

A survey for Wijingadda (northern quoll *Dasyurus hallucatus*) and other fauna on islands in Dambimangari country in Talbot Bay (Kimberley, Western Australia)

RUSSELL PALMER^{1*}, ROWAN MOTT², TRACY SONNEMAN³, SEAN GARRETSON¹,
NORM MCKENZIE¹, NEIL THOMAS¹, DANIEL BARROW³, JULIANA COFFEY²,
KIRK WOOLAGOODJA⁴, ETHAN JUNGINE⁴ AND JERMAINE UMBAGAI⁴

¹ Science and Conservation Division, Department of Parks and Wildlife,
Locked Bag 104 Bentley Delivery Centre, WA 6983, Australia

² School of Biological Sciences, 25 Rainforest Walk, Monash University, Clayton Vic 3800, Australia

³ Western Australian Department of Parks and Wildlife, West Kimberley District Office,
PO Box 65, Broome WA 6725, Australia

⁴ Dambimangari Rangers, Dambimangari Aboriginal Corporation, PO Box 648, Derby WA 6728, Australia

* Corresponding author: russell.palmer@dpaw.wa.gov.au

ABSTRACT

Islands in the Kimberley are of great cultural importance to the traditional owners and a key refuge for numerous species of threatened mammal, including the endangered northern quoll (*Dasyurus hallucatus*). We undertook a survey of islands and several mainland sites in the little-surveyed area of Talbot Bay, Yampi Peninsula in Dambimangari country in the southern part of the Northern Kimberley bioregion. Using existing knowledge of the occurrence of northern quolls on other Kimberley islands, we predicted that Molema Island, one of the larger and more rugged sandstone islands yet to be surveyed, would harbour quolls. Our prediction proved correct. We also found that northern quolls readily occupy smaller tidal islands, which were connected to the mainland at low tide but separated at high tide. In addition, we detected 21 other species of mammal, of which 11 were bats, and 52 species of birds during our five-day survey. With the exception of the pale field-rat (*Rattus tunneyi*) and the semi-aquatic water rat (*Hydromys chrysogaster*), the other ground mammals were confined to mainland sites.

Keywords: biological survey, island conservation, threatened mammals, Yampi Peninsula

INTRODUCTION

Populations of the endangered northern quoll, *Dasyurus hallucatus* (*Environment Protection and Biodiversity Conservation Act 1999; EPBC Act 1999*) across the Kimberley face a grave threat from the spread of the highly toxic cane toad (*Rhinella marina*). Northern quolls are fatally poisoned during predation attempts on cane

toads, which are toxic at all stages of their life cycle (Shine 2010). When cane toads invaded the Northern Territory from Queensland, northern quoll populations collapsed and the species disappeared from many areas where it was once abundant (Hill & Ward 2010; Woinarski et al. 2008; Woinarski et al. 2014). The first cane toads crossed the Northern Territory – Western Australia border in February 2009 and they have continued their advance into the eastern and central Kimberley (Department of Parks and Wildlife 2014). Islands are likely to be important refugia for northern quolls from cane toads, although seawater barriers are not completely impervious to toads (How et al. 2009; Woinarski et al. 2011). The arrival of cane toads on both Magnetic (Queensland) and Vanderlin (Northern Territory) islands resulted in the extirpation of these insular populations of northern quolls (Johnston et al. 1968; Woinarski et al. 2011).

© The Government of Western Australia, 2016

Recommended citation: Palmer R, Mott R, Sonneman T, Garretson S, McKenzie N, Thomas N, Barrow D, Coffey J, Woolagoodja K, Jungine E, Umbagai J (2016) A survey for Wijingadda (northern quoll *Dasyurus hallucatus*) and other fauna on islands in Dambimangari country in Talbot Bay (Kimberley, Western Australia). *Conservation Science Western Australia* 10: 9 [online]. <https://www.dpaw.wa.gov.au/CSWAjournal>

The remote and rugged southern part of the Northern Kimberley bioregion remains a key stronghold for the northern quoll and it is currently free of cane toads (Woinarski et al. 2014). The Dambimangari people are the traditional owners of 2.8 M ha of land and sea country of this region, which stretches from Yampi Peninsula north to the Prince Regent area of the Kimberley. They know the northern quoll as 'Wijingadda', a good hunter with a powerful role in cultural and spiritual stories (Dambimangari Aboriginal Corporation 2012). Native title was awarded to the Dambimangari over their country in May 2011 and the Traditional Owners developed the Dambimangari Healthy Country Plan 2012–2022 to set out a vision, identify conservation targets and threats and recommend management actions for this area. This plan specifically refers to concerns that invading cane toads may 'finish them [Wijingadda] up' (p. 40) and that 'we must work more with researchers to do more trapping to check that all the animals are still there' (p. 22). It also identifies that 'islands are a refuge for many animals that are threatened on the mainland' (p. 36) and that 'so far only small parts of our country have been properly surveyed' (Dambimangari Aboriginal Corporation 2012: p. 28).

The Dambimangari sea country includes an estimated 720 islands, which accounts for almost 20% of all the islands that occur in Western Australia (Conservation Commission of Western Australia 2010). Biological surveys of Dambimangari islands over the past 40 years, albeit limited in number, have detected northern quolls on Augustus, Uwins, Storr and Koolan islands (Gibson & McKenzie 2012; McKenzie et al. 1978; McKenzie et al. 1995). On Kimberley islands, quolls only occur on rugged sandstone islands that are usually >1000 ha in size and located within 3 km of the shoreline (Gibson & McKenzie 2012; How et al. 2009). Based on these criteria, we predicted that the most likely island in Dambimangari country to support an undetected population of northern quolls was Molema Island (1100 ha and 1 km offshore) in Talbot Bay (Fig. 1).

Apart from Koolan Island, which has been mined for iron ore since the 1950s and has the most extensive biological survey history of any island in the Kimberley (McKenzie et al. 1995), there has been little systematic biological survey activity in Talbot Bay. Here, we document the results of a targeted survey of Molema Island and other sites in the Talbot Bay area for northern quolls. We also used this opportunity to record other vertebrate fauna.

METHODS

Study Area

Talbot Bay is an almost enclosed gulf on the northern side of Yampi Peninsula, Western Australia (Fig. 1). Geologically, the Yampi Peninsula is the western end of the King Leopold Orogen, a complex band of

Proterozoic metamorphic and igneous rocks that has been intensely folded (Tyler & Griffin 1992). The rocky ria coast and the adjacent islands were formed during the last post-glacial transgression. The dozens of islands in Talbot Bay and the surrounding waters were high points of the pre-inundation landscape. Surveyed islands were the felspathic and haematitic sandstone terrain of the Yampi Formation, which forms a dissected and rounded topography (Wilson et al. 2011).

The area has a tropical, monsoonal climate with marked, wet summers and dry winters. Temperatures are high year round and the mean annual rainfall is 830 mm for the nearby Koolan Island (Australian Bureau of Meteorology 2015). The dominant vegetation of Yampi Peninsula is open savanna woodland with a canopy of *Corymbia/Eucalyptus* spp. over a grass understorey. Sandstone surfaces on the large islands in Talbot Bay generally support *Acacia*-dominated shrublands over *Triodia* (Lyons et al. 2014). Talbot Bay experiences an extreme tidal range of up to 11 m, with extensive areas of platform reef and massive mud banks exposed during low tide. Parts of the mainland coast in the bay and several of the larger islands are fringed by mangroves, with several extensive low, closed mangrove forests in sheltered areas, including the northern side of Molema Island (Wilson et al. 2011; Fig. 2).

For the purpose of this paper, we assigned informal, descriptive names to identify islands and sites (see Fig. 1) as few islands in Talbot Bay have official names. Umiida is the language name for an island that was surveyed in 2009–10 as part of the Kimberley Island Biodiversity Survey (KIBS; Gibson et al. 2015).

Survey Techniques

The survey team was based on a charter vessel moored next to Molema Island from 23–28 October 2013. All survey work was conducted using two tenders from the larger vessel, apart from the camera-trap surveys on the two more distant sites, Traverse Island and South Koolan. Access to these sites was by helicopter on the days that survey team members were transferred to and from Derby.

Camera traps

Camera traps were set on Molema, Traverse and South Molema islands and the tidal island of South Koolan (Figs. 1 and 2). On Molema, individual cameras were set at 12 sites for four nights around the perimeter of the island. Three cameras were set for three nights on South Molema Island. The helicopter landed at three sites on Traverse Island, with three cameras set at each of these landing sites for five nights. Four cameras were set for five nights at South Koolan from a single landing site. Each camera was spaced at approximately 100 m or more from the nearest camera.

We used commercially available passive infrared camera traps (Hyperfire PC900, Reconyx Inc., Holmen,

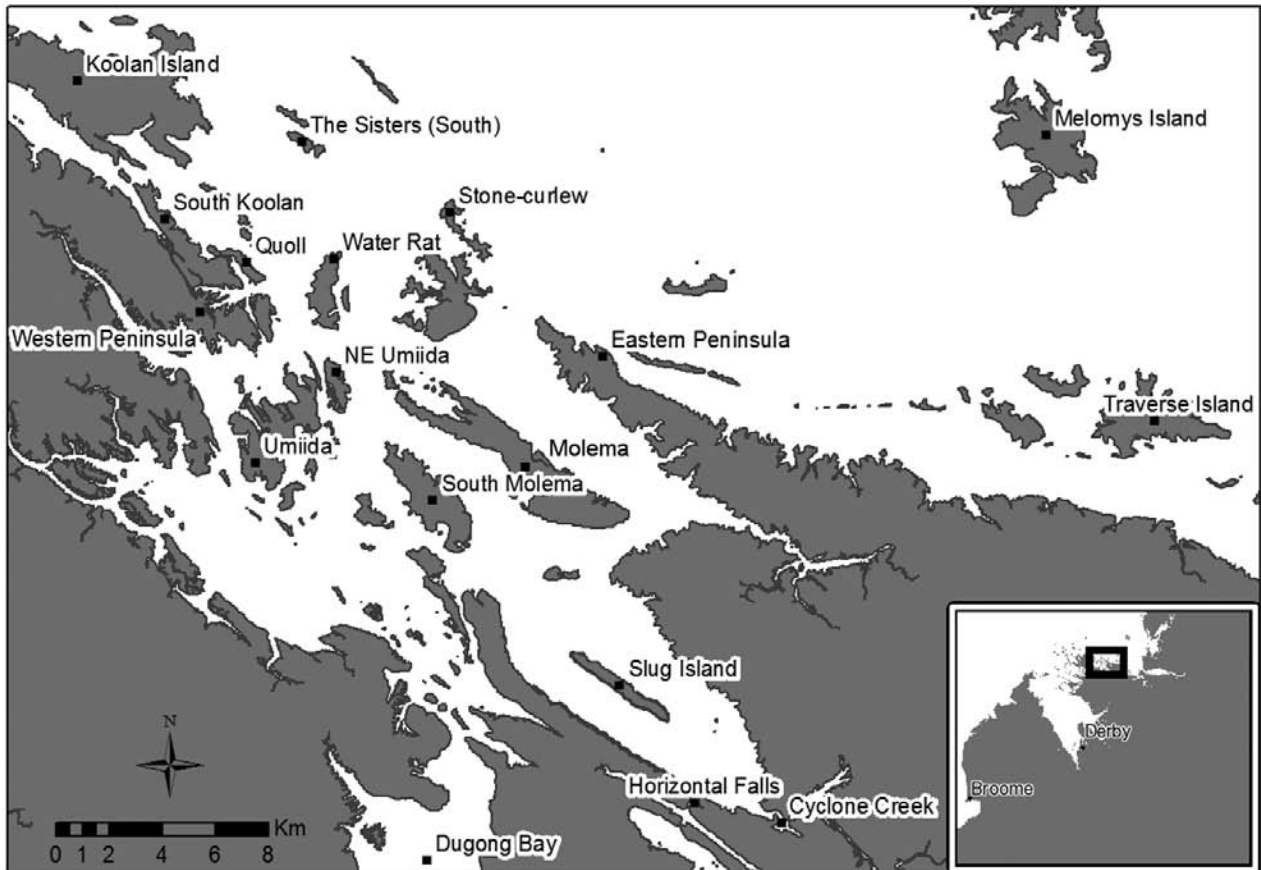


Figure 1. Survey sites in Talbot Bay.

WI, USA). Cameras were mounted 30 cm above the ground on a sturdy plastic peg, facing in a southerly direction. A PVC bait capsule, containing a mixture of universal bait (peanut butter and rolled oats) and sardines in vegetable oil, was placed within the detection zone of the camera trap (2–3 m away). The bait capsule was secured to a rock or tent peg at ground level. Vegetation was cleared from the detection zone to reduce the incidence of false triggers caused by moving vegetation. Cameras were set to 'aggressive', taking five pictures at up to two frames per second upon a trigger, with no quiet period between triggers. The detection sensitivity was set to high.

Trapping

Four trap lines were set on Molema and two trap lines on north-east Umiida for between two and five nights. The trap types used were medium-sized cage traps (Tomahawk Model 105 Live Trap, 41 × 13 × 13 cm) and large Elliott traps (50 × 17 × 17 cm, Elliott Scientific Equipment, Upwey, Victoria). Traps were baited with universal bait and set approximately 10 m apart in lines. Trapping effort on Molema was 144 cage and 30 large Elliott trap-nights. On north-east Umiida Island, it was 36 cage and 48 large Elliott trap-nights.

Beach surveys for mammal tracks and sign

Many islands in the Kimberley have sheltered bays or rocky coves with sandy beaches that are a focal point for animal activity. We applied sand tracking and sign identification techniques widely used for the detection and monitoring of fauna in the Australian arid zone (Moseby et al. 2009) to these beaches. Prior to the survey, satellite images in Google Earth™ were used to identify and map potential sandy beaches on the islands. Each beach was visited in a tender on the rising tide by a survey team. Observers spread out across the face of the exposed beach (i.e. below the recent high tide mark) and walked from one end of the beach to the other looking for fresh animal tracks and signs. If the beach area extended above the high tide mark, these sites were also inspected. In total, 17 beaches were inspected on 11 islands located in the mouth of Talbot Bay. The larger islands inside the bay, such as Molema, South Molema and Umiida lacked sandy beaches.

Scat searches and predator scat collections

We actively searched for predator and herbivore scats, tracks, diggings and other sign in seven other general locations. These included three sites on Molema Island,



Figure 2. Images of the tidal islands we called South Koolan and Quoll on high (left image) and low (right image) tide. On low tides these islands are connected to the mainland by exposed mud banks, which are then inundated at high tide, forming temporary islands. Images courtesy of Google Earth dated 20 November 2014 (left) and 11 October 2009 (right).

two on the eastern peninsula and one each on the tidal islands of Quoll and South Koolan (Figure 2). As most of these areas were on rocky substrate, we specifically focused on locating and collecting predator scats. These surveys were undertaken by between two and six people for two to four hours each. Additional scats were also collected opportunistically while undertaking other survey activities. All predator scats were analysed by Georgeanna Story of Scats About (www.scatsabout.com.au).

Bats

We sampled bats using a Wildlife Acoustics SM2BAT full-wave ultrasound recorder (384 kHz sampling rate) placed at ground level (Table 1). An omni-directional SMX-ultrasonic microphone was tied to the tip of a stake, about 1.5 m above the ground and several metres from obstructions. It was orientated vertically upwards to minimise echoes. The recorder was pre-programmed to switch on at late dusk and recorded until dawn. Sites were sampled for one night each and echolocation calls emitted by passing bats were recorded for an average of 11 h. The detector was placed in areas where bats are likely to forage such as mangroves, savanna woodlands or rugged boulder country (Table 1).

Call extractions and identifications were carried out by one of us (NM) using Kaleidoscope Version 2.3.0 (Wildlife Acoustics 2015). Extracted call sequences were saved as individual sound files in PCM wave format. COOL EDIT 2000, now 'Adobe Audition 2' (Adobe Systems, USA), was used to display each call sequence in spectral view and measure call parameters as described in McKenzie and Bullen (2012). Calls were identified to species using the reference call library and procedure described in McKenzie and Bullen (2012). Call shape, duration and repetition-rate data measured from the sequence were used to confirm the identifications. Calls that did not meet the clarity, duration, shape and sequence repetition-rate criteria listed in the library were ignored.

Table 1

Locations and descriptions of bat recorder survey sites.

Date	Location	Latitude	Longitude	Site details
23 Oct 2013	Molema Island (southern side)	-16.26340	123.90026	Set behind mangrove fringe among rocks with scattered <i>Bauhinia cunninghamii</i> trees. In front of steep cliffs with monsoonal vine thickets.
24 Oct 2013	Molema Island (northern side)	-16.25934	123.90782	Set in large mangrove tree in a channel into a mangrove forest (>100 ha in size), situated ~80 m from steep rocky cliffs.
25 Oct 2013	Umiida (northeast side)	-16.24111	123.84040	Set on rocks above the shoreline, next to low open mangrove woodland.
26 Oct 2013	Molema Island (cove – southern side)	-16.26815	123.90559	Set in rocky scree drainage line in open woodland. Situated ~50 m from mangroves.
27 Oct 2013	Mainland (western peninsula)	-16.22226	123.79876	Set in <i>Ficus</i> tree on rocks next to low mangal.

Birds

Bird surveys were undertaken by experienced bird observers (RM and JC). Two early morning surveys were undertaken from a tender around Umiida and birds were identified by sight and call. Weather conditions during surveys were fine with little to no wind. Birds detected opportunistically while undertaking other field activities were also recorded. Additional bird records for Talbot Bay were accessed from NatureMap (Department of Parks and Wildlife 2007) and eBird Australia (eBird 2012).

Taxonomy for mammals and birds follows the most recent checklist by the Western Australian Museum (WAM 2016).

RESULTS

The northern quoll was recorded via various detection methods on Molema Island and the tidal islands of South Koolan and Quoll (Figs. 1 and 2), and the adjacent mainland (Table 2). Quoll scats were also found on the small tidal island (18.3 ha) on the western tip of Molema (considered here as part of Molema). A further 10 species of ground-dwelling mammals were detected during our survey (Table 2). The pale field-rat (*Rattus tunneyi*) was the only other ground mammal recorded from an island (Table 2). The semi-aquatic water rat (*Hydromys chrysogaster*) was detected via sign (tracks or scats) on Traverse, South Sister, South Molema and 'Water Rat' islands and both of the tidal islands, Quoll and South Koolan. Possum scats were found on a rock shelf on South Koolan as well, these were probably scaly-tailed possum (*Wyulda squamicaudata*), but we were unable to confirm this record to species level.

The other species of conservation significance (listed as threatened under the *EPBC Act 1999*) identified from the mainland were the golden bandicoot (*Isodon auratus*) and the golden-backed tree-rat (*Mesembriomys macrurus*). The latter was the result of an opportunistic

Table 2
Ground mammals recorded (and detection method) for islands and a mainland site in Talbot Bay.

Family and scientific name	Common name	Island			Tidal islands		Mainland	
		Molema	'Quoll'	South Koolan	Eastern peninsula	Eastern peninsula		
Dasyuridae								
<i>Dasyurus hallucatus</i>	Northern quoll	trapped, camera, scats	tracks, scats	camera, scats	tracks, scats	tracks, scats	tracks, scats	tracks, scats
<i>Pseudantechinus ningbing</i>	Ningbing pseudantechinus							
Peramelidae								
<i>Isodon auratus</i>	Golden bandicoot							prey of dingo
Phalangeridae								
Unknown	Possum					scats		
Macropodidae								
<i>Macropus agilis</i>	Agile wallaby							prey of dingo
<i>Macropus robustus</i>	Euro							sighting
<i>Petrogale brachyotis</i>	Short-eared rock-wallaby							sightings
Muridae								
<i>Hydromys chrysogaster</i> *	Water rat							
<i>Rattus tunneyi</i>	Pale field-rat							prey of quoll/dingo
<i>Zyzomys argurus</i>	Common rock-rat	prey of quoll				scats		prey of quoll
<i>Zyzomys woodwardi</i>	Kimberley rock-rat							prey of quoll
Canidae								
<i>Canis dingo</i>	Dingo							tracks, scats

* *Hydromys chrysogaster* was also detected on Traverse (scats), South Sister (tracks), South Molema (scats) and 'Water Rat' (tracks) islands

sighting by Josh Bairstow, the vessel skipper, at a spring fed creek in Dugong Bay (Fig. 1). The prey remains recovered from the 94 northern quoll and five dingo scats we collected contributed five species of mammals to our list; most were from the mainland (Table 2).

We recorded (in predator scats) one mega-bat and (by sound) 10 species of microbat belonging to five families from our five nights of survey (Table 3). All 11 species were found on Molema Island. Three extra species were added to the inventory for Umiida (NW Molema in McKenzie & Bullen 2012). The mangrove forest site on the northern side of Molema provided the richest species list of the five sites surveyed, with seven species recorded. A colony of common sheath-tailed bats (*Taphozous georgianus*) was photographed in a sea cave on the eastern peninsula (Fig. 1). The little red flying-fox (*Pteropus scapulatus*) was also detected at this site in quoll and dingo scats.

We recorded a total of 52 species of birds (Table 4). We added 22 species of bird to the inventory for Umiida (NW Molema in Pearson et al. 2013), which now tallies 44 species. Twenty-two bird species were recorded on Molema Island. Fewer birds were detected at the other

sites, reflecting the relatively short duration of our visits to these locations. When our bird survey data was combined with records from other sources, a total of 88 bird species were reported for Talbot and Dugong bays (Table 4).

DISCUSSION

As predicted, the previously unsurveyed Molema Island in Talbot Bay was found to harbour northern quolls. This finding brings the total number of islands with populations of northern quoll in the Kimberley to 12, five of which are located in Dambimangari country. Island size is a useful predictor for the occurrence of northern quolls on Kimberley islands, so we did not expect to detect them on the smaller islands of Traverse (637 ha, 2.2 km offshore) or South Molema (492 ha, 1.5 km offshore). The smallest island known to support northern quolls in the Kimberley is the Capstan Island (320 ha), near Bigge Island (How et al. 2006). This small island is separated from the mainland by a shallow, 100-m-wide channel, and the persistence of

Table 3

Bat fauna detected in Talbot Bay and Koolan Island. x = current survey; + = previously detected but not during the current survey; b = both current and previous survey.

Family and scientific name	Common name	Molema Island	Umiida (NW Molema Island)	Western peninsula	Koolan Island*
Pteropodidae					
<i>Macroglossus minimus</i>	Northern blossom-bat				+
<i>Pteropus alecto</i>	Black flying-fox				+
<i>Pteropus scapulatus</i>	Little red flying-fox	x [#]			
Megadermatidae					
<i>Macroderma gigas</i>	Ghost bat		+		+
Hipposideridae					
<i>Hipposideros ater</i>	Dusky leaf-nosed bat	x		x	+
<i>Hipposideros stenotis</i>	Northern leaf-nosed bat	x	x		+
Emballonuridae					
<i>Saccolaimus flaviventris</i>	Yellow-bellied sheath-tailed bat		+		+
<i>Taphozous georgianus</i>	Common sheath-tailed bat	x	b	x	+
<i>Rhinonictes aurantia</i>	Orange leaf-nosed bat				+
Molossidae					
<i>Chaerephon jobensis</i>	Northern free-tailed bat				+
<i>Ozimops cobourgiensis</i>	Northern coastal free-tailed bat	x			+
Miniopteridae					
<i>Miniopterus orianae</i>	Large bent-wing bat	x	b	x	+
Vespertilionidae					
<i>Nyctophilus arnhemensis</i>	Arnhem long-eared bat	x			+
<i>Chalinolobus nigrogriseus</i>	Hoary wattled bat	x	x	x	+
<i>Pipistrellus westralis</i>	Northern pipistrelle	x	x		+
<i>Scotorepens greyii</i>	Little broad-nosed bat		+		
<i>Scotorepens sanborni</i>	Northern broad-nosed bat	x		x	+
<i>Vespadelus caurinus</i>	Northern cave-bat	x	b	x	+
Total species		11	9	6	16

* (McKenzie & Bullen 2012); # prey of northern quoll

Scientific name	Common name	Molema Island	Umiida (NW Molema Island)	Stone-curlew Island	Eastern peninsula	Horizontal Falls and Cyclone Creek	Over water on Talbot Bay	Western peninsula and South Koolan	Dugong Bay
<i>Falco subniger</i>	Black falcon								+
<i>Cacatua sanguinea</i>	Little corella					+			
<i>Cacatua galerita</i>	Sulphur-crested cockatoo					+			
<i>Trichoglossus rubritorquis</i>	Red-collared lorikeet		x						
<i>Platycercus venustus</i>	Northern rosella		+						
<i>Aprosmictus erythropterus</i>	Red-winged parrot		b					+	+
<i>Ptilonorhynchus nuchalis</i>	Great bowerbird	x	b		x	b			+
<i>Malurus lamberti</i>	Variiegated fairy-wren					+			+
<i>Myzomela erythrocephala</i>	Red-headed honeyeater					+			+
<i>Cissomela pectoralis</i>	Banded honeyeater					x			x
<i>Lichmera indistincta</i>	Brown honeyeater	x	b	x	b	b		+	b
<i>Philemon citreogularis</i>	Little friarbird					+			
<i>Philemon argenticeps</i>	Silver-crowned friarbird		b		b	+			+
<i>Melithreptus gularis</i>	Black-chinned honeyeater	x	x						
<i>Melithreptus albogularis</i>	White-throated honeyeater		b		x	+			
<i>Ramsayornis fasciatus</i>	Bar-breasted honeyeater					+			
<i>Manorina flavigula</i>	Yellow-throated miner	x	+		x	+		+	
<i>Stomiopera unicolor</i>	White-gaped honeyeater			x	x				+
<i>Gavicalis virescens</i>	Singing honeyeater		+						
<i>Gerygone levigaster</i>	Mangrove gerygone	x			+				
<i>Gerygone magnirostris</i>	Large-billed gerygone		x			+			
<i>Artamus leucorhynchus</i>	White-breasted woodswallow	x			+	+			+
<i>Artamus minor</i>	Little woodswallow		+			+		b	
<i>Cracticus argenteus</i>	Silver-backed butcherbird		+		+	+			+
<i>Cracticus nigrogularis</i>	Pied butcherbird	x	b		+	+			
<i>Coracina novaehollandiae</i>	Black-faced cuckoo-shrike		+			+			+
<i>Coracina papuensis</i>	White-bellied cuckoo-shrike		x		+	+			
<i>Coracina tenuirostris</i>	Cicadabird								+
<i>Pachycephala melanura</i>	Mangrove golden whistler				+	+			+
<i>Pachycephala rufiventris</i>	Rufous whistler		+			+		x	+
<i>Pachycephala lanioides</i>	White-breasted whistler			x	+	b			+
<i>Colluricincla woodwardi</i>	Sandstone shrike-thrush	x			+	+		x	+
<i>Rhipidura leucophrys</i>	Willie wagtail	x	+	x		+	x		
<i>Rhipidura rufiventris</i>	Northern fantail	x				+			+
<i>Rhipidura phasiana</i>	Mangrove grey fantail				+	+			
<i>Myiagra rubecula</i>	Leaden flycatcher	x	+			+			
<i>Myiagra ruficollis</i>	Broad-billed flycatcher				+	+			+
<i>Myiagra Alecto</i>	Shining flycatcher					+			+
<i>Myiagra inquieta nana</i>	Paperbark flycatcher								+
<i>Eopsaltria pulverulenta</i>	Mangrove robin					x			+
<i>Microeca flavigaster tormenti</i>	Kimberley flycatcher				+				+
<i>Petrochelidon nigricans</i>	Tree martin						x		
<i>Cisticola exilis</i>	Golden-headed cisticola				x				
<i>Zosterops luteus</i>	Yellow white-eye	x	x	x	+	+		+	+
<i>Dicaeum hirundinaceum</i>	Mistletoebird					+			
<i>Taeniopygia bichenovii</i>	Double-barred finch								x
		22	44	10	26	51	9	11	44

quolls apparently depends on animals crossing from the adjacent mainland (How et al. 2009). In contrast, genetic analyses of northern quolls on the larger islands of Bigge, Boongaree and Koolan, which each have deep channels separating them from the mainland, suggests they harbour long-isolated, relictual populations (How et al. 2009).

Our survey also confirmed northern quolls readily occupy tidal islands adjacent to either the mainland or larger islands. The tidally inundated rocky bar separating the small tidal island (18.3 ha) on the western tip of Molema from the main island is roughly 70 m wide. For animals to reach the tidal island we called 'Quoll' from the mainland, they need to cross up to three mangrove-lined channels that become inundated at high tide, the largest being 200 m wide on a low tide (Fig. 2). While such islands are not 'true' islands they may offer threatened species greater protection against threats that exist on the adjacent mainland, such as altered fire regimes, overgrazing and predation by introduced predators (Gibson & McKenzie 2012; McKenzie et al. 2009). Further surveys of tidal or narrowly separated islands surrounding large islands known to harbour northern quolls are warranted, particularly if quoll populations on the main island are placed at risk of extinction (e.g. increased frequency of fire).

Water rats are highly secretive and difficult to detect via standard fauna survey techniques, with most of the earlier surveys of Kimberley islands failing to record their presence (How et al. 2006; McKenzie et al. 1978; McKenzie et al. 1995; Start et al. 2007). Use of indirect survey techniques, particularly surveys of beaches for water rat sign (presence of partially webbed hind-footprints and distinctive odorous scats) has improved their detection rates. Here we added an additional five islands to the growing list of islands that harbour water rats, including the relatively small South Sister Island (38.9 ha, 5.1 km offshore). They are now the most widely distributed non-volant mammal found on the islands in the Kimberley (Gibson & McKenzie 2012; R Palmer unpub. data). The presence of this semi-aquatic species on islands of variable sizes and distances from the mainland in the Kimberley and Northern Territory indicate substantial inter-island movements by water rats in the tropics (Woinarski et al. 1999).

The pale field-rat was the only other ground mammal detected on an island (Molema). Gibson and McKenzie (2012) also recorded this species on Umiida during the KIBS. The small dasyurid *Planigale maculata* is known to occur on Koolan Island but is yet to be found on any other island in this region (Gibson & McKenzie 2012). Kimberley islands over 400 ha in size generally support at least one species of ground-dwelling rodent (see Appendix 2 in Gibson & McKenzie 2012). Based on this pattern of occupancy, native rodents are likely to occur on both Traverse and South Molema islands but our survey effort (i.e. 20 and 45 camera trap-nights, respectively) may not have been sufficient to detect them.

Our detection of the northern quoll, golden bandicoot and golden-backed tree-rat on Yampi Peninsula was consistent with the known distribution of these threatened species in the Kimberley. Populations of all three species have experienced range contractions to the most mesic limits (usually the coastal fringe) of their former distributions on the Kimberley mainland (Palmer et al. 2004; Start et al. 2012). Scaly-tailed possums were recorded on camera traps from several locations on Yampi Peninsula in 2013 and 2015 (Dambimangari Rangers unpub. data), suggesting the possum scats we found on a rock ledge at the South Koolan site belonged to this poorly known possum that is endemic to the Kimberley.

Molema Island was found to have a rich bat fauna of 11 species. Of the 10 other islands that have been surveyed for bats in the southern part of the Northern Kimberley, only Koolan (16 species, 2508 ha) has more species (McKenzie & Bullen 2012). All of the species we recorded on Molema were also known from Koolan, apart from the little red flying-fox. Our detection of the northern coastal free-tailed bat (*Ozimops cobourgianus*) on Molema extends the known range of this mangrove specialist along the Kimberley coast by a further 20 km. Previously, the only records of this species in the Kimberley were from Koolan, Lachlan, and Sunday islands (McKenzie & Bullen 2012).

Bird survey data for Talbot Bay are scant, with only Umiida having a published island list (Pearson et al. 2013). This previous account was compiled from a campsite located in the centre of the island, so it was not surprising that we were able to double this inventory to 44 species, the bulk of which were shorebirds or coastal wetland species observed from the tender. All of the bird species we detected on the islands had previously been recorded on islands in the Kimberley. We did, however, record a number of coastal waterbirds and shorebirds such as the Australian pied cormorant (*Phalacrocorax varius*), common greenshank (*Tringa nebularia*), common sandpiper (*Actitis hypoleucos*) and red-necked stint (*Calidris ruficollis*) on Molema and/or Umiida that have rarely been recorded from inshore islands in the Kimberley previously (Smith et al. 1978; McKenzie et al. 1995; Pearson et al. 2013; Lamont et al. 2014). The extreme tidal fluxes in Talbot Bay expose extensive areas of platform reef and massive mud banks surrounding Molema and Umiida islands (Wilson et al. 2011; Fig. 2). These intertidal zones and the substantial mangal environments in Talbot Bay are likely to provide important feeding and roosting sites for coastal waterbirds and shorebirds.

Uncommonly reported land-bird species for Kimberley islands were the black-chinned honeyeater (*Melithreptus gularis*) and the white-breasted whistler (*Pachycephala lanioides*). The black-chinned honeyeater was detected on both Molema and Umiida islands. The white-breasted whistler, a mangrove specialist, was detected on 'Beach-curlew' Island and other mainland sites with extensive areas of mangroves.

Our survey was focused towards the detection of northern quolls and it was also for a relatively short duration. The species inventories we compiled for mammals and birds are therefore by no means exhaustive but provide a good foundation for further collaborative surveys with the Dambimangari in this culturally important and remote part of the Kimberley coast.

ACKNOWLEDGEMENTS

We thank the Dambimangari Aboriginal Corporation for granting us access to Talbot Bay for the survey. We are grateful to Josh Bairstow and crew of *MV Kimberley Quest II* and Morgan Inglis from Frontier Helicopters for transporting teams safely between sites. Todd Quartermaine and Jarrad Holmes were instrumental in facilitating the survey. Thanks also to Jarrad Holmes, Lesley Gibson, Tony Start (referee) and one anonymous referee for comments on the manuscript. The survey was funded by Mount Gibson Iron Limited via a mining offset for northern quoll research and the Department of Parks and Wildlife.

REFERENCES

- Australian Bureau of Meteorology (2015) Climate Data Online. Available at <http://www.bom.gov.au/climate/data/index.shtml> [accessed 1 May 2015].
- Conservation Commission of Western Australia (2010). *Status Performance Assessment: Biodiversity Conservation on Western Australian Islands. Phase II – Kimberley Islands*. Conservation Commission of Western Australia Final Report. Western Australia Government, Perth.
- Dambimangari Aboriginal Corporation (2012) *Dambimangari Healthy Country Plan 2012–2022*. Dambimangari Aboriginal Corporation, Derby. Available at: <http://www.klc.org.au/docs/default-source/Ranger-Fact-Sheets/dambimangari-healthy-country-plan-2012–2022> [accessed 1 May 2015].
- Department of Parks and Wildlife (2014) *Cane Toad Strategy for Western Australia 2014–2019*. Western Australian Government, Perth.
- Department of Parks and Wildlife (2007–) NatureMap: Mapping Western Australia's Biodiversity. Department of Parks and Wildlife. Available at: <https://naturemap.dpaw.wa.gov.au/> [accessed 1 May 2015].
- eBird (2012) eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available at <http://www.ebird.org> [accessed 1 May 2015].
- Gibson LA, McKenzie NL (2012) Occurrence of non-volant mammals on islands along the Kimberley coast of Western Australia. *Records of the Western Australian Museum, Supplement* **81**, 15–39.
- Gibson LA, Yates S, Doughty, P (eds) (2015) Biodiversity values on selected Kimberley islands, Australia. *Records of the Western Australian Museum, Supplement* **81**, Western Australian Museum, Perth.
- Hill BM, Ward SJ (2010) *National Recovery Plan for the Northern Quoll* *Dasyurus hallucatus*. Department of Natural Resources, Environment, The Arts and Sport, Darwin.
- How R, Schmitt L, Teale R, Cowan M (2006) Appraising vertebrate diversity on Bonaparte Islands, Kimberley, Western Australia. *Western Australian Naturalist* **92**, 92–110.
- How R, Spencer P, Schmitt L (2009) Island populations have high conservation value for northern Australia's top marsupial predator ahead of a threatening process. *Journal of Zoology* **278**, 206–217.
- Johnston L, Wharton R, Calaby J (1968) Eradication of cattle tick (*Boophilus microplus*) from Magnetic Island, Queensland, in the presence of native fauna. *Australian Veterinary Journal* **44**, 403–405.
- Lamont CR, Bamford MJ, Harvey MS, Fitzpatrick JJ (2014) Terrestrial fauna. In *Ecological Studies of the Bonaparte Archipelago and Browse Basin* (eds J Comrie-Greig, L Abdo), pp. 103–186. INPEX Operations Australia Pty Ltd, Perth.
- Lyons M, Keighery G, Gibson L, Handasyde T (2014) Flora and vegetation communities of selected islands off the Kimberley coast of Western Australia. *Records of the Western Australian Museum, Supplement* **81**, 205–243.
- McKenzie N, Bullen R (2012) An acoustic survey of zoophagic bats on islands in the Kimberley, Western Australia, including data on the echolocation ecology, organisation and habitat relationships of regional communities. *Records of the Western Australian Museum, Supplement* **81**, 67–108.
- McKenzie N, Burbidge A, Chapman A, Youngson K (1978) Part III, Mammals. In *The Islands of the North-West Kimberley, Western Australia* (eds AA Burbidge, NL McKenzie), pp. 22–28. Wildlife Research Bulletin No. 7, Department of Fisheries and Wildlife, Perth.
- McKenzie N, Fontanini L, Lindus N, Williams M (1995) Biological inventory of Koolan Island, Western Australia 2. Zoological notes. *Records of the Western Australian Museum* **17**, 249–266.
- McKenzie N, Start T, Burbidge A, Kenneally K, Burrows N (2009) *Protecting the Kimberley: A Synthesis of Scientific Knowledge to Support Conservation Management in the Kimberley Region of Western Australia. Part B: Terrestrial Environments*. Department of Environment and Conservation, Perth.
- Moseby K, Nano T, Southgate R (2009) *Tales in the Sand: A Guide to Identifying Australian Arid Zone Fauna*

- using *Spoor and Other Signs*. Ecological Horizons, Kimba, South Australia.
- Palmer C, Taylor R, Burbidge AA (2004) *Recovery Plan for the Golden Bandicoot Isoodon auratus and Golden-backed Tree-rat Mesembriomys macrurus 2004–2009*. Northern Territory Department of Infrastructure Planning and Environment, Darwin.
- Pearson DJ, Cowan MA, Caton W (2013) The avifauna of larger islands along the Kimberley coast, Western Australia. *Records of the Western Australian Museum, Supplement* **81**, 125–144.
- Shine R (2010) The ecological impact of invasive cane toads (*Bufo marinus*) in Australia. *The Quarterly Review of Biology* **85**, 253–291.
- Smith LA, Johnstone RE, Dell J (1978) Part IV Birds. In *The Islands of the North-West Kimberley, Western Australia* (eds. AA Burbidge, NL McKenzie), pp. 29–41. Wildlife Research Bulletin No. 7, Department of Fisheries and Wildlife, Perth.
- Start A, Burbidge A, McDowell M, McKenzie N (2012) The status of non-volant mammals along a rainfall gradient in the south-west Kimberley, Western Australia. *Australian Mammalogy* **34**, 36–48.
- Start A, Burbidge A, McKenzie N, Palmer C (2007) The status of mammals in the North Kimberley, Western Australia. *Australian Mammalogy* **29**, 1–16.
- Tyler IM, Griffin TJ (1992) *Explanatory Notes on the Yampi 1:250 000 Geological Sheet, Western Australia (Second Edition)*. Geological Survey of Western Australia, Perth.
- WAM (2016) Checklist of the terrestrial vertebrate fauna of Western Australia. Available at <http://museum.wa.gov.au/research/departments/terrestrial-zoology/checklist-terrestrial-vertebrate-fauna-western-australia> [accessed 1 November 2016].
- Wilson B, Blake S, Ryan D, Hacker J (2011) Reconnaissance of species-rich coral reefs in a muddy, macro-tidal, enclosed embayment, Talbot Bay, Kimberley, Western Australia. *Journal of the Royal Society of Western Australia* **94**, 251–265.
- Woinarski J, Palmer C, Fisher A, Brennan K, Southgate R, Masters P (1999) Distributional patterning of mammals on the Wessel and English Company Islands, Arnhem Land, Northern Territory, Australia. *Australian Journal of Zoology* **47**, 87–111.
- Woinarski J, Oakwood M, Winter J, Burnett S, Milne D, Foster P, Myles H, Holmes B (2008) *Surviving the Toads: Patterns of Persistence of the Northern Quoll Dasyurus hallucatus in Queensland*. Report submitted to the Natural Heritage Trust Strategic Reserve Program, as a component of project 2005/162: Monitoring and Management of Cane Toad Impact in the Northern Territory.
- Woinarski J, Ward S, Mahney T, Bradley J, Brennan K, Ziembecki M, Fisher A (2011) The mammal fauna of the Sir Edward Pellew island group, Northern Territory, Australia: refuge and death-trap. *Wildlife Research* **38**, 307–322.
- Woinarski J, Burbidge A, Harrison P (2014) *Action Plan for Australian Mammals 2012*. CSIRO Publishing, Melbourne.