition of the barn owl (*Tyto alba*) and Australian kestrel (*Falco cenchroides*) on Dirk Hartog Island based on pellets collected in 2013.

MNI = minimum number of individuals in the pellets. % occurrence = the proportion of pellets in a given sample that contained a particular prey catergory. % volume = relative volume of each food category in a given sample of pellets.

	Barn Owls (n=92)		**Australian Kestrel (n=77)**	
Prey Categories	% occurrence	% of total MNI	% occurrence	% volume
Mus musculus	93.5	46.2	6.5	4.2
Pseudomys hermannsburgensis	38.0	11.9	9.1	6.2
Pseudomys albocinereus	14.1	3.6	5.2	1.9
Pseudomys sp.	3.3	1.0		
Microbat	2.2	0.5		
Skinks	4.3	1.9	76.6	16.0
Dragons	6.5	1.4	57.1	27.5
Geckos	37.0	13.6		
Goannas			1.3	0.1
Birds	8.7	2.6	5.2	1.9
Beetles	47.8	12.9	39.0	6.4
Centipedes	1.1	0.2	48.1	26.7
Grasshoppers	18.5	4.0	27.3	7.1
Spiders	1.1	0.2		
Ants			14.3	0.6
Unidentified invertebrates			14.3	1.2

Table 3 Diet composition of the barn owl (*Tyto alba*) at Herald Bay Outcamp, Dirk Hartog Island based on collections from May and October 2013.

MNI = minimum number of individuals in the pellets. % occurrence = the proportion of pellets in a given sample that contained a particular prey catergory.

	May 2013 (n=44)				October 2013 (n=48)			
Prey Categories	MNI	Mean # per pellet	% of total MNI	% occurrence	MNI	Mean # per pellet	% of total MNI	% occurrence
Mus musculus	115	2.61	51.3	97.7	79	1.65	40.3	89.6
Pseudomys hermannsburgensis	20	0.45	8.9	36.4	30	0.63	15.3	39.6
Pseudomys albocinereus	6	0.14	2.7	11.4	10	0.21	5.1	18.8
Pseudomys sp.	1	0.02	0.4	2.3	3	0.06	1.5	4.2
Microbat	1	0.02	0.4	2.3	1	0.02	0.5	2.1
Skinks	8	0.18	3.6	9.1				
Dragons	2	0.05	0.9	4.5	4	0.08	2.0	8.3
Geckos	44	1.00	19.6	52.3	13	0.27	6.6	22.9
Birds	9	0.20	4.0	13.6	2	0.04	1.0	4.2
Beetles	10	0.23	4.5	22.7	44	0.92	22.4	70.8
Centipedes	1	0.02	0.4	2.3				
Grasshoppers	7	0.16	3.1	15.9	10	0.21	5.1	20.8
Spiders	1	0.02	0.4	2.3				

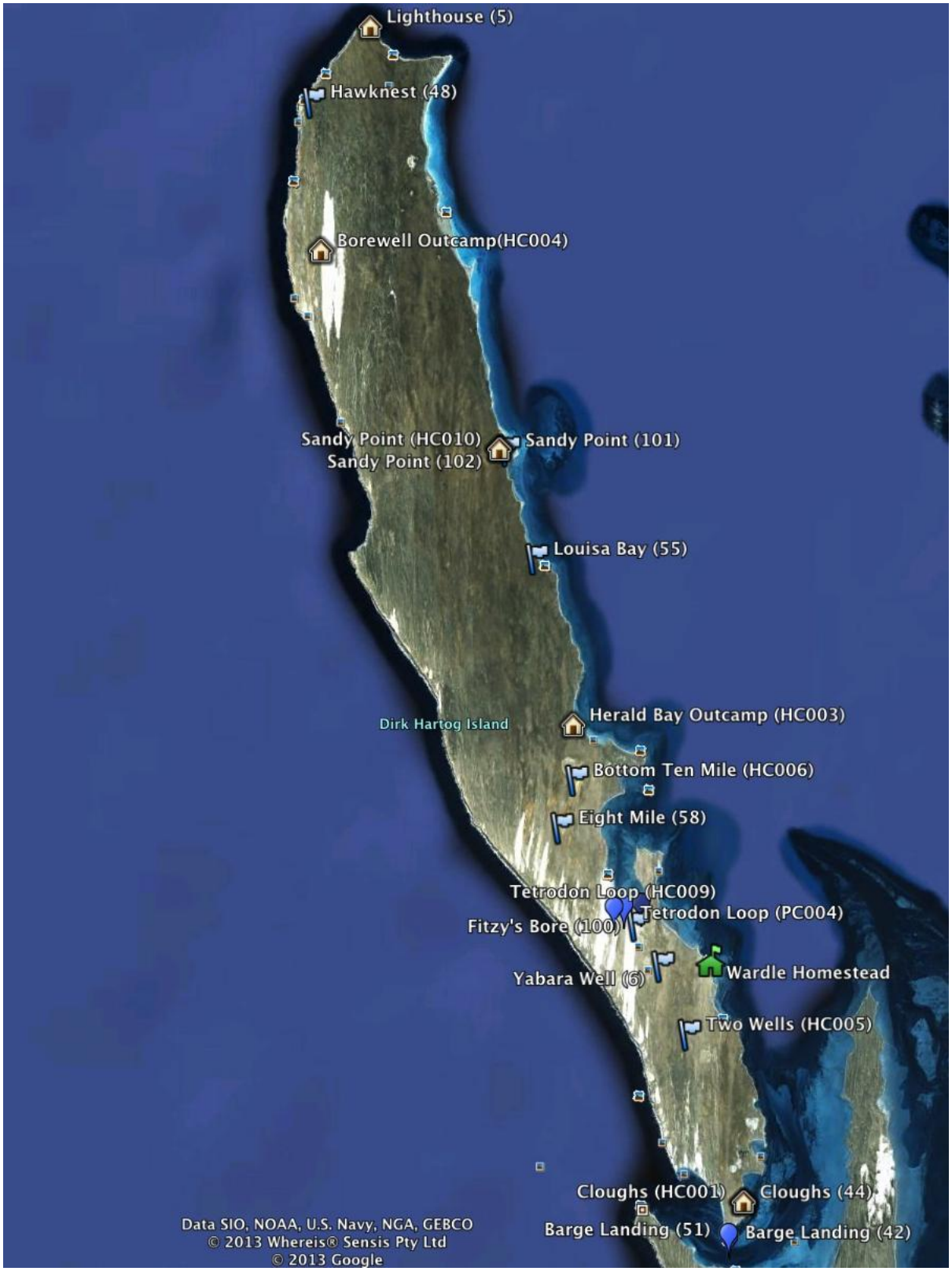

Figure 1 Location of camera trap sets on Dirk Hartog Island.

Figure 2 Location of the eight camera trap sets at the Wardle homestead complex.

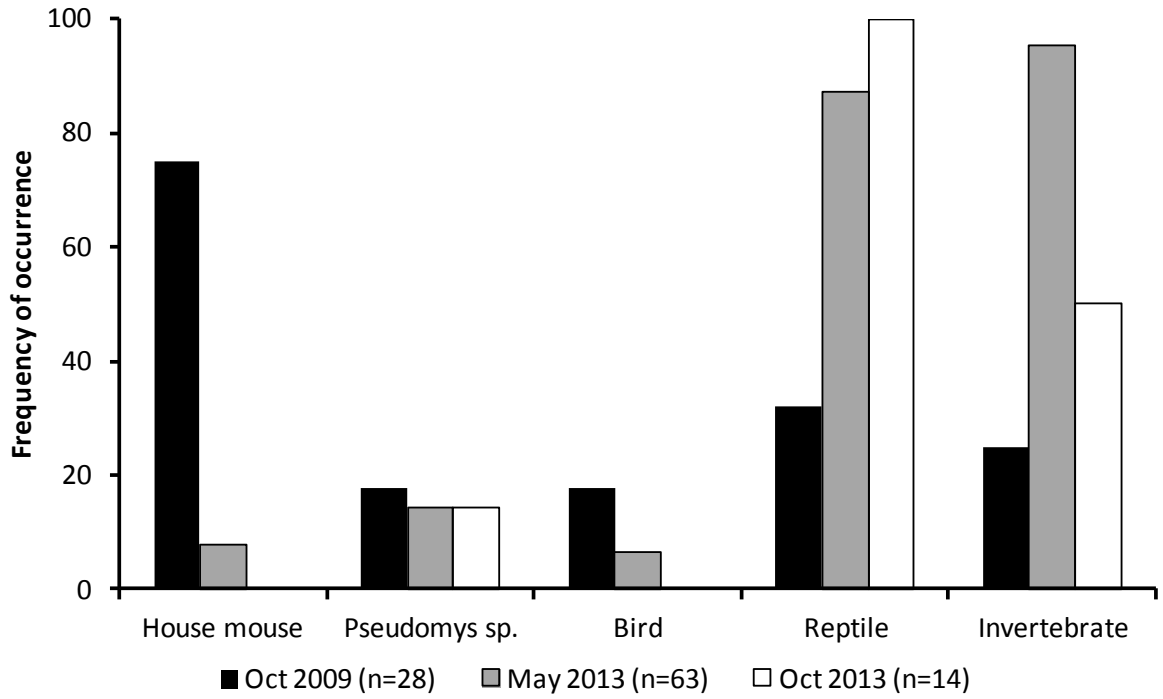

Figure 3 Australian kestrel diet for Dirk Hartog Island in 2009 (October) and 2013 (May and October)