AUSTRALIAN Wildlife

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Celebrating a new century of wildlife preservation in Australia

Journal of the Wildlife Preservation Society of Australia Limited
(Founded 1909)

Tasmanian native hen (*Tribonyx mortierii*)

Torres Strait pigeon (*Ducula spilorrhoa*)

Leadbeater's possum (*Gymnobelideus leadbeateri*)

SEE PAGE 7 and 8 **FOR MORE** DETAILS

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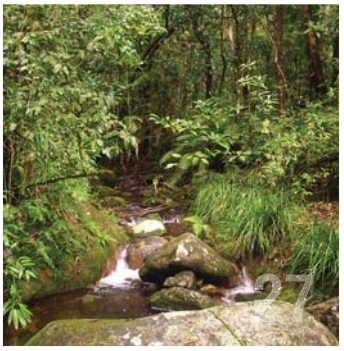

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Front cover:
Photo by Jennifer Parkhurst, wildlife photographer, featured in her book *Vanishing Icon*

Back cover:
Top: The Fraser Island dingoes are quite pretty-looking with the mascara around the eyes, narrower head than the mainland dingo, white socks and white hair at the tip of the tail. It is wonderful to see their ears without tags.

Bottom: Dingoes don't have body odour because they perspire through the pads of their feet. A dingo can swivel or move its ears independently at least 180 degrees in each direction. Photo by Jennifer Parkhurst

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

Australian Wildlife

is the official journal of the Australian Wildlife Society (Wildlife Preservation Society of Australia Limited).

Founded in 1909, the Society is dedicated to the conservation of our unique Australian wildlife in all its forms.

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Directors 2015

Notice to our members

The Australian Wildlife Society (Wildlife Preservation Society of Australia Limited) is managed and controlled by an elected board of ten volunteer directors. The Society is a registered company limited by guarantee with ASIC and is responsible for complying with all its regulations.

Any member who might like to consider serving as a director of the Society is invited to contact the national office for more details. The most important qualification to serving as a director is 'a commitment to and love of Australian wildlife'.

The Society holds regular monthly meetings on the first Wednesday of each month in Sydney.

The Editor would like to feature a member's profile in the fortnightly email newsletter and occasionally in our quarterly magazine. Members are invited to consider submitting a short article with a photograph for possible publication.

Our Mission

The Australian Wildlife Society (Wildlife Preservation Society of Australia Limited) is an independent, voluntary, non-profit conservation organisation, formed in 1909, and is committed to the preservation of Australia's precious flora and fauna. We act as a watchdog and provide advice to government agencies and institutions regarding environmental and conservation issues concerning all aspects of wildlife preservation. Our mission is to conserve Australia's fauna and flora through education and involvement of the community. We are dedicated to the conservation of our unique Australian wildlife in all its forms through national environmental education programs, political lobbying, advocacy and hands on conservation work.

Our Society has always known that a conservation battle is never really won until the victory is enshrined in legislation. We have always tried to convince politicians of the necessity to include the preservation of Australia's precious wildlife and its vital conservation habitat in all their planning and environmental issues and discussions.

From the President's desk

Dr David Murray - President

"Regardless of which climate change scenario turns out to be most correct, there are consequences for plants living with an elevated carbon dioxide concentration which are going to happen anyway"

Climate change is already happening. One disastrous consequence of uncontrolled greenhouse gas emissions is the melting of the icecaps. The Arctic is more likely to melt completely before the Antarctic, and it is difficult to put a timetable to these consequences. Climate change is happening faster than predicted, and there should be no room for complacency or inaction on the part of governments. As a wise precaution against massive sea level increase we need to move to 100 percent renewable energy as soon as possible.

Regardless of which climate change scenario turns out to be most correct, there are consequences for plants living with an elevated carbon dioxide concentration which are going to happen anyway.

Because more carbon is being fixed in the process of photosynthesis, proportionately less nitrogen and sulphur are going to be assimilated. Carbon-rich products will be increased, such as fibrous tissues or wax on the plant surface, which will make plant parts less digestible to herbivores. This new imbalance has implications for every food chain that depends on plants or plant products, and could drive a massive extinction of species.

The reproduction of many insects depends on the nitrogen content of the foliage they eat, and they choose the richest available. What will happen when the nitrogen content of leaves falls below that which is critical for reproduction? If insect life cycles fail to be completed, then there will be food shortages for insectivorous birds, for example.

In the human food chain, the sulphur-containing amino acids that are essential in our diet present a problem. Plant seeds such as those of legumes will contain less of the proteins that contain an adequate quantity of sulphur-amino acids. Sulphur-deficient peas have been shown to make alternative proteins that do not contain any sulphur-amino acids.

If domestic animals and birds do not have adequate proteins in their diet, then humans consuming these protein sources will also encounter the same problem – not enough of the essential amino acids. We may have to study earthworms more closely, as they are already adapted to consuming food with a high carbon-to-nitrogen ratio.

The effects of elevated carbon dioxide concentrations on the future quality of food have not been taken seriously enough by those putting off critical decisions on coal mining versus renewable energy sources. It is not an exaggeration to point out that the future quality of life on Earth depends on governments making these decisions in time.

Beach in Fraser Island. For more information see page 9

DONATION TO THE CAIRNS TURTLE REHABILITATION CENTRE

Ken Mason, Vice-President, Australian Wildlife Society

Our oldest member, Margaret Deas, 102 years and still going strong, was determined to prove that she could manage one sit-up for every year of her age. Upon being quietly told that this was a herculean task for someone of her years, she then challenged all and sundry to support her financially if she proved she could do it. Her aim was to donate the proceeds to a cause that had become dear to her, the rescuing of injured and endangered sea turtles.

The stage was set, the physiotherapist was in place, and the count started. To the amazement of all except her four daughters, Margaret succeeded, and the 'doubting Thomases' were happy to honour their pledges. The princely sum of $6,000 was raised, and a cheque for the sum was presented to Dr Jennie Gilbert at the Cairns Turtle Rehabilitation Centre on Friday 10 July.

The event was well captured by Queensland Channel 7 reporters and broadcast on prime time news throughout Queensland. The podcast is featured on our website and can be viewed on Youtube at https://www.youtube.com/watch?v=WfEmYc9b6U8&feature=youtu.be

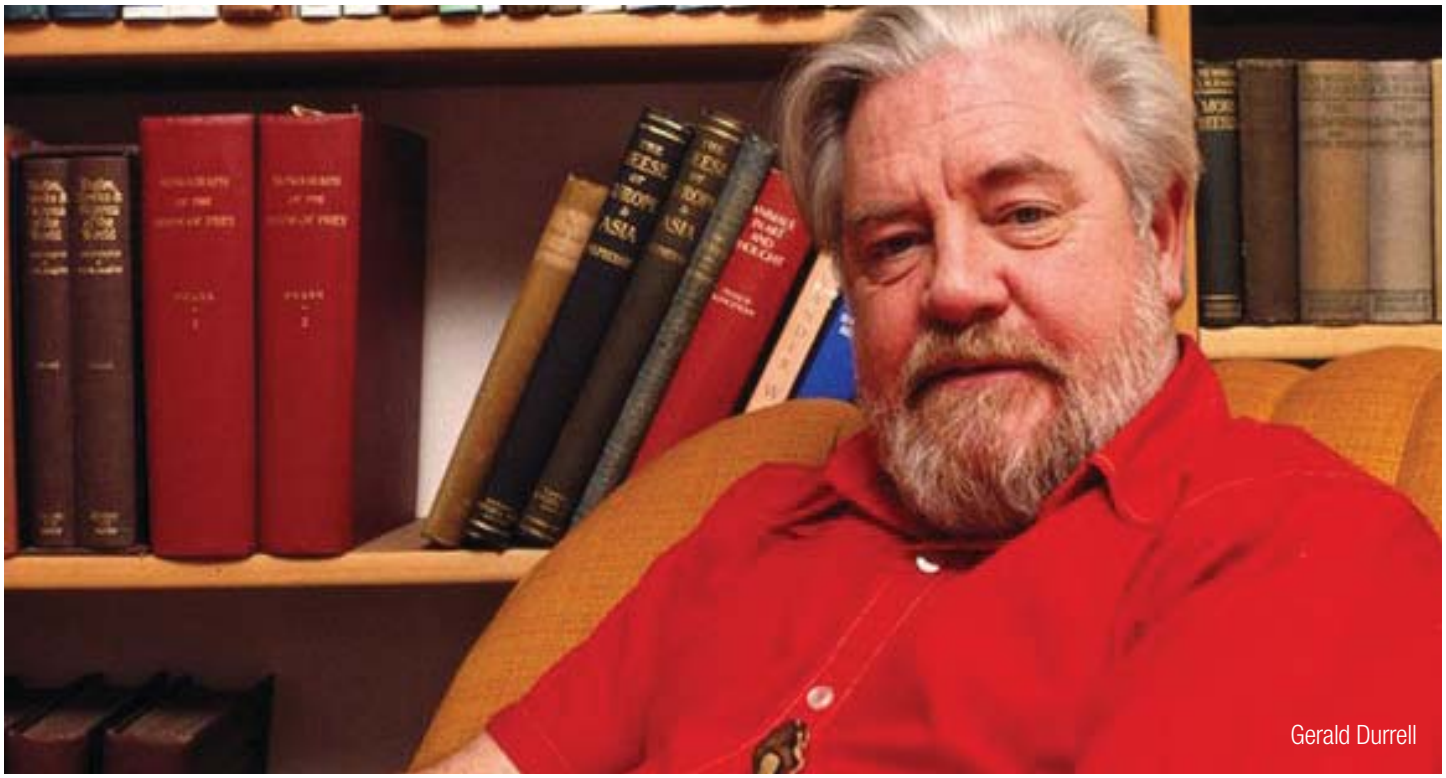
The cheque presentation at Cairns Turtle Rehabilitation Centre. L to R: Christian Miller, Jennie Gilbert, Colin Riddell and grandson, Ken Mason, Sue Emmett, Felix Clark and Barbara Bartlett

As a result of the publicity, another of our members, who asked to remain anonymous, saw the report and organised a birthday party at which guests were asked to forego presents and donate instead to the charity of our member's choice, the Cairns Turtle Rehabilitation Centre. This resulted in another cheque for $1,450, which was dispatched north to Cairns Turtle Rehabilitation Centre.

The Society applauds this direct assistance to a worthy cause, and hopes that Margaret Deas is able to make it '103' next year.

Margaret the sea turtle, named after Margaret Deas. Dr Jennie Gilbert, our regional councillor in Cairns, recommended that the funds raised by Margaret Deas sponsor a recently rescued large green sea turtle. The turtle is a mature green turtle aged approximately 80+ and measures 1.1 metres. Jennie said that this is one of the oldest female breeding turtles she has ever rescued. The turtle was rescued in 25 knot winds and large seas between Cairns and Fitzroy Island by the dedicated staff of the Cairns Dive Centre boat who saw she was in trouble, stopped the boat, and the staff dived over to rescue her. It took eight people to lift her onto the boat! She is suffering from severe starvation from the lack of food resources in the north. The turtle is now safely at Cairns Rehabilitation Centre on Fitzroy Island and started eating 40 squid a day. The sea turtle will be in care for an extended period and when released will have a satellite tracker attached to her to monitor her movements

Suzanne Medway presented Margaret Deas with a fundraising calendar featuring Margaret the sea turtle as 'Miss September'



Gerald Durrell

Gerald Durrell and Australian wildlife

Greg Byrnes

You cannot begin to preserve any species of animal until you preserve the habitat in which it dwells. (Two in the Bush, 1962, p. 349)

English conservationist Gerald Durrell (1925–1995) had many connections with Australian wildlife.

He visited Australia twice in the 1960s and it is interesting to review the situation he described and to take stock of what has happened in the half-century since then.

Durrell's earliest direct contact with Australian marsupials was as a junior zookeeper at Whipsnade Park, caring for wallabies and a wombat called 'Peter', creatures which stimulated his curiosity to see 'the topsy-turvy continent of Australia with its strange red deserts and its stranger fauna, a fauna that leaped and bounced, mammals that laid eggs like birds and other wonders...'.

Durrell started his own zoo on Jersey and by 1960 he was breeding the quokka (*Setonix brachyurus*) because of his concern for their decreasing numbers in the wild. "In this way, even if the quokka disappeared in the wild state, it would not be lost for ever." Today the quokka is still vulnerable and decreasing, due to competition from introduced species such as feral pigs.

Durrell's first visit here (1962) included night filming of the Leadbeater's possum (*Gymnobelideus leadbeateri*). He warned that because of its limited habitat, should a bushfire break out, this species would be doomed. Bushfire did occur in 2009, with terrible impact on the population, but the other problem is logging. Today, despite an erratic captive breeding program here and overseas, the Leadbeater's possum is still endangered and its numbers are decreasing. In fact, in April this year, it was classified as Critically Endangered by the federal government.

Durrell's admiration for David Fleay (1907–1993) was another factor which drew him to study Australian conservation firsthand. "Anyone who can keep and breed a platypus is a genius with animals", he said in an interview with *Australian Women's Weekly*. The two naturalists met at Fleay's Fauna Reserve at West Burleigh, Queensland, and formed a lifelong friendship, with Durrell sending Fleay personally illustrated Christmas cards every year.

The conservation status of the platypus (*Ornithorhyncus anatinus*) is now considered of least concern, but as there have been local extinctions within its range, and as it is so dependent on clean running water, complacency would be fatal.

Durrell was also in contact with Eric Worrell (1924–1987), founder of the Australian Reptile Park, and received from him some (Papuan) sugar gliders (*Petaurus breviceps*). These wide-ranging possums may or may not be more than one species but more research is needed. Their conservation status is currently of least concern and probably stable.

Having returned to Jersey, Durrell regularly worked with Australian animals, which are described in his in-house scientific report *Dodo*. They include corroboree frog (*Pseudophryne corroboree*), echidna (*Tachyglossus aculeatus*), Tasmanian native hen (*Tribonyx mortierii*), Cape Barren goose (*Cereopsis novaehollandiae*), kowari (*Dasyuroides byrnei*) and Parma wallaby (*Macropus parma*), with several of them breeding in captivity. For brevity's sake, just a comment on one of these: the Tasmanian native hen has a restricted range and it may be decreasing. Also, being flightless, it is vulnerable to the fox which has, disastrously, now

Greg Byrnes

appeared in that island, and has been pretty well eradicated by the Fox Taskforce..

The inveterate traveller returned in 1969–1970 for a more extensive six-month tour. He went snorkeling on the Great Barrier Reef and wrote of the irreplaceable beauty of this ecosystem. Despite increased public awareness, the Reef today is less healthy and is even more at risk from repeated attempts at nearby development. Durrell also sounded a warning for the Torres Strait pigeon (*Ducula spilorrhoa*), which he admired there, offshore at Port Douglas: "Australia's hunters say that [it] is too numerous to exterminate, but if poaching and robbing of nests continue this beautiful white pigeon will follow the [North American] passenger pigeon to extinction." Today the Torres Strait (or imperial) pigeon is listed as of least concern and (yet) decreasing.

Fauna is also at risk from motor traffic and overhead wires, so it is not surprising that Durrell supported pioneer injured-wildlife carer Iris Anderson of Western Australia, praising her in *Dodo*. Impressed by her work when visiting her sanctuary at Denmark, Western Australia, he later sent her a donation of $500, a considerable sum in those days.

Durrell was kept up to date with conservation developments in Australia by his many correspondents and contacts, from bird-watchers in Queensland to Dr Harry Frith (1921–1982) of the CSIRO, who was a member of Jersey Wildlife Preservation Trust's scientific committee.

To give just one example, having learnt about the downgrading of plans for the proposed Captain James Cook National Park from 50,000 acres to a token 7,000 or so, Durrell wrote, politely but firmly to *The Age* (Melbourne) to register a protest. He made the point that "the beauty and uniqueness of your continent is of importance not only to Australians but to everybody in the world", a challenging reminder of our global responsibilities.

Durrell wrote of that 1969–1970 expedition: "...while I found a great deal that was heartening I found a great deal that was depressing to a degree, when you considered that you were dealing with an educated and literate population who were not in any way deprived". If I understand him correctly here, he is alluding to situations he had witnessed in, for example, Africa or Asia, where large, impoverished populations were doing slash-and-burn farming in an attempt to feed themselves and their numerous children, whereas in Australia, a small affluent population was gratuitously destroying the environment.

Shortly after that, however, Durrell was favouraly impressed by the conservation reforms of the Whitlam era. The sweeping bans on trade in endangered animals and their products prompted Durrell to write that "[t] hese new moves... are remarkable and every person in the world interested in conservation should congratulate Australia...".

Later that decade, Durrell obtained some specimens of *Acacia pravissima* (wedge-leafed wattle) from Victoria and planted them as a border around the 'Australian section' of his zoo. Around the same time, the first students from Australia were joining others from around the globe who were studying conservation methods in Durrell's training institute at Jersey Zoo.

Later in life he wrote a children's book, *The Fantastic Flying Journey*, in which the characters include the Australian outback and its animals in their travels, scenes which probably drew on memories of his road trip to Alice Springs in 1970.

Gerald Durrell died at the comparatively young age of just seventy years. Despite the great distance from his home on the other side of the world, and a busy schedule of his many other projects, he was a loyal friend to Australian wildlife (thanks to Peter the wombat!).

Greg Byrnes is from Sydney, New South Wales. He enjoys natural history and has previously contributed to this magazine in 2001 and 2011. His experience includes tutoring, ethnic radio, historical research, diversional therapy and migrant education. He currently works with Australia for United Nations High Commission for Refugees.

Fraser Island, Australia

Fraser Island lies just off the east coast of Australia. At 122 kilometres long and 22 kilometres at its widest point, it is the largest sand island in the world. Majestic remnants of tall rainforest growing on sand and half the world's perched freshwater dune lakes are found inland from the beach. The combination of shifting sand-dunes, tropical rainforests and lakes makes it an exceptional site.

In 1860 Fraser Island was gazetted as an Aboriginal reserve. The reserve was largely revoked two years later following the discovery of valuable stands of timber. The remnant Aboriginal reserve was revoked in 1906, after the Aborigines were removed from Fraser Island. In 1908 the central part of Fraser Island was declared a forestry reserve, and by 1925 most of the island had been set aside as state forest. Fraser Island (Great Sandy National Park) (74,900 ha), was gazetted in 1971.

The remainder of Fraser Island consists predominantly of vacant Crown land of 78,404 ha in public ownership, which has been proposed as a national park extension subject to resolution of Aboriginal land interests.

On-ground management of the property is the responsibility of the Queensland Parks and Wildlife Service, Department of Environment and Resource Management, guided by the Great Sandy Region Management Plan, and activity-specific management plans for Fraser Island. As the majority of the island is national park, the strongly protective provisions of the *Nature Conservation Act 1992* and the *Recreation Areas Management Act 2006* apply. The narrow marine zone surrounding the island lies within the Great Sandy Marine Park and is subject to the provisions of the *Marine Parks Act 2004*. Indigenous, community and scientific advice on protection and management of the World Heritage values is provided to the State of Queensland and Australian governments by three Fraser Island World Heritage Area advisory committees.

Key threats requiring ongoing attention include degradation due to visitor numbers, inappropriate fire, invasive plants and animals, and climate change. Recreational use of the area is intensive and localised degradation can occur from excessive numbers of visitors potentially impacting on, in particular, lake water quality. Appropriate fire management is required to maintain the integrity of the World Heritage

values. Significant human and financial resources are being directed to the management of these threats as well as to the protection and monitoring of the property.

Fraser Island is a place of exceptional beauty, with its long uninterrupted white beaches flanked by strikingly coloured sand cliffs, and over 100 freshwater lakes, some tea-coloured and others clear and blue, all ringed by white sandy beaches. Ancient rainforests grow in sand along the banks of fast-flowing, crystal-clear creeks.

Fraser Island is the only place in the world where tall rainforests are found growing on sand dunes at elevations of over 200 metres. The low 'wallum' heaths on the island are of particular evolutionary and ecological significance, and provide magnificent wildflower displays in spring and summer.

The immense sand blows and cliffs of coloured sands are part of the longest and most complete age sequence of coastal dune systems in the world and they are still evolving. They are a continuous record of climatic and sea level changes over the last 700,000 years. The highest dunes on the island reach up to 240 metres above sea level.

The Great Sandy Strait, separating Fraser Island from the mainland, is listed by the Convention on Wetlands of International Importance (Ramsar Convention).

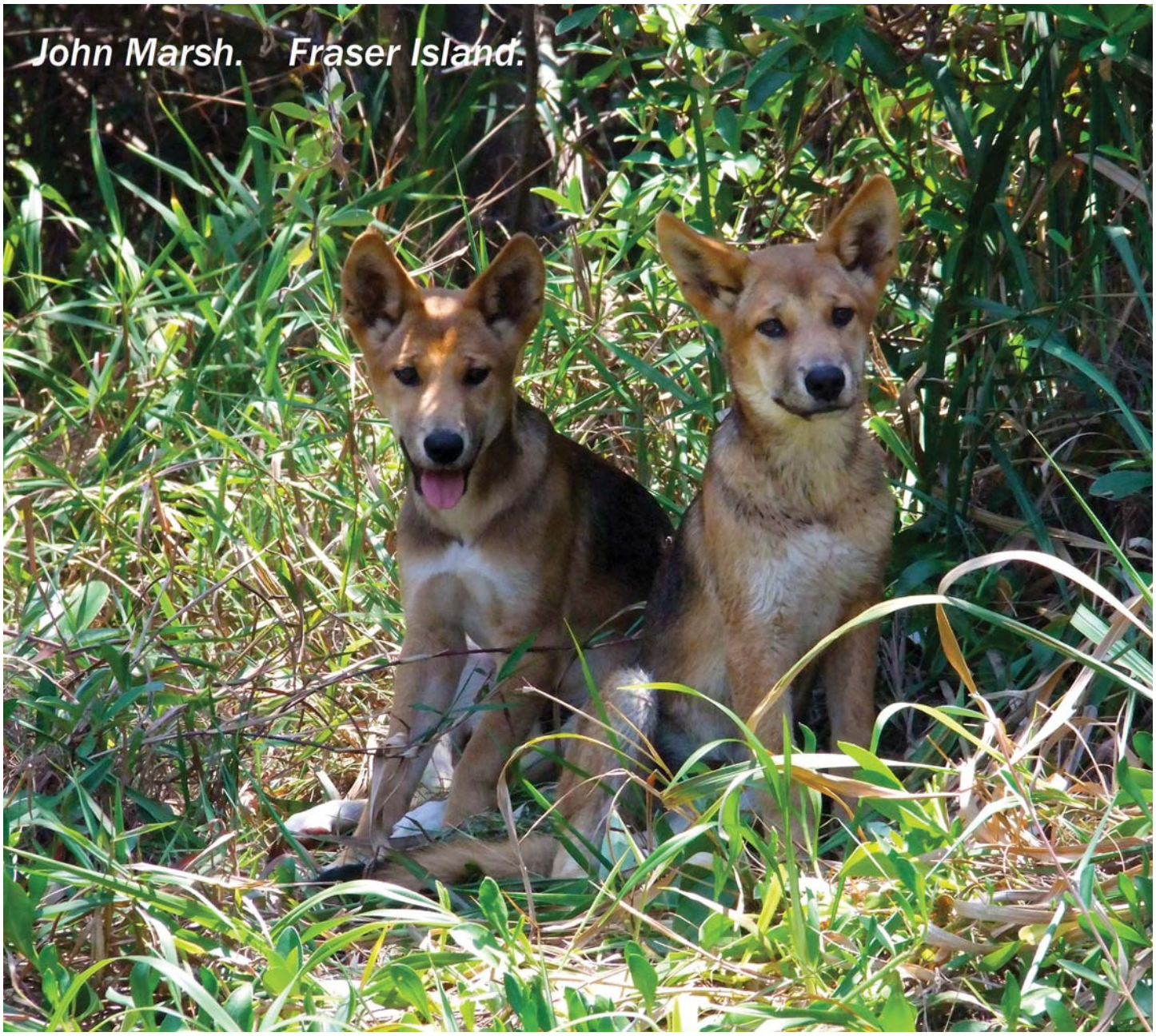
The wetlands include: rare patterned ferns; mangrove colonies; sea-grass beds; and up to 40,000 migratory shorebirds. Rare, vulnerable or endangered species include dugongs, turtles, Illidge's ant-blue butterflies and eastern curlews.

The species listed below represent a small sample of iconic IUCN Red Listed animals found on Fraser Island:

LwAlisterus scapularis | Australian king-parrot
SBufo marinus | Giant marine toad
Canis lupus dingo | Australian dingo
Caretta caretta | Loggerhead turtle
Chelonia mydas | Green turtle
Coggeria naufragus | Satinay sand skink
Crinia tinnula | Tinkling froglet
Dermochelys coriacea | Leatherback turtle
Diomedea exulans | Wandering albatross
Eretmochelys imbricata | Hawksbill turtle
Erythrotriochis radiatus | Red goshawk
Esacus giganteus | Beach thick-knee / Beach stone-curlew
Lepidochelys olivacea | Olive Ridley turtle
Litoria cooloolensis | Cooloola sedge frog
Litoria freycineti | Wallum rocket frog
Litoria olongburensis | Wallum sedge frog
Macronectes giganteus | Southern giant-petrel
Petaurus breviceps | Sugar glider
Phoebetria fusca | Sooty albatross
Pterodroma mollis | Soft-plumaged petrel
Pteropus poliocephalus | Grey-headed flying-fox
Thalassarche chrysostoma | Grey-headed albatross
Turnix melanogaster | Black-breasted button quail
Xeromys myoides | False water rat

The species listed below represent a small sample of iconic plants found on Fraser Island:

Acacia baueri baueri | Little wattle
Araucaria cunninghamii | Hoop pine
Archontophoenix cunninghamiana | Piccabeen palm
Backhousia myrtifolia | Small-leafed grey myrtle / carrol
Banksia integrifolia | Coastal banksia
Boronia keysii | Key's boronia
Callitris glaucophylla | Cypress pine
Casuarina equisetifolia | Beach she-oak
Cryptocarya foetida | Stinking cryptocarya
Eucalyptus pilularis | Blackbutt
Lophostemon confertus | Brush box
Macrozamia pauli-guilielmi | Pineapple zamia
Pandanus tectorius | Screwpine
Schoenus scabripes | Bogrush
Syncarpia hillii | Satinay / Fraser Island turpentine
Tecomanthe hillii | Fraser Island creeper



Fraser Island dingoes

The dingo (*Canis lupus dingo*) is a free-ranging dog found mainly in Australia. Its exact ancestry is debated, but dingoes are generally believed to be descended from semi-domesticated dogs from East or South Asia, which returned to a wild lifestyle when introduced to Australia. As such, it is currently classified as a subspecies of the grey wolf, *Canis lupus*. The Australian name has therefore sometimes been applied to similar dogs in South-East Asia, believed to be close relations. As free-ranging animals, they are not considered tame, although tame dingoes and dingo-dog hybrids have been bred.

The survival of the Fraser Island dingoes relies on three management factors – education, engineering and enforcement. Fraser Island dingoes are part of the island ecology, and are protected by law. The Dingo Conservation and Risk Management Strategy for Fraser Island (2013) uses dingo-deterrent fencing, enforcement (fines) and education campaigns to protect people and to help the dingoes retain a natural way of life. Less than one per cent of areas on Fraser Island that are accessible to people, including some campgrounds, townships and resorts, currently have dingo-deterrent fences and grids. These are installed for the safety of dingoes as much as they are for the safety of people.

The dingo is protected in Queensland national parks as a native species. The Queensland Parks and Wildlife Service has a legal responsibility to conserve these populations on national parks

Above: Most of these puppies have not survived; many are destroyed due to juvenile behaviour/negative encounters with tourists and yet residents and tour operators do not have problems with the dingoes. It truly comes down to education and knowing how to behave around a wild animal. Photo by John Marsh

and protected areas, even though the dingo is a declared pest outside of these areas.

Wildlife authorities recognise that Fraser Island dingoes may become the purest strain of dingo on the eastern Australian seaboard and perhaps Australia-wide[1].)as they have not crossbred with domestic or feral dogs to the same extent as most mainland populations. Therefore, their conservation is of national significance.

On Fraser Island, dingoes are normally a golden sandy colour. They are often born with black markings, particularly on the back and tail, and lose the black hair as they get older. Juveniles may retain black on their backs and sometimes on their tails. Most have white markings on their chests, tail tips and feet described as 'socks'. Some have black muzzles and all have pricked ears and bushy tails. Tail tips, socks and any fighting scars are unique to each individual dingo and these help in individual dingo identification.

Adult dingoes on Fraser Island stand more than 60 cm high, about 1.2 m long and have an average weight of around 18 kg. This is a higher average mass than dingoes from Kakadu (16 kg), the Victorian Highlands (15 kg) and Central Australia (13 kg)[2]. The dingoes from these three areas were also about 1.2 m long, indicating that Fraser Island's dingoes are about the same size as dingoes from other areas and, if anything, a bit heavier. They certainly are not leaner than dingoes from other areas.

Most female dingoes become sexually mature at two years of age, but some may produce pups in their first year. Unlike the domestic dog, the dingo breeds only once a year. Gestation takes about 63 days and litters of 1–10 pups (normally 4–6) are born and cared for (whelped) during the winter months. Dens are hidden in areas such as a hollow log or in a hole dug under the roots of a tree. Pups usually become independent at 3–4 months or, if in a pack, when the next breeding season begins.

Dingoes produce several types of vocalisations. They howl to announce their location and find out where other dingoes are in the landscape, mostly at night to keep the pack together and to warn others to stay away. Packs often howl in a chorus, which may be more intimidating to other packs. Strangely, Fraser Island dingoes often howl at the sound of aeroplanes landing or taking off. Dingoes also produce bark-howls, which are agitated calls made when the animals are alarmed. Other dingo sounds are moans and snuffs. Wild dingoes have not been recorded to bark, but captive dingoes sometimes learn to bark from nearby domestic dogs.

(Endnotes)

1 Woodall et al. 1996 as quoted in Fraser Island dingo management strategy

2 Corbett 1995 The Dingo in Australia and Asia, UNSW Press, Sydney

Dingoes have almond-shaped eyes with a mascara line around both top and bottom eyelid. Their sense of smell is around 100 times better than ours. Photo by Jennifer Parkhurst

Save Fraser Island dingoes

Cheryl Bryant (Publicity Officer)

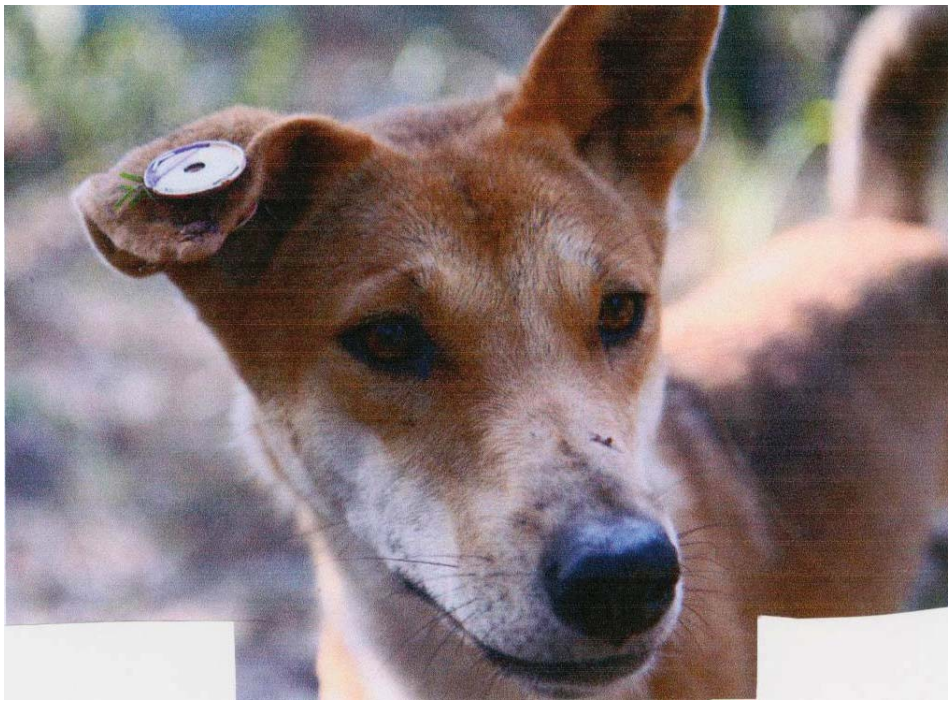
Save Fraser Island Dingoes Inc. (SFID) is a voluntary organisation founded in 2009 due to concerns raised by the community and visitors regarding the health and wellbeing of the Fraser Island dingoes. The dingo population was on the verge of possible extinction; government legislation allowed animals to be trapped, tagged, hazed (shot with clay pellets) and destroyed. Apart from a few visitors and local residents, the public were generally unaware of the critical situation. SFID became the eyes and ears of the island, reporting their findings to the media, the public, researchers and scientists. Public education is a major component of SFID policy.

SFID is a collaborative effort of a committed group of people. The committee members have brought their knowledge and expertise together to form a conservation strategy and keep the public informed. SFID currently has over 300 members, with a social media following of more than 3,000 supporters. The fate of the Fraser Island dingo depends on public support, therefore community involvement is paramount. Visitors, employees and residents of the island report their observations and SFID follow through at government level and media outlets. This ensures that any policy regarding dingo management remains transparent and open to public scrutiny. Quarterly newsletters are sent to all members updating research, information, projects and activities. There has been significant support from the public and local community. Membership in the organisation continues to grow as people want to be more informed of the situation on Fraser Island.

SFID is working with experts in dingo/wildlife management within Australia and overseas. The organisation aims to ensure 'best practice' is adhered to when dingo management strategies are released. Scientific research has established that the Fraser Island dingo has significant conservation value due to the fact that the dingo is an integral part of this unique environment and as apex predator is vital in maintaining the health and balance of the island's fragile ecosystem. The Fraser Island dingo is a genetically unique species because of its isolation from the mainland; therefore we have an obligation to ensure that the genetic integrity of the animal is preserved. The Fraser Island dingo adds to the value of the island as a major international tourist attraction; it is one of few places where visitors may get the chance to observe a dingo in its natural habitat.

SFID continues to liaise with the scientific community and government in order to develop strategies to maintain a viable and healthy dingo population, both on conservation and compassionate grounds. SFID's objective is to ensure that the Fraser Island dingo not only survives, but thrives on its island home. A major goal was to have the Fraser Island

Above: Dingoes only breed once a year. They usually have white socks and tail tips. A dingo's paw structure is longer than a dog's, it actually walks on its toes. Dingoes howl and generally don't bark. Photo by Jo Emanuele



Thank goodness that more care now is taken when ear tagging and ears like these are a thing of the past

Dingo Management Strategy (FIDMS) peer-reviewed and establish an independent advisory committee to oversee the ethical and humane treatment of the dingo.

Following lobbying and promoting public awareness, the review was undertaken in 2013. This was a notable achievement and has brought about significant changes in management policy.

SFID's aims are to:

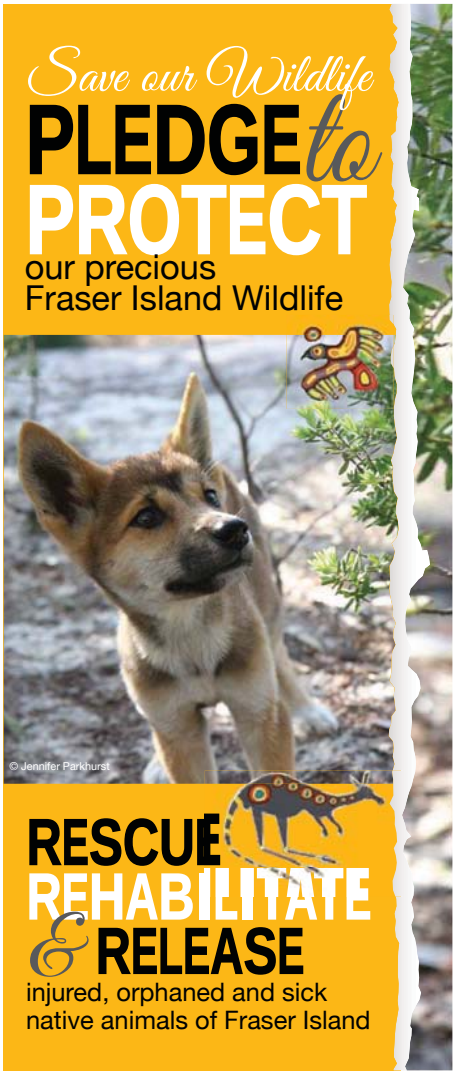
- recruit individuals and organisations with necessary skills and abilities to assist with the conservation of the Fraser Island dingo in the wild;
- encourage and promote government and legislative policy change to ensure the protection and survival of the Fraser Island dingo in the wild;
- assist with education programs to ensure the Fraser Island dingo maintains its status on the island as a native animal;
- ensure the Fraser Island dingo remains an integral part of the World Heritage listed status it enjoyed at the original listing;
- fund specific research trips to the island, with the assistance of expert volunteers;
- fund urgently needed external and independent scientists and veterinarians to assist in analysing data, including incident reports, tag registers, and necropsy reports;
- gather figures on prey availability, analysis done on DNA/scats to determine dingoes' current diet and sustainability of food/prey sources; and
- conduct detailed research on visitor attitudes and their understanding of dingo behaviour, which must be undertaken in order to develop clear educational material. This will inevitably improve human–dingo interaction.

The dingo population on Fraser Island is regarded as the most pure strain of dingo remaining in eastern Australia. Under sections 17 and 62 of the *Nature Conservation Act* 1992, the dingoes are provided legal protection as a 'natural resource' of the island, but that protection is limited. Due to a lack of facilities, many injured animals do not receive medical treatment. Animals have been observed with fish hooks embedded, some causing serious infection. Current policy is to euthanase dingoes with broken limbs or other unspecified injuries, when many of these injuries could be treated. There have also been reports of paralysis tick attack and other treatable illnesses.

SFID is currently raising funds for a proposed Care Centre for Fraser Island. It is unacceptable that there is presently no facility to treat sick or injured animals. The former Minister for Environment Andrew Powell was very supportive, however since the state election we have yet to meet with the new Minister for Environment and we do not know what his thoughts will be on this proposal.

Despite improved management in many areas, the mortality rate from vehicle strikes continues to rise, ear tagging continues and visitors interfering or attempting to interact with dingoes may still result in animals being destroyed. The campaign for a healthy and thriving population continues.

SFID is a registered not-for-profit environmental organisation with tax-deductible status. Our mission is the conservation and protection of this unique and iconic species. The organisation continues to monitor all activity on Fraser Island that affects the sustainability of the island's dingoes. More information is also available on its website www.savefraserislanddingoes.org.au



The Nature Conservation Council of NSW

The Nature Conservation Council of NSW was formed in 1955 and is a diverse, democratic network of environmental organisations and individuals with a shared passion for the conservation of nature and a vision of a sustainable future for New South Wales.

Our Society was a foundation member of the Council and our President Dr Vincent Serventy AM was a foundation member of the Council in 1955. We have had three past presidents serve on the Board of the Council – Dr Vincent Serventy AM, Dr David Murray and Patrick Medway AM – since its foundation in 1955.

60 years of fighting for the conservation of nature - 1955-2015

Before the Nature Conservation Council of NSW formed 60 years ago, nature in this state was pillaged on an industrial scale with large-scale and widespread land clearing and habitat destruction for agricultural purposes across New South Wales.

Land clearing was uncontrolled, rainforests were clear-felled, wildlife was being decimated, and mining companies recklessly destroyed our extraordinary wild places. Before NCC, there was no National Parks and Wildlife Service, no Environment Protection Authority, no Land and Environment Court, and no marine parks!

The achievements of the environment movement in New South Wales over the past six decades are a tribute to the hard work, vision and tenacity of the many thousands of people who have had the courage to be a voice for the conservation of nature and its wildlife in all its forms.

As we celebrate 60 years since the foundation of the Nature Conservation Council of NSW, we can all take heart that there have been some major achievements in conserving much of our natural heritage across the state. We now have a large number of national parks, nature reserves and marine reserves protecting our native wildlife and its vital habitat, from the Snowy Mountains down to the seashores and out into new marine parks and marine sanctuaries proving habitat for fish and crustaceans.

It was a delight to attend the 60th anniversary celebrations at the Australian Museum in Sydney and to present the President of the Council, Professor Don White, with a Certificate of Appreciation from the Australian Wildlife Society.

Above: Vice-President Dr Clive Williams OAM, Professor Don White and CEO Patrick W. Medway AM at the celebrations.

OUR **VANISHING** EMUS

CALLUM MENEY

The Australian coastal emu (*Dromaius novaehollandiae*) has dwelled in the grasslands of coastal Australia since the origin of the species on the continent.

Coastal emus survive in these grasslands due to the availability of ample amounts of fresh water that they need daily. Coastal emus, among every other species on the planet, are suited and adapted to their environment. As we have seen in countless other situations in the world, displacement from their natural habitat has devastating effects on the species' survival as a whole. The coastal emu is no exception to this, but there is one major issue that we are turning a blind eye to. The coastal grasslands of Australia, as well as being the perfect habitat for the coastal emu, are also the prime location for Australia's growing population's housing. As the number of people residing in Australia climbs, so does the number of houses required. New housing estates are driving coastal emus further and further inland or worse, fencing them in with nowhere to go.

The coastal emu has been listed as Endangered under the *NSW Threatened Species Conservation Act* since 1995 and the bird's population has halved in the last 20 years.

As emu sightings are relatively rare, when people started seeing less and less of the species, they did not naturally suspect that the emu population was decreasing. That was until 2002, when a survey revealed a 50 percent decrease in the species' numbers. As numbers are falling dangerously low, the animals are less likely to find a mate to breed with, resulting in a steady decline of the species. In many parts of New South Wales, emus are being fenced into small patches of isolated grassland. It seems like a recurring theme that humans do not take into consideration the migration of a species when building long barbed-wire fences. Emus are unable to escape from these fences due to their lack of flight ability. Hence, emus are being kept in small and most likely overcrowded areas of habitat, and we can only assume that those emus that do make it out of those areas probably don't survive the trip across roads and through civilised areas to a larger, more suitable area of grassland. Five years ago, seeing emus in the bush alongside roads in coastal New South Wales was a common occurrence. Nowadays, seeing an emu like this is extremely rare. If grassland habitat is not preserved, we may see the extinction of coastal emus sooner than we think.

Above: Australian coastal emus roam bush and grasslands all throughout the coast of Australia

Signs such as this one are becoming less and less relevant due to urban sprawl

Victim of surban sprawl: this emu paced back and forth along this fence searching for a way out

This sign reads 'beware of kangaroos and emus on this property' although there are no obvious signs of any substantial population of either species in the fenced area

An emu nests in grasslands in New South Wales. Emus can produce up to 10 eggs a year

This bulldozer sits outside a fenced-off area of emu habitat in coastal New South Wales, ready to prepare land for housing

This emu was alerted when a car drove just metres from its habitat

Meet southwest Western Australia's *Setonix*

(aka the quokka: "the happiest animal in the world")

Kit (Amy) Prendergast (Zoologist and Conservation Biologist)

With an adorable little face that seems to bear a perpetual smile, it's no wonder the pop-culture website BuzzFeed.com produced a page featuring images of these smiling marsupials entitled '25 Selfies That Prove Quokkas Are The Happiest Creatures On Earth'. Despite this international web-wide acclaim to fame, few people (Australians included) know much about the actual biology and ecology of this marsupial. Moreover, despite its happy demeanour, the situation this species faces regarding its recognition as being vulnerable to extinction is not so 'happy'.

Meet the quokka

The quokka (*Setonix brachyurus*) is a small marsupial in the family Macropodidae (the group including kangaroos, wallabies, pademelons and tree kangaroos). This species is believed to have diverged early from other lineages that gave rise to other macropod genera. The closest living relatives of the quokka are believed to be the rock wallabies (genus *Petrogale*).

The first recorded observation of the quokka occurred as early as 1658 by Samuel Volckertzoon, describing them as a "wild cat resembling a civet-cat but with browner hair". Almost 40 years later Willem de Vlamingh observed these animals, describing them as "a kind of rat as big as a common cat", resulting in naming the island on which he observed them 'Rottnest' – that is, 'rat's nest'! Clearly, these early explorers were severely lacking in their accuracy of natural history observations! Of course quokkas, being marsupials, are not evenly remotely related to rats (or cats), the latter which are eutherian (also known as placental) mammals, sister group to the marsupial mammals.

The quokka is highly distinctive, and as such is the only species within its genus *Setonix*. The quokka's genus name

brachyurus

Setonix derives from the Latin 'seta' meaning bristle and the Greek 'onyx' meaning claw. The species epithet, *brachyurus*, derives from the Greek 'brachys' meaning short, and 'oura' meaning tail; as denoted by its species epithet, quokkas have fairly short tails for a macropod (26–31 cm long).

Appearing to have a mouth looking like it is permanently smiling, it is no wonder the quokka earned the moniker 'the happiest animal in the world'. With a round face, short snout, dewy puppy-dog eyes, and short, round ears, the quokka arguably could also run for contender as 'the cutest animal in the world'! Adult male quokkas are about 54 cm long and weigh up to 4.2 kg, whereas females are smaller, being 50 cm long and weighing up to 3.5 kg. Like all macropods, the quokka has relatively large feet, large hind legs but small fore legs, and females possess a clearly defined pouch. This small wallaby has fairly short, thick, coarse brown fur which is lighter on the underparts. The tail is sparsely furred, and tapers towards the tip. The base of the tail merges smoothly with the rest of the body (a common trait of marsupials distinguishing them from eutherians, which feature tails that are clearly differentiated from the body). Like all macropods, the tail functions in balance, and also acts as a 'fifth limb' when they are travelling slowly along the ground whilst browsing using their tail along with both fore and hind limbs to ambulate. Interestingly, quokkas can store fat in their tail, which is an adaptation for coping with varying seasonal food availability. Consequently, this means that tail circumference (a proxy for fat storage in the tail) relative to body weight provides researchers with a means to assess health and body condition of a quokka.

Quokkas are browsing herbivores, feeding upon plant leaves and stems. Quokkas display a clear preference to feed on new young growth. Quokka numbers are often highest in areas with abundant young vegetation, where the high nitrogen levels of new growth maximise health and body condition. Whilst faecal analyses of quokka scats in the northern jarrah forest identified 29 different plant species in the scats, five species accounted for 71 percent of the diet. *Thomasia* species (a native southwest Australian endemic plant) were the most common component. A different floral community exists on Rottnest, and here the diet of quokkas largely comprises succulents like *Arthrocnemum halocnemoides*, *Carpobrotus aequilaterus*, and *Rhagodia baccata* (berry saltbush). Because these native plants are deficient in nitrogen, quokkas often supplement their diet with the introduced stinkwort, and even snails and people's food scraps!

A southwest endemic

Southwest Western Australia is one of the world's 31 biodiversity hotspots, a status awarded by featuring a large number of species found nowhere else on the planet. The quokka contributes to this hotspot of endemic biodiversity: it occurs only in southwest Western Australia, restricted to a few localities on the mainland, as well as on two offshore islands, Bald Island, and of course, Rottnest Island. Quokkas on Rottnest and Bald Island became isolated from mainland subpopulations following sealevel rises some 7,000 and 10,000 years ago respectively.

On the mainland, its range extends from just south of Perth to the Hunter River. Within this already limited distribution, quokkas occur in small, isolated fragments of suitable habitat. The region has a Mediterranean climate, characterised by hot, dry summers and mild, wet winters.

There are seven distinct subpopulations of quokkas: Rottnest Island, Bald Island, northern jarrah forest, central jarrah forest, southern forests, south coast, and Stirling Range.

Quokkas are renowned for their association with Rottnest, an island covering 19 km^2 located 12 km off the coast of Fremantle. Indeed, the quokka's presence on Rottnest is a major drawcard for tourists. The Rottnest population is the largest of all quokka populations, typically comprising 4,000–8,000 individuals. However, estimates are imprecise, and numbers on Rottnest fluctuate widely in response to environmental conditions between years. Summer droughts are particular 'population crunches', where, during severe conditions, numbers can be severely reduced. The overall trend of Rottnest quokkas however is thankfully stable. Bald Island is the second largest subpopulation, with an estimated 600 quokkas, also with a stable population trend.

Unfortunately the situation for mainland populations is less secure. Almost all mainland subpopulations are decreasing and under threat of localised extinction. On the mainland, quokkas occur in two major groups: one set in the northern and central jarrah forest, and another set of groups in the south. These groups are genetically differentiated from each other, as well as from the island subpopulations.

Numbers in each mainland subpopulation are low, and in the north, only 1–36 quokkas per subpopulation were recorded in a survey conducted in 2003. This

is concerning given that estimates suggest that unless a population is connected with others to represent a larger metapopulation, populations with 50 individuals or less are unviable. Already, in the 2003 survey, of the eight sites surveyed that previously supported quokkas in the early 1990s, it was discovered that at three of these, quokkas had become extinct.

Genetic and morphological analyses of quokkas sampled from different subpopulations throughout their range suggests that whilst all subpopulations comprise a single 'evolutionary significant unit', differentiation between various subpopulations suggests that some should be managed separately.

Rottnest Island quokkas appear to have evolved distinct adaptive differences associated with their unique environment which are absent from mainland quokkas, and should be recognised and managed as an important, unique subpopulation. Likewise, unique differences between the northern jarrah forest and southern forest quokka subpopulations also indicate both are important and each must be conserved.

The ecological, genetic, and morphological distinctiveness of the island populations suggests that despite being more abundant and stable, it is inadvisable to use individuals from Rottnest to supplement the dwindling mainland populations since this may lead to outbreeding depression – reduced fitness due to maladaptive genes being introduced into the mainland populations. Rather, efforts should be better directed to improve the extent and connectivity of quality habitat to boost numbers within each mainland population (possibly with supplementation from captive breeding) and to restore dispersal between the now fragmented and isolated subpopulations.

Habitat

Quokkas in different populations appear to have different habitat preferences. On the mainland they prefer dense, low vegetation that provides shade and a refuge from potential predators like owls, cats, and foxes. In the northern Jarrah Forest, quokkas are almost exclusively found in dense native vegetation – namely *Agonis* swamp shrubland, close to waterways and where the dense habitat offers shade and protection from predators. In the south, mainland populations occupy a wider range of habitat types, but are often associated with a mosaic of vegetation providing both protection from heat and predators, as well as more open areas for foraging.

On Rottnest, quokkas prefer dense thickets of *Gahnia* and *Acanthocarpus* species which provide shady microhabitats, especially during hot summers. Quokkas on Rottnest experience a trade-off: whilst they are free from competitors for food and habitat, and from predators, and roadkill – all sources of mortality on the mainland – Rottnest Island is not an ideal habitat. Whilst Rottnest has some spectacular salt lakes, there are very few freshwater sources, and there is less dense, shady, floristically diverse vegetation. During summer, the island becomes parched, and palatable herbage declines. This deterioration in habitat is accompanied by a deterioration in the body condition of the quokkas, and many quokkas lose body weight. Mortality rates are also highest during this trying time of the year.

Island quokkas

Despite the relatively larger size and stability of the island quokka subpopulation, and lack of predators and traffic as a cause of mortality, the Rottnest and Bald Island quokkas are not without threats. Due to being colonised from a few animals representing just a subset of the original mainland population, followed by long-term isolation, the island populations have low levels of genetic variation compared with the mainland populations. This is the result of what is known as the 'founder effect' followed by genetic drift and inbreeding under lack of gene flow. Fortunately, these lower levels of genetic variation do not seem to be associated with inbreeding depression (the situation that occurs when individuals that are closely related produce inbred offspring which are associated with suffering declines in health, survivorship or reproduction, which may be attributed to inheriting two copies of deleterious recessive alleles whose negative effects are normally masked when a deleterious recessive allele is paired with a different non-deleterious allele in non-inbred animals). Nevertheless, a lack of genetic variation at the population level is concerning because genetic variation is important for a population to adapt under changing environmental conditions in the future.

The Rottnest population appears to be both genetically and ecologically distinct, having adapted to the unique conditions present on Rottnest Island. Unlike on the mainland, where quokkas appear to have high water requirements, and are found in riparian habitats which provide access to freshwater throughout the year, on Rottnest, quokkas appear to have adapted to cope with limited water

supplies. A study on the metabolic rates, feeding rates and water fluxes of Rottnest Island quokkas by Nagy et al. in 1990 reported that water ingested in their food could completely account for the quokka's water intake. Whilst Rottnest quokkas suffer from water deficiencies during summer and autumn where seepage water is scarce or absent, they nevertheless can survive (albeit in poor condition and suffering higher mortality rates) without drinking! In fact, the poor conditions and mortality rates stem not from water but rather nutrient deficiencies during these trying times. In regions where free-standing water is absent, in summer when evaporative water loss is highest, quokkas are impelled to consume succulent herbage. Whilst this can prevent them from dying from dehydration, it means this preference for succulent herbage results in a deficiency of other nutrients.

Quokkas also have kidneys adapted to limit water loss in urine, being capable of excreting only 3 mL or less of highly-concentrated urine: a huge water-saving compared with the 25 mL/hr of urine that quokkas excrete in winter or in captivity when they are not water-limited! Likewise, in summer they can also limit water loss in their faeces, producing faeces with 15 percent less water content in summer than in winter.

Rottnest Island quokkas are thus remarkable in that whereas mainland quokkas clearly prefer, and appear to depend upon, densely-wooded, high-rainfall habitat, Rottnest quokkas persist at high abundances in the semi-arid, scrubby habitat that covers the island. They have adapted to seasonal drought by being able to survive long periods without water, deriving all the water they need from succulent plants, and their kidneys are so efficient at conserving water and producing highly-concentrated urine that they are even known to be able to drink sea water with no observable ill effects!

Quokka antics

Quokkas live in small group territories or colonies. On the mainland, typically no more than one or two dozen individuals will be sighted together, whereas densities are higher on Rottnest.

On the mainland, quokkas are rare and shy, posing a hurdle in effectively monitoring these populations. Often their presence is only inferred by characteristic runways they make or by their scats (which can be hard to distinguish without genetic analyses from scats of co-occurring other macropod species). During the day, quokkas rest in the cover of sedges, and come out into more open habitat to feed only under the cover of the night's darkness.

Mainland quokkas' secretive behaviour contrasts markedly with that of the highly inquisitive Rottnest quokkas! Having evolved over thousands of years in the absence of predators, Rottnest quokkas have lost the shyness displayed by their mainland congeners. Unlike those on the mainland, island quokkas congregate in large numbers, feed in the open, and do not restrict activity to the cover of dark night-time affords. The limited supply of freshwater on the island also draws quokkas into close proximity to human settlements, and about 46 percent of Rottnest quokkas occur around settled areas where water, grassy lawns, and other resources are ever-present. They have become remarkably tame, and are unfazed by tourists ogling at these cute critters, and will even approach people offering them food. Whilst Rottnest's tourists and human populace certainly enjoy being able to get up-close and personal with these endearing marsupials, and the quokkas benefit from the predictable resources associated with human habitation, this does not come without risks to the quokkas. High rates of human visitation to the island have led to high rates of disturbance, degrading the plant communities that provide quokkas with habitat. Quokkas have also been victims of extreme animal abuse and cruelty. In the 1990s and again in the early 2000s, quokkas were subjected to the sadistic activities of some cruel imbeciles who devised 'quokka soccer', kicking the animals about, often fatally.

What's even cuter than quokkas? Their joeys!

Quokkas have the potential to breed throughout the year, however the number of births declines in summer on the mainland, and on Rottnest quokkas become anoestrous (cease breeding) in summer. This is a facultative response to insufficient resources which induce a concomitant decline in body condition of females. Where quokkas inhabit areas around rubbish tips that provide an ongoing, predictable abundance of food, they breed throughout the year unlike the other seasonally starved quokkas at other sites on Rottnest Island. Similarly, females in captivity given *ad lib* access to water and quality food show no seasonal declines in reproduction. Bald Island quokkas also appear to breed once per year. On island habitats, most births occur from mid-February to late April. The poor climatic conditions in summer causing loss of body condition and inducing anoestrus over summer, and pattern of the timing of birth, is an adaptive response to ensure births are timed

such that when young are weaned in spring, this coincides with high-nutrient forage generated following winter rains, thereby maximising their survival during this critical period.

On the mainland, quokkas have high fertility, and can wean two joeys per year, whereas on Rottnest typically only one joey per year is weaned. Despite the relatively high reproductive rate on the mainland, recruitment of the pouch young to independence is low, and it appears that juveniles suffer high mortality, potentially due to predation by cats. In studies conducted in the northern jarrah forest, less than one in two pouch young survived to independence.

After conceiving, quokkas have a non-delayed gestation period of a mere 25–27 days! Like all marsupials, this short gestation period means that a newborn quokka joey is essentially embryonic: born tiny, naked, blind, deaf, and yet to have many systems fully developed; they cannot regulate their body temperature, their hindlimbs are mere buds, and many muscles and neural systems develop only later during pouch-life. A newborn joey is minuscule, weighing on average a mere 0.3 g or less. Hence, a newborn joey is only about a one-fifteen-thousandth of the weight of its mother! Despite this state of extreme underdevelopment, the newborn joey has well-developed forearms that bear tiny claws, enabling it to crawl, without any assistance from the mother whatsoever, all the way from the cloaca to the pouch. Once within the safe, warm confines of the pouch, it latches onto one of its mother's four teats where it will remain permanently attached for the next 70 days. Only at about four months after birth does the quokka joey start to resemble a eutherian mammal newborn! A quokka joey's eyes do not open until 115 days. Its ability to regulate to some extent its body heat by shivering to warm itself up in response to cold does not develop until 121 days, and only by 125 days of age does fur start to develop. The joey emerges from the pouch at about 180–200 days of age. During this critical stage when major developmental events are occurring, growth rate is extremely rapid: at 50 days of age, joeys weigh on average 15 g, by 120 days old they weigh 110 g, and at pouch emergence at about 180–200 days of age, the joey weighs about 400–500g. So, in only half a year, nurtured by its mother's unique milk, a joey's weight is 1,667 times greater than that when born!

Females become reproductively mature at about 252 days of age, with males reaching reproductive maturity somewhat later at 389 days. Females appear to begin breeding earlier in captivity than in the wild: whereas females in captivity can breed at 8–9 months of age, studies on wild populations have found the youngest females to breed are 15 months old on the mainland, and on Rottnest they start breeding even later when 12–30 months old. Male quokkas also exhibit this pattern of later age of sexual maturity on Rottnest than on the mainland. Quokkas are known to have the potential to live for 10 years in the wild, but under the benign conditions of captivity have a lifespan of 14 years. In the wild most populations appear to comprise 50 percent adults, 25 percent juveniles, and 25 percent pouch young. Whilst twins may be produced, this is very rare and most females only produce one joey per pregnancy.

Marvellous milk

Compared with eutherian lactation, marsupial lactation is unique and highly sophisticated for the volume and composition of the milk are not uniform throughout lactation, but rather change to meet the changing needs of the offspring as it transitions from being a tiny under-developed neonate to independence. Given the tiny size of the neonate, only small volumes are initially produced, yet this milk is relatively high in sugar to fuel the joey's escalating growth. This early milk also is the joey's only source of water, and is relatively dilute, since the young joey's kidneys are underdeveloped and cannot conserve water. As the joey grows and transitions between key milestones in development, this is accompanied by increases in both volume and major constituents of the milk, to accommodate the nutritional demands of the offspring. Milk compositional changes are tailored to meet the distinct developmental and behavioural stages of the joey. By 70 days after birth, the joey no longer remains permanently attached to the teat, although it still stays within the safe confines of the pouch, suckling frequently. At 150 days, it starts to poke its head out of the pouch and see the big wide world, and will start to nibble at grass whilst its mother is feeding. About 30 days later the joey makes its first full emergence from the pouch, but will continue to return to the pouch (especially if cold or alarmed), and suckles intermittently. At about 180–200 days of age it exits the pouch permanently, but continues to suckle until about 300 days of age. Between 150 and 300 days, herbage consumption increases until at 300 days the joey is weaned and relies totally on herbage for energy and nutrition.

A study by Miller et al. (2009) measured the changes in the composition of quokka milk from when the joey was 70 days old to 300 days old. Protein levels rose steadily from an average

of 60 g/L after the joey first detached from the teat to ~125 g/L towards the end of lactation. The concentration of lipids was fairly low from 70 days until 180 days, remaining at on average 45 g/L. After the joey exited the pouch at 180 days of age, lipid contents rose sharply, increasing to ~80 g/L during the period transitioning from the pouch to permanent pouch exit, and then continuing to rise steeply to ~150 g/L at around 230 days of age. Lipid levels then dropped sharply to 72 g/L during the last 30 or so days of lactation.
In contrast, the total carbohydrate concentrations were highest at the start of lactation, then began to fall sharply at 150 days from ~80 g/L to ~20 g/L at permanent pouch exit, then continued to decline to ~12.5 g/L at the end of lactation. This decline in carbohydrates in the milk can be explained by how after 150 days old, the joey starts to eat forage, and can rely on plants it consumes to obtain carbohydrates. Similarly, lactose – the major milk sugar – was high and rose gradually during the first phase of lactation, but during the time that the joey began to transition to exiting the pouch, dropped steeply from ~28 g/L to ~12 g/L at 200 days when the joey permanently exits the pouch, to then continue to decline gradually to 6 g/L at the end of lactation. This trend likely also reflects the shift in relying on milk sugars to those supplied in the adult diet of herbage. The pattern of decreased milk carbohydrates relates to how quokkas, as foregut fermenters, need to establish a suite of symbiotic microbes in their forestomach, which ferment the tough, indigestible cellulose in plants into volatile fatty acids which provide the quokka host with energy. Unlike lactose, a specific milk sugar, two other carbohydrates, galactose and glucose, were present only at very low concentrations initially, increasing at about 150 days to peak at permanent pouch exit, and then gradually declining until the end of lactation. Galactose and glucose are simple sugars, and likely serve to provide the joey with a readily absorbed source of energy while the young's digestive system is transitioning to the adult fermentation-based system. Once the fermentation forestomach is fully developed, symbiotic microbes can provide the quokka with its energy, so that concentrations of other sugars in the milk decline towards the end of lactation. The overall increase in protein and lipids corresponds with the joey's growing needs, supplying the joey with a rich source of energy and amino acids for growth and development. Lipids are a high-concentration source of energy, and the increase in lipid content after the joey emerges from the pouch provides it with the extra energy needed to thermoregulate itself, no longer snug and warm within its mother's pouch, and as the joey increases its activity levels when it begins to learn how to forage and increases its movement (no longer getting to be carried around in the pouch by mum!).

Embryonic diapause

Quokkas, along with some other macropod and possum species, have the amazing marsupial adaptation of being able to exhibit embryonic diapause. A mere one day after a female gives birth, she becomes sexually receptive again, and will mate. Because she is already supporting a young joey in the pouch, the resulting new embryo becomes dormant (diapauses). Over the next five months, if the pouch young dies, rather than have to find a mate successfully, the female has this 'back-up', and in the absence of suckling which maintains the diapause state, this results in the embryo being re-activated, resuming development and being born 24–27 days later. If the first joey survives, under summer the diapaused embryo degenerates, but if the female is in good condition, the diapaused embryo resumes growth once the first joey is weaned.

While it may sound appalling to us, as a survival tactic when a mother quokka is pursued by a predator, she may expel her pouch young, leaving the predator to feed on the evicted offspring and thereby allowing the mother to escape. Because offspring survival is fairly low anyway and a female has about seven but potentially up to 17 opportunities to produce offspring over her lifetime, this tactic is adaptive, especially since the female has a 'back-up' diapaused joey to compensate for the lost young. Nevertheless, this survival mechanism can negatively affect population growth if a female is harassed repetitively, since it will prevent raising any young to independence.

Conservation situation

Owing to a decline in geographic range, reduction in the number of known populations, and the perceived threat of predation, the quokka has been recognised as being threatened with extinction, and is listed as Vulnerable by the WA Threatened Species Scientific Committee (using the IUCN Red List categories and criteria), and also is listed as Vulnerable under the national *Environmental Protection and Biodiversity Conservation Act*. In recognition of its threatened status, this led to the creation of the *Quokka (Setonix brachyurus) Recovery Plan* by the Western Australian Department of Environment and Conservation (now the Department of Parks and Wildlife) in 2013. This Recovery Plan outlines actions for quokka conservation

covering 10 years, with the overall long-term objective of the recovery program to at least maintain the quokka's current distribution and abundance.

Fossil deposits indicate quokkas appear to have occupied approximately 49,000 km² in southwest Western Australia. They were widespread and abundant when Europeans first colonised the region in the 1830s. However, they underwent a drastic decline over the following century. Another major decline occurred in 1980–1992. The quokka continues to decline in range, abundance, and sites where it once occupied. Overall, the area quokkas occupy has been reduced by at least 50 percent since the 1930s, and it is estimated they now only occupy an overall area of 5,700 km², in small, isolated patches.

Hunting of quokkas would have contributed to early declines. These formerly abundant marsupials were once declared as 'vermin' in 1933 and these endearing animals were cruelly hunted and poisoned at commercial levels. Fortunately, this abhorrent practice has been outlawed and no longer poses a threat to quokkas. Faced with the onslaught of habitat destruction, road mortality, hunting, compounded by increased predation following the introduction of foxes in the 1930s, these once-ubiquitous marsupials, commonly seen grazing in a diverse array of habitats, are now seldom sighted, and are confined to remnant patches of dense native vegetation.

Historical records suggest that quokkas have never had a continuous distribution on the mainland, but have inhabited numerous habitat patches in regions of high rainfall that promote dense vegetation, with movement occurring occasionally between these discrete patches. Genetic data suggests mainland quokkas became differentiated into a number of discrete subpopulations within a metapopulation (rather than a single, large, undifferentiated population) ~1,000 years ago as a result of reduced rainfall creating discrete refugia of suitable habitat patches. Yet whilst quokkas once formed what is known as a 'metapopulation' – where subpopulations in patches of habitat moved between patches, allowing recolonisation of patches in the event of random declines or localised extinction – now the lack of suitable intervening habitat, and destruction of many habitat patches, means that mainland subpopulations are isolated and cannot move between subpopulations.

The current lack of dispersal between subpopulations, confirmed by telemetry studies, can be attributed to the large distance between suitable habitat patches and lack of suitable connecting habitat; risk of predation; the fact that mainland populations are all below the carrying capacity of their habitat such that there is no restriction on resources that would otherwise impel individuals to disperse away from the security of their habitat; and a philopatric tendency (preference to use the same site they were born at to feed and breed).

Whilst most mainland subpopulations are declining, there have been some successes. Some subpopulations seem to be recovering at some locations, which appears to be associated with feral species management programmes, in particular eradication of feral pigs (*Sus scrofa*). Indeed, feral pigs are a major threat to quokkas (as well as a host of other species). The rooting behaviour of feral pigs destroys and degrades habitat. Being omnivores, pigs also compete for food resources with quokkas, and may even predate on quokkas as well (as suggested by evidence of native mammal remains in pig scats). Pigs have a particularly devastating effect around waterways – the prime habitat of quokkas. The major disturbance of native riparian vegetation by pigs also degrades water quality, causes erosion, and favours establishment of weeds. By opening up and destroying the dense riverine vegetation, pigs also increase the ease at which predators can access and successfully kill quokkas. Quokkas have become extirpated from areas that once supported the species following disturbance by feral pigs invading the area and rendering the sites unsuitable.

Red foxes (*Vulpes vulpes*) are almost always charged as guilty in declines of a diverse array of native species and are vilified as the scourge of native species conservation. This has led to a continual, ongoing, and unethical attempt to eradicate foxes by large-scale, expensive, intensive baiting using the horrific poison 1080, which native species have some resistance to. Not only is this form of control extremely inhumane, causing death of eutherian animals (including dingos, pet dogs and cats) when they ingest these toxic baits, 1080 baiting directed at killing off foxes appears to have done little to improving the fate of quokkas. This is highlighted in the study 'First in, first served: uptake of 1080 poison fox baits in south-west Western Australia' by Dundas et al. published in the journal *Wildlife Research* in 2014. The study monitored bait uptake at riparian sites in the northern Jarrah Forest where intensive baiting regimes have been implemented supposedly for the protection of quokkas. It was discovered that 99 percent of the baits were taken by native species, with 48 percent of incidences involving quokkas! Despite native marsupials evolving some resistance to 1080, it is likely that this

poison has sublethal effects, preventing native animals ingesting the toxic baits from foraging or evading predators as effectively. Even when foxes do die from ingesting these toxic baits, this can actually worsen the situation for native species owing to increased predation by cats (which tend to avoid eating 1080 baits): foxes suppress cat numbers, and so when foxes are removed, cats increase in abundance and activity – a phenomenon known as mesopredator release. Cats not only directly threaten quokkas by predation, but also can cause quokka deaths by transmitting fleas, ticks and the protozoan parasite *Toxoplasma gondii*. Further evidence of the lack of fox control being effective and the incorrect assumption that fox predation is the main factor limiting population growth is how despite intense fox control occurring in some locations for 15 years, quokka populations have not recovered, many have continued to decline, and some have even become locally extinct. A survey conducted in the northern Jarrah Forest at sites where quokkas occurred found despite being baited intensively for almost a decade with 1080 baits delivered monthly at 100m intervals, with even surrounding areas receiving large-scale aerial fox poisoning, quokkas at these sites had not recovered, and some had even become extinct. Evidently, this costly, cruel practice of delivering poisons to eradicate foxes is not having the beneficial outcomes envisioned for quokkas, and needs to be replaced with other measures for quokka conservation.

Nevertheless, fox predation is still a cause of mortality, and certain other factors can exacerbate this threat. Construction of roads, e.g. for logging, allows foxes to disperse into quokka habitats and facilitates predation.

The plant pathogen *Phytophthora cinnamomi* indirectly threatens quokkas by causing dieback disease of susceptible plants, resulting in a decline in the complex vegetation structure quokkas prefer. Loss of forest structure can both remove food resources, as well as make quokkas more exposed to heat and predation. Forestry operations, roadworks, mining, and feral pigs can introduce *Phytophthora* dieback into quokka habitat.

Overall, the major factor in the quokkas decline has been past and ongoing clearing of vegetation, often for urban development, but especially agriculture, with livestock product and logging being particularly devastating. Clearing of vegetation removes food and shelter, thereby increases exposure to predators, resulting in sites being no longer able to support enough quokkas for them to persist. Clearing not only reduces the extent of a given habitat patch, but also fragments patches, preventing gene flow between patches and migration to reverse declines or restore populations that have become locally extinct. When populations become small and isolated, this also leads to loss of genetic diversity, which can decrease reproductive output, and increase susceptibility to disease. Localised extinctions in the northern Jarrah Forest have been attributed to habitat reductions and reduced floristic diversity of native plants.

Large-scale fires have also contributed to loss of habitat and consequent declines in quokka populations. Both deliberately lit fires and those from escaped 'prescribed burns' are a significant and ongoing threat. Prescribed burns are often touted as being necessary for native species, yet this is a political statement based on appealing to outdated ideas about benign burning by Aborigines and a fear of bushfires occurring near human habitation. Moreover, despite claims that a mosaic of fire ages and frequent small-scale fires emulating Aboriginal burning is needed, there is no evidence that lack of fire has any adverse impact on quokka populations; in fact, it is on Rottnest and Bald Islands where vegetation has not been burnt for over 120 years that populations are doing well. Likewise, Mount Gardner has not been burnt for over 60 years and quokkas are still thriving there. Rather than run the risk of fires escaping under 'controlled burns', or direct mortality and loss of habitat occurring under 'traditional burning', efforts should be made to protect key habitat from fire, and limit litter build-up fuelling fires by alternative measures.

Timber harvesting and associated infrastructure has been associated with quokka declines and poses a severe threat in the future given current mainland quokkas are mainly confined to state forests and timber reserves. Timber harvesting is harmful to quokkas not only by removing the extent of habitat, but also removes key components of habitat, decreases shelter, increases vulnerability to predation, spreads weeds and plant pathogens, and forces quokkas to attempt to disperse out of the area into unsuitable and dangerous habitats. Additionally, quokka mortalities occur during clearing or when quokkas are hit by vehicles under the increased construction of roads and associated traffic.

Activities that alter hydrological regimes across the quokka's range will likely have severe impacts by drying out the moist swamp habitats quokkas are confined to. Mining, forestry activities, and land clearing all can result in quokka habitat becoming degraded. Ground and surface water abstraction also take their toll.

Climate change: a major threat

Being a regional endemic species quokkas are particularly vulnerable to climate change.

Southwest Western Australia has already been hard-hit by climate change. Since the 20th Century mean annual temperatures have increased, and since the 1970s there has been a significant decline in autumn and early winter rainfall (rainfall has declined by 15 percent). The consensus from climate models is that in southwest Western Australia, temperatures will continue to increase, and precipitation to decrease.

Projected increases in temperature and aridity in this region are likely to have a detrimental impact on quokkas and their preferred habitat. A drier, hotter climate will likely reduce critical habitat for quokkas, and exacerbate the seasonal debilitation of quokkas on Rottnest. Because historically quokka populations on the mainland have always been confined to areas receiving >700 mm of rain annually, and now all remaining subpopulations are confined to areas receiving >1000 mm/yr, the ongoing declines in rainfall under climate change is concerning. Modelling studies have revealed that precipitation is the most important factor defining the distribution of mainland quokkas, and observational studies confirm quokkas thrive in regions that receive high rainfall for this promotes healthy vegetation cover and nutritious leafy green digestible forage for them, whereas loss of vegetation and reduction of availability of surface water can lead to starvation, loss of body condition, and ultimately death.

Hotter, drier conditions also increase the length of the bushfire season, and increase the scale and intensity at which fires occur. Increased fire frequency and severity has already been observed under this drying climate, and is predicted to increase. The small size of remnant quokka subpopulations means this is a severe threat, for a single fire could wipe out an entire subpopulation, leaving no survivors for recovery of a subpopulation.

The effect of climate change on quokka distribution has been the subject of a modelling study conducted by Gibson et al. in 2010. Under three scenarios – (1) low greenhouse gas emissions resulting in a lower-impact scenario; (2) moderate emissions scenario, and (3) ongoing high emissions resulting in a high-severity impact scenario – by 2070 average annual ttemperatures are projected to increase by at least 0.8 deg.C, to up to 4.5 deg. C from present temperatures. Mapping these temperature changes across the southwest landscape based on modelling how these scenarios would impact the future distribution of quokkas on the mainland found under all scenarios, quokkas distribution contracted, with the magnitude of contraction being severest under the high-severity climate change forecast.

The small, isolated subpopulations of quokkas makes them susceptible to loss of genetic diversity, which limits their potential to cope with climate change by adapting *in situ*. Whilst one way a species can cope with climate change is by shifting its range to cooler regions, this response is unlikely for quokkas given their limited dispersal behaviour, fragmented habitat, and the fact that quokkas already occupy the southern cooler portion of Western Australia, and Western Australia's flat landscape provides no chance to migrate to cooler, higher altitudes. Given quokkas appear to be unlikely to disperse naturally, conservation actions often aimed at facilitating native species to cope with climate change by increasing habitat connectivity and creating dispersal corridors may be not particularly effective. Rather, conservation strategies aimed at identifying, expanding, and protecting core refugia sites where quokkas still persist are likely to have the best outcome for enabling their long-term persistence.

Whilst quokka distribution on the mainland appears to be highly threatened by reduced precipitation under climate change, there is some hope that they will persist, given evidence that quokkas are physiologically able to cope with aridity based on the high abundance and long-term stable persistence of quokkas on Rottnest, and studies finding that quokkas are physiologically efficient at conserving water.

How you can help quokkas stay happy

Whilst some threats facing quokkas cannot be addressed by the everyday citizen, everyone can help reduce the severity of climate change, which arguably is one of the greatest threats jeopardising the persistence of this adorable little marsupial now and in the future. The most significant way anyone can reduce their carbon footprint is by eliminating meat from their diet. Not only is eating meat unnecessary, inherently unethical, and linked to many health problems including heart disease and colon cancer, livestock produced for meat have an even greater contribution to greenhouse gas emissions than all forms of transport combined! Moreover, given that climate change models suggest that unless greenhouse gas emissions are seriously constrained, quokkas will lose virtually all of their range by 2070, the most significant way people can help this species is by mitigating severe climate change, with removing meat from your diet being the greatest way you can do this.

With past and future land clearing being the most significant factor causing population declines, removing meat from your diet will eliminate the need for further land clearing, thereby preventing further losses of key quokka native habitat being cleared and converted to livestock. Consequently, the most effective way you can make the biggest difference to improving the plight of quokkas (and the state of the planet and its biodiversity overall) is going meat-free.

Agricultural activities involved in meat production not only result in clearing of land which could otherwise be used as habitat for quokkas, but also degrade the land and waterways and demand a huge amount of water. Given the large amount of water required for livestock production, switching to a vegetarian diet will go a long way in reducing anthropogenic demand for water (the average meat eater's diet requires fifteen times more water than a plant-based diet!). Hence, one of the simplest, most significant ways to reduce our environmental impact and help conserve quokkas, as well as biodiversity overall, is to reduce our environmental impact by embracing a meat-free diet. For, not only is livestock production cruel to the victims killed for their meat, livestock production requires more land, water, fossil fuels and other resources than crop production. Indeed, the United Nations has revealed the livestock industry is "one of the most significant contributors to today's most serious environmental problems", including climate change, loss of fresh water, habitat destruction, increased desertification, air and water pollution, acid rain, and soil erosion.

Citizens can also request all sites where quokkas occur be protected. Given that each population is important for the persistence of the species overall, and range expansions are unlikely, this will help to ensure the species does not become extinct. It is highly concerning that given the noted declines associated with or located near regions that have been logged or subjected to bauxite mining that these activities are still allowed to occur. About 60 percent of the quokka population are recorded in state forests or timber reserves, which are likely to be harvested.

Quokkas – a key conservation priority

Given the uniqueness of this species, both from an evolutionary perspective being the only species in its genus, and a geographical perspective being endemic to southwest Western Australia, the quokka is a key species warranting dedicated protection. Conserving quokkas will also benefit the tourist industry, given the high international and national appeal of this adorable smiling marsupial.

Rottnest Island largely owes its claim to being arguably Western Australia's most popular tourist destination thanks to quokkas being the star attraction. Any costs associated with recovery actions aimed at protecting, restoring and improving the condition of quokkas and their habitat will be more than offset by saving these smiling sweet marsupials.

THE DAINTREE CHALLENGE

CAROLYN LITTLE

The day is overcast, and the tops of the range are shrouded in cloud. The track into the forest is muddy after early rain. Beneath the canopy of taller trees are stands of majestic fan palms and vines of the vicious wait-a-while palm snaking up and around tree trunks to reach the light. As you progress, bird calls die away and there are a few urgent rustlings in the undergrowth. If you hope to spot a cassowary, there is no sign yet. The trees close overhead and the filtered sunlight does little to illuminate the forest floor. You can hear the splash and gurgle of the creek as the track draws parallel with the watercourse. Rare and primitive plants such as *Gymnostoma australe* and *Noahdendron nicholasii* can be found here. You are in the oldest rainforest on Earth, the majestic Daintree, the largest unbroken stretch of rainforest in Australia, and part of the Queensland Wet Tropics World Heritage Site. Australia was once covered in such rainforest.

We use superlatives to describe the Daintree. The oldest..., largest..., richest in biodiversity. A place of great beauty and energy, the teeming life here abounds and flourishes.

Prior to the World Heritage citation in 1988, the lower Daintree in particular was opened up to private usage, but there is now a concerted 'buy-back' program aimed at restoring and consolidating the natural environment. Many private residents also take a responsible attitude, and encourage growth and regrowth on their properties.

The forest faces a number of challenges. Some development still takes place. Not only is there loss of forest itself, the margins are subjected to weed infestation, while pathogens such as myrtle rust, and feral animals take their toll. Fragmentation of the forest area limits the ability of animals to move freely, which ultimately can reduce the survival of some species. Money is needed for both buy-back and remediation, and unfortunately there seems to be little government will for this to happen.

Above: The trademark of all rainforests is their canopy – a thick layer of leaves and branches that shades the forest floor. This forces the plants into a super competitive state as they fight their way up towards the sun. The individual plants of the forest each have their own unique tricks for surviving in what many botanists refer to as 'the battlefield'. Some are soldiers in the war for sun, some have good homeland security and some become good at finding allies

The mouth of the Daintree River

Tourism is a multi-million dollar industry. It requires the establishment and maintenance of roads, transport, accommodation and other tourist facilities. This places demands on the amenity of the area, and the challenge is to balance the competition between the needs of the industry and the preservation and health of the World Heritage site.

Climate change will inevitably have an effect. Clouds on the peaks of the granite ranges will rise as temperatures climb. This will impact on forest boundaries and on the viability of some organisms. Climate change is, of course, a natural phenomenon, and over the millennia of its existence, the Daintree has withstood the cyclical changes. However, as the rate of climate change is perceived to be on the rise, its capacity to cope will be tested.

The incredible diversity of plant life is a source of hundreds of thousands of chemical compounds, many of them alkaloids, which a plant may produce as part of its defence mechanism. This has proved attractive to pharmaceutical companies who, prior to the ground-breaking legislation introduced by the Queensland Government in 2004, were freely able to collect samples of plant material for analysis. The legislation follows United Nation guidelines for such activity, and limits and attempts to control biopiracy. Companies must now apply for a permit to exploit the rainforest bounty. Fortunately, the impact of biodiscovery is minimal, as only small samples of plant material are required.

Cyclones have a devastating effect as they tear through the forest, cutting great swathes as they pass across the coastline and into the interior. The rainforest has proven resilient to this seasonal threat, and within a very short time, natural regrowth and repair of staggering proportions is underway. It is likely that future weather events will be more extreme, and resilience may be challenged.

In reality, resilience is a marked characteristic of the Daintree. Left to itself, it will respond and adapt to external stress as it always has. The real challenge is to commit to a full understanding of the ongoing impact of human intervention, and to deal with it. Organisations such as Rainforest Rescue deserve our support.

Carolyn Little is the author of *Bergstroms Orange* (Short Stop Press, $24.99), now available at all book stores and online at www.shortstoppress.com

KANGAROO RESEARCH GETS A BOOST FROM AWS SCHOLARSHIP

In 2014 UTS postgraduate student Ray Mjadwesch commenced his thesis researching the history and status of the four large macropod species, the western grey kangaroo (*Macropos fuliginosus*), eastern grey kangaroo (*M. giganteus*), the wallaroo/euro (*M. robustus*) and the red kangaroo (*M. rufus*), in New South Wales.

Ray is using, amongst other things, vegetation types and land use in New South Wales to characterise landscapes in terms of habitat values for kangaroos, and is then sampling various habitat types to develop stratified population models for the species within a contemporary land-use context.

How does human activity affect kangaroos? Population centres, roads and intensive agriculture all have known impacts on wildlife; it is expected that the widespread and continuous kangaroo meta-populations that existed at settlement in 1788 will have fractured into sub-populations, with some landforms today completely expunged of kangaroos, where they had formerly abounded.

Fieldwork commenced in 2015. With the help of the **2015 Australian Wildlife Society's Wildlife Ecology Science Research Scholarship**, Ray purchased 24 camera traps which are being deployed in arrays covering 25 km² blocks across New South Wales, to quantify densities and distribution of target species. This equipment is vital to the gathering of the data that will confirm kangaroo presence and abundance.

One of the study sites is at 'Narimba', a wildlife sanctuary to the west of Narrandera in the Riverina of south-western New South Wales. As might be expected, it is already clear that while red and grey kangaroos are thriving in the sanctuary where remnant habitat provides shelter and there is

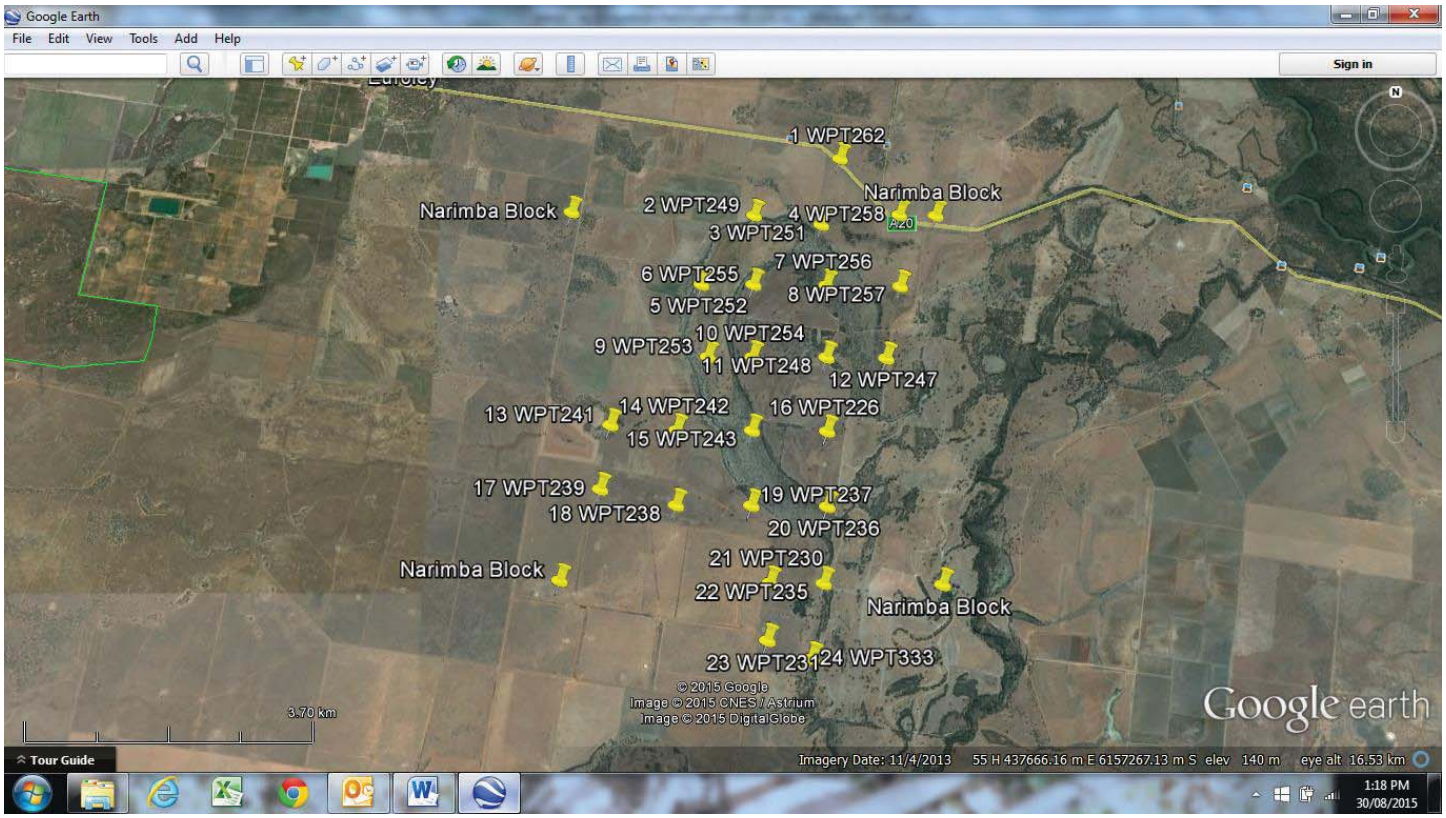
Above: Red kangaroo doe with joey in black box (*E. largiflorens*)/river red gum (*E. camaldulensis*) floodplain woodland at 'Narimba'. Photo: Ray Mjadwesch

Browning Strike Force camera, set to take time-lapse and motion activated images. Photo: Ray Mjadwesch

Ray Mjadwesh was awarded **2015 Australian Wildlife Society's Wildlife Ecology Science Research Scholarship** and was presented with a cheque for $5,000 by Patrick Medway, CEO of Australian Wildlife who sits on the judging panel.

no shooting, surrounding cropping and grazing properties are almost completely devoid of the animals.

Over the next six months sampled landscapes will include national parks and nature reserves, state forests, non-government sanctuaries and other private production systems through central and western New South Wales. This will complement the OEH Wildcount camera-trapping program that has been running in the east of the state since 2012, and providing a more complete picture of how the large macropod species continue to occupy landscapes across NSW than presently exists.



Narimba survey block (source: Google Earth)

ENVIRONMENTAL ACCOUNTING: THE WAY FORWARD?

Bill Geary and Rachel Fetherston

AS PEOPLE WHO ARE SOMEWHAT ENVIRONMENTALLY CONCERNED, WE ARE CONSTANTLY ASKING OURSELVES ONE QUESTION: HOW DO WE BEST COMMUNICATE THE IMPORTANCE OF NATURE TO THOSE WHOM WE HAVE ELECTED TO MAKE DECISIONS FOR US?

Sure, we can pull out statistics like "Australia has the worst mammalian extinction rate on Earth", or "there are only 50 to 60 orange-bellied parrots left in the world" . But is this negative "you'd-better-do something-or-else" mantra working? It certainly doesn't seem so. Often with nature blogs, we're preaching to the converted. You're probably thinking to yourself right now: "What can I do to help reverse the current situation?" On the other hand, we might get the inevitable response from Joe Bloggs in the street: "Why should we save something that does nothing for *me*?" It's a fair point. Aside from its intrinsic value (i.e. taking value from the simple knowledge that things exist), what exactly *does* the orange-bellied parrot do for the average person?

MONEY MATTERS

The world revolves around money – this we know for sure. In the age of free markets and gross domestic products, most governments are almost solely focused on achieving a surplus. Unfortunately, the environment rarely gets considered in such conversations, aside from the occasions it becomes a resource (i.e. timber harvesting, redirecting stream flows for irrigation). One approach to resolve this is to put a price on nature, a process called environmental accounting.

ENVIRONMENTAL ACCOUNTS

The approach to environmental accounting is simple. By applying accounting principles to quantifiable aspects of nature, we can estimate how much a species, ecosystem or region is worth to the economy and therefore measure how its worth changes over time. The significance of this is substantial, potentially allowing for the importance of nature to be communicated beyond its intrinsic value. In fact, the Wentworth Group of Concerned Scientists (including acclaimed scientist Tim Flannery) has highlighted developing a set of environmental accounts as an important step in the conservation of Australia's biodiversity. Why? Because money is the language of human civilization. If we can quantify nature in terms of dollars and cents, we are suddenly speaking the language of those in power; those who make the big decisions and run the world. Essentially, we would be illustrating the value of nature in the most literal way that is currently possible. Furthermore, if we can put a dollar-value on entire ecosystems, we can then measure how their value might change over time. This allows us to monitor how our actions, good or bad, impact the environment on a large scale. This is inherently relatable to other businesses and industries that measure success or failure in terms of money.

NATURAL CAPITAL: HOW MUCH IS THAT WETLAND WORTH?

For years now, various groups have attempted to put a price on nature. The seminal but controversial paper by Daily et al. (1997) estimated that the Earth and its ecosystems could be valued at a whopping $127.3 trillion. This process essentially asked the question: "How much money would humans have to spend to ensure ecosystem function and services are maintained in the event nature stopped doing it for us?"

One way to look at it is to think of a local wetland or creek and the complex things it does. A stream might flow through it, and the plants, algae and invertebrates all contribute to cleaning and filtering its water. This could even be a tributary that runs into the Thomson Dam, Melbourne's largest source of drinking water. Taking away the naturally occurring water filtration system, humans would have to perform that same function to ensure we could still drink water from the dam. That, as you can imagine, would cost big bucks.

Radiolab's story on the value of nature begins at 51:50.

This concept has been put into practice with another incredibly important and valuable process: pollination. A recent study put the value of crop pollination by bees, bats and birds to the American economy at $29 billion. This is an enormous figure, illustrating that if pollination stopped, so would the American economy to a major extent. This has actually happened in China, where mass die-offs of pollinators (e.g. bees) led to Chinese farmers having to pollinate each crop by hand. As reported by Radiolab, this led to an increase in profits because the minimum wage is so low in China. However, in a developed country, pollination by hand would bear an enormous cost to the economy.

PROBLEMS: THE WORTH OF PRICELESSNESS

There is an inherent problem with the environmental accounting approach. How does one put a price tag on that which is priceless? Inevitably, there are some things that, comparatively, aren't worth anything to humanity in terms of dollars and cents. For example, should we place the same monetary value on species that differ in terms of their influence on ecological function?

Consider comparing the value of a rare keystone species such as a large predator to that of a small rodent which shares an ecosystem with species that are ecologically similar. The former would perhaps be considered much more ecologically 'valuable' than the latter whose function can be carried out by a number of other organisms.

This intrinsic value of nature and its relative importance in comparison to monetary value is a key tension. This must not be forgotten when considering environmental accounts as a tool, lest we risk ignoring those aspects of nature that do not provide a 'service'.

As explained above, the problem here is that ecologically non-significant species would suffer in the context of environmental accounts. For example, many of Australia's increasingly rare species could be deemed economically irrelevant in terms of ecological function and would subsequently be last on the priority list when it comes to 'valuing' our natural world. There would indeed be casualties, as there are in any budget. Such a view of nature is therefore perhaps part of the problem. Viewing our natural world through the human eye means that we more highly value what is useful to *us*, but value less that which may actually be vital to the non-human. Many environmental philosophers agree with this concept, deeming such a view an 'anthropocentric' understanding of the world around us. Unfortunately, such a view often involves an oppositional attitude towards the primary idea at the root of environmental accounting – that is, capitalism. Should we be placing a dollar-value on nature or should we be learning to value nature more than the dollar?

In the opinion of many leading environmental philosophers and ecocritics, the capitalist model of the West is becoming more and more unsustainable in the face of climate change and environmental destruction. Amongst others, Val Plumwood is one philosopher who suggested that people still struggle to perceive the natural world without the influence of human bias.

The term 'non-anthropocentrism' is often used to describe a worldview that attempts to encompass a less human-centric appraisal of nature. This would involve a society that deprioritises monetary gain and instead accepts that humankind's understanding of nature does not and often *cannot* involve the needs of the non-human.

That is not to say that it would be easy to implement said non-anthropocentrism. In many ways, it is currently an impossible as well as undesirable prospect. In the context of such a radically different worldview, humans may no longer enjoy many of the positive features of a society that values material goods and services; our favourite movies and TV shows, the amazing variety of products that some are lucky enough to afford, and perhaps even the ability to take a holiday and visit some of our world's incredible natural wonders are just some of the things that may be lost if we choose to devalue financial gain.

CAN WE HAVE OUR CAKE AND EAT IT TOO?

The bigger issue is, then, is it possible to have our cake and eat it too? Can we enjoy the perks of placing a monetary value on the environment whilst simultaneously educating the public to understand nature through a 'more-than-human' lens? It is a difficult thing to test, but is indeed something to keep in mind if a monetary model for nature is developed.

So, is environmental accounting a silver bullet for speaking the language of politicians and treasurers across the world? No, not really. But, it does help us further communicate the value of nature to those that cannot or will not connect with its intrinsic value. Thus, it has the potential to be a very, very useful tool for ensuring the environment gets a seat at the budget table – something that has scarcely occurred in recent times.

If you would like to read further articles on Environmental Accounting, a short list is as follows:

- *Accounting for Nature* (2008). Wentworth Group of Concerned Scientists
- *Daily*, Gretchen. *Nature's services: societal dependence on natural ecosystems*. Island Press, 1997
- *Environmental Culture: The Ecological Crisis of Reason*, by Val Plumwood
- *Understanding Environmental Philosophy* by Andrew Brennan & Y.S. Lo.

Editor's note: Radiolab is a popular science and philosophy-based internet podcast that has a very large audience. They did a show on Environmental Accounting that can be listed to at the following link: http://www.radiolab.org/story/what-dollar-value-nature/)

Rachel Fetherston is an Arts and Science graduate who is passionate about communicating the importance of the natural world through literature. She recently completed her Honours year in Literary Studies, involving research into environmental philosophy, dystopian literature and the significance of the non-human animal in understanding the human connection with the environment. She is the Arts and Philosophy Editor for conservation NGO Wild Melbourne.

Billy Geary is a wildlife ecologist from Melbourne, Victoria. He is particularly interested in predator ecology, ecophysiology and fire ecology. Whilst working as an ecologist, he is also studying environmental policy at Melbourne University part-time and working passionately as a science communicator. He is the Science and Conservation Editor for conservation NGO Wild Melbourne.

2015 University Student Grants Scheme winners

The Australian Wildlife Society's University Research Grants are scholarships offered to honours or postgraduate students at Australian universities. Each year, ten grants of $1,000 are awarded. Grants are available for research projects of direct relevance to the conservation of Australian wildlife; plant or animal. Grants may be used for the purchase of equipment and consumables, travel expenses related to field research, or attendance at conferences at which you are presenting your work.

The Australian Wildlife Society is delighted to announce the winners of the ten grants of $1,000 each to honours or postgraduate students conducting research that will contribute to the conservation of Australian wildlife. The winners for 2015 are:

Bianca Amato - School of Natural and Built Environments, University of South Australia
Project: The contribution of native flower visitors and their hosts plants to crop pollination on the Yorke Peninsula, South Australia

Benjamin Arthur - Marine Science, University of Tasmania
Project: Changing climate and the winter foraging ecology of Antarctic fur seal populations

Matt Christmas - University of Adelaide
Project: Climate adaptation of the hop bush, Dodonaea viscosa, along an environmental gradient

Amanda Edworthy - Research School of Biology, Australian National University
Project: Dispersal and genetic structure of forty-spotted pardalotes across fragmented landscapes: conservation of an endangered songbird

Christine Evans - Flinders University
Project: The hidden costs of extra pair paternity: implications for survival and reproductive success in an endemic woodland bird

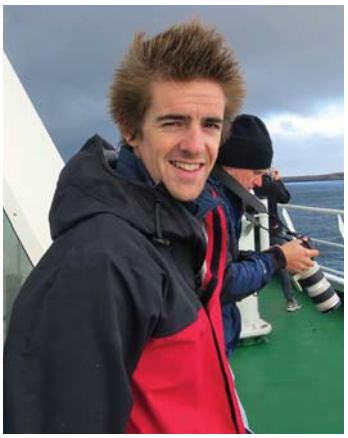
Sarsha Gorissen - University of Sydney
Project: Conserving the endangered fauna of highland swamps

Emily Gregg - School of Biosciences, The University of Melbourne
Project: No water, no hope: the on-ground feasibility of a waterless barrier to prevent the spread of cane toads in Western Australia

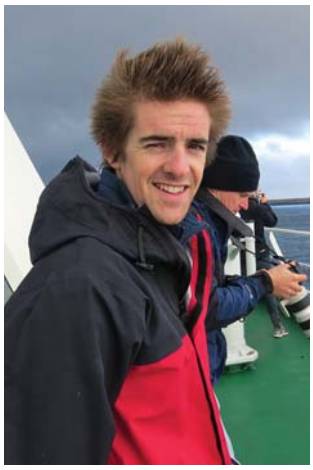
David Hamilton - Department of Biological Sciences, University of Tasmania
Project: Contact networks and transmission of facial tumour disease in the Tasmanian devil

Harry Moore - School of Life & Environmental Sciences, Deakin University
Project: By supressing both the abundance and activity of invasive mesopredators in arid environments, could dingoes have a positive influence on native mammal species

Estibaliz Palma - The School of Bio Sciences and the Faculty of Sciences, University of Melbourne
Project: Plant invasion ecology: relationship between species traits and demographic dimensions of invasiveness



In the following two issues of *Australian Wildlife*, articles on the winners' projects will be featured.



Changing climate and the winter foraging ecology of Antarctic fur seal populations

Ben Arthur,
Marine Science,
University of Tasmania

The Southern Ocean is a rapidly changing environment and there is a pressing need to increase our understanding of this complex ecosystem, the impacts of large-scale climate changes, and the effectiveness of conservation and management measures. Despite many studies into the effects of large-scale climatic changes on the physical structure of the Southern Ocean, how such changes will impact ecosystem structure and function are poorly understood. Any changes, however, will be reflected in the responses of high-trophic level species, such as the Antarctic fur seal (*Arctocephalus gazella*), making them ideal indicators of wider ecosystem change.

In the Southern Ocean, variation in prey availability to higher trophic levels occurs as part of normal oceanographic and atmospheric phenomena. However, there is increasing evidence of anthropogenic changes in the distribution and abundance of prey, particularly through large-scale climate changes. Several studies have already documented demographic changes in predator populations associated with the predicted effects of climate change and there are growing signs that responses such as these are indicative of large-scale ecosystem shifts. However, despite these studies, the links between the physical effects of climate change, biological productivity and the response of top predators in the Southern Ocean remain poorly understood.

During the winter, Antarctic marine predators face a substantially different environment, both physically and

Antarctic fur seals on sub-Antarctic Marion Island in the Southern Indian Ocean. Photo: Ben Arthur

biologically, from the summer season. As a result, winter foraging patterns can differ markedly from the more constrained summer foraging behaviours that are well documented for many species. Quantitative studies into the winter habitat use and foraging ecology of top predators are therefore critical to better understand the influence of environmental variability and fluctuations in prey resources on higher trophic level species. Until recently, quantifying the habitat use of Antarctic marine predators during the pre-breeding winter period was difficult, but advancements in bio-logging technology have made tracking the at-sea movements of animals more attainable and affordable.

The winter foraging behavior of the Antarctic fur seal is the focus of an international collaborative study lead by the Institute for Marine and Antarctic Studies (IMAS) at the University of Tasmania. The Antarctic fur seal is a numerous and key Southern Ocean predator with a global population that has increased rapidly since sealing operations ceased in the early 20th century after the species was driven to economic extinction. Of the 10 major breeding islands of the species, two are Australian territories: Macquarie and Heard Island. The populations of fur seals at both of these colonies are still recovering from over-exploitation, having re-established in the second half of the 20th century.

Since 2008, the winter foraging movements of over 200 female Antarctic fur seals has been studied at three circum-polar breeding sites using miniature geo-locating (GLS) tags. The project is a collaboration between the Antarctic research programs of Australia, South Africa, Britain, the United States and, soon, France. Such a coordinated study is greatly increasing our understanding of the habitat and dietary preferences of this top predator, information that is needed to inform ecosystem models and management measures in the Southern Ocean. Australia has a particularly important obligation in this regard due to its large territorial claim of Antarctic and sub-Antarctic waters.

The rare behavioural data set resulting from this program also provides an exceptional opportunity to understand the effects of climate shifts on a higher-level predator. To date, this project has revealed considerable variability in the overwintering migrations of female fur seals from different colonies, the long-term re-use of important oceanic foraging grounds by individuals over multiple years and the first insights into the diving behaviour and vertical habitat use of this species during the winter period. Future work aims to identify important foraging habitats, and the oceanographic factors influencing these, for female Antarctic fur seals from several Southern Ocean colonies including those with no previous data, and model the potential responses of Antarctic fur seals to the rapidly changing Antarctic marine ecosystem.

A female Antarctic fur seal and pup. The female is carrying a geo-location tag attached to her flipper, which records light level used to estimate the location of winter migrations. Photo: Chris Oosthuizen

Christine Evans holding a male superb fairy wren. Photo: Katharina Peters

The hidden costs of extra pair paternity:

Implications for survival and reproductive success in an endemic woodland bird

Christine Evans, PhD Student,
BirdLab, School of Biological Sciences,
Flinders University

The superb fairy-wren is an iconic and charismatic Australian woodland songbird found throughout south-eastern Australia. The species is considered common but like many woodland birds, superb fairy-wren population numbers are rapidly declining in the face of habitat fragmentation, degradation and destruction in the Mount Lofty Ranges region of South Australia. Monitored populations within this region also suffer from high nest predation and low rates of nesting success. My project examines how the behavioural ecology of this species influences offspring survival and reproductive success.

Like most fairy-wren species, superb fairy-wrens are notorious for being highly promiscuous. The female mates with males other than her pair male and most nests have at least one chick sired by an extra-pair male. This female strategy increases the genetic variance of her offspring yet there may be hidden costs of extra-pair paternity (EPP) as pair males lower their parental care when they perceive low parental investment into offspring. Parental care includes feeding chicks and nest guarding, which are important for the development and survival of chicks, and overall reproductive success. Mating with multiple males therefore can be a risky strategy for the female, because her offspring might receive less male parental care.

Female superb fairy wren feeding chicks in nest. Photo: Katharina Mahr

My study examines the impacts of EPP on the survival and reproductive success in the superb fairy-wren. We test if nests with many extra-pair young receive less male parental care, and if nests with lower parental care have lower fledgling success. Over the past three years we found and monitored over 70 nests of superb fairy-wrens at Cleland Conservation Park and Scott Creek Conservation Park, in the Mount Lofty Ranges. Active nests were monitored every 2–3 days to assess breeding stage, clutch size, hatching date, brood size, chick body condition, number of fledged young, fledging date and nest outcome. We also monitored behaviour of adult birds at the nests, including incubation behaviour, male nest guarding and male and female feeding rates. These data will be analysed in relation to the proportion of extra-pair young per nest to determine if the mating of the female with extra-pair males adversely affects offspring survival.

Thanks to the financial support of the Australian Wildlife Society, I am able to fund my lab work to determine which chicks are unrelated to the pair male. This involves extracting DNA from small blood samples taken from adult birds and chicks and comparing the genotypes between the female, male and chicks. Differences in the genotypes between the pair male and chick will indicate the male is not the genetic father of the chick. The outcomes of this project on extra-pair paternity and male parental care will provide an important snapshot of selective forces and behavioural patterns that shape survival and reproductive success in this locally declining species.

Male superb fairy wren at nest. Photo: Katharina Mahr

Male superb fairy wren feeding chicks in nest

Contact networks and transmission of facial tumour disease in the Tasmanian devil

David Hamilton,
Department of Biological Sciences,
University of Tasmania

I'm a PhD student at the University of Tasmania and my main research focus is the patterns of contact Tasmanian devils have with one another in the wild.

Tasmanian devils are severely threatened due to a novel, contagious cancer known as Devil Facial Tumour Disease, or DFTD. The disease has been spreading through the island state since 1996, causing declines of up to 90 percent in some devil populations. One of the reasons that DFTD has spread so rapidly, and comprehensively, throughout Tasmania lies in its ability to transfer from devil to devil when they bite one another. It is therefore of great importance to gain an understanding of how devils interact in the wild, and how this affects the ability of DFTD to spread. This is where my research comes in.

Over the next two years I'll be studying the encounters devils have with one another in the wild, using devices called proximity loggers. These emit unique ultra-high frequency signals that allow units to identify when they are in close range (30 cm or less, i.e. within devils' biting range) of other units, and log the duration of their interaction. When outfitted on collars which can be put on a population of devils, this allows me to study which individuals are interacting, and for how long. In addition to this I also regularly re-catch collared devils in order to monitor when they pick up new bite wounds, as these are representative of encounters which could lead to disease transfer.

This year I've been studying a completely healthy population of devils in the far north-west of Tasmania, while next year I'm going to be studying a population which has recently contracted the disease. This will allow me to assess a variety of things, including if the patterns of contact within devil populations alter with the arrival of DFTD, and whether this is assisted by behavioural changes in the devils themselves. For example, do devils become more aggressive as a result of contracting the disease; a mechanism the cancer could use to facilitate its own spread, much as is the case with rabies in dogs.

Studying devil contact patterns will also allow me to establish whether certain sex/age classes of animals are of particular importance to disease spread.

In the event that a vaccine is developed (which is looking hopeful; field trials of a potentially effective vaccine are commencing in Narawntapu National Park in September), this will be of particular importance. These animals, known as 'super-spreaders', are those which should be prioritised for vaccination; they come into contact with such a high proportion of the population that their removal as potential disease carriers can considerably slow, or even halt, the spread of disease.

A greater understanding of how devil behaviour in the wild contributes to disease spread will enhance our ability to manage the disease which has proven so destructive to devil populations Tasmania-wide.

Thanks to advancements in our understanding of both the nature of DFTD itself, and how it affects its host, there is definitely hope for the future of the devil.

Tasmanian devil at the entrance to a trap

Plant invasion ecology:

Relationship between species traits and demographic dimensions of invasiveness

Estibaliz Palma,
The School of Bio Sciences and the Faculty of Sciences,
University of Melbourne

Invasive plants are recognised as one of the most important drivers of environmental change, with detrimental impacts on native biodiversity and ecosystem services worldwide. More than 28,500 exotic plants have been introduced to Australia, which is almost double the number of native plant species. Roughly 10 percent of these exotic plants have become naturalised and 1 percent are currently considered invasive. Weed management costs the Australian economy over $4 billion each year. Improving our understanding of causes and impacts of plant invasion will not only have benefits for Australian unique ecosystems, but it will also reduce, or at least optimise, the budget dedicated to weed management.

The ability of a plant to become invasive (i.e. invasiveness) relates to its characteristics, or traits. However, it is unlikely that all invasive plants share a unique set of traits, given that they may become invasive for different reasons and through different mechanisms. In fact, recent advances in invasion science suggest that the inconsistent and contradictory findings about invasive plant traits may reflect the existence of different types of invaders. Thanks to the support of the Australian Wildlife Society, I aim to quantify the relationship between plant traits and four types of invasive species: locally abundant plants, rapidly spreading plants, plants that occur in many different environmental conditions (e.g. habitat types), and widely distributed plants that occur across Victoria. Doing so, I will be able to determine whether specific traits promote particular forms of invasion and whether trade-offs exist among different forms of invasiveness in Victoria, and more generally in Australia.

The results of this project will be useful to improve weed management. First, knowledge of which traits of the introduced flora match ecosystem impact is of paramount importance to improve Australia's biosecurity and quarantine services. Current risk assessment procedures may be improved by explicitly acknowledging that traits boost invasion through different mechanisms. Second, results stemming from this project can guide the strategic investment of management budgets for exotic plants already introduced to Victoria. My findings of the main invasion mechanisms used by plants with different life-strategies will inform managers of the potential efficiency of currently used management tools (e.g. is it better to prioritise control of quickly spreading plants or local abundant ones?). Finally, this project has the potential to identify recently introduced types of plants (i.e. functional groups) expected to become problematic in the near future. This is essential information for government and local managers to develop effective contingency plans while control of the species is still an affordable option.

Water hyacinth is one of the world's worst aquatic weeds. It infests rivers, dams, lakes and irrigation channels on every continent except Antarctica. It devastates aquatic environments and costs millions of dollars every year in control costs and economic losses

Conservation of an endangered reptile of Blue Mountains' highland swamps

Sarsha Gorissen, PhD candidate,
Shine Lab, School of Biological Sciences,
The University of Sydney

Worldwide, the endangered Blue Mountains water skink (*Eulamprus leuraensis*) is found solely within the Eastern Highlands of Australia, inhabiting a rare type of montane peat swamp of the Blue Mountains and the adjacent Newnes Plateau. As the only vertebrate endemic to the area, this lizard is an icon; admired by locals, its image and profile feature publically. The skink is known only from about 60 fragmented swamps, which range in locality from bush swamps in the national park and state forest, to urban swamps on council, crown and private land. Genetic studies suggest very low rates of lizard dispersal and thus gene flow between populations of these isolated swamps. The swamps themselves are also threatened by processes acting on a local scale, such as urbanisation (industrial development, weed invasion, introduced animals, and pollution), forestry and mining; and, on a landscape scale, such as changes in climate, and in fire and hydric regimes. Until now, the response of this endangered reptile to disturbance via these key threatening processes was unknown.

By conducting annual field surveys we have collected data from the majority of known swamps, mainly on lizard distribution and demography, and quantified habitat characteristics associated with the Blue Mountain water skink's occurrence at both macro- and micro-scales. We focused on the impacts of threatening processes, such as fire and groundwater loss, on urban and bush populations of the skink, ultimately with the aim of developing conservation strategies and management guidelines for the species.

The beautiful black and yellow Blue Mountains water skink (*Eulamprus leuraensis*) atop the thick and spikey swamp vegetation. Photo: Sylvain Dubey

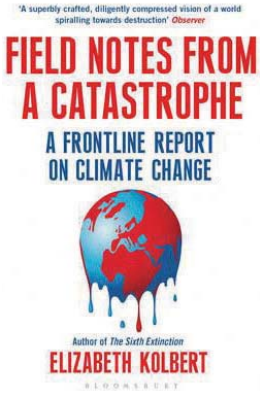
Broadly, we have uncovered more on the ecology and conservation biology of the Blue Mountains water skink and its endangered swamp habitat. We were able to extend the range of the known distribution of the species and get a better estimate of skink health and population. In combination with GIS-based mapping, our survey results indicate fewer lizards in urban-associated swamps and in sites that have experienced major, frequent fires over the last half century. However, we have determined that populations of this endangered reptile persist even in anthropogenically disturbed swamps and swamps that have experienced several fires over decades. We have applied this research by informing all relevant stakeholders of our project outcomes to date and suggested appropriate management guidelines. We are currently analysing our remaining data to develop further guidelines for more effective conservation of this highly distinctive, highly threatened ecosystem.

The Australian Wildlife Society has further assisted in conserving the Blue Mountains water skink by enabling the presentation of my latest research at a paramount international conservation conference (ICCB-ECCB) in Europe earlier this year. I thank them for their generous support and congratulate them on the excellent work they are doing for Australian wildlife.

Fingers crossed for lizards: checking a funnel trap for fauna in a pristine swamp at Newnes Pleateau, New South Wales, on a lovely summer's day. Photo: Nakia Belmer

Success! Trapping a healthy Blue Mountains water skink in a 'sophisticated' trapping device known as a 'pitfall trap' (i.e. a bucket in the ground)

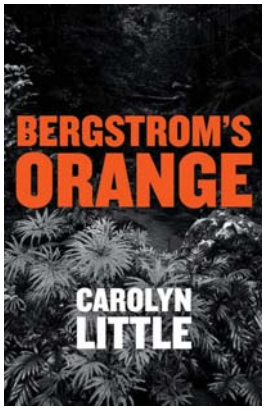
Book Reviews



Field Notes from a Castastrophe: A Frontline Report on Climate Change by Elizabeth Kolbert

Known for her insightful and thought-provoking journalism, New York writer Elizabeth Kolbert now tackles the controversial subject of global warming. This book gives a powerful message to us all on the problems many communities are faced with.

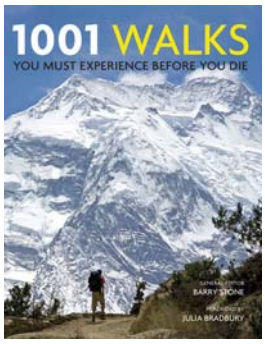
Publisher: Bloomsbury Paperbacks
RRP: $19.99



Bergstrom's Orange by Carolyn Little

This entertaining and informative contemporary thriller explores the growing interest in biodiscovery and the modern crime of biopiracy, against the backdrop of the beauty and challenges of the Daintree World Heritage site, a startling contrast to the laid-back and popular resort world of Port Douglas.

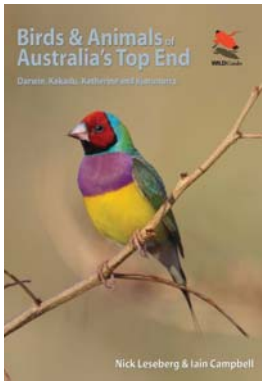
Publisher: A&A Book Publishing Pty Ltd
RRP: $24.99



1001 Walks You Must Experience Before You Die

Every page of *1001 Walks You Must Experience Before You Die* provides a wealth of information about a must-try walk, including start and end points, overall distance, difficulty rating, map references, and an estimation of the time it should take to complete. Created by an international team of travel writers and walking enthusiasts, it is the perfect guide for walking the world.

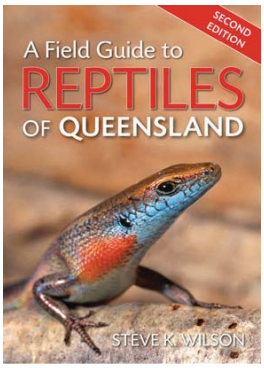
Publisher: Murdoch Books | RRP: $49.99



Birds & Animals of Australia's Top End by Nick Leseberg & Iain Campbell

An essential field guide for anyone visiting one of the most amazing and accessible wildlife-watching destinations on earth, the 'Top End' of Australia's Northern Territory. This book will vastly enhance your appreciation of the region's remarkable wildlife. The region includes some of Australia's most popular and impressive tourist destinations, such as Kakadu, Litchfield, Nitmiluk, and Gregory national parks, and is visited by more than 200,000 tourists every year.

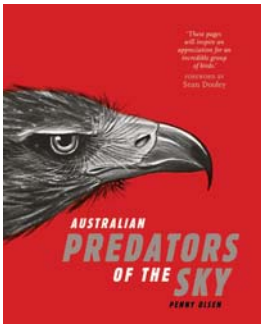
Publisher: Princeton University Press
RRP: $27.95



A Field Guide to Reptiles of Queensland by Steve K. Wilson

This field guide covers all of Queensland's 440 named species of reptiles, including 135 that occur nowhere else. Colour photographs are complimented by line drawings, keys, distribution maps and descriptions.

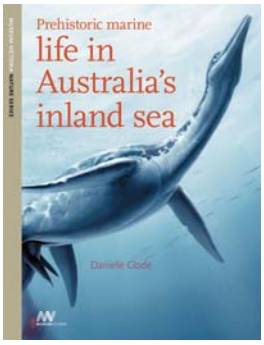
Publisher: New Holland Publishers Australia | RRP: $35.00



Australian Predators of the Sky by Penny Olsen

This book begins with a fascinating chapter on the European discovery of birds of prey in Australia – for example, the earliest sightings of eagles by William Dampier's expedition in 1699 in south-western Australia and Captain James Cook's reports of kites, hawks, eagles and owls at Endeavour Bay in Queensland in 1770; the naming and describing of species in the nineteenth century; and John Gould's visit to Australia to describe and illustrate its birds, including the birds of prey which filled the first of the seven volumes of his *The Birds of Australia* in the 1840s. Our relationship with the birds of prey has always been conflicted. Raptors are admired for their strength and independence, but despised for their depredations on livestock and favourite garden birds, while the owls are at once respected for their wisdom and watchfulness and feared for their mournful cries and association with darkness and ill-omen. For each species, a distribution map is provided, as well as the origins of its scientific name. Several full-colour illustrations of the species by various artists are accompanied by intriguing notes about the bird.

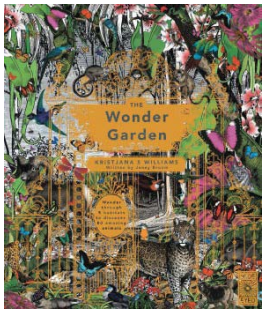
Publisher: National Library of Australia
RRP: $39.99



Prehistoric Marine Life in Australia's Inland by Danielle Clode

In her book, *Prehistoric Marine Life in Australia's Inland Sea*, Danielle Clode takes us back to a time when a vast but shallow sea covered the desert which now makes up inland Australia. It was roughly 100 million years ago and the sea persisted for about 20 million years. There were many species quite similar to today. There were fish and crabs and shells on the shore. There were turtles and sharks. But there were many animals which don't survive today. As well as armoured fish, there were some extremely large marine reptiles. Plesiosaurs and ichthyosaurs swam with schools of ammonites. Pterosaurs flew overhead and giant carnivorous amphibians lurked in the rivers. This richly illustrated book brings to life yet another aspect of the fascinating world of Australia's prehistoric past and provides an accessible introduction to some of the amazing fauna, geology and fossils found in this part of the world.

Publisher: Museum Victoria Publishing
RRP: $24.95



The Wonder Garden by Kristjana S. Williams

This is a very different book from the norm. This almost decadent book is embossed in gold and dripping with explosive colour. It offers a detailed insight into several very different habitats in the most glorious technicolour surroundings. Readers experience an incredible journey to five of the Earth's most unique and extraordinary habitats. Trek through the Amazon Rainforest, travel to the Chihuahuan Desert, dive in the Great Barrier Reef, delve deep into the Black Forest and stand on the roof of the world – the Himalayan Mountains – to see nature at its wildest.

Publisher: Allen & Unwin | RRP: $35.00






Bequest Program for wildlife conservation work

The Society has a Bequest Program to assist with their wildlife conservation work across Australia. Interested members are invited to complete the bequest form on page 46 in this issue of "Australian Wildlife" and send it to the National Office for processing.

In recent times much of the Bequest Program has been dedicated to our Society's environmental education programs, which are designed to educate the next generation of young Australians about our precious native wildlife in all its forms. There is an urgent need for further wildlife conservation work in this field.

Many families have already included a bequest in their personal last will and testament dedicating funds to the ongoing wildlife conservation work of the Society. You might like to consider including a bequest to the Society in your own will.

Friends of Australian Wildlife Society

The Society has been dramatically expanding its conservation and environmental work program and has embarked on an exciting new chapter in its history of wildlife conservation in Australia.

You can be a part of the Australian Wildlife Society's conservation future by becoming a 'Friend'. Application form is available from our national office.

University Grants Scheme

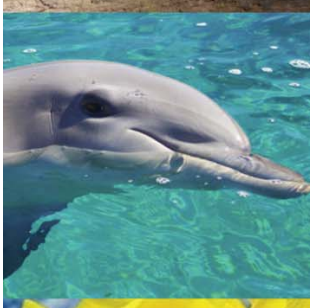
The Society already offers Wildlife University Research Grants of $1,000 each for honours/postgraduate students currently studying at any university in Australia, but the new award is aimed at a more significant level and for potentially a larger sum of funding to study wildlife conservation at the University of Technology Sydney.

The aims of this scholarship are: 1) to benefit the preservation of Australian wildlife by supporting applied scientific research with a wildlife conservation focus; 2) to further the Society's commitment to environmental education by supporting science students with a research interest in conservation; and 3) to increase awareness of, and attract new members to, the Wildlife Preservation Society of Australia and its wildlife conservation work.

We can also name a University Wildlife Education Scholarship after any person who is prepared to make a significant donation to this innovative program. We currently have ten national scholarships and a major university scholarship scheme at the University of Technology Sydney. We would be pleased to provide further information to members at any time.

Please contact the National Office at any time for further details of the Bequest Program, the Friends of Australian Wildlife Society and the University Grants Scheme.




Australian Wildlife Society

Community Wildlife Conservation Award

The Australian Wildlife Society Community Wildlife Conservation Award is an annual award to a community conservation group that is making a major contribution to wildlife preservation in Australia.

Our Society is very conscious that we need to join together with other conservation groups to save and protect all native Australian wildlife populations in all its many and varied forms across Australia.

The Australian Wildlife Society wants to recognise and help these conservation groups continue with their good work on behalf of the whole community. Our Society knows that many organisations and thousands of volunteers are already working tirelessly to save our threatened species, as well as the humble and more common Australian species, and the precious wildlife habitat in which they live.

The Award

Our Society will present a crystal trophy and a cash award of $3,000 to the winning conservation group that is helping to save our precious Australian wildlife.

Nominations

Nominations for the Australian Wildlife Society Community Wildlife Conservation Award should be made in writing to be received by our Society by 31st December. Nomination forms can be downloaded from our website at www.australianwildlife.net.au. Completed nomination forms can be sent to the Australian Wildlife Society by email to info@australianwildlife.net.au or faxed to 02 9599 0000 or mailed to PO Box 42 Brighton Le Sands NSW 2216

Selection Procedures

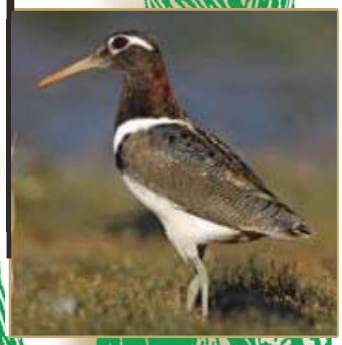
The decision on the granting of each year's award will be decided by a full meeting of the Council of the Australian Wildlife Society.

For further information, please contact the National Office on Tel 02 9556 1537.

Founded in 1909 and dedicated to the conservation of Australia's unique wildlife

Australian Wildlife Society

The Serventy Conservation Medal



The Australian Wildlife Society created the Serventy Conservation Medal in honour of three members of the Serventy Family.

In memory of Dr Vincent Serventy AM, who was a member of the Wildlife Preservation Society of Australia for more than fifty years, President for thirty years and was the President of Honour. Over the sixty years of his environmental work in Australia, and internationally, Vin worked to realise his vision of a world whose people understand that we do not own this earth, but are trustees for its future, and that we should live in harmony with nature. He has justly been called the '*father of conservation in Australia'*.

In memory of Lucy Serventy who seventy years ago became a Life Member of the Society and so began a lifetime interest in conservation.

In memory of Dr Dominic Serventy, who as the elder of the eight strong Serventy clan, played a leading part in encouraging their interest in natural history. He is regarded as among the world's greatest ornithologists.

Our intention is to award the medal to those who labour as a volunteer in the conservation field for a love of nature and a determination that is should be conserved.

Medal Design

The medal has been designed by Australia's foremost sculptor Stephen Walker. The Australian Wildlife Society also gives a cash reward of $1,500 to thewinner. Many conservationists in the past have suffered financially for their devotion to the cause. This cash award will be some tribute for their dedication. The bronze medalwill be a constant reminder that the conservation movement has remembered their work in the past, just as history will remember the same achievements in the future.

Nominations

Nominations for the ***Serventy Conservation Medal*** should be made in writing to be received by our Society by 31st December. Nomination forms can be downloaded from our website at www.australianwildlife.net.au. Completed nomination forms can be sent to the Australian Wildlife Society by email to info@australianwildlife.net.au, or mailed to PO Box 42 Brighton Le Sands, or by fax 02 9599 0000.

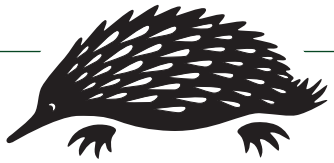
Selection Procedures

The decision on the granting of each year's medal will be decided by a full meeting of the Council of the Australian Wildlife Society.

For further information, please contact the Secretary of the National Office on telephone 02 9556 1537 or by email info@australianwildlife.net.au

Founded in 1909 and dedicated to the conservation of Australia's unique wildlife

Membership Form



WILDLIFE PRESERVATION SOCIETY OF AUSTRALIA LIMITED

PO Box 42 Brighton Le Sands NSW 2216

Membership

Become a member of the Wildlife Preservation Society Limited
Simply fill out this form.

Name:.....

Address:.....

City/Suburb:..... Postcode: .....

Telephone:..... Fax: .....

Email: .....

Membership category (please tick)

- ☐ Individual: $55
- ☐ Family: $70
- ☐ Concession (pensioner/student/child): $50
- ☐ E-mag (emailed as PDF, no hardcopy will be sent): $30
- ☐ Associate (library, school, conservation groups): $85
- ☐ Corporate: $125
- ☐ Life: $1,000

(Includes postage within Australia. Add $40 for overseas postage)

Three year membership (please tick)

- ☐ Individual: $150
- ☐ Family: $190
- ☐ Concession (pensioner/student/child): $135
- ☐ E-mag (emailed as PDF, no hardcopy will be sent): $81
- ☐ Associate (library, school, conservation groups): $230
- ☐ Corporate: $340

(Includes postage within Australia. Add $60 for overseas postage)

Payment details (please tick)

☐ Direct Debit ☐ Cheque ☐ Money Order ☐ Mastercard ☐ Visa

Card Security Code (CSC) __ __ __ __

Card Number:

Name on Card: .....Expiry:.....

Signature:.....

Amount $.....

Donation $.....

Total $.....

Mail to the: **Wildlife Preservation Society Limited**
PO Box 42, Brighton Le Sands NSW 2216.
Email: accounts@aws.org.au Website: www.wpsa.org.au

Direct debit: **BSB:** 062 235
Account No: 1043 2583
Account Name: Wildlife Preservation Society of Australia

Note: All cheques to be made out to the Wildlife Preservation Society of Australia

Consider - A Bequest

Another way which you can support the work of the Wildlife Preservation Society of Australia (Australian Wildlife Society) is to remember us in your will.

If you would like to make a bequest, add the following codicil to your Will:

> I bequeath the sum of $..... to the Wildlife Preservation Society of Australia for its general purposes and declare that the receipt of the Treasurer for the time being of the Society shall be complete discharge to my Executors in respect of any sum paid to the Wildlife Preservation Society of Australia Limited.

"The challenge to the present adult generation is to reduce the increasing pressures on the Earth and its resources - and to provide youth with an education that will prepare them emotionally and intellectually for the task ahead.

Wallum is characterised by flora-rich shrubland and **heathland** on deep, nutrient-poor, acidic, sandy soils, and regular wildfire. Seasonal changes in the water table due to rainfall may create swamps. The name is derived from the Kabi word for the **wallum** banksia (*Banksia aemula*). See page 10 for more details

Rottnest Island is an island off the coast of Western Australia, located 18 kilometres west of Fremantle. The island covers 19 square kilometres in land area, and is administered by the Rottnest Island Authority under a separate act of parliament. See page 18 for more details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