THIS IS WHAT CLIMATE CHANGE LOOKS LIKE

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Please note that the photos of healthy and degraded ecosystems are not necessarily of the same locations in all examples. Where possible, we have used photos of the same or nearby locations. In other cases, we have chosen photos that depict healthy and degraded examples of the same ecosystem type but from different locations.

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Cover image: 'Mangroves before and after marine heatwave' by Norman Duke. Reproduced with permission.

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Preface

The word "unprecedented" has been in regular use lately. As predictions about climate change increasingly become observations, we are witnessing firsthand the impacts of more frequent and severe weather events. These events are playing havoc with our health, our agricultural systems, our communities and our economy. But they are also having devastating impacts on our natural ecosystems and unique wildlife.

This report highlights recent examples of these impacts. In many cases, our ecosystems and species were already under threat from other human-associated causes - like land clearing, over-harvesting, and invasive feral animals and weeds. Climate change is adding to this litany of woes, in some cases providing what might be the last straw for species and systems already under grave stress.

The Climate Council is extremely grateful to the many colleagues who have advised on the examples in this report, and generously provided images: Mick Baron, Dr Ian Bell, Dr Dana Bergstrom, Catherine Dickson, Dr Norman Duke, Dr John French, Dr Ken Green, Rob Gregory, Dr Dean Heinze, Alyse Huyton, Emma Ligtermoet, Dr George Matusick, Dr John Morgan, Dr Ajay Narendra, Dr Robert Nowicki, Prof. Sharon Robinson, Dr Denis Saunders, Dr Mike Saynor, The Shark Bay Research Project, Bruce Thomson, Dr Jordan Thomson, Prof. Eric Warrant, David White, and Dr Dick Williams.

Key Findings

1

Australia is home to more than a million species of plants and animals, yet our track record on conservation is woeful; climate change is making it even harder to protect our natural ecosystems and unique wildlife.

- Our natural ecosystems and unique wildlife are already under grave stress from land clearing, over-harvesting and invasive feral animals and plants; climate change is adding to this litany of woes and is proving to be the last straw for some systems and species.
- The status of biodiversity in Australia is considered 'poor and deteriorating' according to the most recent State of the Environment Report, which also found that the traditional pressures facing the environment are now being exacerbated by climate change.
- Between 1996 and 2008, Australia was among the top 7 countries responsible for 60% of global biodiversity loss. The International Union for the Conservation of Nature ranks Australia fourth in the world for species extinction and first for loss of mammals.

2

Australia has one of the highest rates of species extinction in the world and it now holds the first record of a mammalian extinction due to climate change. Other species are in grave danger because of our warming climate.

- The Bramble Cay melomys was listed as endangered but no active steps were taken to protect the native rodent found on a low-lying atoll in the Torres Strait; storms and rising sea levels led to its extinction.
- Green turtles are in grave danger because the animals hatching in the northern Great Barrier Reef are 99% female due to warming. The complete 'feminisation' of the population may occur in the very near future with disastrous consequences.
- Bogong moths are in decline in the Australian alps because drought has affected the grass on which the larvae of the moths feed. These moths are a vital part of the food chain for many alpine birds and mammals.

3

Droughts, 'dry' lightning strikes and heatwaves are transforming many Australian forests.

- Ignitions from 'dry' lightning storms are increasing in frequency because of climate change, sparking many remote bushfires. Thousands of dry lightning strikes in early 2016 caused bushfires that devastated nearly 20,000 hectares in the Tasmanian Wilderness World Heritage Area.
- The Murray-Darling Basin has suffered a long-term drying trend, seriously affecting the magnificent river red gums that line the waterways. Climate change-exacerbated droughts, on top of water mismanagement, are depriving the gums of the flooding they need every few years to remain healthy.
- The jarrah forests of Western Australia are suffering as a result of long-term rainfall decline, as well as drought and heatwaves.
- Giant kelp forests that support rich marine biodiversity are declining around the southern mainland coast and Tasmania due to underwater heatwaves and the impacts of changes in the distribution of marine herbivores.

4

Australia needs to take a far bolder approach to conservation to ensure our species and ecosystems are as resilient as possible to worsening extreme weather.

- Australia's high greenhouse gas emissions are contributing to increasingly severe changes in the climate system, which means further deterioration of our environment is inevitable.
- Creating and connecting new habitats and the translocation of some species will be necessary to prevent further extinctions.
- Australia must achieve deep and rapid cuts to greenhouse gas emissions to keep temperature rise to well below 2 degrees above pre-industrial levels.
- Australia needs to accelerate the transition to clean, affordable and reliable renewable energy and storage technologies and ramp up other climate solutions in transport, industry, agriculture, land use and other sectors.

Contents

Introduction

Australia is a global biodiversity hotspot, home to more than a million species of plants and animals – approximately 8% of global biodiversity – many of which are found nowhere else on Earth. Our environment is our life support system, fundamental to our health, well-being, and economy.

Ecosystem services are the benefits that people derive from natural assets. The environment provides the food we eat, the air we breathe, the water we drink, and many of the materials we use for fibre and fuel. The environment also helps regulate our climate and ameliorate the impacts of extreme weather.

But this life support system is under extreme stress. A landmark new report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) warns that the global decline of nature is occurring at a rate unprecedented in human history, with flow on impacts to all human societies. More than one million species globally are threatened with extinction, many within a few decades. This species decline has been especially rapid in Australia since European settlement. Between 1996 and 2008, Australia was among the top seven countries responsible for 60% of global biodiversity loss. The International Union for the Conservation of Nature (IUCN) ranks Australia fourth in the world for species extinctions, and first for loss of mammals.

The most recent State of the Environment Report (2016) is a damning indictment of Australia's conservation track record, describing a continuing trajectory of species and habitat loss, and concluding that "Based on the information available about vegetation extent and condition, and the small number of species for which there is some understanding of trends in distribution and abundance, the status of biodiversity in Australia is generally considered poor and deteriorating". The report notes that the traditional pressures facing the Australian environment – habitat loss and fragmentation, invasive species, pollution and overharvesting – are now being exacerbated by climate change. These threats interact with one another, resulting in synergistic and cumulative impacts.

The risks of climate change, driven largely by ongoing emissions of greenhouse gases from fossil fuels, are accelerating. In Australia we have just experienced the hottest summer on record, and 2018 was our 3rd hottest year. In fact, nine of the ten hottest years in Australia have occurred since 2005. The recently published Australia's Environment Report (2018) notes that national average rainfall in 2018 was the lowest since 2005, total runoff into waterways was 20% less and soil moisture 6% less than in 2017, with much of the country still gripped by severe drought. Extreme events such as bushfires, heatwaves and storms are increasing in frequency and severity. Australia has been identified as the most vulnerable developed country to such risks, and our unique species and ecosystems are already suffering.

This report provides a range of graphic examples of how climate change is affecting the Australian environment, with many of the examples having occurred in the last few months or years. In some cases, these impacts have been exacerbated by existing degradation due to factors such as land clearing, whereas in others, the climate change signal is overwhelming. These examples should be a wakeup call, heralding what we are in escalating danger of losing.

Coral reefs are bleaching

Underwater heatwaves in the summers of 2015/2016 and 2016/17, as part of the longest global coral bleaching event on record, devastated coral reefs worldwide, with catastrophic impacts on the Great Barrier Reef (GBR) and others off the northwestern Australian coast.

On the GBR, over 90% of individual reefs sustained some degree of bleaching, with the worst effects seen in the formerly pristine reefs in the north. The underwater heatwave conditions that drove the 2015/2016 bleaching event are estimated to have been made 175 times more likely due to climate change. In the eight months after the 2015/16 event, nearly 30% of shallow water corals died. There was additional mortality after the 2016/17 event, with the fastest growing corals such as staghorns the most badly affected. Two years later, recruitment of new coral has been reduced by about 90%. The return period of global bleaching events has decreased from 27 years in the 1980s to only about six years today. If climate change continues unabated this trend will continue for the foreseeable future, with the possibility of recovery between catastrophes steadily diminishing. Given that these reefs are also suffering from the impacts of ocean acidification, rising sea levels, and increased severity of tropical cyclones, the outlook for these icons of marine biodiversity is very grim.

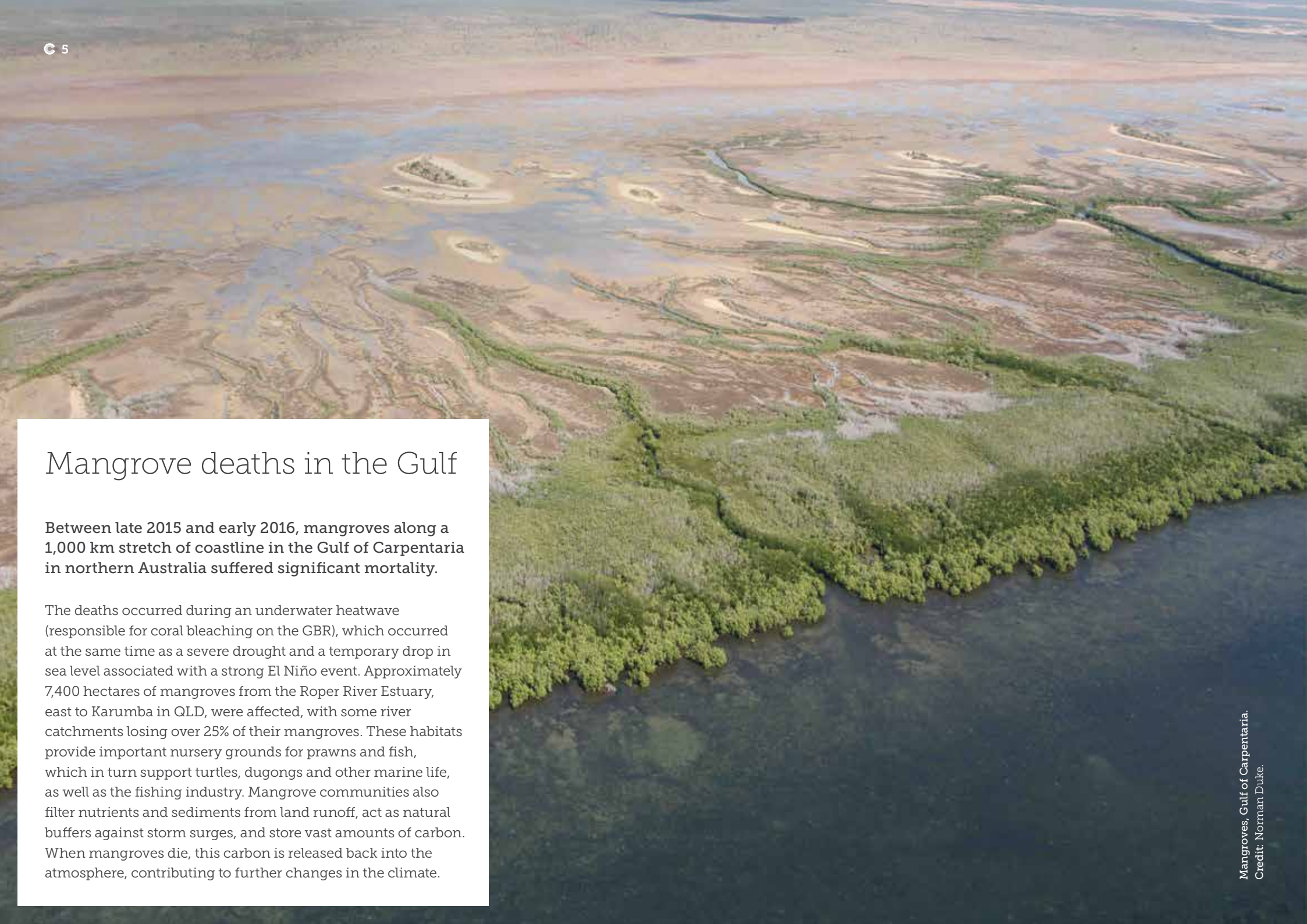
Healthy coral reef.
Credit: Klaus Stiefel.

Lizard Island, Great Barrier Reef, May 2016.
Credit: The Ocean Agency/XL Catlin Seaview Survey.

Mangrove deaths in the Gulf

Between late 2015 and early 2016, mangroves along a 1,000 km stretch of coastline in the Gulf of Carpentaria in northern Australia suffered significant mortality.

The deaths occurred during an underwater heatwave (responsible for coral bleaching on the GBR), which occurred at the same time as a severe drought and a temporary drop in sea level associated with a strong El Niño event. Approximately 7,400 hectares of mangroves from the Roper River Estuary, east to Karumba in QLD, were affected, with some river catchments losing over 25% of their mangroves. These habitats provide important nursery grounds for prawns and fish, which in turn support turtles, dugongs and other marine life, as well as the fishing industry. Mangrove communities also filter nutrients and sediments from land runoff, act as natural buffers against storm surges, and store vast amounts of carbon. When mangroves die, this carbon is released back into the atmosphere, contributing to further changes in the climate.



Mangroves, Gulf of Carpentaria.
Credit: Norman Duke.

Mass die-back of mangroves, Gulf of Carpentaria.
Credit: Norman Duke.

Saltwater intrusion into Top End freshwater wetlands

Sea levels in northern Australia are currently rising at about twice the global average. Much of the World Heritage-listed Kakadu National Park is only 0.5m above sea level and intrusion of saltwater into the iconic freshwater wetlands is already evident, accelerating since the 1950s.

In the East Alligator River region, intrusion of saltwater has occurred over the past few decades along several kilometres of tidal creeks, resulting in a nine-fold increase in the area of saline mudflats and mangroves and loss of more than 60% of *Melaleuca*-dominated freshwater swamp vegetation. The causes of the intrusion are complex, likely a combination of sea-level rise, higher flood levels, high tidal range, and buffalo damage to the protective levee that acts as a partial barrier between fresh and saltwater in Kakadu. By 2060, it has been estimated that 60% of the wetlands within Kakadu National Park may be dramatically affected.

Melaleuca wetlands, Kakadu
Credit: Emma Ligtermoet

Saltwater intrusion at Point Farewell.
Credit: Mike Saynor.

Destruction of Tasmanian World Heritage Forests

Thousands of dry lightning strikes in January and February 2016 caused multiple intense bushfires in Tasmania burning over 120,000 hectares, including nearly 20,000 hectares in the Tasmanian Wilderness World Heritage Area.

Ignitions from 'dry' lightning storms are increasing in frequency because of climate change, sparking many remote bushfires that are difficult to reach and control. The 2016 fires killed species in ancient Gondwanan forests including pencil pines, King Billy pines and cushion plants thought to be over 1,000 years old. These plants are very slow-growing, poorly dispersed, and genetically impoverished, and unlike eucalypts, are not adapted to fire; little recovery was evident one year after the fires. Long-term drying and warming will continue to increase the risk that this fire-sensitive vegetation will be replaced by more flammable, fire-tolerant species.

Ancient pencil pines, Tasmania.
Credit: © Ashley Whitworth.

Burnt thousand-year-old pencil pine, Mackenzie fire, Tasmania.
Credit: Rob Blakers.

Death of iconic river red gums

The magnificent forests dominated by river red gums *(Eucalyptus camaldulensis)* lining the waterways and floodplains of the Murray-Darling River system have been dying.

After being extensively cleared for agriculture, the gums and the ecological communities they support have suffered from the over-allocation of river flows to urban and irrigation uses. By 2008, mapping of River Red Gum stands along the Murray River (1,600 km) indicated that only 30% were in good condition and in the Macquarie Marshes, there was a 44% loss of river red gums between 1993 and 2012.

Climate change is now adding to these woes. Since the 1970s, most of the Murray-Darling Basin (MDB) has been warming at 0.2-0.4°C per decade, compared with a national average of around 0.15°C per decade, and the region has also suffered a long-term drying trend. To remain healthy, the river red gums need to be flooded about once every three years. Climate change-exacerbated droughts, on top of environmental water mismanagement, are depriving the gums of this flooding.

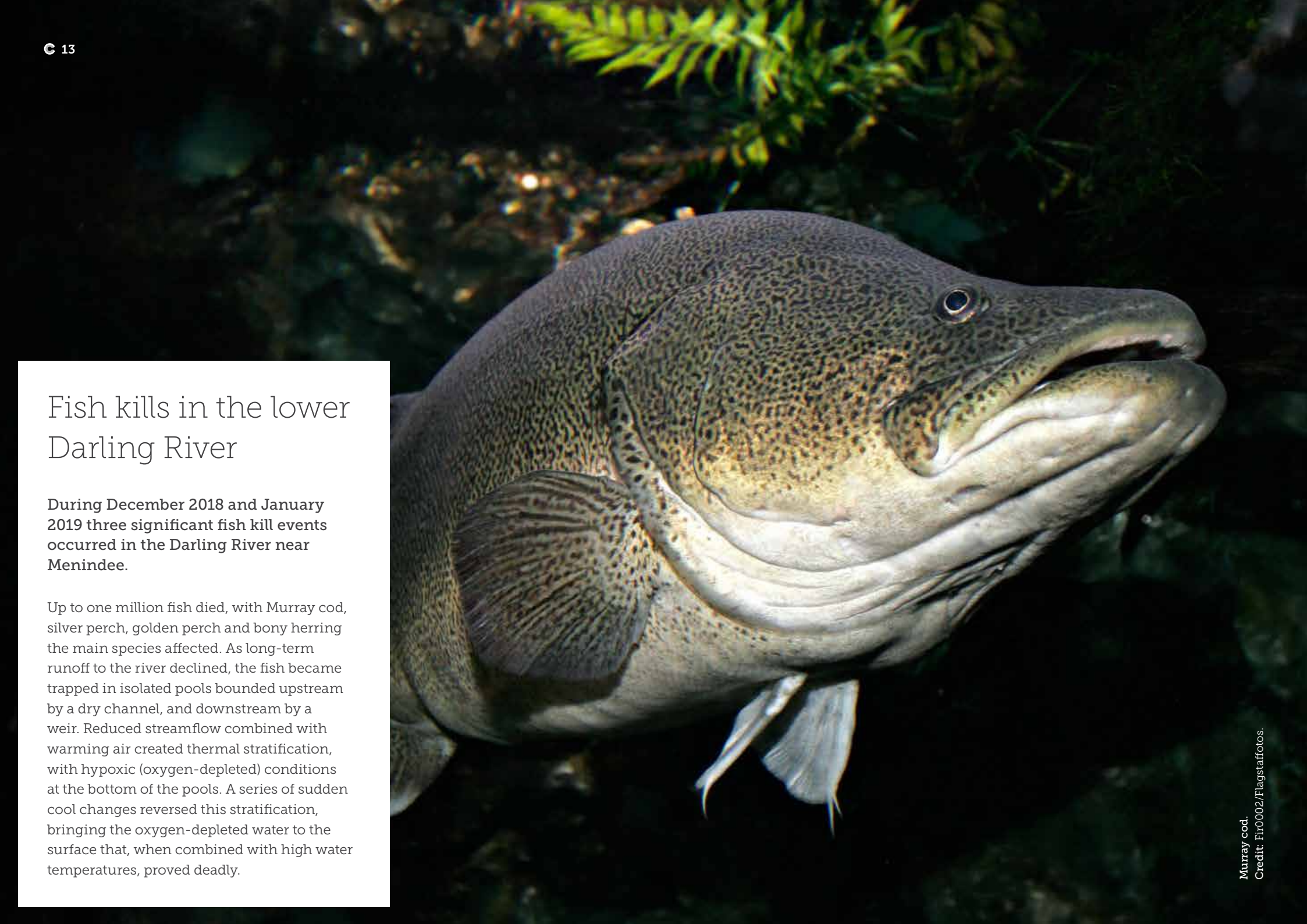
River red gums, South Australia.
Credit: Bill Bachmann.

Die-back of river red gums.
Credit: Amy Toensing.

Fish kills in the lower Darling River

During December 2018 and January 2019 three significant fish kill events occurred in the Darling River near Menindee.

Up to one million fish died, with Murray cod, silver perch, golden perch and bony herring the main species affected. As long-term runoff to the river declined, the fish became trapped in isolated pools bounded upstream by a dry channel, and downstream by a weir. Reduced streamflow combined with warming air created thermal stratification, with hypoxic (oxygen-depleted) conditions at the bottom of the pools. A series of sudden cool changes reversed this stratification, bringing the oxygen-depleted water to the surface that, when combined with high water temperatures, proved deadly.



Murray cod.
Credit: Fir0002/Flagstaffotos.

Fish deaths on the Darling River.
Credit: Amy Toensing.

Devastated kelp forests

Giant kelp forests cover more than 71,000 km^2 around the southern mainland coast and Tasmania. These ecosystems are highly productive and support rich marine biodiversity but are declining due to underwater heatwaves, as well as damage from boats, nutrient and sediment runoff, and overgrazing by marine herbivores.

In December 2015 the kelp forest shown on this page was reasonably healthy. Marine heatwaves in the summer of 2015/16 caused the kelp forest to wither and die. By April, 2016 it was almost completely gone.

Adding to the impacts of heatwaves are changes in the distribution of marine herbivores. Since the 1970s, the long-spined sea urchin *(Centrostephanus rodgersii)*, originally a resident of the New South Wales coast, has been migrating southwards under the influence of the warming and strengthening East Australian Current. It has now established in large numbers in Tasmania where warming waters mean that the larvae can survive the winter. The urchins graze on the kelp, creating bare patches called "barrens". The habitat of over 150 species is being lost during this process, with flow-on impacts to the abalone and lobster fishing industries, worth over $100 million per year (2016 figures).

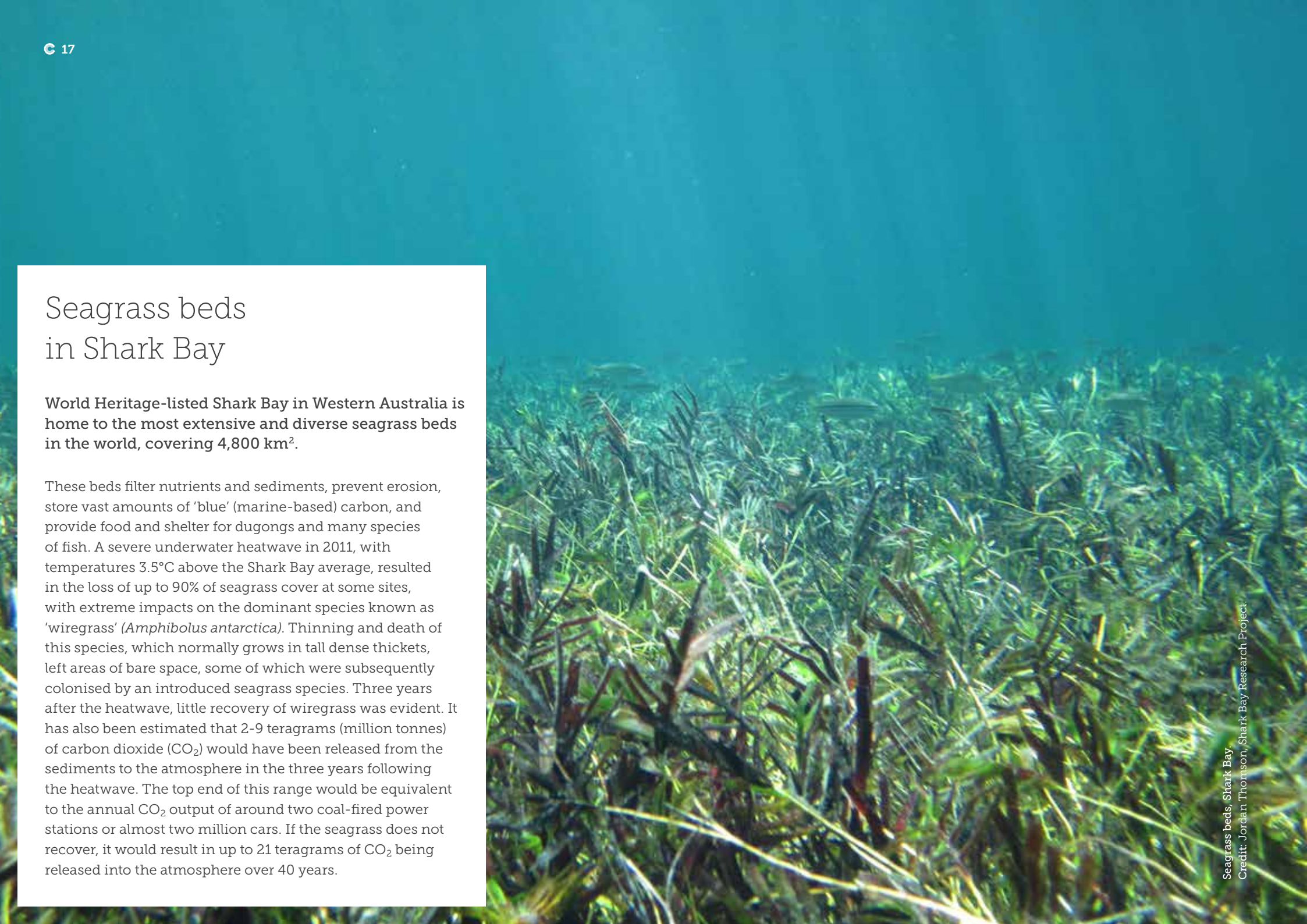
The last significant kelp forest on the east coast of Tasmania, Munro Bight, 2012. Credit: Mick Baron.

Sea urchin barren.
Credit: John Turnbull.

Seagrass beds in Shark Bay

World Heritage-listed Shark Bay in Western Australia is home to the most extensive and diverse seagrass beds in the world, covering 4,800 km^2.

These beds filter nutrients and sediments, prevent erosion, store vast amounts of 'blue' (marine-based) carbon, and provide food and shelter for dugongs and many species of fish. A severe underwater heatwave in 2011, with temperatures 3.5°C above the Shark Bay average, resulted in the loss of up to 90% of seagrass cover at some sites, with extreme impacts on the dominant species known as 'wiregrass' *(Amphibolus antarctica)*. Thinning and death of this species, which normally grows in tall dense thickets, left areas of bare space, some of which were subsequently colonised by an introduced seagrass species. Three years after the heatwave, little recovery of wiregrass was evident. It has also been estimated that 2-9 teragrams (million tonnes) of carbon dioxide (CO_2) would have been released from the sediments to the atmosphere in the three years following the heatwave. The top end of this range would be equivalent to the annual CO_2 output of around two coal-fired power stations or almost two million cars. If the seagrass does not recover, it would result in up to 21 teragrams of CO_2 being released into the atmosphere over 40 years.



Seagrass beds, Shark Bay.
Credit: Jordan Thomson, Shark Bay Research Project.

Dead seagrass beds following marine heatwave, Shark Bay.
Credit: Robert Nowicki, Shark Bay Research Project.

Transformation of Macquarie Island

The alpine fellfield vegetation of World Heritage-listed Macquarie Island is one of the world's rarest ecosystems. In 2008/9, extensive dieback of the most widespread endemic species of cushion plant, *Azorella macquariensis,* and many associated moss species, was observed.

Loss of *A. macquariensis* was so dramatic the species was subsequently declared critically endangered. Climate change is the leading cause of the decline. Between 1992 and 2008, Macquarie Island had 17 consecutive seasons of summer water stress, as well as increases in wind speed, sunshine hours, and evapotranspiration. As the cushion plants and mosses die off, they leave bare ground leading to loss of soil carbon and providing opportunities for invasion by grasses and pathogens. Nearly a decade later, dieback is still evident at nearly 99% of sites recently surveyed.

Macquarie Island, Antarctica.
Credit: Brett Phibbs.

Die-back of *Azorella macquariensis*, an endemic species of cushion plant.
Credit: Dana Bergstrom. Credit (inset): Catherine Dickson.

East Antarctic moss beds

The vegetation of the Windmill Islands and the Vestfold Hills in coastal ice-free areas of East Antarctica is dominated by very slow growing, long-lived mosses and lichens.

The moss banks provide critical habitat for Antarctic invertebrates. Over the period 2008 to 2013, approximately 30% of regional endemic moss species in the wetter sites have been dying, replaced by hardier drought-tolerant species. In drier sites, even drought tolerant species have died or become moribund (lacking in vitality), in some cases now being overgrown by lichens. These changes are associated with a regional drying trend, most likely caused by a combination of ozone depletion and the climate change-driven intensification of the Southern Annular Mode (SAM), which has led to strong westerly winds and decreased water availability.

Healthy moss beds, East Antarctica (red-tinged mosses show signs of stress).
Credit: Sharon Robinson

Grey areas show dead moss.
Credit: Sharon Robinson.

Alpine flora

Australia's alpine zone is considered one of the most vulnerable terrestrial ecosystems to the impacts of climate change. Snow cover and duration have been declining in the Snowy Mountains since the 1960s and fire risk is increasing. But the influence of climate change on pathogens is an under-appreciated additional source of trouble.

The alpine shrub *Nematolepis ovatifolia* is endemic to the alpine and sub-alpine areas of the Snowy Mountains where it dominates large areas of heath. In the spring/summer of 2011/12, mass dieback (a condition in which plants begin to die from their roots or tips) of this species was observed and many individuals subsequently died. Surveys in 2013/14 and 2014/15 confirmed that at least 59 populations were affected by dieback, with more than 90 others showing some symptoms. Subsequent research has pointed to the root pathogen *Phytophthora cambivora,* which thrives in warm, wet soils, as the main culprit. Alpine soils are usually too cold for this type of pathogens to flourish, but following two very wet seasons (2011/12 and 2012/13), soils near the dieback sites were more than 2°C (2012/13) above the long-term average. This dieback event could be a preview of future conditions, exposing our vulnerable alpine flora to new risks.

Alpine shrub *Nematolepis ovatifolia*, healthy, dying, dead (left to right).
Credit: Ken Green.

Die-off in WA jarrah forests

The combination of drought and heatwaves, against a backdrop of long-term rainfall decline and warming, is transforming many Australian forests, with particularly severe impacts in the jarrah *(Eucalyptus marginata)* forests of southwest Western Australia.

A severe drought and multiple heatwaves in 2010-11 caused the deaths of an estimated 26% of mature trees across 7,000 hectares. Recovery from these events has been very slow, with the forests transformed from being dominated by tall trees to being dominated by shorter, multi-stemmed trees with more flammable fuel, potentially contributing to greater future fire risk and the release of more carbon into the atmosphere.

jarrah forests showing patches of dead trees, southwest Western Australia.
Credit: George Matusick.

Dying marri and jarrah trees.
Credit: George Matusick.

They don't like it hot...

RINGTAIL POSSUMS

Wildlife rescuers retrieved more than 100 dead and injured ringtail possums *(Pseudocheirus peregrinus)* on Somers Beach on the Mornington Peninsula, Victoria in March 2019, during a 4-day heatwave. Local carers speculate that the possums had become so dehydrated that they may have attempted to drink saltwater.

SUFFERING PENGUINS

The western Antarctic Peninsula has warmed by about 3°C over the past 50 years (compared to the global average of about 1°C over the past century). Antarctic ice is now melting six times faster than in the 1980s, contributing to rising sea levels. But on land, warming is also affecting local species, including gentoo penguins *(Pygoscelis papua)*, recently photographed panting due to heat stress.

Ringtail possums.
Credit: Alyse Huyton.

Heat-stressed gentoo penguin chick.
Credit: Will Steffen.

SPECTACLED FLYING FOXES

Climate change is making heatwaves in Australia longer, more frequent, and more intense. In November 2018 an extreme heatwave in the Cairns region resulted in daytime temperatures of over 42°C for two consecutive days. An estimated 23,000 spectacled flying foxes *(Pteropus conspicillatus)* – one third of the entire population of the species - simply dropped dead out of the trees. Hundreds more were collected and taken to rehabilitation shelters, including many orphaned babies. In response to this event, the species has now been listed as endangered.

This is the second largest known flying fox die-off in Australia – the largest being an estimated 45,000 deaths during a heatwave in southeast Queensland in 2014, consisting mostly of black flying foxes *(Pteropus alecto)*.

Orphaned spectacled flying foxes.
Credit: David White.

Spectacled flying foxes.
Credit: David White.

CARNABY'S BLACK COCKATOO

Carnaby's black cockatoo *(Calyptorhynchus latirostris)* is an endangered species in Western Australia that has undergone a dramatic decline in abundance and geographic range over the past 50 years, largely due to habitat loss from land clearing. But the species is also very susceptible to heat stress. The Esperance cockatoo population was almost completely wiped out in a single day in January 2010 with 200 birds found dead after temperatures reached 48°C.

Carnabys cockatoos.
Credit: Rick Dawson.

Carnabys cockatoos and other birds, collected January 2012.
Credit: Unknown.

OUTBACK BUDGIES

A severe heatwave in January 2009 near the Overlander Roadhouse between Geraldton and Carnarvon in Western Australia caused the deaths of thousands of budgerigars and other birds. These birds are generally considered well adapted to hot and arid conditions but the photo shows the birds desperately seeking shade as the temperatures soared, with many succumbing to the extreme conditions.

Budgerigars, 2009 heatwave, Western Australia
Credit: © West Australian Newspapers Limited (Benjamin Strick).

Going, going...

TURTLE FEMINISATION

The gender of animals such as turtles and crocodiles is determined by the temperature experienced during egg development. Green turtles *(Chelonia mydas)*, for example, develop into females if the temperature of the nest is more than 29°C (sand temperatures above 34°C are fatal). Recent surveys have found that turtles hatching from beaches in the southern Great Barrier Reef are 65-69% female, but those hatching from northern beaches are 99% female. The researchers concluded that the northern rookeries have been producing primarily females for more than two decades, and that complete 'feminisation' of the population may occur in the very near future, with disastrous consequences.

BOGONG MOTHS DECLINE IN THE AUSTRALIAN ALPS

Each spring for thousands of years, tens of millions of bogong moths *(Agrotis infusa)* have migrated more than 1,000 kilometres from their breeding grounds in southern Queensland, north and western New South Wales, and Victoria, to caves in the Australian Alps. Settling in densities of up to an estimated 17,000 per m^2, the moths have been of great cultural significance for Aboriginal people who would converge to feast during ceremonies. The moths are also a vital part of the food chain for many alpine birds and mammals, including the endangered mountain pygmy possum *(Burramys parvus)*. But prolonged drought through parts of southern Queensland and northern New South Wales has now affected the availability of grass on which the larvae of the moths feed, severely reducing moth populations in the Alps, and for the past two years there have been no moths at all in many of the caves. Recent observations of starving mountain pygmy possums with dead young in their pouches suggest these trends might have already had catastrophic impacts.

Green turtle hatchlings.
Credit: © Violeta Jahnel Brosig

Bogong moths.
Credit: Eric Warrant
Credit (inset): Ajay Narendra

Dead pouch young of mountain pygmy possum.
Credit: Dean Heinze.

Mountain pygmy possum, Kosciusko National Park.
Credit: Australian Alps.

... gone

A DUBIOUS RECORD

Australia not only has the dubious honour of being the continent with one of the highest rates of species extinctions, we now hold the first record of a mammalian extinction due to climate change. The Bramble Cay melomys *(Melomys rubicola)*, a native rodent, once lived on a tiny, low-lying sandy atoll in the Torres Strait. Found in the hundreds in the 1970s, the population declined precipitously over the next few decades, with the last individual being seen in 2009. Despite being listed as endangered, no active steps were taken to protect the species, and it has now been officially declared extinct. Surveys have revealed that the island had been repeatedly inundated by storms, worsened by rising sea levels. The last of the Bramble Cay melomys simply drowned.

Bramble Cay, Torres Strait.
Credit: Ian Bell.

The now extinct Bramble Cay melomys.
Credit: Bruce Thomson.

Conclusion: Our Life Support System on Life Support

Australia's ecosystems are being transformed before our eyes. Already bruised and battered by multiple human-induced stresses including land clearing, invasive species and freshwater diversion, climate change is adding insult to injury. As high levels of greenhouse gas emissions drive ever more severe changes to the climate system, accelerating deterioration of Australia's environment is inevitable.

Climate change must necessarily move the goalposts for conservation policy and natural resource management. We must redouble our efforts to combat and reverse the effects of habitat loss and degradation so that our species and ecosystems are as resilient as possible to worsening extreme weather. We must also take a far bolder, more proactive approach to conservation, recognising that creating and connecting new habitats, and translocation of some species will be necessary to prevent further extinctions.

The good news is that protecting our natural assets has great benefits for people too. Urban greening can cool our cities as well as providing habitat, healthy riparian vegetation can help limit flood impacts, and intact coral reefs and mangroves can help protect our coastlines from storm damage. Healthy vegetation and soils also store enormous quantities of carbon, helping to address the cause of the climate problem.

But simply doing conservation better is not enough. We must achieve deep and rapid cuts to greenhouse gas emissions to meet the target of the Paris Climate Agreement to keep temperature rise to well below 2°C above pre-industrial levels. Given that dramatic, and in some cases, irreversible environmental changes have occurred with 'only' 1°C of warming, we cannot delay.

Solutions are at hand. We need to accelerate the transition to clean, affordable and reliable renewable energy and storage technologies and ramp up other climate solutions in transport, industry, agriculture, land use and other sectors. Our health, economy, communities, and precious natural icons depend on it.

We have so much to lose ... but it doesn't have to be this way.

Credit: © Shutterstock / ChameleonsEye / WWF

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Page 22: Dying East Antarctic moss beds by Sharon Robinson. Reproduced with permission.

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Page 29 (right): Dead carnaby's cockatoos collected after Esperance heatwave. Photographer unknown.

Page 30: Budgerigars at the Overlander Roadhouse 200km south of Carnarvon by © Benjamin Strick, West Australian Newspapers Limited.

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7,400 ha of **mangroves along the Gulf of Carpentaria** were affected by an underwater heatwave in 2016.

The Bramble Cay melomys, from the Torres Strait, is the first documented mammalian species to go extinct due to climate change.

Green turtles hatching on the northern beaches of the Great Barrier Reef are now 99% female, due to warmer temperatures.

Saltwater intrusion into freshwater wetlands has resulted in a nine-fold increase in the area of saline mudflats and mangroves in the East Alligator region over recent decades.

Underwater heatwaves in 2016 and 2017 caused severe bleaching of the **Great Barrier Reef,** resulting in the death of 1/3 of hard corals.

An underwater heatwave in 2010-11 resulted in the loss of up to 90% of **seagrass cover at some sites in Shark Bay.**

One third of the locally endemic **spectacled flying fox** population died in a heatwave in Cairns in 2018.

Long-term declines in rainfall and run-off in the **Murray-Darling Basin** have contributed to the death of river red gums and over one million fish.

Prolonged drought has led to a decline in **bogong moths** in the Australian alps, in turn threatening the endangered **mountain pygmy possum.**

Drought and heatwaves in 2010-11 caused the death of 26% of mature trees in **jarrah forests in southwest Western Australia.**

Giant kelp forests in Tasmania have declined due to underwater heatwaves and the increased range of sea urchins.

Australia's alpine zone is vulnerable to climate change. A mass dieback of alpine shrubs occurred in 2011/12 due to a pathogen that thrives in warmer soils.

Heatwaves have caused mass deaths of budgerigars and the endangered **Carnaby's cockatoo** in Western Australia.

Mosses on Macquarie island and in Antarctica are declining and becoming diseased as the climate warms.

Ignitions of 'dry lightning' fires are increasing due to climate change, sparking fires that have killed species in **ancient Gondwanan rainforests** thought to be over 1000 years old.

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