



Bradshaw Field Training Area Northern Territory

8–19 May 2017

Bush Blitz Species Discovery Program



Australian Government

Department of the Environment and Energy



bhpbilliton

Sustainable Communities



EARTHWATCH
INSTITUTE



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

ALA

Atlas of Living Australia

AM

Australian Museum

ANIC

Australian National Insect Collection

BFTA

Bradshaw Field Training Area

CSIRO

Commonwealth Scientific and Industrial Research Organisation

DENR

Department of Environment and Natural Resources (NT)

EPBC Act

Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

MAGNT

Museum and Art Gallery of the Northern Territory

NLC

Northern Land Council (NLC)

QM

Queensland Museum

TPWC Act

Territory Parks and Wildlife Conservation Act 2007 (Northern Territory)

WAM

Western Australian Museum

Summary

A Bush Blitz survey was conducted on Bradshaw Field Training Area (BFTA), Northern Territory, between 8 and 19 May 2017. BFTA is located over an area of approximately 9000 km², 150 km west of Katherine and 270 km south of Darwin. BFTA has considerable environmental and cultural value, and is registered on the Commonwealth Heritage List. It is also subject to an Indigenous Land Use Agreement.

The Bush Blitz program provided an opportunity for scientists to undertake surveys in an area poorly known to western science. Though BFTA and the surrounding region have been relatively well surveyed, there were no records from BFTA for many of the target taxa—even butterflies, which are one of the best collected groups of Australian insects.

The survey took place at the end of the wet season, which occurred later than usual with above average rainfall. This meant that timing of sampling was optimal for most of the target taxa. This Bush Blitz recorded 902 species, 377 of which had not been recorded previously at BFTA (12 vertebrates, 167 invertebrates and 198 plants) and 15 of the species may be new to science (1 plant, 1 gecko, 1 frog and 12 spiders). Over 60 of the records are noticeable range extensions for plants and animals. Six threatened vertebrate taxa were also recorded—scats of the EPBC-listed Black-footed Tree-rat (*Mesembriomys gouldii*) were found at one site. The EPBC and TPWC-listed Partridge Pigeon (*Geophaps smithii*) and Gouldian Finch (*Erythrura gouldiae*) were both observed during the survey and the TPWC-listed semi-aquatic Merten's Water Monitor (*Varanus mertensi*) and the Yellow-spotted Monitor (*Varanus panoptes*) were recorded. The Angalarri Grunter (*Scortum neili*) is Vulnerable under the TPWC Act; it is one of Australia's rarest fish. In total over 1000 voucher specimens were added to museum and herbarium collections.

Among the hundreds of plant and animal records obtained, some highlights included:

- A new Acacia species; *Acacia* sp. Bradshaw (B.Wirf 1484) was recorded at BFTA
- the known number of sites for one of Australia's rarest fish—Angalarri Grunter (*Scortum neili*) was doubled and juveniles of the species were recorded for the first time
- a geographically isolated and morphologically distinct population of Exquisite Rainbowfish (*Melanotaenia exquisita*) was observed
- two cryptic species, one reptile and one amphibian, that are potentially new to science were recorded—a gecko (*Amalosia* aff. *rhombofer*) and a small froglet (*Crinia* aff. *deserticola*)
- baseline records for Odonata and diurnal Lepidoptera in BFTA
- significant range extensions for a number of taxa, including Lepidoptera, Odonata and vascular plants
- a damselfly, the Spot-winged Threadtail (*Nososticta kalumburu*), was recorded for the first time in the Northern Territory
- two undescribed species of tarantula and a possible new species of crab spider were observed
- two bird species were recorded for the first time at BFTA — Partridge Pigeon (*Geophaps smithii*) and Sarus Crane (*Grus antigone*)
- small population of Gouldian Finche (*Erythrura gouldiae*) was recorded; recently fledged juveniles were present and they were observed within open woodland that is not consistent with known preferred breeding habitat for gouldian finch.

Introduced species noted included Cattle (*Bos taurus*), Pig (*Sus scrofa*), Asian Water Buffalo (*Bubalus bubalis*), Horse (*Equus caballus*), Donkey (*Equus asinus*) and Cat (*Felis catus*). Cane Toads (*Rhinella marina*) were recorded at most sites. A significant attribute of the survey sites was the lack of introduced fish species. Thirteen introduced plant species were recorded, one of which, Rubber Bush (*Calotropis procera*), is a declared weed (Class B and C).

BFTA supports a high diversity of vertebrates, and sound management of the property will ensure the long-term conservation of a fauna broadly characteristic of the arid interior and northern tropical forests of the Northern Territory.

Management recommendations include:

- future surveys during different seasons, and in differing habitats to gain a comprehensive record of the biodiversity of BFTA
- control vehicle and human movements through known weedy areas, and control weeds already present
- control populations of feral animals to protect vegetation and habitat for fauna
- alternative fire management regimes, ensuring fuel reduction burns avoid critical habitats
- encourage ongoing vigilance and awareness of potentially invasive fish, particularly Eastern Gambusia (*Gambusia holbrooki*), aquarium fishes such as Guppy (*Poecilia reticulata*) and the highly invasive Tilapia (*Oreochromis mossambicus*). Continue to discourage the use of live fish bait within BFTA
- additional monitoring of the Angalarri Grunter and barriers to fish passage to ensure movement of juveniles around the Angalarri floodplain
- care should be taken with any fish monitoring or any instream works in the range extent of the Exquisite Rainbowfish population to ensure there is absolutely no risk of transferring eggs or adults of Western Rainbowfish on fish sampling or other gear and any actions that could change the natural distribution pattern.

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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 Bradshaw Bush Blitz

The survey took place between 8 and 19 May 2017 so the results are representative of those taxa present/active at the end of the wet season. The wet season rainfall was above average and ended later than usual. The climate of BFTA is drier than the more northern areas of the NT, though wetter than the Kimberley area of Western Australia. The month of May saw higher than average temperatures for the Northern Territory. An important feature of this Bush Blitz was the participation of Traditional Owners with assistance from the Northern Land Council.

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. Information from the survey was shared with schools across Australia as the 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 and Andrea Haas from Earthwatch Australia coordinated the TeachLive activities. The teachers and scientists also visited Timber Creek School to share in two-way learning with the students of Timber Creek and Bulla Camp Schools. The school visit gave the scientists the opportunity to share their enthusiasm about their finds on the Bush Blitz, and the different collection methods they used. It was also an opportunity for the students to meet real life scientists, and for them to share their own observations of the natural world.

A number of Defence environmental staff visited BFTA during the Bush Blitz and participated in the expedition for several days. This provided a valuable opportunity for Defence staff to learn from subject matter experts about field ecology while sharing information on the policies and tools used to safeguard and manage biodiversity on the Defence estate.

The expedition base was located at Bradshaw Task Force Maintenance Area (TFMA). From here, sites were accessed by four-wheel drive vehicle, helicopter and on foot.

Bush Blitz provided the logistical coordination and overall leadership for the survey. The Museum and Art Gallery of the Northern Territory, and the Northern Territory Herbarium were the host institutions

for this Bush Blitz, providing the core group of personnel and accessioning the specimens into their collections.

Experts from the following organisations also conducted the field and laboratory work:

- Aurecon
- Australian Museum (AM)
- Australian National University (ANU)
- Department of Environment and Natural Resources (Northern Territory) (DENR)
- George Brown Darwin Botanic Gardens
- Northern Land Council (NLC)
- Queensland Museum
- South Australian Museum
- University of Queensland
- Western Australian Museum (WAM)

Acknowledgements

The ABRS acknowledges the Traditional Owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present.

The Bush Blitz team consisted of Kate Gillespie, Megan Donaldson and Anna-Lisa Hayes. They would like to acknowledge Djamundjung, Nungaili/Ngaliwurru, Murinkura, Murinpatha and Wardaman People as the Traditional Owners of country, and thank them for their support. In particular, special thanks are given to Lorraine and Josie Jones who provided a welcome to country and to Johnathan Jones for assisting the scientific teams with their surveys. The team would also like to thank the Northern Land Council, in particular Greg Kimpton for conducting extensive consultation with Traditional Owners prior to the survey.

The team wishes to thank the Department of Defence staff, particularly the Range Control Officer Chris Kerney, who was instrumental in the operational side of the expedition, and environmental staff, Fredrick Ford, Katie Elsley, Claire Joseph, Sean Cummins, Adrianna Poutsma and Katrina Brady.

The interest and enthusiasm of the TeachLive participants and their coordinators, Bruce Paton and Andrea Haas (Earthwatch Australia), were gratefully received. TeachLive participants on the trip were Krystle Perdevski (VIC), Ashley Mulcahy (NSW), Lisa Smith (QLD), Louise Rogers (TAS) and Kate Battishall (NSW).

Finally, the team wishes to thank the caterer Robbie; the helicopter pilots Tommy Smith and Joel Lewis; and all the other participants.

Reserve overview^{1,2}

Reserve name: Bradshaw Field Training Area

Area: 9000 km²

Description

The site is a former pastoral/cattle station located over an area of approximately 9000 km², near Timber Creek in the north-west of the Northern Territory, 150 km west of Katherine and 270 km south of Darwin. It is bounded to the north by the Fitzmaurice River and Wombungi Station, to the west by the Joseph Bonaparte Gulf, to the south by the Victoria River and to the east by Coolibah and Innesvale Stations.

The Northern Territory Government granted a Defence lease for BFTA on 31 May 2004. The Commonwealth has entered into an Indigenous Land Use Agreement (ILUA) with Traditional Aboriginal Owners and the Northern Land Council (NLC) to facilitate the Commonwealth's use of the BFTA for Defence purposes. BFTA is also listed on the Commonwealth Heritage List under the EPBC Act. Under the ILUA and EPBC Act, the Department of Defence has various obligations for the use of the BFTA.

The property is approximately 150 km east to west and 70 km north to south. BFTA lies within the bioregion of Victoria-Bonaparte. It consists of six major physiographic regions—hills and plain to the east (Eastern Hills), a large open plain (Angalarri Plain), a central plateau (Yambarran Plateau), a narrow valley (Koolendong Valley), dissected hills to the west (Western Hills), and a littoral zone which borders the ocean. The vegetation represents a transition between vegetation associations to the west and north-west of the NT, and the northern Kimberley. Most of the vegetation communities within this bioregion are well-represented in the Kimberley region and in other parts of the Northern Territory.

Conservation values

BFTA is a biologically diverse area with important regional value, including *Xerochloa* grasslands and *Melaleuca minutifolia* low woodland that occur almost exclusively in the Victoria-Bonaparte Bioregion. BFTA also provides important habitat for a number of species of national conservation significance including the Gouldian Finch, Crested Shrike-tit, Purple-crowned Fairy-wren, Ghost Bat, Northern Quoll and various other terrestrial and aquatic species.

¹ Information sourced from <https://nautilus.org/publications/books/australian-forces-abroad/defence-facilities/bradshaw-field-training-area/>

² Information sourced from https://ntepa.nt.gov.au/_data/assets/pdf_file/0007/286549/draft_eis_bradshaw_training_area_vegetation_fauna.pdf

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	
Mammalia	Mammals	Sandra Walters	Aurecon
Aves	Birds	Jared Archibald	MAGNT
		Sandra Walters	Aurecon
Amphibia and Reptilia	Amphibians and reptiles	Dane Trembath	MAGNT
		Paul Doughty	WAM
		Jodi Rowley	AM
		Stephen Mahony	
Pisces	Fishes	Michael Hammer	MAGNT
		Eloise Wigger	
		Glenn Moore	WAM
Lepidoptera	Butterflies and moths	Jared Archibald	MAGNT
		Eloise Wigger	
Odonata	Dragonflies and damselflies	Jared Archibald	MAGNT
		Eloise Wigger	
Arachnida	Spiders and scorpions	Renan Castro Santana	QM
		Tamara Anderson	
		Ian Cowie	
Vascular plants		Donna Lewis	NT Herbarium
		Nicholas Cuff	
		Ben Wirf	George Brown Darwin Botanic Gardens
		Kym Brennan	NT Flora/Fauna Division

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

- Robert Raven for assisting with identification of spiders
- Michael Braby for his assistance with identification of Lepidoptera
- Stephen Richards for his assistance with identification of Odonata

Site selection

All terrestrial scientists surveyed two standard survey sites selected by Bush Blitz by using modelling prepared by CSIRO. Each standard survey site was centred on a point (permanently marked), but the actual area surveyed varied between taxa. Standard methodologies were used to sample these sites.

The use of standard survey sites provides a unique opportunity to examine broad-spectrum biodiversity. Among other benefits, this will enable Bush Blitz's partners at CSIRO to test assumptions that underpin many conservation decisions (e.g. assumptions about relationships between the diversity of different taxa). It will also allow comparisons between sites, and establish a basis for future monitoring by reserve managers.

Apart from standard survey sites, site selection and collection methods were at the discretion of the individual scientist. Site selection depended on access, suitability for trapping and time restrictions. Site locations were recorded using global positioning systems.

Survey techniques

A standard suite of survey techniques was used:

- **Mammal** sampling included visual and acoustic searches, motion-sensing infrared cameras, scat searches, diurnal bird surveys, opportunistic species identification, and fauna habitat assessment. An Anabat SD2 bat call recorder (Titley Scientific) was used to record echolocation bat calls. Three nights of active and passive Anabat survey was undertaken, during which spotlights were also used to observe any animal in flight.
- **Bird** observations were made opportunistically throughout the survey, and when time permitted, a bird survey was completed at each site.
- **Amphibian and reptile** sampling employed various methods. All sites were searched in the afternoon, followed by extensive spotlighting in the evening. Intensive pit-fall and funnel trapping was conducted at two sites, with trap-lines checked and emptied every morning and afternoon. Freshwater turtles were sampled using aquatic turtle traps at two sites. At each standard survey site, two people hand collected within 100 m of the study site marker for one hour. Collection times were mid-morning, around 9 am. Both sites were also surveyed at night (starting within one hour of sunset) using head torches in the same way (one-hour search by two people within 100 m of the study site marker).
- **Freshwater fish** sampling employed a rapid assessment design in order to cover as wide a spatial distribution and variety of habitats/environmental conditions as possible. Backpack electrofishing was the primary survey technique, employed at wadeable sites especially smaller streams or runs between larger pools, using a Smith-Root model LR-20B with voltage and frequency adjusted according to water conductivity. Bait traps were used to supplement electrofishing at several sites.

The traps consisted of collapsible mesh nets with conical openings on each end (45 x 25 x 25 cm) that were set on strings amongst vegetation cover, flat on the bottom, for 1–2 daylight hours and baited with fish-flavoured dry cat food.

- A 6 m x 1.2 m net with 6 mm mesh Seine net was used at one site to target rainbowfish. Fyke nets were used at one wetland site, set from the bank in the afternoon and checked every four hours. Sampling at many sites was also supplemented with dip-netting for sampling shallow habitats or edges, and angling was used for opportunistic sampling of predatory species such as bream (grunters) and catfish.
- Captured fishes were sorted on site, with the majority returned to the point of capture. Subsamples retained as vouchers were held in a bucket with aeration and transported back to the field laboratory. Retained fish were ultimately euthanased using AQUI-S, and vouchers were fixed in 10% formalin solution with a matching genetic tissue sample preserved in both 100% analytical grade ethanol and liquid nitrogen. On return to MAGNT, all material was sorted and re-examined to provide final confirmation of identifications after Allen *et al.* (2002)³ and primary literature keys where applicable.
- **Insects** were surveyed using techniques aimed at targeting dragonflies and damselflies (Odonata), and butterflies and day-flying moths (diurnal Lepidoptera). Collecting methods included visual observation and use of a standard entomological sweep-net (400 mm internal diameter). Typically, around two to three daylight hours were spent surveying at each site in either the late morning or early afternoon when diurnal Lepidoptera and odonates were most likely to be active. Lepidoptera specimens retained as vouchers were placed in glassine envelopes, frozen for 24 hours, and then pinned and set in the field. Odonata were placed in glassine envelopes, fixed in acetone, dried, and stored in boxes containing naphthalene and silica gel to prevent insect attack and mould.
- **Spiders** were surveyed primarily using pit fall traps. However, various other methods were used including visual observation, rock rolling, bark brushing, bark stripping and night collection.
- **Vascular plant** specimens were collected, pressed and dried, with some small, fragile plants or parts such as flowers or fleshy fruits preserved in an alcohol solution (70% alcohol, 1% glycerol). Material from taxa of particular interest to specialists for molecular analyses were sub-sampled from the larger preserved specimen and stored in airtight plastic bags with silica gel. Specimens from lower plant groups, typically including part of the attached substrate of rock or bark, were packaged in paper or plastic bags in the field.
- All appropriate incidental plant records and specimens collected from the two standard survey sites were databased in the NT Herbarium Specimen Database (HOLTZE) following identification. In addition, seeds were collected as part of the Australian Seed Bank Partnerships project targeting mainly sandstone species using standard seed collecting methodology. Detailed floristic and structural data were collected at the two standard survey sites in accordance with the full-floristic vegetation site assessment methodology used by the NT Government.

³ Allen, G.R., Midgley, S.H., Allen, M., 2002. Field Guide to the Freshwater Fishes of Australia. Western Australian Museum, Perth.

Identification

The specimens taken were identified using available literature and the holdings of museums and herbaria. Identification included inspecting specimens under a microscope and obtaining mitochondrial DNA sequences from the tissue samples taken. Fauna specimens were deposited with MAGNT and QM and vascular plants were deposited with the NT Herbarium. Data for all specimens can be accessed through the Atlas of Living Australia (ALA) and all plant specimens collected as part of the survey are also available in the Australasian Virtual Herbarium (AVH).

Results

Locational data for all flora and fauna records are available to reserve managers. More than 377 species were new records for the BFTA (some results are yet to be finalised), including 15 putative new species—these await formal identification. Six threatened animal species were observed. Twenty-one introduced plant or animal species were also recorded. Table 2 provides a summary of the flora and fauna records for the BFTA.

Table 2 Summary of flora and fauna records

Group	Common name	Total species recorded	Species newly recorded for reserve	Putative new species	Threatened species*	Exotic and pest species**
Mammalia	Mammals	24	0	0	1	6
Aves	Birds	122	2	0	2	0
Reptilia	Reptiles	46	3	1	2	0
Amphibia	Frogs and Toads	21	2	1	0	1
Pisces	Freshwater fish	26	5	0	1	0
Lepidoptera	Butterflies	38	38	0	0	1
Lepidoptera	Moths	2	2	0	0	0
Odonata	Damselflies, dragonflies	36	36	0	0	0
Arachnida	Spiders	89	89	12	0	0
Arachnida	Scorpions	1	1	0	0	0
Arachnida	Pseudoscorpions	1	1	0	0	0
Vascular plants	Vascular plants	496	198	1	0	13
Total		902	377	15	6	21

* Species listed as Threatened under the Commonwealth EPBC Act or TPWC Act.

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

Species lists

Species lists for the BFTA are provided in Appendix A. Species lists were compiled using data from participating institutions. Lists of species previously known to occur in the study areas were provided for some taxonomic groups but not others so this should not be considered a complete species list for the park.

Some specimens have been identified only to family or genus level. This is partly because identification of specimens is very time-consuming, with detailed microscopic examination needed in many cases.

Also, some groups are 'orphans': currently no experts are working on them, or are available to work on them, and the taxonomic literature is out of date; species-level identification is not possible for these groups. Unidentified Bush Blitz specimens are held in institutional collections where they are available for future study. Collections hold many such specimens, among them species not yet described (i.e. unnamed species) as well as described species that have not been identified. For example, ANIC holds tens of thousands of unidentified specimens. Specimens often wait decades before the resources become available for their study. A key component of Bush Blitz is the funding of studies of specimens collected on Bush Blitz surveys.

Nomenclature and taxonomic concepts used in this report are consistent with the Australian Faunal Directory, Australian Plant Name Index and Australian Plant Census.

Discussion

Putative new species

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

Fauna

Vertebrates

Reptiles

Previous studies have shown that geckos from a single widely distributed species can be genetically divergent and sometimes morphologically different from individuals of the same species from another location (i.e. comprise species complexes of two or more species). The Velvet Gecko (*Amalosia rhombifer*) is normally a woodland species, yet the specimens sampled at BFTA have a different dorsal pattern and appear to be associated with sandstone outcrops and may prove to be a different species. The tissues collected will be used in a new molecular analysis and the specimens examined compared with other *Amalosia* specimens from across the Australian monsoonal tropics.

Frogs

Two individuals of a small froglet (*Crinia* aff. *deserticola*) were collected during the Bush Blitz. These individuals were sequenced to confirm their identity, and preliminary results revealed that they are most closely related to, but genetically divergent from, the Desert Froglet (*Crinia deserticola*). Additional sequencing of these specimens and other *Crinia deserticola* from across their range is underway and will reveal whether or not this frog represents an undescribed species.

Fish

No distinct new species were observed on the survey. However, more subtle variation in the form of cryptic species cannot be ruled out, especially with the Northern Purple Spotted Gudgeon, (*Mogurnda mogurnda*), which showed variation in appearance across the property (especially isolated populations on sandstone escarpment). Quite a number of obligate freshwater fishes need to be reviewed based on the presence of likely cryptic taxa (e.g. catfishes, Mouth Almighty), and the survey successfully collected paired tissue and voucher material to advance future research.

Table 3 lists the putative new vertebrate species that were collected in the park.

Table 3 Putative new vertebrate species

Family	Species
Reptiles	
Diplodactylidae	<i>Amalosa</i> aff. <i>rhombrifer</i>
Frogs and Toads	
Myobatrachidae	<i>Crinia</i> aff. <i>deserticola</i>

Invertebrates

Spiders

Twelve spiders have been recorded as putatively new, however, for a number of the new species, either only one male, female or juvenile was found. While it is still possible to describe a new species with one male or female, it is not generally accepted and can cause complications in the future.

Table 4 lists the putative new invertebrate species that were collected in the park.

Table 4 Putative new invertebrate species

Family	Species
Arachnida	
Araneidae	<i>Araneus</i> spnov tabr05
Clubionidae	<i>Clubiona</i> tabr12
Clubionidae	<i>Clubiona</i> tabr13
Gnaphosidae	<i>Hemicloea</i> spnov tabr29
Miturgidae	<i>Argoctenus</i> tabr07
Miturgidae	Mitugidae spnov+genov tabr43
Miturgidae	<i>Miturga gilva</i> spnovgroup tabr44
Miturgidae	<i>Miturga</i> spnov tabr45
Pisauridae	<i>Dendrolycosa</i> spnov tabr17
Salticidae	<i>Holoplatys</i> spnov tabr34
Theraphosidae	Theraphosidae spnov+genov tabr93
Thomisidae	<i>Tharpyna</i> spnov tabr91

Flora

One new species was recorded; *Acacia* sp. Bradshaw (B.Wirf 1484). Based on the two specimens collected, it was closest morphologically to *Acacia praetermissa*, however preliminary DNA analysis determined it is not. Furthermore, three specimens in particular could not be identified conclusively and require further taxonomic investigation. These include *Corymbia* sp. aff. *dunlopiana*, *Heliotropium* sp. aff. *ramulipatens* and *Stemodia* sp. aff. *lathraia*.

Threatened species

Australia is home to an estimated 580,000–680,000 species, most of which have not been 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 gone extinct; many others are considered to be threatened, i.e. at risk of extinction.⁴

Fauna

Vertebrates

Mammals

One threatened mammal species was recorded during the survey —Black-footed tree-rat (*Mesembriomys gouldii*) is listed as Endangered under the EPBC Act. Scats from a Black-footed tree-rat were collected at one site, though no other evidence was recorded during the BFTA Bush Blitz.

Birds

Two threatened bird species were recorded during the survey. Partridge Pigeon (*Geophaps smithii*) is listed as Vulnerable under the EPBC Act and TPWC Act. The Gouldian Finch (*Erythrura gouldiae*) is listed as Endangered under the EPBC Act and Vulnerable under TPWC Act. Although Gouldian Finches are known from the area, this breeding record is significant for the land managers.

Reptiles

Two threatened reptile species were recorded during the survey—Mertens' Water Monitor (*Varanus mertensi*) and the Yellow-spotted Monitor (*Varanus panoptes*) are listed as Vulnerable under TPWC Act. These species are known to have experienced population declines in the Daly River region due to predation on toxic Cane Toads⁵; observation of a fresh carcass of a Mertens' Water Monitor during the survey suggests it may have succumbed to Cane Toad toxins.

Freshwater Fish

The Angalarri Grunter (*Scortum neili*) is listed as Vulnerable under the TPWC Act and is one of Australia's rarest fish, previously only known from two scientifically recorded locations, the East Baines River and a

⁴ Chapman, A. D. 2009, Numbers of Living Species in Australia and the World, 2nd edn. Australian Biological Resources Study, Canberra.

⁵ Doody, J.S., et al. 2009, Population-level declines in Australian predators caused by an invasive species. *Animal Conservation* 12: 46–53.

series of large pools on a tributary of the Angalarri River⁶. Managing this type of habitat, for example by control of feral animals and use of appropriate fire regimes, will help protect the Angalarri Grunter.

Table 5 lists the Threatened vertebrate species that were observed in the park.

Table 5 Threatened vertebrate species

Family	Species	Common name	Status
Mammals			
Muridae	<i>Mesembriomys gouldii</i>	Black-footed Tree-rat	Endangered (EPBC Act)
Birds			
Columbidae	<i>Geophaps smithii</i>	Partridge Pigeon	Vulnerable (EPBC Act and TPWC Act)
Estrildidae	<i>Erythrura gouldiae</i>	Gouldian Finch	Endangered (EPBC Act) Vulnerable (TPWC Act)
Reptiles			
Varanidae	<i>Varanus mertensi</i>	Mertens' Water Monitor	Vulnerable (TPWC Act)
Varanidae	<i>Varanus panoptes</i>	Yellow-spotted Monitor	Vulnerable (TPWC Act)
Fish			
Terapontidae	<i>Scortum neili</i>	Angalarri Grunter	Vulnerable (TPWC Act)

Flora

Twenty-seven plant species of conservation significance were recorded during the survey (Table 6). Thirteen species assessed as Near Threatened were recorded during the survey and 14 Data Deficient. Also worth noting are the restricted range taxa that were recorded as part of the survey and the species endemic to BFTA. Three restricted range taxa were recorded including *Boronia filicifolia*, *Micraira dunlopia* and *Ricinocarpus trichophyllus*.

Table 6 Flowering plants of conservation significance

Family	Species	Status
Acanthaceae	<i>Dipteracanthus australasicus</i> subsp. <i>dalyensis</i>	Data Deficient
Alismataceae	<i>Butomopsis latifolia</i>	Data Deficient
Amaranthaceae	<i>Tecticornia halocnemoides</i> subsp. <i>tenuis</i>	Data Deficient

⁶ Corbett, L., Batterham, R., Sewell, S., Welch, M., Richards, G., Larson, H.K. 2002, The Angalarri grunter, *Scortum neili* Allen, Larson and Midgley (Teleostei: Terapontidae): description of adults and their habitat. The Beagle, Records of the Museum and Arts Gallery of the Northern Territory 18: 57–62.

Family	Species	Status
Apocynaceae	<i>Cynanchum brevipedicellatum</i>	Data Deficient
Cyperaceae	<i>Actinoschoenus arthrostyloides</i>	Near Threatened
Cyperaceae	<i>Cyperus viscidulus</i>	Data Deficient
Euphorbiaceae	<i>Ricinocarpus trichophyllus</i>	Near Threatened
Fabaceae	<i>Acacia setulifera</i>	Near Threatened
Fabaceae	<i>Acacia</i> sp. Kununurra (G.Lullfitz 6195)	Near Threatened
Fabaceae	<i>Plagiocarpus longiflorus</i>	Data Deficient
Fabaceae	<i>Rhynchosia filiformis</i>	Near Threatened
Fabaceae	<i>Tephrosia procera</i>	Near Threatened
Goodeniaceae	<i>Scaevola revoluta</i> subsp. <i>stenostachya</i>	Data Deficient
Lamiaceae	<i>Pityrodia jamesii</i>	Data Deficient
Linderniaceae	<i>Lindernia clausa</i>	Near Threatened
Linderniaceae	<i>Lindernia lobelioides</i>	Near Threatened
Malvaceae	<i>Triumfetta albida</i>	Near Threatened
Malvaceae	<i>Triumfetta arnhemica</i>	Near Threatened
Malvaceae	<i>Triumfetta parviflora</i>	Near Threatened
Menyanthaceae	<i>Nymphoides indica</i>	Data Deficient
Phyllanthaceae	<i>Breynia cernua</i>	Data Deficient
Phyllanthaceae	<i>Notoleptopus decaisnei</i>	Near Threatened
Phyllanthaceae	<i>Synostemon hubbardii</i>	Data Deficient
Picrodendraceae	<i>Petalostigma quadriloculare</i>	Data Deficient
Plantaginaceae	<i>Stemodia grossa</i>	Data Deficient
Polygalaceae	<i>Polygala barbata</i>	Data Deficient
Rutaceae	<i>Boronia lanuginosa</i>	Near Threatened

Exotic and pest species

Conservation reserves help to 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

Mammals

Six species of feral mammal were sighted during the survey including Cattle (*Bos taurus*), Pig (*Sus scrofa*), Asian Water Buffalo (*Bubalus bubalis*), Horse (*Equus caballus*), Donkey (*Equus asinus*) and Cat (*Felis catus*). Large numbers of feral herbivores such as donkeys and cattle can cause extensive structural damage to riparian habitats and the native fauna therein, especially towards the end of the dry season as they concentrate at waterholes and streams. Cane Toads (*Rhinella marina*) were present at a number of the survey sites, and some reptile species that were expected to occur but known to experience population declines following the arrival of Cane Toads were not found during the survey.

Frogs and toads

Cane toads (*Rhinella marina*) were recorded at most sites. The high abundance and wide occurrence (throughout the park and region) of this recently arrived pest make any specific management recommendations, other than research into broader biological control, difficult.

Fishes

No introduced fish species were recorded in the survey, and there are no historical records of such species from the Victoria River catchment. Fishing is heavily actioned in the area, and a potential risk is the accidental transfer of fish used as live bait for fishing (although this practice is discouraged within BFTA). The release of unwanted aquarium fish into natural waterways is another common means by which introduced species are spread. Ongoing multi-agency and stakeholder awareness and vigilance are recommended. Potential invaders to be aware of include Eastern Gambusia (*Gambusia holbrooki*) which is known in restricted areas of the Kimberley⁷, aquarium fishes such as Guppy (*Poecilia reticulata*), and the highly invasive Tilapia (*Oreochromis mossambicus*) that is already established in the Pilbara and eastern Australia⁸.

Invertebrates

Only one exotic invertebrate species was recorded—the Tawny Coster butterfly (*Acraea terpsicore*). The Tawny Coster is an Asian species that became established near Darwin in 2012 and it has since rapidly spread across northern Australia.⁹ This species was very abundant, being recorded at more than half the sites sampled (59%). No studies have been undertaken as yet to ascertain whether this species has, or will, become invasive and therefore a threat to Australian butterfly communities. However, it is noteworthy that the Australian native Glasswing (*Acraea andromacha*) was only recorded at a single site. The two species use the same larval food plant (*Hybanthus enneaspermus*) and it remains to be determined if *A. terpsicore* is outcompeting *A. andromacha*.

Table 7 lists the pest and exotic vertebrate species that were observed at BFTA.

⁷ 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.

⁸ 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

⁹ Braby MF, Bertelsmeier C, Sanderson C & Thistleton B. 2014. Spatial distribution and range expansion of the Tawny Coster butterfly, (Linnaeus, 1758) (Lepidoptera: Nymphalidae), in South-East Asia and Australia. *Insect Conservation and Diversity* 7, 132-143.

Table 7 Exotic and pest fauna species

Family	Species	Common name	Comments
Vertebrates			
Bovidae	<i>Bos taurus</i>	European Cattle	Seen from air and evidence at many sites
Bovidae	<i>Bubalus bubalis</i>	Swamp Buffalo, Water Buffalo	Seen from air
Bufo	<i>Rhinella marina</i>	Cane Toad	High abundance at numerous sites
Equidae	<i>Equus caballus</i>	Horse	Seen from vehicle
Equidae	<i>Equus asinus</i>	Donkey	Seen from the air
Felidae	<i>Felis catus</i>	Cat	One individual / tracks seen
Suidae	<i>Sus scrofa</i>	Pig	Family groups seen and pig diggings at many sites
Invertebrates			
Nymphalidae	<i>Acraea terpsicore</i>	Tawny Coster	Rapidly spreading Asian species; no studies yet undertaken to ascertain whether this species is a threat to Australian butterfly communities.

Flora

During the Bush Blitz, 13 introduced plant taxa were recorded. Rubber Bush (*Calotropis procera*) was the only declared (Class B and C) weed species among them. NT Herbarium and DENR Weeds Branch database records indicate that a number of additional declared weed species are known from BFTA.

Table 8 lists the weed species that were collected or observed during the Bush Blitz.

Table 8 Introduced flora species

Family	Species	Comments
Apocynaceae	<i>Calotropis procera</i>	Common; declared Class B and C in the NT
Fabaceae	<i>Clitoria ternatea</i>	Abundant at junction of Angalarri and Victoria rivers
Fabaceae	<i>Stylosanthes hamata</i>	Common; 1 km east of homestead
Fabaceae	<i>Stylosanthes humilis</i>	Common; Angalarri River Gorge

Family	Species	Comments
Fabaceae	<i>Stylosanthes viscosa</i>	Common; 1 km east of homestead, near Angalarri River
Lamiaceae	<i>Mesosphaerum suaveolens</i>	Abundant, especially on river flat and foot slopes; probably associated with high feral donkey usage
Malvaceae	<i>Sida acuta</i>	Scattered
Malvaceae	<i>Sida cordifolia</i>	Scattered
Plantaginaceae	<i>Scoparia dulcis</i>	Rare
Poaceae	<i>Chloris barbata</i>	Common
Poaceae	<i>Cynodon dactylon</i> var. <i>dactylon</i>	Occasional in riparian grassland
Poaceae	<i>Digitaria bicornis</i>	Occasional; ephemeral, semi-tidal creek
Poaceae	<i>Urochloa mosambicensis</i>	Abundant; co-dominant understorey species

Range extensions

Fauna

Vertebrates

Fish

The Fitzmaurice River system has been sampled for fish only lightly in the past and so many species recorded at sites in this system represent first catchment records. Most are otherwise continuously distributed in catchments to the west and or east, but nevertheless represent important infill.

Reptiles

The Marbled Velvet Gecko (*Oedura marmorata*) detected on the survey represent an important infill between populations south of Timber Creek and east toward Claravale. This expands their distribution across bio-geographic boundaries (Victoria River and Whirlwind Plain) important for understanding the separation of Kimberley and Northern Territory fauna.

Invertebrates

Butterflies & Moths

Prior to this study BFTA had not been previously surveyed for Lepidoptera so no species had been formally recorded from within the estate. Comparison of the data from this survey with distribution maps indicate that at least five species of diurnal Lepidoptera (*Arhopala micale*, *Mydosama sirius*, *Elodina padusa*, *Candalides delospila*, *Dysphania numana*) have not previously been recorded from this part of the Top End; thus, their occurrence on BFTA represents significant extensions to their geographic range.

Dragonflies

BFTA had not been surveyed for Odonata before this Bush Blitz so no species had been recorded previously within the property. Five species were recorded as range extensions; two were for dragonflies and three for damselflies. Distributions of both dragonflies, *Diplacodes nebulosa* and *Nannophlebia mudginberri*, were extended south from the Daly River area to BFTA in the south-west Top End. The range extensions for the damselflies are all from the genus *Nososticta*. As with the dragonflies, the range of *Nososticta baroalba* was extended south to BFTA from the Daly River area, whereas distribution of *Nososticta liveringa* was extended northward.

The most notable range extension was that of *Nososticta kalumburu*. Formerly this species was known only from the Kimberley region, but an isolated population was recorded on BFTA during this survey. This is the first record of this species in the Northern Territory and extends their known range eastward by over 250 km. In addition to range extensions, seven significant infills were recorded for dragonflies and two for damselflies.

Flora

Vascular Plants

Significant range extensions were recognised for 44 taxa ranging from trees, woody and non-woody shrubs, tussock and hummock grasses, sedges and forbs. These could be broadly categorised into those which represented:

1. Arnhem Land: A number of taxa collected during the survey were new collections with the core of their distributions centred on the Arnhem Plateau sandstone.
2. Taxa to the east and NT Gulf: A suite of the significant range extensions collected as part of this survey represent the most westerly known records of these taxa.
3. Taxa from similar latitudes to the west (east Kimberley): Collections from this survey were range extensions along latitudinal parallels and often represent outliers from adjacent biogeographic regions or sub-regions. Many of these taxa could also be considered as range extensions associated within specialist habitat types, for example the dissected sandstones of the east Kimberley and Keep River National Park/Spirit Hills.
4. Northern taxa: A suite of taxa, many of which were new records for BFTA were southerly range extensions of 'Top End' taxa. Many of these represent characteristic tropical elements of the NT flora and could also be considered as range extensions associated with specialist habitat types for example dry vine thicket and wetlands.
5. Southern taxa (VRD/Tanami): It is interesting to note the scarcity of range extensions for taxa from the semi-arid/arid southern NT flora in the collections from this survey. A number of taxa found during the survey were minor range extensions from the adjacent Tanami Biogeographic Region.
6. Habitat: Many of the taxa collected during this survey that were assessed as significant range extensions were associated with specialist or rare habitat types. These included wetland and aquatic habitats associated with permanent or semi-permanent water sources and dry vine thicket. These habitats provide suitable outlying patches within the broader savanna matrix for taxa outside the core of their distributions and many of these taxa are likely to be at the limits of their range in the NT.

Table 9 Range extensions

Family	Species	Common name	Nearest previous record / Comments
Fish			
Ariidae	<i>Neoarius graeffei</i>	Blue Catfish	~10 km
Belontiidae	<i>Strongylura krefftii</i>	Freshwater Longtom	~10 km
Eleotridae	<i>Oxyeleotris selheimi</i>	Blackbanded Gudgeon	~10 km
Plotosidae	<i>Neosilurus ater</i>	Black Catfish	~10 km
Plotosidae	<i>Neosilurus hyrtlii</i>	Hyrtl's Catfish	~10 km
Plotosidae	<i>Neosilurus pseudospinosus</i>	Falsespine Catfish	~20 km
Terapontidae	<i>Amniataba percooides</i>	Barred Grunter	~10 km
Terapontidae	<i>Syncomistes butleri</i>	Butler's Grunter	~20 km
Butterflies			
Lycaenidae	<i>Arhopala micale</i>	Shining Oak-blue	100 km SSW of Daly River; range extension south
Lycaenidae	<i>Candalides delospila</i>	Spotted Dusky-blue	100 km NW of Timber Creek, NT; range extension north
Nymphalidae	<i>Mydosama sirius</i>	Cedar Bush-brown	90 km SW of Fish River Station, NT; range extension south
Pieridae	<i>Elodina padusa</i>	Narrow-winged Pearl-white	85 km NW of Gregory National Park, NT; range extension north
Moths			
Geometridae	<i>Dysphania numana</i>	Six O'Clock Moth	150 km SW of Fish River Station, NT; range extension south
Dragonflies			
Libellulidae	<i>Diplacodes nebulosa</i>	Charcoal-winged Percher	100 km SSE of Wadeye Road area, NT; range extension south

Family	Species	Common name	Nearest previous record / Comments
Libellulidae	<i>Nannophlebia mudginberri</i>	Top End Archtail	165 km SSW of Daly River Road area, NT; range extension south
Damselflies			
Platycnemididae	<i>Nososticta baroalba</i>	Black-winged Threadtail	130 km S of Daly River Mission, NT; range extension south
Platycnemididae	<i>Nososticta kalumburu</i>	Spot-winged Threadtail	260 km ENE of El Questro Gorge, WA; range extension east into NT
Platycnemididae	<i>Nososticta liveringa</i>	Malachite Threadtail	100 km N of sites in Judbarra/Gregory NP, NT; range extension north
Flora			
Acanthaceae	<i>Brunoniella australis</i>	Blue Trumpet	158 km south-westerly extension of predominantly 'Top End' taxon
Acanthaceae	<i>Dipteracanthus australasicus</i> subsp. <i>dalyensis</i>		82 km extension of range from the Daly River basin to the north
Acanthaceae	<i>Rostellularia adscendens</i> var. <i>clementii</i>	Rostellularia, Pinktongues, Purple Pipe-cleaner	62 km
Amaranthaceae	<i>Alternanthera denticulata</i>	Alternanthera, Lesser Joyweed	22 km western extension of distribution
Amaranthaceae	<i>Gomphrena affinis</i>		46 km
Amaranthaceae	<i>Gomphrena affinis</i> subsp. <i>affinis</i>		22 km
Amaranthaceae	<i>Gomphrena breviflora</i>		38 km
Apocynaceae	<i>Cynanchum brevipedicellatum</i>	Sarcostemma, Caustic Vine, Pencil Caustic, Milk Bush, Milk Vine	12 km; previously known only from west of the Victoria River
Asteraceae	<i>Sphaeranthus africanus</i>		310 km; First record south-west of Cox Peninsula
Aizoaceae	<i>Trianthema rynchocalyptera</i>		17 km westerly extension of widely distributed taxon

Family	Species	Common name	Nearest previous record / Comments
Boraginaceae	<i>Heliotropium cunninghamii</i>		30 km
Celastraceae	<i>Stackhousia</i> sp. Leafless (I.D.Cowie 14078)		9 km
Cleomaceae	<i>Cleome cleomoides</i>		15 km; widely distributed sandstone taxon
Cyperaceae	<i>Cyperus latzii</i>		57 km northerly extension of Southern region taxon
Cyperaceae	<i>Eleocharis setifolia</i>		138 km westerly extension of widely distributed taxon
Cyperaceae	<i>Rhynchospora leae</i>		245 km south-westerly range extension
Droseraceae	<i>Drosera dilatato-petiolaris</i>	Drosera, Sundew	91 km southerly extension of Top End taxon
Droseraceae	<i>Drosera ordensis</i>	Drosera, Sundew	62 km easterly range extension
Fabaceae	<i>Acacia gonoclada</i>	Acacia, Wattle	3 km
Fabaceae	<i>Acacia oncinocarpa</i>	Acacia, Wattle	27 km
Fabaceae	<i>Aeschynomene aspera</i>		215 km; first record south-west of Reynolds River
Fabaceae	<i>Chamaecrista symonii</i>	Chamaecrista, Dwarf Cassia	57 km northerly range extension of Southern region taxon
Fabaceae	<i>Plagiocarpus axillaris</i>		80 km southerly extension from Daly Rive area
Fabaceae	<i>Sesbania simpliciuscula</i>		19 km
Fabaceae	<i>Stylosanthes viscosa</i>	Stylosanthes, Stylo	99 km
Fabaceae	<i>Vigna</i> sp. Station Creek (R.J.Lawn CQ3284)		130 km westerly range extension
Goodeniaceae	<i>Goodenia brachypoda</i>		12 km
Haloragaceae	<i>Gonocarpus implexus</i>		21 km
Hydatellaceae	<i>Trithuria cowieana</i>		236 km; significant extension of rarely encountered taxon from the Finnis River and Nitmiluk NP

Family	Species	Common name	Nearest previous record / Comments
Lamiaceae	<i>Anisomeles farinacea</i>		98 km; regional endemic
Loganiaceae	<i>Mitrasacme galbina</i>		30 km; disjunct from the western side of the Victoria River
Malvaceae	<i>Abutilon hannii</i> subsp. Prostrate (P.K.Latz 427)	Abutilon, Lantern-flower	117 km northern extension of predominantly Southern region taxon
Malvaceae	<i>Brachychiton tuberculatus</i>	Brachychiton, Kurrajong, Largeleaf Kurrajong	46 km easterly extension of predominantly Spirit Hills centred distribution
Malvaceae	<i>Hibiscus arnhemensis</i>		3 km; Bradshaw-Kakadu disjunct
Malvaceae	<i>Hibiscus zonatus</i>		60 km
Menispermaceae	<i>Pachygone ovata</i>		41 km southerly extension of monsoon forest taxa widespread across the Top End
Malvaceae	<i>Triumfetta arnhemica</i>		31 km; Bradshaw-Arnhem Plateau disjunct
Poaceae	<i>Chamaeraphis hordeacea</i>		216 km westerly range extension
Poaceae	<i>Eragrostis rigidiuscula</i>	Eragrostis, Lovegrass	121 km southerly extension of Top End taxon
Proteaceae	<i>Grevillea byrnesii</i>	Grevillea, Prickly Grevillea	13 km
Poaceae	<i>Panicum latzii</i>		11 km range extension of predominantly southern region taxon
Polygalaceae	<i>Polygala crassitesta</i>		48 km north-westerly range extension
Solanaceae	<i>Nicotiana benthamiana</i>	Nicotiana, Native Tobacco, Wild Tobacco	42 km northerly extension of southern region taxon
Vitaceae	<i>Cayratia maritima</i>		122 km range extension from the north-east

Other points of interest

Fauna

Vertebrates

Mammals

Bat call analysis was undertaken using current AnaLookW software (Titley Scientific). Animals were identified to species where possible, though in some instances, it is not possible to separate the Anabat call signature of sympatric species whose call frequencies overlap. These bats are presented in Appendix A as complexes. A total of 135 calls were attributed to unknown bat species, either because the call sequence was too short, there was too much variation in the pulses, or there was too much background noise to obtain a clear signature.

A number of threatened mammal species that have been previously recorded at BFTA were surveyed opportunistically during the Bush Blitz; Northern Quoll (*Dasyurus hallucatus*), Ghost Bat (*Macroderma gigas*) and Nabarlek (*Petrogale concinna concinna*). No individuals of these species were sighted, however, the survey effort was insufficient to conclude that these species are absent from BFTA.

The status of Northern Quolls at BFTA is unknown, though Cane Toads, which were in abundance at BFTA, have been implicated in the decline of Northern Quolls across northern Australia. Future surveys and monitoring should be undertaken in the peak activity period for Northern Quoll (June–August) and should be focused within the elevated plateaux in the western and north-eastern regions of BFTA. Given the expansive area of suitable habitat, the use of Northern Quoll-trained Wildlife Detection Dogs and the deployment of baited motion detection/infrared cameras are the preferred survey methodology.

Searches for Ghost Bat roosts should be incorporated into standard environmental monitoring methodology, as this species is unlikely to be detected via echolocation call instruments. The use of camera traps and scat collection during standard monitoring events will provide future opportunities for the detection of Nabarlek, should a population of this species persist at BFTA.

Birds

The Sarus Crane, though not a threatened species, is a species not often seen in the Northern Territory. A flock of approximately six birds was seen from a helicopter on a small wetland in the west of the property. In comparison, Brolga sightings were common across the property. The Partridge Pigeon has declined in numbers across its range over the past few decades. It is listed as Vulnerable under both the TPWC Act and the EPBC Act and was recorded at a number of sites on the property.

The other avian records of interest for the survey were sightings of Gouldian Finches. Gouldian Finches are listed as Vulnerable under the TPWC Act and Endangered under the federal EPBC Act. Although Gouldian Finches are known from the area, this breeding record is significant for the land managers of BFTA. Targeted surveys for Gouldian Finch should include further investigation of the observations in the south west of the Ikymbon Sector, to determine whether this area provides important breeding resources, and to further characterise the habitat value to the local population.

Two other threatened bird species have historically been recorded at BFTA, though were not observed during this survey; Crested shrike-tit (*Falcunculus frontatus whitei*) and Masked owl (*Tyto novaehollandiae kimberli*). Further surveys should include the use of spotlighting and call playback for

masked owl, deployment of baited cameras standardised bird counts for crested shrike-tit and partridge pigeon.

Reptiles and Amphibians

Though only two possible undescribed reptiles or frogs were encountered during the survey it is highly probable that some of the wider ranging species are actually comprised of sets of cryptic species. The collection of vouchers and tissues from BFTA will enable researchers to study the relationships of these species. It appears that the north-western sections of the area are virtually unsurveyed due to limited access. It is also possible that in some of the north-western sections of the area endemic terrestrial vertebrates could be present on the flat tops of the rock outcrops.

BFTA supports a high diversity of vertebrates, and sound management of the property will ensure the long-term conservation of a fauna broadly characteristic of the arid interior and northern tropical forests of the Northern Territory.

Fishes

The key species-based land management issue highlighted from the BFTA fish survey concerns the Exquisite Rainbowfish. The form of Exquisite Rainbowfish (*Melanotaenia exquisita*) observed on BFTA and the interlinked upper section of Ikymbon River on the Wardaman IPA is geographically isolated and morphologically distinctive (high dorsal fin, yellow fin colour) from other populations in the east Kimberley and Kakadu regions. This potentially new species with a highly restricted range would be vulnerable to extinction should any changes occur in the Ikymbon River at or upstream of the waterfall. This barrier seems critical to maintaining natural separation from Western Rainbowfish which is common in all other local habitats. The Western Rainbowfish being a larger growing fish, is likely to interbreed and out-compete the Exquisite Rainbowfish should they become mixed.

In addition to the species recorded during this survey, four other freshwater species were recorded in previous sampling at BFTA. Three of these records have been verified with museum specimens, namely Silver Cobbler (*Neoarius graeffei*), Macleay's Glassfish (*Ambassis macleayi*) and Giant Glassfish (*Parambassis gulliveri*). The fourth record is enigmatic, being the Saratoga (*Scleropages jardinii*). This is a large and distinctive fish but no verification (specimens, photos or other descriptive text) was provided, despite the potential significance of this record, as it would be a major western range extension of several catchments and 300 km west of the Adelaide River.

Appendix A also includes 10 species recorded near BFTA that could potentially occur on the property, primarily in lowland habitats connected to estuaries like the lower tidal section of the Angalarri River. These include several larger species with cultural significance, namely Freshwater Sawfish (*Pristis pristis*), Bull Shark (*Carcharhinus leucas*), Freshwater Whipray (*Urogymnus dalyensis*), Boofhead Catfish (*Sciades leptaspis*) and Toothless Catfish (*Anodontiglanis dahli*), and also smaller species — Munro's Goby (*Glossogobius munroi*), Empire Gudgeon (*Hypseleotris compressa*) Blackbanded Rainbowfish (*Melanotaenia nigrans*) and Kimberley Sole (*Leptachirus triramus*). A significant find on the nearby Judbarra / Gregory National Park Bush Blitz was the Swamp Eel (*Ophisternon gutturale*); traditional aboriginal knowledge suggests this species may also occur in wetland habitats on BFTA^{10,11,12,13}.

¹⁰ Hammer, M., Moore, G. & Williams, R. (2015) Bush Blitz: fishes of Judbarra / Gregory National Park, western Top End, Northern Territory. Report to Australian Biological Resources Study. 22 pp.

Future management should encourage ongoing vigilance and awareness of potentially invasive fish and continue to discourage the use of live fish bait. Additional monitoring of the Angalarri Grunter to fill in gaps in the known life-history of the species including the timing of spawning, potential spread under appropriate conditions, the types of habitat where they occur, and the methods best suited to their detection. Fish passage to allow movement of juveniles around the Angalarri floodplain (e.g. road crossings) is an additional management recommendation.

Invertebrates

Butterflies

As no surveys of Lepidoptera (or any other invertebrates) have been carried out previously at BFTA this survey can be considered the first baseline study of Lepidoptera for the area. The relative abundance of species based on their frequency distribution or occurrence within each site indicates that the most abundant species were *Junonia orithya*, *Acraea terpsicore*, *Hypocysta adiante*, *Euploea corinna* and *Junonia villida*. All of these species breed predominantly in savannah woodland and are a characteristic component of the tropical savannah landscape. *Danaus petilia* is another species that is common and widespread in northern Australia, but surprisingly it was recorded in relatively low frequency. Eighteen taxa were recorded from only one or two sites, reflecting either their local habitat specialisation or low detectability. The ALA indicated that 17 other butterfly species have been recorded from within 30 km of the borders of BFTA, and these species almost certainly occur within the boundaries of the property.

Two additional species of day-flying moth were recorded from the area: a bee hawk moth (*Cephonodes* sp.) and a tiger moth (*Amata* sp.), but neither could be reliably identified to species. Hence, these species were excluded from this list for the time being.

As mentioned, the Tawny Coster became established in northern Australia in 2012. During the survey, this species was found at 13 of the 22 sites sampled (59%) and was abundant at all of these sites. However, the Glasswing, the closely related Australian species, was recorded at only a single site and only from a single individual. It is not known whether the presence of the Tawny Coster is impacting on populations of Glasswings, which otherwise is a common and widespread species in the monsoon tropics; there may be a correlation between the high numbers of the Tawny Coster and the apparent low abundance of the Glasswing. Further research is needed to ascertain if there is a causal link between these discrepancies in relative abundance and if the Glasswing is in decline.

¹¹ Hector, I.K., Kalabidi, G.J., Banjo, S., Dodd, T.N.N., Wavehill, R.J.W., et al. (2012) Bilinarra, Gurindji and Malngin Plants and Animals: Aboriginal knowledge of Flora and Fauna from Judbarra /Gregory National Park, Nitjpurru, Kalkarindji and Daguragu, North Australia. Diwurruwurru-jaru Aboriginal Corporation and Mimi Aboriginal Art and Craft, Katherine.

¹² Marchant Jones, J., Bardbarriya, D., Raymond, E., Roberts, D., McDonald, D., et al. (2011) Jaminjung, Ngaliwurru and Nungali plants and animals: Aboriginal knowledge of flora and fauna from the Bradshaw and Judbarra/Gregory National Park area, North Australia. Diwurruwurru-jaru Aboriginal Corporation and Dept. of Natural Resources, Environment, the Arts and Sport, Darwin.

¹³ Widjburra, B. et al. 2010, Ngarinyman Plants and Animals: Aboriginal Knowledge of Flora and Fauna from the Gregory National Park and the Victoria River Area, Northern Australia. Department of Natural Resources, Environment, the Arts and Sport and Diwurruwurru-Jaru Aboriginal Corporation, Katherine.

Odonata

As no previous surveys of Odonata have been carried out at this very large property, this survey can only be considered the first baseline study of Odonata taxa for the BFTA. Due to the late end of the above average 2016–17 wet season, sampling was carried out in excellent conditions for odonates with all drainage systems still flowing and fresh clean water still available in ephemeral creek lines and pools.

Comparing the odonate species list recorded for the nearby Judbarra/Gregory Bush Blitz undertaken two years earlier with this survey, a further seven species of odonate could be assumed to be present on the BFTA but are yet to be recorded. A review of the ALA found a further two species of odonate have been recorded from within 50 km of the borders of BFTA, and are also likely to be found within the site. In addition, three additional species of dragonfly and one damselfly were observed during the survey, but could not be identified to species.

Large feral animals present on BFTA have the propensity to degrade and potentially destroy sensitive habitats around water sources, especially during the late dry season when surface water is scarce. Managers need to ensure that any fuel reduction burns avoid these critical habitats, for example, by burning early in the dry season so that the threat of destructive wildfires is greatly diminished late in the dry season. Attempts should also be made to burn in a mosaic or patchwork pattern so that fauna may survive in unburnt areas (refuges) from which they can recolonise recently burnt areas. Further surveys need to be undertaken at the site during different seasons, and in differing habitats to gain a comprehensive record of the invertebrate fauna of this property.

Spiders

Spiders have not previously been surveyed at BFTA, however collecting had occurred on the other side of the river opposite the base. The numbers of adults and juveniles caught were almost even with only a couple more juveniles caught. Without molecular work on the juveniles, determination of the juveniles beyond family or genera is difficult. Despite the number of putative new species, publication of descriptions is withheld due to a lack of males, usually considered essential for identification. More sampling is recommended to obtain a more comprehensive understanding of the spider fauna of this region.

Flora

The overall condition of BFTA is relatively good with few exotic plant species and feral animals observed during the field survey. Overall, BFTA is reasonably well surveyed for vascular plants with some 18% of the NT vascular flora represented in accessions from the BFTA. Despite the amount of previous survey effort on BFTA and apparent comprehensiveness of the species list, this survey added 198 new taxa to the inventory of BFTA. It is likely that further targeted surveys in rare habitats at appropriate times will yield further new records, especially on the alluvial plains. Twelve undescribed taxa were collected during the survey and an additional ten others had been recorded previously but were not recorded on the 2017 survey.

Seasonal factors are highly likely to have influenced the collection and hence recording of some taxa during the survey. Some species (e.g. some ground orchids and *Typhonium*) are difficult to detect at any time but best detected during the early wet season. Others such as some *Portulaca*, *Utricularia* and other ephemeral herbs are only found when the wet season is still active or very soon after, while for others the intensity of survey effort may have been insufficient to allow their detection.

An area of BFTA of particular interest is the dissected sandstone in the Western Hills and Koolendong sectors and the extensive sandstone habitats associated with the ranges and plateaus, including Fitzmaurice, Yambarran and Lalngang sectors. The sandstone habitat in this area is quite extensive and is known to support a number of restricted, regionally endemic and disjunct species. It is highly likely to support further, as yet undetected, elements of the sandstone flora known from adjacent biogeographic and botanical regions as well as taxa disjunct from the western Arnhem Plateau.

Although there was evidence of weeds in some areas, generally weeds were conspicuous by their absence. Careful control of vehicle and human movements through known weedy areas, meticulous cleaning of vehicles that enter BFTA and controlling weeds already present will help keep weed species under control on the property.

Further follow up surveys and surveys in other seasons would help to improve the completeness of the species inventory.

Glossary

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

Diurnal: active during the day

Endemic: native to or limited to a certain region.

Exotic species: a species occurring outside its native range.

Pest species: a species that has the potential to have a negative environmental, social or economic impact.

Putative new species: an unnamed species that, as far as can be ascertained, was collected for the first time during the Bush Blitz.

Range extension: 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.

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

Taxonomy: the categorisation and naming of species. The science of identifying and naming species, as well as grouping them based on their relatedness.

Threatened species: fauna or flora that are listed under Section 178 of the EPBC Act or TPWC Act in any one of the following categories—extinct, extinct in the wild, critically endangered, endangered, vulnerable, conservation dependent.

Undescribed taxon: a taxon (usually a species) that has not yet been formally described and named.

Vascular plants: A lineage of plants that possess well-developed veins (vascular tissue) in their stems, roots and leaves. Vascular plants include the majority of familiar land plants: flowering plants, ferns, conifers, cycads and fern allies, but not mosses, liverworts or algae.

Vouchers (voucher specimens): any specimen, usually a dead animal or preserved plant sample, that serves as a basis of study and is retained as a reference.

Notes

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BACK COVER Stream flowing through a gorge at Bradshaw, habitat of Angalarri Grunter © Copyright, Michael Hammer, Museum and Art Gallery of the Northern Territory.

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