



BushBlitz
SPECIES DISCOVERY PROGRAM

Durack River and Karunjie Stations Western Australia

26 May–5 June 2014

Bush Blitz species discovery program



Australian Government

Department of the Environment and Energy



bhpbilliton

Sustainable Communities



Australian
Biological
Resources
Study

What is Bush Blitz?

Bush Blitz is a multi-million dollar partnership between the Australian Government, BHP Billiton Sustainable Communities and Earthwatch Australia to document plants and animals in selected properties across Australia.

This innovative partnership harnesses the expertise of many of Australia's top scientists from museums, herbaria, universities, and other institutions and organisations across the country.

Abbreviations

ABRS

Australian Biological Resources Study

DPaW

Department of Parks and Wildlife

EPBC Act

Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

FRM Act

Fish Resources Management Act 1994 (Western Australia)

ILC

Indigenous Land Corporation

KLC

Kimberley Land Council

MAGNT

Museum and Art Gallery of the Northern Territory

UNSW

University of New South Wales

WAM

Western Australian Museum

WAH

Western Australian Herbarium

WC Act

Wildlife Conservation Act 1950 (Western Australia)

Summary

Durack River and Karunjie Stations in the Kimberley, Western Australia, were the focus of a Bush Blitz expedition from 26 May to 5 June 2014. These former pastoral properties are located along the Gibb River Road within the Pentecost River Catchment. The Indigenous Land Corporation (ILC) purchased the properties along with the neighbouring Home Valley Station and opened a pastoral, tourism and indigenous training centre in 2008.

The Kimberley is one of the most ecologically important regions of Australia. Collecting occurred within a relatively dry corridor running north to south through the eastern Kimberley, which is less well known than the wetter parts of the western Kimberley or the area between Kununurra and the Northern Territory border. In many cases, the records fill a significant distribution gap between the eastern and western Kimberley, suggesting that this gap is a collecting artefact rather than a biogeographic feature. The Bush Blitz records will be important for future biodiversity modelling in the Kimberley.

The Bush Blitz survey recorded 793 species, 419 of which had not been recorded previously for the properties (36 vertebrates, 181 invertebrates, 189 flowering plants, 6 ferns, 2 spikemosses, 5 lichens). Forty-one species that may be new to science were identified (21 true bugs, 3 spiders, 1 pseudoscorpion, 14 flowering plants, 2 lichens). Seven flowering plants listed under Western Australia's *Wildlife Conservation Act 1950* (WC Act) were collected. Gouldian Finch (*Erythrura gouldiae*), listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), were recorded at Bindoola Gorge. A sawfish species (*Pristis* sp.) was identified to genus based on recent anecdotal records—all sawfish species are protected from recreational and commercial fishing under the Western Australian *Fish Resources Management Act 1994* (FRM Act) and listed as Vulnerable under the EPBC Act. The Ghost Bat (*Macroderma gigas*), listed as Vulnerable under the EPBC and WC Acts, was identified from sound recordings.

Of the hundreds of species of plants and animals recorded, some highlights included:

- Collecting many putative new plant taxa; in most parts of Australia, finding just one flowering plant taxa new to science is a rare event.
- Three lichen species were first records for Western Australia.
- New information about spadefoot toads that will be added to future field guides. The juvenile Northern Spadefoot (*Notaden melanoscaphus*) possessed colouration very similar to its sandhill-dwelling desert relative, Desert Spadefoot (*N. nicholli*), which is later covered by black pigment as it increases in size.
- An undescribed species of rainbowfish (*Melanotaenia* sp.). Scientists are undertaking ongoing research to determine its relationship to populations of Exquisite Rainbowfish (*Melanotaenia exquisita*) living in Kakadu in the Northern Territory.
- Three new species of goblin spider (family Oonopidae) and a new species of pseudoscorpion (*Geogarypus* n. sp. *).
- The first crevice weaver spider (*Wandella centralis*) record for northern Australia.
- A new record of a butterfly in Western Australia, the first for ten years. The butterfly is the Chrome Awl (*Hasora chromus*), whose natural habitat is the monsoon vine thickets found in the

top end of the NT and north Queensland. It had not previously been recorded from WA, despite extensive surveys of the vine thickets in the Kimberley.

- The survey of true bugs documented 124 species. The richness of the collections was beyond expectation. Highlights included a potential new genus and new species of true bug belonging to the tribe Agriopocorini, and the collection of a true bug from the oriental *Thaumastomiris* genus was a new record for Australia.

A significant attribute of the survey sites is the lack of introduced fishes confirmed during this Blitz. Cane Toads (*Rhinella marina*) had recently invaded the area but were detected at only a few locations. The Tawny Coster butterfly (*Acraea terpsicore*) was recorded; a recent introduction to Australia, this species has the potential to impact on the native butterfly fauna, particularly the Glasswing (*Acraea andromacha*). The Rutherglen Bug (*Nysius vinitor*) was the only true bug captured that is considered a pest of agricultural crops. A single male specimen of the Brown Dog Tick (*Rhipicephalus sanguineus*) was collected at the base camp. This species is common in tropical and semi-tropical Australia and has a circum-tropical distribution globally.

Few exotic plant species were identified, none of which are declared weeds and all were relatively minor at the sites where they were recorded. The botanists targeted areas remote from cattle camps and stockyards, and well away from the Gibb River Road along which many weeds will spread. If those areas were targeted more weeds would have been noted. In general, the areas surveyed were all of high quality and represented good examples of the vegetation of the Kimberley.

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Introduction

This is a report for the Bush Blitz program, which aims to improve our knowledge of Australia's biodiversity. Bush Blitz is an initiative of the Australian Government, through the Australian Biological Resources Study (ABRS), in partnership with BHP Billiton Sustainable Communities and Earthwatch Australia. Bush Blitz aims to:

- promote, publicise and demonstrate the importance of taxonomy through species discovery
- undertake a national species discovery program
- support the science of taxonomy in Australia through training of students and early career researchers, and by providing grants for species description and resolution of taxonomically problematic, nationally important groups
- promote partnerships between scientific institutions, government, industry and non-government organisations
- inform reserve managers and other stakeholders of the results of Bush Blitz projects.

The Durack River and Karunjie Stations Bush Blitz

This survey took place between 26 May and 5 June 2014. Therefore, these collection records represent taxa active in the early to mid dry season. The weather was dry with warm nights (minimum 18–20°C) and hot sunny days (maximum 32–35°C). Conditions were warmer than is usual for the time of year, and the landscape had dried rapidly in the lead-up to the survey. Therefore, the results are representative of dry season activity in the area. Some species may be absent or impossible to detect under those conditions: many species only flower during the wet season.

An important feature of this Bush Blitz was the involvement of Nyaliga Traditional Owners, with assistance from the Kimberley Land Council (KLC). They joined the Blitz for the entire duration and were involved in sampling for all organisms. They learnt field survey methods and familiarised themselves with or revisited remote and inaccessible parts of the properties. For some it was the first opportunity to visit their traditional homelands, which was a moving experience. Scientists and Traditional Owners shared a positive two-way cultural exchange while checking traps and searching for specimens. With three generations present, there was much recounting stories of growing-up on the stations.

Five teachers from around Australia participated in Bush Blitz TeachLive, a collaborative program between the Bush Blitz partners and the Australian Science Teachers Association. The teachers worked alongside scientists, reinvigorating their love for science and generating new ideas and skills to take back to their schools. Bush Blitz information from the survey was shared with schools across Australia as teachers taught 'live' to their classrooms via the TeachLive website and Skype sessions, taking their students on a virtual expedition and inspiring the next generation. Bruce Paton from Earthwatch Australia coordinated the TeachLive activities.

Aside from collecting many valuable specimens, the Bush Blitz team took time out to celebrate this 21st expedition with a Community Day at Home Valley Station. Students from Kununurra and Wyndham high schools participated in a range of field activities, learning about the scientific techniques used to collect specimens in the field. They also spent time talking with scientists and viewing the extraordinary range of plants and animals that had been collected on the expedition.

The ABRS provided the logistical coordination and overall leadership for the survey. Experts from the following organisations conducted the field and laboratory work:

- Western Australian Museum (WAM)
- Western Australian Herbarium (WAH)
- WA Department of Parks and Wildlife (DPaW)
- Museum and Art Gallery of the Northern Territory (MAGNT)
- University of New South Wales (UNSW)
- Australian Biological Resources Study.

Acknowledgements

The Bush Blitz team were Jo Harding, Kate Gillespie, Mim Jambrecina, Brian Hawkins and Robyn Lawrence. They would like to acknowledge the Nyaliga people as the Traditional Owners of country, and thank them for their support and participation in the field. The support of the ILC and the KLC in facilitating engagement with Traditional Owners was exceptional. The team would also like to thank the helicopter pilots Dan Driscoll and Duncan Burbury (Helispirit) for getting people where they needed to go, Olive and Robbie Bayliss (RJs Catering) for keeping everyone fed, and all other Bush Blitz participants, including the staff at Home Valley Station where the expedition team was based.

Reserve overview¹

Reserve names:

Durack River Station

Karunjie Station

Area:

Durack River Station: 365,208 hectares

Karunjie Station: 273,941 hectares

Land manager/owner:

ILC

Description

Karunjie and Durack are large properties in the eastern Kimberley, located along the Gibb River Road within the Pentecost River Catchment. The ILC purchased the properties along with the neighbouring Home Valley Station in 1999 and opened a pastoral, tourism and indigenous training centre there in 2008.

Conservation values

The east Kimberley lies within a transition zone between the desert and monsoonal north Kimberley, and contains elements of desert flora and fauna, as well as several rare or restricted species, some of which are found nowhere else.

The rugged landscapes of Karunjie and Durack are characterised by savanna woodland, with grassy plains, small patches of rainforest (monsoon vine thicket), riverine habitats, sandstone gorges, escarpment and ridges from which the extreme monsoonal climate has removed much of the soil.

The climate is one of extremes with high rainfall during the monsoonal 'wet season' (November/December—March/April) and the near absence of rainfall in the intervening 'dry season', as well as the unpredictable quantity and timing of falls. Wet season conditions are generally hot with temperatures reaching 36°C. The dry season is dominated by south-east trade winds with an average minimum of 12°C.

Karunjie and Durack are located in a relatively dry corridor running north to south through the eastern Kimberley. This area is less well known than the wetter parts of the western Kimberley or the area between Kununurra and the Northern Territory border. Much of the Kimberley is still in a phase of basic documentation, for example, data from the Western Australian Herbarium reveal that one in eight plants collected in the wet season are new species for the Kimberley. Despite a long history of botanical and zoological collecting and biodiversity and taxon-specific surveys, many gaps exist in species inventory, distribution and status. Much of the previous work has focused on conservation reserves or along road corridors, and work on invertebrates is extremely limited.

¹ McKenzie, N. L., Start, A. N., Burbidge, A. A., Kenneally, K. F. & Burrows, N. D., 2009, *Protecting the Kimberley: a synthesis of scientific knowledge to support conservation management in the Kimberley region of Western Australia*, Department of Environment and Conservation, Kensington, Western Australia. Kimberley Science and Conservation Strategy, published 2011, Department of Environment and Conservation, Kensington, Western Australia.

Whilst the natural environment of the Kimberley is still in good condition, it faces many conservation challenges. Inappropriate fire regimes, particularly large late dry season fires, are stripping soil profiles across the landscape and simplifying plant composition and diversity. Weeds out-compete native plants. Unmanaged feral herbivores damage vegetation, spread weeds and exacerbate soil erosion. Cane Toads (*Rhinella marina*) are beginning to spread west through the region. Climate change is predicted to significantly affect average rainfall, temperatures, and frequency and intensity of extreme weather events over the next few decades, with unknown implications for other processes.

Methods

Taxonomic groups studied and personnel

A number of taxonomic groups were selected as targets for study. Table 1 lists the groups surveyed and the specialists who undertook the fieldwork.

Table 1 Taxonomic groups surveyed and personnel

Group	Common name	Expert	Affiliation
Amphibia and Reptilia	Amphibians and reptiles	Paul Doughty	WAM
Pisces	Fishes	Glenn Moore	WAM
		Michael Hammer	MAGNT
Lepidoptera	Butterflies	Matthew Williams	DPaW
Heteroptera	True bugs	Gerry Cassis	UNSW
		Jacqueline Karras	UNSW
		Nikolai Tatarnic	WAM
Odonata	Dragonflies and damselflies	Nikolai Tatarnic	WAM
Myriapoda	Millipedes and centipedes	Mark Harvey	WAM
Arachnida	Spiders, scorpions, ticks, mites and pseudoscorpions	Mark Harvey	WAM
Vascular plants	Vascular plants	Kevin Thiele	WAH
		Ryonen Butcher	WAH
		Tony Start	WAH
Lichens	Lichens	Patrick McCarthy	ABRS

The Bush Blitz team would also like to acknowledge the contributions of the following people:

- Robert Whyte from Toadshow Pty Ltd, who was the expedition photographer, taking many macro-photos of animals and plants, and producing two excellent evenings of slide shows shared with the team and the Traditional Owners.
- Nathan Litjens from runwildtv assisted the fish team in the field and took wonderful film footage of the expedition.
- Norm McKenzie provided the ultra-sonic equipment used to record bats, and analysed the call recordings to identify the bats.

- Scott van Barneveld, KLC Biodiversity Officer, coordinated the Nyaliga Rangers involvement in the first week of the expedition. The KLC undertook reptile trapping at Karunjie Station as part of an existing biodiversity monitoring program, working closely with Paul Doughty from WAM.
- Mike Hislop, Rob Davis, Juliet Wege, Frank Obens, Matt Barrett and Russell Barrett from the Western Australian Herbarium who assisted with the plant identifications back in Perth.

Teachers participating in the Bush Blitz TeachLive were Malcolm Rogers (Cowel Area School, SA), Shae Nechwatal (Merri Creek Primary School, VIC), Kate Cusworth (La Salle College, WA), Anjali Chandrasekar-Rao (Castle Cove Public School, NSW) and Peta Jackson (Rosewood State High School, QLD).

Site selection

Site selection and collection methods were at the discretion of the individual scientist. CSIRO modelling was provided to suggest survey locations that thoroughly sample the full range of biophysical characteristics (soil characteristics, elevation, temperature, moisture etc.) on the property. Because different biophysical characteristics are important to different taxa, four sets of sites were selected, each appropriate to a particular taxon or group of taxa.

Site selection also depended on access, suitability for trapping and time restrictions. Locations were recorded using global positioning systems.

Survey techniques

A standard suite of survey techniques was used:

- Bats were sampled using a Wildlife Acoustics SM2BATmono full-wave ultrasound recorder (384 kHz sampling rate) connected to an omni-directional SMX-ultrasonic microphone on a two-metre extension lead. The microphone was tied to the tip of a stake, about 1.5 m above the ground, several metres from obstructions, and orientated vertically upwards to minimise echoes. The recorder was pre-programmed to switch on at dusk and record until dawn. Two sites were sampled:
 1. A riverine pool in savanna woodland where Dimboola Creek crosses the Gibb River Road (15°45'54"S 127°42'57"E) for three nights (29–31 May 2014).
 2. A riverine pool in savanna woodland at 16°18'31"S 127°13'00"E, 2.8 km SE of Karunjie Homestead, for one night (2 June 2014).

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.² F_{peak} and Q-values were determined for several of the search-mode calls comprising sequences. After Q-values were divided by three (by 2 if $F_{\text{peak}} < 25$ kHz), 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 by comparison against a reference call library from the

² McKenzie, N. L. & Bullen, R. D., 2012, *An acoustic survey of zoophagous bats on islands in the Kimberley, Western Australia, including data on the echolocation ecology, organisation and habitat relationships of regional communities*, Records of the Western Australian Museum, Supplement 81: 67–108.

Kimberley using the procedure described in McKenzie and Bullen. Call shape, duration and repetition-rate data 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.

- **Amphibians and reptiles** were sampled at Karunjie in the first week using two 50-metre pitfall trap lines made of five 20-litre buckets and 10 funnel traps connected by a low flywire fence dug into the soil. This was supplemented by hand searching at night around the homestead and surrounding structures. In the second week, sites on Durack were hand searched for two to six hours overnight using head torches.
- **Fishes** were sampled primarily by backpack electrofishing. Hand-netting was used opportunistically as either dipnet from the surface (estuary) or underwater on snorkel (upland pools), along with gill and seine nets, and angling at several sites.
- **Butterflies** were recorded from visual observation and caught with nets. Each locality was centred within a 100–500 m radius and was sampled for a two to four hour period.
- **True bugs** were collected by beating or sweeping vegetation, focusing particularly on flowers, fruits and seeds. Specimens were also collected at light.
- **Damselflies and dragonflies** were caught with large insect nets from around water bodies. Specimens were also collected opportunistically at light.
- **Spiders** were sampled by hand searching under rocks, logs and bark, and sifting leaf litter. Some specimens were collected opportunistically from vertebrate pitfall traps, and from samples collected while beating and sweeping vegetation for insects. A few specimens were collected at night, using head torches and black lights.
- **Vascular plants** were collected with opportunistic and targeted sampling; collections were pressed and dried in the field and at the base camp.
- **Lichens** on sandstone were taken, usually along with their substratum, using a hammer and cold chisel. Slivers of bark and wood supporting lichens, as well as soil samples, were collected with the aid of a sharp knife. Specimens were air-dried, wrapped in tissue paper, stored in stiff paper bags or small cardboard boxes and returned to the laboratory for identification.

Data was also obtained for non-target taxa. Birds were recorded opportunistically through visual observation. Bat calls were recorded using a bat recorder activated for four nights each at Bindoola Creek crossing on the Gibb River Road and at the pool on Karunjie.

Identification

The specimens taken were identified using available literature and the holdings of museums and herbaria. Fauna specimens were deposited with WAM, true bugs with UNSW, and vascular plants and lichens with WAH.

Results

Locational data for all collection or observation records are available to reserve managers. At least 419 species were new records for the reserves (some results are yet to be finalised), including 41 putative species new to science—these await formal identification. Two threatened animal and seven threatened plant species were observed. Four exotic or pest animal species and eight weed species were also recorded. Table 2 provides a summary of the flora and fauna records for the reserve.

Table 2 Summary of flora and fauna records

Group	Common name	Total number of species	Species new to the reserves	Putative new species	Threatened species*	Exotic and pest species**
Mammalia	Mammals	11	0	0	0	0
Aves	Birds	103	0	0	1	0
Reptilia	Reptiles	24	19	0	0	0
Amphibia	Frogs and toads	11	6	0	0	1
Pisces	Fishes	38	11	0	1	0
Lepidoptera	Butterflies	31	31	0	0	1
Heteroptera	True bugs—aquatic	6	6	0	0	0
Heteroptera	True bugs—terrestrial	118	118	21	0	1
Odonata	Damselflies and dragonflies	14	14	0	0	0
Diplopoda	Millipedes	1	0	0	0	0
Chilopoda	Centipedes	4	0	0	0	0
Arachnida	Spiders	48	11	3	0	0
Arachnida	Scorpions	2	0	0	0	0
Arachnida	Ticks and mites	2	0	0	0	1
Arachnida	Pseudoscorpions	6	1	1	0	0
Crustacea	Crabs and prawns	5	0	0	0	0
Magnoliophyta	Flowering plants	316	189	14	7	8
Monilophyta	Ferns	11	6	0	0	0
Selaginellaceae	Spikemosses	3	2	0	0	0
Lichens	Lichens	39	5	2	0	0
Total		793	419	41	9	12

* Species listed under the Commonwealth EPBC Act, Western Australia's WC and FRM Acts.

** Includes native species that are at times pests or are exotic to this region.

Species lists

Species lists for the reserves are provided in [Appendix A](#). Species lists were compiled using the results of this Bush Blitz.

Names in **red bold text** are putative new species. Species marked with an asterisk (*) have not been previously recorded. Those without an asterisk have been recorded previously and were confirmed by this survey.

Some specimens have been identified only to family or genus level. This is partly because identifying specimens is very time-consuming, with detailed microscopic examination needed in many cases. Also, some groups are ‘orphans’: there are no experts currently working on them, and the taxonomic literature is out of date. Species-level identification is not possible for these groups. Unidentified specimens are held in institutional collections where they can be subject to future study.

Nomenclatural and taxonomic concepts used in this report are consistent with the Australian Faunal Directory, Australian Plant Name Index, Australian Plant Census, and the Checklist of the Lichens of Australia and its Island Territories.

Key to the species lists:

- ^ Exotic and pest species
- # EPBC listed
- ~ WC Act listed
- † FRM Act listed

Discussion

Putative new species

Here we use the term ‘putative species new to science’ in the sense of an unnamed species that, as far as can be ascertained, was collected for the first time during the survey. It is confirmed as a new species once it is named and its description published. Specimens collected during the Bush Blitz also include unnamed taxa that are already known from museum and herbarium collections: these are not counted as putative new species.

Fauna

Invertebrates

True bugs

Twenty-one new species of true bugs were collected. These included 14 new species of plant bug (Miridae) and three new species of lace bug (Tingidae), as well as one new species each of leaf-footed bug (Coreidae), unique-headed bug (Enicocephalidae), Geocoridae and assassin bug (Reduviidae). Mirid diversity usually decreases in monsoonal Australia, so the large number of new mirids from the eastern Kimberley was unexpected.

Of the Miridae, a new kleptoparasitic species of the genus *Setocoris* was found on the insectivorous plant genera *Byblis* (rainbow plants) and *Drosera* (sundews). This true bug species steals the plant’s animal prey but doesn’t become entangled in the plant’s sticky trichomes.

It was interesting to capture a new *Thaumastomiris*, an oriental genus that had not been captured before in Australia. This genus is known from pandanus plants in Southeast Asia. In the east Kimberley, it was in large numbers in the basal leaf sheaths of pandanus, and was captured in association with a large number of *Pachygrontha* sp_KIMB14Msp.011 and multiple specimens of the stinkbug genus *Oncocoris*.

Other mirid specimens belonging to the genera *Kundakimuka* and *Rayieria* may also be new species but require further study.

Three new species from the lace bug family Tingidae were collected, including a new species of the grass-inhabiting genus *Agramma*.

Specimens belonging to the cryptozoic tribe Agriopocorini were caught that may represent a new genus, as well as a new species.

Arachnids

Three different species from two genera of Goblin Spider (family Oonopidae), *Cavisternum* and *Pelcinus*, were collected from under rocks and in litter. All represent new species, with the *Cavisternum* representing yet another new species of this diverse tropical group.³

Flora

Vascular plants

Fourteen putatively new flowering plant taxa were collected. Further study may confirm that some simply represent extra variation in recognised taxa, or have been difficult to place for other reasons. However, it is clear that at least 5–6 specimens will require naming as new taxa. The first new taxon (*Goodenia heterotricha*) has already been described.⁴

Lichens

A new lichen species, *Monerolechia norstictica* (Physciaceae)⁵ was described based on collections made during this Bush Blitz, as well as material collected at Jabiru, Northern Territory and Charters Towers and Mount Morgan in Queensland. This very inconspicuous species grows on the walls of river gorges at Durack Station where it initially parasitises thalli of other lichens (*Lecanora* and *Pertusaria* species), before continuing to grow as an independent lichen.

A putatively new species of *Peltula* (Peltulaceae), related to the common *P. placodizans*, was collected at several localities in Durack. One of several species of that genus seen during the survey, the anomalous taxon is characterised by a crustose thallus with exceptionally small areoles and apothecia (fruiting structures). It will be the subject of further investigation to determine its status.

Threatened species

Australia is home to an estimated 580,000–680,000 species, most of which are yet to be described. Approximately 92% of Australian plants, 87% of mammals, 93% of reptiles and 45% of birds are endemic. Changes to the landscape resulting from human activity have put many of these unique species at risk. Over the last 200 years, many species have become extinct; many others are considered to be threatened, i.e. at risk of extinction.⁶

³ Baehr, B.C. and Harvey, M.S., 2010, Two new species of the endemic Australian goblin spider genus *Cavisternum* (Araneae: Oonopidae) from Queensland. *Australian Entomologist* 37: 171–177; Baehr, B.C., Harvey, M.S. and Smith, H.M. (2010), A review of the new endemic Australian goblin spider genus *Cavisternum* (Araneae: Oonopidae). *American Museum Novitates* 3684: 1–40; Baehr, B.C., Raven, R.J. and Whyte, R. (2013), Biodiversity discovery program Bush Blitz yields a new species of goblin spider, *Cavisternum attenboroughi* (Araneae: Oonopidae), from the Northern Territory. *Zootaxa* 3616: 396–400; Harvey, M.S. and Baehr, B. (2013), Two new species of the goblin spider genus *Cavisternum* from tropical Australia (Araneae: Oonopidae). *Memoirs of the Queensland Museum - Nature* 58: 359–366.

⁴ Barrett, R. L. & Barrett, M. D. 2015, 'Four new species of Goodeniaceae from Western Australia including the smallest species in the family, a putative seed article elaiosome, and possible floral mimicry in *Lechenaultia*', *Australian Systematic Botany* 27(5–6).

⁵ Elix, J. A. 2015, 'A new species of the lichen genus *Monerolechia* (Ascomycota, Physciaceae) from Australia', *Telopea* 18: 91–95. <<http://plantnet.rbgsyd.nsw.gov.au/emuwebnswlive/objects/common/webmedia.php?irn=79904&reftable=ebibliography>>

⁶ Chapman, A. D. 2009, *Numbers of Living Species in Australia and the World*, 2nd edn. Australian Biological Resources Study, Canberra.

Fauna

Vertebrates

Bats

The Ghost Bat (*Macroderma gigas*) was recorded at site 1, a riverine pool in savanna woodland where Dimboola Creek crosses the Gibb River Road. It is listed as Vulnerable under the EPBC and WC Acts.

Fishes

A record of a sawfish is more than likely one of three species of the genus *Pristis*, as these are the sawfish species known to enter estuaries and freshwater. It was observed in an estuary of the Pentecost River by Traditional Owners. All sawfish species are protected from recreational and commercial fishing under the FRM Act and the Freshwater Sawfish (*Pristis pristis*) is listed as Vulnerable under the EPBC Act.

Table 3 Threatened vertebrate fauna

Family	Species	Common name	Status
Fishes			
Pristidae	<i>Pristis</i> sp.	Sawfish	Totally Protected FRM Act

Invertebrates

Damselflies and dragonflies

No Kimberley dragonflies are listed at the state or federal level, but some species have been flagged for possible listing.⁷ These include the following: Kimberley Emperor (*Anax georgius*), Kimberley Longlegs (*Austrocnemis obscura*), Kimberley Hunter (*Austrogomphus mouldsororum*), Northern Pondsitter (*Austrosticta fieldi*), Kimberley Pondsitter (*Austrosticta soror*), Kimberley Pin (*Eurysticta kununurra*), Cave Duskhawker (*Gynacantha nourlangie*), Top End Archtail (*Nannophlebia mudginberri*), and Spot-winged Threadtail (*Nososticta kalumburu*), all of which have restricted distributions or are data deficient (i.e. known from only a few records). Typically, with terrestrial invertebrates the lack of ecological, distribution and abundance data means the conservation status of most species cannot be accurately determined.

Flora

Relatively few taxa collected are conservation-listed under Western Australian regulations, and none listed under the EPBC Act. Note, however, that this is partly a reflection of the relatively poor state of knowledge of plant distributions and abundances in the Kimberley. On the one hand, some taxa currently listed in Western Australia under Priority (IUCN Poorly Known) status are likely to be more widespread than currently known; on the other, some listed (and unlisted) taxa are likely to be rare and threatened.

⁷ Hawking, J. H. & Theischinger, G. 2004, 'Critical species of Odonata in Australia', *International Journal of Odonatology* 7(2):113-132.

Table 4 Threatened flora

Family	Species	Common name	Status
Flowering plants			
Araliaceae	<i>Hydrocotyle grammatocarpa</i>	—	Priority 1 Karunjie
Fabaceae	<i>Indigofera ammobia</i>	Austral Indigo	Priority 3 Durack R
Goodeniaceae	<i>Goodenia heterotricha</i> n. sp.	—	Priority 1 Durack R, Karunjie, Home Valley
Haloragaceae	<i>Myriophyllum costatum</i>	—	Priority 2 Durack R
Spikemosses			
Selaginellaceae	<i>Selaginella pygmaea</i>	Swamp Clubmoss	Priority 2 Karunjie

Exotic and pest species

Conservation reserves help protect Australia’s rare and threatened ecosystems and provide refuge for species at risk. Invasive species can have a major impact on already vulnerable species and ecosystems, as well as economic, environmental and social impacts. The inclusion of exotic and pest species records as part of this report is designed to provide land managers with baseline information to assist with further pest management programs.

Fauna

Vertebrates

Frogs and toads

Cane Toads (*Rhinella marina*) had recently invaded the area and were evident at some sites only, being common around Home Valley Station on lower Bindoola Creek and moderately common around waterholes on the Chamberlin River, 77 km south-west of Doon Doon Roadhouse.

Fishes

A significant attribute of the survey sites was the lack of introduced fishes. Potential invaders include Eastern Gambusia (*Gambusia holbrooki*), which is known elsewhere in the Kimberley, aquarium fishes such as Guppy (*Poecilia reticulata*), and the highly invasive Tilapia (*Oreochromis mossambicus*), which is already established in the Pilbara and eastern Australia.

Invertebrates

Butterflies

None of the butterfly species recorded are listed as pests; however, the Tawny Coster Butterfly (*Acraea terpsicore*) is a recent introduction to Australia and has the potential to impact on the native butterfly fauna, particularly the Glasswing (*Acraea andromacha*).

True bugs

The only true bug species captured that is considered a pest (of agricultural crops) is the Rutherglen Bug (*Nysius vinitor*). A single specimen was captured at each of two localities.

Table 5 Pest vertebrates

Family	Species	Common name	Status
Frogs and toads			
Bufoidea	<i>Rhinella marina</i>	Cane Toad	Uncommon

Table 6 Pest invertebrates

Family	Species	Common name	Status
True bugs			
Lygaeidae	<i>Nysius vinitor</i>	Rutherglen Bug	Uncommon

Flora

Relatively few weeds were noted, partly because the areas targeted by the botanists were remote from cattle camps and stockyards, and well away from the Gibb River Road along which many weeds will spread. Undoubtedly, if those areas were targeted more weeds would have been noted. None of the weeds recorded are listed under State or Commonwealth legislation, and all were relatively minor at the sites where they were recorded.

Table 7 Non-gazetted weeds

Family	Species	Common name	Status
Flowering plants			
Asteraceae	<i>Emilia sonchifolia</i> var. <i>sonchifolia</i>	Lilac Tasselflower	A minor weed at several locations in swampy areas on Durack, not common
Asteraceae	<i>Tridax procumbens</i>	Tridax Daisy	A frequent weed of the watered lawn areas of Home Valley homestead
Cucurbitaceae	<i>Citrullus lanatus</i>	Afghan Melon, Pie Melon, Bastard Melon, Bitter Melon, Wild Melon, Camel Melon	A minor weed at several locations in swampy areas on Karunjie, not common
Euphorbiaceae	<i>Euphorbia hirta</i>	Ara Tanan, Asthma Plant, Snake Weed	A minor weed at two locations on Karunjie

Family	Species	Common name	Status
Fabaceae	<i>Stylosanthes hamata</i>	Carribbean Stylo, Verano	Relatively widespread throughout Karunjie, but not abundant
Poaceae	<i>Cenchrus pedicellatus</i>	Annual Mission Grass	A minor weed at several locations in swampy areas on Durack, not common
Poaceae	<i>Echinochloa colona</i>	Awnless Barnyard Grass	A minor weed at several locations in swampy areas on Durack, not common
Poaceae	<i>Eragrostis amabilis</i> var. <i>amabilis</i>	Bunchgrass	A minor weed at Home Valley

Range extensions

Karunjie and Durack are situated in a relatively dry corridor that has received substantially less collecting effort than the wetter parts of the western Kimberley such as the Mitchell Plateau, or the eastern Kimberley between Kununurra and the Northern Territory. Helicopter access available during this Bush Blitz allowed collecting from a wide range of sites.

Fauna

Vertebrates

Reptiles and frogs

This survey was located within the so-called 'Berkeley Collecting Gap' roughly from 127°E to 128°30' E, which meant there were many new records for reptiles and frogs, and several interesting specimens were collected. The record of Black-shinned Rocket Frog (*Litoria tornieri*) was one of the more interesting, as it closed a more than 120 km gap between Kimberley plateau populations and those to the east from Kununurra and Keep River National Park, Northern Territory.

Fishes

The fishes previously known from Karunjie and Durack were limited to a handful of species sampled at stream crossings on the Gibb River Road, and some larger angling species such as Barramundi (*Lates calcarifer*) and Western Sooty Grunter (*Hephaestus jenkinsi*). Ten species were added for both stations. While outside the core survey area, the estuary had an additional 14 species not previously reported on and appears to be a poorly studied habitat type.

Invertebrates

Butterflies

Two butterfly species—Chrome Awl (*Hasora chromus*) and Tawny Coster (*Acraea terpsicore*)—were recorded substantially further west than their previously known ranges.

The natural habitat of the Chrome Awl is the monsoon vine thickets found in the top end of the Northern Territory and north Queensland. It had not previously been recorded from WA, despite extensive surveys of the vine thickets in the Kimberley. It is usually confined to these vine thickets because it only breeds on one plant, the Pongam Oiltree (*Millettia pinnata*). This tree is naturally restricted to the vine thickets; however, it is sometimes grown in gardens. The butterfly is a strong flier and capable of migrating over large distances—probably hundreds of kilometres in suitable conditions. These facts may explain why one was found at Home Valley Station—it may have flown there from some place where *Pongamia* occurs naturally (such as the top end near Darwin) or is being grown (e.g. Katherine in the NT). It is also possible that Pongam Oiltree is being grown somewhere else nearby. However, we'll probably never know how it really got there.

True bugs

All true bug taxa are new records for the eastern Kimberley and represent range extensions based on records held by the UNSW.

Spiders

Significant records for spiders include:

- the first record for the eastern Kimberley of the spider family Orsolobidae. A single female specimen was collected from rainforest litter on Durack. There is an earlier record from the west Kimberley islands
- the first record for the eastern Kimberley of the Spinifex Orb-weaving Spider *Cyrtobill darwini*
- the first record for northern Western Australia of the lynx spider genus *Peucetia*. According to the Atlas of Living Australia, *Peucetia* has been recorded from the Pilbara region, but these two specimens are new records of this genus for the Kimberley and for northern Australia⁸
- the first record for northern Australia of the crevice weaver *Wandella centralis*
- a considerable range extension for the large garden orb-weaver (*Eriophora* sp.). There are specimens in the Western Australian Museum of *E. transmarina* from Walcott Inlet, western Kimberley coast and Adelaide River in the northern Northern Territory⁹
- a specimen of a lynx spider (Oxyopidae) was collected that is most similar to *Oxyopes elegans*, which is recorded from Queensland and New South Wales
- the specimen of *Holoplatys complanata* from Karunjie is the first specimen of this species identified within Western Australia, but this species has a broad distribution, from the east coast of Queensland, northern Northern Territory and a single record from Morobe Province, Papua New Guinea.

⁸ <www.ala.org.au/>, accessed 2 December 2014.

⁹ Davies, V.T., 1980, Two large Australian orb-weaving spiders, *Eriophora transmarina* (Keyserling 1865) and *Eriophora biapicata* (L. Koch 1871). *Memoirs of the Queensland Museum* 20: 125–133.

Flora

Flowering plants

Many of the new records of flowering plants fill large gaps in the ranges of widespread species, or significantly extend the ranges of species otherwise known from further east or west, thus contributing greatly to our knowledge of the Kimberley flora. Previous collecting of flowering plants was mostly confined to the Gibb River Road and some adjacent stock route corridors. A number of stock routes traversing the northern edge of the stations were collected during the 1950s to 1970s by CSIRO land system surveys. Relatively little collecting has occurred since the late 1970s, with mostly incidental collecting along the narrow corridor of the Gibb River Road. Taxon maps for vascular plants show an apparent gap in many species distributions in this dry corridor. In many cases, the records obtained fill a significant distribution gap between the eastern and western Kimberley, suggesting that this gap is a collecting artefact rather than a biogeographic feature. These records will be important for biodiversity modelling in the Kimberley.

Many flowering plant specimens represent range extensions within the Kimberley, consistent with the relatively poor understanding of distributions there and the low state of knowledge for the dry corridor in which the surveyed stations are located. Many of the collections of named plants will be range extensions to varying extents.

Lichens

Three lichen species collected are first records for Western Australia. Those records, along with *Monerolechia norstictica*, bring to 751 the number of lichen species currently known from this state.

Table 8 Range extensions

Family	Species	Common name	Nearest previous record
Reptiles			
Diplodactylidae	<i>Oedura gracilis</i>	Gracile Velvet Gecko	80 km to the west and east. Fills a large gap in records for the eastern Kimberley between Ellenbrae and Mt Nyulasy
Gekkonidae	<i>Heteronotia planiceps</i>	North-west Prickly Gecko	80 km to the WNW and 60 km from Mt Nyulasy
Scincidae	<i>Ctenotus tantillus</i>	Dwarf Ctenotus	100 km to the west and 60 km to the north-east
Boidae	<i>Liasis olivaceus olivaceus</i>	Olive Python	80 km from Lake Argyle and 60 km from junction of Durack and Pentacost Rivers. Western-most records of the east Kimberley population, which is widely separated from the west Kimberley

Family	Species	Common name	Nearest previous record
Frogs and toads			
Hylidae	<i>Litoria tornieri</i>	Black-shinned Rocket Frog	Fills a ~ 200 km gap between collection sites, 100 km to WNW and again from near Kununurra
Butterflies			
Hesperiidae	<i>Hasora chromus</i>	Chrome Awl	300 km to the east. First recording from WA
Nymphalidae	<i>Acraea terpsicore</i>	Tawny Coster	300 km to the east
Spiders			
Araneidae	<i>Cyrtobill darwini</i>	Spinifex Orb-weaver	200 km to the west. New record for the east Kimberley
Araneidae	<i>Eriophora</i> sp.	A garden orb-weaver	150 km to the west. A considerable range extension for this genus to the eastern Kimberley
Filistatidae	<i>Wandella centralis</i>	A crevice weaver	600 km to the south-west
Orsolobidae	Orsolobidae sp.	—	460 km to the west
Oxyopidae	<i>Oxyopes</i> sp. 01 (<i>elegans</i> ?)	A lynx spider	600 km to the north-east
Oxyopidae	<i>Peucetia</i> sp.	A lynx spider	1200 km to the south-west
Salticidae	<i>Holoplatys complanata</i>	A jumping spider	650 km east, Roper River, NT
Salticidae	<i>Simaetha broomei</i>	A jumping spider	400 km to the west. A considerable range extension from Broome, the type locality

Family	Species	Common name	Nearest previous record
Flowering plants			
Haemodoraceae	<i>Haemodorum</i> sp. A Kimberley Flora (K.F. Kenneally 8639)	—	Poorly-known taxon previously only recorded from the Mitchell Plateau area. A significant range extension and an important collection
Lentibulariaceae	<i>Utricularia</i> sp. Theda (M.D.Barrett 20156)	—	Poorly-known taxon, previously known from a single collection from Theda Station. A significant range extension, and a significant addition to the specimen base
Lichens			
Physciaceae	<i>Pyxine microspora</i>	—	500 km to the north-east. New record for WA (previously known from NT, Qld)
Physciaceae	<i>Rinodina ramboldii</i>	—	500 km to the north-east. New record for WA (previously known from NT, SA, Qld, Vic)
Thelenellaceae	<i>Thelenella brasiliensis</i>	—	2,500 km to the south-east. New record for WA (previously known from Qld)

Other points of interest

Fauna

Vertebrates

Bats

Eleven zoophagic bat species were detected, including four that roost in caves or rock crevices: Dusky Leafnosed-bat (*Hipposideros ater*), Ghost Bat (*Macroderma gigas*), Common Bentwing-bat (*Miniopterus schreibersii oriana*) and Common Sheath-tail-bat (*Taphozous georgianus*). These are the first records of Dusky Leafnosed-bat and Ghost Bat from the Berkeley sub-region of the Northern Kimberley bioregion.

Reptiles, frogs and toads

The eastern Kimberley herpetofauna is highly diverse for many groups, especially frogs and snakes. Survey work continues to reveal new species; recent cases include the discovery of the Chattering Rock Frog (*Litoria staccato*) just outside Wyndham and the description of King's Rock Dtella (*Gehyra koirra*), Northern Beaked Gecko (*Rhynchoedura sexapora*) and Kimberley Fat-tailed Gecko (*Diplodactylus custos*).^{10 11 12 13} New cryptic species of clawless (*Crenadactylus* spp.) geckos were also recorded in the eastern Kimberley on recent island surveys.¹⁴ These findings highlight that the area is still in a phase of basic documentation and that further discoveries are likely. Much of this work has relied upon genetic analyses of tissue samples, which have only been taken in recent years but are needed for the more difficult revisionary work. Many tissue samples have been sent for gene sequencing.

May to June is the quietest time for herpetofaunal activity. Although not breeding, frogs can still be found along creeks and waterholes. There are also many hatchlings and juveniles from the previous wet season, which are difficult to identify. Despite this, over 70 reptile and frog voucher specimens and tissue samples were collected.

No new species were discovered, but several interesting specimens of groups the WAM herpetology section is revising were collected. These include *Uperoleia* toadlets, *Oedura*, *Gehyra* and *Heteronotia* geckos, *Diporiphora* dragons and *Eremiascincus* skinks. *Eremiascincus isolepis* is of particular interest as this is a species complex across the Australian Monsoonal Tropics and likely represents an unnamed species; the specimen also fills somewhat of a collecting gap.

Three species of tree frogs (Hylidae) were found: Bumpy Rocket Frog (*Litoria inermis*), Common Rock Frog (*L. coplandi*) and Black-shinned Frog (*L. tornieri*). In addition, shower blocks had many Green Tree Frog (*L. caerulea*), Northern Laughing Tree Frog (*L. rothii*) and Little Red Tree Frog (*L. rubella*), but these were 'station pets', very common and off-limits to collecting. No burrowing frogs of the genus *Cyclorana* were found.

The medium to large-bodied Northern Spadefoot (*Notaden melanoscaphus*) and Ornate Burrowing Frog (*Platyplectrum ornatum*) were trapped on the creekline at Karunjie Station during the first week. They are common inhabitants of the eastern Kimberley. The juvenile Northern Spadefoot possessed colouration very similar to its sandhill-dwelling desert relative, Desert Spadefoot (*N. nichollsi*), which is later covered by black pigment as it increases in size. This useful information will be added to future field guides.

Toadlets assigned to Northern Toadlet (*Uperoleia borealis*) were found along flowing creeks at Karunjie and brought in from elsewhere by other teams. In addition, the Bilingual Frog (*Crinia bilingua*) could be

¹⁰ Doughty, P. & Anstis, M. 2007, 'A new species of rock-dwelling hylid frog (Anura:Hylidae) from the eastern Kimberley region of Western Australia', *Records of the Western Australian Museum* 23:241-257.

¹¹ Horner, P. 2005, '*Gehyra koirra* sp. nov. (Reptilia:Gekkonidae), a new species of lizard with two allopatric subspecies from the Ord-Victoria region of north-western Australia and a key to the *Gehyra australis* species complex', *The Beagle*, Records of the Museums and Art Galleries of the Northern Territory 21:165-174.

¹² Pepper, M., Doughty, P., Hutchinson, M. N. & Keogh, J. S. 2011, 'Ancient drainages divide recent species in Australia's arid zone: morphological and multi-gene evidence for four new species of Beaked Geckos (*Rhynchoedura*)', *Molecular Phylogenetics and Evolution* 610:810-822.

¹³ Oliver, P. M., Couper, P. J. & Pepper, M. 2014, 'Independent transitions between monsoonal and arid biomes revealed by systematic revision of a complex of Australian geckos (*Diplodactylus*:*Diplodactylidae*)', *PLoS ONE* 9(12):e111895.

¹⁴ Palmer, R., Pearson, D. J., Cowan, M. A. & Doughty, P. 2013, 'Islands and scales: a biogeographic survey of reptiles on Kimberley islands, Western Australia', *Records of the Western Australian Museum*, Supplement 81:183-204.

heard calling during the survey, one of the few species to call during the dry season, but none were collected as they are extremely difficult to catch in dense vegetation.

Two specimens of the large-bodied Gracile Velvet Gecko (*Oedura gracilis*) were found on the last night of surveys. Investigation of this species complex is currently underway, and the tissue samples are being analysed.

Three kinds of dtella (*Gehyra* spp.) geckos were collected: Northern Dtella (*G. australis*) (large-bodied and found on trees and human-made structures), *G. koira koira* (large-bodied and found on rock outcrops) and *G. aff. nana* (small-bodied and found on rocks but also trees and human-made structures). The latter species is currently under investigation and is considered an unnamed species here. This form seems to be a Durack Range endemic, occurring along the southern Kimberley.

Two species of *Heteronotia* were collected, namely Bynoe's Gecko (*H. binoei*) and North-west Prickly Gecko (*H. planiceps*). The former is quite common so mostly tail tips and photographs were taken. However, the single specimen of North-west Prickly Gecko was interesting as WAM staff are currently working on this group, and this specimen fills a large collecting gap.

Three dragon species were collected including Gilbert's Dragon (*Lophognathus gilberti*), Yellow-sided Two-line Dragon (*Diporiphora magna*) and a single hatchling assigned to *Diporiphora* sp. B (based on the results of a genetic screen by J. Melville, Museum Victoria) caught at Home Valley Station.

Fishes

Freshwater fishes are a key part of natural resource management due to their diversity in number and form, intriguing life histories and adaptations, links within food chains, value as bio-indicators, role in human culture and use, and as icons for aquatic conservation and environmental awareness.¹⁵

¹⁵ Berra, T. M. 2001, *Freshwater Fish Distribution*. Academic Press, Sydney; Bunn, S. E., and Arthington, A. H. 2002, 'Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity', *Environmental Management* 30:492-507; Hammer, M., Wedderburn, S. & van Weenan, J. 2009, *Action Plan for South Australian Freshwater Fishes*. Native Fish Australia (SA) Inc., Adelaide; Morgan, D. L., Allen, M. G., Beatty, S. J., Keleher, J. J. & Ebner, B. C. 2014, *A Field Guide to the Freshwater Fishes of the Pilbara Province Western Australia*. Freshwater Fish Group, Murdoch University, Murdoch.

There is little previous information on the fishes of Durack and Karunjie, apart from opportunistic surveys at water crossings on the Gibb River Road and fishes commonly caught for angling (e.g. Barramundi (*Lates calcarifer*), catfish and black bream).¹⁶ The Kimberley lies within the western part of the Timor Sea Drainage Division (National Mapping Division 1997), which supports around half of the freshwater fish species known from Australia.¹⁷ Several biodiversity surveys have examined the freshwater fishes of the Kimberley and have identified some 49 species, with around 40 per cent endemism.^{18 19} However, due to the inaccessible landscape of much of the region, many waterways remain poorly surveyed or not at all, particularly in the eastern Kimberley.²⁰

Fourteen sites were sampled using helicopter and vehicle access, recording 38 taxa from 16 families. The focus was on isolated upland habitats including small to medium sized rivers and streams, waterfalls, springs and gorges. Sampling occurred at the end of a moderate wet season and most stream sites had low to medium flow. One lowland site in the Pentecost estuary was opportunistically sampled as part of a community engagement day.

In upland stream and river habitats 23 species were recorded, which is a relatively high number for this habitat type and the region. Fish were recorded from all but the seasonal habitat upstream of Oomaloo Falls (crustaceans were collected here). The most ubiquitous species was the Spangled Perch (*Leiopotherapon unicolor*) Australia's most widespread fish, which was recorded from most sites (n = 12). Nine other species were widely recorded at seven sites or more. The Bindoola Creek sub-catchment, isolated above the large Bindoola Falls in its lower reaches, only had four species, but one is a likely new species. The area was also a stronghold for the endemic Kimberley Mogurnda (*Mogurnda oligolepis*), which was recorded in surprisingly low abundance elsewhere. Strong populations of other Kimberley endemic species were recorded outside of Bindoola Creek, especially Kimberley Grunter (*Syncomistes kimberleyensis*), which was previously known from a handful of records.²¹

An additional 15 species were recorded from the Pentecost estuary, including several range extensions and new state records for gobies and glassfish. Two species from the Pentecost estuary could only be identified to genus, namely a river garfish *Zenarchopterus* sp. that was observed but not caught, and anecdotal reports of sawfish *Pristis* sp. caught by Traditional Owners. Many more species are likely to occur in this estuarine habitat.

¹⁶ Allen, G. R. & Leggett, R. 1990, 'A collection of freshwater fishes from the Kimberley region of Western Australia' *Records of the Western Australian Museum* 14:527-545.

¹⁷ Unmack, P. J. 2001, 'Biogeography of Australian freshwater fishes', *Journal of Biogeography* 28:1053-1089; Allen, G. R., Midgley, S. H. & Allen, M. 2002, *Field Guide to the Freshwater Fishes of Australia*. Western Australian Museum, Perth.

¹⁸ Allen, G. R. 1975, 'A preliminary checklist of the freshwater fishes of the Prince Regent River Reserve north-west Kimberley, Western Australia', in: Miles, J. M. & Burbidge, A. A. (eds), 'A biological survey of the Prince Regent River Reserve Northwest Kimberley, Western Australia in August, 1974', *Wildlife Research Bulletin of Western Australia* 3:89-96; Hutchins, J. B. 1981, *Freshwater fish fauna of the Mitchell Plateau Area, Kimberley, Western Australia. Biological survey of Mitchell Plateau and Admiralty Gulf, Kimberley, Western Australia*, Western Australian Museum, Perth. 229-247 pp.; Allen, G. R. & Leggett, R. 1990, 'A collection of freshwater fishes from the Kimberley region of Western Australia', *Records of the Western Australian Museum* 14:527-545; Morgan, D. L., Allen, M. G., Bedford, P. & Horstman, M. 2004, 'Fish fauna of the Fitzroy River in the Kimberley region of Western Australia—including the Bunuba, Gooniyandi, Ngarinyin, Nyikina and Walmajarra aboriginal names', *Records of the Western Australian Museum* 22:147-161.

¹⁹ Unmack, P. J. 2001, 'Biogeography of Australian freshwater fishes', *Journal of Biogeography* 28:1053-1089; Morgan, D. L., Allen, G. R., Pusey, B. J. & Burrows, D. W. 2011, 'A review of the freshwater fishes of the Kimberley region of Western Australia', *Zootaxa* 2816:1-64.

²⁰ Morgan, D. L., Allen, G. R., Pusey, B. J. & Burrows, D. W. 2011, 'A review of the freshwater fishes of the Kimberley region of Western Australia', *Zootaxa* 2816:1-64.

²¹ Moore, G. I. & Hammer, M. P. 2015, 'Freshwater fishes of three tributaries of the Pentecost River, Kimberley, Western Australia', *Records of the Western Australian Museum* 30:64-71.

Genetic and morphological material was retained from 31 named species. This material enables the Pentecost Catchment fishes to be included within broader taxonomic evaluations. Fish diversity in Australia increases dramatically in the tropical north, and it appears that there is still much to be documented in terms of the species baseline.²² New, novel forms continue to be recorded from remote regions of Australia, and recent studies using genetic techniques suggest that there are likely to be two to three times the number of species actually present than is currently recognised.^{23 24}

At least five undescribed species were collected. A colourful, slender rainbowfish was recorded from three sites in the Bindoola Creek system, upstream of the significant barrier presented by Bindoola Falls, which separates it from the more widespread Western Rainbowfish (*Melanotaenia australis*). The fish is superficially similar to Exquisite Rainbowfish (*Melanotaenia exquisita*), however recent genetic analyses suggests that this population is distinct from other populations known from Kakadu Escarpment Country in the Northern Territory. Although genetic samples suggested this species to be distinct, prior to this survey no specimens were available.²⁵ This undescribed rainbowfish appears to reside in allopatry (only species of rainbowfish in a habitat). Despite sampling similar habitats outside of the Bindoola Creek sub-catchment and below the falls, this species was not recorded from any other sites, suggesting a highly restricted range and even smaller area of occupancy based on linear aquatic stream habitat.

Collections were made of the widespread Northwest Glassfish previously known as *Ambassis muelleri*, which is now a distinct species left without a name as '*muelleri*' was earlier applied as a synonym of Agassiz's Glassfish (*Ambassis agassizii*) occurring in eastern Australia.²⁶

An undescribed species of grunter similar to the Drysdale Grunter (*Syncomistes rastellus*) was recorded from several sites. This species has only recently been recognised and is currently being described.²⁷

A yellow finned glassfish from the Pentecost estuary, tentatively named Yellowfin Perchlet (*Ambassis elongata*) may also be an undescribed species. This species is known from the Gulf of Carpentaria in Queensland, however, given the geographical isolation between the Gulf and the east Kimberley, the specimens collected on this survey may represent a cryptic new species. Further work across northern Australia, especially molecular genetics, is required to clarify the status of these two glassfish.

²² Unmack, P. J. 2001, 'Biogeography of Australian freshwater fishes', *Journal of Biogeography* 28:1053-1089; Allen, G. R., Midgley, S. H. & Allen, M. 2002, *Field Guide to the Freshwater Fishes of Australia*. Western Australian Museum, Perth.

²³ For example, Pusey, B. J. & Kennard, M. J. 2001, '*Guyu wujalwujalensis*, a new genus and species (Pisces:Percichthyidae) from north-eastern Queensland', *Ichthyological Exploration of Freshwaters* 12:17-28; and Morgan, D. L., Beatty, S. J. & Adams, M. 2013, '*Nannoperca pygmaea*, a new species of pygmy perch (Teleostei:Percichthyidae) from Western Australia', *Zootaxa* 3637:401-412.

²⁴ Hammer, M. P., Adams, M. & Hughes, J. H. 2013, *Evolutionary Processes and Biodiversity. Ecology of Australian Freshwater Fishes*, eds Humphries, P. & Walker, K. CSIRO Press, Melbourne.

²⁵ Unmack, P. J., Allen, G. R. & Johnson, J. B. 2013, 'Phylogeny and biogeography of rainbowfishes (Melanotaeniidae) from Australia and New Guinea', *Molecular Phylogenetics and Evolution* 67:15–27.

²⁶ Allen, G. R., Midgley, S. H. & Allen, M. 2002, *Field Guide to the Freshwater Fishes of Australia*. Western Australian Museum, Perth.

²⁷ Work undertaken by Shelley, J. & Le Feuvre, M. from Melbourne University.

An unidentified mangrove goby *Amoya* sp. 3 was recorded from the Pentecost River estuary, which matched reference material from the adjacent Keep River estuary. The apparently undescribed species is under review.²⁸ A second unnamed goby was also recorded from the Pentecost estuary, a barred *Pseudogobius* sp. currently being described.²⁹

Bush Blitz sampling added to overall biodiversity knowledge of Karunjie and Durack, including potential new discoveries. The species list for freshwater fishes now considers all major habitats of these properties. The study also provided important material for broader taxonomic revisions and genetic studies of key species under investigation by researchers (e.g. grunters, gudgeons and glassfish), and as such the eventual species list is likely to include several more species or names for undescribed forms. Efforts to document the Nyaliga language names for *Ji* (fishes) would be beneficial and complement other excellent work in the Kimberley.³⁰

Invertebrates

Butterflies

These surveys provide records from areas that have never been sampled for butterflies. Thirty-one species of butterflies were recorded, approximately 50 per cent of the species expected from the area.

Karunjie and Durack River Stations occur in a slightly lower rainfall zone compared with the adjacent El Questro Station in the east, which has been well surveyed and provides a useful reference point.³¹ Previous surveys for butterflies in the region focused primarily on the western Kimberley and around Kununurra and El Questro Station.³² Because the survey sites were in a lower rainfall zone than these previous studies, the area was expected to support a lower diversity of butterflies, but the composition of the fauna was difficult to predict given the lack of detailed recording for this part of the East Kimberley.

The properties preserve a suite of species characteristic of the drier areas of the monsoon tropics. None of the species recorded are endemic to the study area, although several are endemic to the 'Top End' region. The remaining species occur more widely across the monsoon tropics of northern Australia and the eastern coast of Australia. The most significant discoveries were range extensions and new locations for several species.

²⁸ Work undertaken by Jaafar, Z. & Hoese, D., see Larson, H. K., Williams, R. S. & Hammer, M. P. 2013, 'An annotated checklist of the fishes of the Northern Territory, Australia', *Zootaxa* 3696:001–293.

²⁹ Work undertaken by Larson, H. & Hammer, M.

³⁰ Smith, M. 1997, *Fish-capture sites and the maritime economies of some Kimberley Coastal Aboriginal communities*. *Western Australian Museum, Perth*. Report for National Estate; Morgan, D. L., Allen, M. G., Bedford, P. & Horstman, M. 2004, 'Fish fauna of the Fitzroy River in the Kimberley region of Western Australia—including the Bunuba, Gooniyandi, Ngarinyin, Nyikina and Walmajarri Aboriginal names', *Records of the Western Australian Museum* 22 (see: <http://www.freshwaterfishgroup.com/publications-and-posters.php>).

³¹ Braby, M. F., 2012, The butterflies of El Questro Wilderness Park, with remarks on the taxonomy of the Kimberley fauna, Australia. *Records of the Western Australian Museum* 27: 161-175.

³² Braby, M. F., 2008, Biogeography of butterflies in the Australian monsoon tropics. *Australian Journal of Zoology* 56: 41-56; Braby, M. F., 2012, The butterflies of El Questro Wilderness Park, with remarks on the taxonomy of the Kimberley fauna, Australia. *Records of the Western Australian Museum* 27: 161-175; Franklin, D. C., Michael, B. & Mace, M. (2005) New location records for some butterflies of the Top End and Kimberley regions. *Northern Territory Naturalist* 18: 1-7; Williams, A. A. E., Williams, M. R. & Swann, G. (2006) Records of butterflies (Lepidoptera) from the Kimberley region of Western Australia. *Victorian Entomologist* 36: 9-16.

Three species that have rarely been sampled in the eastern Kimberley, Dusky Knight (*Ypthima arctous*), Darwin Ringlelet (*Hypocysta adiante*) and Two-spotted Line-blue (*Nacaduba biocellata*) were recorded at several new locations. Darwin Ringlelet and Dusky Knight were collected at several sites and are typically restricted to seasonally damp areas (e.g. along streamlines or in gorges). Their relatively high frequency of occurrence in this survey may be a result of the above average rainfall in the two previous wet seasons. Two-spotted Line-blue was recorded at only one locality.

Twenty-one locations were sampled and 155 unique records were obtained, of which 119 were collected specimens (vouchers) and 36 were visual observations only. Of the species recorded, vouchers were obtained for all but the Orange Migrant (*Catopsilia scylla*).

True bugs

The true bugs of Australia comprise about 2,500 named species (Australian Faunal Directory) and recent surveys during the first phase of the Bush Blitz programme (Bush Blitz Phase 1) revealed 1,391 species, of which 391 are new to science. The predicted total Heteropteran fauna of Australia is about 6,500 species.³³

The eastern Kimberley is an area of interest because of its monsoonal influence and remoteness, and limited collecting of true bugs in the past. Because of this, there was an expectation that a number of new species would be encountered.

The survey of true bugs documented 124 species, with the greatest species richness occurring in the Pentatomidae (25 species), Miridae (22 species) and Reduviidae (14 species). Specimens were collected from 42 localities and 42 host plant species belonging to 16 families of flowering plants. The great majority of plant host species belonged to the speciose plant families Myrtaceae (8 species) and Fabaceae (11 species). In terms of taxon richness, the collections were beyond expectation for a six-day period, considering the relatively dry conditions and limited access to sites. It was also the first time that the UNSW had captured a species of the genus *Dentisblissus*.

Damselflies and dragonflies

Their large membranous wings (held out to the sides in dragonflies, folded over the abdomen at rest in damselflies), large eyes and elongate bodies make dragonflies and damselflies (Odonata) easy to recognise. They are primarily aquatic insects, and are voracious predators both as larvae and as adults. They spend the majority of their lives as water-dwelling nymphs. As adults, they remain closely associated with water, around which they hunt, defend territories, mate and lay eggs. There has been increasing interest in the study of Odonata as indicators of global climate change, as distributions shift in response to changes in climate, and more generally as indicators of aquatic ecosystem health, as they and other aquatic insects are highly susceptible to changes in water quality.³⁴

³³ Cassis, G. & Laffan, S. 2012, *Heteroptera integration and spatial analysis*, School of Biological, Earth and Environmental Sciences, University of New South Wales, unpublished report prepared for the ABRS, Canberra.

³⁴ Theischinger, G. & Endersby, I. 2009, *Identification Guide to the Australian Odonata*, Department of Environment, Climate Change and Water NSW.

The Australian Odonata fauna is largely described; however, a lack of targeted survey work has resulted in limited data on distribution and biology.³⁵ Such is the case for the Kimberley region. Published reports include that of Thompson,³⁶ which reports his findings following a five-week collecting trip in the western Kimberley region in April and May 1988, and that of Bailey and Richards,³⁷ who report on the insects of Prince Regent Nature Reserve. According to WAM records, there are no recent surveys of the region, and none specifically dealing with the eastern Kimberley.

There are 320 species of Odonata in Australia. A comprehensive guide to the Australian Odonata, *The Complete Field Guide to Dragonflies of Australia*, includes detailed distribution data and serves as the baseline record of species found in the Kimberley.³⁸ The most recent guide, *Identification Guide to the Australian Odonata*, is freely available online.³⁹

During this Bush Blitz, 14 Odonata species were collected. The low diversity and numbers reflect the time of year, with greater diversity expected closer to the beginning of the dry season. Nonetheless, important vouchers were collected, including six species not represented in the WAM collection, significantly improving our knowledge of Kimberley region Odonata. Two species, Green Emperor (*Anax gibbosulus*) and Common Glider (*Tramea loewii*) are not recorded for the region in Thomson's 1991 survey, the WAM holdings or the Atlas of Living Australia. However, the recent guide to Australia's Odonata lists these species as present in the region.

Without a clear and comprehensive review of the Odonata of the region, it is difficult to assess how the current survey sites and their species composition differ from the greater Kimberley region. Future surveys would benefit from more days collecting at a greater diversity of sites, and a shift in the timing closer to the end of the monsoonal wet and the start of the dry season.

Arachnids

Many of the arachnids, particularly the spiders, were unidentifiable either because specimens collected were juveniles (adults are needed for positive species identification) or because little is known about their taxonomy at present. Of the target spider groups, only two females and one juvenile (infraorder Mygalomorphae) spider and three juvenile wolf spiders (family Lycosidae) were collected. The paucity of some taxa was due to the extremely dry conditions after several weeks without rain. Collecting efforts were concentrated on gorges associated with river systems, as these habitats tend to have vine thickets that harbour interesting invertebrate species.

Two species of white-tailed spiders (family Lamponidae) were identified from vertebrate pitfall traps, *Asadipus kunderang* and the widespread *Lamponina scutata*. Both species have been previously recorded from northern Australia, although the *A. kunderang* specimens are the most northerly records for this species in Western Australia.⁴⁰

³⁵ Hawking, J. H. & Theischinger, G. 2004, 'Critical species of Odonata in Australia', *International Journal of Odonatology* 7(2):113-132.

³⁶ Thompson, D. J. 1991, 'Dragonflies from the western Kimberley Region', *Western Australian Naturalist* 18(7):197-200.

³⁷ Bailey, W. J. & Richards, K. T. 1975, 'A report on the insect fauna from Prince Regent River Reserve, north-west Kimberley, Western Australia', *Wildlife Research Bulletin of Western Australia* 3:101-112.

³⁸ Theischinger, G. & Hawking, J. 2006, *The Complete Field Guide to Dragonflies of Australia*. CSIRO Publications, Collingwood.

³⁹ See <<http://www.environment.nsw.gov.au/resources/publications/09730AustOdonata.pdf>>.

⁴⁰ Platnick, N.I., 2000, A relimitation and revision of the Australasian ground spider family Lamponidae (Araneae: Gnaphosoidea). *Bulletin of the American Museum of Natural History* 254: 1–330.

A single juvenile specimen of the genus *Herennia* (family Nephilidae) was collected from a web on a tree trunk. This genus has a circumtropical distribution globally and there is one named species from Australia, *Herennia oz* from the Northern Territory. It is not possible to identify the specimen from Home Valley, as it is a juvenile.

Jumping Spiders (Salticidae) were the most numerous spiders collected and specimens represented 10 genera.

Most of the pseudoscorpions collected were members of the diverse and widespread family Olpiidae. Their taxonomic status is unknown because while many species have been found in Western Australia, none has been formally described.

Millipedes are remarkably rare in north-western Australia and only a single male pincushion millipede of the genus *Phryssonotus* was collected. Two kinds of centipede were collected, one of which, *Cormocephalus lissadellensis*, is the first specimen of this species recognized since it was described in 1983. *C. lissadellensis* is also recorded from Darwin, Northern Territory and Lankelly Creek in far northern Queensland.

Flora

Vascular plants

A total of 604 specimens were collected (262 from Karunjie, 313 from Durack and 29 from Home Valley) comprising 330 taxa. Due to the dry conditions, upland and dry plain areas (including black soil plains) were not worth targeting, as almost all plants were past flowering. Instead, wet sites (rivers, streams, run-on areas) and gorges were targeted. A small number of ad hoc collections were made along the Gibb River Road and around Home Valley Station, in areas where collecting was permitted.

Lichens

The lichens of the Kimberley region of Western Australia have been the subject of intensive study only in comparatively recent times, due to remoteness and difficulty of access and the often highly localised distribution of lichens in sheltered microhabitats in an otherwise extreme environmental mosaic. High ambient temperatures, considerably higher rock surface temperatures, the rarity of suitable corticolous (bark) and terricolous (soil) habitats, and seasonal drought result in greatly reduced lichen diversity.⁴¹

Lichen diversity was, as expected, low, certainly in comparison to less seasonally extreme climatic zones. Most species were found on shaded rock surfaces in river and creek gorges, comparatively sheltered habitats that retain sufficient moisture to sustain lichens. Open rock surfaces experience such high temperatures over the long dry season, and consequent drought, that lichen growth cannot be supported.

⁴¹ Rambold, G. 1989, 'A monograph of the saxicolous lecideoid lichens of Australia (excl. Tasmania)', *Bibliotheca Lichenologica* 35:1–345; Grgurinovic, C. (ed.) 1992, *Flora of Australia. Volume 54, Lichens—Introduction Lecanorales 1*. Australian Biological Study, Canberra & CSIRO Publishing, Melbourne; Grgurinovic, C. (ed.) 1994, *Flora of Australia. Volume 55, Lichens—Lecanorales 2, Parmeliaceae*. Australian Biological Study, Canberra & CSIRO Publishing, Melbourne; Elix, J. A. & Ralston, K. 1999, 'Lichens of the Kimberley Region, Western Australia', *Australasian Lichenology* 44:16–34; McCarthy, P. M. (ed.) 2001, *Flora of Australia. Volume 58A, Lichens 3*. Australian Biological Study, Canberra & CSIRO Publishing, Melbourne; McCarthy, P. M. (ed.) 2009, *Flora of Australia. Volume 57, Lichens 5*. Australian Biological Resources Study, Canberra & CSIRO Publishing, Melbourne; McCarthy, P. M. & Mallett, K. (eds) 2004, *Flora of Australia. Volume 56A, Lichens A*. Australian Biological Study, Canberra & CSIRO Publishing, Melbourne; Elix, J. A. 2011, *Australian Physciaceae (Lichenised Ascomycota)*. Australian Biological Resources Study, Canberra. Version 18 October 2011. <<http://www.anbg.gov.au/abrs/lichenlist/PHYSICIACEAE.html>>.

The survey yielded 485 collections, and 39 lichen species have been confirmed (although not all have been conclusively identified), with communities dominated by species of the families Physciaceae and Peltulaceae. This intensive, localised survey of selected sites in a vast, rather flat and seasonally wet, but otherwise dry landscape indicates a flora that is sparse and species poor, with pockets of diverse and luxuriant lichen communities in microhabitats that retain moisture during the dry season and are less likely to be inundated during the wet. Thus, in rocky gorges and on sheltered overhangs, the lichen flora is dominated by crustose, squamulose and closely appressed-foliose species of Physciaceae and Peltulaceae. Future investigations in this and similar habitat-complexes in the Kimberley are likely to yield only occasional, inconspicuous novelties, while new records will probably represent species that are already known from semi-arid parts of the Northern Territory and Queensland.

Glossary

Appressed-foliose: closely and flatly pressed against a surface, leaf-like.

Crustose: crust-like, used for lichens having a thallus stretched over and firmly fixed to the substratum by the whole of the lower surface; such lichens generally lack rhizines and a lower cortex.

Cryptic species (cryptospecies): species that are physically similar but reproductively isolated from each other.

Endemic: native to or limited to a certain region.

Herpetofauna: the reptiles and amphibians of a particular region, habitat or geological period.

Host plant: a species of plant that is used by larvae of insects as a place to feed and grow up.

Kleptoparasitic: a plant or animal that steals food or other resources from either their own or another species.

Oriental: characteristic of Asia, especially east Asia.

Putative new species: a species that has been recognised by an expert as never having been named or described in the scientific literature.

Range extension: an increase in the known distribution or area of occurrence of a species.

Species range: the geographical area within which a particular species can be found.

Squamulose: having small leafy lobes.

Taxon (plural taxa): a member of any particular taxonomic group, e.g. a species, genus, family.

Taxonomy: the science of discovering, naming, describing and classifying life on earth.

Thallus: the vegetative part of a lichen, a more or less undifferentiated plant body.

Trichome: fine hairs or other growths on plants.

Type locality: the location where the holotype (type specimen) was originally found.

Type specimen (holotype): the specimen on which the description of a new species is based.

Undescribed taxon: a taxon (often a species) that has been discovered but not yet formally described or named.

Vouchers (voucher specimens): any specimen that serves as a basis of study and is retained as a reference.

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