

FREE-FLOWING RIVERS OF AUSTRALIA'S NORTH



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Adelaide River during the wet season. Credit: Janelle Lugge

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Daly River Floodplains. Credit: Shaana McNaught

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The Daly River. Credit: Jason Fowler

SUMMARY OF RECOMMENDATIONS

1. TURN THE POLICY PRIORITY TO RIVER PROTECTION

1.1 DEVELOP LAWS AND POLICIES TO PROTECT HIGH-VALUE RIVERS AND ASSOCIATED HABITATS (WETLANDS, FLOODPLAINS AND AQUIFERS)

As specified in the National Water Initiative, develop laws and policies to identify 'surface and groundwater systems of high conservation value' and 'protect and enhance those values'. To herald a commitment to river conservation, identify the highest priority unprotected rivers for protection as a key focus of the renewed National Water Initiative. Enact tenure-blind mechanisms to prohibit harmful activities in these rivers and on their floodplains.

1.2 STRENGTHEN PROTECTION OF CULTURAL HERITAGE AND FACILITATE TRADITIONAL OWNER MANAGEMENT

In laws and policies to reflect the hybrid cultures of river management, articulate the perceptions and values of rivers in Indigenous terms; strictly protect cultural heritage as identified by Traditional Owners; and support Traditional Owners to sustain their cultural connections and exercise their custodial responsibilities for managing river systems.

1.3 STRENGTHEN WATER ALLOCATION PROCESSES TO ACHIEVE MORE SUSTAINABLE DEVELOPMENT

Where river systems are not wholly protected, strengthen laws to optimise the sustainability of any water-focused developments, including requirements for transparent water planning, assessments of cumulative catchment impacts and allocations of cultural flows in addition to environmental flows.

2. IMPLEMENT BEST-PRACTICE GOVERNANCE

2.1 ENACT UNDRIP AND NWI GOVERNANCE PRINCIPLES

Strengthen governance by enacting relevant principles under the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) and the National Water Initiative Agreement (NWI). This includes UNDRIP Article 32.2 requiring the free and informed consent of Indigenous peoples before the approval of projects affecting their lands or territories and other resources. Relevant NWI provisions include requirements for statutory water planning. Other elements of sound governance include respecting Traditional Owner ways of perceiving and relating to rivers, and optimising transparency, accountability, community engagement and evidence-based decision-making.

3. REPLACE THE WHITE PAPER WITH A PLAN TO SUPPORT SUSTAINABLE LIVELIHOODS

3.1 REVIEW THE WHITE PAPER AND ASSOCIATED POLICIES AND PROGRAMS

As part of the proposed 'refresh' of the White Paper on Developing Northern Australia, commission an expert review and consult with stakeholders, the public and experts to determine how best to support genuinely sustainable development in the North that is aligned with the aspirations, cultures and skills of Traditional Owners and other northern residents and with broader government commitments such as Nature Positive, meeting climate targets, Closing the Gap and protecting cultural heritage.

3.2. INVEST IN EVIDENCE-BASED AND CO-DESIGNED DEVELOPMENT PATHWAYS

Refocus public investment on development opportunities that are aligned with the long-expressed aspirations of people who live in the North and consistent with sustaining and restoring the cultural and environmental values. With Traditional Owners, codesign opportunities that help achieve the goals of strategies such as Closing the Gap.

1 INTRODUCTION



1.1 THE LIFE OF A BARRAMUNDI

A big old barra lurks in a snag. She's just arrived in her favourite wet-season billabong, where life is surging. Although she hasn't fed for days and is lean after a long dry season, she stays put, for an equally hungry bull shark is patrolling not far away. But as the night deepens and the shark moves on, she ventures out to faster-flowing waters and waits.

A young barramundi sweeps towards her. She opens her mouth wide and, with a powerful whoosh, sucks it in. Her first feed of the season is an act of cannibalism, the opportunism of a supreme predator.

As an old barra a metre long, she – definitely a *she*, for there are no old males – has led an eventful life. In pursuit of food, and also to avoid pursuit, she has travelled at times more than 300 kilometres inland, up numerous tributaries, and then back out to sea, living variously in fresh, brackish and salty waters. Thanks to supreme guile and extreme luck, she is the lone survivor from the 30 million eggs her mother spawned one summer some 15 years ago.

She started life quietly – but as a *he*, the universal sex of young barramundi – hatching on a mudflat, then drifting into a mangrove forest, feeding on plankton and small crustaceans. The following summer, lured by fresh water, he sallied upriver. Although river travel is harder and riskier than staying on the coast, he could grow much faster in fresh water.

When the river broke its banks, he moved onto the fertile floodplain, sucking up almost any prey up to half his size. And when the waters receded, he chose his dry season refuge carefully to avoid being trapped with too little water or too many predators.

With a run of bumper wets, he grew quickly, and in the fifth year his ripening gonads propelled him back to the estuary, where under a new moon he cast his sperm into water thick with freshly spawned eggs.

A month later, he started growing ovaries, and became fully female while travelling back upriver. For several years, she didn't return to the estuary, forgoing reproduction in favour of weight gain – for the bigger she grew, the more eggs she could produce.

Now, in most years, particularly those with big wets, she returns to her birthplace, heavy with eggs...

Opposite: Barramundi (*Lates calcarifer*). Credit: Karl Timmer

1.2 THE IMPORTANCE OF FLOW

There are many forks in the life of a barramundi – decisions about where to live, when to travel and when to reproduce. Only recently have researchers appreciated just how varied are their lives – some living mainly or wholly in coastal and estuarine waters; others migrating into fresh water as juveniles and returning to the estuary after a few years to spawn initially as males and later as females; and others remaining in a river for many years, returning to the estuary only as large females [1]. Strongly influencing these choices are river flows.

We've learned quite a bit more about the lives of barramundi in recent times because governments are proposing to change how rivers flow in many northern catchments – by allowing large extractions of surface and ground water, and potentially also the construction of dams and weirs, to enable large-scale irrigated cropping.

Behind the dam walls in the Ord River system, barramundi would die out if they were not restocked because they can no longer return to the estuary for breeding [2]. That most other rivers of the North still have healthy barramundi populations reflects one of the standout features of the region: its rivers are mostly still free-flowing and healthy. This feature alone makes them of global significance – a sad reflection on the poor state of many of the world's rivers, including in Australia. Globally, some 2.8 million dams now impede rivers [3]; nearly 70% of wetlands have been destroyed since 1900 [4]; and monitored populations of fishes, turtles and other freshwater vertebrates have declined on average by more than 80% since 1970 [4].

The rivers of the North are of standout significance for many other reasons as well – their diversity of species, the strongholds they provide for species in decline elsewhere, the exhilarating abundance of wildlife and their cultural significance for the people who have lived there for tens of thousands of years.

Recent research is showing just how much these values rely on maintaining natural flow regimes. Barramundi are 'especially vulnerable to hydrologic disturbance' and water extraction could, for example, increase the proportion of barramundi that adopt a slower-growing, estuarine life strategy, reducing the productivity of barramundi fisheries and their ability to withstand fishing pressure [1].

For the big old barra featured above, water extraction could mean less habitat at critical times, less prey, more exposure to predators, and greater susceptibility to fishing and the impacts of climate change. Other species are also sensitive to changes in water flow regimes – the critically endangered largemouth sawfish especially so, as well as prawns, sooty grunter, several small fish species and cherabin (large freshwater prawns) [5–10].

Australians should deliberate very carefully over the future of these rivers – for they have enormous value in their current form for people and nature (Box 1). The nation has already paid dearly for the over-exploitation and degradation of many southern rivers, particularly in the Murray–Darling Basin, where rivers have been regulated and exploited with little consideration of whether this would genuinely benefit communities and be safe for nature.

Cheap and apparently abundant water is luring irrigators to the North:

'Overallocation of water resources in many areas of southern Australia, memories of the recent millennium drought, future projections of reduced rainfall across southern Australia ... and perceptions of an abundant amount of water in northern Australia have domestic irrigation investors increasingly looking north for agricultural opportunities ... In fact, some foreign companies have already invested heavily in irrigation in northern Australia ...' [11].

Despite some reforms, the approach to development in the North shares many features with the processes that have led to the degradation of southern rivers. They are based on the same assumptions that rivers should be exploited – up to some level deemed 'sustainable' – and that there is some optimal balance between environmental, social and economic outcomes. Development decisions are largely governed by the same legal frameworks and economic models that have led to overexploitation elsewhere.

Decisions are proceeding in the North unguided by any long-term vision for the future of the rivers and catchments, uninformed by a comprehensive consideration of the environmental, social and economic consequences of irrigation developments, and often without the meaningful involvement of communities in decision-making. Traditional Owners continue to be sidelined in decisions about the rivers they have managed for 50,000 years, or more, and that remain vital to their cultural and economic wellbeing.



Daly River, Northern Territory. Credit: Jasmine Burke

BOX 1: MANY WAYS OF TREASURING THE RIVERS OF THE NORTH

The treasuring of rivers in Australia's North is multi-faceted, reflecting the cultural diversity of the people and the many ways they relate to rivers. Here are a few representative voices on what the rivers mean to people in the North.

For Traditional Owners, rivers are spiritual and cultural systems, living beings with a right to life. Rivers 'must run free so that the spiritual force of the river is not interfered with or blocked and so that the increase of all species is maintained' [12].

'The River is very important for us. River got the meaning, River got the story, River got the songs ... We want to protect our River. Our River is like our Mother. ... We got a rule that we do the right thing, what was given by Woonyoomboo - Law is still there standing.'
(Annie Milgin, Nyikina Traditional Custodian, Martuwarra Fitzroy) [13].

'All our songlines follow the water. We are all connected.
If you take our water, you kill our culture. If you kill our culture, you kill our people.'
(The Roper Water Rights Coalition Statement to Government) [14].

'The ecosystems, the species, lots of those animals are Dreamtime totems. The chosen ones, that's your Dreaming, you need to look after that one, and protect the environment where it feeds, nests and lives. We are trying to preserve the water, for the habitat and the species.'
(Senior member of the Yirendali, Flinders catchment) [11].

Rivers are also important to Traditional Owners as resources, and as sites for social interactions and learning.

'[The Daly] is an important source of food for many of my people, providing fish such as barramundi and turtle. It is teeming with life.'
(Miriam Rose Ungunmerr Baumann, Ngangikurungkurr Traditional Custodian) [15].

'The river is very important. It has water to drink, it has food for fish and for ourselves. It is the place where our ancestors camped along the river. They did not go far, they could not carry the water too far. Everyone needs water to live. Without it there is nothing for anyone.'
(Senior member of the Mitakoodi, Flinders catchment) [11].

For many other northern residents, rivers are central to their lifestyle – for fishing, boating, swimming and hanging out – and sites of beauty and solace [16,17]. In focus groups, residents have talked of the importance of rivers for personal reflection and inspiration, as spaces where people 'can realise our place' and where 'the beauty and the sound of the water' can be appreciated [17].

'I like the seasonality – I look forward to it flowing but I also like the beautiful sandbeds, the waterholes that only last a few months.' (Focus group participant, Queensland) [17].

'With access to some of the world's most beautiful river systems ... as well as many of Australia's most sought after fish species to chase, the Territory offers a fishing experience for everyone – locals and visitors alike.' (Territory Labor 2020) [18].

'If you were to design the perfect barramundi river, it's the Fitzroy River.'
(Bluey Vaughn, Kimberley fishing guide) [19].

All fishers, recreational and commercial, understand the fundamental importance of healthy rivers, and fishers from many other parts of Australia have experienced a loss of fishing opportunities due to ecological degradation [20,21].

BOX 1 (CONTINUED)

'The flows of these rivers are their lifeblood. Without the sustenance it provides to all living things – including the big barramundi we all go out to catch – we've got nothing. We all bear a responsibility to nurture it for those of us here today and tomorrow.'
(Roxanne Woolley, recreational fisher and educator, Humpty Doo) [22].

'It is essential to recognise that, despite a lot of rhetoric from down south, there is no such thing as wasted water in the Top End – all water has a value to the environment and every drop we divert away from our iconic floodplains, catchments and fisheries must be justified in social and economic terms.' (David Ciaravolo, CEO Amateur Fisherman's Association NT) [23].

There are commercial fisheries in the North for prawns, mud crabs, barramundi and other finfish. Recent research in the Gulf of Carpentaria has highlighted that 'river flows fuel the productivity of the entire ... ecosystem' [24].

'The underpinning of our successful fishery over 40 years has been the environmental flows that sustain the baby prawn. ... Whether it's irrigated pasture for cattle, or more intensive cropping operations like cotton, it all begins to interfere with the natural flow of those coastal and estuarine systems that are so important to us.'
(David Carter, chief executive of Austral Fisheries) [25].

'In tropical northern Australia, river flow is crucial to the ecosystem services that support the life cycles of a suite of estuarine and marine species that are important in commercial, recreational and indigenous fisheries.'
(Rob Kenyon and others, fisheries biologists) [26].

Other scientists studying northern rivers have also emphasised their ecological values.

'Northern Australia represents one of the few relatively undisturbed tropical riverine landscapes in the world.' (Neil Pettit and others, 2017) [27].

'With such enviable relatively intact freshwater, riparian and adjacent terrestrial ecosystems that support endemic, endangered and scientifically significant species and communities, the creation of protected areas and a management plan in the Fitzroy River catchment is an opportunity to establish an internationally acclaimed and scientifically endorsed conservation regime.' (*Fitzroy River Science Statement*) [28].

'Australia's tropical rivers and their wetlands, floodplains and estuaries are the most biologically diverse and healthy aquatic ecosystems in Australia today.'
(Australian Tropical Rivers Group [29])

Although there is strong disagreement about whether an irrigation industry is desirable and could be sustainable in the North, irrigation industry leaders have agreed that maintaining healthy rivers and thriving wildlife populations is important.

'The irrigated agriculture sector is committed to ... achieving healthy rivers and environment.'
(National Irrigators' Council) [30].

'We are keenly aware ... of the fragility and environmental values of northern Australia.'
(Australian Cotton Cooperative Research Centre) [31].



THE MARTUWARRA/FITZROY – MARDOOWARRA, BANDARALNGARRI

Traditional Owners: Ngarinyin, Nyikina, Mangala, Bunuba, Gooniyandi, Walmajarri, Warrwa and Wangkatjungka peoples

The mighty Martuwarra stands out globally for its complex dynamism, with one of the most variable flow regimes in the world driving a boom-and-bust ecology. The abundant life thriving there has adapted in innovative ways to the alternating plenitude and poverty of water and resources.

The Martuwarra is one of Australia's great river systems – rich in fish, with more species than any other Western Australian river, part of an endemism hotspot; important for waterbirds, with wetlands of national and international significance; and a lifeboat for critically endangered largemouth sawfish, with the world's largest known population and a nursery up to 450 kilometres inland for juveniles in their first four to six years of life.

The outstanding cultural values of the Martuwarra have been recognised by their listing as National Heritage value under national environmental law.

The Martuwarra has been described by the Western Australian Government as 'one of the most extraordinary assets in the state'. The Government has moved away from considering the yearly extraction of up to 400 gigalitres of water – enough to grow more than 50,000 hectares of cotton and set the catchment on a degrading Murray Darling Basin trajectory - to instead committing to stopping further surface water extraction. Debate continues on mechanisms for long term protection and appropriate limits on groundwater extraction, with up to 105 gigalitres of groundwater still under consideration.

'...as living systems, waters have rights and interests, and these are intricately connected with the rights and interests of Indigenous peoples who are the stewards, guardians, and owners of waters.'

Martuwarra RiverOfLife and others [34]



THE DALY

Traditional Owners: Wadjigiynk, Maranunngu, Malak Malak, Kamu, Warai, Nanggiwumerri, Wagiman, Wardaman, Dagoman, Jawoyn, Matngala, and Yangman peoples

The ever-vibrant Daly, with vast wetlands, unique ecological communities and diverse wildlife, is a rarity in the North – one of a handful of major rivers flowing all year round, sustained by groundwater, with dry-season flows five times larger than those of any other Northern Territory river.

Extensive parts of the rivers and floodplains are nationally important wetlands, cacophonous with birds, including the iconic magpie goose. The abundance of waterbirds in the estuary and lower floodplains is of international significance. Annual flooding is essential for fueling aquatic food webs, triggering a dramatic surge in floodplain productivity.

The Daly is rich in fish, with more than 90 species, including the critically endangered largemouth sawfish. It has more turtle species than any other Australian river, eight in all, including the globally endangered pig-nosed turtle, the last surviving member of an ancient turtle family.

The Daly is renowned as the premier barramundi sports fishing location in Australia and attracts major fishing tournaments, which inject millions of dollars into the economy and boost the Territory's tourism brand.

But the Daly is also the centre of a proposed large-scale cotton industry. Water granted by the government for free is attracting irrigators from overseas and southern Australia. But major aquifers underlying the Daly catchment have already been overallocated. Irrigators propose to harvest up to 500 gigalitres of flood waters – the waters essential for replenishing aquifers and sustaining floodplains and the waterbirds and fish, including barramundi and sawfish, that rely on them.

*'We are River people. We cannot hurry the river.
We have to move with its current and understand its ways...
Our culture is different. We are asking our fellow Australians to
take time to know us; to be still and to listen to us.'*

*Miriam-Rose Ungunmerr Baumann, 2021 Senior Australian of the year,
member of the Ngangiwumirr language group group [35]*



THE ROPER

Traditional Owners: Ngalakgan, Alawa, Mangarrayi, Ngandi, Marra, Warndarrang, Nunggubuyu, Ritharrngu-Wagilak and Rembarrnga peoples

The Big River Country of the Roper catchment encompasses a dramatic melange of plateau escarpments, gorges and ridges, salt pans and billabongs, floodplains and tidal flats. Rising from the Arnhem Plateau, the Roper is one of a handful of major rivers in the North that flows all year round. Groundwater sustains not only the channel flows during the long dry, but large wetlands, rich riparian forests with patches of monsoon rainforest and vine thicket, springs and thermal pools, including the famous Mataranka pools and Bitter Springs in Elsey National Park.

The annual Roper floods are essential for the health of the nationally significant coastal wetlands and seagrass beds of Limmen Bight, habitats for turtles and dugongs, as well as the prawns and crabs that are fished commercially. The Roper is a well-known fishing mecca for barramundi.

But the future of the Roper is under imminent threat from large-scale water extraction and fracking for gas. Politicians have talked of turning the Roper River catchment into a super food bowl with up to a million hectares of soils with cropping potential. Permits for extensive land clearing are being granted.

Speaking as one voice in the *Roper River Water Statement*, Traditional Owners have called for a ban on all further water extraction and legal protection for environmental and Indigenous cultural values [14]. They want all Roper River communities to be included in joint decision-making about water, and their scientific and cultural knowledge to be listened to.

'If you take our water, you kill our culture, they say. If you kill our culture, you kill our people' [14].

*'The Roper River is our great spirit....
The water is for cleansing our spirit....
Most of our Dreaming is in the water.
We can't change that law.'*

Gordon Nawundulpi, on behalf of the Yugul Mangi clans of the Roper. [14]



THE MITCHELL

Traditional Owners: Western Yalanji, Djungan, Bar-Barum, Wakaman, Kokominjena, Kokoberra and Kunjen peoples

Connectivity is the lifeforce of rivers. The Mitchell River connects upland rainforests to tropical savannas to expansive wetlands, salt flats and coastal waters. And its waters, still mostly free-flowing, with the largest median streamflow of any river in the north, enable the migration of barramundi, mullet, freshwater whiprays and sawfish [36].

The Mitchell catchment is exceptionally rich in fish, among the most diverse of all Australia's rivers. The shorebirds that spend summer in the Southeast Karumba Plain Aggregation make up the second largest population of shorebirds in Australia [36]. Two other wetland complexes in the catchment are also recognised as nationally important.

The abundance of life in the Mitchell River system is sustained by the boost in energy and nutrients provided by annual flooding, which supports huge biomasses of fish and large bird-breeding events [37]. The bigger the floods, the bigger also the catch of many fish and crustaceans harvested commercially and recreationally, including barramundi and banana prawns. Threatened species such as sawfish, snubfin dolphins and freshwater sharks also rely on those big flows.

But there is talk of damming the Mitchell River after a Commonwealth Scientific and Industrial Research Organisation (CSIRO) assessment found three million hectares of potentially irrigable agricultural soils. Indigenous peoples in the catchment interviewed for the CSIRO studies said they don't want big dams [38]. They want businesses that support Traditional Owners to be on their country to keep it healthy. They want to protect important places, rehabilitate damaged lands, maintain water flow and sustain cultural practices.

'The whole river is sacred. The springs and waterholes, some are medicine and healing waters.... The water and land are the same thing to us, it is one thing to us. You can't separate country.'

Kuku Djungan Director [38]

2 FLOWING TO THEIR OWN TUNE

THE HIGHLY DISTINCTIVE RIVERS OF THE WET-DRY TROPICS

- 2.1. Seasonal living
- 2.2. Riverine rhythms
- 2.3. Aquatic connections

- 2.4. Unfettered flows
- 2.5. Aquatic treasures
- 2.6. Aquatic wildlife

2.1 SEASONAL LIVING

For the Ngan'gi people on the Daly River, the arrival of Wirirr Marrgu, the season for burning spear grass, is a good time for finding northern long-necked turtles [39]. As the dry deepens – through the seasons of Ngunguwe (when mirages shimmer on the horizon) and Lirrimem (the build-up before the rains) – the muddy edges of billabongs become ever more exposed, and hibernating turtles can be found by probing the mud with long sticks [39,40]. Long-necks and other turtles are an important food for many Indigenous people. Most are shared beyond the immediate household, as a way of fulfilling kinship and social obligations, sometimes with people hundreds of kilometres distant [40].

When the big rains arrive, the long-necks emerge from their underground refuges, and their hatchlings also emerge, from eggs laid at the end of the previous wet. Long-necks are the only reptile known to lay eggs underwater, at the edge of wetlands, and their eggs require both drying and wetting to hatch [41].

The Daly River has more freshwater turtle species than any other Australian river – eight in all – including the pig-nosed turtle, recently listed globally as endangered [42,43]. This last surviving member of an ancient turtle family (the *Carettochelyidae*) is now found only in a few rivers in the Northern Territory (the Daly, Victoria, Fitzmaurice, East Alligator and South Alligator) and in southern New Guinea [42,44].

The Ngan'gi people also have a name for the season when pig-nosed turtles lay their eggs – Memenyirr, which means 'hot burning sand', evoking the practice of pig-noses lifting their feet to cool as they lay their eggs in the baking sands of river beaches and banks [39]. Although the eggs are laid at different times, the babies emerge in synchrony, with the final development of the embryo stalled until the right environmental cue. During the first heavy rains of the wet season, within minutes of being immersed the baby turtles emerge explosively, scrambling upward through wet sand to take their first breath outside the egg [45]. The hatching synchrony seems to be aided by communication, perhaps vibrational.

One surprising discovery of recent times is that some turtle species have complex vocalisations, comparable to those of whales and dolphins, probably to synchronise social behaviours. Pig-nosed turtles often bask, nest and feed in groups – and recent recordings of seven individuals revealed a diverse repertoire with harmonic, non-harmonic and pulsed elements [46].

Each river species – and the people who have lived with these rivers for tens of thousands of years – has made their own accommodations to the highly variable flow regimes of the rivers of the Wet-Dry Tropics. In this chapter, we outline some of what is known about these rivers and their wildlife, and what makes them distinctive and special.

The Mitchell Plateau, Kimberley, Western Australia
Credit: Alamy Stock Photo

2.2 RIVERINE RHYTHMS

More than a million gigalitres of rain fall in the North each year, enough to fill Sydney Harbour at least 200 times over [47,48]. About 20% flows down streams and rivers, some 15% drains into aquifers, and the rest, about 65%, evaporates or is transpired by plants [49]. The 200,000 gigalitres flowing downstream represents more than 60% of Australia's total streamflow, yet comes from catchments encompassing just 16% of Australia's land area. In this driest of inhabited continents, where drought visits regularly and a gigalitre of irrigation water can sometimes cost \$8 million [50], such enormous volumes of water flowing out to sea represent, to some people, enormous development potential. Irrigation proponents often call it *wasted water* [51,52].

But, paradoxically, the North is also parched much of the time [53,54]. More than 90% of rain falls during the short wet season (typically starting between September and December and ending in March or April) [55]. And, being monsoonal, most of the rain (about 60%) falls near the coast, limiting the potential for water capture for extensive irrigation [54,56]. For most of the year (10 months on average), the rainfall is exceeded by the potential rates of evaporation (up to 3,000 millimetres a year) and transpiration (water loss through plants) [57]. Average rainfall during the long dry season does not exceed 200 millimetres anywhere across the Wet-Dry Tropics. The highest falls, of just 80 to 110 millimetres on average, occur around Darwin, Cape Arnhem, northern Cape York Peninsula, and the headwaters of the Mitchell River [47].

Over a year, the annual water deficit is typically 400–600 millimetres near the coast and 1,400–1,600 millimetres in the inland [58]. So, unless rivers are sustained by groundwater, they stop flowing much of the year. Only four major northern rivers flow all year – the Daly (NT), Roper (NT), Gregory (NT, Qld) and Jardine (Qld) (Figure 2). A few others have substantial reaches of permanent flow – the Victoria (NT), Mitchell-Coleman (Qld) and Ord-Pentecost (WA) – and some streams (such as those on the Arnhem Land Escarpment) flow year round [58]. Overall, three-quarters of the rivers and streams in the Wet-Dry Tropics for which there is data stop flowing for much of the year (Figure 2, Figure 3).



Victoria River near Timber Creek, Northern Territory
Credit: Ian Beattie

The monsoon is fickle, which means the timing and duration of the wet season varies greatly from year to year. Since 1930, annual rainfall totals in the north have varied about 4-fold [54]. Wet season flows in a river can vary between years by 2–3 orders of magnitude [59]. As a result of climate change, the variability of flows could increase, with the potential for fewer but more intense rainfall events [55].

As the seasons cycle, the northern rivers assume very different characters – most turning from swollen torrents to parched sandy beds with isolated waterholes. These characteristics are a major reason that most rivers in the North still flow freely. It hasn't been for want of trying that the *promise* of these rivers is considered by irrigation proponents to be *untapped* [60]. The extreme variability and unpredictability of river flows has stymied several grand schemes to develop large-scale irrigated cropping (Chapter 5). Wildlife have adapted to this variability, but many developers in the North have not.



Figure 2. Perennially flowing rivers and streams in Australia

Source: Bureau of Meteorology [61]

Notes: Although the majority of rain falls in the north, only a smattering of northern rivers and river stretches have perennial flows. There are no perennial rivers in the central and western regions. Only in south-eastern Australia are perennial flows typical of many rivers.

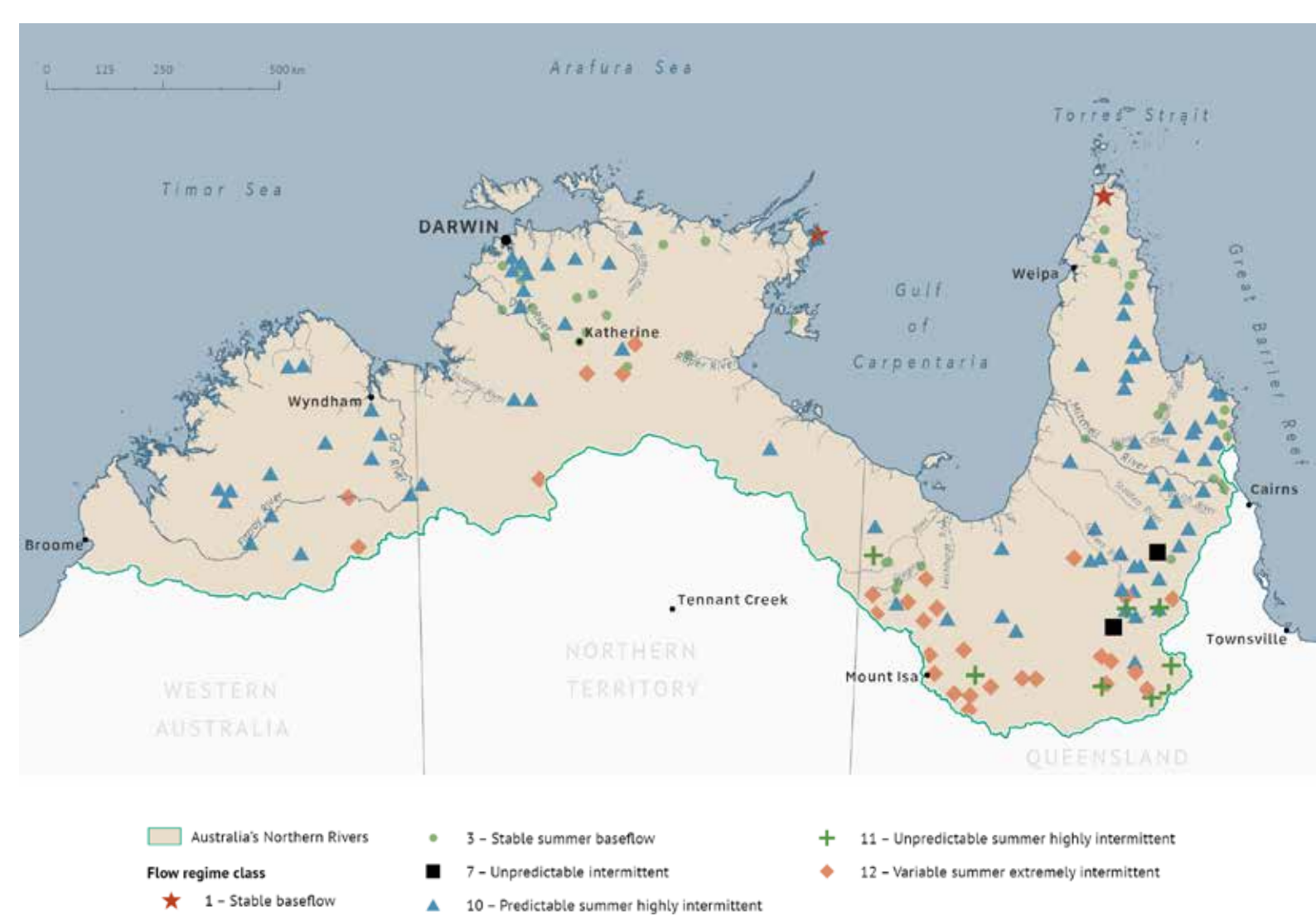


Figure 3. The variety of flow regimes in the Wet-Dry Tropics

Source: Kennard et al. 2010 [62]

Notes: The patterns of flow in rivers are of immense ecological consequence. Six types of natural flow regimes (of 12 possibilities) are represented in the rivers and streams of the Wet-Dry Tropics [62]. Of the 156 northern streams that have been classified, three-quarters have 'highly' or 'extremely' intermittent flows, with the different classes varying in their predictability:

- **Class 10 (predictable summer highly intermittent): 50%.** The flows are highly intermittent (usually zero flow for 100–200 days a year) and seasonally predictable, dominated by summer runoff, although the timing of annual maximum flows is variable. Most are large rivers flowing into the Timor Sea or Gulf of Carpentaria.
- **Class 12 (variable summer extremely intermittent): 19%.** The flows are extremely intermittent (usually zero flow for >250 days a year) and summer-dominated but with weak seasonality. The flows are dominated by infrequent large floods that can occur at any time of year. They are characteristic of arid and semi-arid regions and found in the southern Gulf of Carpentaria.
- **Class 11 (predictable summer highly intermittent): 5%.** The flows are highly intermittent and summer-dominated, but with weaker seasonality, more variable and less predictable than class 10 streams. Most are large rivers on the north-east coast.
- **Class 7 (unpredictable intermittent): 1%.** The flows are highly variable and have very low predictability. The timing of maximum flows is variable. These are found on the north-east coast.

The other 25% of northern streams have stable baseflows due to groundwater discharge:

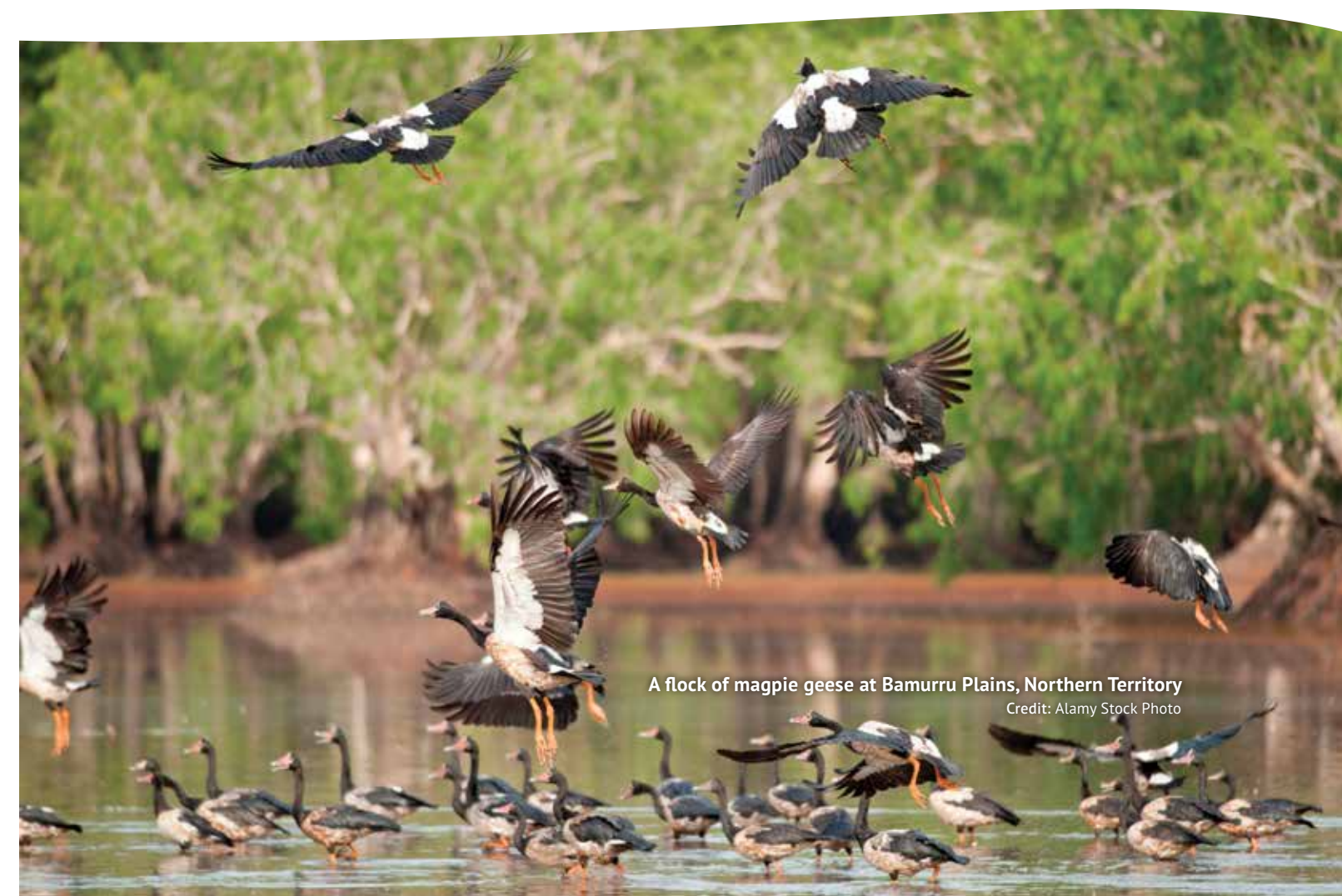
- **Class 3 (stable summer baseflow): 24%.** The flows are perennial with a high baseflow contribution and high runoff magnitude but with lower constancy and predictability of monthly mean flows than class 1 streams. These occur mainly on the north-east coast and in the Top End.
- **Class 1 (stable baseflow streams): 1%.** The flows are perennial with a comparatively high baseflow contribution, high runoff magnitude and high constancy of monthly mean flows. There are only two of these streams.

2.3 AQUATIC CONNECTIONS

Bangkerrang, the season of irregular 'knock-em down' storms and receding floodwaters, when the afternoon sky changes colour, is when Gundjeihmi people (and others) of the South Alligator Rivers region go collecting the eggs of magpie geese, a staple food source [63]. Magpie geese build floating nests of grasses and sedges in deep waters on floodplains and swamps and then rely on a succession of wetlands during the dry season to raise their young, travelling up to 15 kilometres each day to feed on wild rice, water chestnuts and other foods as they become available [63]. These multitudinous icons of the north, the only living members of an entire bird family, have been made rare in southern Australia by wetland destruction and degradation [64]. Their abundance in the North is testament to the still mostly intact connectivity between rivers, floodplains and wetlands.

In most rivers of the North, water overtops the banks during the wet season and spreads, filling lagoons and creating vast, shallow wetlands. In some parts of the Gulf, these floodplains make up more than a third of the total catchment area. As the sediments and nutrients settle out, the water clarifies [58]. And in the summer heat, nourished by organic matter carried in floodwaters, plants grow prolifically, providing food and habitats for wildlife and serving as the base for algal growth, an important foundation of aquatic foodwebs [65]. The floodplain is highly productive for fish, turtles, waterbirds and other wildlife – and essential for maintaining their abundance.

Ecologically, therefore, we should not talk just of rivers – for water, being water, never flows just down a channel. It moves in three dimensions – laterally (between the floodplain and river channel), vertically (between aquifers, the surface and the atmosphere), and longitudinally in the river channel – rising and ebbing over the seasons. When unconstrained, this flow shapes and sustains an immense diversity of aquatic habitats – lakes (saline and freshwater), swamps, billabongs, anabranches, overflows, waterholes, streams, lagoons, floodplains...



A flock of magpie geese at Bamurru Plains, Northern Territory

Credit: Alamy Stock Photo

One of the serious limitations of much water law and policy in Australia has been the artificial separation between land and water and between different aquatic habitats. The long neglect of floodplain harvesting in the regulation of water extraction has been a major contributor to the ecological devastation in the Murray-Darling Basin [66]. This separation is not only ecologically nonsensical but anathema to many Aboriginal people, as expressed in the *Mary River Statement* [67]:

‘Water and land cannot be separated. We look and care for country together not separate’.

The variability and unpredictability of water flows often challenge policymakers managing human uses of water. And rather than work with it, the approach for most of Australia’s colonial history has been to try to tame rivers, by regulating their flows, reducing variability and corralling excess waters for productive purposes. In many southern catchments, the result has been the sundering of river connections to land and the conversion of wetland to dryland systems [66].

Other connections often poorly understood and neglected are between the surface and the vast, complex underground networks of water-filled spaces (fissures, cracks, voids and pores) within and between rocks known as aquifers. The size and connectedness of these spaces depends on the type of rock: in hard rock such as granite, water occupies fractures and joints; in carbonate rock such as limestone, water fills voids, sometimes cavernous, created by dissolution; and in sedimentary rocks such as sandstone, water flows in the spaces between sand grains [68]. Aquifers are replenished during the wet, with about 15% of the rainfall trickling down. And in turn, during the dry, through springs, seepages and base flows, they supply waterholes and flowing channels and are tapped by deep-rooted riparian trees [69]. Aquifers are ecosystems in their own right – habitat for micro-organisms and, to an unknown extent in the north, for animals that live permanently underground (stygo fauna) (see section 2.6). For some Traditional Owners, they are also culturally significant as the tunnels and channels by which rainbow serpents travel underground [70].

Another important connection is that with the estuary and sea. Most northern rivers have a large estuary, often 100 kilometre or more long, which forms a major part of the coastal ecosystem. Freshwater flows into the estuary are ecologically important for delivering nutrients, regulating salinity, and facilitating fish migration [27]. Many freshwater fish in the North spend part of their lives in estuarine waters, often as larvae [71].

Natural flow regimes are crucial to sustain the life cycles of a suite of estuarine and marine species that are important in Indigenous, commercial, and recreational fisheries [26]. The abundance of barramundi, mud crabs, threadfin and banana prawns, among others, depends on a brackish ecotone within estuaries, which is maintained by low flows, and the migration cues provided by floods [26].



Coastal estuary in the Northern Territory
Credit: Boyloso

2.4 UNFETTERED FLOWS

One of the outstanding qualities of Australia’s North – too little celebrated by many Australians – is that almost all the rivers flow free. Largely unimpeded by dams and weirs, their flows are governed by seasons rather than irrigators. River ecologists consider these rivers ‘the most biologically diverse and healthy aquatic systems’ in Australia [69]. Other regions with high concentrations of free-flowing rivers are in the Arctic/subarctic (Siberia, Canada, Alaska), Himalaya, Amazon, Congo and New Guinea [3].

These days, it is an increasingly rare privilege – and responsibility – to live among healthy rivers. A global assessment of river threats – based on 23 different stressors associated with water resource development, catchment disturbance, pollution and invasive fish that threaten human water security or biodiversity – found that 80% of the world’s people live where rivers are highly threatened [72]. Almost two-thirds (65%) of global river discharge, and the aquatic habitats supported by this water, are moderately to highly threatened. Australia’s North has one of the world’s largest concentrations of least threatened rivers (for biodiversity values), along with the Amazon and Arctic/subarctic regions (Figure 4) [72].

There is a strong correlation globally between river degradation and water resource development [72]. Australia has a water storage capacity of about 95,000 gigalitres (in dams with more than 10 gigalitre capacity), which is more per person than in any other country, accounting for almost a quarter of total continental runoff [73]. While there are more than 550 dams across Australia with more than 10 gigalitres capacity, just 12 occur in the Wet-Dry Tropics (Figure 5, Table 1) and only four of these are used for irrigation, all in the Ord River system. Lake Argyle is Australia’s second-largest dam, with a capacity exceeding 10,000 gigalitres [74].

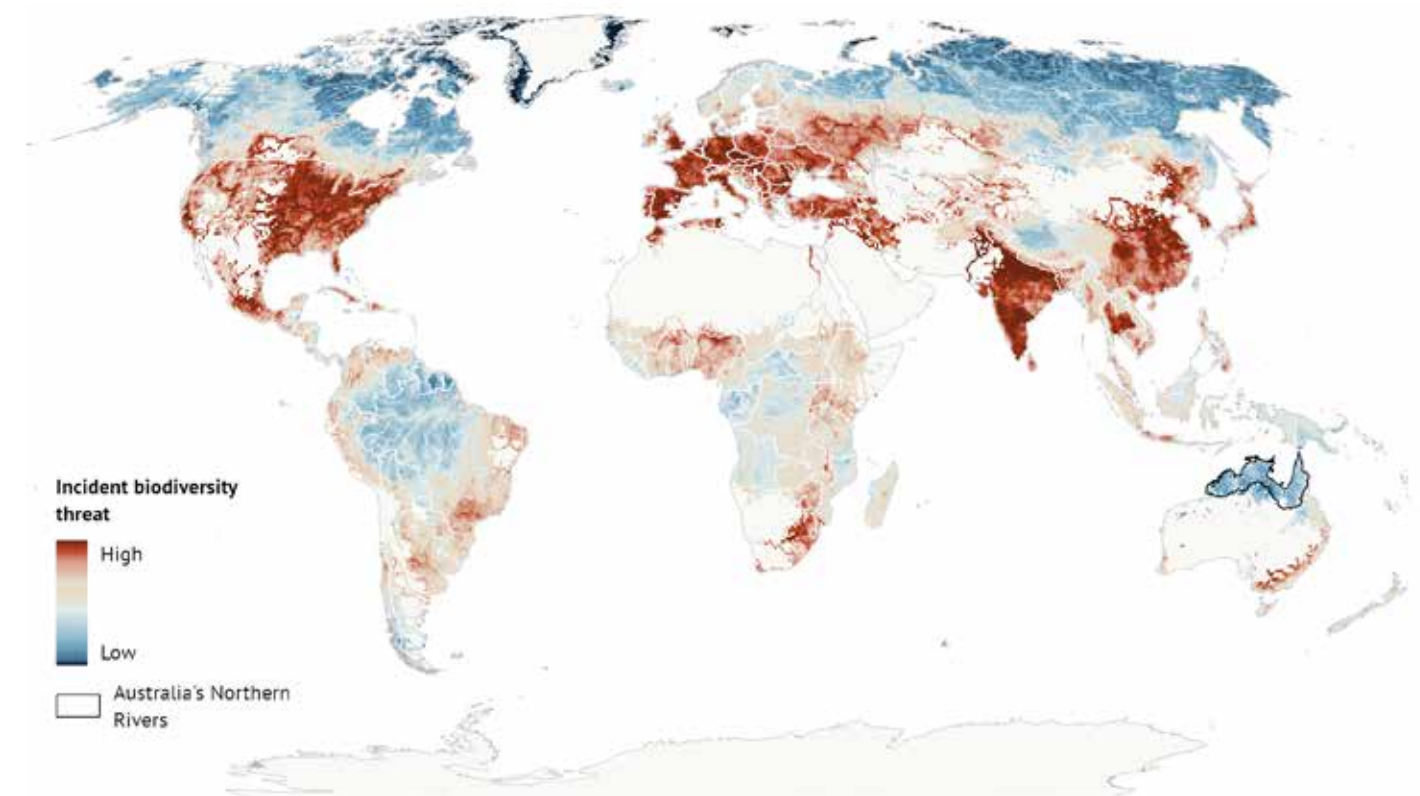


FIGURE 4. The state of threats to the biodiversity values of the world’s rivers

Source: Vörösmarty et al. 2010 [72]

Notes: Multiple stressors of four threat types – catchment disturbance, pollution, water resource development and invasive species – were combined using relative weights to derive a cumulative threat index for impacts on river biodiversity. Stressors associated with dams and flow depletion are the clearest sources of threats to river biodiversity. Two-thirds (65%) of global river discharge is under moderate to high threat.

Australia thus represents two extremes in the state of rivers – with some of the world’s healthiest rivers in the North and some of the most damaged in the south and the east. Of the northern freshwater ecoregions, the Arafura–Carpentaria ecoregion has 98% free flow (as an average proportion of watercourse length) and the Kimberley ecoregion 94% [75]. But the eastern coastal ecoregion has only 56% free flow and the Murray–Darling Basin 46%. With only two of its 22 major rivers free of dams and about 10,000 barriers obstructing flows [76], the Murray–Darling ranks among the worst 2% of ecoregions in the world for impeded flows [75]. The pitiable state of many of these rivers epitomises how not to treat rivers – and represents what many people in the North are determined to avoid (Chapter 5).

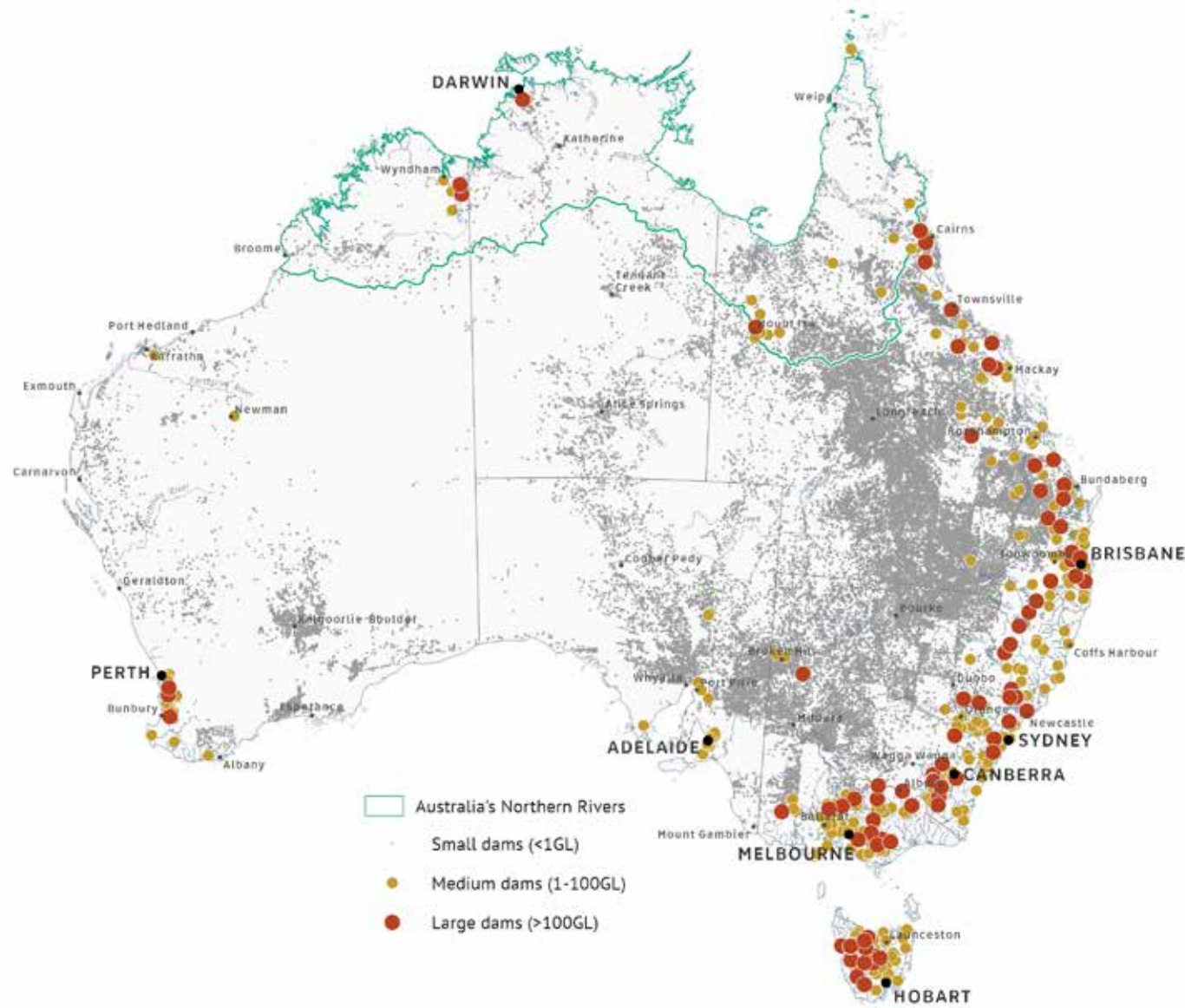


FIGURE 5. Dams in Australia

Sources: ANCOLD 2022 [74], Bureau of Meteorology 2015 [79]

Notes: Australia’s large (>100 gigalitre capacity) and medium-sized dams (1–100 gigalitre capacity) can store a total volume of about 80,000 gigalitres and supply about three-quarters of Australia’s annual water use (totalling about 25,000 gigalitres) [80]. Of more than 500 such dams Australia-wide, 22 are in the North. Most dams used for irrigation exceed 10 gigalitres capacity. There are at least 238 of these Australia-wide, with just 12 (5%) in the North, in six catchments (Table 1). The five large northern dams (>100 gigalitres capacity) are the Ord River Dam (Lake Argyle), Lake Mitchell, Lake Moondarra, Lake Kununurra and Darwin River Dam (Table 1). Only the two in the Ord River system are used for irrigation. The Australian landscape is also peppered with more than 500,000 small dams (<1 gigalitre capacity), about 5,500 (1%) of which are in the Wet-Dry Tropics.

This is not to say that the northern rivers are pristine. An assessment for Australia’s 2016 State of the Environment Report rated 20 river systems in the North as *least disturbed* (in the top two of eight degrees of disturbance) but 11 (over a third of the region) – including the Mary, Adelaide, Finnis, Daly, Normanby, Ord, McArthur, Fitzroy, Gilbert, Flinders, and Leichhardt rivers – were rated in the three bottom categories of *disturbed* (Figure 6).

In addition to the regulation and exploitation of several rivers, almost all northern catchments have been impacted by major changes in land use and land management since colonisation. Much of the region is used for grazing and there are patches of cropping, forestry and mining, mostly around permanent water sources [77] (section 3.2). But apart from damage caused by weeds, feral animals and livestock, most of the rivers, wetlands and estuaries are in good condition [58,77,78]. Critically, less than 5% (on average) of the catchment areas have been cleared. Those most modified are the Ord, Flinders, Leichhardt, Martuwarra Fitzroy and Daly catchments, particularly where irrigated cropping has been concentrated [53].

Large-scale clearing for cropping would fragment and damage the world’s largest remaining expanse of relatively intact tropical savanna woodland. This vegetation type used to cover 12% of terrestrial Earth. With 70% having been cleared, more than a quarter of what remains in good condition is in northern Australia [77].

TABLE 1. DAMS ON THE NORTHERN RIVERS EXCEEDING 10 GIGALITRES CAPACITY

RIVER BASIN	STATE	STORAGE NAME	WATERWAY	CAPACITY (GL)
Ord River	WA	Ord River Dam (Lake Argyle)*	Ord River	10,760
Finniss River	NT	Darwin River Dam	Darwin River	265
Mitchell River	Qld	Southedge Dam (Lake Mitchell)	Mitchell River	190
Leichhardt River	Qld	Lake Moondarra	Leichhardt River	103
Ord River	WA	Lake Kununurra*	Ord River	101
Ord River	WA	Arthur Creek Dam*	Arthur Creek	60
Gilbert River	Qld	Copperfield River Gorge Dam	Copperfield River	21
Adelaide River	NT	Manton Dam	Manton River	16
Flinders River	Qld	Corella Dam	Corella River	15
Leichhardt River	Qld	Lake Waggaboonyah	Greenstone Creek	14
Leichhardt River	Qld	Lake Mary Kathleen	East Leichhardt River	12
Leichhardt River	Qld	Julius Dam	Leichhardt River	11

Source: ANCOLD 2022 [74]

Notes: The dams marked with an asterisk, all in the Ord River system, are used for irrigation. Most other irrigation is with groundwater.

2.5 AQUATIC TREASURES

Australia's North is rich in natural and cultural assets of recognised international and national environmental significance, due in large part to their aquatic values. Here and in Figure 7 is a partial accounting of those with high environmental and cultural values; many other high-value sites have not been formally recognised. The cultural significance of aquatic sites, in particular, is poorly reflected in formal designations.

Wetlands of international importance: five northern wetlands are listed under the Ramsar Convention – the Ord River Floodplain (WA, 141,453 hectares), Kakadu (NT, 1,979,766 hectares), Cobourg Peninsula (NT, 220,700 hectares), Roebuck Bay (WA, 7,614 hectares) and Lakes Argyle and Kununurra (WA, 117,495 hectares). The lakes are listed despite being artificial, formed by the damming of the Ord River (Box 5) [83].

Wetlands of national importance: 83 northern wetlands, covering 5.4 million hectares, are listed in Australia's Directory of Important Wetlands, making up about a third of the area of listed wetlands across Australia [84].

World heritage areas (WHAs): four northern sites are listed under the World Heritage Convention – Kakadu National Park (for natural and cultural values), Purnululu National Park, Riversleigh and the northern estuaries overlapping the Great Barrier Reef WHA [85–88]. Cape York Peninsula has been assessed as having world heritage values, including for its aquatic ecosystems and freshwater biodiversity [89].

National heritage places: eight northern sites are listed under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* as national heritage places for their natural or cultural values or both. In addition to the three world heritage sites, they are the West Kimberley, Ngarrabullgan, Wave Hill Walk Off Route, Wurrurrwuy and Quinkan Country [90]. Another eight northern sites have been nominated for national heritage listing, including Cape York Peninsula.

Key biodiversity areas (KBAs): 39 northern sites covering 12.5 million hectares have been designated by Birdlife International as KBAs. These are sites assessed according to a set of criteria as globally important for the conservation of bird populations [91].

State reserves: 115 protected areas (national parks, conservation parks, nature reserves) in the North cover 11 million hectares, 9% of the northern rivers focus area. In Queensland, 49 national parks cover 7% of the focus area; in the Northern Territory 29 cover 11%, and in Western Australia, 37 cover 8%.

Indigenous protected areas (IPAs): 25 IPAs cover 16 million hectares, 13% of the northern rivers focus area. In Queensland, six IPAs cover 3% of the focus area; in the Northern Territory 12 IPAs cover 14% and in Western Australia, one IPA covers 29%.

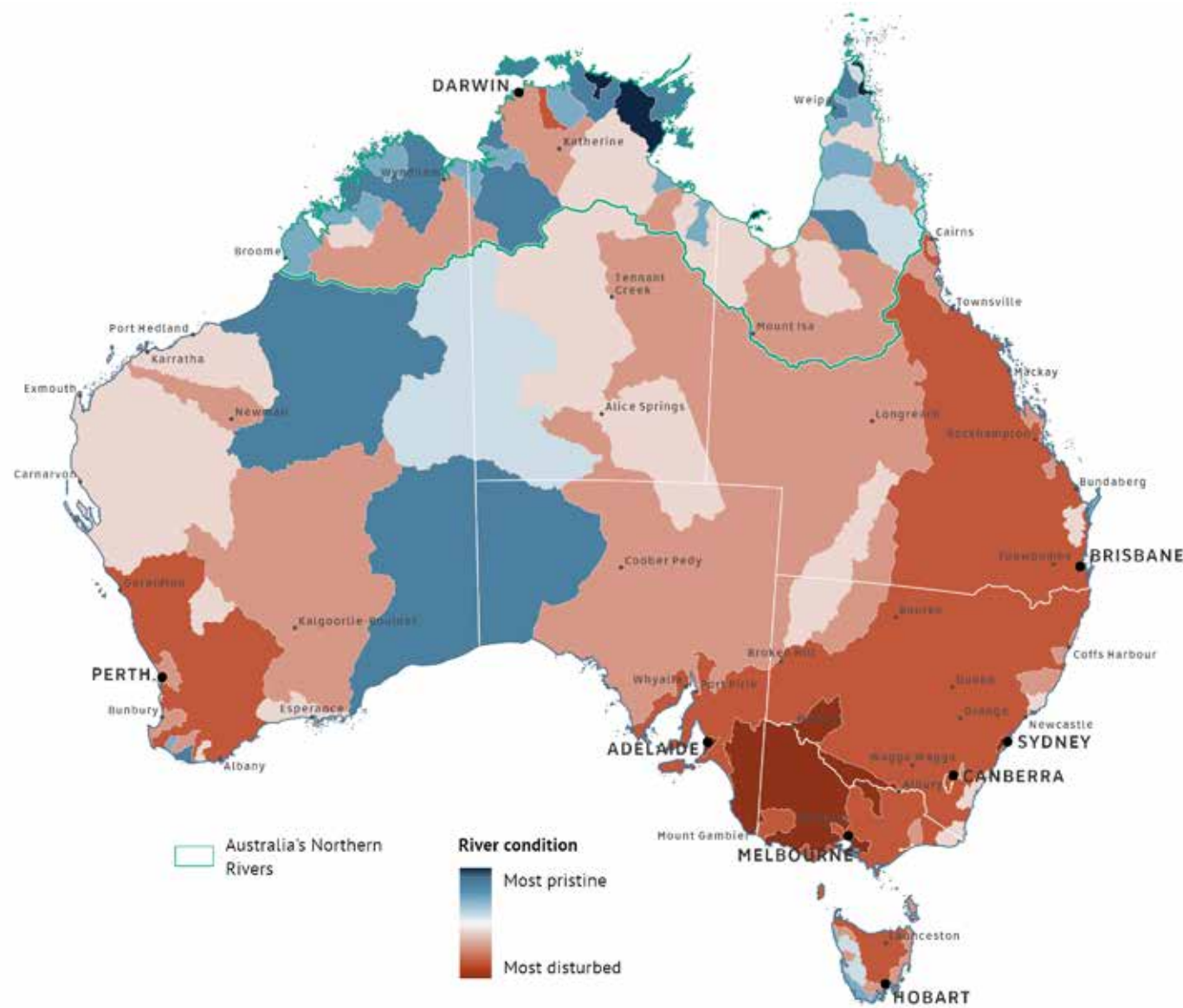
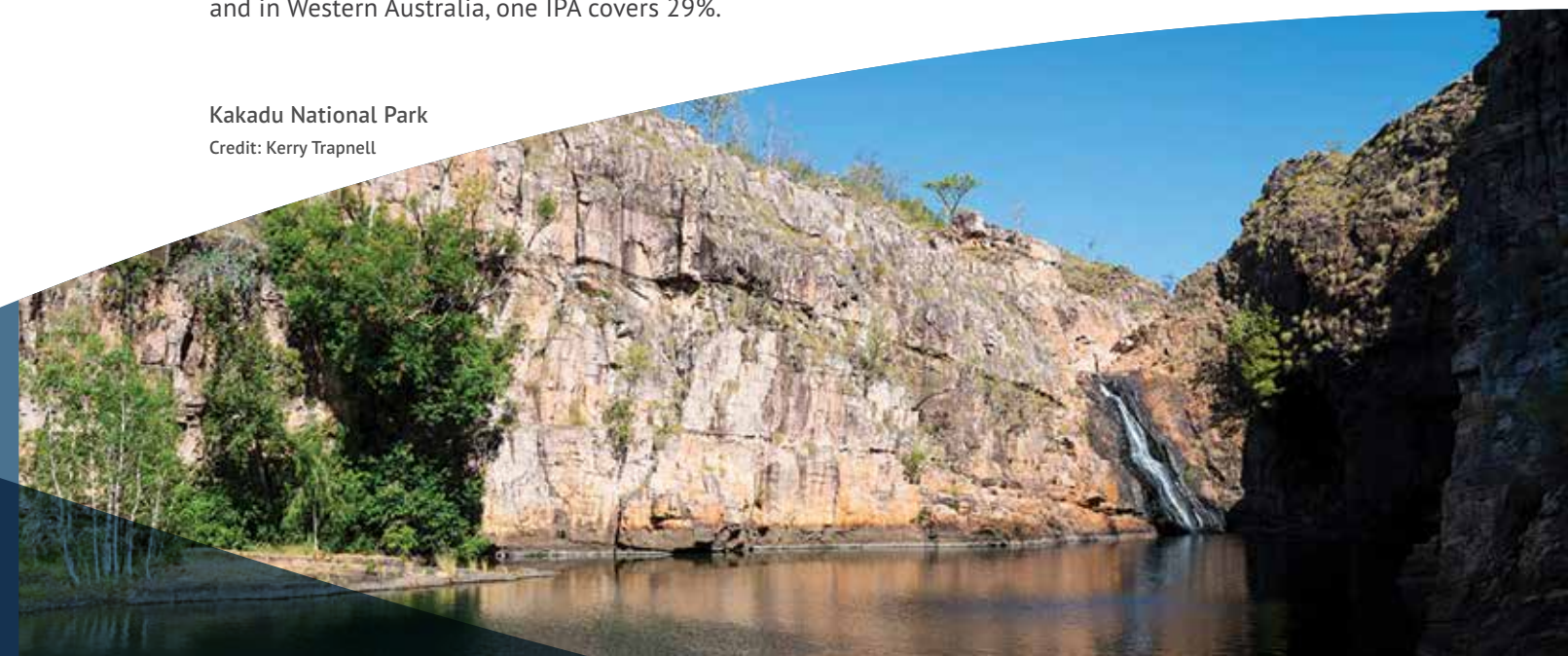


FIGURE 6. The condition of rivers and catchments in Australia

Source: Department of Environment and Energy [81], based on Stein et al. 2002 [82]

Notes: The river disturbance index is based on measures of the extent and intensity of human activities. It combines indices of (1) in-stream disturbances (impoundments, flow diversions, levee banks), (2) land use activity, (3) settlements and structures, and (4) extractive industries and other point sources of pollution.

Kakadu National Park
Credit: Kerry Trapnell



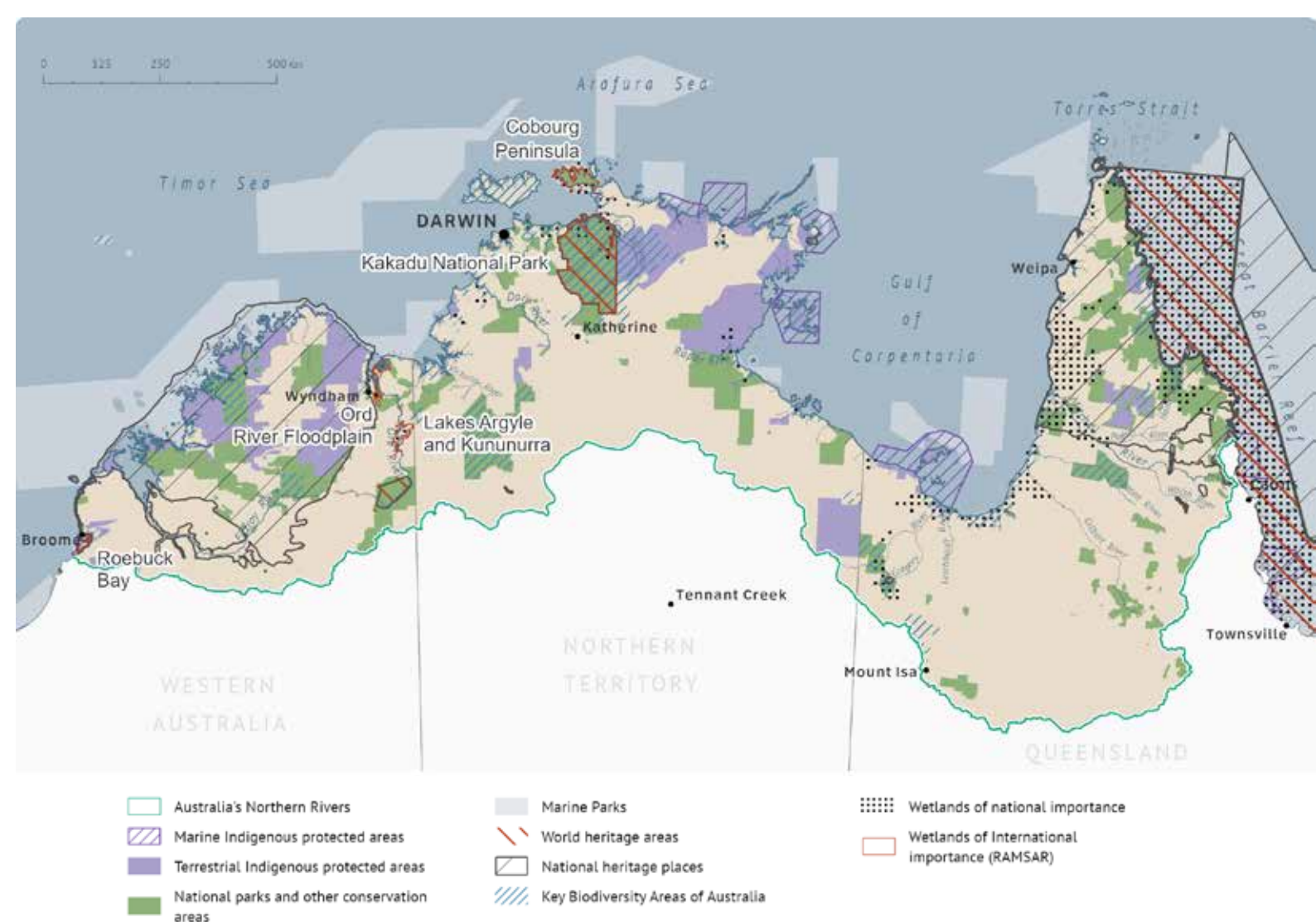


FIGURE 7. Some sites of recognised national and international significance in the Wet-Dry Tropics

Sources: Australian Government (DCCEEW) [92-95, 98], BirdLife Australia, 2022 [96], Australian Government (DAWE), 2020 [97]

2.6 AQUATIC WILDLIFE

EXISTENTIAL CHALLENGES

Towards the end of the wet season, when the soils are still moist, the aptly named burrowing frog (*Cyclorana australis*) buries itself in a shallow, round chamber a few centimetres below the soil surface. As the soil dries out, it keeps from drying out by building a watertight cocoon of dead skin and water-repelling secretions [99,100]. Then, in what seems the epitome of patience, it waits out the dry season with a much-slowed metabolism, a phenomenon known as aestivation [100]. This is not unusual – many other frogs, some turtle species and the freshwater crocodile also retreat underground during the dry. The extreme contrasts between wet and dry in the Wet-Dry Tropics are ‘a formidable existential challenge’ for wildlife, which has led to this and all sorts of other ingenious adaptations to survive the long dry season [101].

Many aquatic plants deploy a variation on burial by growing quickly for the few months after flooding and setting seed as the waters dry up. Their seeds then lie dormant until the next rains [65]. Plants such as waterlilies have a tuber that remains dormant during the dry and resprouts in the wet, producing leaves quickly from the stored energy.

The monsoonal flooding can create tremendous forces, scouring the river channel [59]. Plants such as ribbon weed (*Vallisneria nana*) cling to their place with deep root systems and then regenerate from rhizomes or tubers. Other plants are torn out but quickly recolonise the streambed from areas less vulnerable to disturbance [59].

Fish, however, must endure the extremes and take their chances when they choose a dry season refuge. Crowded into shrinking waterholes or stranded on the floodplain, many do not make it, lost to predators or evaporation.

RICHNESS, UNIQUENESS, ABUNDANCE

The cacophony of wetlands, vast flocks of waterbirds and plentiful fish in the North are exuberant indicators that wildlife still exists in abundance in intact river systems. This region of high species richness and uniqueness contributes substantially to the megadiversity for which Australia is renowned.

BONY FISHES

The northern rivers are Australian hotspots for freshwater fishes, with both high diversity and high endemism (uniqueness). The majority of freshwater fish also spend part of their lives in estuaries or the sea, their tolerance of salty water pointing to an ancestry as marine species [71]. A marine origin is one distinctive feature of the northern fishes – as if, at one time, the region ‘became largely devoid of fishes; an empty space into which marine species could adapt and radiate’ [71].

There are also many estuarine and marine species that sometimes inhabit freshwater. For example, just four days of electrofishing in the lower part of the Daly River returned 30 more species than previously recorded, mainly estuarine species [71]. The estuarine fish fauna is rich and it is not known how many use freshwater; however the the distinction between freshwater and estuarine ecosystems is a ‘rather arbitrary one’ [71].

Native waterlilies have tubers that remain dormant during the dry and resprout in the wet

Credit: Chris Ison / Alamy Stock Photo



By 2017, 153 fish species (not including sharks, rays and other elasmobranchs) had been documented in freshwater habitats in northern Australia – 42 mostly near-shore or estuarine species and 111 freshwater species, of which 45 occur in both freshwater and estuarine habitats [102]. Since then, another 20 freshwater species have been recorded in the Kimberley [103] and others have been discovered through genetic studies revealing hidden diversity. The river systems particularly rich in species are the South Alligator, East Alligator, Jardine, Wenlock, Flinders/Norman, Mitchell/Coleman, Daly, Finnis, Archer/Watson, Mary, Nicholson/Leichhardt and Olive/Pascoe, each with more than 40 freshwater fish species [102,104].

Dozens more species are likely to be found in rivers not yet sampled by fish scientists, particularly in the Kimberley, or hidden within cryptic species complexes (closely related fishes that can't easily be distinguished by looks) [104,105]. The mouth almighty (*Glossamia aprion*), for example, may be five species rather than one [105].

The Kimberley is distinctive for having many narrow-range endemic fishes, with 27 species there known from only one or two river systems – making it a freshwater fish 'endemism hotspot' [104]. This is likely due to the long-term isolation of rivers from each other on the rugged Kimberley Plateau and climate cycles driving diversification over the past three million years [104]. Narrow-range species are particularly vulnerable to extinction if conditions become unsuitable for them.

There has been much greater connectivity between rivers elsewhere in the North. During periods of lower sea levels, the large depression in the Gulf of Carpentaria was a lake into which many rivers flowed, as recently as about 10,000 years ago [104]. This explains why more than half the fish species in the northern province are shared with New Guinea.

Many northern fishes are great travellers – to reproduce (often in the estuary), find food (often on the floodplain) and take refuge during the dry season [71]. In the Daly River, such refugia are in the main channel and larger tributaries; in the Alligator rivers, they are in the foothills of the escarpment.

DILIGENT FISH PARENTS

Fish don't have a great reputation as parents. Generally, the young are on their own as soon as the eggs are released. But in a few northern species, fish, particularly male fish, are among the world's most diligent parents, often at cost to their own health and survival.

Several species are mouth brooders. The male mouth almighty, an abundant predator across the north, forgoes feeding for two to three weeks while he broods up to 500 young (as eggs and newly hatched larvae) in his mouth – protecting them from predators and providing a favourable environment for growth [107,108]. Although mostly monogamous, mouth almighties sometimes brood eggs that are not their own [108]. Perhaps this is because females are attracted to males that are already mouth-brooding.

The males of sea catfish (species from the *Ariidea* family) and females of the gulf saratoga and southern saratoga also mouth-brood their young. The mouth of the blue catfish mouth thickens up before the four to five weeks of incubating up to 88 eggs, and the larvae are thought to feed on food items entering their father's mouth [107,108].

The male nurseryfish (*Kurtus gulliveri*), native to northern Australia and southern New Guinea (and one of only two species in an entire suborder of fish), has a unique method of parental care – carrying the eggs around 'like a bunch of grapes' on his forehead [109,110]. He has a bony hook that becomes engorged, which may serve to clamp the eggs in place and also provide oxygen and nutrition to the young.

Fishes have evolved many different reproductive strategies in response to the highly variable flow regimes of the Wet-Dry Tropics. Every season has its spawners – some fish spawn only under very specific flow conditions, such as with the onset of the wet season or during the dry season, while others do so in multiple seasons [106]. Different seasons offer different advantages. Low-flow periods can be good for spawning in shallow, slack-water habitats, where prey is concentrated, predators are fewer, and swimming is easier for larvae. Aseasonal spawning may involve a gamble that reproducing across different seasons will increase the chances that at least some of the young will encounter optimal conditions for growth and survival and avoid episodic increases in predation and competition [106]. Strategies can differ between rivers and regions for the same species, which highlights the importance of gaining local information rather than extrapolating from studies elsewhere. The reproductive biology of most freshwater-spawning species is not well understood in any river [106].

ELASMOBRANCHII (SHARKS AND RAYS)

Almost all sharks and rays are marine, but five elasmobranch species are known to live in freshwater in the North and several others inhabit the tidal reaches of rivers [71]. Most are threatened, being long-lived, slow-growing, with a restricted range and low fecundity, and prone to capture by fishers.

Sawfishes (a type of ray) are distinctive in many ways, most obviously so for their saw-like rostrum, which can be more than a metre long on the largest species. It is a multi-purpose tool – used to detect electromagnetic signals from potential prey and to slash, impale and manipulate prey; and probably also for self-defence [111,112]. Sawfishes are also among the most evolutionarily distinct and threatened of species [113]. All five species are listed as endangered or critically endangered on the International Union for Conservation of Nature (IUCN) Red List.



Fish swimming in South Alligator River, Kakadu National Park, Northern Territory
Credit: Alamy Stock Photo



Speartooth shark (*Glyphis glyphis*)
Credit: Shutterstock



Mangkurtu kutjarra – a stygofaunal crustacean (*Spelaegriphacea*)
Credit: Jane McRae / Bennelongia



Pig-nosed turtle (*Carettochelys insculpta*)
Credit: Daniil Melnikov



Green sawfish (*Pristis zijsron*)
Credit: Shutterstock

Northern Australia is now the major population stronghold for four of these species. This is the case for the only sawfish species known to live partly in freshwater – the largetooth sawfish (*Pristis pristis*), also known as the freshwater sawfish – even though it has been recently assessed as critically endangered in Australia, having suffered a population crash suspected to exceed 80% in the past three generations (66 years) [114]. This sawfish has been ranked as the most ‘evolutionarily distinct and globally endangered (EDGE) species’ [57]. The major cause of decline has been accidental capture by trawl and gillnet fisheries. Although fisheries management has considerably improved, even the current low rates of bycatch mortality are considered unsustainable [114]. Changes to water flows and quality due to irrigation would add to these pressures. It is thought the young are born at the mouth of a river and then spend their first several years in freshwater, while adults mainly inhabit marine waters [115]. Important nurseries include the Martuwarra Fitzroy, Durack, Robinson and Ord rivers in Western Australia, the rivers draining into the Van Diemen Gulf and the Daly and Victoria rivers in the Northern Territory [115].

The three other sawfishes in northern Australia – the green, dwarf and narrow sawfishes, all globally and nationally threatened – inhabit marine and estuarine waters, but are not known to live beyond the tidal reach of rivers [115]. The dwarf sawfish (*Pristis clavata*), whose global range has declined by 70% and is now found only in northern Australia and New Guinea, has an important refuge and nursery in the Fitzroy River estuary [116,117].

Two of the world’s three river shark species are found only in northern Australia and southern New Guinea. The northern river shark (*Glyphis garricki*) and speartooth shark (*Glyphis glyphis*), both rare and assessed as vulnerable in a recent Australian assessment, are each known from only a few river systems as well as estuarine and coastal waters [114]. One reason they are susceptible to decline is a lack of movement between neighbouring populations, which means if one population is depleted, it is unlikely to be supplemented by immigration [114]. Both species are thought to be in decline, with commercial gillnet, line and pot fisheries the main threat [118,119].

In contrast to the river sharks, the bull shark (*Carcharhinus leucas*) has a large global distribution [120]. This apex predator occurs in most northern rivers, up to hundreds of kilometres inland (350 kilometer in the Daly River). It is believed that females give birth in the river mouth or estuary and that the pups migrate upstream, where they remain for up to five years [71].

One northern whipray species inhabits freshwater, while others inhabit the tidal reaches of rivers and estuaries [114]. The young of the freshwater whipray (*Urogymnus dalyensis*) are thought to migrate upstream from estuaries to spend their first years of life in freshwater. The little known about it suggests the species ‘would be significantly affected by loss of longstream connectivity’ [31]. Juveniles of two other whiprays – the mumburarr whipray (*Urogymnus acanthobothrium*), scientifically described only in 2016, and Hortle’s whipray (*Pateobatis hortlei*) – have been found in the tidal reaches of a few northern rivers [114]. Both have been recently assessed as data deficient, with too little known about them to assess their extinction risk [114].

TURTLES

Turtles are ancient survivors, with a fossil history of some 230 million years, having come through two mass extinctions during which 80% of life became extinct [121]. But now they are one of the most threatened groups of life on Earth, with about half recently assessed as globally threatened [122].

With 27 species, Australian turtle diversity is fairly high by global standards, and the number of endemic species is the third highest of any country [122]. Fourteen species, about half of Australia’s total, are found mainly or only in the North [122]. They include the pig-nosed turtle (*Carettochelys insculpta*), the only surviving member of a once widespread family of turtles. All other Australian species are in the family known as side-necked turtles. The northern species include four considered threatened or near threatened (Table 2). Kuchling’s long-necked turtle (*Chelodina kuchlingi*), known only from the Ord River floodplain and not recorded since 1974, is likely to be extinct (Box 5) [123,124].

There haven’t been any detailed assessments of the potential impacts of water extraction on threatened turtle populations, but reduced connectivity during the dry season could be particularly detrimental to the pig-nosed turtle. In the Daly River, during the dry, pig-noses rely almost wholly on ribbon weed (*Vallisneria nana*), a low-energy food, and often have to travel more than 10 kilometres to forage [69]. They are thought to be energy limited, laying eggs only every second year, so any additional constraints could reduce their reproductive success and result in population declines [69,125,126].



Mumburarr whipray (*Urogymnus acanthobothrium*)
Credit: Peter Kyne, Charles Darwin University



Gulf snapping turtle (*Elseya lavarackorum*)
Credit: A Freeman / Queensland Parks And Wildlife Service

STYGOFAUNA

Only this century has it become clear that many groundwater habitats in Australia are rich in wildlife. In fact, Australia is a global biodiversity hotspot for animals living in groundwater (stygofauna) and in subterranean voids above the water table (troglofauna) – probably because of the continent’s long-term geological stability and the range of climates and subterranean habitats [127]. The aridification of the continent as it has drifted north is thought to have been a major driver over many millions of years for the colonisation of subterranean habitats [127].

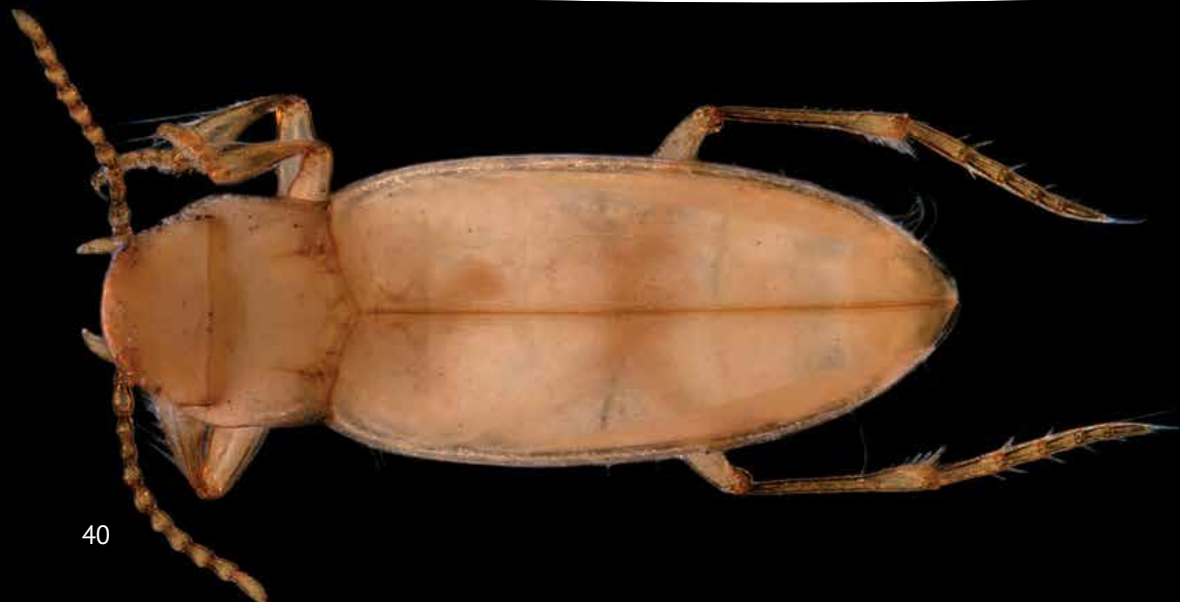
Stygofauna can be found in aquifers with pore sizes bigger than about 1 millimetre, up to about 100 metres below ground, most commonly in fresh or brackish water [128]. Their communities are typically dominated by crustaceans (shrimps, amphipods, copepods, ostracods, isopods, syncarids and decapods), often also with worms, molluscs, mites and beetles, and very occasionally with fish [129]. Adapted to life below-ground, these animals are typically eyeless (but with highly developed non-visual senses), colourless and wingless and often long-legged. They are thought to mainly live on biofilm (aggregations of micro-organisms) or prey on other stygofauna. Many species are found only in a single void or part of an aquifer, which means they face high risks of extinction from mining or groundwater depletion or contamination.

Not surprisingly, little is known about the lives of stygofauna, for it is difficult to access their habitats. The only way to find stygofauna is to drill a borehole and sample the groundwater by pumping or with a net [127,129]. There is probably not a single subterranean species in Australia whose way of life is well understood [130].

There has been almost no searching for stygofauna across northern Australia, with the little there has been typically triggered by mining proposals. A recent pilot study in the Beetaloo sub-basin in the Northern Territory, where shale gas mining is proposed, revealed the ‘presence of a diverse stygofaunal community’ whose species were all new to science [129]. DNA analysis indicated a high degree of aquifer connectivity, which means that activities altering groundwater quality or quantity could have impacts over a large area, including on rare species [129]. Although research in the Kimberley has been sparse, some ‘notable ancient lineages of crustaceans are known from the area’ [131].

Stygofauna (*Limbodessus bennetti*)

Credit: Jane McRae / Bennelongia



THE WET-DRY TROPICS AS A ‘LIFEBOAT’

The critically endangered largemouth sawfish has shown that the huge volumes of water flowing out to sea during the northern wet season are not superfluous to needs. The survival of the species relies, it seems, on maintaining the biggest floods of all. From 2002 to 2018, researchers conducted annual surveys of largemouth sawfish in the Fitzroy River and tributaries, an important nursery for juvenile largemouth in their first four to six years of life [9]. In only three of the 17 years was there successful (moderate or high) recruitment to the river – and all three were years of exceptional flooding [9]. These occasional peak flows are, therefore, essential for replenishing sawfish populations. The lack of such floods in the Ord River, since the installation of dams, probably explains why very few largemouth sawfish are found there now [9]. The peak flows may be needed to enable young sawfish to swim through estuarine pools into freshwater. When water levels are lower, the young may not have enough energy to cross shallow riffle zones with high water velocities and may become trapped in the estuary, where there are more predators and competitors. Lower water levels are likely to also expose sawfish to higher predation pressure in the river channel [9,132].

The North is commonly called a stronghold or lifeboat for threatened species [135–137]. It serves this role for largemouth sawfish because the conditions almost everywhere else have been so dire for the species. But the lifeboat is fragile, as that study in the Fitzroy indicates.

The list of threatened species in the Wet-Dry Tropics has been growing rapidly – in part because of new information and threats growing elsewhere, but also because conditions in the North have been changing – with the adverse fire regimes, the intensification of grazing and invasive species impacts [77,138,139].

About 140 nationally listed threatened taxa have at least a quarter of their likely range in the Wet-Dry Tropics [140]. Table 2 lists examples of threatened or declining species reliant on aquatic ecosystems and therefore likely to be reliant on rivers being maintained in a healthy state. They include fish species such as the largemouth sawfish and Barnett River gudgeon (*Hypseleotris kimberleyensis*), turtle species such as the pig-nosed turtle, and birds such as the purple-crowned fairy-wren (*Malurus coronatus coronatus*), yellow chat (*Epthianura crocea tunneyi*) and Australian painted snipe (*Rostratula australis*) that inhabit riparian, floodplain and wetland habitats. Other species would be sensitive to the impacts of irrigated agriculture due to land clearing.

Martuwarra/Fitzroy River, Western Australia

Credit: Nick Covelli



TABLE 2. SOME THREATENED OR NEAR-THREATENED TAXA IN THE WET-DRY TROPICS WITH A STRONG RELIANCE ON AQUATIC ECOSYSTEMS

LIFE FORM	COMMON NAME	SPECIES	GLOBAL STATUS (IUCN REDLIST)	AUSTRALIAN STATUS (EPBC ACT)	STATE/TERRITORY STATUS	EXPERT ASSESSMENT (AUSTRALIAN STATUS)
Bird	Purple-crowned fairy-wren	<i>Malurus coronatus coronatus</i>	Not evaluated	Endangered	NT: Vulnerable WA: Endangered	Vulnerable [141]
Bird	Australian painted snipe	<i>Rostratula australis</i>	Endangered	Endangered	NT: Vulnerable WA/Qld: Endangered	Endangered [141]
Bird	White-bellied crimson finch	<i>Neochmia phaeton evangelinae</i>	Not evaluated	Endangered	Qld: Endangered	Least concern [141]
Bird	Yellow chat (Alligator Rivers)	<i>Epthianura crocea tunneyi</i>	Not evaluated	Endangered	NT: Endangered	Endangered [141]
Bird	Princess parrot	<i>Polytelis alexandrae</i>	Near threatened	Vulnerable	NT: Vulnerable WA: Priority 4	Near threatened [141]
Bird	Australasian bittern	<i>Botaurus poiciloptilus</i>	Vulnerable	Endangered	WA: Endangered	Endangered [141]
Fish	Greenway's grunter	<i>Hannia greenwayi</i>	Least concern	Not listed	WA: Priority 1	
Fish	Barnett River gudgeon	<i>Hypseleotris kimberleyensis</i>	Endangered	Not listed	Not listed	
Fish	Drysdale hardyhead	<i>Craterocephalus helenae</i>	Near threatened	Not listed	WA: Priority 2	
Fish	Prince Regent hardyhead	<i>Craterocephalus lentiginosus</i>	Least concern	Not listed	WA: Priority 2	
Fish	Largetooth sawfish	<i>Pristis pristis</i>	Critically endangered	VulnerableB	NT: vulnerable WA: vulnerable	Critically endangered [114]
Fish	Green sawfish	<i>Pristis zijsron</i>	Endangered	VulnerableB	NT: vulnerable WA: vulnerable	Endangered [114]
Fish	Dwarf sawfish	<i>Pristis clavate</i>	Critically endangered	VulnerableC	Not listed	Endangered [142]
Frog	Howard River toadlet	<i>Uperoleia daviesae</i>	Endangered	Vulnerable	NT: vulnerable	
Frog	Kimberley froglet	<i>Crinia fimbriata</i>	Least concern	Not listed	WA: Priority 3	
Lizard	Merten's water monitor	<i>Varanus mertensi</i>	Endangered	Not listed	NT: vulnerable	Endangered [143]
Lizard	Mitchell's water monitor	<i>Varanus mitchelli</i>	Critically endangered	Not listed	NT: vulnerable	Critically endangered [143]
Mammal	Water mouse	<i>Xeromys myoides</i>	Vulnerable	Vulnerable	Qld: vulnerable	Vulnerable [144]

TABLE 2. (CONTINUED)

LIFE FORM	COMMON NAME	SPECIES	GLOBAL STATUS (IUCN REDLIST)	AUSTRALIAN STATUS (EPBC ACT)	STATE/TERRITORY STATUS	EXPERT ASSESSMENT (AUSTRALIAN STATUS)
Mammal	Spectacled flying-fox	<i>Pteropus conspicillatus</i>	Endangered	Endangered	Qld: endangered	Near threatened [144]
Plant	A triggerplant	<i>Stylidium ensatum</i>	Not evaluated	Endangered	NT: Endangered	
Ray	Freshwater whipray	<i>Himantura dalyensis</i>	Vulnerable	Not listed	Not listed	Vulnerable [142]
Shark	Bull shark	<i>Carcharhinus leucas</i>	Vulnerable	Not listed	Not listed	Least concern [114]
Shark	Northern river shark	<i>Glyphis garricki</i>	Vulnerable	EndangeredA	NT: Endangered WA: Priority 1	Vulnerable [114]
Shark	Speartooth shark	<i>Glyphis glyphis</i>	Vulnerable	Critically endangeredA	NT: Vulnerable	Vulnerable [114]
Turtle	Pig-nosed turtle	<i>Carettochelys insculpta</i>	Endangered	Not listed	Not listed	
Turtle	Gulf snapping turtle	<i>Elseya lavarackorum</i>	Not evaluated	Endangered	Qld: Vulnerable	Data deficient [122]
Turtle	Cann's snake-necked turtle	<i>Chelodina canni</i>	Not evaluated	Not listed	Not listed	Near threatened [122]
Turtle	Kuchling's snake-necked turtle	<i>Chelodina kuchlingi</i>	Not evaluated	Not listed	Not listed	Critically endangered [122] Presumed extinct [124]

3 LIVING WATERS OR RESOURCES

CONFLICTING WAYS OF PERCEIVING RIVERS

- 3.1 Cultures and rivers
- 3.2 Northern people and land uses
- 3.3 The cultural foundations of modern water use
- 3.4 Traditional custodian river cultures
- 3.5 Other values and views

3.1 CULTURES AND RIVERS

In 2006, a five kilometre stretch of the McArthur River was rerouted to make way for a massive open-cut zinc mine in the riverbed. In anyone's culture, this is a brutal way to treat a river. But for many traditional custodians, the damage to the dreaming tracks followed by two Yulanji (Rainbow Serpents) that converge at the mine site also has spiritual and cultural consequences [145]. 'The Rainbow Serpent is one of our powerful ancestral beings,' explained Jacky Green, a Garawa man from the southwest Gulf of Carpentaria [146]. 'It rests under McArthur River... Under our law we are responsible for protecting its resting place from disturbance, and for nurturing its spirit with ceremony and song.' The river diversion smashed its resting place and severed its back. 'Interfering with these powerful places, it pulls people down. Seeing our land suffer, we suffer.' [146] Explaining the harm caused by such actions is difficult – for they are intangible personal and spiritual matters and occur within a cultural framework 'that never considered industrial-scale damage to land or sites' [145].

How to respect the cultures and beliefs of Indigenous peoples remains one of the critical challenges for Australian society – including in water policy.

Rainbow Serpents and other spiritual beings feature in many Indigenous cultures across Australia, typically as creators and protectors of waterways and wetlands, who must be respected and protected [147]. This is a very different worldview from that underpinning the way rivers are perceived and managed under Australia's water laws and policies. Although these laws and policies sometimes minimally acknowledge Indigenous cultures, this has largely not altered the way they function. How to respect the cultures and beliefs of Indigenous peoples remains one of the critical challenges for Australian society – including in water policy.

In this chapter we briefly characterise the people of the North and the different ways that people perceive, value and relate to the northern rivers.

Martuwarra/Fitzroy River, Western Australia
Credit: Nick Covelli

3.2 NORTHERN PEOPLE AND LAND USES

People have lived in the North of Australia a long, long time. Archaeologists have shown that it was from the north that people first arrived, when Australia was joined to New Guinea as part of Sahul [148,149]. There is evidence from several northern sites for about 50,000 years of human occupation and evidence from a couple of sites suggests even longer [150–153]. Whatever the number, the period since European colonisation represents a miniscule proportion of the human presence in the North – fewer than 10 generations compared to 2,000 or more.

With the most enduring living cultures in the world, Australia's Indigenous peoples have lived through dramatic geological, climatic, environmental and social changes. One relatively recent change, about 8,000-10,000 years ago, was the 120-metre rise in sea levels that split New Guinea from Australia and shaped the current riverscapes [154]. This means that Indigenous peoples have kept company with these rivers for as long as they have existed in their current form.

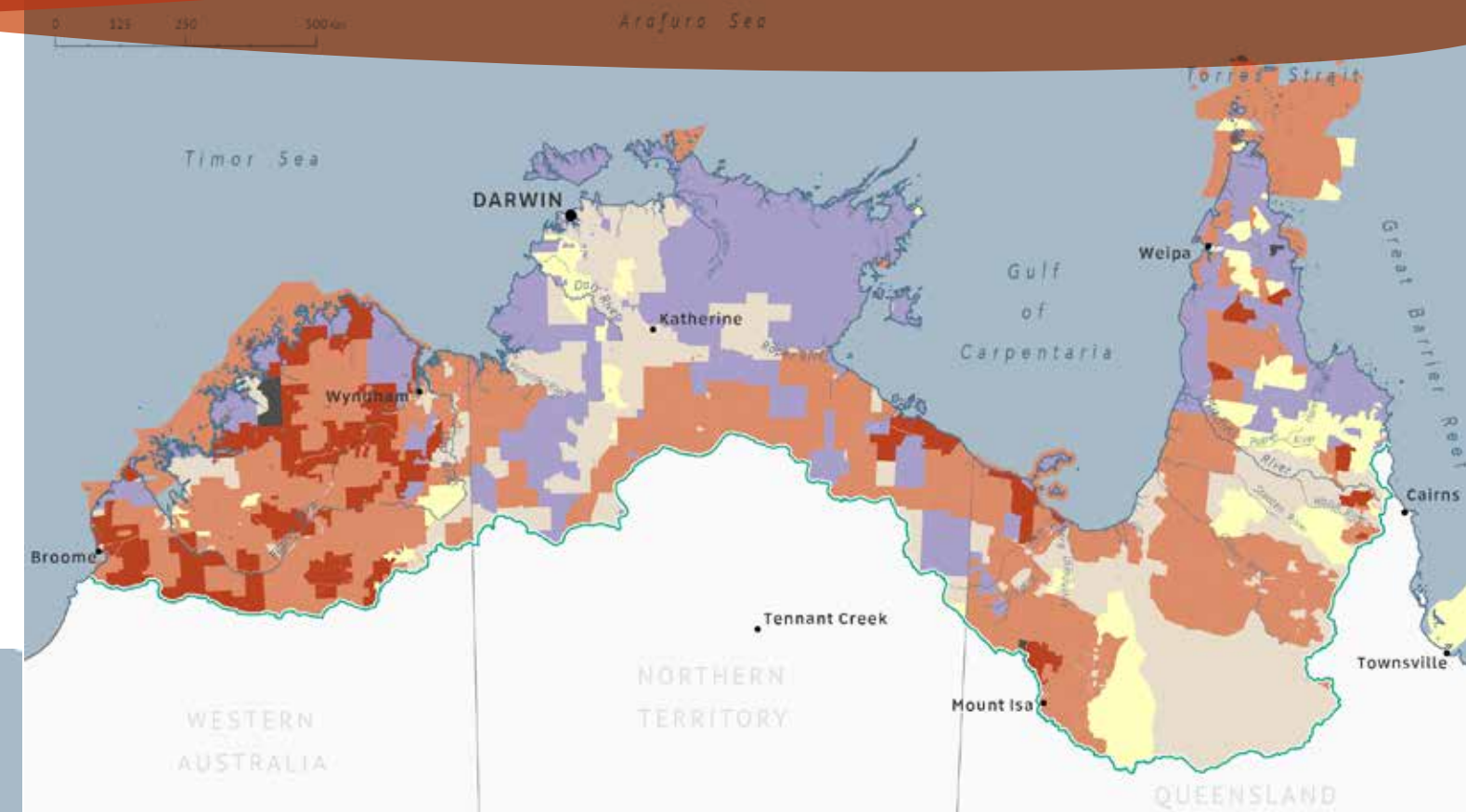


FIGURE 9. Aboriginal lands in northern Australia – native title and land trust lands

Sources: National Native Title Tribunal 2022 [173], WA Department of Planning, Lands and Heritage 2020 [168], Aboriginal and Torres Strait Islander Land Services 2020 [174], NT Department of Lands, Planning and the Environment 2019 [165]

Notes: The Aboriginal land trusts lands featured here comprise Northern Territory Aboriginal land trusts, Queensland land trusts (DOGIT, Land Trust ALA, Land Trust TSILA, CATSIA ALA, CATSIA TSILA, Council ALA) and Western Australian land trusts. Where a land trust overlaps native title (exclusive possession), only the land trust is shown. The native title applications category includes registered and non-registered applications.

Massive upheaval – violent dispossession, social oppression and cultural suppression – came when Europeans arrived pursuing gold and pastures [77]. Other colonists followed with ambitious schemes for large-scale cropping. In 1875, the South Australian Government, which had annexed the Northern Territory, offered a reward of £5,000 to any company that produced 500 tons of sugar in the Territory [155]. The scheme was promoted all over the world and some 40,000 hectares were taken up for sugar plantations. But, in what came to be a recurring story in the North, only a few tons of sugar were ever produced and a decade later the industry was dead. Many people have gone north with unrealistic plans for pursuing wealth – resulting in ‘an unsettled European population ... slow to understand how the northern country really worked’ [77].

Although the Wet-Dry Tropics covers about 16% of the mainland, fewer than 2% of Australians, about 280,000 people, live here. And although Indigenous peoples make up only 3.2% of the Australian population (based on the 2021 census), in the North they comprise 29% of residents [156].

Three forms of land tenure make up about three-quarters of the North – 54% as pastoral leases, 26% Aboriginal land trust lands and 10% conservation reserves (many of which are Aboriginal tenures) (Figure 8). The remaining area consists of leasehold lands (5%), other Crown lands (reserves and vacant crown land) (4%), and freehold (3%).

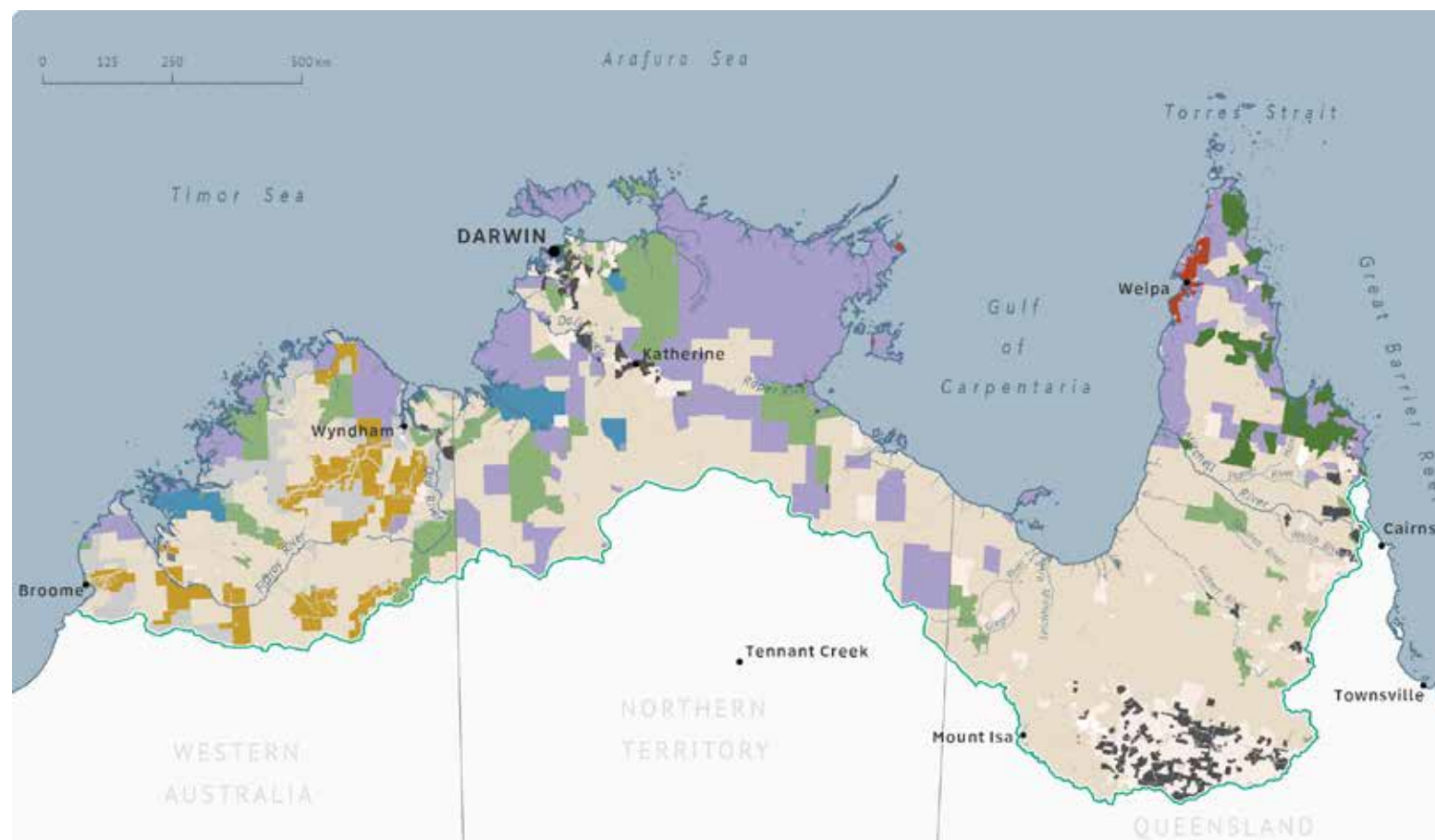


FIGURE 8. Major land tenures in the northern rivers region

Sources: Northern Territory Government [165–167], Government of Western Australia [168,169], Queensland Government [170–172]

Notes: The conservation reserves shown here are those managed by governments or jointly managed and do not include Indigenous protected areas. Conservation reserves in the Northern Territory overlap Aboriginal land trusts in areas but are generally leased back to government whereas in Queensland they are managed by Indigenous groups. Information on Indigenous pastoral lease ownership is not available for the Northern Territory and Queensland.

Aboriginal people have some form of title over two-thirds (69%) of the region – native title, Aboriginal land trusts and Indigenous-owned pastoral leases (Figure 9). About a third of the region (34%, 43 million hectares) has an Aboriginal title for exclusive possession. Native title is recognised over half the area (50%, 62 million hectares), about a quarter of which is exclusive possession (14%, 17 million hectares). About 20% of the Aboriginal land trusts area is additional to native title areas (6% overlaps native title areas).

Despite their large landholdings in the North, Aboriginal people hold few legal rights to water. Some Indigenous-specific water reserves have been established in Queensland and the Northern Territory, typically as part of processes allocating large volumes of water for industry – but almost no water has actually been provided or licenced for Indigenous cultural or economic uses [157,158]. Particularly in the Northern Territory, access is tightly constrained – limited to areas with water allocation plans despite most licences being issued in areas without such plans, and only for economic or commercial uses by native title holders with exclusive possession.

The major land use across the North is cattle grazing, occurring across 56% of the region (Figure 10). Most grazing is on native vegetation but exotic pastures have been planted across more than 100,000 hectares, including highly invasive, high biomass, flammable grasses such as gamba grass, olive hymenachne, para grass, mission grass, annual mission grass and buffel grass (the first five are listed nationally as a key threatening processes) [159–161].

There is little cropping in the North (Figure 10). Dryland cropping occurs across about 30,000 hectares (0.03% of the region), mainly in the Daly, Normanby and Mitchell catchments. Irrigated cropping occurs across about 50,000 hectares (0.04% of the region) – 26,000 hectares of grains/fibre, 23,000 hectares of horticulture and 2,000 hectares of pastures – mainly in the Mitchell catchment, Ord irrigation area, around the Daly River, near Darwin and in parts of the Gulf region [162] (section 4.2, Table A1 in appendix). These figures are from data compiled prior to 2020, so do not include recent new cropping.

The Department of Defence manages 1.4% of the region, and mining leases, mainly at Weipa and Nhulunbuy for open-cut iron-ore extraction, cover less than 1% of the region (Figure 10). Also noted as a land use, the fourth most prevalent at 5%, is water (Figure 10) – indicating the expansiveness of wetlands and floodplains, particularly on the coastal plains of the Gulf of Carpentaria and Top End.

Despite most land in the North being used for agriculture, it contributes little to regional employment or economic output. Agriculture, forestry and mining combined employ fewer than 5,000 (4,891 in the most recent census), about 4% of employed people [163]. The government sector, including health and education, provides most employment in the region, accounting for more than a quarter of all jobs [164].

3.3 THE CULTURAL FOUNDATIONS OF MODERN WATER USE

Modern water laws and policies are based explicitly on the notion of rivers and aquifers as resources – with water regarded as a valuable commodity that should be put to productive use [175]. The main aim of the 2004 National Water Initiative is to achieve a 'nationally-compatible, market, regulatory and planning based system of managing surface and groundwater resources for rural and urban use' [176].

Since colonisation, the use of water for productive purposes has been framed as a moral imperative [17,177]. According to the Australian Government's White Paper on Developing Northern Australia, irrigation is essential to 'unlock' the potential of northern Australia and to help feed the world [60,178]. No tropical or subtropical region has ever made significant economic progress without 'adequately harnessing its water resources' the CSIRO says in its preamble to water resource assessment reports, without offering evidence for this sweeping claim (section 4.2) [179]. There has been little attempt to explore the options for northern development that do not rely on extensive water exploitation (section 7.2).

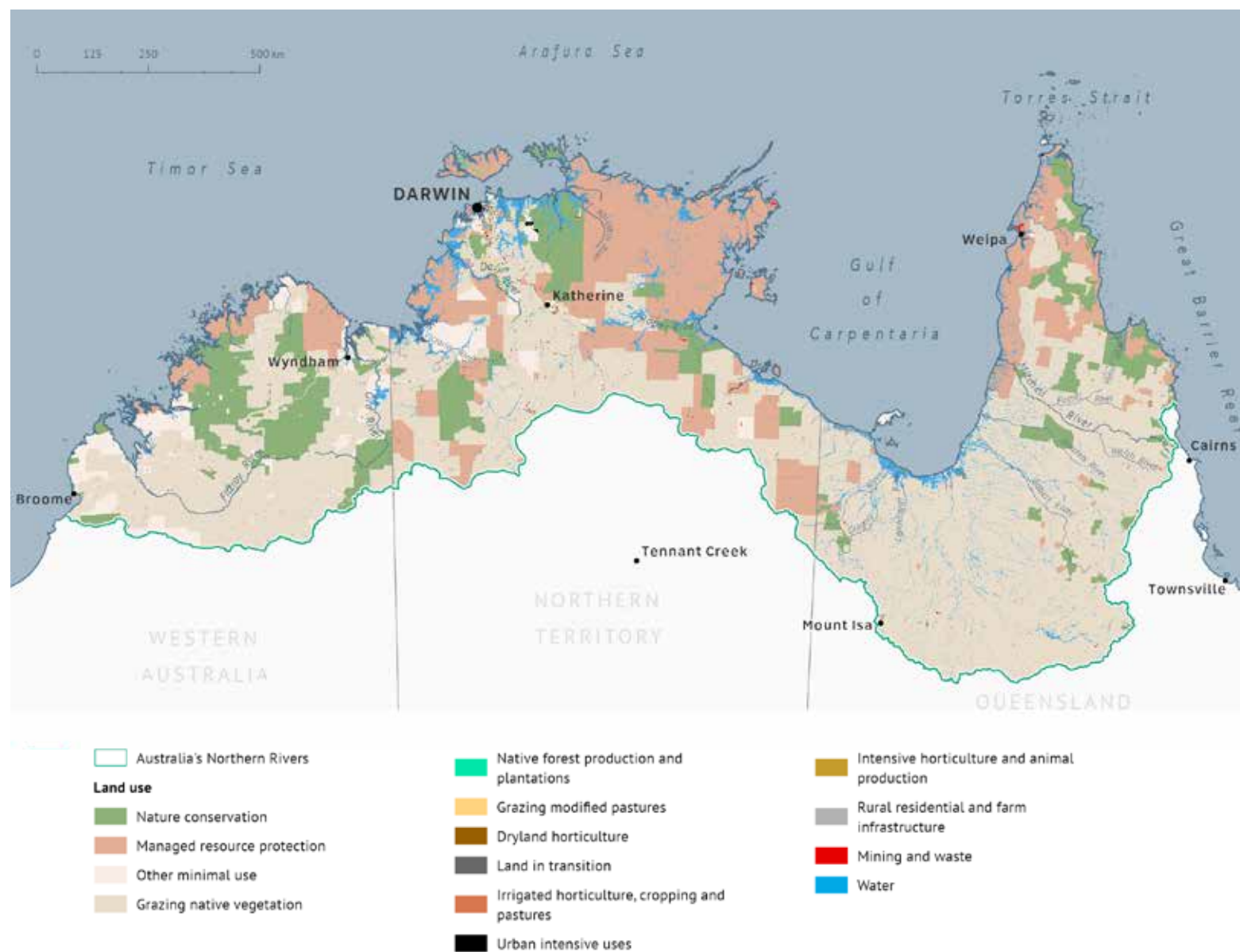


FIGURE 10. Land uses in northern Australia

Source: ABARES 2021 [162]

Notes: The data was last updated (although only in some areas) in 2020.



Large dams for irrigating cotton crops in New South Wales
Credit: Shutterstock

A related refrain is that letting rivers flow free is wasteful. Water 'uselessly flows ... out into the ocean,' says one of the North's major landholders, and the government should allow farmers to 'tap into this huge wasted water source' [51]. Western Australia's water policy is explicit that the water available for extraction should be maximised, to the extent that doesn't compromise the 'integrity of the resource' [180]. Water is characterised in volumetric terms, with the aim of water planning typically being to apply a formula – for example, X% extraction when flows exceed X GL/day – for allocating water for agriculture.

More than most other countries, Australia has applied market mechanisms to water and now has one of the world's largest water markets, with an annual turnover of \$1–3 billion [181,182]. The rationale is that water markets facilitate the transfer of water use rights to where they produce the highest economic value. Facilitating 'efficient water markets' is essential to 'stimulate economic development in regional communities,' says the Queensland Government [183]. But the almost exclusive framing of water as commodity 'makes it easy to lose sight of what water is to a river, and how every drop of water ... defines the character and function' of a river [184]. It fosters the perception of unexploited rivers as untapped sources of wealth – in which case it becomes almost illogical not to pursue exploitation.

Under modern water regimes, the environment is characterised as one water user, with a quantifiable degree of need.

Under modern water regimes, the environment is characterised as one water user, with a quantifiable degree of need. 'Before we decide how much water can be abstracted from a water resource,' says the Western Australian Government, 'we first assess how much water the environment needs to maintain its integrity and associated values' [180]. 'Sometimes the environment doesn't need all its water,' said one recent environment minister about the Murray-Darling Basin, while 'farmers desperately do need water' [184]. There have also been complaints that environmental water allocations are wasteful – the rice industry has said that environmental water has 'not been subject to the same standards of efficiency' as water for industry [185] and an irrigators' group has complained that the environment benefits from sources of water such as dam spills that are not available to irrigators [186].

Salinisation of a wetland near Mildura in the Murray-Darling Basin
Credit: Alamy Stock Photo



Water planning is typically portrayed as a 'balancing' task. Planning 'balances the needs of water users and the environment,' says the Queensland Government [183]. 'Consumptive and non-consumptive (in-situ) uses are in competition with one another,' says the Western Australian Government [180]. But in apparent contradiction, the National Water Initiative says the aim of planning should be to 'optimise' economic, social and environmental outcomes. However, as pointed out in the report of the Murray-Darling Basin Royal Commission, the assumption that all three outcomes 'can actually be optimised simultaneously is fallacious' [187]. When water is allocated for human use, the environment loses it.

Indigenous culture too has been portrayed as a competing water use. Although Indigenous cultural needs have been ignored in water policy until recently, there is now interest by some governments in labelling certain volumes of water as 'cultural' flows (Chapter 6). Queensland's *Water Act 2000* requires that water plans specify the 'cultural outcomes' of the management and allocation of water, although there is no requirement that there be any such outcomes. Neither the Northern Territory nor Western Australia has any legal requirements to consider cultural values. There has been an assumption by governments that cultural values can be protected by tweaking environmental flow rules [188]. But this can misconstrue the cultural significance of rivers to Traditional Owners (section 3.4).

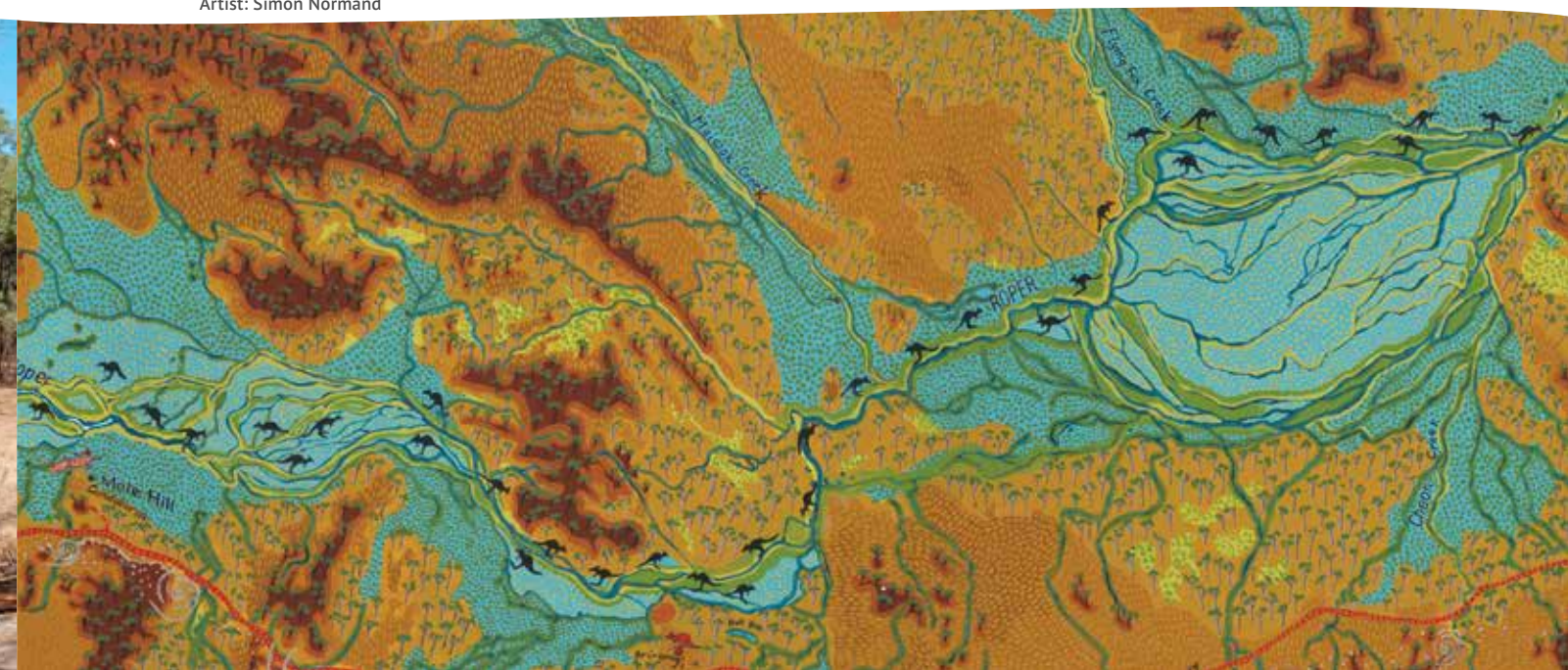
3.4 TRADITIONAL CUSTODIAN RIVER CULTURES

Those who study and manage natural resources in Australia often take for granted their own ways of understanding the natural world. Therefore, a foundational challenge for governments committed to protecting Indigenous cultural values is to understand and accept as legitimate the ways in which Traditional Owners understand, value and relate to their environment. The gulf between them is 'immense' [187].

For many Traditional Owners, rivers are living, spiritual forces with their own interests and rights, created by ancestral beings who still inhabit the landscape and have great influence over the river and people. These beings must be treated with respect according to protocols specified by customary laws [13,53,189,190].

The Roper River cultural map - a 13-metre hand-painted cultural map produced in collaboration with Traditional Owners from across the river's catchment

Artist: Simon Normand



Across northern Australia, many sacred sites are concentrated around water. They are often connected through Dreaming tracks, which represent the travels of ancestral beings [53] – ‘great creative beings who came out of the Earth and travelled across the land and sea ... walking, slithering, crawling, flying, chasing, hunting, weeping, dying, giving birth ... performing rituals, distributing the plants, making the landforms and water, and making the relationships between one place and another, one species and another’ [191].

Although Australia’s Indigenous groups all share a sense of spiritual and cultural connection to waterways and have custodial responsibilities [192], the particular beliefs, stories and practices are specific to each site and group, so attempts to portray a universal culture risk misrepresenting some groups. To avoid that, we rely here on one example. Traditional Owners from the Martuwarra/Fitzroy catchment, as researchers themselves or in collaboration with non-Indigenous researchers, have sought to explain their water-related worldviews and relationships to a non-Indigenous audience. To aid understanding between Aboriginal and non-Aboriginal cultures, researchers with the National Environmental Science Program have compared the living waters model of Traditional Owners in the Martuwarra Fitzroy catchment with the prevailing western resources model of rivers, as represented in water laws and policies (Figure 11).

‘Under Warloongarri law, the Traditional Owners of the Mardoowarra regard the River as a living [sacred] ancestral being (the Rainbow Serpent), from source to seas, with its own ‘life-force’ and spiritual essence. It is the ‘River of Life’ and has a right to Life.’

Martuwarra RiverOfLife et al. 2020 [149]

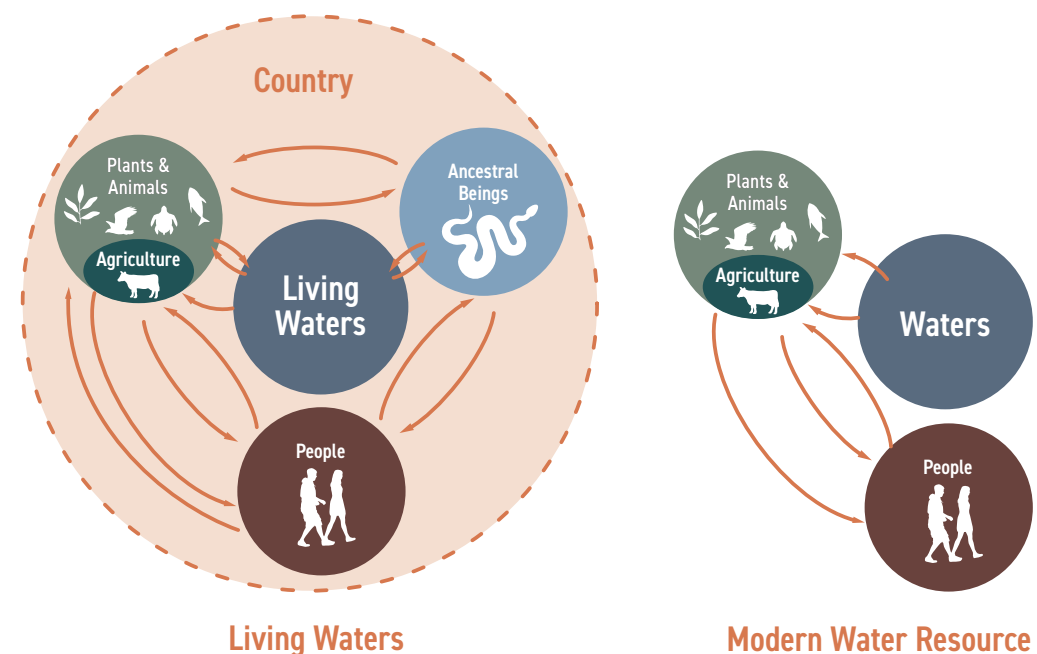


FIGURE 11. The living waters model of Traditional Owners in the Martuwarra Fitzroy catchment and the resource model of modern water management regimes.

Source: Laborde and Jackson 2021 [193]. Also see [175] and a story map [194].

Notes: The arrows represent relationships and dependencies. The dotted line in the living waters model represents ‘Country’. The diagrams are a simplification and do not represent all relationships.

The living waters model is a ‘customary system of management handed down over generations’ [193]. Water is understood as a life force created by ancestral beings that continue to shape the world. As such, rivers have ‘rights and interests’ [34]. Country (all that within the dotted line in Figure 11) is ‘constituted by reciprocal or mutual relationships between all phenomena – amongst people, and between people and other beings, including living waters’ [193]. All are bound to each other and have mutual obligations. And to ‘hold these relationships together’, traditional custodians must maintain their customary laws, which requires them, for example, to visit sites and speak to them in language and care for the country around them [193]. Waterholes harbouring rainbow snakes can be dangerous and must be approached with songs appropriate to the site-specific snake [195]. And when developments threaten the integrity of a river and its inhabitants, Traditional Owners must act to protect the river’s rights and interests [34]. Rivers ‘must run free so that the spiritual force of the river is not interfered with or blocked’, says the Martuwarra River Council, ‘so that the increase of all species is maintained’ [12].

While the resources model acknowledges the dependency of humans, wildlife and agriculture on rivers, it does not feature the reciprocal relationships and obligations of the living waters model. It also does not feature the spiritual elements of the living waters model – the relationships between people and ancestral beings (such as snake-spirits that inhabit and protect water places) [193].

In acknowledging the cultural differences and their importance to Traditional Owners, water planners have tried to integrate them into an approach that manages water as a resource. By classifying them as ‘cultural values’, planners seek to manage them alongside social and environmental outcomes through water allocations and protection of particular sites. But the category of cultural values in water planning does not encapsulate the relationships and custodian obligations of the living waters model – it misrepresents ‘complex and reciprocal notions of responsibility and care as solely benefits or values from water to people’ [193]. And nor does the allocation of certain volumes of water for cultural purposes suffice to maintain those relationships. The use of planning based on worldviews incompatible with Traditional Owner cultures is essentially a rejection of the cultural values that are meant to be protected – it ‘can be felt as an unacceptable restriction of custodial requirements that perpetuates the imposition of colonial frameworks’ [193].

A community member shares the importance of their connection to the Roper River using a cultural map
Artist: Simon Normand | Photo credit: Cat Sparks





The impact of cattle on the Oakover River in the Pilbara can be clearly seen
Credit: Krystle Wright

3.5 OTHER VALUES AND VIEWS

The Australian Government's 2015 White Paper on Developing Northern Australia, which set in motion much of the current push for large-scale irrigation in the north (section 4.2), presumes that the presented vision of dams, large-scale irrigation development and large cities is shared by most northern residents. It does not acknowledge that many people who live in the North have very different hopes for the future.

Governments have done little to find out what residents in the North think about the prospects of a major irrigation industry. Instead, they provide piecemeal opportunities for public consultation on particular water plans, policies, licences or project approvals. However, the public commentary and the limited research undertaken all indicate a widespread lack of social licence for large-scale irrigated cropping in the North.

Some northern farmers are excited by emerging opportunities for cropping – as a chance to diversify and increase their incomes and contribute to development. Of cotton, the NT Farmers Association says [196]:

'...it is an exciting emerging industry in the Territory that will significantly contribute to the economy and create employment opportunities in regional areas.'

The North is 'underdeveloped and [has] unlimited potential' for agricultural development, says the Northern Territory Cattlemen's Association [197]. But the creation of the Fitzroy River National Park 'seriously threatens' the future of the region, says the Pastoralists and Graziers Association of WA, because it will 'limit the ability of landholders to maximise water use' [198]. This is despite the tourism industry in the Kimberley generating more jobs and revenue than agriculture, with plenty of potential for growth (Box 10).

Farmers are not a homogenous group. While some irrigation proponents are antagonistic to environmental and cultural concerns – with calls, for example, to rescind the national heritage listing in the Kimberley because it is seen as a barrier to development [199] – others acknowledge that social licence is important [31,200]. Some pastoralists warn against 'grand schemes' and would prefer to see more support for current practices rather than greenfield irrigation developments [201]. This partly reflects the value many pastoralists place on their lifestyle and identity rather than the ability to

generate more income; others question the economic viability of large-scale irrigation or are concerned about the broader damage to social licence for farming. 'We need to ... accept the need for a social licence', said the president of the NT Farmers in 2018, which would inevitably be damaged if the 'political push for dams is continued' [200]. Some local horticulturalists say 'the need is to develop sustainable and economically viable farming systems rather than expanding or clearing more land for farming' [202].

Many businesses proposing irrigated agriculture are new to the North, with pastoral properties regularly being purchased by southern or international irrigation businesses [203]. It is understandable that southern cotton growers want to move north – to evade the climatic uncertainties, water constraints and high water costs that now prevail in the Murray-Darling Basin [36,204,205]. In 2020, Australia's cotton crop was the smallest in 40 years, down by almost 90% on the 2018 crop due to the impacts of drought in south-eastern Australia [206]. However, the spectre of the south – fish kills, dead river gums, desiccated wetlands, rivers reduced to muddy trickles – is a major barrier to a social licence for the irrigation industry in the North. A common refrain in focus groups and surveys is that northern Australians want to avoid the mistakes of the south [17]. In a February 2021 poll of Northern Territory residents, 69% of respondents agreed with a statement that the cotton industry shouldn't be allowed into the Territory until they 'fix up their mess' in the Murray-Darling Basin [16].

The CSIRO concluded from stakeholder analyses (based on literature reviews and a few interviews) that northern stakeholders have 'varied and sometimes conflicting interests and values relating to the use of water resources and irrigated agricultural development' – with 'implications for the ability of developers to gain and maintain social licence to operate through the development process' [201]. Their analysis found very little support locally, regionally or nationally for large-scale new irrigation developments (Figure 12) [201]. It noted a shift in the North from 'productivist values and goals towards consumptive (for amenity) and protectionist values' [201]. A more detailed values schema in Table 3 shows the diversity of ways in which people can value rivers.

The only strong supporters for greenfield developments reported by the CSIRO are agricultural and mining interests and certain government agencies [201]. That federal and state/territory agricultural agencies, the federal water agency and the Office of Northern Australia are classified as the strongest supporters of irrigation developments (stronger even than agricultural organisations) is a concern for governance – indicating a tendency for these agencies to function as champions of irrigation rather than act on behalf of the broader public interest. In contrast, government environmental agencies are classified as close to neutral (slightly unsupportive).

The CSIRO assessment places environmental organisations and conservationists as being the most unsupportive of new irrigation developments [201]. This group is said to ‘prefer developments that contribute to diversity, sustainability, equity and prosperity’ – smaller developments ‘with minimal environmental impacts that involve and benefit Indigenous northern Australians’. From an ecological worldview, rivers and aquatic habitats are valued for their naturalness, representativeness, diversity and richness, rarity and refugial qualities [207]. Such values are almost inevitably diminished by irrigated agriculture.

Most Traditional Owners have been explicit in opposing large-scale irrigation, particularly if it involves dams.

Two separate surveys have confirmed that residents of the North highly value their rivers and do not support developments that degrade rivers.

Other groups depicted on the strongly unsupportive side are commercial and recreational fishers, retired domestic tourists and the tourism industry. The Amateur Fishermen’s Association of the NT has said it has ‘real concerns with the drive to develop water resource and agriculture in northern Australia as many of the important recreational fish have a strong reliance on river flows for their productivity’ and that any decline in wild caught fish harvests is ‘an unacceptable trade-off’ [208]. The northern prawn fishing industry says it strongly opposes the damming of rivers and other water developments that jeopardise their industry [209].

The CSIRO also classifies residents (which don’t include primary producers and Indigenous groups) as unsupportive, noting their strong recreation and amenity-orientated values and high levels of attachment to local rivers [201]. Residents place significant value on environmental condition, in part because it is ‘a suitable condition for recreational fishing’. Almost two-thirds of respondents (63%) in a February 2021 poll of Top End residents said they use the rivers for fishing, boating or other recreation [16].

Most Traditional Owners have been explicit in opposing large-scale irrigation, particularly if it involves dams (Box 12). In a series of participatory scenario planning workshops in the Kimberley, almost all Traditional Owners rated future scenarios of irrigation development as negative for their wellbeing [210]. The CSIRO found that the strongest response by Traditional Owners in the Fitzroy catchment to the prospect of water extraction of any kind was ‘to reject extraction entirely’ [211]. ‘[A]ny disturbance resulting from large scale irrigation extractions or other consumptive purposes is a threat to ... the Martuwarra’s right to flow as a living entity’, says the Martuwarra Fitzroy River Council [13]. In the Darwin and Mitchell catchment assessment areas, the CSIRO reported that Indigenous peoples expressed opposition to large-scale infrastructure [36,212]. Nine language groups along the Roper River have called for ‘a ban on all further water extraction, licenses and surface water harvesting in the Roper catchment, including the groundwater and floodplains’ [14].

TABLE 3. A CLASSIFICATION OF STAKEHOLDERS ACCORDING TO THEIR LIKELY SUPPORT OF IRRIGATED AGRICULTURE IN A GREENFIELD SITE IN THE FITZROY, DARWIN AND MITCHELL CATCHMENTS

	STRONGLY SUPPORTIVE	MILDLY SUPPORTIVE	NEUTRAL	MILDLY UNSUPPORTIVE	STRONGLY UNSUPPORTIVE
Local	Local primary producers (horticulture, pastoralism, forestry) Mining interests		Local shires		Amateur fishers Commercial fishing representatives
Regional & National	Government agencies: primary industries, water, Office of Northern Australia Agricultural and mining interests/representatives	NRM organisations Government agencies: Indigenous heritage protection Regional economic development representatives	National research organisations	Government environmental agencies Retired domestic tourists Residents	National environmental NGOs Southern Australians Bushwalkers Four-wheel drivers Tourism industry

Source: Modified from CSIRO [201]. We have removed Traditional Owner and Indigenous organisations from this table. In contrast to their placement as mostly neutral in the original 2018 diagram, many Traditional Owner groups have since spoken out strongly against large-scale irrigation.

Two separate surveys have confirmed that residents of the North highly value their rivers and do not support developments that degrade rivers [164,213].

A 2008 willingness-to-pay survey of residents in the catchments of the Mitchell, Fitzroy and Daly Rivers revealed a strong preference for healthy river systems managed under conservation schemes 'even if this comes at a private cost' [213]. Maintaining fishing quality and waterholes in good condition were important for most respondents, while 'irrigated agriculture was not regarded positively'. Maintaining waterholes in good condition was particularly important for Indigenous respondents.

A survey in 2011-12 for the North Australia Water Futures Assessment found that most respondents highly valued rivers, primarily for their biodiversity, life and bequest values (see Table 4 for an explanation of these values) [164]. Even respondents from the agriculture and industry/transport sectors rated the biodiversity and life values of rivers higher than commercial values. A 'large proportion' of respondents were strongly opposed to development – fewer than a third approved of upstream development even when the impacts on social and cultural values were said to be relatively minor, and more than half said they would be willing to accept a decline in income if it came with improved opportunities to enjoy the social and cultural values of rivers. A substantial percentage of respondents refused to consider trade-offs, and some noted they had spent thousands of dollars fighting development proposals in and around their rivers.

It is clear that keeping rivers intact and healthy is very important to many northern Australians. Community opposition to major irrigation projects and social conflict about the future of the North seem likely to escalate.

TABLE 4. SOME OF THE WAYS PEOPLE VALUE RIVERS

VALUE TERM	DESCRIPTION
Life	Water for sustaining human life
Biodiversity	Water for sustaining other life
Commercial	Water for commercial and economic purposes
Bequest	Knowing that rivers will be there for descendants
Existence	Knowing that the river exists (without needing to visit it)
Fishing	Using rivers for recreational fishing
Recreation	Recreating at rivers – e.g. meeting friends and family, swimming, picnicking, boating
Aesthetics	The pleasure of looking at rivers, being inspired
Teaching	Rivers as a place for teaching and learning – to maintain customs, connect with history, remember ancestors

Source: Stoeckl et al. 2012 [164]



Canoeing along the Dimond Gorge in the Kimberley, Western Australia
Credit: David MacKenzie



4.1 'Idle' soils in an 'empty' land

4.3 Fallacies underpinning the proposed development pathway

4.2 Current and proposed irrigated cropping

4.1 'IDLE' SOILS IN AN 'EMPTY' LAND

In the 1950s, optimism was surging in Australia about the potential to turn the 'empty north' – with its 'idle soils, abundant sunshine and water resources barely tapped' – into a prosperous food bowl [214,215]. Politicians and commentators claimed Australia could become 'one of the world's largest rice-producing countries' [216] – with apparent potential for 4,000 rice farms in the Northern Territory [217] and 'millions of acres' under rice in the Kimberley [218].

In 1956 an American firm, Territory Rice Ltd, signed a 30-year agreement with the Australian Government to crop rice at Humpty Doo, near Darwin. The plan was to eventually crop 200,000 hectares of rice a year on the Adelaide and Alligator river floodplains, alternating with cotton in the dry season [219,220].

It was all said to be based on science – 'no longer the hit-or-miss gamble which has so often in the past come to grief' [219]. The CSIRO had surveyed the region for cropping potential (although their recommendations about rice were cautious) and researchers were trialling various rice varieties at a government research station at Katherine [219].

In fact, it would be fair to say that every major irrigation scheme in the north has been an agricultural or economic flop.

But just 4 years later, Territory Rice Ltd went bankrupt. The company blamed magpie geese. 'Shoot every God-damned goose in the Northern Territory' the American investor had instructed his Darwin manager [221]. The company was even granted the assistance of soldiers with machine guns. But shooting magpie geese didn't solve the real problems they faced – damage from floods that topped the two metre high walls around the crop, dam failure, water shortages, poor germination and insect damage, as well as limited capital and management expertise [221–223]. No more than 2,000 hectares of rice were planted and yields were only half of what had been anticipated [223].

This failure did not stymie the pursuit of other big irrigation projects – by entrepreneurs chasing opportunity and governments hoping to populate the North. While planning the damming of the Ord River in the mid-1950s, Western Australia's Director of Works predicted that within 25 years the population of the Ord region would be half a million [221]. The push to populate was driven in part by fears that the North would otherwise be vulnerable to invasion by land-hungry countries in Asia. There was also a powerful sense of moral obligation to make productive use of resources [177] – as expressed in a 1938 book, *Australia's Empty Spaces* [224]:

'In the eyes of the world Australians are not making full and proper use of their country and therefore have no more right to its unutilized lands than had the aborigines whom the forefathers of the Australians dispossessed for the same reason.'

Opposite: Ord River Dam, Lake Kununarra, Western Australia
Credit: Cindy Hopkins / Alamy Stock Photo

4 FOLLIES AND FALLACIES PAST AND PROPOSED IRRIGATION DEVELOPMENTS IN THE NORTH

Despite misgivings about the commercial viability of the Ord River scheme, Prime Minister Robert Menzies granted £5 million in 1959 to build a diversion dam [221]. In 1967, facing a tough election, his government then agreed to fund the main dam (Lake Argyle), even though no commercially viable crop had yet been found and the existing farms relied on massive subsidies. Two years after the dam was declared open (in 1972), cotton farming was abandoned there because it became too expensive to control cotton pests (50% of costs) [225,226]. The predicted population boom of half a million never came close to eventuating. Even today, the population of the Wyndham-East Kimberley shire is just 8,000 and irrigated agriculture employs fewer than 300 people (the latest census reports that 306 people were employed across the agriculture, forestry and fishing sectors) [156,227,228].

Today, the Ord scheme remains the only large-scale (>10,000 hectares) irrigation scheme operating in the North – but only because of massive public subsidies [177,227]. Of the more than \$2.3 billion spent developing the scheme (up to 2014), at least \$1.7 billion (2021 dollars) has been public money (Box 2) [227]. It has proved a woeful investment. The return between 1959 and 1991 was just 17 cents for every public dollar invested, representing a loss of about a billion dollars (2021 dollars), while private investors made modest gains of \$35 million [227]. The economic losses have been compounded by devastating environmental and cultural damage and greenhouse gas emissions – externalities not factored into any cost-benefit assessments [226] (Box 5).

The continued push by the Western Australian and Northern Territory governments to expand this loss-making irrigation scheme seems a classic case of the sunk cost fallacy.

Despite, or perhaps because of, the massive losses, governments have been reluctant to relinquish proposals for the development of yet more cropping areas in the Ord – ‘as if clinging to the hope that success was just around the corner, and a new crop, a new technique, or a new market might finally pay dividends’ [177]. In 2007, the Western Australian Treasury found that further expansion of the scheme could not be justified on economic grounds [229]. And yet, in 2010–14, the Western Australian Government invested another \$334 million (>\$400 million in 2021 terms) to expand the cropping area by about 7,000 hectares – a decision severely criticised by the state’s Auditor-General for its lack of a business case or detailed costings and the resulting 52% cost over-run [229]. The continued push by the Western Australian and Northern Territory governments to expand this loss-making irrigation scheme seems a classic case of the sunk cost fallacy – the tendency to justify increased investment based on past investment rather than on its present merits [230].

In a considerable understatement, the CSIRO says in its 2018 northern water resource assessment reports that many irrigation attempts in the north ‘have not fully realised their goals’. In fact, it would be fair to say that every major irrigation scheme in the North has been an agricultural or economic flop. Box 2 outlines seven of the most recent schemes, which were preceded by many other failures. A CSIRO analysis concluded that the main causes of failure were problems with management, planning, finances, supply chains and markets [223]. In most cases, the anticipated crop yields were far too optimistic. Climatic factors and crop pests and diseases were other barriers. Only one small enterprise achieved the area of cropping intended, and almost all schemes ended up bankrupt. The Ord is the only one to have survived, but only because of those massive public subsidies.

BOX 2. SEVEN FAILED AGRICULTURAL SCHEMES IN NORTHERN AUSTRALIA

1 TERRITORY RICE LIMITED (HUMPTY DOO, NORTHERN TERRITORY), 1955–1961

Established by an American entrepreneur, this company had ambitions to grow 200,000 hectares of rice as a ‘future granary for Asia’ [222]. The Australian Government granted exclusive rights to the company to develop the sub-coastal plains east of Darwin, built a dam and agreed to provide a rice seed nursery and investigate rice varieties, growing techniques and hydrological conditions. But over six seasons of planting, only about 2,000 hectares were cultivated and yields were about half of what had been anticipated [223]. The company went bankrupt.

2 CAMBALLIN IRRIGATION AREA (FITZROY RIVER FLOODPLAIN, WESTERN AUSTRALIA), 1957–1982

Northern Developments Pty Ltd proposed a scheme for large-scale rice production. The Western Australian Government built a dam and barrage, leased land to the company and conducted agronomic research [231]. The company undertook to grow 8,000 hectares of rice, but planted no more than 1,280 hectares, with yields much lower than anticipated [223,231]. The Australian Land and Cattle Co took over in 1969 and grew mainly sorghum, with a maximum planting of 1,933 ha. This company went bust in 1982 and a large flood in 1983 breached a 17 kilometre levee bank, causing major damage to machinery and infrastructure.

3 TIPPERARY LAND CORPORATION (NORTHERN TERRITORY), 1967–1971

A group of Texan investors embarked on a large sorghum and cattle fattening operation on Tipperary Station, but yields were only about half of what they anticipated and they achieved less than 10% of the planned 79,000 hectare planting [223]. Cash flow constraints ended cropping after only three years.

4 LAKELAND DOWNS (NEAR COOKTOWN, NORTH QUEENSLAND), 1968–1974

The goal was to grow large areas of irrigated and dryland grain integrated with cattle production. Two dams were constructed and 14,000 hectares of land were cleared [223,232]. One dam was washed away in the first wet season, and only about 500 hectares was planted for irrigated production. Crop yields were only about half of what was anticipated and did not provide sufficient returns. The company went bust. The area was eventually split into small farms.

5 NORTHERN AGRICULTURAL DEVELOPMENT CORPORATION (NEAR KATHERINE, NORTHERN TERRITORY), 1971–1974

The company bought Willeroo Station with plans to grow stylo (legume) pastures and 25,000 ha of grain sorghum and establish a feedlot to fatten cattle [223,233]. They cleared 50,000 hectares but planted only 10,000 hectares of sorghum and achieved yields lower than anticipated. Little was invested in infrastructure, and grain stored in the open suffered damage. The company went bankrupt.

6 PEANUT CO. OF AUSTRALIA (NORTHERN TERRITORY), 2007–2010

The company intended to grow 4,000 hectares of rain-fed wet-season crops (peanuts, corn, hay) and 3,200 hectares of dry-season irrigated crops, but only planted 2,000 hectares [223]. Yields were considerably less than anticipated, although commercially viable. The company sold its operations after three years in part because of high operating costs, uncertainty over longer-term water allocations and insufficient capital to scale-up. The properties are now used for sandalwood plantations.

4.2 CURRENT AND PROPOSED IRRIGATED CROPPING

CURRENT IRRIGATION

Large-scale irrigated cropping hasn't failed in the North from a want of trying. Despite more than a century of concerted attempts with large government subsidies, irrigated cropping in the North currently makes an insignificant contribution to Australian agriculture and regional economic activity [242,243]. Smaller-scale irrigation has succeeded, particularly for niche crops with a local or high-value seasonal market. The current irrigated area of about 60,000 hectares makes up just over 3% of the Australian total (Table A1 in Appendix) [162,243]. It represents less than 1% of economic activity in the North and supports just over 1% of the region's jobs (1,700 full-time equivalents) [11].

Given the history of failure and the well-known impediments to an irrigated cropping industry in the North, the question to governments is this:

What, if anything, has changed to give Australians confidence that a large-scale irrigated cropping industry in the North can now succeed?

Despite the failures to date, a major expansion of irrigated agriculture is still being touted as the major pathway to development of the North [60]. Recently, there has been a renewed determination by the irrigation industry and various federal and state/territory government agencies to finally 'unlock the north's vast potential.' [60]. Large sums of public funding have been invested since the release of the White Paper on Northern Development to try to resurrect the old vision of the North as a major food bowl (Tables A2, A3 in Appendix).

Given the history of failure and the well-known impediments to an irrigated cropping industry in the North, the question to governments is this: What, if anything, has changed to give Australians confidence that a large-scale irrigated cropping industry in the North can now succeed?

There has been no analysis demonstrating that the industry is now economically viable due to changes in operating circumstances. Contrary to the headlines, this is not what the CSIRO's 2018 analyses of the potential for irrigated agriculture in the Fitzroy, Darwin and Mitchell catchments show (section 4.2). If anything, the impediments to an irrigation industry have grown – new crop pests keep arriving, major input costs (freight, fertilisers, pesticides) are rising, the climate is warming, environmental carbon stocks are becoming more valuable, and the recognised environmental and cultural values and vulnerabilities of the North are growing (Box 4).

BOX 2. (CONTINUED)

7 ORD RIVER IRRIGATION AREA (WESTERN AUSTRALIA), 1960–PRESENT

Funded jointly by the Western Australian and Australian governments, this extremely costly, mostly publicly funded scheme currently comprises about 21,000 hectares of land for irrigated agriculture (14,000 hectares in stage 1 and 6,700 hectares in stage 2) [234–236].

Initially, 70,000 hectares of cotton was planned, but the maximum achieved was 5,000 hectares. Production largely ceased in the mid-1970s due to damage by the cotton boll worm and other pests (pesticides made up 50% of growers' costs), poor quality cotton and the removal of subsidies [223,234]. Rice was grown from 1973 to 1983, and a local processing mill was built. But it too was abandoned due in large part to crop damage (including by ducks and magpie geese and heat stress and cold stress) [234,237]. Another attempt, in 2010 and 2011, also failed, due to a new fungal disease (rice smut) [237].

Sugarcane was attempted from the mid-1990s with the construction of a sugar mill and sugar and molasses tanks. But the scale was too small to be viable and production ceased in 2007 [223]. Sandalwood became popular from the early 2000s, making up half the cropped area at its peak a decade later. Chia became the next major crop but yields became uncompetitive when cheaper international production flooded the market in the late 2010s. Current crops include melons, vegetables, chia, sandalwood, maize, fodder and niche crops [234].

The public investment of at least \$1.7 billion dollars (up to 2014) resulted in losses by 1991 of more than a billion dollars (in 2021 terms) [227]. A lack of transparency precludes more up-to-date cost-benefit assessments. A 2016 analysis by the Western Australian Auditor General of the Ord-East Kimberley Development Plan found that the predicted social and economic benefits used to justify the decision to proceed with the most recent expansion at a public cost of about \$400 million were not realised and were not even being measured [229]. The project lacked a business case and detailed costings. A follow-up report by the Public Accounts Committee of the Western Australian Parliament in 2019 criticised the lack of transparency, poor governance and 'lax and insular reporting' on the scheme [236].

PUBLIC INVESTMENT IN THE ORD RIVER IRRIGATION SCHEME (2021 \$BILLION)

YEARS	PUBLIC COST	PRIVATE COST	TOTAL COST
1959–1991	1.23	0.53	1.76
1992–2009	0.08	0.03	0.11
2010–2014	0.41	Unknown	0.41+
2015–	0.12	Unknown	0.12+
Total	1.84	0.56+	2.40+

Sources: [227,229,235,236,238–241]

Notes: Dollars were converted to 2021 amounts using the Reserve Bank's inflation calculator. Funding by the federal government for the East Kimberley Development Package (equivalent to about \$0.24 billion in 2021 dollars) is not included in the 2010–14 total. There is little information about more recent public or private funding. Since 2015, governments have provided funding for a cotton gin (\$4 million for an electrical supply upgrade, \$34 million infrastructure loan), an upgrade of irrigation channels (\$77.1 million) and support for cotton cropping trials (no public cost information) [238].

Credit: Alamy Stock Photo

It is also not sufficient that an irrigation industry simply be economically viable. For governments to support the development of large-scale irrigated cropping, they should also demonstrate that the industry would be:

- (a) an effective and optimal way to improve the lives of northern residents compared to other economic options, compatible with the preferred livelihood options of residents, and a beneficial use of public resources (funding, land and water);
- (b) sustainable – done in a way that sustains rivers and protects the outstanding environmental and cultural values of the Wet-Dry Tropics (constraints that largely did not apply with past projects).

In this section, we consider whether recent proposals for large-scale irrigated cropping in the North can meet such expectations.

WHITE PAPER ON DEVELOPING NORTHERN AUSTRALIA

In 2015, the Australian Government released the White Paper on Developing Northern Australia, with a dominant focus on developing water infrastructure for irrigated cropping – claiming that it ‘should be the first, and last, white paper for the north’ [60]. The region as defined in the White Paper is far larger than the region of focus here, being the area north of the Tropic of Capricorn and including all of the Northern Territory (about 300 million hectares).

The White Paper does not specify any particular objectives, goals or targets. Instead, it lays out a vision to ‘unlock the great potential and opportunities of the north – by government-facilitated’ (as distinct from government-led) economic growth, the removal of impediments to growth, infrastructure building as the catalyst for new large-scale developments and rapid population growth, while also safeguarding ‘the incredible northern environment’ and working in ‘full partnership’ with Indigenous Australians to create opportunities. The one quantifiable target in the paper is a population increase from about 1.3 million to 4-5 million by 2060. This is equivalent to 21-28 times the population of Darwin, or 10 times the population of Darwin for the northern-most catchments [244].

The White Paper specified five industry pillars for the north – food and agribusiness, resources and energy, tourism and hospitality, international education, healthcare, medical research and aged care. But most of the focus and most of the promised funding was for building roads and dams – including \$5 billion for concessional loans to build infrastructure (the Northern Australian Infrastructure Facility, \$600 million for roads, \$200 million for water infrastructure, \$100 million for ‘beef roads’ and \$75 million for research (largely for agriculture). The last three pillars in particular received little focus in the White Paper.

Although the White Paper acknowledges that good governance is critical for success, it fails in one of the most basic tenets of good governance – to provide evidence that the proposed roads-and-dams pathway to development is viable and optimal for northern Australia and will genuinely benefit the main intended beneficiaries – the people living in the North, including Indigenous Australians. Despite the avowals in the White Paper that development has to be undertaken in full partnership with Aboriginal people, there is no evidence of meaningful engagement with locals to develop this preferred pathway.

The development pathway in the White Paper was selected, according to one critique, ‘without any consideration of current science/best-practice policy approaches for regional development’ [245]. It perpetuates a more-of-the-same, single-sector-based model of development focused primarily on agriculture – described by the OECD as an old approach [246] (Box 3). In contrast, the ‘modern economy’, as described by the OECD in its ‘new rural paradigm’, is a network economy, led by the service sector, with a highly skilled core workforce, driven by innovation, with most jobs created by entrepreneurs and small and medium-sized enterprises. In contrast to claims in the White Paper, the OECD found that ‘density is not a prerequisite for high-performance’. Globally, the most efficient growth ‘appears to be occurring in less populated regions’ [246].

Another weakness of the White Paper is its failure to acknowledge and value the variety of ways in which free-flowing and healthy northern rivers benefit people and are already extensively used for economic and non-economic purposes. The cultural values of rivers and waterways are mentioned just once while cultural heritage protection is represented as a costly impediment to development. The values of rivers for recreational and commercial fishing and tourism are not mentioned. Indigenous access to water is only mentioned to say that it is up to each jurisdiction to establish relevant policies.

The White Paper perpetuates a more-of-the-same, single-sector-based model of development focused primarily on agriculture – described by the OECD as an old approach.

In these various deficiencies, the White Paper perpetuates several historical tendencies – of imposing others’ visions on the people of the North and simplistically equating development with building infrastructure and supporting export-driven agriculture, while ignoring the cultural, environmental and economic values of intact and healthy rivers. Instead of an evidence base, one critic says, ‘the White Paper uses narrative to paint a mirage of northern development that continues historical support for a pre-assumed outcome of irrigation-led development’ [245].

In May 2023 the Australian Government announced it would ‘refresh’ the White Paper as part of a commitment to address ‘the unique and complex challenges that hinder Northern Australia’s development potential’ [247].

Cotton modules ready for processing at a cotton gin
Credit: Alamy Stock Photo

BOX 3. THE NEW RURAL PARADIGM – PLACED-BASED, MULTI-SECTORAL RURAL DEVELOPMENT

Across the OECD, including in Australia, agriculture is ‘no longer the backbone of rural economies’ – its weight in rural economies has been ‘low and declining’ for the past several decades [249]. In 2006, recognising that rural policies focused primarily on agriculture had been failing to arrest economic decline, the member countries of the OECD endorsed the New Rural Paradigm [248].

The policies emerging from this paradigm, which converge with recommendations from decades of work by rural policy academics, disavow the single-sector support for agriculture in favour of a ‘holistic place-based approach’ with a focus on multiple sectors [248–250]:

NEW APPROACH	OLD APPROACH
Holistic, place-based, multi-sectoral focus	Policy targets focused on single sectors – mainly agriculture or forestry
Focused on increasing the competitiveness of rural areas	Focused on increasing agricultural income and competitiveness
Fosters distinctive regional identities, valorises local assets	Fosters sameness across regions – single solutions despite region-specific advantages and challenges
Broad focus on multiple indicators, including wellbeing as an important dimension	Narrow focus on economic indicators
Involves all levels of government, Indigenous organisations, local stakeholders (public, private, NGOs)	Key actors are national/state/territory governments and agribusinesses

Rather than defensively trying to halt rural decline through yet more investment in agriculture, many countries are concentrating on seizing new, mostly non-agricultural opportunities [249]. They recognise that farmers are now ‘more dependent on the broader rural economy than the rest of the rural economy is on them’ [250]. Contrary to this trend, Australian rural policy for the North remains largely captive to agricultural interests – pursuing through the White Paper the single-sector approach labelled by the OECD as the ‘old approach’ [249].

For policy-makers, the new paradigm is much more challenging than the old, for it requires a region-by-region approach, integrating the work of different agencies and all levels of government, involving more constituencies and fostering more bottom-up policy development [248]. But regions that have been able to implement integrated policy packages across multiple sectors have, on average, better economic performance [248]. Relatedly, countries that foster self-directed Indigenous development have also been more successful in improving Indigenous economic outcomes [251].

While the single-sector approach renders regions more alike (and landscapes ‘more monotonous’), a place-based, multi-sectoral approach focuses on maintaining and benefiting from the distinctiveness of each region [252]. It fosters reconnection, values local knowledge and valorises local assets [249,252]. It recognises the increasing value to society of natural and cultural amenities [249] and elevates wellbeing as a crucial policy issue [248]. It includes opportunities for agriculture to develop new products and services aligned with local assets and identities, focused on activities for which there is a social licence [252].

The concepts of the new rural paradigm overlap with those in the Indigenous development literature, including a strong focus on Indigenous-led development and on ‘sustainable livelihoods’, with integration of human, social, natural and physical dimensions as a basis for economic development [253,254].

THE CSIRO'S ASSESSMENTS OF WATER DEVELOPMENT OPTIONS

In August 2018, the CSIRO released water resource assessments for three northern catchments (at a cost of \$15 million). The reports were promoted with headline figures highlighting the potential for 400,000 hectares of irrigated crops, \$5.3 billion of annual activity and 15,000 jobs. News articles had more than a whiff of the over-optimistic commentary that greeted the rice farming ventures of the 1950s – trumpeting the potential for the next great food bowl [255,256].

‘Six dams planned in vision for the north: Scott Morrison has been handed a scientific blueprint to transform northern Australia into the nation’s ‘next great food bowl’.
The Australian, 30 August 2018

‘Giant dams could be built in parts of north Queensland and the Northern Territory to turn those areas into major national agricultural food bowls and generate significant economic benefits.’ *ABC News, 28 August 2018*

The 420,000-480,000 hectares of potential irrigated cropping highlighted in these assessments comprise (Table A4 in Appendix):

- Martuwarra Fitzroy River catchment: 190,000 hectares (off-stream storage and groundwater)
- Greater Darwin catchments (Adelaide, Finnis, Mary and Wildman rivers): 90,000 hectares (two large dams, off-stream storage, groundwater)
- Mitchell River catchment: 140,000 hectares (four large dams) or 200,000 hectares (off-stream storage)

Although this scale of irrigated cropping is portrayed as modest – it ‘would only occupy about 3% of the assessment area’ [257] – it is proportionately far larger than other irrigation regions in Australia: more than double the irrigated proportion of the Murray-Darling Basin (about 1.5%) and triple the irrigated proportion of the Burdekin catchment, northern Australia’s largest and most intensively developed agricultural floodplain [258] (Table 5).

Combined with other CSIRO assessments and other proposals – including for the Flinders, Gilbert and Ord rivers – the possible area of irrigated cropping would amount to more than 600,000 hectares, which would be triple the irrigated proportion of the Murray-Darling Basin (Table 5) and the combined volumes of possible water use (Table A4 in the appendix) would come close to the volume applied in the Murray-Darling Basin. Additional assessments are being undertaken in the Roper (NT), Victoria (NT) and Gregory (Qld, NT) rivers [261]. There is nothing modest about the irrigation industry being contemplated for the North.

The footprint of irrigated agriculture would be considerably larger than the area cropped – due to the downstream habitats impacted by water extraction, the loss or degradation of floodplain wetlands, the additional areas cleared for infrastructure and fallow cropping areas and the habitats polluted by nutrient and pesticide runoff.

In playing up the possibilities for irrigated cropping, the public messaging from the CSIRO assessments focused on highly optimistic scenarios and glossed over the more sobering substance of the technical assessments. For all six catchments in the three most recent assessment areas, the CSIRO's analysis of costs and benefits concluded [201]:

- Viable new irrigation development would require 'challenging combinations' of low-cost infrastructure, high-productivity farms, management of a wide range of risks, and off-farm value-adding.
- It would be challenging to find new irrigation opportunities that 'met regulatory requirements, gained stakeholder support' and provided 'a financial rate of return to investors commensurate with the level of risk involved.'
- Farm gate revenue from broadacre cropping would be 'unlikely to fully cover the costs of new irrigated development.'
- Risks include low water reliability, climate variability, price fluctuations, and the need to adapt farming practices to new locations.

Other analysts have also found the business case for irrigated agriculture to be marginal at best. For the Martuwarra Fitzroy catchment, for example:

- Irrigation developments are 'likely to be mostly unprofitable, create a poor return on public investment and create few jobs' (Connor et al. [251]).
- Converting 'the water resource into a commercial operation with adequate returns is difficult' (Giovi Agriculture [260]).
- Mosaic irrigation developments 'may not necessarily generate a major economic boost to the financial returns of typical northern beef enterprises' (MacLeod et al. [261]).

The CSIRO's less-than-rosy prognoses came despite several optimistic assumptions in their analyses. They noted that their estimated crop yields, for example, reflect optimum management and assume no unexpected pest or disease incursions. In fact, insect and disease incursions are likely to be common and can be catastrophic, as demonstrated by the 1970s collapse of the cotton industry in the Ord irrigation area. On-farm costs for establishing irrigation businesses were mostly assumed to be \$10,000–15,000 a hectare, even though the costs for greenfield sites requiring land preparation can often exceed \$40,000 a hectare (including for supporting infrastructure) [245].

TABLE 5. A COMPARISON OF CSIRO-IDENTIFIED IRRIGATION POSSIBILITIES WITH EXISTING IRRIGATION AREAS ELSEWHERE

	FITZROY CATCHMENT	DARWIN CATCHMENTS	MITCHELL CATCHMENT	ORD CATCHMENT	BURDEKIN CATCHMENT	MURRAY-DARLING BASIN
Catchment area (km ²)	94,000	30,000	71,530	46,100	136,000	1,061,000
Cropping area – existing + possible ^(A) (km ²)	1,904	1,224	2,150	520	1,200	15,000 ^(B)
Proportion catchment area	2.0%	3.9%	2.8%	1.1%	0.9%	1.4%

Sources: Fitzroy [262], Darwin [263], Mitchell [36], Ord [236,264], Burdekin [258], Murray-Darling Basin [265]

Notes: (A) By 'possible' we mean the areas identified in the CSIRO's water resource assessments or government documents for the northern river catchments. (B) The area for the Murray-Darling Basin is that reported for 2017–18, the largest for the past few years.

CURRENT IRRIGATION DEVELOPMENT PROPOSALS

Since the 2015 White Paper, there has been a concerted push to develop irrigation projects in northern Australia, with at least \$200 million spent so far on assessments, feasibility studies, business case assessments, agricultural research and infrastructure (Table A2 in the appendix) – focused mainly on the Mitchell, Flinders, Gilbert and Palmer catchments in Queensland; the Adelaide, Finnis, Mary, Wildman, Roper and Ord catchments in the Northern Territory; and the Martuwarra Fitzroy and Ord catchments in Western Australia [266]. There has been a particularly strong focus on developing cotton and horticultural crops in the Northern Territory, fodder crops in Western Australia and horticultural crops in Queensland. Major irrigation projects currently being planned or developed would increase the area of irrigated agriculture by more than 100,000 hectares, roughly tripling the current area (Table A3 in the appendix).

In contrast, very little has been spent on baseline studies to better understand the environmental and cultural values of the northern rivers to provide a basis for assessing the impacts of developments, and almost nothing has been spent on investigating other development options, including those preferred by Indigenous people.

There has been a strong focus on developing cotton crops in the Northern Territory

Credit: Alamy Stock Photo



4.3 FALLACIES UNDERPINNING THE PROPOSED DEVELOPMENT PATHWAY

No government facilitating large-scale irrigation in the North has published any analysis demonstrating the industry is economically viable and ecologically sustainable or an optimal pathway for development. Currently, they are proceeding project by project – on the apparently unquestioned assumption that this will be beneficial for the region. Here we outline four fallacies underpinning that assumption. A fifth fallacy – that an irrigation industry in the North can be ecologically sustainable – is addressed in the next chapter.

FALLACY 1: THERE IS PLENTY OF WATER TO SPARE

This is the fundamental premise of irrigation proponents – that there is water aplenty in the North that doesn't otherwise provide any benefits. But for the ecosystems adapted to the highly variable flows of the Wet-Dry Tropics, there is little water to spare. As the Northern Australia Land and Water Taskforce pointed out in their 2009 report on sustainable development in northern Australia [49]:

'All water is fully in use. ... even 'wasted' water running out to sea is needed by estuarine systems and near-shore ecosystems. Underground, groundwater supports riparian vegetation, maintains perennial reaches of many rivers and provides a dry-season source of water. Whilst current levels of use are low relative to total water stocks, any perturbation will have consequences through the hydrological cycle.'

The apparent waste during the monsoonal floods represents essential flows for the likes of sawfish, barramundi and banana prawns (Chapter 2).

The northern rivers, tributaries, aquifers and floodplains are also already used for many human purposes – sustaining settlements, Indigenous cultures, recreation (including fishing), nature and cultural tourism, commercial fishing, mining and agriculture [267]. A large-scale irrigation industry would inevitably compromise the value of rivers for existing users – as implied by the opposition of the commercial fishing, recreational fishing and tourism sectors to greenfield irrigation developments (section 3.5) [201]. These water-dependent industries are economically important for the North, so it would be irrational to undermine their potential.

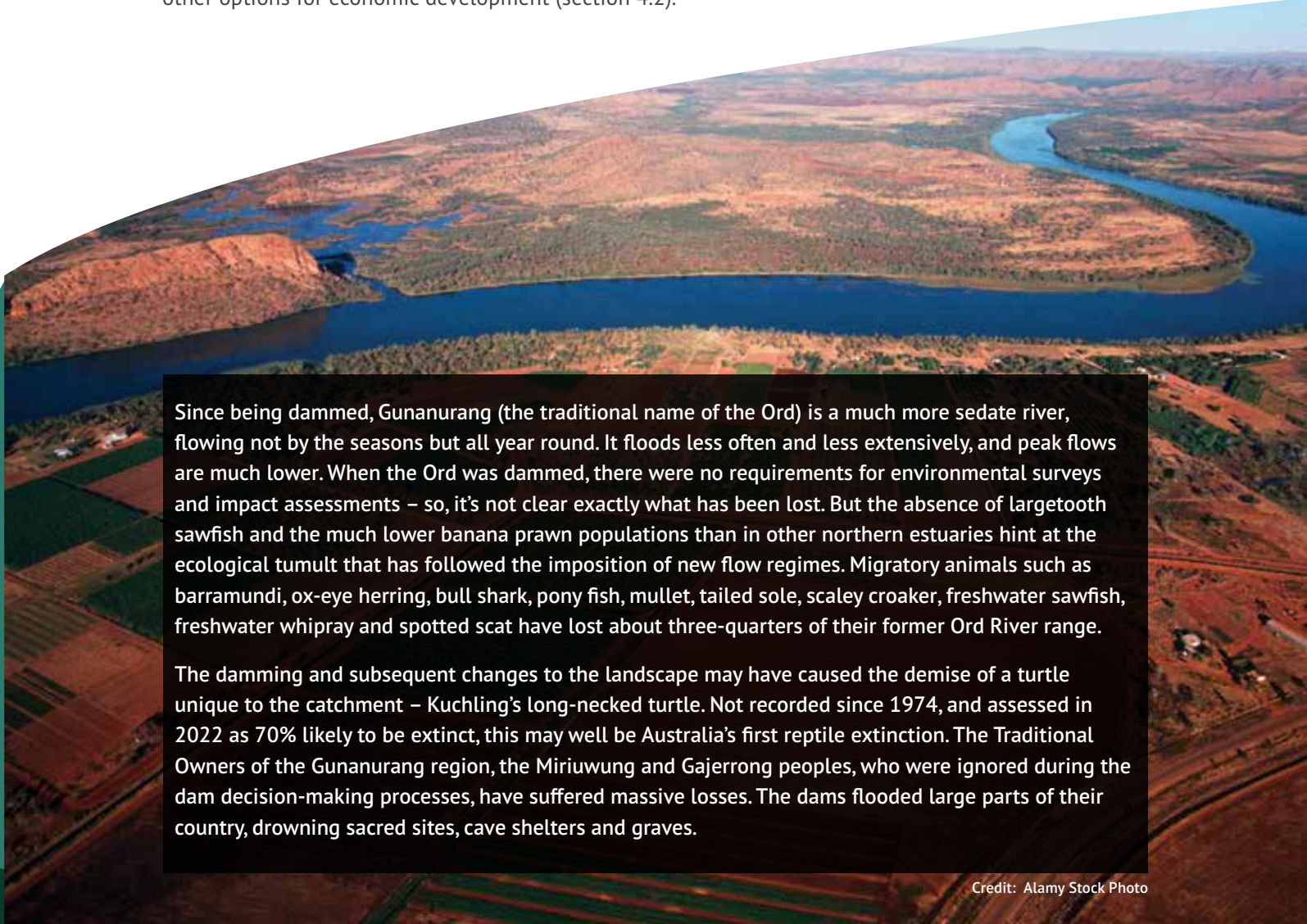
Already, under current policy settings in the Northern Territory, there appears to be little or no additional water available for irrigating cotton crops in the areas primarily targeted for cotton farming. Major groundwater resources in the Daly and Roper river regions have been 'overallocated' (the volumes of water allocated under water licences exceed the NT Government's 'estimated sustainable yield') [203].

FALLACY 2: LARGE-SCALE IRRIGATION IS ESSENTIAL FOR DEVELOPMENT

The perception of water development as an essential path to economic development is a major driver of irrigation development. The 2015 White Paper says that 'building the right water infrastructure in the right place will be crucial to realise the full potential of the north'. The preamble to some of the CSIRO reports cite 'commentators overseas' to claim that [179]: 'no country or region in a tropical or sub-tropical climate has ever managed to make significant economic progress without adequately harnessing its water resources.'

But the preamble references just one commentator, who offers no evidence for the claim except that developed countries like Australia and the United States have more than 5,000 m³ of water storage per person while countries like India and Pakistan have about 150 m³ per person [268]. The commentator falsely claims correlation as causation. And the correlation is faulty anyway: among the top 10 countries for dam storage per person are some of the world's poorest countries (Suriname, Zimbabwe, Zambia, Venezuela and Ghana), and among the lowest are wealthy countries (Belgium, Denmark, Germany, Hungary and Singapore) [269]. The OECD does not even mention water development in its reports on modernising rural economies [246].

The adoption by governments of irrigated cropping as the major developmental pathway for the North has not come about through a process of local engagement. Governments have been unwilling to fully investigate other options for economic development or analyse the costs and benefits of other options, particularly for Indigenous Australians, whose economic wellbeing is often invoked as reason for development. In contrast to the \$100 million or so spent investigating water supply and cropping options for irrigation in the North (Table A2 in the appendix), very little has been spent investigating other options for economic development (section 4.2).



Since being dammed, Gunanurang (the traditional name of the Ord) is a much more sedate river, flowing not by the seasons but all year round. It floods less often and less extensively, and peak flows are much lower. When the Ord was dammed, there were no requirements for environmental surveys and impact assessments – so, it's not clear exactly what has been lost. But the absence of largetooth sawfish and the much lower banana prawn populations than in other northern estuaries hint at the ecological tumult that has followed the imposition of new flow regimes. Migratory animals such as barramundi, ox-eye herring, bull shark, pony fish, mullet, tailed sole, scaly croaker, freshwater sawfish, freshwater whiplay and spotted scat have lost about three-quarters of their former Ord River range.

The damming and subsequent changes to the landscape may have caused the demise of a turtle unique to the catchment – Kuchling's long-necked turtle. Not recorded since 1974, and assessed in 2022 as 70% likely to be extinct, this may well be Australia's first reptile extinction. The Traditional Owners of the Gunanurang region, the Miriung and Gajerrong peoples, who were ignored during the dam decision-making processes, have suffered massive losses. The dams flooded large parts of their country, drowning sacred sites, cave shelters and graves.

FALLACY 3: THE IRRIGATION FAILURES OF THE PAST WON'T BE REPEATED

It is 'technically possible to produce pineapples in Antarctica', economist Bruce Davidson wrote in 1965, pointing out the difference between technical feasibility and commercial viability [177,270]. As the CSIRO reports and other analyses make clear, it is possible to grow irrigated crops in the North – there are arable soils and harvestable water – but there are major impediments to the achievement of a viable, let alone ecologically sustainable, irrigation industry in each of the catchments assessed.

Proponents of large-scale irrigation in the North typically blame restrictive government policies for the limited current extent of irrigated cropping (Table A1 in the appendix) – over-regulation and lack of investment in infrastructure [199,271,272] – rather than features inherent to the region (such as distance to market, short growing seasons and labour constraints) or the irrigation industry. If they do address the history of irrigation failures, proponents say that the lessons of history have been learned and that a booming Asian middle class and improvements such as new crop varieties will ensure success in the future [271]. But there is no analysis showing this to be the case. As exemplified in Box 4, many past impediments such as high freight and fertiliser costs, new pests and diseases, and climate variability are becoming more severe. The risks of failure of major irrigation projects may be higher now than in the past.

Australia's 2014 Agricultural Competitiveness Green Paper noted that 'profitability in Australian agriculture is low, particularly given the riskiness of the business' [273]. The average rate of return across broadacre farms over the 20 years to 2012–13 was just 1.1% excluding capital appreciation, and 4.2% inclusive of appreciation (3.2% for horticulture over the 5 years to 2011–12). This was considerably lower than the average 6% yield on 10-year government bonds (considered very safe investments) over the same period [273]. While there is considerable variation in the rate of returns across producers, the additional costs and challenges of farming in the North imply a high risk of commercial failure.

As is now well recognised in economics, humans are highly prone to optimism bias, a cognitive bias that causes us to 'overestimate the likelihood of positive events, and underestimate the likelihood of negative events' [274]. It is one of the most 'consistent, prevalent, and robust biases' recorded in behavioural economics [274]. Also typical in major projects around the world are political and economic incentives to justify projects rather than critically scrutinise them. Over-optimistic benefit estimates 'are often seen as a necessary means to getting projects started' [275].

Policymakers should be wary of the analyses of irrigation proponents for, over and over again, there have been significant divergences between predictions and outcomes. For example, an analysis of 79 major irrigation projects in sub-Saharan Africa found they supported only a median 15% of the initially predicted cropping area and 20% were inactive [276]. The performance of irrigation schemes had not improved over six decades, indicating a failure to learn. In Australia, for the major dam projects for which information is available, the mean cost overruns have been 120% higher than contracted costs [277].

Ord River Diversion, 1963
Credit: State Library of WA

An unwillingness by governments to scrutinise viability was laid bare in a scathing 2016 analysis by the Western Australian Auditor General of the most recent expansion of the Ord River irrigation scheme (stage 2) [229]. The project went ahead in 2009 without a business case or detailed costings. The expansion cost \$334 million, which was \$114 million (52%) more than was budgeted, took three years longer than predicted, and did not achieve the cropping targets. A 2007 WA Treasury analysis had determined that expansion of the scheme was not viable on economic grounds, but perhaps could be considered viable if it brought social and economic benefits [229]. However, the Auditor General found those predicted benefits had not been realised and were not even being measured [229]. This has been typical of a reluctance by governments to fully investigate the external costs (hidden subsidies) of irrigated cropping (cultural losses, land degradation and biodiversity losses, Chapter 5) in cost-benefit analyses.

FALLACY 4: IRRIGATED AGRICULTURE WILL BENEFIT PEOPLE OF THE NORTH

It should be of great public concern that governments are simply assuming that irrigation development of the North is socially desirable rather than undertaking detailed analysis of whether an irrigation industry is an optimal pathway for development. After all, the intended beneficiaries are purportedly northern people, and Aboriginal people in particular.

...many past impediments such as high freight and fertiliser costs, new pests and diseases, and climate variability are becoming more severe. The risks of failure of major irrigation projects may be higher now than in the past.

The typical public benefit claim is that irrigated cropping will create thousands of jobs for local people – 2,500 jobs by 2030 says the cotton industry in the Northern Territory [302]; 110 permanent and up to 1,350 seasonal jobs, claims a company developing a 3,500-hectare horticultural project on Singleton Station in the Territory [303]. It is standard practice for industries to exaggerate the potential for jobs. The claims by the cotton industry are not plausible considering that the cotton industry Australia-wide employs fewer than 1,600 people (466 people growing cotton and 1,121 people ginning cotton) and that most purchases are from national or international suppliers rather than local businesses [304]. An analysis of the Singleton project found that local jobs would probably amount to no more than 10% of the claimed numbers (on a full-time equivalent [FTE] basis) [303]. This project was recently granted free entitlement to 40 gigalitres of groundwater a year, the largest licence in the Territory, worth \$70–300 million on the market [303].

The irrigated cropping industry is typically an intensive user of land, water and capital, but not labour [304]. The North's biggest irrigation scheme, the \$2 billion Ord River scheme, provides fewer than 300 FTE jobs [227]. Estimates of jobs generated by irrigated agriculture are often calculated using standard input-output analysis – for example, CSIRO's estimate of 15,000 jobs from irrigated cropping of 387,000 hectares is based on an assumption that 'each \$25 million increase in agricultural activity could create about 110 to 270 jobs' [262]. But other economists say this method considerably overstates the job potential for regional communities because it wrongly assumes an unconstrained supply of labour at a fixed price [245].

Due to the lack of a local workforce, most horticultural jobs in the North have to be filled by interstate or overseas workers. In the Northern Territory, only 11% of horticultural workers during the harvest season are locals [305].

An analysis of the likely consequences of proposed irrigation developments in the Flinders and Gilbert catchments found that the majority of jobs would likely result in the redeployment of workers already in the sector [306]. It also found that the irrigation projects would result in a welfare loss under business-as-usual assumptions and were unlikely to deliver 'clear welfare gains' even with optimistic assumptions [306].

More important is the question of whether the gross number of jobs that might eventuate is even an appropriate measure of public benefit. It misconstrues the concept of development as equivalent to economic growth [307]. These should be treated as very different concepts, particularly in light of government strategies and policies focused on improving the lives of Indigenous Australians. The distinction between the concepts is highlighted by the fact that irrigated agriculture can diminish the wellbeing of Indigenous Australians by degrading what they value while at the same time creating jobs and increasing gross domestic product. But even in economic terms, an analysis of development scenarios in the Daly River catchment found that Indigenous residents would gain little income from irrigated agriculture and stand to lose more than other residents because of their reliance on aquatic wild resources [308].

Using the creation of jobs that some people may or may not desire as justification for an irrigation industry is inconsistent with these government policies and strategies. The wellbeing of Indigenous Australians is not well served by offering low-skilled, low-security jobs that lack cultural resonance and are not of their choosing.

Western Australia's Aboriginal Empowerment Strategy, adopted in 2021, says that Aboriginal people should be able to 'choose their own futures' and be 'empowered to live good lives'. The Northern Territory's Everyone Together Aboriginal Affairs Strategy 2019–2029 says that 'people and place' should be at the centre of government policy design and people 'empowered to determine their own futures'. Among the outcomes sought under Closing the Gap is that 'Aboriginal and Torres Strait Islander people enjoy high levels of social and emotional wellbeing'. Using the creation of jobs that some people may or may not desire as justification for an irrigation industry is inconsistent with these government policies and strategies. The wellbeing of Indigenous Australians is not well served by offering low-skilled, low-security jobs that lack cultural resonance and are not of their choosing.

While a few businesses will derive considerable benefits from government investment in irrigation projects and the availability of free or low-priced water, it appears that most target beneficiaries 'stand to gain little from the investments and may even face major and costly changes to their livelihoods, lifestyles, and cultural values' [245].

BOX 4. HAS IRRIGATED CROPPING IN THE NORTH BECOME MORE OR LESS VIABLE?

As exemplified by the Ord River irrigation scheme, the optimistic claims by irrigation proponents about the economic viability of irrigated cropping in the North are contrary to the history of repeated failures and analyses by the CSIRO and others (section 4.2) [229]. The claims by proponents are not based on a detailed analysis of what has changed to ensure that history does not repeat.

What has changed to improve the viability of irrigated cropping in the North?

- New crop varieties have improved water efficiency and pest resistance.
- Asian middle-class populations are growing, creating a larger potential market for Australian produce.
- Irrigation investors and growers from elsewhere are shifting to the North.

What has changed to reduce the viability of irrigated cropping in the North?

- New crop pests are arriving and biosecurity risks are growing.
- The northern climate is becoming more unpredictable.
- Abating greenhouse gas emissions will become more expensive.
- Freight is becoming more expensive.
- Fertilisers and pesticides are becoming more expensive.
- The recognition of environmental values and their vulnerabilities is growing.
- The recognition of cultural values and their vulnerabilities is growing.

NEW CROP PESTS KEEP ARRIVING

It would be 'perilous' to invest in developing irrigated agriculture in the North without considering the risks of new invasive crop pests and diseases [278]. These were major reasons for the rapid demise of the cotton and rice industries in north-west Australia [31, 237]. The 'warm, moist and high-nutrition conditions' needed for crops are those that favour diseases and crop-devouring insects, and the warmth of the Wet-Dry Tropics facilitates rapid multiplication and the evolution of resistance to pesticides [11]. The region is a convenient destination for pests and diseases from nearby countries and irrigated crops there would serve as a 'green bridge' to southern areas as well as increase the risks of new species invading the natural environment [278]. Three very recent invasions likely to cause substantial crop damage in the North are the:

- fall armyworm (detected 2020) – can cause 'significant' damage to sugarcane, cotton, pasture grasses, rice, fruits and flowers [279, 280]
- American serpentine leafminer (detected 2021) – can reduce the yield of a wide variety of horticultural and ornamental plants [281]
- guava root-knot nematode (detected 2022) – can 'greatly reduce' the yield of vegetable crops and ornamental plants [282].

BOX 4. (CONTINUED)

THE CLIMATE IS LIKELY TO BECOME EVEN MORE CHALLENGING FOR CROPPING

The rainfall in the Wet-Dry Tropics is already highly variable year to year and over longer periods, with runs of very wet and very dry periods in the climate record spanning several years to decades [283]. This variability could increase due to climate change, with some predictions including an increase in the number and severity of extreme rainfall events as well as rising temperatures, a higher frequency of hot days, and a rise in the potential evaporation rate [284]. Projections for the Australian monsoon are highly uncertain, with about half the models predicting an increase in rainfall and half predicting a decrease [285]. Some predictions are for severe decreases. For north-western Australia, the intensity of extreme events is projected to increase (although there is a low level of confidence in this) but whether the frequency will change is not clear [286].

Crops are likely to be impacted in complex ways by several aspects of climate change – reduced water availability, rising atmospheric carbon dioxide, higher temperatures and higher vapour pressure deficit [287,288]. The variability and uncertainty of climate impacts undermine the need of largescale irrigators for ‘a consistent and secure water supply to make land productive’ and reduce the ability of growers to guarantee consistency in supply, a necessity under the current market system [202]. Another challenge is that increasing heat stress in the North is likely to lead to population reduction rather than the growth that the White Paper says is necessary [289].

ABATING GREENHOUSE GAS EMISSIONS WOULD ADD TO THE COSTS OF IRRIGATED AGRICULTURE

Irrigated cropping adds substantially to Australia’s greenhouse gas emissions. Although producers do not currently pay to abate these emissions, to achieve net zero by 2050 will require that such emissions be measured and abated. This is likely to add significantly to the costs of cropping, particularly in greenfield sites and for projects requiring water storage. The sources of emissions include land clearing; water storage and delivery; operational activities; fertilisation; and freight.

Clearing tropical eucalypt woodlands and grasslands results in emissions of an estimated 195 ± 44 tonnes of carbon dioxide equivalent per hectare [290]. If offsets were required, this would result in additional costs of more than \$3 million per thousand (based on the most recent auction price by the Emissions Reduction Fund). At a time when reforestation for carbon credits is becoming a financially competitive land use, it seems counterproductive to be clearing yet more land in Australia [291].

The amount of carbon in soil is usually even greater than the amount in vegetation. No data from northern Australia is available, but global estimates are that conversion from savanna to crops reduces soil organic carbon in the upper 30 centimetres of soil by a median of 25% [292].

Greenhouse gas emissions from dams – large, in-stream dams as well as smaller farm dams – mostly come from the release of methane, which is formed when organic matter decays in bottom sediments [293]. Globally, large dams contribute an estimated 7% of greenhouse gas emissions [294].

For irrigated cotton, other emissions (calculated for the Darling Downs in Queensland) include 1.4 tonnes a hectare due to application of agrochemicals, 1.6 tonnes a hectare for emissions of nitrous oxide from soils (due to the addition of nitrogen to the soil), 1.3 tonnes a hectare for electricity and 0.4 tonnes a hectare for combustion of fossil fuels [295].

BOX 4. (CONTINUED)

FREIGHT, FERTILISER AND PESTICIDE COSTS ARE RISING

Fertilisers, pesticides and freight make up a significant proportion of cropping costs, and ‘constantly challenge the sustainability and profitability of the horticultural sector’ in the North [202]. The CSIRO found that freight costs ‘can represent a significant proportion of gross returns’ – for example, rice 18–58%, chickpeas 10–26%, mangoes 8–10%, bananas 17–18%, watermelons 24–27%, cotton 15–57% [296]. Achieving profitable enterprises ‘will be difficult without a pathway for reducing freight costs as a percentage of the value of product’ [262]. Most horticultural produce for export has to be shipped to southern ports and this is not likely to change in the foreseeable future even if there was greatly increased agricultural production in the North [296]. Freight is also ‘a considerable cost burden’ for obtaining essential products such as fertilisers and pesticides [262].

Freight costs have risen rapidly in recent times – due to the effects of the COVID-19 pandemic, rising fuel costs and increased e-commerce. Between January 2020 and March/April 2022, the costs of container shipping from Australia rose by 117% and the costs of international air freight rose by 59% [297]. Between July 2020 and March 2022, oil prices rose by 158% [298]. Across Australia the costs of fuel and fertiliser for cropping industries amount to 22% of production costs. Between January and December 2021 the price of Australian fertiliser imports rose by 128% [298]. The large amount of energy needed to produce fertilisers and pesticides and declining phosphorous stocks will put increasing pressure on prices in the future [299].

The recent rapid price rises in essential inputs indicate the risks faced by developers of large-scale greenfield projects and the significant profit margins needed to justify investment in the face of high uncertainty.

RECOGNITION OF THE ENVIRONMENTAL VALUES AND VULNERABILITIES OF RIVERS IS GROWING

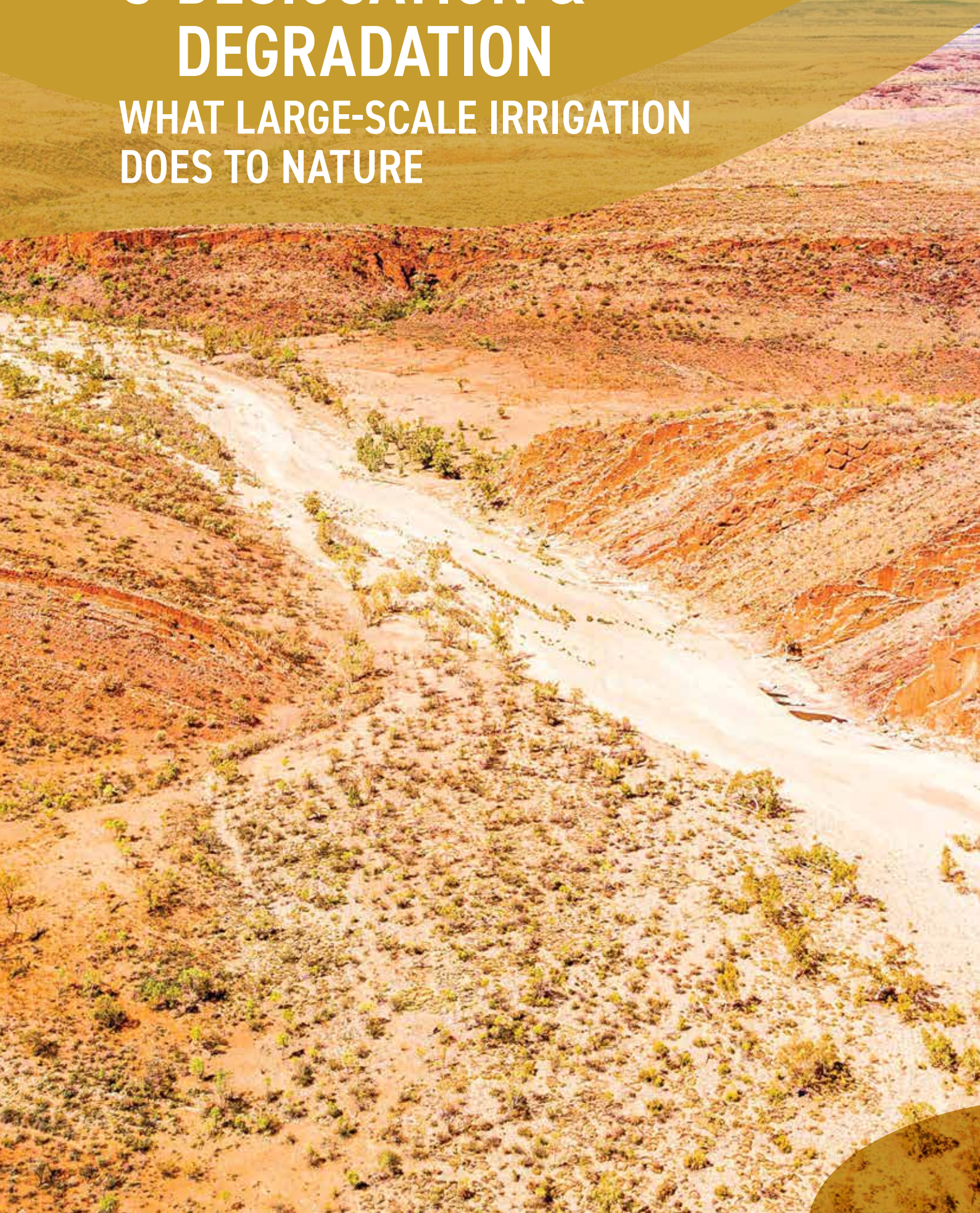
Although irrigation proponents call for less environmental regulation [60, 273], there is increasing recognition that threats in the Wet-Dry Tropics are escalating and biodiversity is declining under current laws and policies (Chapter 5). The Ord River scheme has had devastating environmental impacts, including the likely extinction of a unique turtle species (Box 5). Large-scale irrigated agriculture is a new emerging threat. More rather than less rigorous environmental protection will be needed to avert extinctions and degradation.

RECOGNITION OF THE CULTURAL VALUES AND VULNERABILITIES OF RIVERS IS GROWING

Water resource developments have typically neglected the social, cultural and economic impacts on Indigenous communities, and contemporary management processes still do not adequately involve Indigenous people in decisions fundamentally impacting their lives and cultures [300]. Although irrigation proponents call for looser regulation of cultural heritage [199], there is a growing commitment by governments to strengthen protections – in recognition that the current legal regime has been woefully deficient, as revealed by the destruction of Juukan Gorge [301]. There are also increasing efforts to more fully incorporate Indigenous people’s knowledge of and interests in rivers into environmental research and economic activities [300].

5 DESICCATION & DEGRADATION

WHAT LARGE-SCALE IRRIGATION DOES TO NATURE



5.1. What northern Australians don't want

5.3 Potential impacts of irrigation developments on wildlife

5.2 The environmental impacts of irrigated agriculture

5.1 WHAT NORTHERN AUSTRALIANS DON'T WANT

The Barkandji people have native title rights over and custodial responsibility for one of Australia's most degraded rivers – the Barka (Darling River), in the Murray-Darling Basin. The damage to this river system has been horrifyingly evident in scenes of millions of floating dead fish that made global news in the summer of 2018–19 and again in 2023. They died in 2018–19 from lack of oxygen arising from overextraction and drought [309]; the causes in 2023 are yet to be determined.

In a submission to South Australia's Royal Commission on the Murray-Darling Basin, Barkandji Elder William (Badger) Bates described how it was when he was a boy, 'living beside the river in tents, humpies and tin huts, and moving a lot, getting to know every bend in the river' [310]. The river then 'was always fresh enough to drink and his family would always get a feed of fish, or yabbies, duck or turtle or something'. There were 'birds everywhere', and lots of water rats, river goannas and water dragons. Now, many of the plants and animals 'have gone or are just disappearing'. The water is 'unfit to drink' and signs warn people also 'not to swim, or take fish or yabbies – our river is dying for lack of water', says Badger Bates [310].

In the past, the Barka 'nearly always had water flowing' and when, on rare occasions, the flows stopped, the 'big waterholes were still good'. (Records show that from 1885 to 1950, prior to flow regulation, the Barwon–Darling flowed 92% of the time and mostly kept flowing, even during severe droughts [311].) But in recent times, the river has dried up 'for miles and miles, and this just keeps happening now' [310].

Opposite: A dry creek bed downstream of Glen Helen Gorge, West MacDonnell Ranges, Northern Territory

Credit: Alamy Stock Photo

Brolgas are culturally important to the Barkandji people – ‘Kularku are our relations, they tell us things and they dance for us’ [310] – but are now rare in the Murray-Darling Basin:

‘But now there are seldom any Brolgas in Barkandji country because they need water on the floodplains and swamps for food and shelter for their nests, and these days the floodplains don’t get the water. To MDBA [Murray-Darling Basin Authority] they think it is all OK if there is somewhere where the brolgas can live, but they don’t understand how it breaks our heart if they can’t come and live on Barkandji country like they used to.’

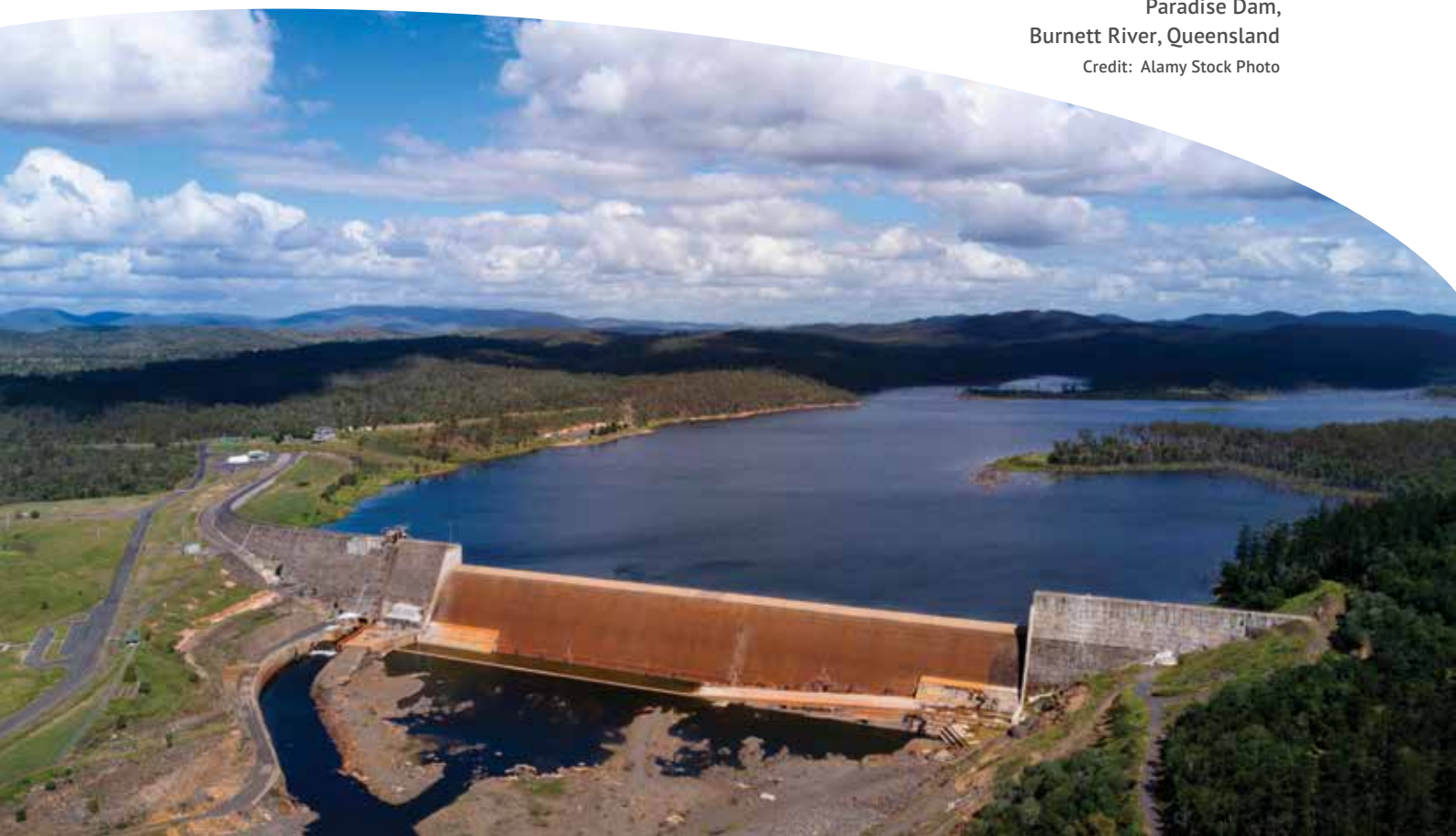
Brolgas still thrive in northern Australia, but are threatened in the Murray-Darling Basin, mainly because so much wetland habitat has been lost [312]. Declining wildlife, fish kills and wetland degradation – these are among the consequences of irrigated agriculture that people in the North want to avoid.

Although damage to the Murray-Darling Basin has resulted from many decades of mismanagement, overdevelopment and overextraction, and northern governments say its lessons will be heeded [188], it is hardly surprising that many people in the North are sceptical in the face of ongoing degradation of the Murray-Darling. Of the 450 billion litres of water meant to be returned to the system by 2024 under the \$13 billion basin plan, less than three billion litres (about 0.5%) had been delivered by August 2022 [313].

Although humans have practised irrigation for more than 5,000 years, it has rarely been sustainable, said the CSIRO’s Northern Australia Land and Water Science Review of 2009 – and yet we persistently pretend that it is [314]. This pretence is problematic, the authors say, because we keep repeating the avoidable errors of previous irrigation developments.

Are there any major irrigation precincts in the world where the industry has not substantially altered the character of aquatic ecosystems and caused serious environmental harm? Unless governments can point to where this has been achieved, people cannot be expected to believe it is possible. In a search of the academic literature, we have not been able to find any such exemplars. While some schemes have sustained agricultural productivity and brought economic benefits, this has almost inevitably come at significant environmental cost [315,316]. Said the then-director of the Salinity Laboratory with the US Department of Agriculture [315]:

Paradise Dam,
Burnett River, Queensland
Credit: Alamy Stock Photo



‘We know enough about how to manage irrigated land so that we can keep it productive indefinitely. But we are kidding ourselves if we say we can do that without some environmental insult. And whether we’re willing to pay that price is a political decision...’

In this chapter, we briefly consider some of those *environmental insults* – the avoidable and unavoidable impacts of irrigated agriculture, for which there is a voluminous literature.

5.2 THE ENVIRONMENTAL IMPACTS OF IRRIGATED AGRICULTURE

As a dry, drought-prone country with a thin moist margin, highly variable river flows, and weathered, infertile soils, Australia is ecologically and climatically poorly suited to large-scale irrigation [317]. Despite that, most rivers suitable for dams have already been dammed, with a capacity to capture about 23% of annual runoff [317,318]. So fervid has been the dam-building, mostly since the mid-1950s, that dams in the Murray-Darling Basin can between them store more than 100% of the basin’s average annual runoff [66]. Irrigators are Australia’s biggest users of water, typically accounting for 60 to 70% of total use (in 2020–21, about 7,800 gigalitres) [243,317–319]. Water users in all Australian sectors (domestic, industrial, agricultural) are inefficient – for cropping, the water footprint exceeds the global average [317].

The evidence in Australia is overwhelmingly that large-scale irrigated agriculture is highly damaging to the environment. Of about 2.3 million hectares of irrigated agricultural land in Australia, almost two-thirds (up to 1.5 million hectares) is in the Murray-Darling Basin, an acknowledged and much-analysed environmental disaster [187]. As one index of damage, more than half the floodplain wetlands on developed rivers may no longer flood, while others have been turned into permanent water storages [66]. Figure 13 shows the particularly high levels of disturbance in the catchments of south-eastern Australia. The Northern Australia Land and Water Science Review warned that the many problems of irrigation – ‘including salinisation, local-scale waterlogging, nutrient depletion and the degradation of surrounding landscapes’ – typically take a long time to manifest and ‘even longer to ameliorate’, if amelioration is even possible [314].

The one major dam in the North, on the Ord River, proceeded without any environmental assessment or baseline studies, so precisely defining the impacts is not possible, but severe damage is evident (Box 5).

A more recent irrigation development, and Queensland’s biggest, was the damming of the Burdekin River in 1987 to provide water mainly for growing sugar cane (about 100,000 hectares) on the delta and coastal floodplain [258,321]. Unlike many older dams, this one was built on the basis of a comprehensive environmental impact assessment. It predicted the dam would have good water clarity and would even improve river clarity to the coast. But the opposite has resulted – the water is now ‘almost permanently turbid’ [322]. The Burdekin Dam traps almost all the sand washing in from the catchment, depriving the coast of material for maintaining a peninsula that protects a Ramsar-listed wetland. Polluted waters now drain into these wetlands, and nutrients from irrigated crops are degrading the Great Barrier Reef, driving outbreaks of coral-eating crown-of-thorns starfish [322]. The water table in irrigated areas is rising, threatening land salinisation. Despite these problems, there are now proposals to raise the dam wall and construct another dam on a tributary to the Burdekin [323].

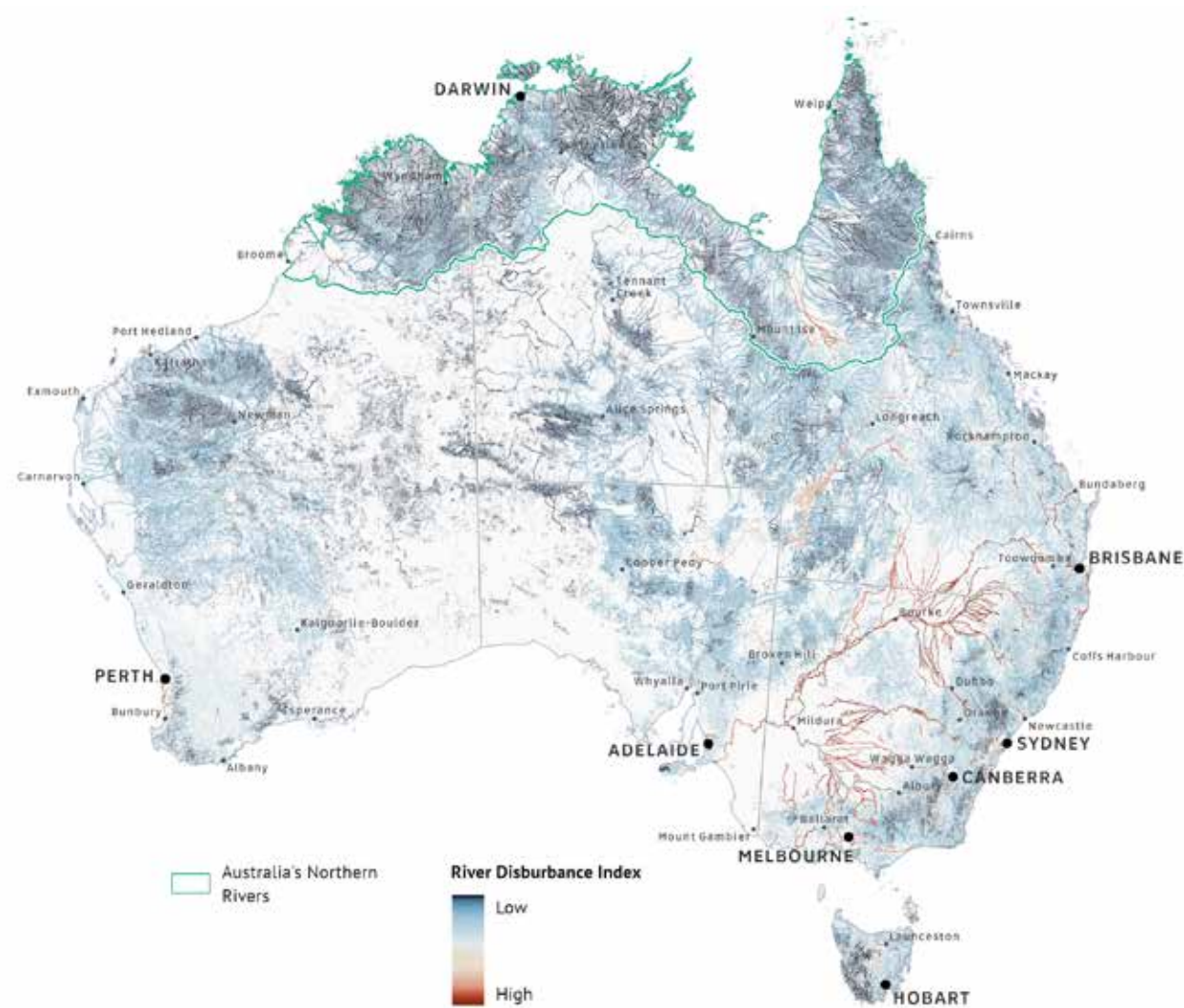


FIGURE 13. Levels of disturbance in catchments across Australia

Source: Stein et al. 2012 [322]

Notes: This map is based on attributes describing the natural and anthropogenic characteristics of the stream and catchment environment. The attributes contributing to the disturbance index include the degree of river connectivity, vegetation clearance, pollution and intensive land uses.

Globally, the consequences of irrigated cropping have been catastrophic for biodiversity [324–327]. Upstream of a dam barrier, a flowing river becomes a deep lake, ‘a hostile environment’ for many riverine organisms, while downstream the river is often starved of flow [328]. These new habitats often favour invasive fish and weeds. Invasive carp are now the dominant fish in the Murray-Darling Basin, making up 90% of the fish biomass in some areas [329]. A dam wall becomes an impassable barrier or impedance for many fish and other animals, and traps sediment and nutrients [328]. Globally, migratory fish populations have reportedly declined by 76% since 1970 and almost a quarter of global annual sediment flux is trapped behind dams [330–332].

Wetlands are often drained, drowned or wetted much less frequently and floodplains are turned into terrestrial habitats [66,324]. In the Murray-Darling Basin, the large, Ramsar-listed Barmah-Millewa redgum forest has lost about half its former wetland extent [324]. In the Ord River catchment, most of the wetlands on the lower floodplain have permanently dried [333].

CSIRO modelling of the potential impacts of proposed dams in the assessed northern catchments reveals likely severe impacts on floodplain wetlands [334]. Construction of the Pinnacles Dam in the Mitchell River catchment would result in major (>20%) losses of wetland connectivity, and the proposed Mount Bennett Dam in the Finnis catchment would reduce connectivity by more than 20% in larger floods. This would mean less habitat for fish, birds and other aquatic wildlife and reduced productivity due to less carbon and nutrients [334]. Production of algae on the Mitchell River floodplain, an estimated 85 tonnes a day [335], could decline by up to 26% with water resource development [336]. Algae are critical to northern aquatic foodwebs, with some 42–97% of fish biomass in river systems coming from foodwebs based on floodplain algae [37,335].

Irrigated cropping often necessitates land clearing, which destroys habitat and emits greenhouse gases. Approvals for land clearing on pastoral properties in the Northern Territory have surged more than 10-fold in the past decade, from an average of about 1,000 hectares a year in 2010–2015 to more than 20,000 hectares a year in the subsequent six years, for a total exceeding 120,000 hectares [203].

Cotton being harvested
Credit: Alamy Stock Photo



BOX 5. SOME CONSEQUENCES OF DAMMING THE ORD

Since being dammed, Gunanurang (the traditional name of the Ord) is a much more sedate river. It no longer flows by the seasons but all year round – tamed to provide water for crops and drive turbines for electricity [346]. It floods less often and less extensively, and peak flows are much lower.

When the Ord was dammed – creating the largest impoundment in the southern hemisphere, fluctuating between 9 to 20 times the size of Sydney Harbour [347] – there were no requirements for environmental surveys and impact assessments. So, it's not clear exactly what has been lost. But the absence of largemouth sawfish and the much lower banana prawn populations than in other northern estuaries hint at the ecological tumult that has followed the imposition of new flow regimes [32]. Migratory animals such as barramundi, ox-eye herring, bull shark, pony fish, mullet, tailed sole, scaley croaker, largemouth sawfish, freshwater whiplay and spotted scat have lost about three-quarters of their former Ord River range [333].

The damming and subsequent changes to the landscape may have caused the demise of a turtle unique to the catchment, perhaps Australia's first reptile extinction – Kuchling's long-necked turtle, not recorded since 1974 and assessed in 2022 as 70% likely to be extinct [123,124]. Changes to the floodplain, which established 'open channel connectivity' close to the Victoria River catchment in the Northern Territory, may have facilitated the spread of a related, widespread turtle, the northern snake-necked turtle, into the Ord catchment and hybridisation with and loss of the rare local turtle [123].

Some changes to the river are obvious. The river channel has infilled, the banks have eroded, the overlap of fresh and salty water has shifted downstream, and there is now permanent water upstream of the wall [346]. Nutrient levels are higher than in other perennial rivers in the north, presumably leached from fertilised crops. Much of the former floodplain no longer floods. Only a small part is now inundated by a 1-in-10-year flood, and the probability of the lower floodplain being inundated has declined from 1-in-2 years to 1-in-67 years [333].

However, as is the case for many environmental changes, some species have benefited. The creation of a large body of water and perennial river flows has created new habitat for waterbirds and, for that reason, the two artificial lakes have been listed as Ramsar wetlands.

The Traditional Owners of the Gunanurang region, the Miriuwung and Gajerrong peoples, who were ignored during the dam decision-making processes, have suffered 'massive losses' [348]. Until the damming, they had been able to maintain traditional livelihoods while also working on pastoral stations [347]. They maintained kin connections and trade relations by travelling up and down the Ord, as recounted by a Traditional Owner [347]:

'We used to walk to every station. It took two days to go from here to Dunham River, three days to Lissadell, two days to Argyle, one day to Newry, and one day to Carlton.
But I belong to this country...'

The dams flooded large parts of Miriuwung and Gajerrong country and ended tens of thousands of years of human occupation. They lost sacred sites, cave shelters and graves [333]. The diversion dam was built on an important cultural site known as Darram (Bandicoot Bar).

It took many years of struggle and negotiation for the Miriuwung and Gajerrong peoples to have their custodianship of the Ord recognised by the Western Australian Government in the form of an Indigenous land use agreement in 2006 [347]. The agreement provides native title consents and heritage clearances over 65,000 hectares of land for expanding the Ord irrigation scheme [349]. It provides for the co-management of conservation areas and a waterscape reserve (100,000 hectares of wetland), compensation for loss of native title due to land appropriations for irrigation and community development initiatives. It does not include a water allocation.

A significant proportion of recent clearing is either explicitly linked to cotton developments or likely to be in anticipation of future cotton projects, and some has probably been illegal [203,337].

Removal of native vegetation alters soil and catchment hydrology, amplifies flood events and accelerates soil erosion, leading to increased sedimentation in waterways [338]. For example, the mean annual soil loss for tilled areas in the Daly River catchment is 1.9–8.1 tonnes a hectare compared to 0–2.8 tonnes a hectares in undisturbed areas [338]. Other hydrological impacts include reduced groundwater recharge, reduced baseflow discharge and increased incidents of fish kills [267,339]. Wetland loss due to land clearance for cropping has been a major problem throughout eastern Australia [339].

Broadacre irrigated cropping is likely to also reduce water quality, potentially risking human and ecological health – due to the industry's substantial use of fertilisers and biocides (herbicides, fungicides and insecticides) [203]. Government surveys of the Daly River have detected nine different pesticides, mainly herbicides, in groundwater and dry season flows [340]. Atrazine – 'very toxic to aquatic life with long lasting effects', according to safety information [341] – was the most common contaminant, found in 15 of the 25 bores tested. Crops such as cotton require large inputs of nitrogen in most northern areas [342]. And with naturally very low nutrient levels, northern rivers are highly susceptible to pollution by fertilisers, which can cause eutrophication, algal blooms and other changes to the aquatic flora [338,343].

This is a time of escalating pressures on nature, including in the Wet-Dry Tropics, despite its apparent intactness. Several mammal species are in precipitous decline [77,138,344] and tropical savannas are one of 19 Australian ecosystems considered at risk of collapse – 'potentially irreversible change to ecosystem structure, composition and function' – due to climate change and multiple regional impacts such as invasive species and habitat loss [139]. Preventing land clearing and limiting water extraction will be essential to optimise the resilience of the savannas to climate change impacts [345]. A major new irrigation industry is likely to severely undermine resilience.

5.3 POTENTIAL IMPACTS OF IRRIGATION DEVELOPMENTS ON WILDLIFE

Rivers are often accused of being wasteful, with thousands of gigalitres flowing each year uselessly into the ocean, kept from productive use by green tape [350]. The studies to date show the contrary – that the massive flows are essential for maintaining the high diversity of life in northern rivers. As the Martuwarra Fitzroy River Council says [13]:

'All the water that makes up these flow regimes is already allocated to Traditional and environmental uses and values – it sustains people and places, plant, animal and fish populations and customary harvestable production, and community and spiritual connections.'

The peak floods that occur only every few years are essential for the recruitment of largemouth sawfish and important also for barramundi recruitment. Other fish have different flow requirements, with dry-season spawners benefiting from drier years and wet-season spawners from wetter years. It is in part the variability of flow regimes that maintains high levels of diversity. A reduction in total annual flows by even 10% can be significant for some species in some years [351]. But whether and how it would impact on particular species is uncertain due to insufficient information on most of the species that would be appropriate to model the likely changes.

The following information details a very few northern river species for which there is some information about flow-ecology relationships – barramundi, largemouth sawfish, prawns, cherabin and small fishes.



Australian barramundi (*Lates calcarifer*)
Credit: Shutterstock

BARRAMUNDI

As an abundant predator, barramundi are ecologically influential. They are important for Traditional Owners, culturally and as food, and probably the most important fish for recreational and commercial fishers in northern Australia [12,351,352].

Barramundi are sequential, protandrous hermaphrodites – developing initially as males and then becoming females (typically at 700–900 mm) [1,353]. Because size rather than age determines this sex change, faster-growing barramundi probably make a ‘disproportionate contribution to population fecundity’ [353].

Studies in Northern Territory rivers have identified three different barramundi life history strategies: (a) some live mainly in coastal and estuarine habitats, perhaps with occasional forays into fresh water; (b) others migrate into fresh water as juveniles and return to the estuary after a few years to spawn initially as males and later as females; and (c) others remain in fresh water for many years, returning to the estuary only as large females [1].

The migratory tactics pursued by individual barramundi are probably heavily influenced by river flows, as well as body condition and predators, with trade-offs between the faster growth that can be achieved in fresh water and the higher mortality and energy costs of migration [1].

Barramundi recruitment and growth are highest when the monsoon is strong and river flows are high, although the specifics of flow-recruitment relationships appear to be particular to each river system [351,354–356]. High flows may be important for extending access for juveniles to highly productive floodplain habitats, improving food-web productivity, increasing the availability of nursery habitats, and enhancing the downstream migration opportunities for mature fish [351,354,355].

Therefore, barramundi may be ‘especially vulnerable to hydrologic disturbance’ [1]. Water extraction has the potential to reduce recruitment and alter the frequency of the three different life history strategies [1]. If, as a result, more barramundi adopt the slower-growing, estuarine life strategy, ‘the productivity of barramundi fisheries and their ability to sustain fishing pressure may be adversely affected’ [1].

Modelling of barramundi recruitment in the Daly River found that extraction of 10% of wet season flows would substantially reduce predicted year-class strength across all years [356]. Modelling for the Mitchell River predicted smaller barramundi if river discharge was reduced – a 12% lower growth rate



Largetooth sawfish (*Pristis pristis*)
Credit: Yves Lefèvre-BIOS/AUSCAPE

for an 18% reduction in discharge and 8% lower for an 8% discharge reduction [357]. Under a major water development scenario (6,000 gigalitres extraction), three-year-old barramundi would be on average about 19% smaller [358].

Water extraction could also reduce the resilience of barramundi to the impacts of climate change. Because barramundi are highly vulnerable to changes in monsoonal strength or frequency, barramundi researchers recommend ‘a conservative approach’ to water and fisheries management until these changes can be predicted with some confidence [351].

Another potential impact on barramundi from irrigation is reduced water quality due to the use of pesticides. Pesticide residues are ubiquitous in north Queensland’s rivers and the Great Barrier Reef lagoon and often above Australian guidelines in water near areas of intensive cropping. Health indicators for barramundi in north Queensland rivers are lower in agricultural regions than in more-natural areas [359]. Genetic material for immune functions was found to be less abundant in barramundi from 3 rivers in intensively cropped catchments than from two rivers in areas with much less cropping – indicating altered immunity or a stress response to pesticides. Atrazine, a herbicide banned in 60 countries but widely used in Australia, is the most commonly detected pesticide in rivers discharging into the Great Barrier Reef lagoon [360,361]. Experiments have shown that one of the effects of short-term exposure to atrazine is a reduced androgen-to-estrogen ratio in juvenile barramundi [360]. Although it’s not yet known whether this impairs sexual development, researchers warn that chronic exposure to pesticides ‘may be sufficient to ultimately influence sexual and reproductive development and thus population dynamics of fish species’ [360].

LARGETOOTH SAWFISH

More largemouth sawfish have been documented in the Martuwarra Fitzroy river system than in any other system globally [9]. For up to at least 450 kilometres inland, the Fitzroy and tributaries serve as a nursery for juveniles in their first four to six years of life [9]. They have also been found in 19 other northern rivers [362].

To survive the dry season, largemouth sawfish need sufficient water in the river to maintain habitable pools, while for recruitment they need very high flows, at levels that occur only every few years in the Fitzroy system [9]. There, they also need high flows to cross the Camballin barrage to access upstream habitats [363]. From 2002 to 2018, researchers in the Fitzroy recorded high levels of recruitment in

only two of the 17 years (12%) and moderate levels in one year [9]. These peak flows may be needed to enable young sawfish to swim through estuarine pools into freshwater reaches, potentially by passage through floodplain habitats. When water levels are lower, the young may not have enough energy to cross shallow riffle zones with high water velocities and may become trapped in the estuary, where there are more predators and competitors. In the years when sawfish are unable to migrate upstream, overall recruitment to the Fitzroy River nursery is 'likely negligible' [9]. Water extraction would also reduce the frequency with which largemouth sawfish can cross the Camballin Barrage, limiting their access to deep-water pool habitats [364].

Even 'slight deviation' from the natural flow regimes of the Fitzroy could be detrimental to sawfish populations [9]. Water extraction is likely to exacerbate the impacts of climate change arising from increased flow variability between years and intensifying dry season conditions due to rising temperatures [6], and irrigated cropping is likely to reduce water quality due to leakage of pesticides and fertilisers.

BANANA PRAWNS

Banana prawns are the basis of an important commercial fishery, the Australian Northern Prawn Fishery [367]. Although caught in the ocean, their catchability relies on freshwater flows [8]. Adults spawn offshore and their larvae drift with currents to shallow waters, where they live for 4–6 months. Their ability to osmoregulate (internally balance water and electrolytes) then changes and wet season floods force them to move from their estuarine nurseries into the ocean, where they mature and become available to the fishery. Otherwise, the prawns stay near to shore. High flows may benefit banana prawns in deeper waters by stimulating production at the base of their food web and creating turbidity, which helps them avoid predators [8].

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Water extraction could undermine the migration cue in some years [8]. Modelling for the Mitchell, Gilbert and Flinders rivers predicts that extraction of 825 gigalitres in the low-flow scenario that was tested would reduce the catch by 17%. The impacts would be even greater with dams on the Mitchell River, with catches predicted to decline by 53% during a year with low flow [8]. This would undermine the livelihoods of many fishers.

CHERABIN

Cherabin (also called giant freshwater prawns) and other migratory shrimps are ecologically influential in tropical river systems – often dominating macroinvertebrate communities. They are important prey for many fish and influence the growth, abundance and structure of bottom-growing algae [366]. Growing up to 26 centimetres long, they are also an important food for Indigenous and non-Indigenous residents [367].

The cherabin life cycle has been studied only in the Northern Territory's perennial Daly River. Larvae are produced during the wet season along the length of the river and then drift to the estuary to feed and moult. The wet-season floods need to be large enough for larvae to rapidly reach the estuary, within 5–7 days, some from more than 400 kilometres away; otherwise, they die [7]. At the end of the wet season, when the cherabin migrate upstream, the flows need to be substantial enough to connect pools. More than 10 million cherabin migrated upstream in the Daly in 2013 and 2014. Water extraction would impact cherabin if it slowed their downstream drift to the estuary or limited the extent of their upstream migration [7].

SMALL FISHES

The life histories of many small fish in the northern rivers are 'intricately linked with cycles and magnitude of flooding' [368]. The variability of flow regimes maintains high levels of diversity – drier years foster the recruitment and growth of species that spawn in the dry season, and wetter years foster spawning by wet-season spawners. Therefore, long runs of very dry or very wet years – or water extractions that moderate flow variability – could hinder the ability of one or the other group to reproduce, resulting in assemblages dominated by either dry-season or wet-season spawners [368].

The major driver of the recruitment and growth of wet-season spawners and bony bream (a perennial spawner) is the duration of moderate-to-low flow periods at the end of the wet season and the start of the dry. Shorter transition periods due to water extraction are therefore likely to limit replenishment of their populations while benefiting dry-season spawners [368].

When water levels drop due to extraction, shallow billabongs or creeks, which have high densities and diversity of small fish, are particularly susceptible to drying or declining in water quality. But under water allocation rules, the focus is typically the water depths of main channel pools, which may not correlate with the depths of smaller creek and billabong habitats [368].



Banana prawn (*Penaeus indicus*)
Credit: Alamy Stock Photo

Cherabin (*Macrobrachium rosenbergii*)
Credit: Alamy Stock Photo

6 CUSTODIANSHIP & CONSERVATION

NEW WAYS OF TURNING AGE-OLD RESPECT FOR RIVERS INTO LAWS

- 6.1. How a major new cropping industry can just happen
- 6.2. Australian water laws and governance processes
- 6.3. Mechanisms to protect intact rivers
- 6.4. River governance – whose views, values and voices should count?

6.1 HOW A MAJOR NEW CROPPING INDUSTRY CAN JUST HAPPEN

The Daly River is a rarity in the North – one of a handful of major rivers with perennial flows, sustained by groundwater, with dry season flows five times larger than those of any other Northern Territory river [369]. It supports vast wetland areas, unique ecological communities and rich, diverse wildlife, including some 90 fish species [370]. Extensive parts of the Daly and Katherine rivers and floodplains are listed as nationally important wetlands [371] and the estuary and lower floodplains meet criteria for listing as a Ramsar wetland of international importance, because of the abundant waterbirds [371].

The Daly is also the centre of a proposed large-scale cotton industry, which is proceeding piecemeal – application-by-application for land clearing and water licences – without any process for determining whether the industry is compatible with the natural, cultural and social values treasured by people, or whether it is supported by Traditional Owners on their traditional lands.

The Northern Territory Government and irrigation industry say most cotton cropping (about 80%) will be dryland (not requiring irrigation) [372,373] – but whether this is viable, given the unreliability of rainfall and the much lower yields of dryland cotton, is dubious. Even 20% irrigated would require substantial volumes of water from an already overallocated system. In two aquifers underlying the Daly River catchment the water granted under licence exceeds the government's estimated sustainable yield, and water from a third aquifer is being allocated despite the lack of an estimated sustainable yield or water allocation plan [283,374,375]. Water planners acknowledge they do not have a high level of confidence in estimates of sustainable yield [376].

Industry proponents have claimed there is potential to harvest 500 gigalitres of flood waters from the Daly system [377] (more than triple the volume of water already allocated), hinting at an intention for much larger-scale irrigation than professed and overlooking the interconnectedness of surface and subterranean waters and the vital ecological role of peak floods. The seasonal inundation and drainage of tropical floodplains are thought to be 'the primary drivers of ecological processes' in large floodplain rivers [378]. Flooding triggers a dramatic surge in primary productivity, providing 'the energy that fuels aquatic food webs.' About 60% of the fishes recorded in the Daly River, including barramundi and sawfish, use floodplain habitats [379].

But regardless of whether cotton is irrigated or dryland, the industry will lead to large-scale habitat destruction. To meet the industry forecasts of cotton production in the Northern Territory would likely require the availability of 100,000–150,000 hectares of cleared arable land in the short term and 400,000–600,000 hectares in the longer term (including areas for crop rotation and fallowing) [203]. In 2003, because of concern about development pressures driven by the cotton industry, the Northern Territory Government imposed a moratorium on land clearing in the Daly Basin, pending completion of an integrated regional land use plan [338,345]. But catchment planning, initiated in 2011, was abandoned when the government changed [380,381]. Since then, clearing in the Daly Basin has surged.

Under current water laws and decision-making processes in the Northern Territory, it seems that the cotton industry will be allowed to proceed without consideration of cumulative impacts – on nature, culture and the existing industries that rely on healthy rivers (recreational and commercial fishing, nature tourism and cultural tourism). And, as has happened elsewhere [187], including in states with more rigorous laws than the Northern Territory, it seems likely that over time the powerful irrigation lobby will ratchet up demands for water and clearing approvals.

In this chapter, we consider the current adequacy of laws and policies for river protection and the options for strengthening these. Gaining momentum globally is the creation of laws that prioritise the protection of the natural values of rivers, and sometimes also their cultural values. There is also a growing global movement to restore Indigenous cultural authority over river management, typically in co-governance arrangements with governments. New models of river governance are being developed in New Zealand, Canada, the United States, Spain, Colombia, Peru, Ecuador, Chile, Bolivia, India and Bangladesh [181,382–388].

6.2 AUSTRALIAN WATER LAWS & GOVERNANCE PROCESSES

LACK OF FOCUS ON RIVER PROTECTION

With rare exceptions, Australian water laws and policies do not provide for the holistic protection or management of rivers as rivers. Instead, based on narrow perceptions of riverine ecosystems as water resources, they are mostly focused on enabling and managing extraction for economic purposes (section 3.3). Apart from Queensland's *Regional Planning Interests Act 2014*, which protects some rivers in the Gulf and Cape York Peninsula regions (and further south in the Lake Eyre Basin), there are no legal frameworks in the North for protecting the optimal ecological functioning of intact rivers. The only other rivers safe from large-scale extraction are those encompassed by protected areas or in catchments where land is not suitable or available for irrigated cropping. As outlined in section 4.2, numerous catchments – the Daly, Roper, Adelaide, Finnis, Mary, Wildman and Victoria in the Northern Territory; the Fitzroy and Ord in Western Australia; and the Mitchell, Flinders and Gilbert in Queensland – are the focus of feasibility assessments or proposals for new or expanded irrigated cropping.

Over the past four decades, Australian governments have undertaken major reforms of water laws, policies and processes. They were driven to it mainly by *extreme urgency* – as responses to a succession of environmental crises in the Murray-Darling Basin: toxic algal blooms, salinisation, overextraction exacerbating the impacts of severe drought, wetland degradation and lack of flow to the sea [187].

The latest reforms, precipitated by the Millennium Drought, include the 2004 Intergovernmental Agreement on a National Water Initiative, the federal *Water Act 2007* and the 2012 Murray-Darling Basin Plan. The National Water Initiative has driven many improvements – particularly the requirement for planning to underpin water allocations, statutory caps on extraction and protection of environmental flows. However, of the three governments across the north, only Queensland has a requirement for water plans and statutory protection of environmental flows [389]. These are reforms essential for limiting harmful exploitation but not for optimally protecting riverine and floodplain ecosystems.

The implementation of reforms has been seriously deficient in the Murray-Darling Basin, as outlined in a recent analysis by a South Australian Royal Commission – mainly due to 'failures in good and proper governance', including a disregard of law, lack of transparency, and failures to meaningfully involve Traditional Owners in decision-making [187]. The Royal Commission found that the Murray-Darling Basin Authority, in an 'attempted appeasement of irrigation communities and vested political interests' has 'adopted an approach that is fundamentally inconsistent with the requirements of the Water Act and the best available scientific knowledge'. The failures have led to a 'manifest lack of trust' by communities in the Murray-Darling Basin and by scientists [187]. They also serve as a powerful warning to northern communities about the preparedness of governments to elevate the interests of the irrigation industry above those of Traditional Owners, other farmers, fishers, conservationists and the environment.

The refrain of governments in the North is that they know how to avoid a Murray-Darling Basin disasters. The Western Australian Government says its water allocation policies 'have been designed to address many of the concerns raised regarding managing water in the Murray-Darling Basin' [188].



Tourism industry along the Daly river
Credit: Jason Fowler

It is true there are substantial differences between river management in the Murray-Darling Basin and that for the rivers of Australia's North. The irrigation industry has been established a long time in the Murray-Darling and much damage was caused long before modern environmental regimes and any commitment to 'environmental flows'.

But there are sound reasons for concern that embarking on a substantial irrigation industry in the North will put some catchments on a Murray-Darling trajectory, for many of the same hallmarks of poor governance are evident there – in particular, the powerful influence of the irrigation industry and the contrasting limited role for Traditional Owners and community stakeholders. Because of high capital costs, big business will dominate the irrigation industry and future governments are likely to yield to pressure from influential investors – as has occurred in the Murray-Darling Basin [390,391].

With rare exceptions, Australian water laws and policies do not provide for the holistic protection or management of rivers as rivers. Instead, based on narrow perceptions of riverine ecosystems as water resources, they are mostly focused on enabling and managing extraction for economic purposes.

'The tyranny of incrementalism ... must end', said then Prime Minister John Howard in 2007 when his government embarked on reform of the Murray-Darling system [392]. But incrementalism remains inherent to the current policy frameworks for most exploited rivers, with processes focused on project-by-project, piecemeal assessments, which are notoriously poor at considering cumulative impacts. Although the current water allocation processes are far more sophisticated than the approaches that led to the environmental and cultural catastrophes of the Murray Darling Basin, they still perpetuate many of the same underpinning values and perceptions of rivers. The damage starts, and the systems that support it become entrenched long before a river reaches crisis point.

A major weakness of water laws in Australia is that they do not distinguish between exploited rivers and intact rivers. It is mostly assumed that it is desirable to facilitate irrigated agriculture wherever feasible. This is despite the National Water Initiative specifying that 'surface and groundwater systems of high conservation value' should be identified, and these systems managed 'to protect and enhance those values'. Australia mostly lacks effective policy mechanisms for achieving this, with high values often treated as hurdles for irrigation projects rather than as priorities for protection.

LIMITED RECOGNITION OF INDIGENOUS INTERESTS

The National Water Initiative was the first policy by Australian governments to expressly recognise the interests of Indigenous Australian in water issues. The agreement says that governments should provide for Indigenous access to water resources; include Indigenous representation in water planning; incorporate indigenous social, spiritual and customary objectives into water plans; and take account of the possible existence of native title rights to water. However, these principles are discretionary and, as the Royal Commission found, Australia's water laws 'do not provide for or clearly recognise Aboriginal values and interests in water' [187]. A 2021 review by the Productivity Commission found that progress against these commitments has been slow [389].

Exclusive possession native title, which is rarer, does not include control over water, but does allow native title holders to refuse access to a water source from their land. Such rights can be recognised under the *Native Title Act 1993* or under a state/territory law such as the Northern Territory *Aboriginal Land Rights Act 1976*. Australia has the 'least formal recognition' of Indigenous water rights of any colonised country [393]. The traditional rights to water under the laws and customs of Indigenous Australians still exist – they have not been ceded – but the Australian legal system mostly does not recognise them [394]. Initially, it was assumed that the *Native Title Act* would be 'the main avenue for securing Aboriginal water interests' [157]. But although rights to water have been recognised for some river lengths, they have been mainly of a non-exclusive nature for 'satisfying personal, domestic, social, cultural, religious, spiritual or non-commercial communal needs' [394]. Exclusive possession native title, which is much rarer, entitles the rights holder to control access to water from their land, but not to exclusive possession of water.

Amendments to the *Native Title Act* have made it difficult for claimants to obtain more substantial interests in waters. Although healthy rivers are essential for maintaining many native title rights, the *Native Title Act* validates water laws regardless of their potential impact on native title (Box 6). Compensation may be payable in some circumstances, but this hasn't been tested.

Fitzroy Bluff, Western Australia
Credit: Annabelle Sandes / Kimberley Media



The Darling River near Wilcannia, New South Wales
Credit: Lincoln Fowler

The Northern Territory has provided for strategic Indigenous reserves under some water allocation plans. These are intended to provide water to help Traditional Owners realise economic aspirations, but mostly lack any allocation, in part due to prior overallocation, and they do not provide the means for Traditional Owners to protect cultural values [203]. The Western Australian Government also proposes to establish Indigenous water reserves, but also only for economic purposes while allocating much larger volumes to irrigators and other industries [188]. The commercial value of such reserves would depend on the degree of industry competition for water (if the water can be sold) or the financial resources available to Traditional Owners to develop it themselves. With the high capital costs of irrigation development, such a resource is unlikely to benefit many Traditional Owners. There is a risk that a strategic reserve could be misinterpreted by governments as a primary means to recognise Traditional Owner rights and interests in water and therefore constrain future opportunities to strengthen cultural water rights.

In 2007 the Murray and Lower Darling Rivers Indigenous Nations introduced the concept of 'cultural flows' in the Echuca Declaration – as one way of gaining legal and practical recognition of their interests in rivers [187]. Cultural flows were defined as:

'Water entitlements that are legally and beneficially owned by the Aboriginal nations and are of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Aboriginal nations; this is our inherent right.'

The concept has been incorporated into the Murray-Darling Basin Plan, but only to require consultation about cultural flows when the states prepare water resource plans. Meagre volumes of water have been allocated so far for cultural flows [136,395,396]. The 'elephant in the room', said the Royal Commissioner, is 'where will water for cultural flows come from, in a largely overallocated system?' An Australian Government commitment in 2018 to spend \$40 million buying water entitlements for Aboriginal people for economic and cultural outcomes in the Murray-Darling Basin has not yet proceeded [397,398].

OTHER DEFICIENCIES OF DECISION-MAKING

Other reforms are needed to rectify long-recognised deficiencies in decision-making processes about water-based developments.

The Northern Territory and Western Australia lack robust, transparent processes for determining water allocations and granting licences. Neither has implemented the requirement under the National Water Initiative for statutory water plans with provisions for the environment [389]. In the Northern Territory, only 28% of licenced water entitlements are based on water allocation plans [399]. Even where there are water plans, these are not binding on decision-makers. Decision-makers have broad discretion to issue water licences. In the Northern Territory, the Water Controller is only required to 'take into account' factors such as the availability of water, applicable water allocation plans and water quality, which means they can be ignored.

A major weakness of water laws in Australia is that they do not distinguish between exploited rivers and intact rivers.

Water plans often lack a robust methodology and evidence for determining environmental and cultural flow requirements [399]. The Northern Territory's most recent water allocation plan (for the Georgina and Wiso basins) has been described by 18 water experts as 'particularly poor and regressive, putting at risk many significant environmental and Indigenous values' [400]. It does not establish environmental or cultural requirements for water or trigger rules for assessing unacceptable impacts.

Another deficiency is a lack of planning and legal mechanisms across the North to integrate land and water management. Decisions about water allocations are often made in isolation from consideration of the cumulative environmental, cultural, social and economic impacts of the resulting developments across catchments. The lack of comprehensive integrated catchment planning fosters 'shifting baseline syndrome' [401], whereby developments are considered only as changes to the existing condition of species and habitats rather than as part of the trajectory of change since colonisation and into a climate-altered future. It also leads to neglect of the concerns and aspirations of people living in the catchment and those with traditional custodial responsibilities for land and water.

REASONS TO SEEK A NEW APPROACH

There are strong reasons for northern communities to seek new approaches to river and water management – to strengthen protection for riverine ecosystems and reform decision-making processes. There is widespread community distrust in decision-making processes, which often seem weighted in favour of the irrigation industry, as well as scepticism about the touted benefits of a large-scale irrigation industry. Current water laws and policies do not reflect the ways that many people perceive and value rivers – as much more than an economic resource. This is particularly the case for Indigenous Australians, whose worldviews are poorly understood and ignored in policy (section 3.4). The cultural importance of water is often acknowledged but ignored in river management and water allocation. The rights of traditional custodians, both legal and moral, are poorly recognised and they are accorded little influence in decision-making processes.

But it doesn't have to be this way – and recent reforms around the world provide examples of alternative approaches.

6.3 MECHANISMS TO PROTECT INTACT RIVERS

In the United States, a collection of exceptional rivers has been 'spared from biological wreckage' [405]. In what now seems unthinkable, in 1968 the US Senate voted unanimously to pass the *Wild and Scenic Rivers Act* while the House of Representatives voted 265 to 7 in favour [406]. It enabled the preservation of rivers with 'outstandingly remarkable' qualities for 'scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values' – as a counterbalance to the 'untempered and frenetic' dam-building of the time [405]. It was also motivated by a growing appreciation of the recreational values of rivers [407]. Recreation is 'serious national business', said the director of the US Bureau of Outdoor Recreation in 1962, because of its economic benefits and for the 'physical, cultural, social and moral well-being of the American People'.

The law has been used to create the most extensive protected network of free-flowing rivers in the world – 226 river segments totalling more than 20,000 kilometres [382]. But, world-leading though the law is, the protected segments make up only 0.4% of the nation's rivers and perennial streams [406]. More than 3,000 rivers on a national inventory potentially meet the criteria for designation, but the pace of listings is slow [382]. Dams block parts of almost every river outside Alaska [405].

Damming has been the fate of a large and growing proportion of the world's rivers, including most Australian rivers where this is feasible [408]. Australia's portion of the world's remaining rivers with good connectivity is small – about 19,000 kilometres, just 3% of the global total by length (Figure 14) – another indication of how precious the northern rivers are [3].

In 2007, the Brisbane Declaration, issued by participants at a global symposium on rivers, included a call for the identification and conservation of a global network of free-flowing rivers. In 2020, a motion was passed at the IUCN World Conservation Congress to encourage governments to 'identify, restore and protect free-flowing rivers or stretches, and their associated ecosystems' [409].

Such protection is rare, but gaining momentum in some countries [382,410]. Mechanisms being used or that potentially could be used include protected areas, river conservation laws, planning laws, cultural heritage laws, legal rights for rivers and constitutional protection for rivers. We briefly discuss each of these options.



Georgina River, Queensland.
Credit: Alamy Stock Photo

PROTECTED AREAS

Most protected areas have been established for terrestrial ecosystems, with rivers typically only partly protected and often serving as a boundary [382]. A protected area often cannot constrain threats to rivers, including water extraction or damming outside the protected area.

Only 11% of the world's rivers are protected in their entirety and about 30% have partial protection. This global analysis found that Australia has one of the lowest continental proportions of free-flowing rivers within protected areas – 13% of river length, compared to 17% globally and 28% in South America [330]. The overall proportion of river length protected in Australia also stands at just 13%.

Australia's portion of the world's remaining rivers with good connectivity is small – another indication of how precious the northern rivers are.

It has long been recommended that Australia should establish a representative protected areas network for freshwater ecosystems, as is sought for terrestrial ecosystems, with special protection for substantially intact rivers [411]. The need for this has been recognised under the Convention on Biological Diversity, with the recently adopted Kunming-Montreal Global Biodiversity Framework including a 2030 target to effectively conserve and manage through 'ecologically representative, well-connected and equitably governed systems of protected areas' at least 30% of terrestrial and inland water areas, 'especially areas of particular importance for biodiversity and ecosystem functions and services' [412].

In the Wet-Dry Tropics, 107 major rivers are partly protected and 13 are fully protected in national parks and state reserves [79]. Just three of the fully protected rivers are more than 100 kilometres long – the South Alligator, West Alligator and Jack rivers. In our analysis, 15% of river length in the region (about 5,600 kilometres) is within protected areas, and 12% overall for Australia (slightly less than calculated in the global assessment).

Rivers can also be declared as Ramsar wetlands, which offers some protection against 'significant impacts' under the federal environmental law (*EPBC Act*). In the North, three rivers and parts of their catchments are encompassed within Ramsar wetland listings (South Alligator, West Alligator and Wildman). Two other rivers have partial protection in a Ramsar wetland (East Alligator and Ord).

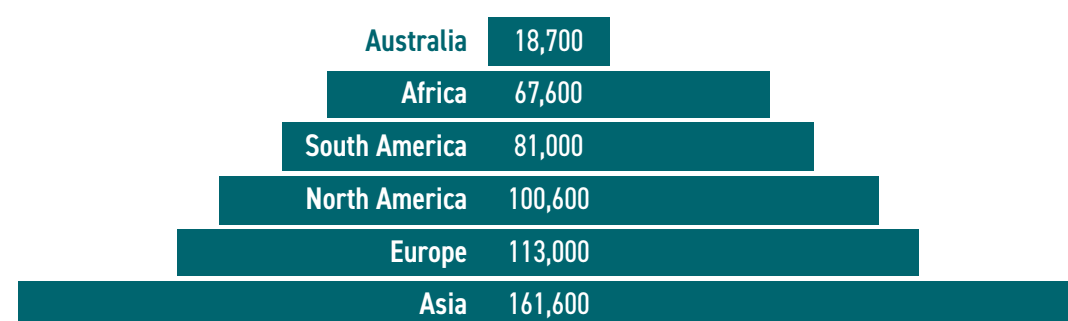


FIGURE 14. The length of river stretches (km) with 'good connectivity' on each continent

Source: Grill et al. 2019 [3]

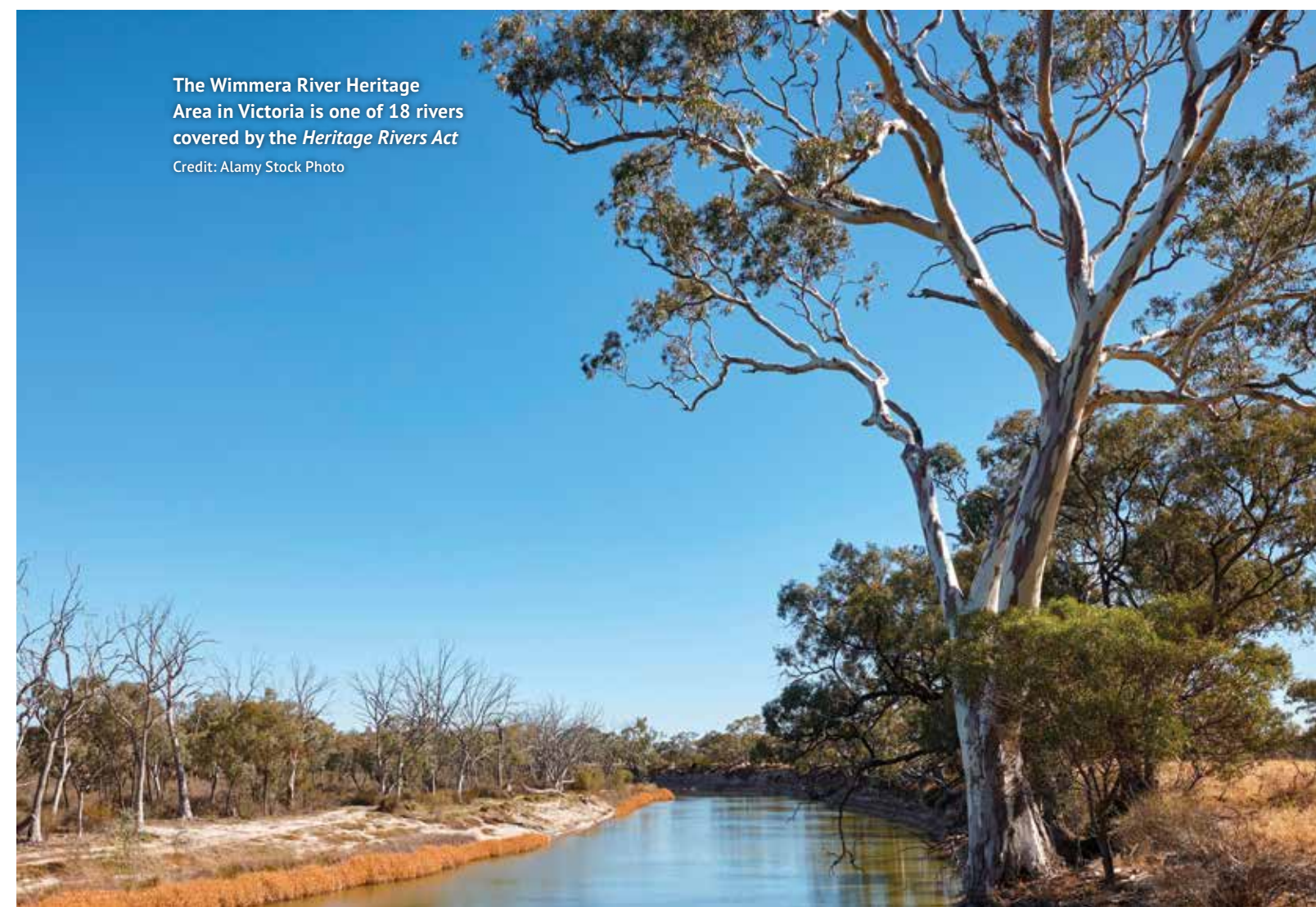
Another approach is exemplified by the Canadian Heritage Rivers System, under which 41 rivers have been designated heritage rivers [413]. They are not protected under law, but the status of these rivers and a consensus on their values by governments and stakeholders 'has engendered active conservation' [414].

RIVER CONSERVATION LAWS

In 2005 Queensland enacted one of the world's few laws to protect free-flowing rivers – the *Wild Rivers Act 2005*. It enabled the declaration of rivers, prohibited certain types of intensive development within a kilometre of a declared river (such as crops, clearing, dams and weirs) and provided for regulation of activities in other parts of the declared area. Although welcomed by some Traditional Owners, it was opposed by others, and repealed in 2013, replaced by the *Regional Planning Interests Act 2014* (see next section). While the *Wild Rivers Act* was world-leading in providing for the holistic protection of rivers and floodplains, the controversy that led to its repeal provides lessons about how to better recognise Indigenous interests in designing and implementing river protections.

Victoria is the only other Australian state with a law focused on river protection. The *Heritage Rivers Act 1992* provides for the 'protection of public land in particular parts of rivers and river catchment areas [with] significant nature conservation, recreation, scenic or cultural heritage attributes'. It protects the entirety of 26 small, essentially natural catchments and stretches of 18 major rivers [414].

Other river conservation systems exist in the United States, New Zealand, Norway, Finland, Sweden, Spain and Mexico, with more than 1,000 rivers protected in whole or part [382]. Mexico has taken a different approach, with water allocation mechanisms that sometimes serve as 'de facto river protection policies' by setting a monthly flow allocation for rivers close to natural flow levels [382].



The Wimmera River Heritage Area in Victoria is one of 18 rivers covered by the *Heritage Rivers Act*

Credit: Alamy Stock Photo

PLANNING LAWS

Planning laws in some Australian states can be used for river protection by specifying the activities permitted or not permitted in declared or zoned areas.

The most powerful is Queensland's *Regional Planning Interests Act 2014*, which provides a layer of protection for rivers and floodplains that are part of declared 'strategic environmental areas'. Several northern waterways previously declared under the now-repealed *Wild Rivers Act* are partly or entirely encompassed within strategic environmental areas – Staaten River, Morning Inlet, Settlement Creek (most) and Nicholson River (upper) in the Gulf region; and Wenlock River (most), Archer River, Lockhart River (part), Stewart River (most) and Ducie River (small part) in the Cape York Peninsula region. These declarations ensure protection against instream dams, as well as mining and broadacre cropping in strictly protected areas called 'designated precincts'. The strength of catchment protection depends on the extent of these strictly protected areas.

Outside these precincts, water storage and broadacre cropping are generally acceptable, but must be assessed and not 'result in a widespread or irreversible impact on an environmental attribute of a strategic environmental area' [415,416]. Due to discretion for decision-makers and lack of independent oversight, this does not guarantee protection from potentially harmful activities [417]. Only a small proportion of the declared northern catchment areas are strictly protected. More extensive protection applies in the Channel Country (Lake Eyre Basin), where the entire declared area is a designated precinct, protected from broadacre cropping and future oil, gas, and open-cut mining.

Western Australia's *Environmental Protection Act 1986* also offers some potential for river protection, through environmental planning policies that can be created to protect any portion of the environment and specify permissible uses and activities. Such policies exist only for two bodies of water – the Peel Inlet – Harvey Estuary and the Swan and Canning rivers – and can be removed at ministerial discretion. Only a small proportion of the declared northern catchment areas are strictly protected. More extensive protection applies in the Channel Country (Lake Eyre Basin), where the entire declared area is a designated precinct, protected from broadacre cropping and open-cut mining.

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CULTURAL HERITAGE LAWS

Cultural heritage laws in Australia are notoriously weak. This became a national and international scandal in 2020 when a mining company in the Pilbara destroyed, under a Western Australian Government permit, two rock shelters in Juukan Gorge of immense cultural and spiritual significance, with evidence of about 46,000 years of human occupation [301,418]. It highlighted the major weakness of these laws in permitting state and territory government decision-makers, not Traditional Owners, to decide whether to list particular heritage sites and whether to permit their destruction [394]. Every one of more than 460 applications in Western Australia to impact Aboriginal heritage sites on mining leases over the prior 10 years had been approved [419].

Despite their weaknesses, cultural heritage laws offer some potential to protect rivers across all forms of land tenure [394]. The Ashburton River in Western Australia is listed as an Aboriginal heritage site for its mythological values. In 2020, after the destruction of Juukan Gorge, the Aboriginal Affairs Minister refused a proposal to build 10 weirs along the river – to supply water for fodder cropping – due to potential impacts on the river's mythological values, only the third time the government had

BOX 6. THE LIMITATIONS OF NATIVE TITLE

'Interpreting the meaning of the ancient water rights of Aboriginal peoples is an ongoing challenge for the meaning of the legal system. Applying Western meaning to explain Aboriginal values and concepts can often lead to the misrepresentation of Aboriginal rights and interests and distort the concepts of traditional ownership.'

Virginia Marshall, *Overturing Aqua Nullius* [402]

There has been very limited recognition of Indigenous water rights under native title law [181]. Recognition has, with few exceptions, been limited to non-exclusive rights to use water for domestic and traditional cultural purposes. Yet many recognised native title rights depend on healthy rivers and natural water flows – for example, the ability to use and enjoy places and resources on traditional country, maintain places of cultural importance and sustain spiritual connections. Such rights can be compromised by water extraction, particularly if it involves the construction of infrastructure that changes water flows, impacts important water sites or interferes with access to and use of traditional country.

But Australian water laws mostly do not require consideration of these recognised native title rights. The need to consult Traditional Owners is recognised in water policy, but not on the basis of native title rights. The *Native Title Act* validates water laws regardless of their potential impact on native title – leaving only a potential right to compensation [181,403]. The 2004 National Water Initiative requires governments only to 'take account' of the possible existence of native title rights to water in a catchment or aquifer area [176].

Although state and territory governments privilege water laws and licensing regimes over native title rights in water, there are a few pathways by which native title holders and claimants can strive to protect their rights in rivers and water-dependent ecosystems. A report by the Australian Institute of Aboriginal and Torres Strait Islander Studies identified five potential legal pathways, based on the suite of native title rights and interests rather than any particular right to water [403]:

- use of exclusive possession rights to deny or impose conditions on access to a water source (used to prevent access for water testing for a proposed cotton farm in West Kimberley [403])
- use of the *Native Title Act's* 'future acts' process to prevent or impose conditions on activities that might use or interfere with water, where there are rights to negotiate or be compensated (the Timber Creek case established that cultural losses can be subject to compensation [404])
- use of consultation processes under mining and environmental laws to influence government decisions, and subsequent use of administrative law to challenge unfavourable decisions
- litigation to seek injunctions or damages against harmful uses of land and water
- use of the above rights or other aspects of the native title process as bargaining leverage to obtain agreements with governments or industry to limit the impact of projects.

Regardless of the current legal limitations, there is a clear moral argument that Traditional Owners should have cultural authority in decisions about water due to their custodial relationships and rights and responsibilities under their laws and customs. This has been recognised in international law, in academic and policy circles and by some in industry [157,394].

The current water rights of Indigenous Australians fall far short of what the United Nations Declaration on the Rights of Indigenous Peoples specifies. This non-binding law says Indigenous people have rights to maintain and strengthen their spiritual relationship with their traditionally owned territories and waters (Article 25) and to approve the commercial use and development of water on their traditional territories (Article 32.2).

refused permission for destruction of a registered site [420]. The submission by the Aboriginal Affairs Minister to the tribunal said 'the Thalanyji people perceive that human interference with the natural order of the river will have harmful spiritual effects upon Thalanyji country and Thalanyji people' [421].

Heritage sites can also be protected under the national environmental law, the *Environment Protection and Biodiversity Conservation Act 1999*, as national heritage, commonwealth heritage or world heritage sites. The Martuwarra Fitzroy River is part of the listed West Kimberley national heritage place for its demonstration of 'four distinct expressions of the Rainbow Serpent tradition associated with Indigenous interpretations of the different ways in which water flows within the catchment' [422]. It is currently facing proposals for large-scale water extraction and the Traditional Owners warn that the resulting disturbance would threaten its national heritage value [12]. Any action likely to significantly impact national heritage values must be assessed, but the effectiveness of the *EPBC Act* in protecting cultural heritage has not been tested.

Australia's cultural heritage laws fall short of the protections specified in the United Nations Declaration on the Rights of Indigenous Peoples such as rights to 'maintain, protect, and have access in privacy to their religious and cultural sites' (article 12), 'maintain and strengthen their distinctive spiritual relationship with their traditionally owned or otherwise occupied and used lands, territories, waters and coastal seas and other resources' (article 25) and 'maintain, control, protect and develop their cultural heritage' (article 31).

Cultural heritage laws are often also deficient in their application to water, in not reflecting its significance to Indigenous peoples – 'there is a reluctance in some cases to address the full consequences of seeking to protect in a holistic manner the Indigenous relationship to, knowledge of and understanding of water' including the notion that water itself can be living and sacred [394].

RIGHTS OF NATURE LAWS

When philosopher Christopher Stone proposed in 1972 that nature should have legal rights, in a paper entitled *Should trees have standing?* [423], it was widely regarded as a whacky idea [424,425].

'Five fish in the billabong'. Artist: Christina Yambeing



But as Stone pointed out, many non-living entities have legal rights – trusts, corporations, joint ventures, municipalities and ships, [426] and 'each time there is a movement to confer rights onto some new 'entity', the proposal is bound to sound odd or frightening, or laughable' [426].

Recently, the idea has come to seem less odd as several countries have adopted rights-for-nature laws, often led by Indigenous peoples, for many of whom rivers and other natural entities are already regarded as beings with rights.

In 2008 Ecuador adopted rights for nature in its constitution, and in 2011 an Ecuadorean court ruled that the rights of the Vilcabamba River had been violated by road construction [427]. In 2012 the Whanganui River tribe and the New Zealand Government reached an agreement to recognise Te Awa Tupua (Whanganui River) as a legal person. The point of this, said a Māori negotiator, was 'to approximate at law what the river is to us in custom and kawa: a living tupuna, not an inanimate, lifeless resource to be used without regard to its mana' [428]. The legal rights of Te Awa Tupua can be enforced by a guardian comprising one Māori and one government representative (Box 7). In 2016 Colombia's Constitutional Court declared the Atrato River to be a legal subject with rights to protection and restoration by the state and ethnic communities and ordered that a river guardian be appointed (similar to the New Zealand system). There have also been court rulings or rights legislated for rivers in India, Bangladesh and parts of the United States [382]. None of the cases to date have involved free-flowing rivers and no river has been accorded rights to its own water [429].

CONSTITUTIONAL PROTECTION

Few countries have environmental protection in their constitutions, except as a right of humans to a healthy environment, and none have explicit protection for free-flowing rivers [382]. Bolivia and Ecuador have rights-of-nature provisions, and Mexico and Scotland have protection for environmental flows. In Argentina, the constitution of one province, Entre Rios (Between Rivers), prohibits large-scale infrastructure developments that would interrupt or degrade the free flow of two rivers.

6.4 RIVER GOVERNANCE – WHOSE VIEWS, VALUES AND VOICES SHOULD COUNT?

A GLOBAL MOVEMENT

Fundamental to any just and robust system of water governance in Australia must be a central role for Traditional Owners. In Australia and around the world, there is a growing movement, mostly led by Indigenous peoples, to establish new forms of governance that are more aligned with their values and traditional laws. New Zealand has been a leader in reforming governance arrangements.

In 1840, about 500 Māori chiefs signed the Treaty of Waitangi with the British Crown as a means 'for seeking British help to protect their international borders' [430]. The English and Māori versions of the treaty differed – the English version stated that the Māori ceded their sovereignty to the British Crown while retaining property rights but the Māori version gave the British the right only of *kawanatanga* (governorship) with Māori retaining their *rangatiratanga* (chiefly authority, inseparable from sovereignty) and full authority over their *taonga* (what they treasured) [388,431]. Neither version was honoured, and the Māori were dispossessed of most of their lands and waters.

In 1975, after unceasing Māori protests, the New Zealand Government passed the Treaty of Waitangi Act, which established the Waitangi Tribunal, a permanent commission of inquiry into treaty breaches. In 1994 an Office of Treaty Settlements was established to negotiate reparation packages to acknowledge and address the Crown's failures to honour the treaty [388].

Due to treaty settlements, Māori are increasingly recognised as co-governance partners rather than stakeholders across many domains of decision-making about natural resources [432,433]. They have been catalysing innovative co-governance and co-management arrangements and changing how rivers are perceived and managed [388,432]. A common thread is that Māori are 'positioned at the heart rather than being excluded or marginalised', with an emphasis on Māori knowledge, laws and protocols [433].

As a result of three settlement agreements and laws giving effect to those agreements, New Zealand's longest river, the Waikato, and its major tributary, the Waipa, are now subject to co-governance and co-management by the state and 5 river tribes. The Waikato River Authority has a board of five Māori and five government appointees, a vision and strategy articulating Māori values and aspirations for the rivers, a river clean-up trust and integrated river management plans. The vision and strategy prevail over any inconsistency in policy or planning documents, and the river authority has certain powers in local government processes for assessing developments and resource exploitation impacting the rivers [388].

In Australia and around the world, there is a growing movement, mostly led by Indigenous peoples, to establish new forms of governance that are more aligned with their values and traditional laws.

The settlement laws incorporate Māori concepts and worldviews into the legal order of New Zealand with the acknowledgement that 'freshwater systems comprise physical and metaphysical elements' [388]. In the *Weipa River Act (2012)*, for example, the supernatural being Waiwaia is a central figure and the river is recognised as an agent 'that shapes and connects the physical and metaphysical worlds together, carrying with it the histories, stories, and whakapapa (genealogy) of the river tribes' [388].

Melding different worldviews and instituting complex co-governance arrangements are inevitably challenging and, so far, western bureaucratic processes continue to dominate [388]. A recent assessment of the arrangements for the Waipa River based on interviews of participants concluded [388]:

'While there is no guarantee that the new co-management and co-governance arrangements will lead to the radical transformations desired by many Māori, there are clear signs that Aotearoa New Zealand is moving closer towards more sustainable and just river futures for all.'

GOVERNANCE OPTIONS TO RECOGNISE INDIGENOUS RIGHTS AND STRENGTHEN RIVER PROTECTION

By *governance*, we mean the norms, institutions and processes by which decisions about rivers and water are made and who exercises power and influence. It encompasses the following elements, which pivot around questions of power and justice [434]:

- **Rules:** Whose laws and processes apply?
- **Recognition:** Whose values and worldviews count?
- **Authority:** Who makes decisions?
- **Influence:** Who can shape decisions?
- **Entitlements:** Who has rights to water?

Table 6 provides examples around the globe of different responses to these questions, some of which are explained in more detail as case studies in Box 7. They do not necessarily represent cases in which governance is optimal. Most are suboptimal in some respects, but they show that many other countries are moving much more rapidly than Australia to redress injustices and improve governance. The assertion of rights by Indigenous peoples – a restatement of ‘their inherent legal and governance authority’ under customary laws – is driving a trend in some countries towards ‘legal pluralism’ [435]. New Zealand and Canada, in particular, are showing some willingness, albeit slow and incremental, to adopt co-governance and apply new models combining Indigenous and non-Indigenous forms of governance.

Another model of governance, pioneered by New Zealand, is to recognise a river as a legal person. Under the *Te Awa Tupua (Whanganui River Claims Settlement) Act 2017*, a guardian, comprising one Māori and one state representative, has been appointed to act and speak for and on behalf of the river, uphold the river’s recognition and values as an indivisible entity and as a legal person, administer a fund to support the river’s wellbeing, and take other actions to protect environmental, social, cultural, and economic health and well-being of the river [436].

Canada has made progress on involving Indigenous peoples in decision-making. *The United Nations Declaration on the Rights of Indigenous Peoples Act (UNDRIP Act)*, which became law in 2021, requires the Canadian Government to work in consultation and cooperation with Indigenous peoples to take all measures necessary to ensure the laws of Canada are consistent with the UNDRIP [437]. The preamble recognises ‘that all relations with Indigenous peoples must be based on the recognition and implementation of the inherent right to self-determination, including the right of self-government.’ Under UNDRIP, the state is required to obtain the free and informed consent of Indigenous peoples prior to approvals ‘affecting their lands or territories and other resources’, including for the exploitation of water. The government has said it ‘will look for opportunities to build processes and approaches aimed at securing consent, as well as creative and innovative mechanisms that will help build deeper collaboration, consensus, and new ways of working together’ [438].

Narrow chasm leading to the Huka falls on the Waikato river, Taupo, North Island, New Zealand
Credit: Alamy Stock Photo



Canada's governments already have a constitutional duty to consult Indigenous Canadians prior to decisions that could affect their established or potential rights, although Indigenous peoples have often had to resort to legal action to uphold these rights. A 2018 court decision clarified that proper consultation requires 'managing the consultation process in a way that fosters trust as opposed to misunderstanding and betrayal' [439].

Although progress on governance reform in Australia has been slower than in several other countries, potential pathways are opening up. The National Agreement on Closing the Gap now includes an outcome that 'Aboriginal and Torres Strait Islander people maintain a distinctive cultural, spiritual, physical and economic relationship with their land and waters' (although there is no target specific to freshwater).

The negotiation of treaties or settlements, underway in Queensland (initiated in 2019) and the Northern Territory (initiated in 2020), could provide the foundations for developing co-governance arrangements for rivers and water [157,440]. The 2022 report of the Northern Territory Treaty Commission recommends a First Nations Self Government Act, which would 'recognise First Nations peoples' traditional relationship to lands and waters' and include rights to 'practise their own customs and to govern themselves according to relevant institutions within traditional estates' [440].

The time seems right for Australian governments to develop, in partnership with Traditional Owners, new co-governance and co-management arrangements for rivers and catchments.

Linda Williams, a member of the delegation of Traditional Owners presenting the Roper River cultural map to Australian Parliament, talks to press about the cultural map and the places it represents.

Credit: Cat Sparks



TABLE 6. TYPES AND EXAMPLES OF RIVER AND WATER GOVERNANCE RELEVANT TO TRADITIONAL CUSTODIANS

FOCUS	DEGREE OF INFLUENCE BY TRADITIONAL CUSTODIANS	AUSTRALIAN EXAMPLES	EXAMPLES ELSEWHERE
1. RULES WHOSE LAWS & PROCESSES APPLY?	1.1 Traditional custodians apply their own laws and processes (self-governing)	No examples in Australia	Peru: Autonomous Territorial Government of the Wampis Nation [441] United States: Tribal self-governance [442] Bolivia: Charagua Iyambae, the country's first 'autonomous indigenous and aboriginal farming community' [443]
	1.2 Traditional custodians co-design laws, policies or processes with governments	No examples in Australia	New Zealand: Guardianship of Whanganui River as a legal person (Box 7) Colombia: Guardianship of Atrato River as a legal person (Box 7)
2. RECOGNITION WHOSE VALUES & WORLDVIEWS COUNT?	2.1 Traditional custodian values and worldviews are meaningfully recognised	South Australia: Kungun Ngarrindjeri Yunnan agreements (Box 7) Victoria: <i>Yarra River Protection (Wilip-gjin Birrarung murron) Act 2017</i> (Box 7) Western Australia: South West Native Title Settlement [444]	New Zealand: river settlement laws (Waikato, Waipa, Whanganui) (s6.4, Box 7) Colombia: Constitutional Court recognition of biocultural rights (Box 7) Ecuador: the 'intellectual origin of the constitutional rights to nature are in indigenous traditions' [445]
3. AUTHORITY WHO MAKES DECISIONS?	Traditional custodians are the main decision-makers	No examples in Australia	See 1.1 examples
	3.1 Free, prior and informed consent by traditional custodians is required (as per the UN Declaration on the Rights of Indigenous Peoples)	No examples in Australia	Canada: <i>United Nations Declaration on the Rights of Indigenous Peoples Act 2021</i> (Box 7) Philippines: <i>Indigenous Peoples Rights Act</i> [446] Decisions by the Inter-American Court of Human Rights, African Commission on Human and Peoples' Rights, Supreme Court of Belize, Constitutional Court of Columbia
	3.2 Traditional custodians are joint decision-makers on decisions impacting their traditional river country	No examples in Australia	New Zealand: Waikato River Authority (s6.4) New Zealand: joint guardianship under <i>Te Awa Tupua Act</i> (Box 7) Colombia: Atrato River guardianship (Box 7) Canada: Yukon First Nation agreements (Box 7) Canada: Haida Gwaii Reconciliation Agreement (Box 7)
	3.3 Traditional custodians are joint decision-makers with several others	Murray-Darling Basin Authority Board [447]	

TABLE 6 (CONTINUED)

FOCUS	DEGREE OF INFLUENCE BY TRADITIONAL CUSTODIANS	AUSTRALIAN EXAMPLES	EXAMPLES ELSEWHERE
4. INFLUENCE WHO CAN SHAPE DECISIONS?	4.1 Deep consultation with traditional custodians is required	No examples in Australia	Canada: duty to 'consult and accommodate' (Box 7)
	4.2 Traditional custodians have legal rights to challenge decisions impacting their traditional lands and waters, customs, cultures or rights.	Legal rights are extremely constrained, limited mainly to compensation for <i>future acts</i> (Box 6).	Hawaii: public trust doctrine (Box 7) Ecuador: constitutional rights for nature can be defended by any Ecuadorean [445] Inter-American Commission on Human Rights [448]
	4.3 Traditional custodians have a formal and influential advisory role	South Australia: Kungun Ngarrindjeri Yunnan agreements (Box 7)	
	4.4 Traditional custodians are represented as one of several groups on an advisory body	Victoria: Birrarung Council (Yarra River) (Box 7)	Hawaii: Commission on Water Resource Management (Box 7) [451]
5. ENTITLEMENT WHO HAS RIGHTS TO WATER?	5.1 Exclusive Indigenous rights apply over water	Almost all native title rights to water are non-exclusive [450] (Box 6)	Chile: ancestral water rights / Indigenous Land and Water Fund (Box 7) USA: Indian water rights settlements (Box 7) Nicaragua's law for Indigenous Peoples and Indigenous Communities of the Autonomous Regions
	5.2 Non-exclusive Indigenous rights apply over water	Native title (non-exclusive): typically a right to take and use water for domestic, social and cultural purposes [450] (Box 6)	
	5.3 Water is reserved for customary or cultural purposes	Qld: Water Plan (Cape York) 2019 [451]	Peru: <i>Water Act 2009</i>
	5.4 Water is reserved for the economic development of traditional custodians	Qld: Indigenous water reserves [452] NT: Strategic Aboriginal water reserves [453]	

Notes: The examples are of governance mechanisms and do not necessarily represent cases in which they have been optimally applied. Most are suboptimal.

BOX 7: CASE STUDIES OF RIVER LAWS AND GOVERNANCE MODELS FROM AROUND THE WORLD

NEW ZEALAND: LEGAL PERSONALITY AND GUARDIANSHIP (TE AWA TUPUA / WHANGANUI RIVER)

In 1999, the Waitangi Tribunal found that the Crown had breached the Waitangi Treaty in 'depriving Atihaunui of their possession and control of the Whanganui River and its tributaries' [454]. The tribunal described the Whanganui River as 'central to Atihaunui lives, their source of food, their single highway, their spiritual mentor ... the aortic artery of the Atihaunui heart'. They recommended that the ownership and authority of the Atihaunui be recognised and that it be based on Māori conceptions of the river [454]:

'The conceptual understanding of the river as a tupuna or ancestor emphasises the Māori thought that the river exists as a single and undivided entity or essence. Rendering the native title in its own terms, then, what Atihaunui owned was a river, not a bed, and a river entire, not dissected into parts.'

Negotiations then proceeded intermittently between the New Zealand Government and the Whanganui River tribe for a settlement of claims until an agreement was finally reached in 2012. In a global first for rivers, it was agreed to recognise Te Awa Tupua as a legal person. The point of this, said a lead Māori negotiator, was 'to approximate at law what the river is to us in custom and kawa: a living tupuna, not an inanimate, lifeless resource to be used without regard to its mana' [428].

Under the *Te Awa Tupua (Whanganui River Claims Settlement) Act 2017*, the legal rights of the river can be enforced by a guardian comprising one Māori and one state representative. Their duties include [436]:

- acting and speaking for and on behalf of the river
- upholding the river's recognition and values as an indivisible entity and as a legal person
- promoting and protecting the environmental, social, cultural, and economic health and well-being of the river
- taking any other action reasonably necessary to achieve its purpose and perform its functions
- administering a fund to support the river's wellbeing.

There are also an advisory group and a strategy group with Maori and government appointees and a community group of individuals and organisations with interests in the river, whose purpose is 'to act collaboratively to advance the health and well-being of the river'.

One major anomaly is that Te Awa Tupua as a legal person does not have proprietary rights to its own water – 'like saying that a natural person owns his or her skin, but not his or her blood' [455]. The tribunal had recommended that ownership of the river as an entire entity be vested in the Atihaunui.

Despite the progress New Zealand has made in recognising the rights and relationships of traditional custodians with rivers, the translation of legislation into 'meaningful actions that address environmental injustices against Māori and their more-than-human relatives remains a politically fraught and power-laden process' [433].



Whanganui River, North Island, New Zealand
Credit: Alamy Stock Photo

COLOMBIA: BIOCULTURAL RIGHTS AND RIVER GUARDIANSHIP (ATRATO RIVER)

In 2016, Colombia's Constitutional Court declared the Atrato River to be a legal subject and ordered that it be protected from illegal mining. The Atrato flows through a heavily forested, highly biodiverse region of Colombia, where the population is 97% Indigenous and Afro-descendent (the descendants of slaves brought by the Spanish). Illegal mining had been degrading and poisoning the river, destroying people's livelihoods and severing their cultural and spiritual connections with the river [383].

The Constitutional Court found that the state, in failing to control illegal mining, had violated people's constitutional rights to life, health, water, food security, a healthy environment, culture, and territory [383]. Although not requested by the claimants, the court also recognised that the Atrato River had its own rights – to protection, conservation, maintenance, and restoration by the state and ethnic communities.

The court ordered that a river guardian be appointed, with a representative from the claimant communities and one from the government (based on the New Zealand model for the Whanganui River). However, after objections that one person could not represent all communities, a Commission of Guardians was established, consisting of the Ministry of the Environment and seven male and seven female guardians representing the Atrato communities [384].

In their judgement, the Constitutional Court adopted a theory of biocultural rights as 'an alternative vision of the collective rights of ethnic communities in relation to their natural and cultural environment' to underpin the court's recognition of Indigenous peoples as guardians of the Atrato [456]:

'The so-called bio-cultural rights, in their simplest definition, refer to the rights that ethnic communities have to administer and exercise sovereign autonomous authority over their territories – according to their own laws, customs – and the natural resources that make up their habitat. In effect, these rights result from the recognition of the deep and intrinsic connection that exists between nature, its resources, and the culture of the ethnic and indigenous communities that inhabit them, all of which are interdependent with each other and cannot be understood in isolation.'

The court ordered the state to develop plans and policies to restore the river's ecosystems, stop illegal mining, recover traditional practices of subsistence, and conduct toxicological and epidemiological studies [384]. It required the establishment of an inter-institutional monitoring committee to report to the court biannually to verify compliance.

Implementation of the court's orders has been slower than ordered by the court, and is greatly hampered by inadequate budgets, corruption and local economic reliance on illegal mining. However, the ruling has led to a new form of governance for developing policies to protect the river, with the development of a detailed restoration plan that 'respects and guarantees territorial autonomy, the communities' own views of development and their biocultural rights'. Community guardians report they have gained a strong voice in policymaking [384]:

'The plan to restore the environment reflects our perspectives. We developed it together with the Ministry and the other institutions. We participated in that, at the same level as the Ministry. Everything was decided with us, everything was coordinated with us. We are completely reflected in it.'

The plan covers environmental planning and regulation, improvement of environmental conditions, sustainable production, environmental governance and information and knowledge management. The communities now face the momentous tasks of re-establishing the river course, restoring mining-affected areas and transforming an economy dependent on illegal mining, 'in a context of ongoing conflict, poverty, weak institutions and corruption' [384].

Colombia's Constitutional Court is highly unusual. In a quest to 'make fundamental rights a reality', it has developed a practice of 'dialogical judicial activism' that would be 'considered inconsistent with the separation of powers in other countries' [384]. In addition to the Atrato, Colombia's courts have recognised several other rivers as legal subjects, as well as other ecosystems, including the entire Colombian Amazon [384]. Some judgements have recognised the rights and cosmologies of Indigenous peoples, while others have ignored them.

CANADA: CONSENT AND CONSULTATION RIGHTS

In 2015, Canada's Truth and Reconciliation Commission in its final report called for Canada to implement the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) as a 'framework for reconciliation' [457]. In June 2021, Canada's United Nations Declaration on the Rights of Indigenous Peoples Act became law [437]. It requires the Canadian Government to work in consultation and cooperation with Indigenous peoples to:

- take all measures necessary to ensure the laws of Canada are consistent with the UNDRIP
- prepare and implement an action plan to achieve the objectives of the UNDRIP
- develop annual reports on progress and submit them to parliament.

The preamble recognises 'that all relations with Indigenous peoples must be based on the recognition and implementation of the inherent right to self-determination, including the right of self-government'.

This has been a big shift for Canada, which was one of just four countries to vote against the adoption of the UNDRIP in 2007. The other three were New Zealand, United States and Australia. All four countries later endorsed the declaration but emphasised that they regarded it as aspirational rather than binding. Among other provisions, they opposed the UNDRIP's requirement for free, informed and prior consent for resource projects.

Article 32.2 of the UNDRIP requires that:

'States shall consult and cooperate in good faith with the indigenous peoples concerned through their own representative institutions in order to obtain their free and informed consent prior to the approval of any project affecting their lands or territories and other resources, particularly in connection with the development, utilization or exploitation of mineral, water or other resources.'

Governments are also obliged (under article 19) to consult in good faith with Indigenous peoples 'to obtain their free, prior and informed consent before adopting and implementing legislative or administrative measures that may affect them'.

These consent rights have been described as rights to make decisions free from coercion, within a community's own cultural framework, and with adequate time to review and assess all information necessary to make an informed judgement [458]. As interpreted by the United Nations High Commissioner for Human Rights, these rights are not necessarily rights of veto by Indigenous peoples. Rather, 'states must have consent as the objective of consultation', which under 'certain circumstances' extends to an obligation to 'obtain consent' [459]. Many commentators refer to the foundational importance of 'meaningful relationships' between Indigenous peoples and governments (and industry) as the basis for effective implementation of these rights [458]. Canada's prime minister has talked of 'consensus, shared decision-making' and a process of 'working together from the very beginning' [460].

Whether the reforms in Canada will lead to full implementation of the UNDRIP requirement for free, prior and informed consent is not yet clear. The government has said it 'will look for opportunities to build processes and approaches aimed at securing consent, as well as creative and innovative mechanisms that will help build deeper collaboration, consensus, and new ways of working together' [438].

Canada's governments already have a constitutional duty to consult Indigenous Canadians prior to decisions that could affect their established or potential rights. But Indigenous peoples have often had to resort to legal action to uphold these rights. Failures to properly consult led to a series of Supreme Court cases in 2004–2005 clarifying the duty.

The court ruled that consultations must be undertaken in good faith (on both sides) with genuine efforts to achieve reconciliation, which may lead to a need to accommodate Indigenous interests [461]. The extent of the duty [462]:

'...falls along a spectrum ranging from limited to deep consultation, depending upon the strength of the Aboriginal claim, and the seriousness of the potential impact on the right. Each case must be considered individually.'

A 2018 court decision clarified that proper consultation requires 'managing the consultation process in a way that fosters trust as opposed to misunderstanding and betrayal' [439].

The Canadian duty to consult is rooted in a constitutional principle, 'the honour of the Crown' – that the Crown must act honourably in its dealings with Aboriginal peoples – so as to recognise Aboriginal and treaty rights as required under *Canada's Constitution Act 1982* [463].

SOUTH AUSTRALIA: NGARRINDJERI NATION AGREEMENTS (MURRUNDI / MURRAY RIVER)

Ngarrindjeri country is a 'meeting of the waters' estuarine region, where the Murrundi (Murray River) flows through the Coorong and Lower Lakes to meet tidal salt water [464]. The environmental significance of the coastal wetlands is recognised through a listing under the Ramsar Convention and the cultural significance of the area by a listing under state cultural heritage laws.

In the early 2000s, the Ngarrindjeri decided to seek a new relationship with the South Australian Government through agreement making under contract law rather than relying on legislative and policy reforms [465]. Their aim was to build Ngarrindjeri capacity to speak as country and build respect for Ngarrindjeri knowledge, law, traditions, and experience.

Several Kungun Ngarrindjeri Yunnan (listen to Ngarrindjeri people speaking as country) agreements have since been negotiated. These incorporate Ngarrindjeri cultural perspectives and assert 'that Ngarrindjeri rights and responsibilities continue under sovereign Ngarrindjeri Law' [464]. At their core is a 'commitment for all partners to listen respectfully to each other's expressions of authority and expertise as a starting point for collaborative negotiation, decision-making, policy and natural resource management' [464].

In 2008, when the Ngarrindjeri disagreed with the government about a proposed construction of earthen bunds (to maintain water levels in the Goolwa Channel to reduce the risks of acid sulphate soil exposure) they brokered an agreement that led to the installation of temporary rather than permanent bunds and the use of methods to minimise damage to cultural values [464].

A 2009 Kungun Ngarrindjeri Yunnan Agreement established an overarching collaboration and negotiation framework for natural resource and cultural heritage management [466]. It included commitments for regular meetings between Ngarrindjeri leaders and government ministers, a joint taskforce for state government agencies to negotiate programs on Ngarrindjeri country, and the integration of Ngarrindjeri cultural values into planning and management arrangements for lands and water. An essential outcome was that it started the process of 'creating a respectful relationship between [government representatives] and the Ngarrindjeri people' [464].

In 2014, the Ngarrindjeri and the state government agreed a *Speaking as Country Deed* about the Meeting of Waters cultural site, in which the parties committed to [464]:

'together, seek ways to consider Ngarrindjeri rights and to advance Ngarrindjeri interests when decisions are being made about their traditional country, lands and waters including the registered Aboriginal Site titled 'Meeting of the Waters.'

In 2016, the South Australian Government committed to entering into treaty negotiations with three Aboriginal nations, including the Ngarrindjeri. But this was scrapped and other partnership processes stalled after a change of government in 2018 [464]. A new government, elected in March 2022, has once again committed to embark on treaty negotiations as well as establish an Indigenous voice to parliament [467].



Murbpook Lagoon, Murray River, South Australia
Credit: Charles Phillipot



Gila Box Riparian Conservation Area, Gila River, Safford, Arizona, USA
Credit: Alamy Stock Photo

UNITED STATES: INDIAN WATER SETTLEMENT AGREEMENTS (GILA RIVER)

Since 1990, the US Government's policy has been to resolve water claim disputes with Indian tribes not by litigation, but by negotiated settlements, which then become federal law [468]. By the end of 2021, 38 Indian water rights settlements had been approved, costing about \$AU8 billion [385,469]. Negotiated settlements have often resulted in benefits of additional to access to water – some have provided for water infrastructure to improve water access and others have enabled environmental protection and restoration [385].

Indian water rights were first recognised by the Supreme Court in 1907 in a case brought by the US Government on behalf of a tribe that was prevented from developing an irrigation project on their reservation, due to water depletion by other users [470]. The court found that this infringed upon the tribe's ability to 'fulfill the purpose for which the reservation was made'. However, although courts have recognised the prior water rights of tribal peoples, it has been difficult for tribes to gain access to their water due to existing use by others.

The largest agreement, in 2004, was with the Gila River Indian Community in Arizona, who have a history of irrigated cropping stretching back thousands of years. After decades of litigation, the tribe settled for an annual supply of 806 GL water and funds to rebuild and expand a water distribution system [470]. This has enabled them to restore their agricultural way of life, growing both traditional and non-traditional crops. They also generate income by leasing some of the water.

CANADA: YUKON FIRST NATION WATER GOVERNANCE RIGHTS

Of 14 First Nations in Yukon (in north-west Canada), 11 have negotiated modern land claim and self-government agreements that provide for title to settlement lands (about 10% of their traditional territories), self-government on settlement lands and co-governance over other lands and resources. The goals include protecting First Nations' ways of life, based on spiritual and economic relationships with the land. The agreements 'contain powerful acknowledgements of Indigenous water rights and authorities' [386].

One specified right is that water on or flowing through or adjacent to settlement lands remain 'substantially unaltered as to quantity, quality and rate of flow, including seasonal rate of flow' [471]. First Nations can assert their powers of self-government to create laws to help protect this right and they have influence over water licencing decisions across Yukon through a one-third membership of the Yukon Water Board and rights to ask the water board to review or inspect licences to check compliance or recall a licence due to unforeseen impacts on the First Nation.

However, in practice, the power of First Nations people to influence water decisions has thus far been limited. The governance arrangements do 'not reflect Yukon First Nations epistemologies, ontologies and forms of governance' and capacity and funding limitations have prevented full implementation of agreements and optimal engagement in decision-making. Because of these 'jurisdictional asymmetries' the governance arrangements thus 'fall short of co-governance' [386].

The Kunst'aa guu—Kust'aayah or Haida Protocol, for example, is a comprehensive reconciliation agreement; in addition to shared decision-making, the Haida Protocol includes joint decision-making for specific decisions. The Haida Gwaii Management Council (importantly, a body delegated by Indigenous and Crown authority to make joint decisions) engages consensus decision-making for strategic resource management decisions, including those for land use, forestry, and conservation. The Haida are particularly advantaged in their ability to negotiate joint decision-making in that they possess a uniquely strong Aboriginal title claim with no issues of territorial overlap with other First Nations.

Yakoun River estuary, Haida Gwaii (formerly known as Queen Charlotte Islands), British Columbia, Canada
Credit: All Canada Photos / Alamy Stock Photo



HAWAII: ENACTING THE PUBLIC TRUST DOCTRINE

In Hawaii, for over a century, sugar plantations controlled major freshwater and groundwater resources, often leaving little water to support ecosystems or native Hawaiian cultural and agricultural practices. Although the last commercial harvest of sugar on Maui occurred in 2016, 'the physical, legal, and political infrastructures of water management developed in the era of sugar remain dominant forces' [449].

But on Maui, native Hawaiians have been using the courts to reclaim water resources, restore stream flows and renew traditional practices such as taro farming (according to a Hawaiian creation legend, taro is the 'elder sibling of humanity') [449]. Decisions by Hawaii's Supreme Court have increasingly recognised the importance of supporting Indigenous Hawaiians' connections to their rivers and streams by applying the public trust doctrine [472]. This doctrine is based on a longstanding legal principle that certain natural resources are held in trust by the government for the public and must be managed in the public interest [449]. It has unique strength in Hawaii in part because it is consistent with both native Hawaiian laws and systems of resource management as well as western law [449].

Hawaii incorporated the public trust doctrine into its 1979 constitution and requires the state 'to protect, control and regulate the use of Hawaii's water resources for the benefit of its people' [473].

The constitution also requires the state to 'protect all rights, customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by ... descendants of native Hawaiians' [474].

One important court case concerned the freshwater system in central Maui known as Nā Wai 'Ehā – *the four great streams* – which are very important ecologically and culturally [451]. They used to support the largest area of taro cultivation in Hawaii, but had been so overallocated that flows were no longer reaching the ocean [451,475].

In 2004, community groups petitioned the Water Commission (dominated by agricultural representatives) to restore water to the four streams, but in 2010 the commission decided to increase flow to only two streams. The community organisations and the Office of Hawaiian Affairs appealed this decision to the Supreme Court [451].

The court found firstly that the community groups had standing before the court (because their membership included those who relied on the water to exercise traditional and customary rights) and then that the water commission had violated its duty under the public trust doctrine by failing to adequately consider traditional and customary native Hawaiian practices and other public interests in the water [451,475]. After new flow regimes were agreed upon in 2014, 'all four waters of Nā Wai 'Ehā finally flowed from mauka to makai (mountain to ocean) – for the first time in over a century' [451].

Although the public trust has been 'a powerful mechanism to secure water for cultural and ecological needs', it is frequently disregarded by water managers and will require ongoing effort to have it properly enacted [451].



'Iao Valley, part of the Nā Wai 'Ehā, Hawaii
Credit: Alamy Stock Photo

CHILE: INDIGENOUS WATER RIGHTS

Under the Pinochet dictatorship (1973–1990), Chile privatised water rights, enshrining them in the constitution, and separated water ownership from land ownership [183]. After democracy was restored, the Chilean Government finally responded to demands by Indigenous peoples for water rights by recognising ancestral water rights (under the Indigenous Law 1993) and establishing an Indigenous Land and Water Fund to buy water rights in the market. The ancestral water rights provision stipulated that:

‘Waters, including rivers, canals, streams and springs, found on the lands of the Indigenous communities established by this law will be considered property of ownership and use of the Indigenous communities...’

These rights are much stronger than the recognised Indigenous rights to water in Australia and other countries because, as ownership rights, they exclude new uses that would interfere with their rights [183]. However, their practical effect has been limited because they only apply to certain indigenous groups, who must be able to prove the continuity of customary water uses since time immemorial and where they do not interfere with existing rights held by other water users. Most available water had already been allocated to other users [183].

The land and water fund mainly purchases water for economic uses to support Indigenous land production. Water bought in the market is costly and the fund has received limited government support [183].

In early 2022, the Chilean Parliament approved a new water law that limits the duration of new water rights to 30 years and prioritises human consumption [477]. It could lead to the reversal of the separation of water and land rights on Indigenous lands through a provision to ‘ensure the integrity between land and water’ in Indigenous territory [183].

Rio San Pedro, Los Lagos, Chile
Credit: Alamy Stock Photo



VICTORIA, AUSTRALIA: RECOGNITION OF TRADITIONAL OWNER RIVER CONNECTIONS (BIRRARUNG / YARRA RIVER)

The *Yarra River Protection (Wilip-gin Birrarung murrn) Act*, passed by the Victorian Parliament in 2017, is the first law in Australia to recognise the cultural qualities of rivers in Indigenous terms. The preamble was co-written in Woi-wurrung, the language of the Wurundjeri people, through whose land Birrarung, meaning ‘river of mists and shadows,’ mostly flows. It recognises the status of the Woi-wurrung people and their connection to the river:

‘We, the Woi-wurrung, the First People, and the Birrarung, belong to this Country. This Country, and the Birrarung are part of us.

The Birrarung is alive, has a heart, a spirit and is part of our Dreaming. We have lived with and known the Birrarung since the beginning. We will always know the Birrarung.

Bunjil, the great Eagle, the creator spirit, made the land, the sky, the sea, the rivers, flora and fauna, the lore. He made Kulin from the earth. Bunjil gave Waa, the crow, the responsibility of Protector. Bunjil’s brother, Palliyang, the Bat, created Bagarook, women, from the water.

Since our beginning it has been known that we have an obligation to keep the Birrarung alive and healthy—for all generations to come.’

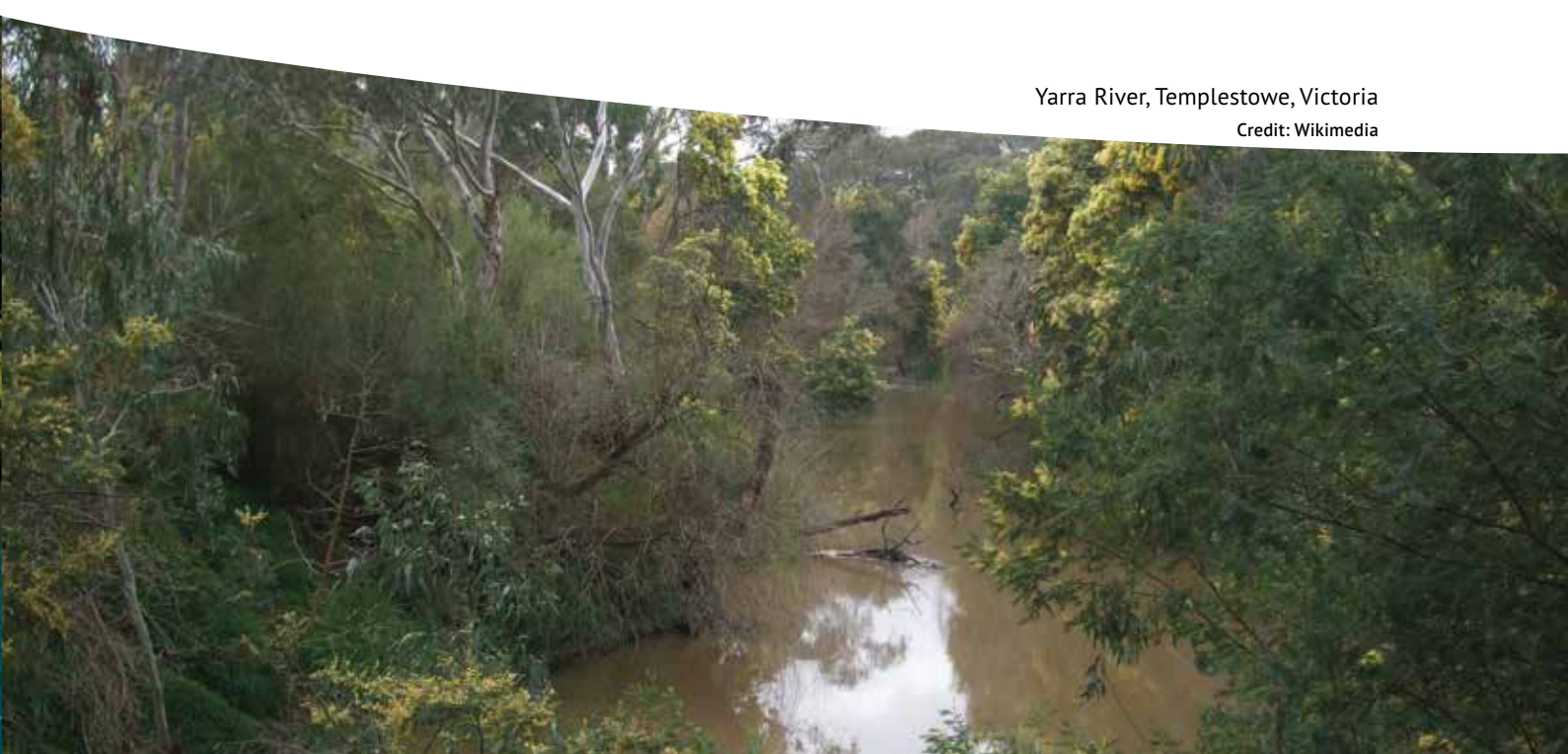
The new law recognises the Yarra River as ‘one living and integrated natural entity’ and requires decision-makers to ‘have regard’ to the following principles (among others):

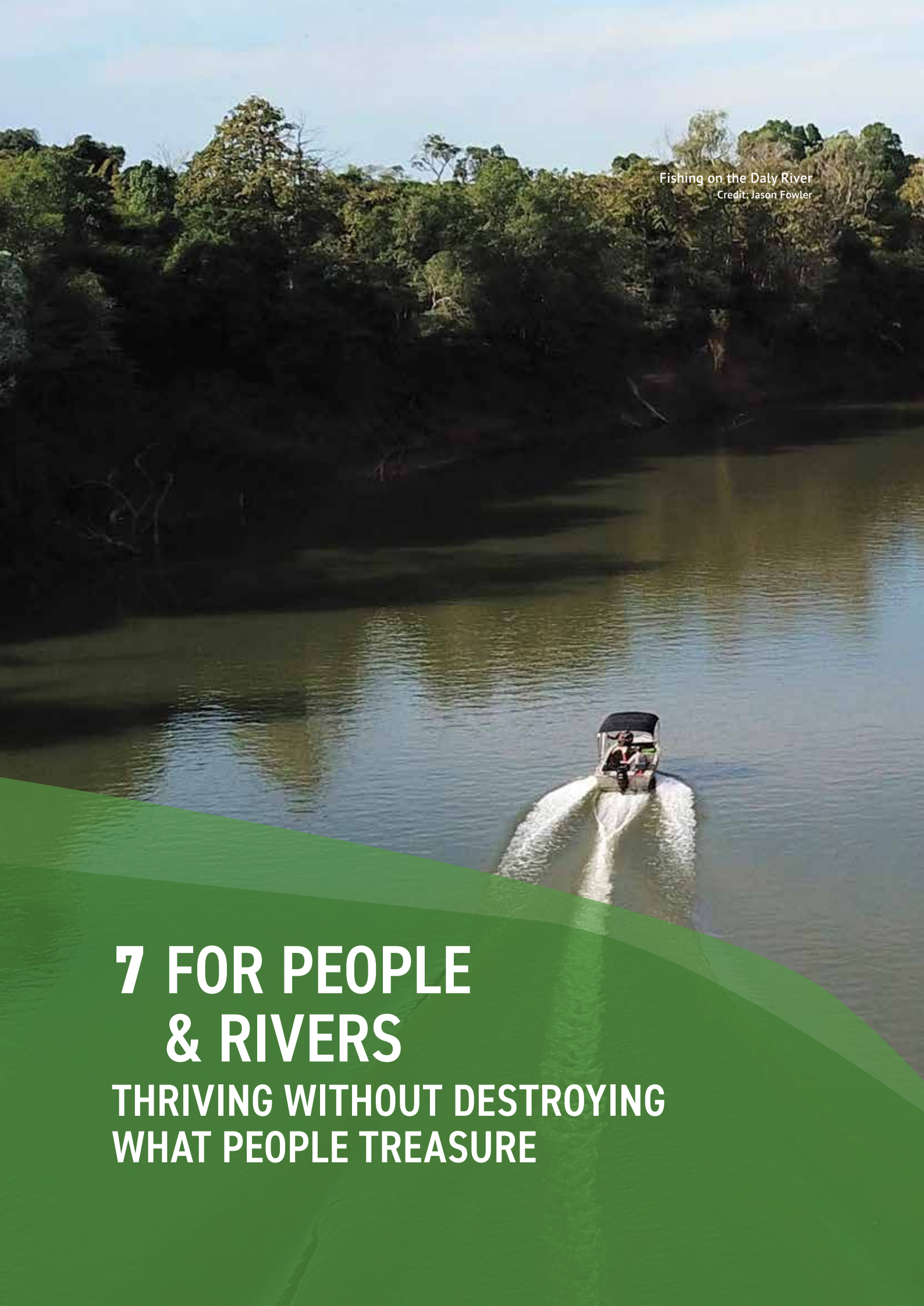
‘Aboriginal cultural values, heritage and knowledge of Yarra River land should be acknowledged, reflected, protected and promoted.

The role of the traditional owners as custodians of Yarra River land should be acknowledged through partnership, representation and involvement in policy planning and decision-making.’

The *Yarra River Protection (Wilip-gin Birrarung murrn) Act 2017* established the Birrarung Council, an independent advisory group with up to 12 members. At least two members must be chosen by the Traditional Owners. The extent to which it will enable the Wurundjeri people to influence river management is unclear. The law does not create water access or usage rights, nor does it accord the Traditional Owners a direct role in decision-making. However, Victoria has started treaty negotiations with Aboriginal Victorians, which may lay the foundations for a more central role for Traditional Owners in river management [476].

Yarra River, Templestowe, Victoria
Credit: Wikimedia





Fishing on the Daly River
Credit: Jason Fowler

7 FOR PEOPLE & RIVERS THRIVING WITHOUT DESTROYING WHAT PEOPLE TREASURE

7.1. Rivers in a modern economy	7.4 Theme 3: Genuinely sustainable development
7.2 Theme 1: River protection	7.5 Final words
7.3 Theme 2: Water governance	

7.1 RIVERS IN A MODERN ECONOMY

The concerted push since mid-last century for large irrigation schemes in the North, backed by billions of dollars in public subsidies, has little to show for it. Irrigated cropping accounts for only about 1% of regional economic activity and jobs (section 4.2). But the rhetoric promoting the industry remains the same. Despite acknowledging that ‘failed projects and plans litter the north’, the White Paper on Developing Northern Australia promises that irrigation developments will now bring prosperity, jobs, population growth and national security.

While there is much expert analysis as well as historical evidence to dispute such claims (section 4.3), some in governments and communities continue to promote the industry because of a pervasive assumption that exploitation of available water is essential for prosperity and degradation is a necessary cost of progress. After all, that has been the approach to economic development in Australia since colonisation. While rural development experts now reject that in favour of multi-sectoral, place-based approaches that value the natural and cultural distinctiveness of different regions (section 4.2, Box 3), it remains entrenched in parts of government.

To sustain thriving rivers in the Wet-Dry Tropics therefore requires not only new policies and institutions focused on protecting rivers, but rejection of the mindset that accepts river degradation as inevitable for people to prosper.

As indicated by surveys and focus groups (section 3.5), most people in Australia’s North treasure their healthy, free-flowing rivers teeming with wildlife and steeped in cultural significance. With refocused funding and strategic support from governments, they will be strongly motivated to develop new ways of prospering while nurturing rivers.

WHY AUSTRALIA NEEDS TO REPLACE THE WHITE PAPER

Few would disagree with the desire of governments expressed in the White Paper – that, by 2035 [60]:

‘Governments want northern Australia to be meeting its full potential, to benefit people living there as well as those around the country.’

But the ‘full potential’ outlined in the White Paper – irrigated agriculture on a vast scale – seems a meagre and outdated vision for a region of such natural and cultural vibrancy. And the benefits promoted for people – the jobs to build dams, plant and plough fields, pick produce, drive trucks – are not those sought by many people (section 4.3).

Although the White Paper says, 'Our north's future will come from its people', the paper was not developed by the people of the North. And according to stakeholder analysis and surveys, large-scale irrigation is not the future desired by most northern Australians. For most residents that have been surveyed, including Traditional Owners, sustaining the health of rivers is preeminent [16,164,193,201].

The White Paper says the North could become 'an exemplar of sustainable development.' But, say CSIRO researchers, Australians should face up to the inherent unsustainability of large-scale irrigation projects [314]. All Australia's major irrigation provinces, in the Murray-Darling, Burdekin and Ord regions, have sustained major environmental and cultural damage.

Northern Australians are talented and have ingenuity, says the White Paper. But there is little ingenuity evident in the proposal to develop irrigation as the mainstay of northern development. It has been tried over and over and failed. It is probably not even economically viable, according to several economic analyses [227,245,251,303,477]. For some decision-makers, viability is apparently not essential [229,478]. The White Paper says the result will be a safe, secure Australia, harking back to the old colonial idea of irrigated fields as evidence of productive occupation of lands.

The White Paper says Australia should 'take advantage of our strengths and our natural advantages.' But large-scale irrigation will threaten many of the natural advantages treasured by people. It would render the Wet-Dry Tropics less distinctive and less special. The White Paper fails to embrace the strengths of the North – including its thriving rivers, rich aquatic wildlife and vibrant cultures – as the foundations of development opportunities rather than impediments.

The North needs a new plan – one that emerges from the region rather than being imposed, and one that delivers on the rhetoric of the White Paper by sustaining the 'natural advantages' of the region while supporting genuinely sustainable development.

Northern Australians are 'talented' and have 'ingenuity', says the White Paper. But there is little ingenuity evident in the proposal to develop irrigation as the mainstay of northern development.

PLANNING A DIFFERENT FUTURE FOR RIVERS AND PEOPLE

In this final chapter, we focus on the broad reforms needed for sustaining thriving river systems in the North. Rather than laws, policies and development programs narrowly focused on exploiting rivers as resources, it requires:

- policies that prioritise the protection of rivers as ecological, cultural and social treasures (theme 1)
- governance arrangements to ensure transparent, evidence-based, precautionary decision-making about water use and the meaningful involvement of Traditional Owners and communities (theme 2)
- support for people to prosper in the North without degrading rivers, based on best-practice, place-based, multi-sectoral rural development policies (theme 3).

7.2 THEME 1: RIVER PROTECTION

'Land, water and people are inextricably connected, which means unity of land, water and Indigenous people. ... We have cultural and kinship responsibilities and obligations under customary law to look after water.' (Mary River Statement 2009 [67])

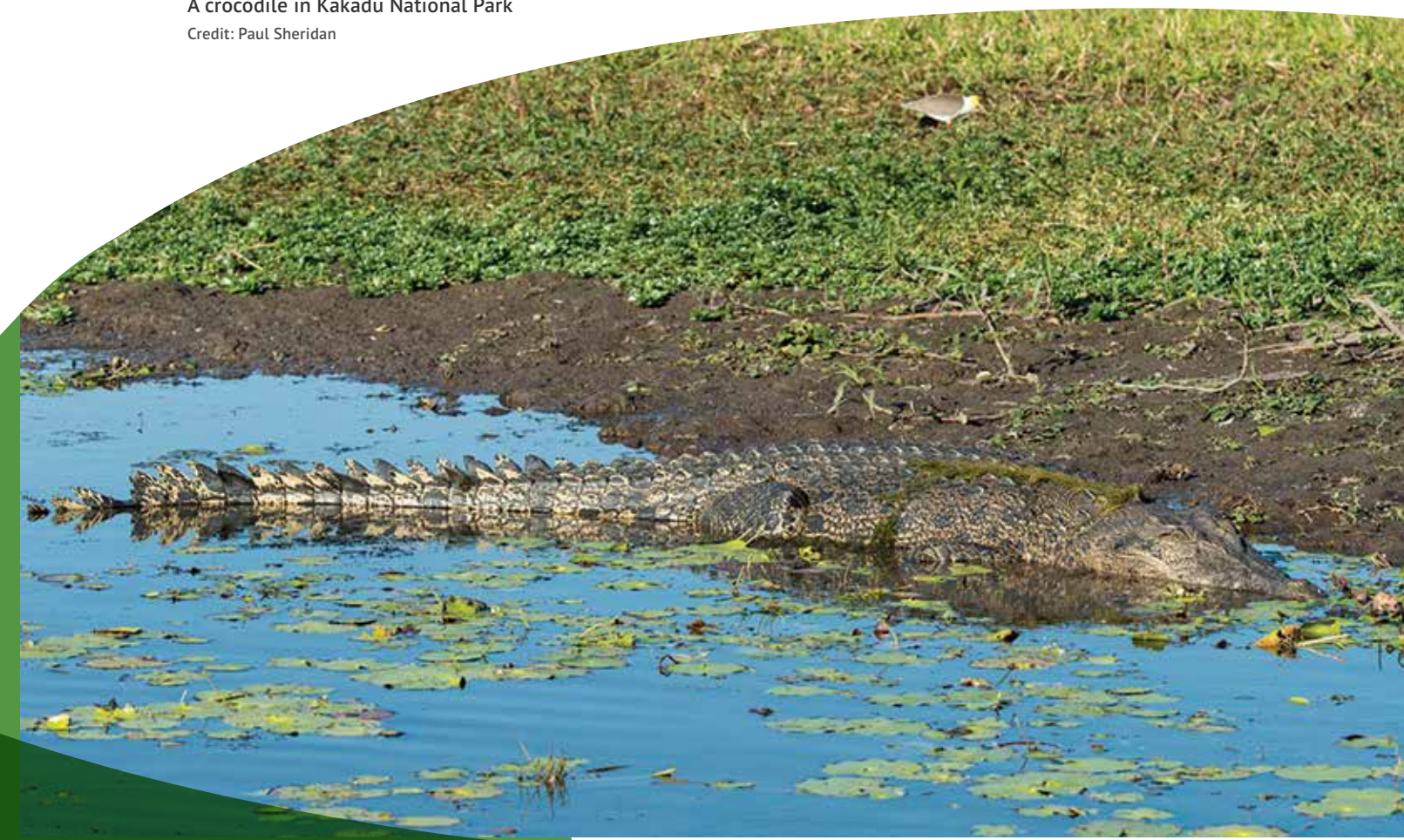
'We must envision a new way of interacting with floodplains – these brilliant social-ecological systems that are not separate to rivers but rather part of the riverine landscape.' (Parsons and Thoms 2021 [479])

'New approaches to water allocation planning and management are needed to ensure that Indigenous people's water related values, ethics, and practices can shape allocation outcomes, including distributive outcomes.' (Douglas et al. 2019 [480])

With one of the world's great concentrations of free-flowing rivers – an increasing rarity, particularly in tropical areas – Australia has the potential to be a global leader in maintaining and restoring thriving rivers. This is consistent with the central importance of rivers to the lives of many northern Australians – spiritually, culturally, recreationally and economically. Because current water laws and policies have been designed primarily to facilitate exploitation, new laws and policies are needed to facilitate the protection of high-value river systems.

Some northern catchments have already suffered evident degradation due to development and there has been little or no attempt to repair this damage. It is not acceptable under any credible conception of sustainability to further degrade these rivers and catchments by incrementally downgrading their values, especially those of national and international significance. Trade-offs accepted by governments as inevitable in water allocation planning should be avoided, particularly given the outstanding environmental and cultural values at stake and the possibilities for economic advancement that don't involve harmful compromises.

A crocodile in Kakadu National Park
Credit: Paul Sheridan



RECOMMENDATION 1. TURN THE POLICY PRIORITY TO RIVER PROTECTION

1.1 DEVELOP LAWS AND POLICIES TO PROTECT HIGH-VALUE RIVERS AND ASSOCIATED HABITATS (WETLANDS, FLOODPLAINS AND AQUIFERS)

The National Water Initiative says Australia's governments should develop laws and policies to identify 'surface and groundwater systems of high conservation value and protect and enhance those values' [176]. Federal government leadership is needed to focus attention on this neglected provision and engender commitments by all governments. Identification of the highest priority unprotected rivers in the renewed National Water Initiative would be an inspirational way to herald a commitment to river conservation.

There has been a recent flowering of river protection models around the world, as exemplified by the case studies in Box 7. These may help inspire the emergence of models that are aligned with the cultures and aspirations of people in Australia's North and compatible with Australian legal frameworks.

Protecting entire systems – rivers and streams, floodplains and aquifers – will require state and territory governments to enact tenure-blind mechanisms to prohibit harmful activities, consistent with the recommendation in the *Science Statement for Protecting the Kimberley's Fitzroy River* for a buffer zone along the river to exclude 'native vegetation clearing, hydraulic fracturing, mining and large water extraction projects' [28]. This would not constrain native title rights, cultural use, compatible economic activities (including most existing agriculture) or recreation.

1.2 STRENGTHEN PROTECTION OF CULTURAL HERITAGE AND FACILITATE TRADITIONAL OWNER MANAGEMENT OF RIVERINE ECOSYSTEMS

One foundation of new river laws should be recognition and strong protection of Indigenous cultural values. River protection models elsewhere have demonstrated the potential for laws to reflect hybrid cultures (Box 7). New laws should include articulation of the perceptions and values of rivers in Indigenous terms, as exemplified in the *Yarra Act*, strict protection of cultural heritage as identified by Traditional Owners, and support for Traditional Owners to sustain their cultural connections and exercise their custodial responsibilities for managing river systems. This could be achieved under new co-governance regimes, and management plans with support by Indigenous ranger programs. Several Indigenous organisations have clearly specified their priorities for river protection (Box 8).

1.3 STRENGTHEN PROCESSES FOR WATER ALLOCATION TO PREVENT ENVIRONMENTAL AND CULTURAL HARM

Where river systems are not wholly protected, reforms are needed to optimise the sustainability of any water-focused developments, including a requirement for transparent water planning to inform allocations, as required under the National Water Initiative, and assessments of cumulative catchment impacts. Identification and strict protection of both cultural and environmental flows are essential.

BOX 8. SOME WATER REFORM PRIORITIES, EXCERPTS FROM NORTHERN POLICY STATEMENTS

GARMA INTERNATIONAL INDIGENOUS WATER DECLARATION (2008) [481]

'We the Indigenous Peoples of the World declare that: Water is not a commodity. Water is a spirit that has a right to be treated as an ecological entity, with its own inherent right to exist.'

MARY RIVER STATEMENT (2009) [67]

A declaration from delegates of the North Australian Indigenous Experts Water Futures Forum.

'Indigenous people have always been part of and are crucial to the maintenance of our ecosystems, and therefore want to ensure minimal impact from settlement and unsustainable development across north Australia.'

PRINCIPLE 1: LAND, WATER AND PEOPLE ARE INEXTRICABLY CONNECTED, WHICH MEANS UNITY OF LAND, WATER AND INDIGENOUS PEOPLE.

Principle 7.3: Indigenous peoples have responsibilities and obligations in accordance with Indigenous laws and customs. We have responsibility for maintaining the rivers and the environment and ecosystem in their natural state so as to ensure their sustainability of this whole environment.

POLICY STATEMENT ON NORTH AUSTRALIAN INDIGENOUS WATER RIGHTS (2009) [482]

A statement by the North Australian Indigenous Land and Sea Management Alliance and the Indigenous Water Policy Group.

'Maintaining water flows is fundamental to ensuring the vitality and existence of Indigenous heritage and spirituality.'

Policy 2: To ensure cultural rights and the equitable use of the consumptive, commercial allocation of water, water legislation and policy must include an allocated Cultural Flow (in accordance with Articles 8, 25-28 of the United Nations Declaration on the Rights of Indigenous Peoples UNDRIP). Cultural Flows are water entitlements that are legally and beneficially owned by Indigenous peoples and are of sufficient and adequate quantity and quality to maintain the spiritual, cultural, environmental, social and healthy livelihoods of Indigenous peoples of northern Australia.

FITZROY RIVER SCIENCE STATEMENT (2017) [28]

'Science shows that the most effective way to protect the remarkable natural and cultural values of the river is to: a) create a protected area upstream to eliminate the threat of dams; b) reduce the impacts of landscape-scale threats such as frequent intense fire, weeds and over-grazing that affect water quality; and c) legislate for a management plan that includes a buffer zone along the river that protects important seasonal wetlands; the alluvial aquifers and other groundwater conduits on which dry season refuge pool are reliant, and the floodplains from which the aquifers recharge. The buffer zone must exclude native vegetation clearing, hydraulic fracturing, mining and large water extraction projects.'

Credit: Kerry Trapnell

BOX 8. (CONTINUED)

A CONSERVATION AND MANAGEMENT PLAN FOR THE NATIONAL HERITAGE LISTED FITZROY RIVER CATCHMENT ESTATE (2020) [13]

'The Martuwarra is a gift to human and non-human beings, such as the birds, the fish, water creatures, animals and all the plants within this system ... we advocate the protection of all river tributaries and wetlands which re-charge and connect the ancient aquifers underground to surface water systems.'

Position statement 6: The Martuwarra Council seeks formal recognition that the River's variable flow regimes are an important feature of the cultural-natural heritage of the region. Therefore, any disturbance resulting from large scale irrigation extractions or other consumptive purposes is a threat to these nationally recognised heritage values and the Martuwarra's right to flow as a living entity. All the water that make up these flow regimes is already allocated to Traditional and environmental uses and values – it sustains people and places, plant, animal and fish populations and customary harvestable production, and community and spiritual connections.

Position statement 7: The Martuwarra Council proposes to formalise a buffer zone that delineates a spatial boundary, which protects the River and its floodplains and identifies their high cultural and social-ecological significance. The rationale for the buffer is to ensure that management and any proposed development strengthens cultural or ecological values.

THE ROPER WATER RIGHTS COALITION STATEMENT TO GOVERNMENT (2022) [14]

'We want a ban on all further water extraction, licenses and surface water harvesting in the Roper catchment, including the groundwater and floodplains that are the life of the River.

We want evidence that environmental and Indigenous cultural values are protected and made into law.

Our scientific and cultural knowledge of freshwater and saltwater Country came long before Colonisation and must be listened to and prioritised.'

Credit: Kerry Trapnell

7.3 THEME 2: WATER GOVERNANCE

'Our water is part of our native title through our cultural and ceremonial practices that are part of the birds, animals, plants and us.' (Mary River Statement [67])

'We all know development will happen if you let it happen. We need to create an opportunity to control it. ... We need statutory recognition for our rights, separate to heritage. Then we can talk about planning and licensing.'

(Bunuba Dawangarri Aboriginal Corporation Traditional Owner [193])

'Earning the trust and confidence of the communities and peoples of the Kimberley and Pilbara is essential to being able to successfully progress irrigated fodder developments.'

(WA Department of Primary Industries and Regional Development (2020) [483])

Current decision-making processes about rivers are largely inimical to sound governance in their narrow, piecemeal focus on water extraction, deficient engagement processes, and government-centric decision-making in which a commitment to irrigation has been pre-determined without consent or support by Traditional Owners and without any social licence for the industry. Governments have largely lost the trust of communities in decision-making about water.

A foundational question for governments is, what should be the role of Traditional Owners, who have governed human activities in the North for 50,000 years or more and who have legal and customary rights over most of the region? The CSIRO's northern catchment reports explained that as custodians, Traditional Owners understand their position in decision-making 'as fundamentally different from, and prior to, all other stakeholders' [211]:

'From this perspective, rather than being participants, the most appropriate Indigenous role is one of Traditional Owner oversight and control over a stakeholder consultation process in which government and development proponents participate as stakeholders alongside other equivalent non-Indigenous community interests.'

International and national agreements and statements by Indigenous groups have outlined principles and elements of appropriate governance models (Box 9).

RECOMMENDATION 2. IMPLEMENT BEST-PRACTICE GOVERNANCE

2.1 ENACT UNDRIP AND NWI GOVERNANCE PRINCIPLES

Governance should be strengthened by enacting relevant principles under the United Nations Declaration on the Rights of Indigenous Peoples and the National Water Initiative Agreement. This includes UNDRIP Article 32.2, which requires that the free and informed consent of Indigenous peoples be obtained before the approval of projects affecting their lands or territories and other resources.

The latest assessment of the National Water Initiative by the Productivity Commission says that planning processes 'need to be upgraded to best practice', including recognising the needs of Aboriginal and Torres Strait Islander people, clearly specifying environmental objectives and outcomes, involving appropriate engagement with stakeholders and communities, and having a strong focus on climate change [389].

Elements of sound governance include:

- respecting Traditional Owner ways of perceiving and relating to rivers, recognising Traditional Owners as partners and supporting their ongoing custodianship of rivers
- implementing processes to optimise the transparency, evidence base and accountability of decision-making and meaningfully engage communities
- focusing on catchment-wide protection and restoration.

Northern Indigenous groups have also proposed a range of institutional models that would strengthen governance, including regional, basin or catchment authorities or a water commission [13, 484]. Institutions and processes should be codesigned with Indigenous groups, in close consultation with communities and other stakeholders.

BOX 9. SOME RELEVANT POLICIES AND PRINCIPLES TO INFORM GOVERNANCE REFORM

UNITED NATIONS DECLARATION ON THE RIGHTS OF INDIGENOUS PEOPLES

Article 27.1. States shall establish and implement, in conjunction with indigenous peoples concerned, a fair, independent, impartial, open and transparent process, giving due recognition to indigenous peoples' laws, traditions, customs and land tenure systems, to recognize and adjudicate the rights of indigenous peoples pertaining to their lands, territories and resources, including those which were traditionally owned or otherwise occupied or used. Indigenous peoples shall have the right to participate in this process.

Article 32.2. States shall consult and cooperate in good faith with the indigenous peoples concerned through their own representative institutions in order to obtain their free and informed consent prior to the approval of any project affecting their lands or territories and other resources, particularly in connection with the development, utilization or exploitation of mineral, water or other resources.

MARY RIVER STATEMENT (2009) [67]

Principle 4: Water dealings based on free, prior, and informed decisions and engagement with Indigenous communities at all levels. This means representative bodies and Indigenous communities on the ground be fully informed and participate in process (Traditional Owners on country).

Principle 7 (in part):

- Indigenous peoples have responsibilities and obligations in accordance with Indigenous laws and customs. We have responsibility for maintaining the rivers and the environment and ecosystem in their natural state so as to ensure their sustainability of this whole environment.
- Indigenous people need to be the primary interface in the planning and development of water usage proposed and regulated.

POLICY STATEMENT ON NORTH AUSTRALIAN INDIGENOUS WATER RIGHTS (2009) [482]

Policy 1. Indigenous peoples' traditional ownership must be fully recognised in Australian law. The Native Title Act should be enhanced to provide for Indigenous rights to be recognised in the modern economy regardless of legal proof of native title.

Policy 4. The planning and ongoing management of water resources will be done jointly with Indigenous traditional owners, native title groups and State and Territory water agencies (in accordance with Articles 8, 18, 19, 23, 26-29 & 32 UNDRIP).

A CONSERVATION AND MANAGEMENT PLAN FOR THE NATIONAL HERITAGE LISTED FITZROY RIVER CATCHMENT ESTATE (2020) [13]

Position statement 10: The Martuwarra Council recognises that heritage protection relies on having equitable and continuing models of governance that recognise cultural knowledge and build on customary law. The Council's proposed models of co-governance would formalise the respect and application of these peaceful and respectful systems of co-governing. The Martuwarra Council has invited the Western Australian Government into negotiations on a co-governance model, offering an invitation to the Western Australian government to become a formal partner in one of the world's longest standing systems of social-ecological management.

Credit: Nick Covelli

BOX 9. (CONTINUED)

Position statement 11: The Martuwarra Council is advocating for the establishment of a Martuwarra Fitzroy River catchment authority as a statutory body based on principles of co-governance and giving primacy to Indigenous knowledge, law and practice across the whole of the Martuwarra catchment including the King Sound. This should be complemented by gazettal of the catchment as an Indigenous Protected Area in accordance to the Fitzroy River Declaration.

CLOSING THE GAP AGREEMENT (2020) [485]

18. This Agreement is a commitment from all Parties to set out a future where policy making that impacts on the lives of Aboriginal and Torres Strait Islander people is done in full and genuine partnership.

20. The Parties acknowledge that strong Aboriginal and Torres Strait Islander cultures are fundamental to improved life outcomes for Aboriginal and Torres Strait Islander people.

Outcome 15: Aboriginal and Torres Strait Islander people maintain a distinctive cultural, spiritual, physical and economic relationship with their land and waters.

ABORIGINAL EMPOWERMENT STRATEGY POLICY GUIDE (WA, 2021) [486]

'A core principle of the Strategy is that policy decisions about Aboriginal people cannot be made without Aboriginal people. For decisions with high potential impact or opportunity for Aboriginal people, this means partnership and/or shared decision-making. For other decisions, it means genuine engagement with affected Aboriginal people at a level proportional to the potential impact or opportunity.'

PRINCIPLES FOR FRESHWATER MANAGEMENT, NORTHERN LAND COUNCIL REGIONAL COUNCILS (2021) [487]

1. Aboriginal people retain cultural and kinship responsibilities and obligations under customary law to look after land and water.
2. Responsibilities to maintain and strengthen our distinctive cultural relationship with lands and waters must be supported and maintained for the benefit of future generations.
3. Rights to access and use water for cultural and social practices under Native Title Law must be upheld and any diminution of these rights must be fairly negotiated or compensated.
4. Aboriginal people have a right to fair and equitable access to water for livelihoods and economic development.
5. Aboriginal people must be central to planning and decision-making processes about the management of land and water that may affect our communities or country.
6. Aboriginal people must be meaningfully consulted about the development, implementation and evaluation of all water policy, legislation, planning and administrative functions that may affect us, with a consultation process that enshrines the principles of free prior and informed consent.
7. Aboriginal people have the right to determine and develop our own priorities and strategies for the sustainable management or use of water.
8. The equitable participation of Aboriginal people in management and decision-making processes about water is determined with Aboriginal people, costed and adequately resourced.

Credit: Nick Covelli

7.4 THEME 3: GENUINELY SUSTAINABLE DEVELOPMENT

'Rural is not synonymous with agriculture and is not synonymous with economic stagnation'. (OECD 2015 [248])

'Importantly, many First Peoples hold the view that if we are to develop sustainable lives and livelihoods on country with our fellow Australians, it must be a true partnership which reflects the collective wisdom: values, ethics and the enshrined laws of both parties'. (Taylor et al. 2017 [488])

'It is not for the Government, or anyone else, to define what 'success' looks like – Aboriginal people must be free to make their own decisions about what makes a "good life" and how to achieve it'. (Aboriginal Empowerment Strategy Working Group 2021 [489])

'Culture is ... not a barrier to economic development, but rather one of the keys to its success'. (Enabling Prosperity, Urbis 2014 [490])

One virtue of the White Paper was that it stimulated a focus on northern Australia and showed the preparedness of governments to invest in its future. But instead of focussing policy and funding primarily on a single sector with unsustainable practices, dubious viability and lack of a social licence, governments should support genuinely sustainable development options aligned with the cultures, circumstances, aspirations and skills of people in the North – and consistent with the place-based, multi-sectoral approach of the 'new rural paradigm' recommended by the OECD 248,249] (Box 3). With this approach, protecting the outstanding values of the northern rivers is entirely compatible with growing the economy and better supporting the people who live there.

This will also help Australian governments meet their policy commitments to address social and economic barriers to the wellbeing of Indigenous Australians, better involve Indigenous people in decision-making and strengthen protection of Indigenous cultural heritage (see Box 9 for some of these policy commitments).

RECOMMENDATION 3. REPLACE THE WHITE PAPER WITH A PLAN TO SUPPORT SUSTAINABLE LIVELIHOODS

3.1 REVIEW THE WHITE PAPER AND ASSOCIATED POLICIES AND PROGRAMS

As part of the proposed refresh of the White Paper on Developing Northern Australia, the Australian Government should commission an expert review and consult with stakeholders, the public and experts to determine how best to support genuinely sustainable development in the North that is aligned with broader government commitments such as Nature Positive, meeting climate targets, Closing the Gap and protecting cultural heritage. Questions to address include those not asked when the White Paper was prepared:

- By what criteria should sustainable development proposals be assessed?
- What development pathways are consistent with sustaining and restoring the cultural and environmental values of the North, including healthy river systems and catchments?
- What development options align with the aspirations, cultures and skills of Traditional Owners and other northern residents?
- How can governments best provide support for sustainable development options?

3.2 INVEST IN EVIDENCE-BASED AND CO-DESIGNED DEVELOPMENT PATHWAYS

There is no need to accept degradation as a cost of economic development. Federal, state and territory governments should invest in the development of new and existing industries in the North compatible with the long-expressed aspirations of people who live there. Existing industries with promise include Indigenous ranger services, tourism, bush products (foods and medicines), arts, carbon farming and small-scale horticulture (Box 10, Box 11, Box 12). Emerging natural capital and nature repair markets may also hold promise.

Co-designing development opportunities with Traditional Owners is essential for achieving goals such as those in the National Agreement on Closing the Gap, Western Australia's Aboriginal Empowerment Strategy and the Northern Territory's Everyone Together Strategy. Treaty negotiations, underway in Queensland and the Northern Territory, are an opportunity to develop preferred pathways to development. Various government and non-government policies offer principles to guide such planning (Box 9).

BOX 11. SOME RELEVANT DEVELOPMENT PRINCIPLES IN GOVERNMENT AND NON-GOVERNMENT POLICIES AND STRATEGIES

NATIONAL AGREEMENT ON CLOSING THE GAP (2020) [485]

Aboriginal and Torres Strait Islander people must determine, drive and own the desired outcomes, alongside all governments.

Shared decision-making: Aboriginal and Torres Strait Islander people are empowered to share decision-making authority with governments to accelerate policy and place-based progress on Closing the Gap through formal partnership arrangements.

The Parties agree to implement all activities under this Agreement in a way that takes full account of, promotes, and does not diminish in any way, the cultures of Aboriginal and Torres Strait Islander people.

ABORIGINAL EMPOWERMENT STRATEGY POLICY GUIDE (WA, 2021) [486]

Cultural economies offer diverse opportunities for participation, drawing on strengths in areas such as the arts, historical and heritage knowledge management, knowledge about Country, expertise in Aboriginal languages and cross-cultural engagement, and legal rights over land, waters and other resources. Tourism, arts, and land management are growth areas for cultural economies.

In addition to cultural economies, there is a wide range of opportunities for Aboriginal people's skills, creativity, know-how and resources to respond to national and global trends, such as the increasing importance of managing climate change through renewable energy, the shift to digital platforms and doing business remotely, and the increasing significance of the service economy.

EVERYONE TOGETHER ABORIGINAL AFFAIRS STRATEGY (NT, 2021) [491]

Everyone Together ... reflects the importance of ensuring that people and place are at the centre of government policy design and service delivery and that people are empowered to determine their own futures.

The NT Government is committed to developing a sustainable Aboriginal tourism sector over the next 10 years that will focus on strengthening the five pillars of living: cultures, communities, lives, spaces and interactions. These pillars will be key to promoting new tourism opportunities within the Territory to share its beauty with each other and our visitors.

ECONOMIES ROUNDTABLE, KIMBERLEY (2005) [492]

A workshop on sustainable livelihoods in the Kimberley found strong support for the development of 'natural resource based businesses that were small-scale, non-extractive and family-based' [253]. There was strong opposition to 'outdated resource-based development paradigms' [492]. Principles included:

- Acknowledgement that culture guides economic activity for Indigenous people and appropriate development is based on healthy country and strong culture.
- The local economies of hunting, fishing, looking after people, culture and country need to be valued and supported.
- Development of a new economic system based on a diversity of enterprises that support the aspirations of Kimberley people.

Credit: Alamy Stock Photo

BOX 11 (CONTINUED)

KIMBERLEY LAND COUNCIL (2019) [493]

The Kimberley Land Council advocates that economic development be guided by 'traditional law and culture, which remains strong' and part of the everyday lives of Traditional Owners. Economic development should be consistent with cultural obligations.

Economic development in Northern Australia must place Indigenous people at its centre rather than on the periphery waiting for 'trickle down' benefits.

A CONSERVATION AND MANAGEMENT PLAN FOR THE NATIONAL HERITAGE LISTED FITZROY RIVER CATCHMENT ESTATE (2020) [13]

Position statement 13: The Martuwarra Council seeks to implement appropriate economic development strategies that offer alternatives to the current exploitative mainstream vision for resource intensive, large-scale irrigation and mineral and energy resources development. The Martuwarra Council is critical of the development discourse that overstates the expected gains from such development. Rather it advocates a development discourse that supports or strengthens culture and ecosystem values and provides livelihood outcomes for Aboriginal people.

Position Statement 15: The Martuwarra Council seeks appropriate economic planning that:

- sustains livelihoods while conserving the spiritual, cultural and environmental health and wellbeing of the Martuwarra Fitzroy River and its people
- promotes the significance of the region's cultural and natural values
- encourages ethical public and private investment in socially and ecologically appropriate economic development
- develops the local Indigenous workforce for the new and emerging regional industries that conform to the values clarified in this document
- achieves higher employment and greater prosperity to the community through business and employment activities that are sympathetic to and consistent with heritage, cultural and ecological conservation.

Credit: Alamy Stock Photo

BOX 12. DEVELOPMENT OPTIONS FOR NORTHERN AUSTRALIA

The following industries have previously been identified as potential development or expansion options in northern Australia.

ECOSYSTEM SERVICES

The North is well positioned to take advantage of 'the rapidly developing global sustainability economy', including in the following ways [494]. Much of it could be undertaken by Indigenous ranger groups.

Carbon farming: Expand Indigenous ranger programs to increase the supply of carbon offsets. One estimate is that expansion of carbon farming in northern Australia could realise more than \$2 billion over a decade [494]. Savanna burning is a proven industry – in 2019, 75 projects registered with the Emissions Reduction Fund produced more than \$100 million in credits and employed more than 400 Indigenous rangers [493]. There may be opportunities in other carbon markets, due to Indigenous carbon being considered a premium product [251].

Biodiversity conservation: Supply an emerging market for biodiversity offsets. Conduct monitoring and management of threatened species. Participate in ecological research.

River rehabilitation: Restore degraded areas such as riparian areas degraded by cattle or invasive species.

Mine rehabilitation: Provide rehabilitation services for current mining operations and restore priority legacy sites [494].

AGRICULTURE AND BUSH FOOD PRODUCTION

Pastoralism: Focus production on pastoral land with high resilience and productive potential [494]. Rehabilitate degraded areas. Develop value add products and diversify economic activities to include ecosystem services and nature-based tourism.

Small-scale horticultural production: Focus on high-value products with a small environmental footprint. Several niche small-scale irrigated cropping businesses operate successfully in the north taking advantage of local demand and seasonal market fluctuations in southern markets to overcome transport cost barriers. Some Traditional Owners have an interest in developing market gardens to supply local communities and tourists, and for growing bush foods, which require small amounts of water [211].

Bush foods and traditional medicines: Invest in the production or harvest of traditional products. The global market is worth more than \$300 billion [251,495,496].

TOURISM, RECREATION AND ARTS

Tourism: The tourism sector is already a major contributor to the economy of the north. For example, in the Northern Territory, 'domestic Aboriginal-focused visits' contribute about \$220 million to the economy [497]. The number of international tourists participating in Indigenous tourism activities in Australia increased by more than 40% from 2013 to 2018 (almost one million tourists), and there is unmet demand [498].

Nature tourism: Tourism Australia's Consumer Demand Project found that world class nature and wildlife, which abound in the North, are growing in importance as factors in travel decisions [499]. For the Northern Territory, the top two (of 18) destination brand values for domestic tourists were 'vast and a place for open spaces and nature and wildlife' [500].

Credit: Sarah Moles

BOX 12. (CONTINUED)

Cultural tourism: A survey by the Western Australia Indigenous Tourism Operators Council identified considerable potential to expand Indigenous-operated tourism ventures. While 20% of leisure visitors to the state had participated in an Aboriginal cultural experience, 66% indicated they would do so if it was readily available [501]. One initiative, supported by Tourism WA, is a 'Camping with Custodians' program to provide activities and accommodation around national parks [501].

Luxury tourism: This could be a promising focus for Traditional Owners – high-end products with 'unique and bespoke itineraries that are constructed with environmental and spiritual knowledge of Indigenous communities and entrepreneurs' [502].

Arts and crafts: Arts is one of the mainstays of Indigenous enterprise – the fifth most common type of activity by the top 500 Indigenous corporations (by income) [503]. Australia's Indigenous arts and crafts industry, involving some 19,000 Aboriginal and Torres Strait Islanders and 126 Indigenous art centres, was valued at about \$250 million in 2019–20 [504].

RENEWABLE ENERGY

Solar, tidal and wind energy production: The North offers very high solar energy yields, and has large tidal, wind and wave energy resources [494].

Algal biofuel production: This has been flagged as a potential industry warranting investigation [494].

Credit: Sarah Moles

BOX 13. THE POTENTIAL OF NATURE TOURISM

'Where would you go if you could go anywhere?' asked the New York Times travel desk in late 2019. After four months of intensive research, consultation and debate, they decided that the Kimberley was number five on their list of the world's top 52 destinations for 2020 [505]. 'Australia's wild north-western corner, a fantasy of escape, rich in epic landscapes and otherworldly corals, a bucket list of natural wonders, a gorgeous natural escape' was how they described it [505–507]. The Kimberley was the only Australian destination to make the list.

Although 2020 turned out to be an unfortunate year for international travel, the listing highlighted the great potential for tourism growth in the Kimberley – and right across the north. Tourism experts consider it 'a highly prospective industry' for growth, and there is substantial interest from Aboriginal entrepreneurs, communities and bodies corporate in further developing the industry [251].

Tourism is already economically important in the Kimberley, generating more jobs and revenue (1,454 / \$447 million) than agriculture (872 / \$391 million) and far more jobs than mining (640 / \$473 million) (figures from 2017–18 [508]). But despite the Kimberley's standout attractions, the tourism sector is small compared to that in most other regions in Western Australia and across northern Australia.

The preliminary results of a survey by tourism researchers from Curtin University indicate considerable potential for tourism growth in the Fitzroy catchment, with 40% of Western Australian respondents and 25% of respondents from other states stating they would potentially be interested in visiting in the next five years [509].

Tourism, of the right sort, offers many advantages as a sustainable development option for Indigenous communities – compatible with connections to country, and traditional environmental and social and cultural practices [509]. Tourism is also labour-intensive, and thus job-creating.

The tourism appeal of the Kimberley and the integrity of its brand relies fundamentally on the 'intactness of its natural environment and cultural landscape' [251]. Preliminary results of the survey by Curtin University researchers show that this is the most important factor influencing interest in visiting the Fitzroy Valley, with 91% of respondents rating this above the midpoint on the importance scale. The results also indicated that a national park in the Fitzroy Valley would increase the likelihood of visitation (likely boosting current visitation by 15%) and that World Heritage listing of the Kimberley would further increase the tourism appeal.

Credit: Robert Corbin

BOX 14. BUSH PRODUCT OPPORTUNITIES IN THE NORTH

'Commercial opportunities exist for a very wide range of bush products, including bush foods, bush medicines, essential oils, timber and wood products, crafts, seeds for horticulture, and wildflowers'.

Woodward et al, CSIRO (2019) [510]

The fledgling Indigenous-led bush products industry in Australia has great potential for growth – if it can be judiciously nurtured [510]. Industry analysts say the market demand is high [510–512], with the global market for functional foods estimated to be worth more than \$200 billion in 2018 [495] and that for complementary medicines worth more than \$100 billion [496]. Other potential bush products include essential oils, beauty products, seeds, nursery plants and cut flowers, and they often feature in Indigenous tourism ventures [510].

Bush product enterprises are a good fit for some Aboriginal communities – not only to generate income, but to achieve social, cultural and environmental benefits such as maintaining traditional knowledge and caring for country [510]. These sort of enterprises can 'provide sustenance on two levels' – income and meaning [513]:

Bushfoods provide to land management activities a unifying cultural motif: for Aboriginal people, there is no more powerful truth than that the land provides sustenance for the people.

Apart from the highly commercial production of macadamias, the Australian contribution to the bush foods market is as yet miniscule, based mainly on 13 products (in order of farm gate value in 2019–20): lemon myrtle, finger lime, Kakadu plum, wattle, mountain pepper, Davidson's plum, anise myrtle, bush tomato, anise myrtle, ribberries, lemon aspen, desert lime, quandong, muntries, bush tomato [511]. The farm gate value for these bush foods in 2019–20 was an estimated \$21 million (\$81 million total retail value), which was forecast to double by 2025. However, most production comes from cultivation rather than wild harvest [511] and Indigenous people's share of the industry is small [514].

One product is gubinge (*Terminalia ferdinandiana*), popularly known as Kakadu plum. It has the highest vitamin C content of any fruit and 'well documented nutraceutical, pharmaceutical and cosmeceutical properties' [515]. The industry output, most of it wild harvested, increased four-fold from 2011-12 to reach 51 tonnes in 2019-20, with a farm-gate value of \$1.6 million and retail value of \$4.3 million [511]. The demand reportedly far exceeds current supply. One of two major suppliers is a cooperative of nine Indigenous corporations – the Northern Australian Aboriginal Kakadu Plum Alliance, established in 2018 to protect the interests of Aboriginal enterprises and communities in the industry [516]. In 2019, the alliance supplied more than 20 tonnes of fruit, with a farm gate value of \$600,000, and processed gubinge powder, worth \$156,000 [517]. Enrichment plantings are being used in some areas to increase production.

Another product is wattle seeds, used commercially in breads, pastries and chocolate. The majority is harvested from the wild (15 tonnes in 2019–20). The farm-gate value in 2019–20 was \$1 million and the retail value was \$4.7 million. The industry is predicted to grow by 140% by 2025 [511].

The Indigenous-led bush products industry suffers from the well-known problems of new industries – limited capacity to match supply with demand, develop production capacity and markets, build product awareness and invest in research and development [510] – as well as problems more specific to small Indigenous communities in remote areas. Establishing such enterprises is 'a very complicated undertaking' and greater government support is required to help Indigenous businesses do so [515].

Credit: Alamy Stock Photo

7.5 FINAL WORDS

Fish flourish in all sorts of ways in the northern rivers. Some spawn only in high flows, others in low flows or during seasonal transitions [108]. The challenging extremes of the northern flow regimes have spurred evolutionary adaptation and innovation – as exemplified by the fluid genders and lifestyles of barramundi. The reliance of different fish on different types of flow means that large-scale water extraction or changes to flow regimes inevitably will be detrimental to some species, whatever the season.

This also offers a thematic hint to governments for determining development priorities – for there are also lots of ways for people to flourish in the North. Rather than following outdated policies that would concentrate resources and attention on one damaging industry – an industry not evolved in the North but the same the world over – governments can foster regional innovation and adaptation to support a diverse range of livelihood options that do not damage rivers.

Australia is privileged to still have the thriving rivers of the North. To not exploit them for irrigation is not to waste water and economic opportunity, but to safeguard enduring ecological and cultural systems that sustain rich communities of life and reciprocal, life-enriching relationships of care. It is to keep safe what many people treasure – the beauty and spiritual succour of rivers with unfettered flows and the pleasures of fishing, boating and swimming – as well as the essential basis of many existing livelihoods. This provides for many more ways for people to flourish in the future than one degrading industry, as well as opportunities that help achieve the goals of strategies such as Closing the Gap.

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APPENDIX

TABLE A1. AREAS OF IRRIGATED CROPPING IN THE WET-DRY TROPICS REGION

IRRIGATION AREA (CATCHMENTS)	IRRIGATED CROPPING AREA (HA)
Ord River (WA)(A)	17,000
Fitzroy River (WA)	2,600
Cape Leveque Coast (WA)	400
Daly River (NT)	4,400
Roper River (NT)	1,200
Mary, Finnis, Adelaide, Wildman rivers (NT)	7,300
Mitchell River (Qld)(B)	21,000
Flinders River (Qld)	1,700
Gilbert River (Qld)	700
Leichhardt River (Qld)	1,600
Normanby River (Qld)	1,300
Total	59,200

Source: Australian Bureau of Agricultural Resource Economics and Sciences 2021 [164]

Notes: The specified irrigated cropping areas are for catchments with >100 hectares of cropping. The ABARES data, updated in 2020, has been compiled from land use datasets collected by state and territory governments, combining land tenure and other types of land use information, fine-scale satellite data and information collected in the field. The specified cropping areas do not consistently match irrigation areas claimed in other sources. We have altered the specified area for the Ord River to accord with information provided to the Western Australian Parliament in 2019 (see Note A) [520].

(A) The ABARES dataset specified 7,900 ha for the Ord River but this is much less than the area commonly reported as irrigated: 14,000 hectares for stage 1 and about 7,000 hectares so far for stage 2 [238]. However, it matches the area reported by the Australian Bureau of Statistics as irrigated in 2020–21 (7,300 ha) [245]. Nonetheless, we have altered the figure to accord with the area reported in the Western Australian Parliament in 2019 [520].

(B) The water for irrigation in the Mitchell catchment mostly comes from outside the catchment, from Tinaroo Falls Dam (Barron River), which is not part of the Wet-Dry Tropics region. About two-thirds of the Mareeba-Dimbulah irrigation area is in the Mitchell River catchment (upper Walsh River area).

TABLE A2. GOVERNMENT FUNDING IN THE PAST DECADE FOR IRRIGATED AGRICULTURE IN THE NORTH

IRRIGATED AGRICULTURAL PROJECTS (COST)	\$ MILLION
Water resource assessments: Gilbert & Flinders (\$5m), Fitzroy (\$5m), Mitchell (\$5m), Darwin (Mary/Finnis/Adelaide/Wildman, \$5m), Roper (\$3.5m), Adelaide (\$2m), Victoria (\$3.5m), Southern Gulf (\$3.5m)	32.5
Feasibility studies: Nullinga Dam (\$5m) Lakeland Irrigation area (\$0.8m), Hughenden (\$2m), Ord siphon (\$0.2m), Ord stage 3 (\$2.5m), NT Irrigated Agriculture (\$1.0m)	11.5
Business cases, planning, assessments & approvals: Hughenden irrigation scheme (\$10m), Lakeland Irrigation Area (\$10m), Boraparte irrigation investigations (2018, \$3.4m), AROWS (Adelaide River Off-stream Water Storage, partly for irrigation) (unknown)	23.4
R&D: Water for Food West Kimberley projects (2014, \$15.5m), WA Northern Beef Futures program, mosaic agriculture (2015, assume \$5m), WA Northern Beef Development project (2020, \$0.2m), CRC Developing Sustainable Cropping Systems for Cotton Grains and Fodder Project (\$1.9m), WA Agricultural Research Collaboration: Northern agriculture (2023, \$6m), NT Government cotton research (unknown)	28.6
Infrastructure: upgrade of Ord irrigation channels (2022, \$77.1m), upgrade of Mareeba-Dimbulah scheme (\$33m, assume \$11m [33%] for Mitchell catchment), electrical upgrade for cotton gin, Kimberley (\$4m)	92.1
Infrastructure loan: Kimberley cotton gin (\$34m)	34.0
Total	222.1

Sources: [236,240,521–528]

Note: This is not a comprehensive accounting of funding. There is often poor transparency on government funding for irrigation projects.

TABLE A3. SOME MAJOR IRRIGATION DEVELOPMENTS PLANNED OR UNDERWAY IN THE WET-DRY TROPICS REGION

IRRIGATION DEVELOPMENT	STATE/ TERRITORY	PROPOSED WATER SOURCE	PROPOSED WATER VOLUME/ YEAR (GL)	PROPOSED AREA (HA)	STATUS
Singleton	NT	Groundwater	40	3,500	Under development
Douglas-Daly Stage II [529]	NT	Groundwater, surface water	?	15,000	Under development
Keep Plains [530,531]	NT	Surface water (Ord River Dam)	?	14,500 (original proposal)	Preferred proponent selected
Larrimah Agricultural Precinct [379,532]	NT	Groundwater	10	~2,000	Preferred proponent selected
Wildman Agricultural Precinct [379,533,534]	NT	Groundwater	8 + ?	16,000 (high-moderate suitability)	Preferred proponent selected
Adelaide River	NT	Surface water (off-stream storage)	17	2,000	Planning
Cotton farming (ad hoc) [205]	NT	Groundwater, surface water (flood water harvesting)	?	?	Ad hoc development underway
Gilbert River Irrigation Area [535]	Qld	Surface water (proposed dam, 323 GL)	130	17,900	Planning (business case completed)
Hughenden Irrigation Scheme (Flinders) [522,536]	Qld	Groundwater, surface water (proposed dam, 161 GL)	83 + ?	10,000	Planning (business case completed)
Lakeland Irrigation Area [537]	Qld	Surface water (proposed Palmer River dam, 205 GL)	80	10,000	Business case completed
15 Mile Irrigated Agriculture Project (Flinders River) [538,539]	Qld	Groundwater, surface water (off-stream storage)	?	918	Approval granted
Fitzroy River water allocation [190]	WA	Groundwater, surface water	Up to 408	?	Water allocation plan in preparation
Goomig Farmlands, Knox Plain, Ord River irrigation scheme, stage 2 [540,541]	WA	Surface water (Ord River Dam)	?	13,400	Under development
Cockatoo Sands, Ord River irrigation scheme, stage 3 [541]	WA	Surface water (Ord River Dam)	?	8,000	Planning

TABLE A4. IRRIGATED CROPPING POSSIBILITIES IDENTIFIED BY THE CSIRO IN THE WET-DRY TROPICS REGION

CATCHMENTS	MAJOR DAMS	CROPPING AREA	&/ OR	OFF-STREAM STORAGE	CROPPING AREA	&/ OR	GROUNDWATER	CROPPING AREA
Fitzroy	-	-		1,700 GL	160,000 ha cotton	&	120 GL	30,000 ha hay
Finniss, Adelaide, Mary, Wildman	436 GL (2 dams)	40,000 ha mangoes / 60,000 ha vegetables	&	600 GL	50,000 ha vegetables	&	35 GL	7,800 ha of vegetables
Mitchell	2,800 GL (4 dams)	140,000 ha sugar cane	OR	2,000 GL	200,000 ha cotton	&	5 GL	-
Gilbert	250 GL (2 dams)	20,000-30,000 ha mixed		-	-		-	-
Flinders	80 GL (6 dams)(A)	15,000 ha sorghum	OR	350 GL	10,000--20,000 ha		-	-
Totals	3,566 GL	220,000 ha		4,650 GL	465,000 ha		160 GL	38,000 ha

Sources: CSIRO [11,259,264,265,542]

Notes: The possibilities noted here are those identified in the CSIRO assessments as the most feasible options.

(A) In the Flinders River assessment, the CSIRO assessment recommended off-stream farm storages in favour of in-stream storages because they are about 10 times more cost-effective.

