Biodiversity surveys in the Northern Kimberley coastal region – Balanggarra and Dambimangari Country

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Front page photographs (M. Cowan): view from Buckle Head sandstone mesa (top), Golden-backed Tree-rat, *Gehyra nana*, Sacred Kingfisher, Spendid Tree-frog (left to right)

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Summary

There is scant biological information available for much of the Northern Kimberley's (IBRA) Berkeley subregion (SR). This includes the relatively few islands located along the associated coast. To help fill this knowledge gap, biodiversity surveys of two islands, Lacrosse and Buckle Head were conducted in May 2014. One site on the adjacent mainland was also sampled. Additionally, Champagny, an island off the north-west coast of the Kimberley was surveyed in July 2014, as a fire had precluded its sampling during the Kimberley Island Biodiversity Survey (KIBS) in 2008. All three islands are proposed conservation reserves. The surveys were conducted in partnership with the Balanggarra (Lacrosse and Buckle Head) and Dambimangari (Champagny) Traditional Owners.

For the three islands sampled, we detected a total of 131 vertebrate species (8 non-volant mammals, 16 bats, 29 reptiles, 5 frogs and 73 birds), of which, 74 were recorded on Buckle Head, 70 on Champagny and 64 on Lacrosse. Of the total 359 plant taxa we recorded on the islands, 199 were detected on Buckle Head, 145 on Lacrosse and 137 on Champagny. These tallies are comparable with those from islands of a similar size sampled during the KIBS. We recorded a total of 13 species endemic to the Northern Kimberley (NK) bioregion (2 mammals, 1 bird subspecies, 6 reptiles and 4 plants) on the three islands, with highest richness on Champagny. New populations of the threatened Northern Quoll (*Dasyurus hallucatus*) and Golden-backed Tree-Rat (*Mesembriomys macrurus*) were recorded on Buckle Head. Additionally, seven taxa listed as Priority Flora were recorded, with the highest number on Champagny.

We detected no introduced vertebrates and few weeds on the three islands. Eight weed species were recorded on Buckle Head and two each on Lacrosse and Champagny.

The discovery of the Northern Quoll on Buckle Head, an island likely to be connected to the mainland at very low tides, highlights the need for surveillance of cane toad invasion on this island.

Overall compositional patterns in terms of species co-occurrences on the combined 2014 and KIBS islands appear to be explained by a combination of rainfall (particularly reptiles, plants and to a lesser degree, bats and birds), ruggedness (particularly non-volant mammals) and geology (plants). As expected, Lacrosse and Buckle Head were most similar to Adolphus, another Berkeley SR island in the east Kimberley. Champagny was most similar to the other relatively high rainfall (>1000 mm) islands along the north-west Kimberley coast.

In terms of conservation significance, Buckle Head is important for its mammal diversity, particularly the occurrence of the threatened Northern Quoll and Golden-backed Tree-rat. It also supports a diverse array of flora assemblages which includes vine thickets. Lacrosse has a unique assemblage of species, including those associated with an ephemeral wetland. Champagny supports a relatively high number of regional endemic species and Priority Flora.

We recorded a total of 65 vertebrates and 115 plant taxa at the Berkeley SR mainland location. Of these, 10 were regional endemics (2 mammals, 1 bird subspecies, 2 reptiles and 5 plants). Detections of another population of the threatened Northern Quoll, and the Scaly-tailed Possum (*Wyulda squamicaudata*), a NK endemic, were further significant finds as there are few records of either

species in the east Kimberley. Only one weed species was detected at this mainland site, *Passiflora foetida*.

The results presented here build on the collective knowledge of the biodiversity values of the Kimberley islands and the poorly understood Berkeley SR. While the comprehensiveness of the species lists will undoubtedly be improved with repeat and more extensive visits, particularly during the wet season, our results further highlight the importance of the islands as conservation refuges. It is vital that conservation planning and management is based on an understanding of the biological values of these islands and the species they support.

Wesley Alberts, Mark Cowan and Jason Gore (left to right) checking traps at the Berkeley SR mainland site (T. Handasyde)

Introduction

Just under a third of Australia's islands occur off the Kimberley coast of north-western Australia (CCWA 2010). These islands have been relatively isolated from many of the threatening processes affecting the adjacent mainland (McKenzie et al. 2009) and are likely to be important conservation refuges. A biological survey of a select number of the largest islands along the north Kimberley coast conducted between 2007 and 2010 – the Kimberley Island Biological Survey (KIBS; Gibson et al. 2014) confirmed that this was the case. Funding availability determined the number of islands that could be sampled during this survey.

For the relatively few islands located along the coast of the Northern Kimberley's (IBRA) Berkeley subregion (SR), there is scant biological information available. Adolphus Island was the only island sampled in this subregion during the KIBS. As well as Adolphus, a further two islands in the Berkeley SR have been nominated as possible conservation reserves – Lacrosse and Buckle Head. Bird species had been listed from Lacrosse by the field naturalist Kevin Coate and a small number of plant species had been lodged at the Western Australian Herbarium (WAHerb). There was no species information known from Buckle Head. Being located in the mouth of Cambridge Gulf, and easily accessible from Wyndham, Lacrosse is susceptible to the invasion of exotic species. Buckle Head is likewise susceptible to invasion as this island is likely to be connected to the mainland at very low tides. To fill a knowledge gap and expand the geographical coverage of the KIBS, a baseline biodiversity survey of both islands was conducted. Additionally, as there is an almost complete absence of biological information available for the Berkeley SR in general, a survey of one site on the adjacent mainland was also undertaken.

Champagny Island, another proposed island reserve, was selected for survey during the KIBS. However, just prior to the scheduled field survey, the island was extensively burnt by a wildfire and was not sampled. Champagny is a relatively large island located in the high rainfall zone (>1000 mm) of the north-west Kimberley and was expected to have a high conservation value. This island was briefly surveyed in the early 1970s (2-days; Burbidge and McKenzie 1978), and there were also a small number of plant, reptile and frog species known from opportunistic visits. A biodiversity survey of Champagny was therefore conducted to expand on this information and fill a knowledge gap.

Baseline biodiversity information is crucial for the effective management of these proposed island reserves. There is no clear understanding of the threats on these islands and as discussed above, some of them are particularly susceptible to invasion by exotic species, including the Cane Toad (*Rhinella marinus*). Information regarding the presence of both existing exotic and native species on the islands is necessary to inform an effective biosecurity program, including the prioritization of pest/weed eradication, control and surveillance programs. The research outcomes can also inform Indigenous management of the islands and contribute to Healthy Country Plans.

The surveys were conducted in partnership with the Balanggarra (Lacrosse and Buckle Head) and Dambimangari (Champagny) Traditional Owners. Balanggarra and Dambimangari Rangers formed part of the survey teams.

Methods

Survey locations

The Kimberley region experiences a tropical monsoon climate with a pronounced dry season extending from around April to October, and a wet season from November to March when almost all rainfall occurs. Cyclonic activity is also a feature of the climate, with an average of two cyclones crossing the northwest Australian coast each cyclone season. Average annual rainfall ranges from 1500 mm in the northwest to 800 mm in the southeast, and average temperatures range from a daily maximum of 33°C in January to a night time minimum of 15°C in July (http://www.bom.gov.au).

Lacrosse is a relatively small island (717 ha) located at the mouth of Cambridge Gulf (14.7496°S, 128.3131°E; Figure 1). The island is composed of steep-sided Pentecost sandstone ridges and rocky slopes, and small areas of saline mudflats. A small ephemeral wetland occurs on the north-western side of the island. The average annual rainfall of this island is estimated to be 957 mm (from bioclimatic modelling) and it is 7.5 km from the adjacent mainland.

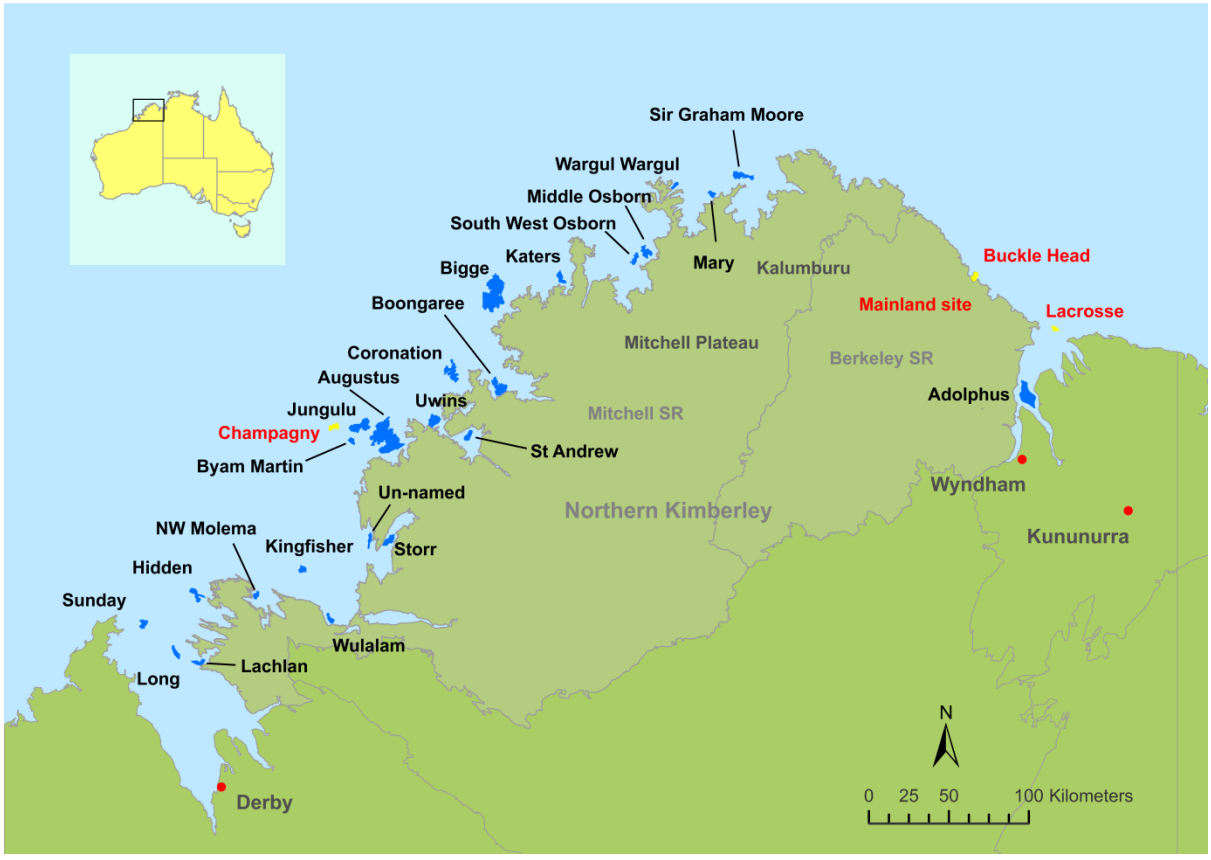

Figure 1. Location of 2014 survey locations (Champagny, Buckle Head, Lacrosse and Mainland site – islands in yellow) and islands sampled during the Kimberley Island Biodiversity Survey. The Northern Kimberley bioregion and its two subregions (Mitchell SR and Berkeley SR) are also shown.

Buckle Head (911 ha) is situated approximately 12 km south-east of the mouth of the Berkeley River (14.4531°S, 127.8610°E; Figure 1). This island is separated from the mainland by a narrow channel that dissects an alluvial mudflat, and is potentially connected to the mainland at very low tides. The

northern section of the island consists of a Warton sandstone mesa surrounded by steep Carson volcanic slopes. The southern section is comprised of a Carson volcanic ridge, undulating slopes and tidal flats. The average annual rainfall of this island is estimated to be 987 mm and it is 200 m from the adjacent mainland.

Champagny Island (1337 ha) falls within the southern section of the Bonaparte Archipelago, and is located just north of Camden Sound (15.3008^{o}S, 124.2581^{o}E, Figure 1). This is a low profile Warton sandstone island with shallow joint controlled drainage lines. At 27 km, it is one of the most distant continental islands from the mainland. The average annual rainfall of this island is estimated to be 1123 mm.

The one site selected for survey on the Berkeley SR mainland is located approximately 3 km south-east of Buckle Head on a deeply dissected King Leopold sandstone ridge (14.4862^{o}S, 127.8196^{o}E; Figure 1). The two drainage systems associated with the surveyed sites occurred as shallow depressions with some small pools, transitioning to steep sided gorges with deeper pools. The average annual rainfall of this area is estimated to be 971 mm.

All survey locations lie within the Northern Kimberley Interim Biogeographic Region of Australia (IBRA; Thackway and Cresswell 1995).

Sampling design

The sampling design largely followed that of the KIBS (Gibson and McKenzie 2012a). We selected survey sites using information on geology and vegetation from maps, local knowledge, satellite imagery and a reconnaissance flight. We placed sites within walking distance of as many habitat types as possible. As Champagny Island had again been extensively burnt just prior to the survey, site selection was restricted to a small unburnt patch on the south-western end of the island. All sites were approved by Balanggarra (Lacrosse and Buckle Head) or Dambimangari (Champagny) Traditional Owners prior to commencement of the surveys, and Aboriginal rangers formed part of the survey teams.

Sites were accessed using a helicopter and sampled over a six-day period. We surveyed Lacrosse, Buckle Head and the mainland site in May 2014 and Champagny in July 2014. Champagny had already been briefly visited during a KIBS wet season survey in February 2009. Opportunistic records from this visit have been included in this report.

Historical records from existing databases (WA Department of Parks and Wildlife - NatureMap and FloraBase, and the Western Australian Museum specimen database) and from literature searches have also been incorporated with the data presented here.

Vertebrate fauna

Mammals

During each survey, we established four transect lines within walking distance of the camp site and these were positioned to sample the major habitat types of the local area (Appendices 1 to 5). Each line consisted of alternating medium Elliot traps (20 traps - 33 x 10 x 10 cm) and large Elliot traps (20 traps - 50 x 17 x 17 cm) with each trap being approximately 15 m apart. Traps were baited with a

mixture of peanut butter and rolled oats, and set for five consecutive nights (i.e. 800 trap nights per sampling location). Sightings or signs of presence (i.e. scats and tracks) were also recorded. All traps were either placed in the shade or covered by vegetation to negate any potential heat stress issues on captured animals and checked each morning within three hours of sunrise.

Passive infrared triggered no glow cameras (Reconyx PC900) were also placed along the four transect lines (20 in total; Appendix 1). These were set on 450 mm pegs and baited with peanut butter and rolled oats scattered 1.5 – 2 metres in front of the camera. Cameras were positioned within the first two days of trap establishment and operated until the final sampling day.

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

Kaleidoscope (Version 2.3.0, Wildlife Acoustics 2015) was used to extract bat call sequences from the recordings, and save them 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). F_{peakC} and *Q*-values were determined for several of the search-mode calls comprising a sequences and, after *Q*-values were divided by three to allow for the higher resolution offered by the full-wave recordings compared to the frequency-divided (/16) output from Anabat II detectors, 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. Echolocation sequences were extracted from recordings and identified to species by N.L. McKenzie.

Reptiles and frogs

Funnel traps (75 x 18 x 18 cm, entrance diameter 4 cm) were arranged along two 15 m lines installed in representative habitat patches, usually in the vicinity of each mammal trap line (Appendix 1) and set for five nights. Each funnel trap line consisted of two pairs of funnel traps, placed alongside a 25 cm high flywire drift fence. All traps were either placed in the shade or covered by vegetation to negate any potential heat stress issues on captured animals and checked each morning within three hours of sunrise.

In addition to the trapping, we undertook active diurnal and nocturnal searches. Diurnal searches included raking of soil and leaf litter, peeling loose bark off trees, log rolling and rock turning. Head-torching for nocturnal species was conducted on most nights for 1-3 hrs. Frogs were sometimes captured in funnel traps, or detected while head-torching, particularly if there were freshwater pools in the survey area.

The primary sources of information for identification were the Western Australian Museum reptile and amphibian field guides (Storr et al. 1983, 1990, 1999, 2002; Tyler et al. 2000). Reference was also sought from Menkhorst and Knight (2011), Van Dyck et al. (2013) (for mammals) and Wilson and Swan (2013). Voucher specimens were collected where necessary and tissue samples taken from all animals for subsequent molecular analyses and lodged at the Western Australian Museum (WAM).

Birds

We recorded birds opportunistically while placing or checking traps, during flora sampling, or on foraging and exploratory trips away from the camp site (calls and observations). Many bird species were also observed at camp sites during rest periods and some were detected on the camera traps Team members carried binoculars to enable close examination of features to aid bird identification. Each evening, bird sightings were discussed by the team, checked against field guides and collated to build up a list for each survey area. These data took the form of presence records; there was no attempt to record abundance of taxa.

Plants

At each survey location, we established one 50 x 50 metre quadrat within each distinct habitat type associated with the vertebrate trap lines – usually four quadrats in total (Appendices 1 to 5). Quadrats were marked with aluminium plates, on steel pegs or glued to rocks, and corners were demarcated with a GPS. Within each quadrat, all vascular plants were recorded and voucher specimens collected. Attributes of the substrate were recorded for each quadrat using the coding systems outlined in McDonald et al. (1990). Broad surficial geology for each quadrat was noted based on field observations and confirmed by 1:250,000 geological maps (Geological Survey of Western Australia 2010). Values of substrate attributes and geological codes are provided in Appendix 6. Additionally, soil samples from the top 10 cm of the profile were taken at 10 spaced points across each quadrat and combined as a site sample (10 x 100 g).

Plant collections were also made outside formal quadrats to supplement species lists for each survey area. Here, we combine the plant taxa recorded from individual quadrats (Appendices 7 to 10) with the 'off-quadrat' data to give a total survey location list (Table 5). All voucher specimens are lodged at the Western Australian Herbarium (WAHerb).

To determine if taxa were endemic to the Northern Kimberley bioregion, broader distributions were examined by querying Australia's Virtual Herbarium (AVH) (www.anbg.gov.au/avh/).

Analysis

For a broader biogeographic context, we combined the island data for each taxonomic group surveyed in 2014 (except frogs), with the data from the KIBS and any historical records, to compare similarities in species composition (see Gibson et al. 2014). Species largely restricted to mangroves were removed from the analyses, as some survey locations were remote from them. Compositional patterns were investigated using PRIMER version 6 (Clarke and Gorley 2006). Compositional similarity between all pairs of islands (based on presence/absence data) was computed using the Sørensen association measure. Hierarchical clustering on the resulting similarity matrix was used to

derive classification groups. The dimensionality of the similarity matrix was reduced using non-metric multi-dimensional scaling (nMDS; minimum stress of 0.005 and 100 restarts) and displayed as a scatter plot.

Results

The islands

Mammals

We recorded a total of eight non-volant mammal species on the three surveyed islands – six on Buckle Head, and two each on Lacrosse and Champagny (Table 1). New island populations of the threatened Northern Quoll (*Dasyurus hallucatus*) and Golden-backed Tree-rat (*Mesembriomys macrurus*) were detected on Buckle Head. We recorded a Kimberley endemic, the Kimberley Rock-rat (*Zyzomys woodwardi*), on Champagny (Table 2). This record confirms the identification of a rodent sighting, thought to be *Z. woodwardi*, on this island (Burbidge and McKenzie 1978). The Water Rat (*Hydromys chrysogaster*) we detected on Champagny is another new species record for Champagny, although tracks thought to belong to this species were detected during a previous visit to this island (M. Cowan pers. comm.). The Agile Wallaby (*Macropus agilis*) recorded on Buckle Head is the second known population of this species on an Australian island – it was previously recorded on Adolphus during the KIBS. We detected a bandicoot species by camera on Buckle Head, but its identity could not be confirmed – the two candidate species are the threatened Golden Bandicoot (*Isoodon auratus*) or the Northern Brown Bandicoot (*I. macrourus*). The latter has been detected on two other Kimberley islands – St Andrew (KIBS) and St Patrick (M. Cowan pers. comm.). The camera traps captured two species that were not detected by any other means, the bandicoot species and Common Rock-rat (*Z. argurus*), both on Buckle Head. The Water Rat on Lacrosse was also detected by camera and this confirmed the tracks that we also observed. Total number of detections for each species and survey location by either Elliot trap (minus known recaptures) or camera trap (may include multiple detections of same individual) is given in Appendix 11.

In the context of the islands surveyed during the KIBS, and according to similarities in their non-volant mammal composition (Figure 2):

- Lacrosse groups with the islands that have moderate topographical gradients and largely lack rugged, deeply dissected boulder country (see Gibson 2014). These islands are mostly located in the drier south-west and north-east sections of the Northern Kimberley coastline, and include species that have distributions extending into semi-arid areas (e.g. Common Rock-rat).
- Champagny is most similar to the other high rainfall (>1000 mm)/low mammal diversity islands located in the north-west section of the Northern Kimberley coast. All these islands have the Kimberley Rock-rat in common.
- Buckle Head groups with the most rugged islands containing deeply dissected sandstone. These islands generally have the highest species richness and include one or more of the threatened mammals – Northern Quoll, Golden Bandicoot and Golden-backed Tree-rat.

We detected a notable 14 bat species on Buckle Head, compared with four and seven on Champagny and Lacrosse, respectively (Table 1). The Kimberley Cave Bat (*Vespadelus douglasorum*), a Kimberley endemic, was recorded on Buckle Head (Table 2). The Bare-rumped Sheathtail Bat (*Saccolaimus* cf.

Table 1. Mammal species detected on the surveyed islands and mainland site (Berkeley SR).

Family	Species	Common name	Buckle Head	Champagny	Lacrosse	Berkeley SR
Dasyuridae	*Dasyurus hallucatus*	Northern Quoll	x			x
Macropodidae	*Macropus agilis*	Agile Wallaby	x			
Macropodidae	*Petrogale brachyotis*	Short-eared Rock Wallaby				x
Peramelidae	*Isoodon* sp.	Bandicoot species	x			
Phalangeridae	*Wyulda squamicaudata*	Scaly-tailed Possum*				x
Rodentia	*Hydromys chrysogaster*	Water Rat		x	x	
Rodentia	*Mesembriomys macrurus*	Golden-backed Tree-rat	x			
Rodentia	*Zyzomys argurus*	Common Rock-rat	x		x	x
Rodentia	*Zyzomys woodwardi*	Kimberley Rock-rat*		x		
Tachyglossidae	*Tachyglossus aculeatus*	Echidna	x			
Total non-volant mammals			**6**	**2**	**2**	**4**
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail Bat	x		x	x
Emballonuridae	***Saccolaimus* cf. *saccolaimus***	Bare-rumped Sheathtail Bat			x	x
Emballonuridae	*Taphozous georgianus*	Common Sheathtail Bat	x	x	x	x
Hipposideridae	*Hipposideros stenotis*	Northern Leaf-nosed Bat	x	x		
Hipposideridae	*Rhinonicteris aurantius*	Orange Leaf-nosed Bat			x	x
Megadermatidae	*Macroderma gigas*	Ghost Bat				x
Miniopteridae	*Miniopterus schreibersii*	Common Bentwing Bat	x	x	x	x
Molossidae	*Chaerephon jobensis*	Northern Freetail Bat	x			x
Molossidae	*^Mormopterus cobourgianus*	North-western Freetail Bat	x			x
Molossidae	*^Mormopterus lumsdenae*	Northern Freetail Bat				x
Vespertilionidae	*Chalinolobus nigrogriseus*	Hoary Wattled Bat	x			x
Vespertilionidae	*Myotis macropus*	Large-footed Myotis				x
Vespertilionidae	*Nyctophilus arnhemensis*	Arnhem Long-eared Bat	x			
Vespertilionidae	*Nyctophilus daedalus*	Northern Long-eared Bat				x
Vespertilionidae	*Nyctophilus geoffroyi*	Lesser Long-eared Bat	x			
Vespertilionidae	*Nyctophilus walkeri*	Pygmy Long-eared Bat	x			x
Vespertilionidae	*Pipistrellus westralis*	Mangrove Pipistrelle	x		x	x
Vespertilionidae	*Scotorepens greyi*	Little Broad-nosed Bat				x
Vespertilionidae	*Scotorepens sanborni*	Northern Broad-nosed Bat	x			

Family	Species	Common name	Buckle Head	Champagny	Lacrosse	Berkeley SR
Vespertilionidae	*Vespadelus caurinus*	Northern Cave Bat	x	x	x	x
Vespertilionidae	*Vespadelus douglasorum*	Kimberley Cave Bat*	x			x
Total bats			**14**	**4**	**7**	**17**
Total mammals			**20**	**6**	**9**	**21**

^Reardon et al. (2014); *Endemic to the Northern Kimberley bioregion; **Call sequences referrable to the descriptions provided in Milne et al. (2009) were noted.

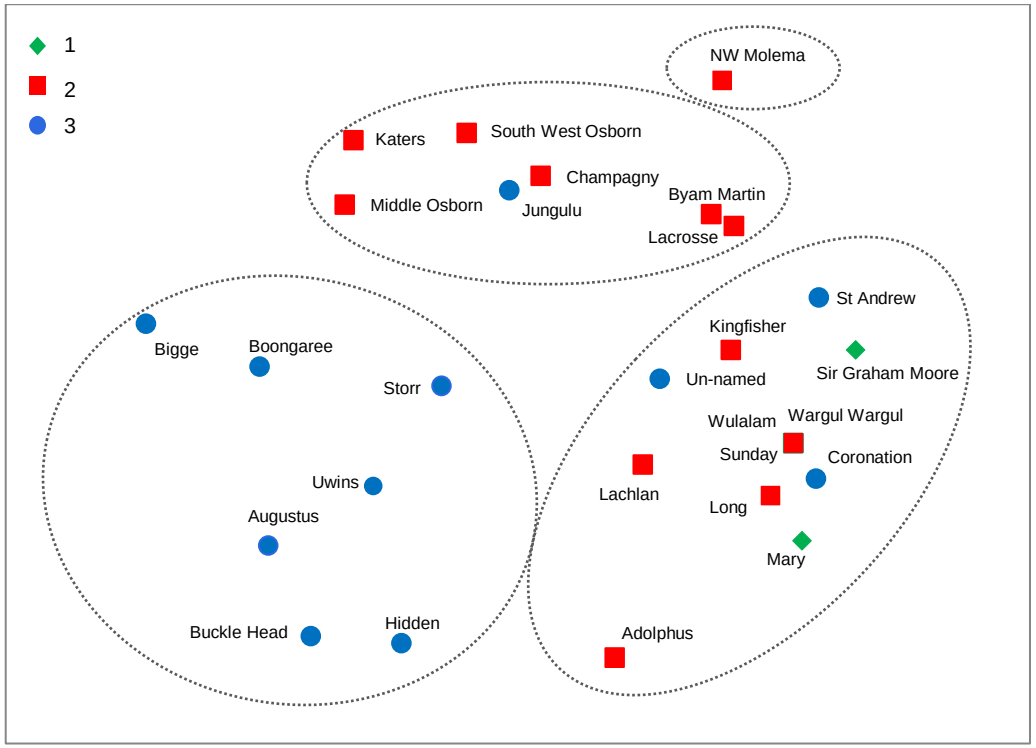

Figure 2. Non-metric MDS plot of compositional patterns of non-volant mammals across the Kimberley islands sampled in 2014 (Lacrosse, Buckle Head and Champagny) and those sampled during the Kimberley Island Biodiversity Survey, based on the Sorensen similarity matrix (2D stress 0.16). Wargul Wargul, Wulalam and Sunday overlap on the plot. Three categories of the extent of rock scree (low = 1, moderate = 2, high = 3) are indicated by dot shape and colour on the plot. Clusters at the 45% similarity level are indicated by elipses.

saccolaimus), detected on Lacrosse, was the first record for that species on a Kimberley island, as was the Lesser Long-eared Bat (*Nyctophilus geoffroyi*) on Buckle Head. The Common Sheathtail Bat (*Taphozous georgianus*), Common Bentwing Bat (*Miniopterus schreibersii*) and Northern Cave Bat (*V. caurinus*) were recorded on all three islands.

When combined with the KIBS bat records:

- Lacrosse groups with the islands that have more widespread species (Figure 3) such as the Common Bentwing Bat, Yellow-bellied Sheathtail Bat (*S. flaviventris*), Common Sheathtail Bat and Northern Cave Bat and only one or two additional species (see McKenzie and Bullen 2012).
- Champagny groups with the relatively species poor/low rainfall islands, with up to five bat species detected.
- Buckle Head is most similar to the species-rich islands in the high rainfall zone along the Northern Kimberley coast.

Table 2. Endemic species with distributions centred on the Northern Kimberley bioregion and detected at the survey locations (subspecies for birds).

Taxon	Group	Buckle Head	Champagny	Lacrosse	Berkeley SR
Grey Butcherbird (*Cracticus torquatus latens* Ford, 1979)	bird	x			x
Wyulda squamicaudata	mammal				x
Zyzomys woodwardi	mammal		x		
Vespadelus douglasorum	mammal	x			x
Acacia tenuispica	plant				x
Cleome kenneallyi	plant		x		
Cleome sp. Bonaparte Archipelago (A.A. Mitchell 4774)	plant		x		
Corymbia bleeseri	plant				x
Jacksonia argentea	plant				x
Planchonia rupestris	plant				x
Spermacoce sp. Berthier Dunes (R.L. Barrett RLB 5753)	plant		x		
Scaevola sp. Sir Graham Moore Island (P.G. Wilson 11204)	plant	x		x	x
Diporiphora bennettii	reptile		x		
Amalosia obscura	reptile		x		
Gehyra xenopus	reptile		x		
Cryptoblepharus megastictus	reptile				x
Cyclodomorphus maximus	reptile	x			
Lerista walkeri	reptile		x		
Carlia johnstonei	reptile	x			x
Total		**5**	**8**	**1**	**10**

Reptiles and frogs

We recorded 29 reptile species in total with highest richness on Champagny – 19 species, compared to 16 species on Buckle Head and 15 on Lacrosse (Table 3). The Champagny list included nine species not previously recorded on the island (Table 3). The highest number of Kimberley endemics was also detected on Champagny (Table 2) and included *Amalosia obscura*, *Diporiphora bennettii* (historical record), *Gehyra xenopus* and *Lerista walkeri*. We detected two Kimberley endemics on Buckle Head – *Cyclodomorphus maximus* and *Carlia johnstonei*. Species we recorded on all three islands were

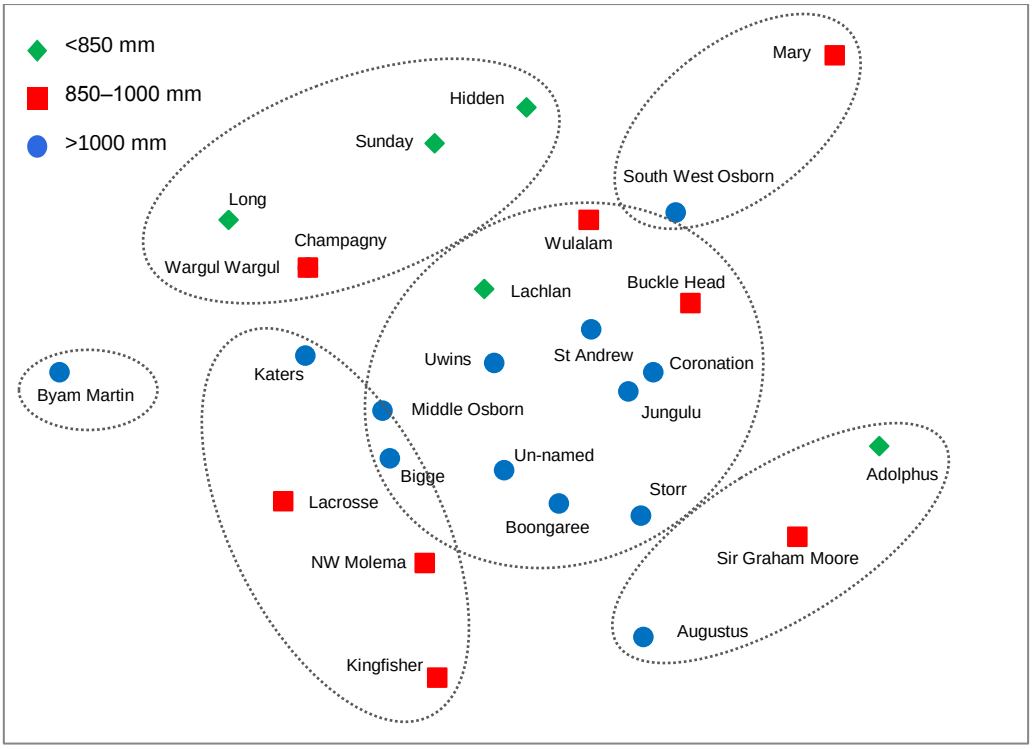

Figure 3. Non-metric MDS plot of compositional patterns of bats across the Kimberley islands sampled in 2014 (Lacrosse, Buckle Head and Champagny) and those sampled during the Kimberley Island Biodiversity Survey, based on the Sorensen similarity matrix (2D stress 0.19). Three rainfall bands (low <850 mm, moderate 850-1000 mm, high >1000 mm) are indicated by dot shape and colour on the plot. Clusters at the 60% similarity level are indicated by elipses.

Ctenotus inornatus, *Cryptoblepharus metallicus*, *G. nana* (although this is likely to be a species complex), *Morethia ruficauda ruficauda*, *Delma borea* and *Eremiascincus isolepis isolepis*. *Varanus tristis* on Buckle Head is a new record for the Kimberley islands. Total number of detections for each species and survey location (minus known recaptures) is given in Appendix 12.

Combining the data for these islands with those of the KIBS (Figure 4), compositional patterns largely reflected geographical position (see Palmer et al. 2013). In terms of species similarity:

- Lacrosse clusters with Buckle Head – the two islands located in the Berkeley SR. Many widespread species occurred on these islands but they mostly lacked the regional endemic species. The position of this cluster in the ordination indicates that they are most similar to the Adolphus and Sir Graham Moore cluster. All four of these islands have in common *G. koira koira*, a large gecko that has not been detected on the remaining islands and appears to replace *G. xenopus*, a similarly large gecko that occurs on the islands further to the west. Congeneric replacement in *A. obscura* by *A. rhombifera* was also apparent, with the latter occurring on Buckle Head, Lacrosse and Sir Graham Moore.
- Champagny clusters with the other predominantly sandstone islands situated in the high rainfall zone (>1000 mm) of the north-west Kimberley. This group contains many widespread and regional endemic species (e.g. *A. obscura*, *C. johnstonei, G. xenopus*, *L. walkeri* and *D. bennettii*).

Table 3. Herpetofauna species detected on the surveyed islands and mainland site (Berkeley SR).

Family	Species	Buckle Head	Champagny	Lacrosse	Berkeley SR
Agamidae	*Amphibolurus gilberti gilberti*				x
Agamidae	*Diporiphora bennettii**		xx		
Boidae	*Antaresia childreni*		xx	x	x
Boidae	*Liasis olivaceus*	x	x		x
Crocodylidae	*Crocodylus johnstoni*				x
Diplodactylidae	*Amalosia obscura**		xx		
Diplodactylidae	*Amalosia rhombifer*	x		x	
Egerniidae	*Cyclodomorphus maximus**	x			
Egerniidae	*Tiliqua scincoides*			x	
Elapidae	*Pseudechis weigeli*		x	x	x
Eugongylidae	*Cryptoblepharus megastictus**				x
Eugongylidae	*Cryptoblepharus metallicus*	x	x	x	
Eugongylidae	*Morethia ruficauda ruficauda*	x	x	x	x
Geckkonidae	*Gehyra koira koira*	x		x	x
Geckkonidae	*Gehyra nana*	x	xx	x	x
Geckkonidae	*Gehyra xenopus**		xx		
Geckkonidae	*Heteronotia planiceps*	x	xx		x
Pygopodidae	*Delma borea*	x	x	x	
Pygopodidae	*Lialis burtonis*			x	
Sphenomorphidae	*Carlia amax*		x		
Sphenomorphidae	*Carlia johnstonei**	x			x
Sphenomorphidae	*Carlia triacantha*		xx		
Sphenomorphidae	*Ctenotus inornatus*	x	xx	x	x
Sphenomorphidae	*Eremiascincus isolepis isolepis*	x	xx	x	x
Sphenomorphidae	*Lerista borealis*	x		x	
Sphenomorphidae	*Lerista walkeri**		x		
Sphenomorphidae	*Notoscincus ornatus*		x		
Typhlopidae	*Ramphotyphlops kimberleyensis*		x	x	
Varanidae	*Varanus acanthurus*	x		x	
Varanidae	*Varanus glebopalma*	x			x
Varanidae	*Varanus mertensi*				x
Varanidae	*Varanus tristis*	x			
Varanidae	*Varanus glauerti*		xx		
Total reptiles		**16**	**19**	**15**	**15**
Hylidae	*Litoria coplandi*				x
Hylidae	*Litoria rothii*	x			
Hylidae	*Litoria rubella*	x			x
Hylidae	*Litoria* sp.				x
Hylidae	*Litoria splendida*				x
Hylidae	*Litoria tornieri*				x
Hylidae	*Litoria wotjulumensis*	x			
Limnodynastidae	*Limnodynastes lignarius*		xx	x	
Myobatrachidae	*Crinia bilingua*				x
Myobatrachidae	*Uperoleia borealis*		xx		
Total frogs		**3**	**2**	**1**	**6**
Total overall		**19**	**21**	**16**	**21**

*Endemic to the Northern Kimberley bioregion; "xx" = previously detected.

Frogs were not a focus of this survey, as we were restricted to a dry season sampling only. However, we detected a small number of frog species on the surveyed islands, with a maximum of three species on Buckle Head (Table 3). The two species detected on Champagny were records from the KIBS opportunistic visit during the wet season (Table 3).

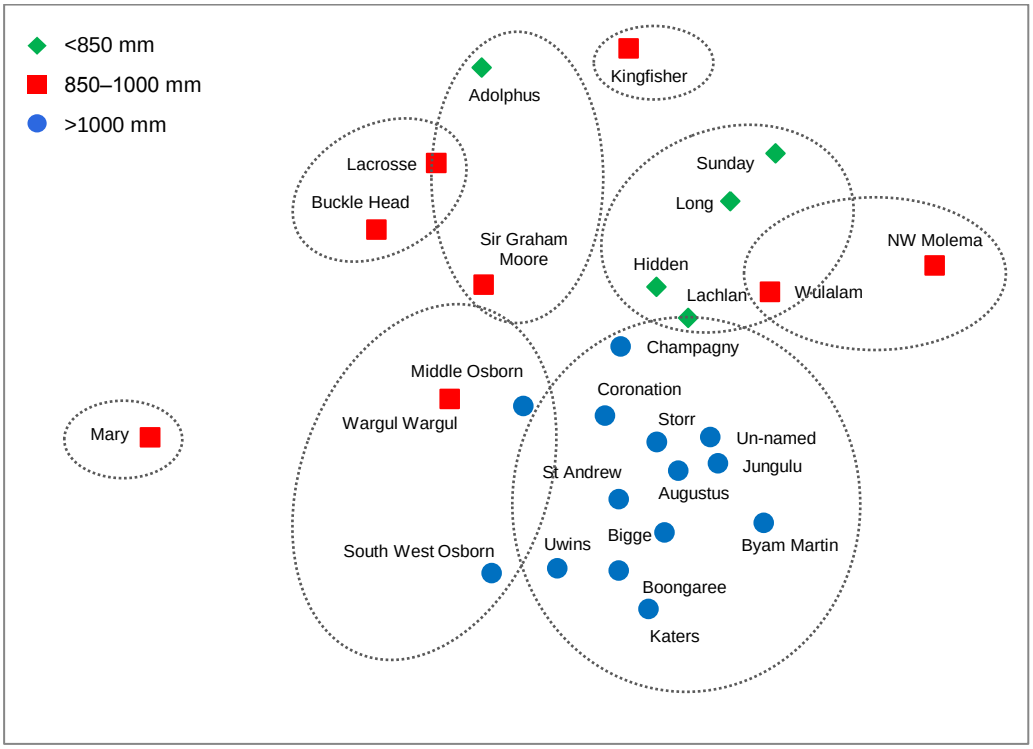

Figure 4. Non-metric MDS plot of compositional patterns of reptiles across the Kimberley islands sampled in 2014 (Lacrosse, Buckle Head and Champagny) and those sampled during the Kimberley Island Biodiversity Survey, based on the Sorensen similarity matrix (2D stress 0.18). Three rainfall bands (low <850 mm, moderate 850-1000 mm, high >1000 mm) are indicated by dot shape and colour on the plot. Clusters at the 55% similarity level are indicated by elipses.

Birds

A total of 73 bird species were recorded on the surveyed islands, with a maximum number of 43 species on Champagny Island (Table 4). The Grey Butcherbird (*Cracticus torquatus latens* Ford, 1979), a Kimberley endemic subspecies, was detected on Buckle Head (Table 2). Several species were recorded on all three islands including the Bar-shouldered Dove, Beach Stone-curlew, Black-faced Cuckoo-shrike, Black-necked Stork, Brahminy Kite, Brown Honeyeater, Mistletoebird, Pheasant Coucal, Rainbow Bee-eater, Red-winged Parrot and Willie Wagtail (Table 4). A Button-quail was also detected on Lacrosse by camera but its identity could not be confirmed (not included in Table 4).

The ordination plot of the bird data combined with the KIBS-sampled islands (Figure 5) shows that:

- Champagny is most similar in species composition to its nearby neighbour Byam Martin, another low profile sandstone island (see Pearson et al. 2013). While these two islands are in the high rainfall zone, they lack the extensive vine thickets present on the other high rainfall islands, and hence were missing some of the taxa more commonly recorded in this habitat type (e.g. Emerald Dove, Rainbow Pitta, Orange-footed Scrubfowl and Yellow Oriole).

Table 4. Bird species detected on the surveyed islands and mainland site (Berkeley SR). Historical records (xx) were sourced from Kevin Coate's unpublished list (cited in CCWA 2010), Johnstone and Storr (1998, 2004) and Smith et al. (1978).

Common name	Scientific name	Buckle Head	Champagny	Lacrosse	Berkeley SR
Australian Kestrel	*Anhinga melanogaster*		xx		x
Australian White Ibis	*Falco cenchroides*			xx	
Banded Honeyeater	*Threskiornis molucca*	x		xx	
Bar-shouldered Dove	*Cissomela pectoralis*	x	x	x	
Beach Stone-curlew	*Geopelia humeralis*	x	x	x	
Black-faced Cuckoo-shrike	*Esacus neglectus*	x	x	x	x
Black-fronted Dotteral	*Coracina novaehollandiae*		x		
Black-necked Stork	*Charadrius melanops*	x	x	x	
Blue-faced Honeyeater	*Ephippiorhynchus asiaticus*				x
Blue-winged Kookaburra	*Melithreptus cyanotis*	x			
Boobook Owl	*Dacelo leachii*	x			x
Brahminy Kite	*Ninox novaeseelandiae*	x	xx	xx	
Brolga	*Haliastur indus*		x		
Brown Booby	*Grus rubicunda*		x		
Brown Falcon	*Sula leucogaster*		xx	x	
Brown Goshawk	*Falco berigora*				x
Brown Honeyeater	*Accipiter fasciatus didimus*	x	x	x	x
Brown Quail	*Lichmera indistincta*		xx		
Chestnut Rail	*Eulabeornis castaneoventris*			x	
Collared Sparrowhawk	*Coturnix ypsilophora*	x			
Common Bronzewing	*Accipiter cirrocephalus*		xx		
Darter	*Phaps chalcoptera*			x	
Double-barred Finch	*Taeniopygia bichenovii*	x			
Eastern Reef Heron	*Ardea sacra*		xx		
Emerald Dove	*Chalcophaps indica*			x	
Great Bowerbird	*Ptilonorhynchus nuchalis*	x			x
Great Egret	*Ardea alba*		x		
Grey Butcherbird*	*Cracticus torquatus*	x			x

Common name	Scientific name	Buckle Head	Champagny	Lacrosse	Berkeley SR
Grey Shrike-thrush	*Pluvialis squatarola*		xx		
Horsfield's Bronze Cuckoo	*Chrysococcyx basalis*		xx		
Intermediate Egret	*Ardea intermedia*			x	
Leaden Flycatcher	*Myiagra rubecula*		x	x	
Little Friarbird	*Philemon citreogularis*		x	xx	
Little Woodswallow	*Artamus minor*				x
Magpie	*Cracticus tibicen*				x
Magpie-lark	*Grallina cyanoleuca*	x		xx	
Mangrove Golden Whistler	*Pachycephala melanura*		xx		
Masked Lapwing	*Vanellus miles*	x		x	
Mistletoebird	*Dicaeum hirundinaceum*	x	x	xx	
Northern Fantail	*Rhipidura rufiventris*	x			
Olive-backed Oriole	*Oriolus sagittatus*		x	x	
Osprey	*Pandion haliaetus*		x	xx	
Peaceful Dove	*Geopelia striata placida*	x	x		
Pheasant Coucal	*Centropus phasianinus*	x	x	x	
Pied Butcherbird	*Cracticus nigrogularis*				x
Pied Heron	*Ardea picata*			x	
Pied Imperial Pigeon	*Ducula bicolor*		x		
Purple Swamphen	*Porphyrio porphyrio melanotus*			x	
Rainbow Bee-eater	*Merops ornatus*	x	x	x	x
Rainbow Lorikeet	*Trichoglossus haematodus*			x	
Red-capped Plover	*Charadrius ruficapillus*		x	xx	
Red-headed Honeyeater	*Myzomela erythrocephala*	x			
Red-tailed Black Cockatoo	*Calyptorhynchus macrorhychus*				x
Red-winged Parrot	*Aprosmictus erythropterus*	x	xx	xx	x
Restless Flycatcher	*Myiagra inquieta nana*		xx	x	
Rufous Whistler	*Pachycephala rufiventris*		xx		
Sacred Kingfisher	*Todiramphus sanctus*	x		x	
Sandstone Shrike-thrush	*Colluricincla woodwardi*				x
Shining Flycatcher	*Myiagra alecto*	x			
Silver Gull	*Larus novaehollandiae*		xx		

Common name	Scientific name	Buckle Head	Champagny	Lacrosse	Berkeley SR
Silver-crowned Friarbird	*Philemon argenticeps*	x		x	
Sooty Oystercatcher	*Haematopus fuliginosus*		x	x	
Spotted Nightjar	*Eurostopodus argus*		x		
Striated Heron	*Butorides striatus*		x		
Striated Pardalote	*Pardalotus striatus uropygialis*	x		x	x
Sulphur-crested Cockatoo	*Cacatua galerita*				x
Torresian Crow	*Corvus orru*	x		x	x
Tree Martin	*Hirundo nigricans*		x		
Varied Triller	*Lalage leucomela*	x			
Variegated Fairy-wren	*Malurus lamberti*	x	x		x
Wandering Whistling Duck	*Dendrocygna arcuata*			x	
White-bellied Cuckoo-shrike	*Coracina papuensis hypoleuca*	x			
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	x	x		x
White-breasted Woodswallow	*Artamus leucorynchus*		x	x	x
White-faced Heron	*Ardea novaehollandiae*		x		
White-gaped Honeyeater	*Lichenostomus unicolor*	x		xx	
White-necked Heron	*Ardea pacifica*		x	x	
White-quilled Rock Pigeon	*Petrophassa albipennis*				x
White-throated Honeyeater	*Melithreptus albogularis*	x			
Willie Wagtail	*Rhipidura leucophrys*	x	x	x	x
Yellow White-eye	*Zosterops luteus*	x	x		
Zitting Cisticola	*Cisticola juncidis*			x	
Total number		**35**	**43**	**39**	**23**

*Endemic subspecies to the Kimberley region.

- Lacrosse did not cluster with any other island. As a result of its ephemeral wetland, species associated with this habitat were well represented on this island, including a small number not recorded on any other island (e.g. Wandering Whistling Duck, White-necked Heron, Purple Swamphen and Pied Heron).
- Buckle Head, although forming its own group, was closely associated with Wulalam and Un-named islands, all three islands had relatively low species richness. They also were missing some of the widespread shorebirds (e.g. Whimbrel, Sooty Oystercatcher and Striated Heron).

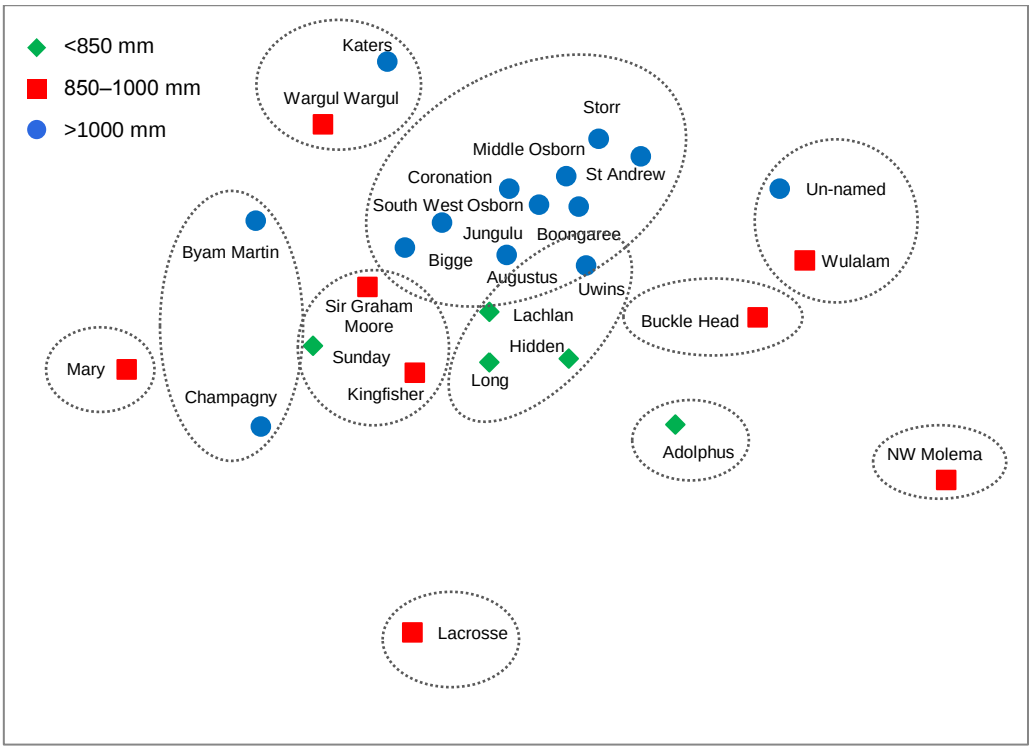

Figure 5. Non-metric MDS plot of compositional patterns of birds across the Kimberley islands sampled in 2014 (Lacrosse, Buckle Head and Champagny) and those sampled during the Kimberley Island Biodiversity Survey, based on the Sorensen similarity matrix (2D stress 0.22). Three rainfall bands (low <850 mm, moderate 850-1000 mm, high >1000 mm) are indicated by dot shape and colour on the plot. Clusters at the 59% similarity level are indicated by elipses.

Plants

In total, we recorded 356 plant taxa on the islands sampled. Buckle Head had the highest species richness with a total of 198 taxa, followed by 141 on Lacrosse and 138 on Champagny (Table 5). The families best represented were Fabaceae (49 taxa), Poaceae (39), Cyperaceae (21) and Myrtaceae (20). We recorded a total of 84 genera with Acacia (10 taxa), Fimbristylis (10) and Corymbia (9) the most species rich. We recorded four species endemic to the Northern Kimberley – *Cleome kenneallyi*, *Cleome* sp. Bonaparte Archipelago (A.A. Mitchell 4774) and *Spermacoce* sp. Berthier Dunes (R.L. Barrett RLB 5753) on Champagny, and *Scaevola* sp. Sir Graham Moore Island (P.G. Wilson 11204) on both Lacrosse and Buckle Head (Table 2). This species has also subsequently been identified from Adolphus. Seven taxa listed as Priority Flora by the Department of Parks and Wildlife

Table 5. Plant taxa detected on the surveyed islands and mainland site (Berkeley SR). *Indicates an exotic species.

Family		Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Acanthaceae		Avicennia marina	x	x	x	
Acanthaceae		Dicliptera armata	x		x	x
Aizoaceae		Sesuvium portulacastrum	x	x	x	
Aizoaceae		Trianthema pilosa		x		
Amaranthaceae		Achyranthes aspera			x	
Amaranthaceae		Amaranthus undulatus		x		
Amaranthaceae		Gomphrena flaccida	x			
Amaranthaceae		Gomphrena tenella		x		
Amaranthaceae		Ptilotus corymbosus		x		
Amaranthaceae		Ptilotus giganteus		x	x	x
Amaryllidaceae		Crinum angustifolium		x		
Anacardiaceae		Buchanania oblongifolia	x		x	x
Anacardiaceae		Buchanania obovata		x		
Apocynaceae		Alstonia actinophylla		x		x
Apocynaceae		Alstonia spectabilis		x		
Apocynaceae	*	Calotropis procera	x		x	
Apocynaceae		Cynanchum carnosum	x	x		
Apocynaceae		Cynanchum pedunculatum			x	
Apocynaceae		Cynanchum puberulum	x			
Apocynaceae		Gymnanthera oblonga			x	
Apocynaceae		Marsdenia pleiadenia		x		
Apocynaceae		Parsonsia velutina	x	x		
Apocynaceae		Sarcostemma ? viminale (sterile)	x			x
Apocynaceae		Sarcostemma viminale		x		
Apocynaceae		Secamone timoriensis	x			
Apocynaceae		Tabernaemontana orientalis	x			
Apocynaceae		Tylophora flexuosa	x		x	x
Apocynaceae		Wrightia pubescens		x		
Araliaceae		Trachymene didiscoides		x		
Arecaceae		Livistona lorophylla	x			

Family		Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Asparagaceae		Asparagus racemosus	x	x		
Asparagaceae		Thysanotus chinensis			x	
Asteraceae	*	Bidens bipinnata/pilosa	x			
Asteraceae		Blainvillea cunninghamii	x			
Asteraceae		Blumea integrifolia		x		
Asteraceae		Blumea saxatilis	x		x	
Asteraceae		Pluchea rubelliflora	x			
Asteraceae		Pterocaulon serrulatum	x	x		
Asteraceae		Pterocaulon serrulatum var. serrulatum				x
Asteraceae		Pterocaulon serrulatum var. velutinum	x			
Asteraceae		Pterocaulon sphacelatum	x			
Bignoniaceae		Dolichandrone filiformis	x			
Bixaceae		Cochlospermum fraseri	x			x
Boraginaceae		Ehretia saligna	x		x	
Boraginaceae		Heliotropium sp.	x		x	
Boraginaceae		Heliotropium glabellum		x		
Boraginaceae		Trichodesma zeylanicum		x		
Burseraceae		Canarium australianum	x		x	
Burseraceae		Garuga floribunda		x		
Byblidaceae		Byblis filifolia	x			
Byblidaceae		Byblis liniflora		x	x	
Cannabaceae		Celtis philippensis	x	x		
Capparaceae		Capparis jacobsii				
Capparaceae		Capparis sepiaria	x	x		
Capparaceae		Capparis sp. (sterile)	x			
Caryophyllaceae		Polycarpaea corymbosa var. corymbosa				x
Caryophyllaceae		Polycarpaea involucrate		x		
Caryophyllaceae		Polycarpaea longiflora		x		x
Celastraceae		Denhamia obscura		x		
Celastraceae		Elaeodendron melanocarpum	x			
Celastraceae		Stackhousia intermedia			x	x
Celastraceae		Stackhousia sp.			x	

Family	Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Chenopodiaceae	Salsola australis		x		
Chenopodiaceae	Tecticornia halocnemoides subsp. tenuis	x			
Chenopodiaceae	Tecticornia indica	x			
Cleomaceae	Cleome kenneallyi		x		
Cleomaceae	Cleome sp. Bonaparte Archipelago (A.A. Mitchell 4774)		x		
Cleomaceae	Cleome tetrandra		x		
Cleomaceae	Cleome viscosa		x		x
Combretaceae	Lumnitzera racemosa	x			
Combretaceae	Terminalia ? volucris (sterile)	x			x
Combretaceae	Terminalia canescens	x		x	
Combretaceae	Terminalia volucris			x	
Commelinaceae	Commelina ensifolia		x	x	
Convolvulaceae	Bonamia pannosa	x	x		
Convolvulaceae	Ipomoea coptica	x			
Convolvulaceae	Ipomoea eriocarpa	x			
Convolvulaceae	Ipomoea pes-caprae	x	x	x	
Convolvulaceae	Jacquemontia pannosa	x			
Convolvulaceae	Merremia incise				x
Convolvulaceae	Operculina aequisepala	x		x	
Convolvulaceae	Operculina brownii		x		
Convolvulaceae	Xenostegia tridentata	x	x	x	
Cucurbitaceae	Cucumis melo	x			
Cucurbitaceae	Trichosanthes cucumerina var. cucumerina		x	x	
Cucurbitaceae	Trichosanthes pilosa		x		
Cyperaceae	Bulbostylis barbata		x	x	
Cyperaceae	Cyperus aquatilis				x
Cyperaceae	Cyperus javanicus	x			
Cyperaceae	Cyperus ? javanicus (sterile)			x	
Cyperaceae	Cyperus bulbosus		x		
Cyperaceae	Cyperus castaneus				x
Cyperaceae	Cyperus crispulus				x
Cyperaceae	Cyperus conicus		x	x	

Family	Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Cyperaceae	Cyperus holoschoenus				x
Cyperaceae	Cyperus microcephalus subsp. microcephalus	x			
Cyperaceae	Cyperus squarrosus		x		
Cyperaceae	Cyperus viscidulus		x		x
Cyperaceae	Fimbristylis acicularis			x	
Cyperaceae	Fimbristylis cymosa	x	x		
Cyperaceae	Fimbristylis dichotoma			x	
Cyperaceae	Fimbristylis microcarya	x			x
Cyperaceae	Fimbristylis polytrichoides	x			
Cyperaceae	Fimbristylis rara	x		x	x
Cyperaceae	Fimbristylis schultzii	x			
Cyperaceae	Fimbristylis sp. A Kimberley Flora (A.S. George 13584)			x	
Cyperaceae	Fimbristylis sp. indet KIS		x		
Cyperaceae	Fimbristylis sphaerocephala		x		
Cyperaceae	Fimbristylis trigastrocarya				x
Cyperaceae	Fuirena ciliaris	x		x	x
Cyperaceae	Schoenus falcatus		x		
Cyperaceae	Scleria rugosa	x		x	x
Dilleniaceae	Hibbertia sp.				x
Dilleniaceae	Hibbertia lepidota	x		x	
Dilleniaceae	Hibbertia oblongata	x			x
Dilleniaceae	Hibbertia oblongata subsp. brevifolia	x			
Dioscoreaceae	Dioscorea bulbifera			x	
Ebenaceae	Diospyros maritime		x		
Eriocaulaceae	Eriocaulon fistulosum			x	
Euphorbiaceae	Croton schultzii	x			
Euphorbiaceae	Croton sp. indet KIS		x		
Euphorbiaceae	Euphorbia armstrongiana		x		
Euphorbiaceae	Mallotus nesophilus		x		
Euphorbiaceae	Microstachys chamaelea			x	
Fabaceae	Abrus precatorius subsp. precatorius	x	x	x	
Fabaceae	Acacia arida	x		x	

Family		Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Fabaceae		Acacia delibrata				x
Fabaceae		Acacia deltoidea subsp. deltoidea	x			x
Fabaceae		Acacia gonocarpa		x		
Fabaceae		Acacia hemignosta				x
Fabaceae		Acacia holosericea	x		x	x
Fabaceae		Acacia latifolia				x
Fabaceae		Acacia leptocarpa			x	
Fabaceae		Acacia neurocarpa			x	
Fabaceae		Acacia orthocarpa		x		
Fabaceae		Acacia plectocarpa subsp. plectocarpa	x	x		x
Fabaceae		Acacia stigmatophylla	x	x	x	
Fabaceae		Acacia tenuispica				x
Fabaceae		Acacia tumida var. tumida	x	x	x	x
Fabaceae		Acacia ? sp. Kununurra (T. Handasyde TH 7958b)				x
Fabaceae	*	Aeschynomene villosa	x			
Fabaceae		Alysicarpus schomburgkii	x			
Fabaceae	*	Alysicarpus vaginalis	x			
Fabaceae		Bauhinia cunninghamii	x			
Fabaceae		Bossiaea bossiaeoides				x
Fabaceae		Cajanus cinereus		x		
Fabaceae		Cajanus latisepalus	x			x
Fabaceae		Cajanus marmoratus	x			
Fabaceae		Canavalia rosea		x	x	
Fabaceae		Cathormion umbellatum	x			
Fabaceae		Cathormion umbellatum subsp. moniliforme			x	
Fabaceae		Chamaecrista mimosoides				x
Fabaceae		Christia australasica	x			
Fabaceae	*	Crotalaria juncea	x			
Fabaceae		Crotalaria medicaginea	x	x	x	
Fabaceae		Crotalaria montana var. angustifolia	x		x	
Fabaceae		Crotalaria novae-hollandiae			x	
Fabaceae		Crotalaria retusa	x			

Family	Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Fabaceae	Crotalaria verrucosa		x		
Fabaceae	Cullen badocanum	x			
Fabaceae	Erythrina vespertilio	x			
Fabaceae	Glycine tomentella			x	
Fabaceae	Gompholobium subulatum		x		x
Fabaceae	Indigofera haplophylla				x
Fabaceae	Indigofera hirsuta			x	
Fabaceae	Indigofera trita		x		
Fabaceae	Jacksonia argentea				x
Fabaceae	Mirbelia viminalis			x	x
Fabaceae	Neptunia dimorphantha	x			
Fabaceae	Rhynchosia minima	x			
Fabaceae	Senna goniodes		x		
Fabaceae	Senna venusta				x
Fabaceae	Sesbania cannabina			x	
Fabaceae	Templetonia hookeri	x	x		x
Fabaceae	Tephrosia macrocarpa				x
Fabaceae	Tephrosia phaeosperma	x			
Fabaceae	Tephrosia polyzyga	x			
Fabaceae	Tephrosia rosea var. rosea				x
Fabaceae	Tephrosia sp. Pentecost River (I.D. Cowie 4168)	x		x	
Fabaceae	Tephrosia subpectinata		x		
Fabaceae	Tephrosia virens	x			
Fabaceae	Uraria lagopodioides	x			
Fabaceae	Vigna lanceolata	x		x	
Fabaceae	Vigna vexillate		x		
Fabaceae	Zornia muriculata		x		
Flagellariaceae	Flagellaria indica	x	x	x	
Goodeniaceae	Goodenia aff. arachnoidea (T. Handasyde TH 7820)			x	
Goodeniaceae	Goodenia aff. byrnesii (T. Handasyde TH 7850)	x			
Goodeniaceae	Goodenia armitiana			x	
Goodeniaceae	Goodenia redacta	x			

Family		Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Goodeniaceae		Goodenia sp.		x		
Goodeniaceae		Scaevola macrostachya		x		
Goodeniaceae		Scaevola sp. Sir Graham Moore Island (P.G. Wilson 11204)	x		x	x
Haemodoraceae		Haemodorum gracile		x		
Haemodoraceae		Haemodorum sp. (sterile)			x	
Haloragaceae		Gonocarpus leptothecus		x		
Hernandiaceae		Gyrocarpus americanus			x	
Lamiaceae		Clerodendrum floribundum			x	x
Lamiaceae		Clerodendrum floribundum var. coriaceum	x		x	
Lamiaceae	*	Hyptis suaveolens	x			
Lamiaceae		Premna acuminata	x		x	
Lamiaceae		Premna sp. (sterile)				x
Lamiaceae		Pityrodia terifolia	x			x
Lamiaceae		Vitex acuminata	x	x		
Lamiaceae		Vitex rotundifolia		x		
Lauraceae		Cassytha aurea		x		
Lauraceae		Cassytha candida	x		x	x
Lauraceae		Cassytha filiformis	x	x		
Lecythidaceae		Barringtonia acutangula				x
Lecythidaceae		Planchonia careya				x
Lecythidaceae		Planchonia ? careya (sterile)				x
Lecythidaceae		Planchonia rupestris				x
Loganiaceae		Mitrasacme connata			x	
Loganiaceae		Mitrasacme laxiceps				x
Loganiaceae		Mitrasacme nudicaulis	x	x	x	
Loganiaceae		Strychnos lucida	x	x		
Loranthaceae		Amyema benthamii		x		
Loranthaceae		Dendrophthoe acacioides			x	
Loranthaceae		Dendrophthoe acacioides subsp. acacioides	x	x		
Lythraceae		Rotala occultiflora			x	
Lythraceae		Sonneratia alba			x	
Malvaceae		Adansonia gregorii	x		x	x

Family	Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Malvaceae	Brachychiton incanus	x		x	x
Malvaceae	Camptostemon schultzii			x	
Malvaceae	Corchorus sidoides subsp. sidoides	x		x	x
Malvaceae	Dicarpidium monoicum				x
Malvaceae	Grewia breviflora	x			
Malvaceae	Grewia retusifolia	x			
Malvaceae	Hibiscus sp.				x
Malvaceae	Hibiscus aff. marenitensis (T. Handasyde TH 7919)	x			
Malvaceae	Hibiscus aphelus				x
Malvaceae	Hibiscus fryxellii var. fryxellii		x		
Malvaceae	Hibiscus geranioides	x	x		
Malvaceae	Hibiscus leptocladus			x	
Malvaceae	Hibiscus meraukensis			x	
Malvaceae	Hibiscus superbus		x		
Malvaceae	Melochia corchorifolia			x	
Malvaceae	Pavonia calycina	x			
Malvaceae	Thespesia populneoides	x	x		
Malvaceae	Triumfetta sp.	x		x	
Malvaceae	Triumfetta sp. indet KIS		x		
Malvaceae	Triumfetta triandra				x
Malvaceae	Waltheria indica	x		x	x
Marsileaceae	Marsilea angustifolia			x	
Melastomataceae	Memecylon pauciflorum var. pauciflorum	x			
Meliaceae	Aglaia elaeagnoidea		x		
Meliaceae	Owenia vernicosa				x
Meliaceae	Turraea pubescens	x			
Menispermaceae	Tinospora smilacina	x	x	x	
Molluginaceae	Glinus oppositifolius			x	
Molluginaceae	Macarthuria vertex				x
Moraceae	Ficus aculeata		x	x	
Moraceae	Ficus aculeata var. indecora		x		
Moraceae	Ficus atricha		x		x

Family	Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Moraceae	Ficus brachypoda		x		
Moraceae	Ficus platypoda		x		x
Moraceae	Ficus subpuberula				x
Myrtaceae	Calytrix achaeta		x		
Myrtaceae	Calytrix brownii				x
Myrtaceae	Calytrix exstipulata		x		x
Myrtaceae	Corymbia ? confertiflora (sterile)	x			
Myrtaceae	Corymbia aff. confertiflora (T. Handasyde TH 7724)			x	
Myrtaceae	Corymbia aff. polycarpa (sterile)	x			
Myrtaceae	Corymbia arenaria				x
Myrtaceae	Corymbia bleeseri				x
Myrtaceae	Corymbia confertiflora		x		
Myrtaceae	Corymbia dichromophloia	x			x
Myrtaceae	Corymbia disjuncta			x	
Myrtaceae	Corymbia ferruginea			x	
Myrtaceae	Corymbia greeniana	x			
Myrtaceae	Corymbia polycarpa			x	
Myrtaceae	Eucalyptus brachyandra				x
Myrtaceae	Eucalyptus miniata	x		x	
Myrtaceae	Eucalyptus tectifica	x			
Myrtaceae	Lophostemon grandiflorus subsp. riparius	x			x
Myrtaceae	Melaleuca alsophila			x	
Myrtaceae	Melaleuca dealbata			x	
Myrtaceae	Melaleuca leucadendra	x		x	
Myrtaceae	Melaleuca viridiflora	x		x	
Myrtaceae	Verticordia cunninghamii		x		x
Myrtaceae	Xanthostemon paradoxus	x			x
Nyctaginaceae	Boerhavia gardneri		x		
Nyctaginaceae	Boerhavia sp.			x	
Nymphaeaceae	Nymphaea sp. (sterile)				x
Nymphaeaceae	Nymphaea violacea			x	
Oleaceae	Jasminum didymum subsp. didymum	x		x	

Family		Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Onagraceae		Ludwigia perennis	x		x	
Opiliaceae		Cansjera leptostachya	x			
Opiliaceae		Opilia amentacea	x			
Orobanchaceae		Buchnera asperata			x	
Orobanchaceae		Buchnera linearis				x
Pandanaceae		Pandanus spiralis	x	x	x	x
Passifloraceae		Adenia heterophylla subsp. australis	x	x		x
Passifloraceae	*	Passiflora foetida var. hispida	x	x	x	x
Phyllanthaceae		Breynia cernua				x
Phyllanthaceae		Bridelia tomentosa	x		x	
Phyllanthaceae		Flueggea virosa subsp. melanthesoides	x		x	
Phyllanthaceae		Notoleptopus decaisnei	x			
Phyllanthaceae		Phyllanthus sp. (sterile)				x
Phyllanthaceae		Phyllanthus aridus	x			
Phyllanthaceae		Phyllanthus maderaspatensis	x			
Phyllanthaceae		Phyllanthus reticulatus	x	x		
Phyllanthaceae		Sauropus trachyspermus	x		x	
Picrodendraceae		Petalostigma quadriloculare		x		
Pittosporaceae		Pittosporum spinescens	x			
Plantaginaceae		Bacopa floribunda			x	
Plantaginaceae		Stemodia lythrifolia			x	x
Poaceae		Aristida sp. (T. Handasyde TH 8031)	x			
Poaceae		Cenchrus elymoides			x	
Poaceae		Chrysopogon ? fallax (sterile)	x			
Poaceae		Cymbopogon ambiguus	x		x	
Poaceae		Cymbopogon bombycinus		x		
Poaceae		Cymbopogon ? ambiguus (sterile)				x
Poaceae		Dichanthium fecundum	x	x		
Poaceae		Digitaria bicornis	x			
Poaceae	*	Digitaria ciliaris		x		
Poaceae		Digitaria papposa	x		x	x
Poaceae		Ectrosia agrostoides		x		x

Family	Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Poaceae	Elytrophorus spicatus				x
Poaceae	Enneapogon pallidus	x			
Poaceae	Eragrostis cumingii	x			
Poaceae	Eriachne ciliate		x		
Poaceae	Eriachne obtusa			x	
Poaceae	Eriachne pauciflora		x		
Poaceae	Eriachne sulcata	x			x
Poaceae	Heteropogon contortus	x		x	
Poaceae	Ischaemum austral				x
Poaceae	Leptochloa neesii			x	
Poaceae	Mnesithea formosa	x			
Poaceae	Panicum ? mindanaense (T. Handasyde TH 7898)	x			
Poaceae	Panicum laevinode	x			
Poaceae	Paspalum scrobiculatum			x	
Poaceae	Pseudopogonatherum contortum				x
Poaceae	Pseudoraphis spinescens			x	
Poaceae	Sacciolepis myosuroides			x	
Poaceae	Sehima nervosum	x			
Poaceae	Setaria apiculata	x			
Poaceae	Sorghum amplum		x		
Poaceae	Sorghum plumosum	x	x	x	
Poaceae	Sorghum stipoideum	x		x	
Poaceae	Spinifex longifolius	x	x	x	
Poaceae	Sporobolus australasicus	x			
Poaceae	Sporobolus virginicus	x	x	x	
Poaceae	Triodia aff. bynoei_BuckleHead (T. Handasyde TH 7840)	x			x
Poaceae	Triodia aff. bynoei_BerkeleySubregion (T. Handasyde TH 7926)				x
Poaceae	Triodia aff. bitextura_CambridgeGulf_ claytonii_form (T. Handsyde TH 7741)	x		x	x
Poaceae	Triodia bynoei		x		
Poaceae	Triodia microstachya s.l.	x	x	x	x
Poaceae	Urochloa subquadripara			x	

Family	Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Poaceae	Xerochloa imberbis		x		
Poaceae	Xerochloa laniflora	x			
Polygalaceae	Polygala galeocephala	x			
Polygonaceae	Persicaria sp. (sterile)			x	
Portulacaceae	Calandrinia quadrivalvis				x
Portulacaceae	Calandrinia uniflora	x			
Portulacaceae	Portulaca oleracea			x	
Proteaceae	Grevillea agrifolia	x		x	x
Proteaceae	Grevillea heliosperma		x		
Proteaceae	Grevillea mimosoides	x			
Proteaceae	Grevillea pteridifolia				x
Proteaceae	Grevillea pyramidalis	x			
Proteaceae	Grevillea refracta		x	x	x
Proteaceae	Hakea arborescens	x			
Proteaceae	Persoonia falcata			x	x
Proteaceae	Stenocarpus cunninghamii	x			x
Pteridaceae	Cheilanthes pumilio	x			x
Putranjivaceae	Drypetes deplanchei	x		x	
Rhamnaceae	Ziziphus quadrilocularis	x			
Rhizophoraceae	Bruguiera exaristata	x	x		
Rhizophoraceae	Ceriops australis		x		
Rhizophoraceae	Rhizophora stylosa	x	x	x	
Rubiaceae	Aidia racemosa	x			
Rubiaceae	Gardenia dacryoides				x
Rubiaceae	Oldenlandia galioides		x		
Rubiaceae	Pavetta kimberleyana	x	x	x	
Rubiaceae	Psydrax pendulina	x			
Rubiaceae	Spermacoce sp.	x		x	x
Rubiaceae	Spermacoce sp. Berthier Dunes (R.L. Barrett RLB 5753)		x		
Rubiaceae	Spermacoce sp. indet KIS		x		
Rutaceae	Boronia wilsonii	x			x
Rutaceae	Glycosmis macrophylla	x	x		

Family		Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Rutaceae		Harrisonia brownii	x			
Rutaceae		Murraya paniculata		x		
Rutaceae		Zanthoxylum rhetsa	x			
Santalaceae		Exocarpos latifolius	x			
Santalaceae		Santalum lanceolatum		x		
Sapindaceae		Alectryon kimberleyanus	x			
Sapindaceae		Atalaya salicifolia	x			
Sapindaceae		Atalaya sp.			x	
Sapindaceae		Atalaya variifolia	x			
Sapindaceae	*	Cardiospermum halicacabum	x			
Sapindaceae		Dodonaea hispidula	x	x	x	
Sapindaceae		Dodonaea hispidula var. ? arida (T. Handasyde TH 7961h)				x
Sapindaceae		Dodonaea lanceolata				x
Sapotaceae		Mimusops elengi	x			
Sapotaceae		Sersalisia sericea	x		x	x
Solanaceae		Solanum ? petraeum (seedling)				x
Solanaceae		Solanum echinatum	x		x	x
Stylidiaceae		Stylidium sp.				x
Stylidiaceae		Stylidium schizanthum			x	
Taccaceae		Tacca leontopetaloides		x		
Taccaceae		Tacca maculata		x		
Verbenaceae		Phyla nodiflora			x	
Violaceae		Hybanthus aurantiacus	x		x	x
Violaceae		Hybanthus enneaspermus subsp. enneaspermus	x			
Vitaceae		Ampelocissus acetosa	x	x	x	
Vitaceae		Cayratia trifolia	x	x	x	
Xyridaceae		Xyris complanata			x	
Zygophyllaceae		Tribulopis angustifolia		x		
Zygophyllaceae		Tribulopis sp. (G.J. Keighery 17340)		x		
Total number			**198**	**138**	**141**	**114**

due to their conservation significance were also recorded from the three islands (Table 6). A further two taxa, *Hibiscus* aff *marenitensis* (T.Handasyde TH 7919) and *Goodenia* aff *byrnesii* (T.Handasyde TH 7916d) and two *Triodia* spp (*Triodia bitextura* CambridgeGulf claytonii form TH7412 and *Triodia bynoei* BuckleHead TH7840) require further work (M.Barrett, pers. comm.).

We detected nine weed species in total, eight of which were recorded on Buckle Head and two each on Lacrosse and Champagny (Table 7). *Passiflora foetida* was recorded on all three islands and *Calotropis procera* on both Lacrosse and Buckle Head. *Passiflora foetida* is a common weed along the north Australian coast, and was detected on all the KIBS islands. *Calotropis procera* is a common weed in Queensland, the Northern Territory and the east Kimberley as far west as the Berkeley River (AVH). It is however largely unrecorded from the west Kimberley, although some infestations are known to occur (AVH; T. Vinnicombe, pers. comm.) It was only recorded on Adolphus Island during the KIBS.

In terms of similarity in species composition:

- Buckle Head and Lacrosse group together, and with Adolphus Island (Figure 6; see Lyons et al. 2014). There were taxa collected on these three islands that were not recorded on the other islands sampled during the KIBS, such as *Brachychiton incanus*. This species is considered to be an east Kimberley endemic (although AVH records two outliers, in the west and north-west Kimberley). Buckle Head, Lacrosse and Adolphus were the only islands sampled in the Berkeley SR.
- Champagny does not group with any other island. This is likely explained by the restricted sampling area (due to the fire) which had limited habitat diversity and hence low species richness. However, the opportunistic sampling in the wet season during the KIBS was undertaken after an intense fire and there were taxa recorded during this time that were not or rarely detected on the other islands [e.g. *Cleome kenneallyi*, *Cleome* sp. Bonaparte Archipelago (A.A. Mitchell 4774), *Zornia muriculata* and *Tribulopis* sp. (G.J. Keighery 17340)].

Berkeley SR – mainland

We recorded four non-volant mammal species from the mainland site – 'Berkeley SR' (Table 1, Appendix 11). Another population of the threatened Northern Quoll was detected, as was the Scaly-tailed Possum (*Wyulda squamicaudata*), a Kimberley endemic. Until recently, the Scaly-tailed Possum was only known outside the north-west Kimberley from one record, although it has recently been recorded in Emma Gorge. Other species included the more widespread Common Rock-rat and the Short-eared Rock Wallaby (*Petrogale brachyotis*). Both the possum and rock wallaby were detected on the camera traps, although the rock wallaby was also sighted. A total of 17 bat species were detected, which included the Kimberley Cave Bat (*Vespadelus douglasorum*), an endemic to the Kimberley (Table 2).

We detected a total of 15 reptile and six frog species at this site (Table 3, Appendix 12). Endemic species included *Cryptoblepharus megastictus* and *Carlia johnstonei* (Table 2). Diversity of habitat types was low at this mainland site with no nearby woodlands, vine thickets or rainforest patches. This, and the difficulty of searching such a rugged area, is likely to have resulted in the relatively low diversity of reptiles detected (Table 3), and consisted of the rock-dwelling geckos (e.g. *Gehyra koira koira*, *G. nana* and *Heteronotia planiceps*) and commonly detected species such as *Ctenotus*

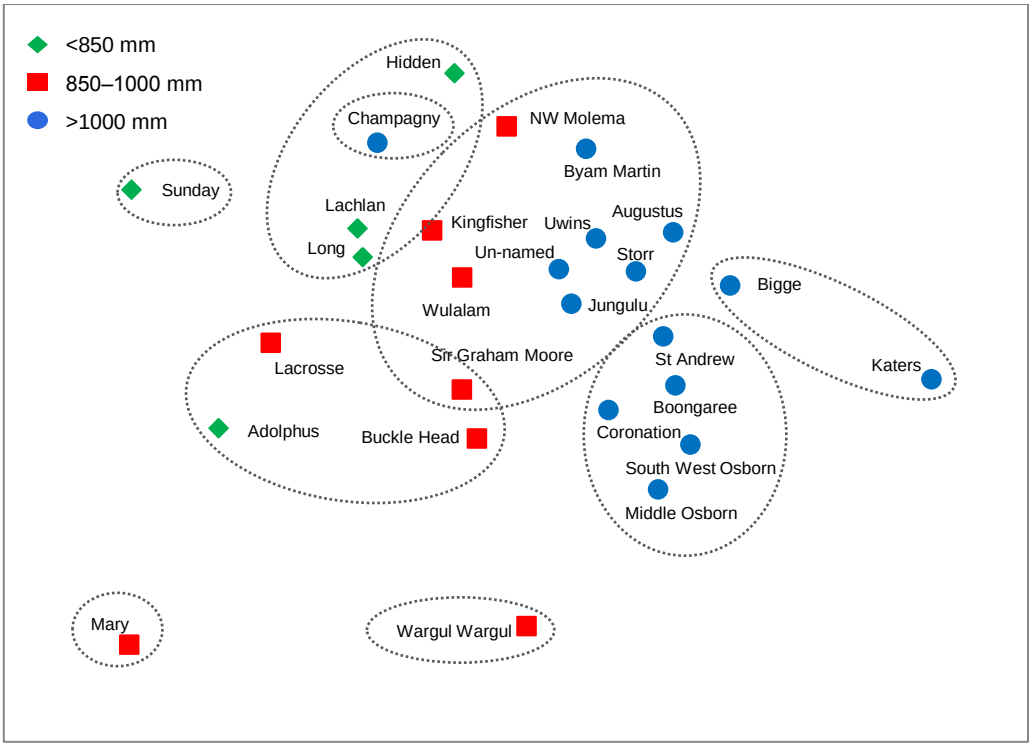

Figure 6. Non-metric MDS plot of compositional patterns of plant taxa across the Kimberley islands sampled in 2014 (Lacrosse, Buckle Head and Champagny) and those sampled during the Kimberley Island Biodiversity Survey, based on the Sorensen similarity matrix (2D stress 0.199). Three rainfall bands (low <850 mm, moderate 850-1000 mm, high >1000 mm) are indicated by dot shape and colour on the plot. Clusters at the 34% similarity level are indicated by elipses.

inornatus, *Eremiascincus isolepis isolepis* and *Pseudechis weigeli*. A freshwater crocodile (*Crocodylus johnstoni*) was also observed in a nearby pool.

Again, the lack of habitat diversity was reflected in the bird diversity, with only 23 species detected (Table 4). We recorded many of the common species such as the Black-faced Cuckoo-shrike, Brown Honeyeater, Rainbow Bee-eater and Red-winged Parrot, but the site was lacking the rainforest and mangrove specialists. Rock specialists detected included the Sandstone Shrike-thrush and White-quilled Rock Pigeon. The endemic subspecies, the Grey Butcherbird, was also recorded at this site (Table 2).

Species richness of the plant taxa at this site was also relatively low with 114 taxa recorded (Table 5). We detected five taxa endemic to the Kimberley [*Acacia tenuispica*, *Corymbia bleeseri*, *Jacksonia argentea*, *Planchonia rupestris*, *Scaevola* sp. Sir Graham Moore Island (P.G. Wilson 11204)] (Table 2) and one Priority Flora species (*Brachychiton incanus*) (Table 6). However, *Dicarpidium monoicum* was only the fourth record of this species in Western Australia, and as for Buckle Head and Lacrosse, a form of *Triodia bitextura* (*Triodia bitextura* CambridgeGulf claytonii form TH7412) previously known from only a couple of collections, adds to the known range of this form which is likely to be separated from the *Triodia bitextura* complex as a new species (M.Barrett, pers. comm.). Additionally, the *Triodia bynoei* we detected at this site, and on Buckle Head (*Triodia bynoei* BuckleHead TH7840), is also a yet to be described species in the *T.bynoei* complex (as also may be

Triodia bynoei BereleySubregion TH7926; M.Barrett, pers. comm.). Only one weed species, *Passiflora foetida,* was detected (Table 7).

Table 6. Plant taxa of conservation significance (Department of Parks and Wildlife Priority Flora) collected from the surveyed islands and mainland site (Berkeley SR). 'Potential' Priority Flora yet to be assigned species status.

Taxon	Priority	Buckle Head	Champagny	Lacrosse	Berkeley SR
Trichosanthes pilosa	1		x		
Acacia leptocarpa	1			x	
Dolichandrone filiformis	2	x			
Cleome kenneallyi	2		x		
Brachychiton incanus	3	x		x	x
Spermacoce sp. Berthier Dunes (R.L. Barrett RLB 5753)	3		x		
Haemodorum gracile	4		x		
Goodenia aff. *byrnesii*	potential	x			
Hibiscus aff. *marenitensis* (T. Handasyde TH 7919)	potential	x			
Total		**4**	**4**	**2**	**1**

Table 7. Exotic plant taxa recorded from the surveyed islands and mainland site (Berkeley SR).

Family	Taxon	Buckle Head	Champagny	Lacrosse	Berkeley SR
Apocynaceae	*Calotropis procera*	x		x	
Asteraceae	*Bidens bipinnata/pilosa*	x			
Fabaceae	*Aeschynomene villosa*	x			
Fabaceae	*Alysicarpus vaginalis*	x			
Fabaceae	*Crotalaria juncea*	x			
Lamiaceae	*Hyptis suaveolens*	x			
Passifloraceae	*Passiflora foetida* var *hispida*	x	x	x	x
Poaceae	*Digitaria ciliaris*		x		
Sapindaceae	*Cardiospermum halicacabum*	x			
Total		**8**	**2**	**2**	**1**

Discussion

Species diversity on the islands

The results of the 2014 island surveys presented here builds on the collective knowledge of the biodiversity values of the Kimberley islands. While the comprehensiveness of the species lists will undoubtedly be improved with repeat and additional surveys of the region, particularly during the wet season, our results further highlight the importance of these islands as conservation refuges.

For the three islands surveyed, we detected a total of 131 vertebrate species (8 non-volant mammals, 16 bats, 29 reptiles, 5 frogs and 73 birds), of which, 74 were recorded on Buckle Head, 70 on Champagny and 64 on Lacrosse. These island tallies are comparable with those sampled during the Kimberley Island Biodiversity Survey (KIBS) for islands of a similar size (Gibson 2014). Champagny

was an exception, with a relatively low diversity of vertebrates (for an island of its size when compared to the KIBS islands) but this may be due to the restricted sampling area which had limited habitat diversity and/or the recent fire history of the island with two extensive fires (both almost completely affecting the whole island) known to occur within the last six years. Even so, previously unrecorded species were detected on Champagny including two mammals, the endemic Kimberley Rock-rat (*Zyzomys woodwardi*) and Water Rat (*Hydromys chrysogaster*), and eight reptile species. Of the total 359 plant taxa we recorded on the islands sampled, 199 were detected on Buckle Head, 145 on Lacrosse and 137 on Champagny, which again is within the range expected for islands of their size when compared to the results of the KIBS (Gibson 2014). The higher diversity of plant species on Buckle Head, compared to Lacrosse and Champagny, is attributable to the additional habitat types present on Buckle Head, particularly those associated with the more fertile Carson volcanics, such as the vine thickets, and an apparent absence of fire. The absence of fire was evident throughout the surveyed area on Buckle Head but was particularly apparent on the rugged plateau of the mesa.

No species were unique to the islands in this survey, which aligns with KIBS results whereby very few vertebrate or plant species were endemic to the islands. Only 10 reptiles and 6 plants with no known mainland distributions were recorded during the KIBS (Palmer et al. 2013, Lyons et al. 2014). This paucity of island endemics is probably explained by the close proximity of the Kimberley islands to the mainland and the relatively short period of time the islands have been isolated from the mainland (How et al. 2009; Gibson 2014). However, endemic fauna of the Northern Kimberley (NK) bioregion was well represented on the KIBS islands (Gibson 2014). Here, we recorded 13 species endemic to the NK bioregion (2 mammals, 1 bird subspecies, 6 reptiles and 4 plants). Among the KIBS islands, highest richness of regional endemics was recorded on the islands with relatively high rainfall (> 1000 mm; Gibson 2014). This association was also observed for the small subset of islands here, with highest richness of regional endemics recorded on Champagny, the island with the highest average annual rainfall.

Compositional patterns on islands

Overall compositional patterns in terms of species co-occurrences on the combined 2014 and KIBS islands appear to be explained by a combination of geology and rainfall (particularly reptiles, plants and, to a lesser degree, bats and birds), and ruggedness (particularly non-volant mammals). These patterns were clear among the KIBS islands (Gibson 2014).

Buckle Head and Lacrosse showed similarities with each other and Adolphus Island, all three being geographically distant from the other islands, and located in the eastern section of the Northern Kimberley bioregion. The exceptions were for the non-volant mammals and bats and this appears to be related to higher species richness of both on Buckle Head. This may be explained by the likelihood that Buckle Head is connected to the mainland at very low tides, consequently facilitating movement from the mainland. Also, Buckle Head has a higher diversity of habitat types, including deeply dissected sandstone, which is suitable habitat for many Kimberley mammals (Gibson and McKenzie 2012b). The proximity of Buckle Head to substantial mangrove stands on the adjacent mainland is likely to explain the high number of bat species detected (McKenzie and Bullen 2012). The similarity between these three islands was not as strong for the birds. Lacrosse is an outlier, probably due to the species associated with its ephemeral wetland which were not or rarely recorded on the other islands.

Champagny, being located in the relatively high rainfall zone of the Kimberley coastal region tended to be most similar to the other high rainfall islands within this area (How et al. 2006; Gibson 2014). There were some exceptions and this inconsistency appears to be related to the lower species richness on Champagny, particularly where the plants and bats were concerned, and birds to a degree. As suggested above, the restricted sampling area on this island and/or its recent fire history may account for this. However, being a low profile sandstone island (Burbidge and McKenzie 1978), Champagny may not have the diversity of habitat types compared to its more rugged neighbours and hence a lower species richness. Another contributing factor could be that this island is located furthest from the mainland of all the islands surveyed and therefore dispersal opportunities are comparatively low.

Conservation significance of islands

In terms of the conservation significance of the three islands, Buckle Head is clearly important as it supports a high number of mammal species including at least two that are threatened (Northern Quoll and Golden-backed Tree-rat). We also detected five regional endemic species (Table 2) and at least two Priority Flora taxa (*Brachychiton incanus* and *Dolichandrone filiformis*) on this island. Additionally, the geological diversity of Buckle Head adds to the diversity of habitat types and vegetation communities on this island, such as the vine thickets at the base of the sandstone mesa and that occur in a depauperate form behind the western mangrove community. Rugged habitat on the mesa plateau of Buckle Head, that supports a mature *Triodia* spp. understorey (indicating a significant period since fire), also provides protection and high quality habitat for fire-sensitive species. The mangrove channel that ostensibly enables Buckle Head to be classified as an island, functions as an important fire-break, which is greatly enhanced by the saline flats that occur either side of the channel.

We detected one endemic plant (*Brachychiton incanus*) and at least two Priority Flora taxa (*Acacia leptocarpa* and *Brachychiton incanus)* on Lacrosse. While the list of conservation significant taxa is small, Lacrosse together with Buckle Head, support unique assemblages not represented on the other more western and south-western islands. They also provide refuge to species still to be described, such as *Hibiscus* aff. *marenitensis* and two *Triodia* species that are believed to be restricted to the Berkeley SR. The ephemeral wetland on Lacrosse is also likely to be important for waterbirds.

As discussed previously, biological knowledge of the Berkeley SR is limited. It therefore of little surprise that the 2014 surveys, both island and mainland, identified numerous new plant records for the coastal area between Cape Londonderry and Cambridge Gulf, a straight line distance of almost 200 km. A number of these new records have previously been commonly recorded to the east and west of this section of coast. For example, *Tabernaemontana orientalis, Mimusops elengi* and *Zanthoxylum rhetsa*, which were all collected from or adjacent to vine thicket communities on Buckle Head, occur not uncommonly from Cape Londonderry and further to the west. There are also records of these species in the Northern Territory and Queensland, and islands to the north of Australia. *Pavonia calycina* (Buckle Head), known only in Australia from several Cape Bougainville and east of Cape Londonderry collections, has also been recorded in Timor (AVH). Records of *Acacia leptocarpa* and *Sacciolepis myosuroides* (Lacrosse) are range extensions, as are records of several sedges (e.g. *Fimbristylis polytrichoides* from Buckle head; *Cyperus crispulus* and *Fimbristylis*

trigastrocarya from the Berkeley SR mainland site). The 2014 Berkeley SR records therefore fill an important gap, linking often disjunct (known) distributions.

Like the other islands in the high rainfall zone of the north-west Kimberley, Champagny is important for its high number of regional endemics, including the Kimberley Rock-rat. Four of the seven listed Priority Flora detected on the islands in 2014 occurred on Champagny. Collectively, the high rainfall islands along the Kimberley coast have probably acted as historically stable refugia where taxa have been buffered from fire (Gibson 2014).

Invasive species and threats on islands

We detected no introduced vertebrates on the sampled islands and very few weeds. However, the recent invasion of Adolphus Island by the Cane Toad (*Rhinella marinus*) indicates that invasion of Lacrosse by toads is possible, particularly as it is situated in the same catchment. The existence of an ephemeral wetland on Lacrosse may also allow the toads to subsist there for a period of time. Being so close to the mainland, and potentially periodically connected to it, Buckle Head is similarly susceptible to Cane Toad invasion. The added concern here is that the Northern Quoll, which is vulnerable to poisoning by ingestion of toads, has been detected on this island. Clearly strategies to prevent the introduction of cane toads to islands, as well as regular surveillance to detect them should they naturally colonise the islands are crucial. Additionally, monitoring vulnerable species on islands should be a priority.

We recorded eight weed species on Buckle Head, and two each on both Lacrosse and Champagny. Buckle Head has a large shallow bay on the west side which is likely to be conducive to entrapping/retaining seed being transported by sea. A depauperate vine thicket behind this bay had a significant weed infestation, with all eight weed species being found in or adjacent to this area. *Hyptis suaveolens, Calotropis procera* and *Passiflora foetida* were reasonably widespread on this island with the range of *Passiflora foetida* extending to the top of the sandstone mesa.

Lacrosse is regularly visited by fishermen, has a lighthouse and historically supported a turtle harvesting enterprise (Green 2011). The detection of only two weeds species here is therefore surprising. However, being located in the mouth of Cambridge Gulf, Lacrosse is subject to continual, significant tidal movement which may reduce weed invasion. In comparison, nearby Adolphus Island which supports at least nine known weed species (Lyons et al. 2014), lies in the mouth of the Ord River which flows directly from the Ord River Irrigation Area. The *Passiflora foetida* infestation at the Lacrosse survey site was reasonably extensive.

As Champagny is 27 km from the mainland, the chance of a weed arriving there naturally is probably relatively low. The widely spread *Passiflora foetida* found on Champagny is likely to be dispersed by strongly flying birds and fruit bats. *Digitaria ciliaris*, a historical record, was detected close to an old radar installation and therefore is likely to have been transported to the island by people. The current low number of invasive species detected on the surveyed islands highlights the importance of quarantine measures to limit, identify and control any future incursions.

Increasing visitation to the islands may also result in increased fire frequency. Fires occurring in the dry season can burn across entire islands, as evidenced on Champagny, and this can have significant consequences for flora and fauna. Fire management on islands is a complex issue that requires a

case by case assessment of island size, fire history, fuel loads and seasonal influences, along with consideration of traditional burning by Aboriginal people. Habitat modification and associated loss of species that has occurred on the mainland due to inappropriate fire regimes make it imperative that the use of fire on islands be very carefully considered. This is critical if species vulnerable to the impacts of fire, either directly or indirectly, are to be protected.

Mainland – Berkeley SR

As a first step, the survey of a mainland site within the Berkeley SR helps to fill a knowledge gap with regard to the biota of this poorly known region. Additional surveys in the region will enable an assessment of the biodiversity patterns and better inform conservation planning. The survey site selected was situated on a rugged King Leopold sandstone ridge. This geology-type is localised and uncommon in the Berkeley SR. Despite the lack of habitat diversity in the local area (i.e. accessible by foot) resulting in relatively low total species richness (65 vertebrates and 115 plant taxa), 10 regional endemics were recorded at this site (2 mammals, 1 bird subspecies, 2 reptiles and 5 plants). Rugged sandstone formations of the Australian monsoon tropics are known to support many endemic species (Woinarski et al. 2006, Bowman et al. 2010). These rugged, rocky landscapes potentially provide protection for species from fire thereby promoting their persistence. The detection of the Scaly-tailed Possum (*Wyulda squamicaudata*), a Northern Kimberley endemic, and a new population of the threatened Northern Quoll were significant finds. *Triodia* species collections will aid in identifying the range of the likely two new species. The collection of what appears to be *Planchonia careya* and *Planchonia rupestris* (both sterile) and intermediate material requires further investigation. Only one weed species was detected at this site, *Passiflora foetida*.

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Lacrosse Island showing ephemeral wetland (M. Cowan)

Appendices

Appendix 1

Geographic coordinates (Datum: WGS84) of trap lines (Elliot traps - start and end), funnel trap lines (start), vegetation (Veg) quadrats, camera traps, bat detectors and camp sites for each survey location.

Location	Site	Lines	Latitude	Longitude
Buckle Head	CAMP	camp	-14.4602	127.8594
Buckle Head	Funnel 1 F1	1	-14.4618	127.8567
Buckle Head	Funnel 1 F2	2	-14.4614	127.8561
Buckle Head	Funnel 2 F1	1	-14.4616	127.8589
Buckle Head	Funnel 2 F2	2	-14.4619	127.8594
Buckle Head	Funnel 3 F1	1	-14.4594	127.8597
Buckle Head	Funnel 4 F1	1	-14.4607	127.8601
Buckle Head	Funnel 4 F2	2	-14.4595	127.8582
Buckle Head	Funnel 4 F3	3	-14.4605	127.8554
Buckle Head	Trap Line 1	start	-14.4621	127.8576
Buckle Head	Trap Line 1	end	-14.4608	127.8551
Buckle Head	Trap Line 2	start	-14.4613	127.8583
Buckle Head	Trap Line 2	end	-14.4625	127.8595
Buckle Head	Trap Line 3	start	-14.4598	127.8595
Buckle Head	Trap Line 3	end	-14.4567	127.8602
Buckle Head	Trap Line 4	start	-14.4607	127.8601
Buckle Head	Trap Line 4	end	-14.4590	127.8565
Buckle Head	Bat Detector 1	1	-14.4628	127.8606
Buckle Head	Bat Detector 2	2	-14.4602	127.8594
Buckle Head	Bat Detector 3	3	-14.4560	127.8607
Buckle Head	Veg Quadrat 1	1	-14.4613	127.8556
Buckle Head	Veg Quadrat 2	2	-14.4560	127.8607
Buckle Head	Veg Quadrat 3	3	-14.4588	127.8596
Buckle Head	Veg Quadrat 4	4	-14.4568	127.8601
Buckle Head	Camera R1	1	-14.4628	127.8583
Buckle Head	Camera R2	2	-14.4600	127.8597
Buckle Head	Camera R3	3	-14.4597	127.8589
Buckle Head	Camera R4	4	-14.4611	127.8561
Buckle Head	Camera R5	5	-14.4570	127.8600
Buckle Head	Camera R6	6	-14.4567	127.8602
Buckle Head	Camera R7	7	-14.4628	127.8597
Buckle Head	Camera R8	8	-14.4588	127.8595
Buckle Head	Camera R9	9	-14.4606	127.8558
Buckle Head	Camera R10	10	-14.4603	127.8572
Buckle Head	Camera R11	11	-14.4617	127.8575
Buckle Head	Camera R12	12	-14.4597	127.8597
Buckle Head	Camera R13	13	-14.4628	127.8606
Buckle Head	Camera R14	14	-14.4617	127.8567
Buckle Head	Camera R15	15	-14.4619	127.8569
Buckle Head	Camera R16	16	-14.4592	127.8578
Buckle Head	Camera R17	17	-14.4617	127.8589
Buckle Head	Camera R18	18	-14.4622	127.8572
Buckle Head	Camera R19	19	-14.4603	127.8553

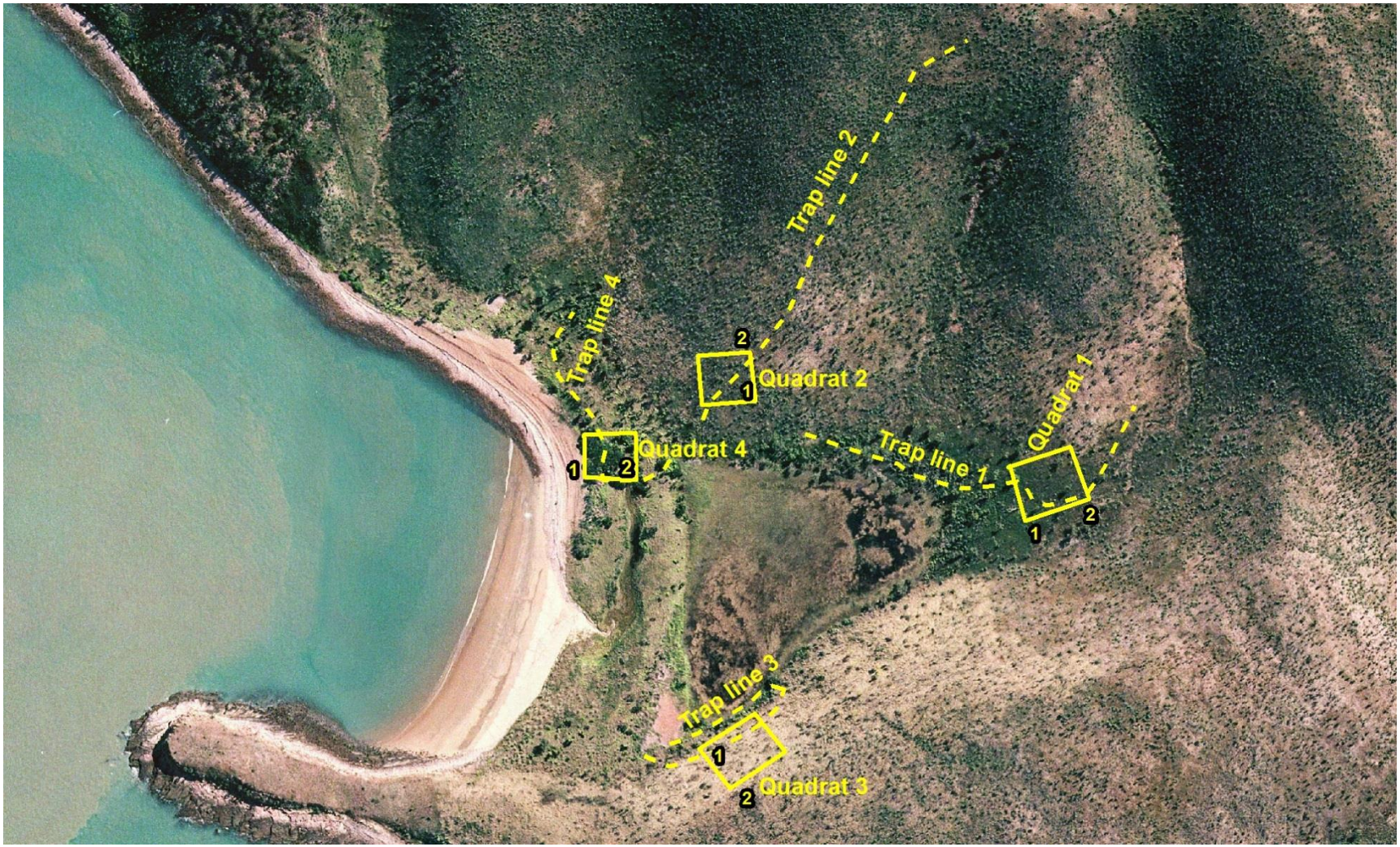
Location	Site	Lines	Latitude	Longitude
Buckle Head	Camera R20	20	-14.4600	127.8553
Buckle Head	Camera R13-2	13-2	-14.4563	127.8603
Buckle Head	Camera R19-2	19-2	-14.4562	127.8605
Buckle Head	Camera R20-2	20-2	-14.4561	127.8606
Buckle Head	Camera R5-2	5-2	-14.4564	127.8605
Buckle Head	Camera R6-2	6-2	-14.4563	127.8607
Buckle Head	Camera R8-2	8-2	-14.4564	127.8603
Lacrosse Island	Funnel 1 F1	1	-14.7436	128.3022
Lacrosse Island	Funnel 1 F2	2	-14.7436	128.3025
Lacrosse Island	Funnel 2 F1	1	-14.7422	128.3021
Lacrosse Island	Funnel 2 F2	2	-14.7418	128.3023
Lacrosse Island	Funnel 3 F1	1	-14.7458	128.3002
Lacrosse Island	Funnel 3 F2	2	-14.7461	128.3002
Lacrosse Island	Funnel 4 F1	1	-14.7436	128.3003
Lacrosse Island	Funnel 4 F2	2	-14.7434	128.3002
Lacrosse Island	CAMP	camp	-14.7435	128.3006
Lacrosse Island	Trap Line 1	start	-14.7436	128.3018
Lacrosse Island	Trap Line 1	end	-14.7434	128.3046
Lacrosse Island	Trap Line 2	start	-14.7433	128.3010
Lacrosse Island	Trap Line 2	end	-14.7404	128.3032
Lacrosse Island	Trap Line 3	start	-14.7462	128.3005
Lacrosse Island	Trap Line 3	end	-14.7461	128.3006
Lacrosse Island	Trap Line 4	start	-14.7438	128.3007
Lacrosse Island	Trap Line 4	end	-14.7426	128.2999
Lacrosse Island	Bat Detector 1	1	-14.7487	128.3032
Lacrosse Island	Bat Detector 2	2	-14.7440	128.3003
Lacrosse Island	Bat Detector 3	3	-14.7487	128.3032
Lacrosse Island	Veg Quadrat 1	1	-14.7443	128.3037
Lacrosse Island	Veg Quadrat 2	2	-14.7433	128.3014
Lacrosse Island	Veg Quadrat 3	3	-14.7461	128.3009
Lacrosse Island	Veg Quadrat 4	4	-14.7438	128.2998
Lacrosse Island	Camera R1	1	-14.7442	128.3039
Lacrosse Island	Camera R2	2	-14.7441	128.3041
Lacrosse Island	Camera R4	4	-14.7463	128.2985
Lacrosse Island	Camera R3	3	-14.7418	128.3023
Lacrosse Island	Camera R5	5	-14.7459	128.3001
Lacrosse Island	Camera R6	6	-14.7451	128.3001
Lacrosse Island	Camera R7	7	-14.7463	128.2987
Lacrosse Island	Camera R8	8	-14.7462	128.3001
Lacrosse Island	Camera R9	9	-14.7427	128.2998
Lacrosse Island	Camera R10	10	-14.7438	128.3003
Lacrosse Island	Camera R11	11	-14.7439	128.3033
Lacrosse Island	Camera R12	12	-14.7438	128.3020
Lacrosse Island	Camera R13	13	-14.7446	128.3025
Lacrosse Island	Camera R14	14	-14.7479	128.3024
Lacrosse Island	Camera R15	15	-14.7484	128.3028
Lacrosse Island	Camera R16	16	-14.7435	128.3002
Lacrosse Island	Camera R17	17	-14.7487	128.3032
Lacrosse Island	Camera R18	18	-14.7462	128.2980
Lacrosse Island	Camera R19	19	-14.7433	128.3000

Location	Site	Lines	Latitude	Longitude
Lacrosse Island	Camera R20	20	-14.7436	128.3003
Champagny Island	CAMP	camp	-15.3106	124.2789
Champagny Island	Trap Line 1	start	-15.3109	124.2790
Champagny Island	Trap Line 1	end	-15.3081	124.2818
Champagny Island	Trap Line 2	start	-15.3101	124.2787
Champagny Island	Trap Line 2	end	-15.3077	124.2811
Champagny Island	Trap Line 3	start	-15.3103	124.2786
Champagny Island	Trap Line 3	end	-15.3075	124.2774
Champagny Island	Trap Line 4	start	-15.3112	124.2786
Champagny Island	Trap Line 4	end	-15.3111	124.2754
Champagny Island	Bat Detector 1	1	-15.3128	124.2784
Champagny Island	Bat Detector 2	2	-15.3114	124.2772
Champagny Island	Funnel 1 F1	1	-15.3107	124.2793
Champagny Island	Funnel 1 F2	2	-15.3105	124.2794
Champagny Island	Funnel 2 F1	1	-15.3091	124.2810
Champagny Island	Funnel 2 F2	2	-15.3073	124.2815
Champagny Island	Funnel 3 F1	1	-15.3099	124.2785
Champagny Island	Funnel 3 F2	2	-15.3075	124.2776
Champagny Island	Funnel 4 F1	1	-15.3110	124.2787
Champagny Island	Funnel 4 F2	2	-15.3114	124.2787
Champagny Island	Veg Quadrat 1	1	-15.3110	124.2794
Champagny Island	Veg Quadrat 2	2	-15.3120	124.2786
Champagny Island	Veg Quadrat 3	3	-15.3093	124.2797
Champagny Island	Veg Quadrat 4	4	-15.3095	124.2797
Champagny Island	Veg Quadrat 5	5	-15.3100	124.2787
Champagny Island	Camera R1	1	-15.3097	124.2800
Champagny Island	Camera R2	2	-15.3122	124.2781
Champagny Island	Camera R3	3	-15.3113	124.2759
Champagny Island	Camera R4	4	-15.3092	124.2792
Champagny Island	Camera R5	5	-15.3075	124.2777
Champagny Island	Camera R6	6	-15.3078	124.2819
Champagny Island	Camera R6A	6-2	-15.3103	124.2786
Champagny Island	Camera R7	7	-15.3081	124.2817
Champagny Island	Camera R8	8	-15.3078	124.2806
Champagny Island	Camera R9	9	-15.3092	124.2811
Champagny Island	Camera R10	10	-15.3119	124.2781
Champagny Island	Camera R11	11	-15.3088	124.2778
Champagny Island	Camera R12	12	-15.3078	124.2819
Champagny Island	Camera R13	13	-15.3089	124.2803
Champagny Island	Camera R14	14	-15.3110	124.2784
Champagny Island	Camera R15	15	-15.3083	124.2800
Champagny Island	Camera R16	16	-15.3111	124.2769
Champagny Island	Camera R17	17	-15.3111	124.2781
Champagny Island	Camera R18	18	-15.3109	124.2755
Champagny Island	Camera R19	19	-15.3086	124.2806
Champagny Island	Camera R20	20	-15.3098	124.2784
Berkeley mainland	CAMP	camp	-14.4862	127.8196
Berkeley mainland	Funnel 1 F1	1	-14.4858	127.8211
Berkeley mainland	Funnel 1 F2	2	-14.4855	127.8225
Berkeley mainland	Funnel 2 F1	1	-14.4852	127.8194

Location	Site	Lines	Latitude	Longitude
Berkeley mainland	Funnel 2 F2	2	-14.4852	127.8191
Berkeley mainland	Funnel 3 F1	1	-14.4842	127.8196
Berkeley mainland	Funnel 1 F1	1	-14.4858	127.8191
Berkeley mainland	Funnel 2 F1	2	-14.4854	127.8202
Berkeley mainland	Funnel 3 F1	3	-14.4854	127.8209
Berkeley mainland	Trap Line 1	start	-14.4862	127.8204
Berkeley mainland	Trap Line 1	end	-14.4853	127.8222
Berkeley mainland	Trap Line 2	start	-14.4852	127.8194
Berkeley mainland	Trap Line 2	end	-14.4847	127.8178
Berkeley mainland	Trap Line 3	start	-14.4842	127.8200
Berkeley mainland	Trap Line 3	end	-14.4831	127.8226
Berkeley mainland	Trap Line 4	start	-14.4843	127.8198
Berkeley mainland	Trap Line 4	end	-14.4826	127.8201
Berkeley mainland	Bat Detector 1	1	-14.4855	127.8194
Berkeley mainland	Bat Detector 2	2	-14.4862	127.8202
Berkeley mainland	Bat Detector 3	3	-14.4921	127.8221
Berkeley mainland	Veg Quadrat 1	1	-14.4859	127.8208
Berkeley mainland	Veg Quadrat 2	2	-14.4840	127.8203
Berkeley mainland	Veg Quadrat 3	3	-14.4899	127.8201
Berkeley mainland	Veg Quadrat 4	4	-14.4818	127.8200
Berkeley mainland	Camera R1	1	-14.4856	127.8223
Berkeley mainland	Camera R2	2	-14.4854	127.8194
Berkeley mainland	Camera R3	3	-14.4853	127.8192
Berkeley mainland	Camera R4	4	-14.4859	127.8211
Berkeley mainland	Camera R5	5	-14.4839	127.8203
Berkeley mainland	Camera R6	6	-14.4844	127.8219
Berkeley mainland	Camera R7	7	-14.4842	127.8206
Berkeley mainland	Camera R8	8	-14.4831	127.8228
Berkeley mainland	Camera R9	9	-14.4859	127.8221
Berkeley mainland	Camera R10	10	-14.4844	127.8172
Berkeley mainland	Camera R11	11	-14.4864	127.8194
Berkeley mainland	Camera R12	12	-14.4831	127.8200
Berkeley mainland	Camera R13	13	-14.4850	127.8192
Berkeley mainland	Camera R14	14	-14.4847	127.8186
Berkeley mainland	Camera R15	15	-14.4842	127.8186
Berkeley mainland	Camera R16	16	-14.4830	127.8201
Berkeley mainland	Camera R17	17	-14.4862	127.8219
Berkeley mainland	Camera R18	18	-14.4858	127.8192
Berkeley mainland	Camera R19	19	-14.4830	127.8203
Berkeley mainland	Camera R20	20	-14.4839	127.8222
Berkeley mainland	Camera R8-2	8-2	-14.4839	127.8214

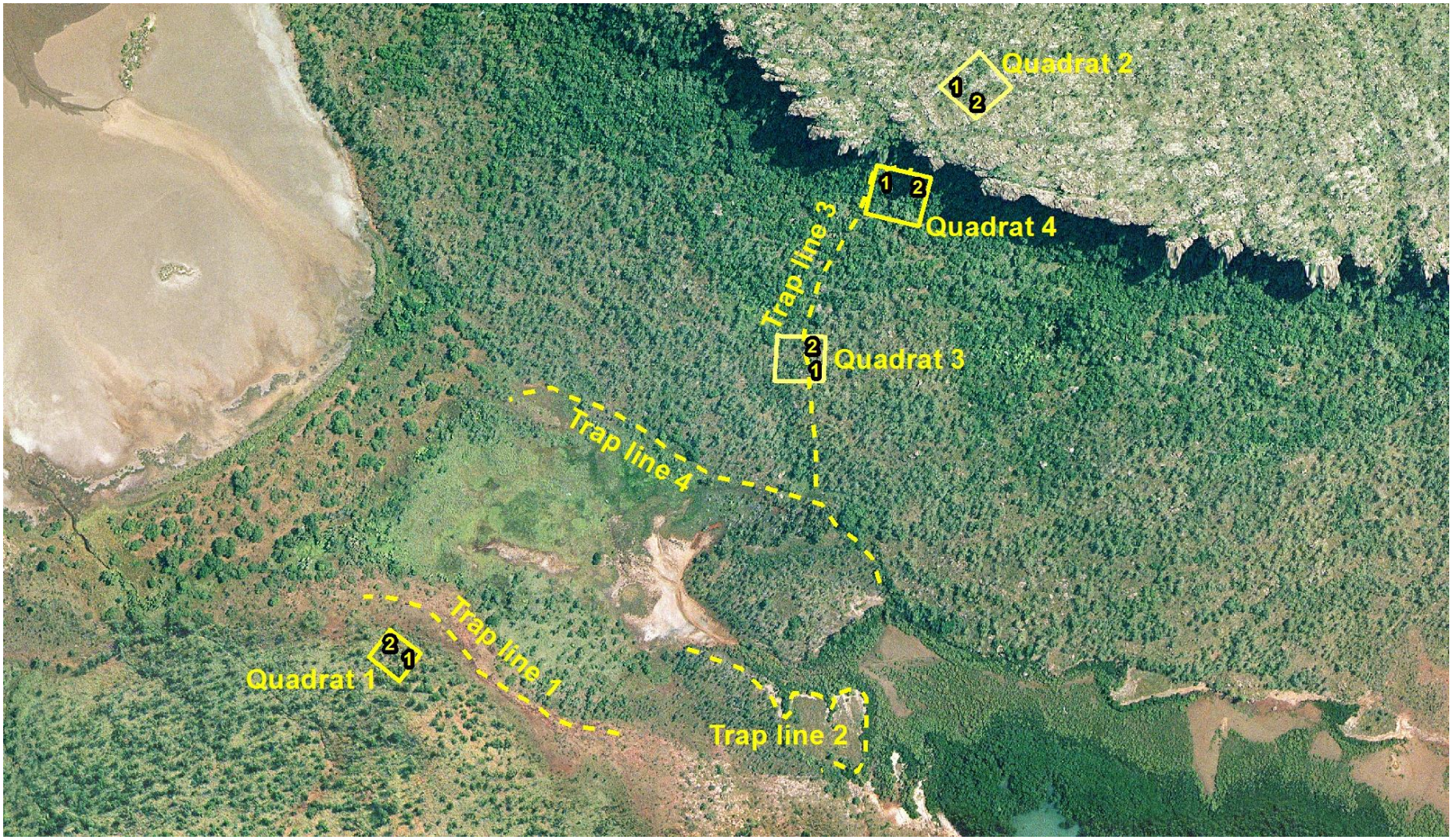
Appendix 2

Location of trap lines and vegetation quadrats (pegs 1 and 2 shown) on Lacrosse Island



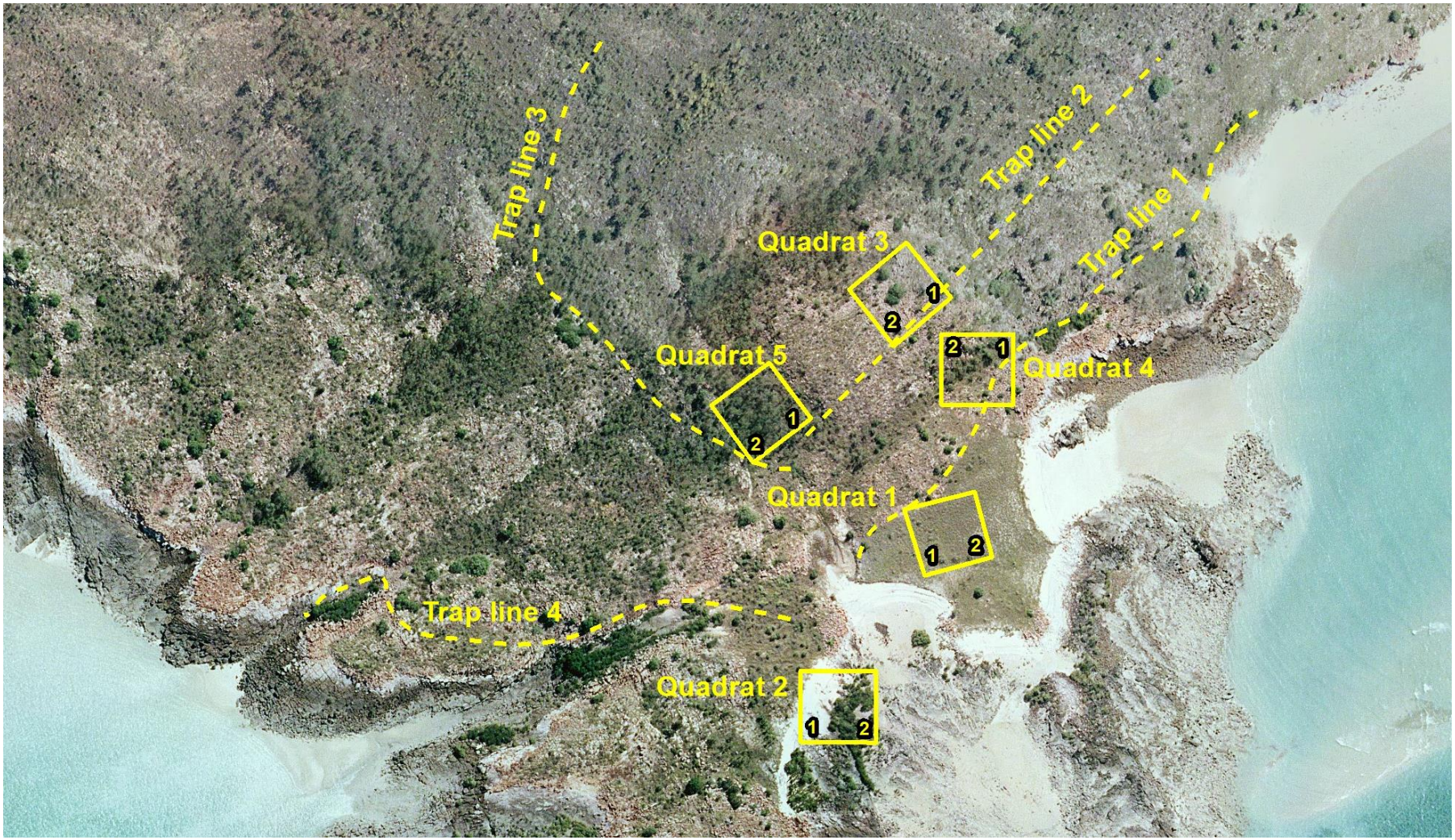
Appendix 3

Location of trap lines and vegetation quadrats (pegs 1 and 2 shown) on Buckle Head



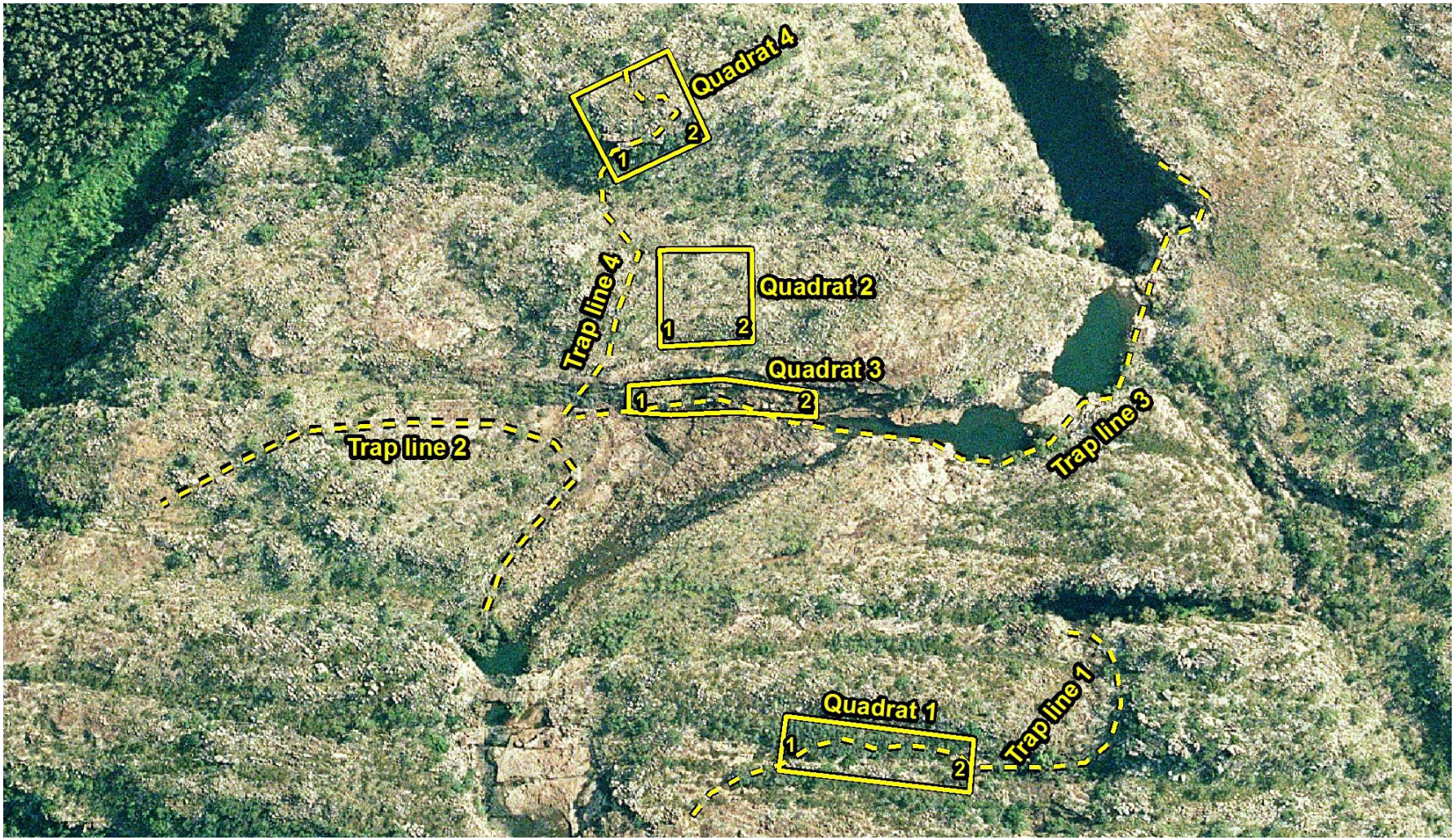
Appendix 4

Location of trap lines and vegetation quadrats (pegs 1 and 2 shown) on Champagny Island



Appendix 5

Location of trap lines and vegetation quadrats (pegs 1 and 2 shown) at the Berkeley SR mainland site



Appendix 6

Substrate attributes of vegetation quadrats at each survey location including geological code

Substrate codes: Rock abundance – coarse fragment abundance (0 – no coarse fragments to 6 – very abundant); Rock size – maximum size of coarse fragments (1 – fine gravely to 7 – large boulders); Bedrock – amount of bedrock exposed (0 – no bedrock exposed to 5 – rockland); Soil texture (LS – Loamy sand, CS – Clayey sand, SL – Sandy loam, L – Loam, S – sand) (McDonald et al. 1998)

Geology codes: Pkl – King Leopold sandstone; Pkw – Warton sandstone; Pkp – Pentecost sandstone; Pkc – Carson volcanics

Location	Quadrat	Rock abundance	Rock size	Bedrock	Geology code	Soil depth (cm)	Soil texture	Litter depth (cm)	Leaf litter %	Bare ground %	Rock %
Buckle Head	1	4	4	0	Pkc	2	L	2-6	90	5	30
Buckle Head	2	5	6	4	Pkw	2	S	10	30	0	30
Buckle Head	3	5	7	-	Pkc	2	LS	15	-	0	30
Buckle Head	4	5	6	0	Pkw/Pkc	2	LS	3	20	10	50
Lacrosse Island	1	-	-	0	Pkp	2	S	15-20	-	-	-
Lacrosse Island	2	5	3	0	Pkp	2	SL	15	70	0	50
Lacrosse Island	3	5	5	0	Pkp	2	LS	5-10	30	0	60-70
Lacrosse Island	4	6	4	0	Pkp	2	LS	10	50	0	90
Champagny Island	1	0	0	0	Pkw	10	S	1-5	<2	-	-
Champagny Island	2	0	0	0	Pkw	10	CS	-	-	-	-
Champagny Island	3	5	4	4	Pkw	5	SL	-	10-20	-	70-80
Champagny Island	4	5	4	4	Pkw	10	SL	5	-	-	20
Champagny Island	5	4	4	1	Pkw	10	SL	5-20	-	-	0
Berkeley mainland	1	5	6	5	Pkl	2	LS	5	20	10-20	80
Berkeley mainland	2	5	6	4	Pkl	1	LS	>5	10	<5	50+
Berkeley mainland	3	-	7	5	Pkl	1	S	>5	<1	<2	90
Berkeley mainland	4	5	6	5	Pkl	1	S	-	20	0	90

Appendix 7

Plant taxa recorded in quadrats on Lacrosse Island

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
Acanthaceae	Dicliptera armata			x	
Anacardiaceae	Buchanania oblongifolia			x	
Apocynaceae	Calotropis procera				x
Apocynaceae	Cynanchum pedunculatum			x	
Apocynaceae	Gymnanthera oblonga				x
Apocynaceae	Tylophora flexuosa		x		
Asparagaceae	Thysanotus chinensis	x			
Burseraceae	Canarium australianum				x
Byblidaceae	Byblis liniflora	x			
Combretaceae	Terminalia canescens	x	x	x	
Commelinaceae	Commelina ensifolia				x
Convolvulaceae	Ipomoea pes-caprae				x
Convolvulaceae	Xenostegia tridentata			x	x
Cucurbitaceae	Trichosanthes cucumerina var. cucumerina			x	x
Cyperaceae	Fimbristylis rara				x
Cyperaceae	Fimbristylis sp. A Kimberley Flora (A.S. George 13584)	x			
Cyperaceae	Fuirena ciliaris	x			
Cyperaceae	Scleria rugosa	x			
Euphorbiaceae	Microstachys chamaelea			x	
Fabaceae	Abrus precatorius subsp. precatorius				x
Fabaceae	Acacia holosericea			x	
Fabaceae	Acacia leptocarpa	x			
Fabaceae	Acacia neurocarpa	x			x
Fabaceae	Acacia tumida		x	x	
Fabaceae	Cathormion umbellatum subsp. moniliforme				x
Fabaceae	Crotalaria medicaginea			x	
Fabaceae	Crotalaria montana var. angustifolia			x	
Fabaceae	Crotalaria novae-hollandiae				x

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
Fabaceae	Glycine tomentella			x	
Fabaceae	Indigofera hirsuta				x
Fabaceae	Tephrosia sp. Pentecost River (I.D. Cowie 4168)			x	
Fabaceae	Vigna lanceolata	x	x	x	
Flagellariaceae	Flagellaria indica				x
Hernandiaceae	Gyrocarpus americanus			x	
Lamiaceae	Clerodendrum floribundum		x	x	
Lamiaceae	Clerodendrum floribundum var. coriaceum	x			
Lamiaceae	Premna acuminata				x
Lauraceae	Cassytha candida	x		x	
Loranthaceae	Dendrophthoe acacioides			x	
Malvaceae	Adansonia gregorii			x	
Malvaceae	Brachychiton incanus		x	x	
Malvaceae	Hibiscus meraukensis				x
Malvaceae	Melochia corchorifolia				x
Malvaceae	Triumfetta sp. (sterile)			x	
Malvaceae	Waltheria indica			x	
Menispermaceae	Tinospora smilacina	x		x	x
Molluginaceae	Glinus oppositifolius				x
Myrtaceae	Corymbia aff. confertiflora			x	
Myrtaceae	Corymbia ferruginea	x	x		
Myrtaceae	Corymbia polycarpa	x			
Myrtaceae	Eucalyptus miniata		x		
Myrtaceae	Melaleuca viridiflora	x			
Nyctaginaceae	Boerhavia sp.				x
Onagraceae	Ludwigia perennis				x
Passifloraceae	Passiflora foetida	x		x	x
Phyllanthaceae	Bridelia tomentosa			x	
Phyllanthaceae	Flueggea virosa subsp. melanthesoides			x	
Phyllanthaceae	Sauropus trachyspermus			x	
Plantaginaceae	Bacopa floribunda	x			
Plantaginaceae	Stemodia sp. (sterile)	x			

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
Poaceae	Cenchrus elymoides var. elymoides			x	
Poaceae	Digitaria papposa	x			x
Poaceae	Eriachne obtusa	x		x	
Poaceae	Heteropogon contortus				x
Poaceae	Sacciolepis myosuroides	x			
Poaceae	Sorghum sp.				x
Poaceae	Sorghum stipoideum			x	
Poaceae	Sporobolus virginicus				x
Poaceae	Triodia aff. bitextura_CambridgeGulf_ claytonii_form (T. Handsyde TH 7741)	x	x		
Poaceae	Triodia microstachya s. l.	x			
Poaceae	Urochloa subquadripara				x
Proteaceae	Grevillea agrifolia	x			
Proteaceae	Grevillea refracta	x		x	
Proteaceae	Persoonia falcata	x			
Solanaceae	Solanum echinatum			x	
Stylidiaceae	Stylidium schizanthum	x			
Violaceae	Hybanthus aurantiacus		x		

Corrin Everitt, Mark Cowan, Lesley Gibson, Phil Mitchell, and Quinten Gore (left to right) on Lacrosse Island (M. Cowan)

Appendix 8

Plant taxa recorded in quadrats on Buckle Head

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
Apocynaceae	Cynanchum puberulum		x		
Apocynaceae	Parsonsia velutina				x
Apocynaceae	Sarcostemma ? viminale (sterile)				x
Apocynaceae	Secamone timoriensis				x
Apocynaceae	Tylophora flexuosa			x	
Arecaceae	Livistona lorophylla		x		
Asparagaceae	Asparagus racemosus	x		x	
Asteraceae	Blainvillea cunninghamii	x			
Asteraceae	Blumea saxatilis	x		x	
Asteraceae	Pterocaulon serrulatum	x			
Bignoniaceae	Dolichandrone filiformis			x	
Bixaceae	Cochlospermum fraseri	x		x	x
Boraginaceae	Ehretia saligna			x	
Boraginaceae	Heliotropium sp.			x	
Burseraceae	Canarium australianum		x		x
Byblidaceae	Byblis filifolia			x	
Cannabaceae	Celtis philippensis	x		x	x
Capparaceae	Capparis sepiaria	x			
Capparaceae	Capparis sp. (sterile)			x	
Celastraceae	Elaeodendron melanocarpum				x
Combretaceae	Terminalia canescens	x		x	
Convolvulaceae	Bonamia pannosa	x		x	
Convolvulaceae	Ipomoea eriocarpa	x			
Convolvulaceae	Operculina aequisepala	x			
Convolvulaceae	Xenostegia tridentata	x		x	
Cucurbitaceae	Cucumis melo	x		x	
Cyperaceae	Cyperus microcephalus subsp. microcephalus				x
Cyperaceae	Fimbristylis microcarya			x	

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
Cyperaceae	Fimbristylis rara			x	
Cyperaceae	Fuirena ciliaris			x	
Cyperaceae	Scleria rugosa			x	
Dilleniaceae	Hibbertia lepidota		x		
Dilleniaceae	Hibbertia oblongata subsp. brevifolia				x
Euphorbiaceae	Croton schultzii				x
Fabaceae	Abrus precatorius subsp. precatorius				x
Fabaceae	Acacia arida			x	
Fabaceae	Acacia holosericea	x			
Fabaceae	Acacia plectocarpa subsp. plectocarpa			x	
Fabaceae	Acacia stigmatophylla		x	x	x
Fabaceae	Acacia tumida		x	x	
Fabaceae	Alysicarpus schomburgkii			x	
Fabaceae	Alysicarpus vaginalis	x			
Fabaceae	Bauhinia cunninghamii			x	
Fabaceae	Christia australasica	x			
Fabaceae	Crotalaria juncea	x			
Fabaceae	Crotalaria medicaginea			x	
Fabaceae	Crotalaria montana var. angustifolia			x	
Fabaceae	Crotalaria retusa	x			
Fabaceae	Erythrina vespertilio	x			
Fabaceae	Neptunia dimorphantha	x			
Fabaceae	Rhynchosia minima	x			
Fabaceae	Templetonia hookeri			x	
Fabaceae	Tephrosia phaeosperma	x			
Fabaceae	Tephrosia polyzyga		x		
Fabaceae	Tephrosia sp. Pentecost River (I.D. Cowie 4168)			x	
Fabaceae	Uraria lagopodioides			x	
Fabaceae	Vigna lanceolata	x			
Flagellariaceae	Flagellaria indica				x
Goodeniaceae	Goodenia aff. byrnesii			x	
Goodeniaceae	Goodenia redacta		x		

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
Goodeniaceae	Scaevola sp. Sir Graham Moore Island (P.G. Wilson 11204)			x	
Lamiaceae	Clerodendrum floribundum var. coriaceum		x		
Lamiaceae	Hyptis suaveolens	x			
Lamiaceae	Premna acuminata	x	x	x	
Lamiaceae	Vitex acuminata	x	x	x	x
Lauraceae	Cassytha candida		x		
Lauraceae	Cassytha filiformis	x			
Loganiaceae	Mitrasacme nudicaulis		x		
Loganiaceae	Strychnos lucida			x	
Loranthaceae	Dendrophthoe acacioides subsp. acacioides	x			
Malvaceae	Brachychiton incanus		x		
Malvaceae	Corchorus sidoides subsp. sidoides			x	
Malvaceae	Grewia breviflora	x		x	
Malvaceae	Grewia retusifolia	x		x	
Malvaceae	Hibiscus geranioides			x	
Malvaceae	Pavonia calycina				x
Malvaceae	Triumfetta sp. (sterile)			x	
Malvaceae	Waltheria indica	x			
Meliaceae	Turraea pubescens	x			
Menispermaceae	Tinospora smilacina		x		x
Myrtaceae	Corymbia aff. polycarpa				x
Myrtaceae	Corymbia dichromophloia		x	x	
Myrtaceae	Eucalyptus miniata		x		
Myrtaceae	Eucalyptus tectifica	x		x	
Myrtaceae	Xanthostemon paradoxus				x
Oleaceae	Jasminum didymum subsp. didymum			x	
Onagraceae	Ludwigia perennis	x			
Passifloraceae	Adenia heterophylla subsp. australis		x	x	x
Passifloraceae	Passiflora foetida var. hispida	x		x	
Phyllanthaceae	Bridelia tomentosa	x		x	
Phyllanthaceae	Notoleptopus decaisnei	x			
Phyllanthaceae	Phyllanthus aridus		x		

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
Phyllanthaceae	Phyllanthus maderaspatensis	x			
Phyllanthaceae	Sauropus trachyspermus		x	x	
Pittosporaceae	Pittosporum spinescens				x
Poaceae	Aristida sp. (T. Handasyde TH8031)				x
Poaceae	Chrysopogon ? fallax (sterile)	x			
Poaceae	Cymbopogon ambiguus				x
Poaceae	Dichanthium fecundum	x			
Poaceae	Digitaria bicornis	x			
Poaceae	Eriachne sulcata	x		x	
Poaceae	Heteropogon contortus	x		x	
Poaceae	Panicum ? mindanaense (T. Handasyde TH 7898)	x			
Poaceae	Panicum laevinode	x			
Poaceae	Sehima nervosum	x			
Poaceae	Sorghum plumosum	x	x	x	x
Poaceae	Sorghum stipoideum			x	
Poaceae	Sporobolus australasicus	x			
Poaceae	Triodia aff. bitextura_CambridgeGulf_ claytonii_form (T. Handsyde TH 7741)		x	x	x
Poaceae	Triodia aff. bynoei_BuckleHead (T. Handasyde TH 7840)			x	
Proteaceae	Grevillea agrifolia		x	x	x
Proteaceae	Hakea arborescens	x			
Proteaceae	Stenocarpus cunninghamii				x
Putranjivaceae	Drypetes deplanchei				x
Rhamnaceae	Ziziphus quadrilocularis			x	x
Rubiaceae	Aidia racemosa				x
Rubiaceae	Pavetta kimberleyana	x	x	x	
Rubiaceae	Psydrax pendulina			x	
Rutaceae	Boronia wilsonii		x		
Rutaceae	Glycosmis macrophylla				x
Rutaceae	Harrisonia brownii				x
Rutaceae	Zanthoxylum rhetsa			x	x
Sapindaceae	Atalaya salicifolia				x

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
Sapindaceae	Atalaya variifolia			x	
Sapindaceae	Dodonaea hispidula		x	x	x
Sapotaceae	Mimusops elengi			x	x
Sapotaceae	Sersalisia sericea		x	x	x
Violaceae	Hybanthus aurantiacus		x	x	
Violaceae	Hybanthus enneaspermus subsp. enneaspermus			x	
Vitaceae	Ampelocissus acetosa			x	

Livistona lorophylla (centre) on the Buckle Head sandstone mesa (M. Cowan)

Appendix 9

Plant taxa recorded in quadrats on Champagny Island

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5
Acanthaceae	Avicennia marina		x			
Amaryllidaceae	Crinum angustifolium					x
Apocynaceae	Alstonia actinophylla			x		
Apocynaceae	Marsdenia pleiadenia			x	x	
Apocynaceae	Parsonsia velutina			x		
Apocynaceae	Sarcostemma viminale			x		
Asparagaceae	Asparagus racemosus			x		
Boraginaceae	Trichodesma zeylanicum	x				
Cannabaceae	Celtis philippensis			x		
Caryophyllaceae	Polycarpaea involucrata			x		
Cleomaceae	Cleome viscosa	x			x	
Convolvulaceae	Ipomoea pes-caprae	x				
Ebenaceae	Diospyros maritima	x		x		
Euphorbiaceae	Croton sp. indet KIS			x		
Fabaceae	Abrus precatorius			x		
Fabaceae	Acacia gonocarpa				x	
Fabaceae	Acacia orthocarpa			x		
Fabaceae	Acacia stigmatophylla					x
Fabaceae	Cajanus cinereus			x	x	
Fabaceae	Templetonia hookeri			x	x	
Flagellariaceae	Flagellaria indica					x
Goodeniaceae	Scaevola macrostachya			x		
Lauraceae	Cassytha filiformis			x	x	
Malvaceae	Hibiscus superbus					x
Malvaceae	Thespesia populneoides	x				
Moraceae	Ficus aculeata	x				
Moraceae	Ficus platypoda			x		
Passifloraceae	Adenia heterophylla			x	x	

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5
Phyllanthaceae	Phyllanthus reticulatus	x		x		
Poaceae	Cymbopogon bombycinus			x		
Poaceae	Triodia bynoei			x	x	x
Poaceae	Triodia microstachya	x				
Proteaceae	Grevillea heliosperma	x				
Rhizophoraceae	Bruguiera exaristata		x			
Rhizophoraceae	Rhizophora stylosa		x			
Rubiaceae	Spermacoce sp. indet KIS	x			x	
Santalaceae	Santalum lanceolatum	x		x	x	
Vitaceae	Ampelocissus acetosa			x		

Champagny Island camp (L. Gibson)

Appendix 10

Plant taxa recorded in quadrats on the Berkeley subregion mainland site

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
Amaranthaceae	Ptilotus giganteus	x			
Apocynaceae	Alstonia actinophylla				x
Apocynaceae	Tylophora flexuosa				x
Asteraceae	Pterocaulon serrulatum var. serrulatum	x			
Capparaceae	Capparis jacobsii				x
Cleomaceae	Cleome viscosa	x			
Combretaceae	Terminalia latipes		x		
Cyperaceae	Cyperus viscidulus			x	
Cyperaceae	Fimbristylis microcarya			x	
Cyperaceae	Fuirena ciliaris			x	
Dilleniaceae	Hibbertia oblongata	x			
Dilleniaceae	Hibbertia sp.		x	x	
Fabaceae	Acacia delibrata	x	x		x
Fabaceae	Acacia deltoidea subsp. deltoidea	x	x		x
Fabaceae	Acacia holosericea			x	
Fabaceae	Acacia plectocarpa subsp. plectocarpa			x	
Fabaceae	Acacia tenuispica		x		x
Fabaceae	Jacksonia argentea	x			
Fabaceae	Templetonia hookeri	x			x
Lamiaceae	Clerodendrum floribundum				x
Lamiaceae	Premna sp.				x
Lamiaceae	Pityrodia terifolia	x	x		
Lauraceae	Cassytha candida	x			
Lecythidaceae	Barringtonia acutangula			x	
Lecythidaceae	Planchonia ? careya (sterile)				x
Lecythidaceae	Planchonia careya	x			
Malvaceae	Brachychiton incanus				x
Malvaceae	Corchorus sidoides subsp. sidoides	x			x
Malvaceae	Hibiscus aphelus	x			

Family	Taxon	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
Malvaceae	Hibiscus sp. (sterile)		x		x
Malvaceae	Triumfetta triandra				x
Meliaceae	Owenia vernicosa	x	x	x	x
Moraceae	Ficus atricha	x			x
Moraceae	Ficus platypoda			x	
Moraceae	Ficus subpuberula				x
Myrtaceae	Calytrix brownii			x	x
Myrtaceae	Calytrix exstipulata	x	x		
Myrtaceae	Corymbia arenaria				x
Myrtaceae	Eucalyptus brachyandra		x		x
Myrtaceae	Lophostemon grandiflorus subsp. riparius			x	
Myrtaceae	Verticordia cunninghamii			x	
Myrtaceae	Xanthostemon paradoxus			x	x
Nymphaeaceae	Nymphaea sp. (sterile)			x	
Pandanaceae	Pandanus spiralis			x	
Passifloraceae	Adenia heterophylla subsp. australis				x
Phyllanthaceae	Breynia cernua				x
Phyllanthaceae	Phyllanthus sp.				x
Poaceae	Ischaemum australe			x	
Poaceae	Triodia microstachya s.l.	x			
Poaceae	Triodia sp. (sterile)		x		
Poaceae	Triodia aff. bitextura_CambridgeGulf_ claytonii_form (T. Handsyde TH 7741)			x	x
Poaceae	Triodia aff. bynoei_BerkeleySubregion (T. Handasyde TH 7926)			x	
Proteaceae	Grevillea agrifolia	x	x		x
Proteaceae	Stenocarpus cunninghamii	x			
Rubiaceae	Gardenia dacryoides	x	x	x	x
Sapotaceae	Sersalisia sericea			x	x
Solanaceae	Solanum ? petraeum (seedling)	x			

Appendix 11

Total number of detections for each mammal species on the islands and mainland site (Berkeley SR) sampled using Elliot traps (minus known recaptures) and camera traps (may include multiple detections of same individual)

	Buckle Head	Champagny	Lacrosse	Berkeley SR	Total
Elliot Traps (800 trap nights)					
Dasyurus hallucatus	10			12	22
Zyzomys argurus			2	33	35
Zyzomys woodwardi		4			4
Mesembriomys macrurus	1				1
Camera (20 cameras)					
Dasyurus hallucatus	53			12	65
Hydromys chrysogaster			3		3
Isoodon sp.	2				2
Macropus agilis	9				9
Petrogale brachyotis				64	64
Tachyglossus aculeatus	1				1
Wyulda squamicaudata				2	2
Zyzomys argurus	8		2	111	121
Zyzomys woodwardi		305			305

Berkeley SR mainland site (M. Cowan)

Appendix 12

Total number of detections for each herpetofauna species on the islands and mainland site (Berkeley SR) surveyed (minus known recaptures)

Species	Buckle Head	Champagny	Lacrosse	Berkeley SR	Total
Reptiles					
Amalosia obscura		4			4
Amalosia rhombifer	6		4		10
Amphibolurus gilberti				1	1
Antaresia childreni		2	3	1	6
Carlia amax		2			2
Carlia johnstonei	21			3	24
Carlia triacantha		5			5
Crinia bilingua				1	1
Crocodylus johnstoni				1	1
Cryptoblepharus megastictus				2	2
Cryptoblepharus metallicus	4	3	1		8
Ctenotus inornatus	35	54	60	9	158
Cyclodomorphus maximus	1				1
Delma borea	2	2	2		6
Eremiascincus isolepis isolepis	6	1	24	1	32
Gehyra koira koira	14		5	4	23
Gehyra nana	11	5	12	4	32
Gehyra xenopus		9			9
Heteronotia planiceps	3	3		1	7
Lialis burtonis			3		3
Liasis olivaceus	3	1		1	5
Morethia ruficauda	2	4	1	1	8
Notoscincus ornatus		5			5
Pseudechis weigeli		4	4	2	10
Ramphotyphlops kimberleyensis		1	1		2
Tiliqua scincoides			2		2
Varanus acanthurus	2		2		4
Varanus glauerti		1			1
Varanus glebopalma	1			1	2
Varanus mertensi				2	2
Varanus tristis	1				1
Frogs					
Lerista borealis	5		3		8
Lerista walkeri		2			2
Limnodynastes lignarius			4		4
Litoria coplandi				5	5
Litoria rothii	1				1
Litoria rubella	1			1	2
Litoria sp.				1	1
Litoria splendida				3	3
Litoria tornieri				2	2
Litoria wotjulumensis	1				1
Uperoleia borealis		2			2