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FLOODPLAIN WETLANDS AND WATERBIRDS OF THE CHANNEL COUNTRY

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Cover photos. Right: Red-kneed Dotterel (Ian Montgomery, Birdway). Left: reticulated wetland on the Cooper Creek floodplain

FLOODPLAIN WETLANDS AND WATERBIRDS OF THE CHANNEL COUNTRY

SUMMARY

This publication addresses floodplain wetlands of the Channel Country, located mostly in south-western Queensland and north-eastern South Australia. Four major river systems – the Georgina, Diamantina and Cooper (part of the Lake Eyre Basin), and Bulloo (in an adjacent basin) – traverse this arid region and support complex wetland ecosystems on densely channelised floodplains. They are intermittent rivers, each running a major flood on average at least once per decade, with intervening smaller floods. Most water is sourced outside the region in the zone of summer-autumn monsoonal rainfall. Major floods can inundate more than a million hectares of Channel Country wetland.

The wetlands experience 'boom and bust' cycles: frequent and often protracted dry periods are punctuated by infrequent and relatively short periods of inundation during which biological production is spectacular. Under boom conditions, vast swamp and channel networks provide temporary habitat for wetland fauna in the floodplains. Waterbirds arrive and breed, but most disperse downriver and to other regions, typically in less than a year, as bust (drought) conditions return.

The boom cycle delivers great biodiversity benefits. For waterbirds, the Channel Country floodplains are of global importance in multiple respects:

- Over 80 species have been recorded including more than a dozen migratory (Asian-breeding) species and a globally threatened species.
- Systematic surveys have documented huge numbers of waterbirds: conservatively 3–4 million, if not twice as many, during the 2000 and 2001 floods.
- For each of nearly 30 waterbird species, the Channel Country can at times support more than one per cent of the known population size.
- Around 20 species breed in colonies in the floodplain wetlands; there are at least 30 major colonies, spread across all river systems, with largest mixed-species (cormorant/heron/ibis) and pelican colonies both containing in the order of 50,000 nests.

Extensive reticulated wetland on the Cooper Creek floodplain

- For a suite of highly mobile species, these floodplains are probably the "engine-room" of recruitment for the entire population.

Nestling of the Eastern Great Egret, a colonial waterbird

Shrubby wetland on the Diamantina River floodplain

The Channel Country also is important for local human communities, holding substantial heritage values for indigenous Australians and supporting grazing, tourism and mining enterprises.

Potential loss of natural flooding regimes through future river regulation and water extraction is the greatest threat to the region's wetlands and waterbirds and to grazing on the floodplains. Small but cumulative water losses already occur. Planning, legislation and enforcement must provide the highest possible levels of protection for natural water regimes. Management of fire in wetland shrublands, control of thorny weeds and prevention of further pest introductions also are significant management challenges.

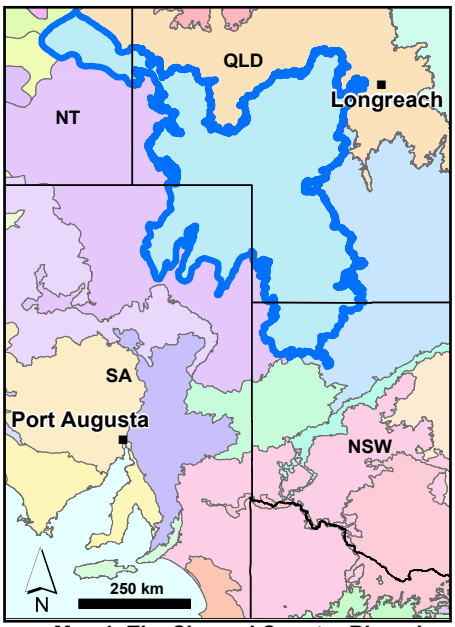
Natural and human-use assets will probably increase in importance as other regions of Australia continue to decline markedly due to water loss and severe landscape degradation. Bitter experience from the Murray Darling Basin demands a 'prevention rather than cure' approach: landholders, scientists and the wider community must avoid complacency and act now to safeguard the Channel Country's future.

Large numbers of waterbirds occur: flock of Glossy Ibis

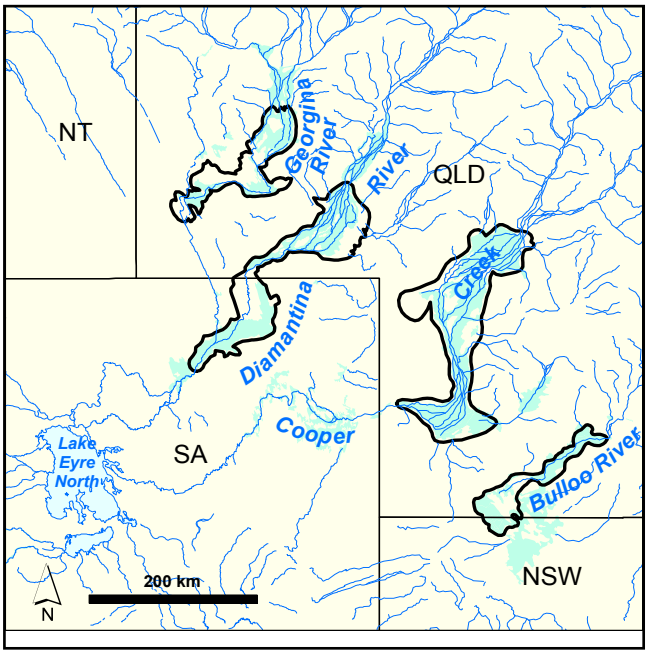
WHAT IS THE CHANNEL COUNTRY?

The 'Channel Country' may be described as that part of the Lake Eyre Basin where the Diamantina and other inland draining rivers divide into myriads of minor channels that then course over extensive floodplains. Long inhabited by indigenous Australians, it became noted for the demise of the Burke and Wills expedition nearly 150 years ago and the Diamantina River was immortalised by early Australian poets as a symbol of the outback.

Channel Country also refers to a (larger) biogeographical region, one of 85 across Australia, having a distinct combination of climate, geology and vegetation (see Map 1). It lies mostly in south-western Queensland, extending substantially into the far north-east of South Australia, with smaller parts in adjacent jurisdictions.



Map 1: The Channel Country Bioregion



Map 2: The Channel Country river systems and the floodplains (outlined) that are addressed in this booklet

Natural assets of a few parts of the Channel Country region, notably the Coongie Lakes and Birdsville Track, are appreciated by many Australians but the core of the bioregion – the often-inaccessible, channelised floodplain country – is less well known. However, new perspectives are emerging from scientific investigations over the past decade, conducted in cooperation with local people. This information document therefore has been produced to alert the wider community to the outstanding natural resources of the Channel Country floodplains and raise awareness of critical management issues. Specifically, this brochure focuses on the floodplains of the Georgina River – Eyre Creek, Diamantina River, Cooper Creek[1] and Bulloo River systems (see Map 2) and the waterbirds that they support. Terminal lakes of these river systems, which lie in sand dune country outside the broad floodplains, generally are not included.

FLOODPLAINS, WETLANDS AND WATERBIRDS

A floodplain is the near-flat adjacent plain over which a river may discharge flood water. The floodplain generally defines the maximum extent of major floods of the river; in the Channel Country, floodplains are commonly 20 and up to 60 kilometres wide. Characteristically, floodplains of inland Australia are dry most of the time.

Normally a floodplain comprises alluvium, which is

Purple Swamphen, a common waterbird visitor to lignum swamps

sediment that has been gradually deposited there by the river. In the Channel Country the soil is mainly grey clay that becomes deeply cracked when fully dry (a vertisol, sometimes called 'blacksoil') and that at the surface commonly has pronounced, interlocking 'gilgai' hollows more than a metre wide. The blacksoil becomes smoother and treacherously soft when saturated to the extent that the cracks have fully closed. Areas of harder white or brown clay may also occur, especially near the floodplain margins.

Complex channel pattern on the Cooper Creek floodplain

Wetlands have been defined, globally and locally (www.epa.qld.gov.au/wetlandinfo), as areas of permanent or temporary inundation, with water that is static or flowing, fresh or saline. Additionally, wetlands support plants and animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle. Taking a management-oriented approach, floodplains – though fully inundated at times – can be considered as land with a mosaic of wetlands that hold water longer than for just the duration of a flood event. Floodplains often exhibit complex networks of channel wetlands.

1 Cooper Creek is its official name; but Cooper's Creek is the name preferred by some local communities

Waterbirds may be defined as birds that are dependent on wetlands for at least part of their life cycle. Major waterbird families include ducks, cormorants, herons, ibises, waterhens, shorebirds and terns. Characteristic waterbird species of the Channel Country floodplains are described below.

HUMAN USE OF CHANNEL COUNTRY WETLANDS

Natural resources of the Channel Country wetlands support human communities, despite the region's harsh climate. Indigenous Australians of several language groups survived dry periods around the deeper waterholes and thrived on abundant plant and animal resources in the floodplain wetlands after floods. Below-ground nodules of nardoo *Marsilea drummondii*, a common aquatic fern, were harvested and processed to make a type of cake; Burke and Wills tried, unsuccessfully, to live on this when their supplies ran out. Aboriginal people captured fish that congregated at in-channel barriers on declining river flows and waterbirds were harvested from dense post-breeding flocks. There are legends about wetland country, such as the Wangkangurru people's story about the black swan and its creation of Goyders Lagoon. Many Aboriginal people maintain active connection with the Channel Country and endeavour to inform descendants and tourists about Aboriginal heritage through art, literature and tour guiding and at visitor displays such as those in national park visitor centres.

Nardoo leaves

Europeans have operated productive pastoral enterprises on the floodplains since the 1860s, fattening cattle on lush natural pasture after floods and using the numerous waterholes, bore water and upland grassland during the dry times. The number of people in the few towns (Birdsville, Bedourie, Windorah, Jundah and Innamincka) is low but tourist numbers are increasing. Oil and gas are being extracted beneath Channel Country floodplains, especially the lower Cooper Creek system. The impacts of land-use on floodplain wetlands are discussed below.

Cattle in floodwater. Photo: Ben Lynes DPI&F, Queensland

Diamantina River in flood

WHERE DOES THE WATER COME FROM?

The Channel Country floodplains lie in an arid region, locally receiving less than 250 mm of average annual rainfall, with erratic timing. Local populations of fishes and many other animals depend on networks of permanent waterholes to survive frequent drought. Revival of the natural resources of the floodplains is made possible principally by flood water arriving from far away, in catchment headwaters up to 500 kilometres to the north and east. Floods in the Channel Country without local rain are sometimes referred to as 'dry floods', but often in flood years the region also receives significant local rainfall.

The Georgina and Diamantina systems rise in Mitchell Grass plains and semi-arid ranges to the north; annual rainfall there is higher, mainly delivered by monsoonal troughs, but it is highly variable. The lower reaches of the Georgina are known as Eyre Creek, which under major flood conditions may join the Diamantina in South Australia to form the Warburton Creek. In this combined catchment (over 36 million hectares in area), grazing and mining occur but native vegetation has not been cleared.

Cooper Creek receives water via the Thomson River from monsoonal rainfall to the north and via the Barcoo River from monsoonal and easterly rain systems to the east. The total catchment area of Cooper Creek is over 29 million hectares and landuse is mostly grazing but there are substantial areas of cleared country.

The Georgina, Diamantina and Cooper floodplains lie intermediate between steeper-sloped, faster-flowing upper catchments and near-flat, sluggish terminal wetlands in the Lake Eyre complex, much of which lies below sea level. Floods most often reach Lake Eyre via the Diamantina – Warburton system (roughly every second year on average), because flow is less hindered by dune country and less depleted by the filling of small lakes than on the Cooper and Georgina systems. In South Australia the lower portions of Cooper Creek and the Warburton exhibit a change to more saline conditions as they approach Lake Eyre.

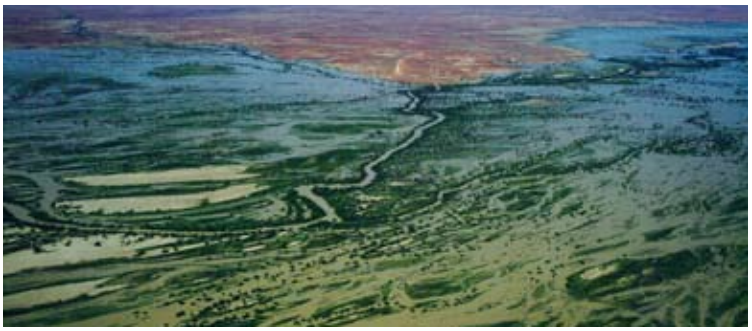
The Bulloo River catchment (Map 2) is part of a separate, internal drainage division but is highly similar to the other Channel Country floodplains in terms of wetlands and biodiversity. Though much smaller, it can receive both summer and winter rainfall.

Water flows slowly in meandering floodplain channels, spreading to adjacent swamps

FLOOD CHARACTERISTICS

By early spring, the floodplains of this arid region usually have been dry for several months; as temperatures increase, fierce evaporation dries and cracks the blacksoil to greater depth. Runoff from the earliest spring-summer thunderstorms in the upper catchments is absorbed in channels until the soil is saturated and cracks are closed. A subsequent moderate rain event may then cause a minor flood whereas heavier monsoonal rains in January-March can produce significant floods in now saturated or running watercourses, which may reach the Channel Country.

Dry gutters, Cooper Creek floodplain



Diamantina River in flood

Rain in the Channel Country may add useful inflow via local tributaries such as Kyabra and Farrars Creeks and Mulligan River. But local rain on its own

Inundated lignum swamp, Eyre Creek

is rarely sufficient to fully saturate the deep-cracked, grey floodplain clay although zones of harder pale clay on some floodplain margins and in dune swales may hold water from local rain for several days or weeks. Periodically, significant biodiversity production occurs in the countless off-river claypans.

Static water in swamp complex, Cooper Creek, April 2000

In each river system, floods in the core of the Channel Country normally occur between November and June, but most often the largest flood of the season is in February-March.

Hydrologists classify floods as minor, moderate or major in relation to specified river heights or monthly discharge volumes at particular gauging points. Elevated river levels may last only days on minor floods and but can continue for weeks or longer when major floods occur. Floodplain road crossings

Figure 1. Monthly discharge of Cooper Creek above Innamincka, 1966-2006 (merged Cullamurra and Nappa Merrie data from WL&BC and NR&W)

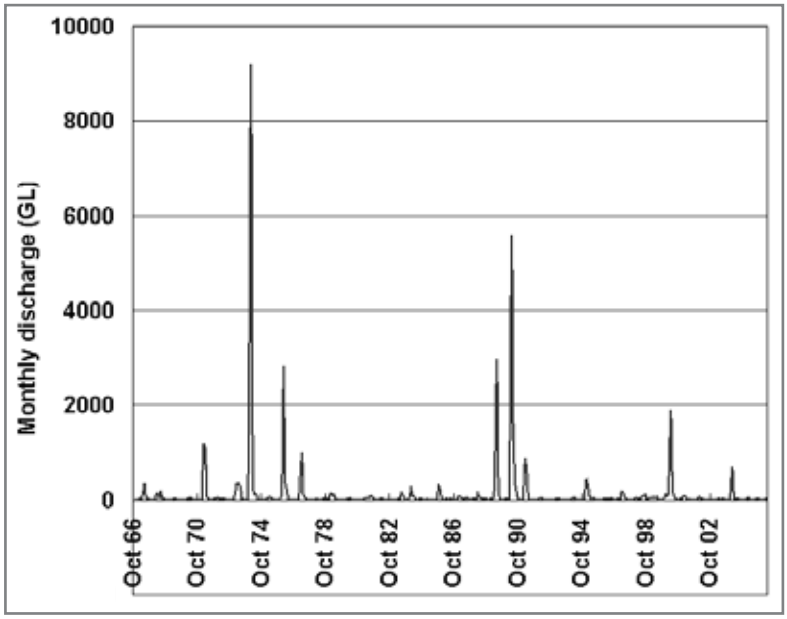
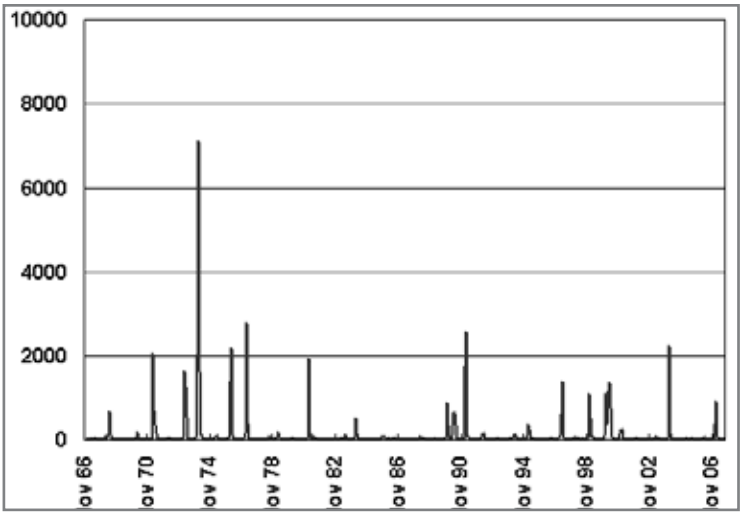


Figure 2. Monthly discharge of Diamantina River at Birdsville, 1966-2006 (data from NR&W)



at Birdsville and at other points where the floodplain is relatively narrow can be impassable for many days or weeks in years of major or multiple floods.

River flow data indicate that on average a major flood occurs in Cooper Creek above Innamincka about every five to six years; frequencies for the other floodplain systems are broadly similar. Figures 1 and 2 illustrate flood frequency and volume in terms of monthly discharge for two of the rivers. In the past decade the largest floods were in 2000 (Cooper), 2001 (Georgina) and 2004 (Diamantina), and there was little or no flow during the severe drought of 2002-3.

Graziers describe four categories of flood in terms of inundation extent and benefit: a channel flood, confined to the deep channels; a gutter flood, which spills into networks of minor gutters and covers up to 15% of the floodplain; a handy flood, which forms sheets of water covering up to 60% of the floodplain; and a good flood, covering 80-100% of the floodplain. Three relevant land systems have been described: frequently flooded alluvial plains; poorly drained swamps and depressions; and flat alluvial plains that are occasionally flooded, being inundated only during good/major floods.

In some years a Channel Country river may receive only one flood but more often there are several pulses, occasionally amplified by local tributary inflows. Early-season runs of any size serve to 'prime' the floodplains by establishing and increasing the growth of plants, which forces subsequent floods to be slower and spread wider, thereby delivering benefits to a larger part of the landscape. Lush floodplain vegetation also filters out more sediment than bare floodplain, making the water less turbid, or clear.

Records show that floods often occur in clusters of years, for example, 1989-91 on Cooper Creek. Certain decades, notably the 1950s and 1970s, had relatively frequent and/or large floods. Again, this delivers cumulative benefits, especially where water, reinvigorated vegetation and/or boosted animal populations have persisted from the previous year.

On the Cooper Creek floodplain, flood waters take about six weeks to run the full length of floodplain between Windorah and Innamincka (landholder knowledge). Water moves at greater speed on 'run-through' country, such as the eastern side below Windorah, than in the swampy western side. The characteristics of channels, flow and some landforms can be greatly altered by 'mega-floods' such as the 1974 event.

In most years, the majority of the floodplain country is dry by the onset of winter (often sooner), with water persisting in some deeper swamps and lakes for up to several more months, occasionally to the next flood season, and in deeper waterholes semi-permanently.

FLOOD RESPONSES AND BENEFITS

At the end of the dry season and especially during major drought, much of the floodplain soil may be bare with woody shrubs nearly leafless. All this is reversed once floodwaters arrive and seemingly dead sticks and stubs of plants, such as rat's tail couch *Sporobolus mitchellii*, rapidly produce new growth. Grasses, sedges and forbs (herbs) appear from below-ground rhizomes, tubers or seed. After smaller floods, growth is confined to the gutters, leaving dry grey-brown country in-between and creating a distinctive 'polygonal' pattern where the reticulated gutters interlock. After larger floods, vast areas may be covered in green plants, standing one or two metres tall in the wetter swamps. Certain plants, such as the thicket-forming pea-bush *Sesbania cannabina*, may proliferate after floods

Rat's tail couch, a floodplain forage grass

in hot weather; others, such as Cooper Clover *Trigonella suavissima*, thrive if inundation occurs in cooler months. However, rarely do two years produce the same combination and patterns of inundation and plant growth.

Animals of the floodplain wetlands also have diverse survival and flood-response strategies. Some invertebrates have life-cycle stages that are dormant and resistant to dryness and so survive buried in the soil; a few other animals survive in deep cracks. Most animals, however, are non-residents and arrive in the floodwaters as adult or non-adult stages (eg. fishes), or move to the floodplains by land or air, often from outside the region (eg. waterbirds). The floodplain wetlands benefit many animals by supporting critical stages such as breeding and migration. But the flood-generated boom of life is soon followed by a 'bust' as aridity returns. Although many animals perish, both old and new generations of surviving wetland animals retreat to waterhole and lake refuges or disperse and thereby boost populations in other regions.

The floodplains also support many animals other than waterbirds, including at times predators such as Letter-winged Kite *Elanus scriptus*, which nest in trees along channels while exploiting booms in numbers of long-haired rat *Rattus villosissimus*.

Human residents benefit from renewal of stock and domestic

Canegrass wetland after floodwater has dried up

water supplies, bush tucker, pasture for livestock, and income from tourism based on observing the flood and its wildlife.

Flood benefits are usually in direct proportion to the volume, duration and frequency of flooding. For example, where any of these variables is high, animal reproduction in the floodplain wetlands may be extended in time and amplified in output.

Upstream reaches of the floodplains, being closer to the main water sources, receive minor floods more frequently than downstream reaches. Especially in years when no moderate to major flood has occurred, flood benefits may be confined to these upstream reaches. Waterholes in the upper floodplain therefore are highly important for sustaining aquatic animal populations.

WETLAND HABITATS IN CHANNEL COUNTRY FLOODPLAINS

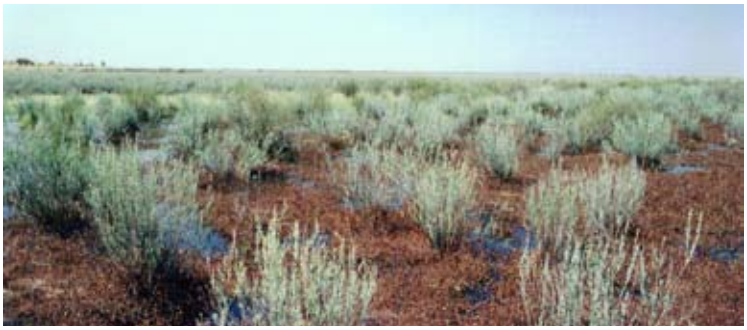
Wetlands in the Channel Country floodplains fall into three broad categories: riverine (channels and waterholes) and palustrine (swamps), which are abundant, and lacustrine (lakes), which are widespread but not as common as in sand dune country outside the floodplains.

The following scheme draws on classifications of the Queensland Wetlands Programme (www.epa.qld.gov.au/wetlandinfo) and the Ramsar Convention on Wetlands (www.ramsar.org), as well as firsthand experience, to illustrate the considerable diversity of wetland types on Channel Country floodplains.

Channels and waterholes are frequently or semi-permanently inundated and lined with trees, mainly coolibah *Eucalyptus coolabah*, often with a shrub understorey.

Wooded swamps are frequently inundated, for up to several months, and are dominated by coolibah trees, belalie *Acacia stenophylla* tall shrubs and lignum *Muehlenbeckia florulenta* shrubs.

Lignum swamps are frequently inundated, for up to several months; belalie shrubs, pea bush thickets, tall tussock grasses, sedges, aquatic creepers, mats of nardoo, and tall forbs may occur with the lignum. Deeper swamps may support submerged and floating plants including water primrose *Ludwigia peploides*.



Bluebush swamps are frequently to occasionally inundated, for up to a few months; northern bluebush *Chenopodium auricomum* is associated with grasses, sedges and short forbs. Drier areas may be dominated by old man saltbush *Atriplex nummularia*.

Sedge swamps are frequently inundated, for up to several months, and are dominated by *Eleocharis plana* with scattered lignum.

Lakes are not common on these floodplains, but examples such as Lakes Koolivoo and Mipia on Eyre Creek's main channel, are frequently inundated, often for more than 12 months. The lakes typically adjoin lignum or wooded swamp.

The combination of inundation regime, micro-topography and vegetation structure of each type offers varied habitat options for feeding and breeding by waterbirds.

Some characteristic plants of Channel Country wetlands:

Belalie (river cooba, native willow) ***Acacia stenophylla***

Budda pea ***Aeschynomene indica*** **(background) and cow-vine**

Cow-vine ***Ipomoea diamantinensis***

Channel millet (wild sorghum) ***Echinochloa turneriana***

The perrenial sedge, ***Eleocharis pallens,*** **common along gutters**

Swamp canegrass ***Eragrostis australasica***

WATERBIRD FOOD

Waterbird use of floodplain wetlands is governed not only by habitat for shelter and breeding but also by food resources. Plant stems, leaves, fruits and seeds; invertebrates, from microscopic size to larger crustaceans and molluscs; and fishes, all provide food for waterbirds. In the Channel Country, they all respond rapidly to a flood, reproducing prolifically. The timing of availability of each item influences the timing of occurrence and breeding by the various waterbird species. Some waterbirds that depend on larger animal food may need to wait longer before breeding; for example, the fish-eating large cormorants tend to breed late in the flood cycle. Meanwhile, some species that nest in floodplain swamps, notably the Straw-necked Ibis *Threskiornis spinicollis*, feed extensively on dryland animals such as crickets and plague locusts found outside the wetland.

Simple water plants, notably algae, apparently play a key role in floodplain productivity. Small invertebrates prosper from consumption of algae, breakdown of detritus and release of nutrients as dry areas become inundated; this alternation between dry and wet is especially significant for productivity. A massive boom of new life occurs in the floodplain ecosystems and higher members of the food web become involved. Larger invertebrates that populate the temporary floodplain swamps comprise similar species to those of waterholes/rivers and include freshwater crayfish *Cherax destructor*, shrimps *Macrobrachium* sp., freshwater crab *Holthuisana transversa* and mussels *Velesunio* spp.

Similarly, native fishes migrate in temporary floodwater from waterhole refuges to floodplain gutters, swamps and lakes. In the floodplain wetlands, spawning occurs and larval and juvenile fish grow significantly, sheltered by the wetland vegetation and aided by high water temperatures, increased feeding opportunities and reduced predator densities. Recent research on Cooper Creek has begun to quantify the contribution of these floodplain wetlands to fish populations, confirming that fish productivity is consistently high over extensive areas and that biomass is transferred between the floodplain and waterholes. Few areas are unreached by fish, with highly mobile species such as spangled perch *Leiopotherapon unicolor* wandering far into the hinterland. Other abundant species that create a bonanza for fish-eating waterbirds include bony herring *Nematalosa erebi* and silver tandan *Porochilus argenteus*. Over 90% of fish in waterholes die off during subsequent dry months and so further flooding is essential to maintain the resilience of the ecosystem.

Spangled perch

Black-tailed Native-hens (Ian Montgomery, Birdway)

WHICH WATERBIRDS OCCUR IN THIS REGION?

Over 80 waterbird species have been recorded in wetlands of the Channel Country floodplains. The 70 that breed and/or occur regularly are listed in Table 1, with information on food preferences and breeding density. Twelve species are annual migrants from Asia.

Most waterbird species occur here temporarily; some are present only briefly, when water and food suit their requirements. Only a few hardy duck and heron species survive through the harsh dry periods, finding refuge in the persistent waterholes.

Table 1: Waterbird species that breed and/or occur regularly in floodplain wetlands of the Channel Country

Food: P = mainly plants A = mainly animals	F = mainly fish O = plants & animals E = mainly feeds on dry land
Breeding: DB = dispersed breeding LB = dispersed or clustered breeding CB = breeds in dense colonies	PB = probably breeding M = migratory species (breeds in Asia)

species	food	breeding
Plumed Whistling-Duck	PE	DB
Musk Duck	O	DB
Freckled Duck	O	DB
Black Swan	P	LB
Australian Shelduck	OE	DB
Australian Wood Duck	PE	DB
Pink-eared Duck	O	DB
Australasian Shoveler	O	DB
Grey Teal	O	DB
Pacific Black Duck	O	DB
Hardhead	O	DB
Blue-billed Duck	O	DB
Australasian Grebe	AF	DB
Hoary-headed Grebe	A	LB
Great Crested Grebe	AF	LB
Australasian Darter	AF	CB
Little Pied Cormorant	A	CB
Great Cormorant	AF	CB
Little Black Cormorant	AF	CB
Pied Cormorant	AF	CB
Australian Pelican	AF	CB
White-necked Heron	A	LB
Eastern Great Egret	A	CB
Intermediate Egret	A	CB
Pied Heron	A	CB
White-faced Heron	A	DB
Little Egret	A	CB
Nankeen Night-Heron	A	CB
Glossy Ibis	O	CB
Australian White Ibis	O	CB
Straw-necked Ibis	AE	CB
Royal Spoonbill	A	CB
Yellow-billed Spoonbill	A	LB
White-bellied Sea-Eagle	AF	DB
Swamp Harrier	A	
Brolga	O	DB
Purple Swamphen	O	LB
Buff-banded Rail	O	PB
Australian Spotted Crake	O	LB
Spotless Crake	O	DB
Black-tailed Native-hen	O	LB
Dusky Moorhen	O	DB
Eurasian Coot	P	LB
Black-winged Stilt	A	LB
Red-necked Avocet	A	LB
Red-capped Plover	A	DB
Oriental Plover	AE	M
Black-fronted Dotterel	A	DB
Red-kneed Dotterel	A	LB
Masked Lapwing	O	DB
Australian Painted Snipe	A	DB
Black-tailed Godwit	A	M
Little Curlew	OE	M
Common Sandpiper	A	M
Common Greenshank	A	M
Marsh Sandpiper	A	M
Wood Sandpiper	A	M
Red-necked Stint	A	M
Sharp-tailed Sandpiper	A	M
Curlew Sandpiper	A	M
Oriental Pratincole	A	M
Australian Pratincole	AE	DB
Gull-billed Tern	A	CB
Caspian Tern	AF	CB
Whiskered Tern	AF	LB
White-winged Black Tern	A	M
Silver Gull	O	CB
Yellow Chat	A	PB
Australian Reed-Warbler	A	PB
Little Grassbird	A	PB

Data are from the ARIDFLO project and Wetlands International and associates, mainly from the past 10 years, and include unpublished information.

Plumed Whistling-Ducks

Black-tailed Native-hen (Ian Montgomery, Birdway)

WATERBIRDS IN THE EARLY STAGES OF A FLOOD

As the very first floodwaters of the 'season' arrive, numerous small animals and seeds are flushed out of cracks and others (eg. fish) are carried in the new water. There are few systematic surveys of waterbirds at this unpredictable stage of the flood cycle but opportunistic feeders such as White-faced Heron *Egretta novehollandiae*, Straw-necked Ibis and Grey Teal *Anas gracilis* are known to be among the birds exploiting this resource.

Once water has started to spread widely on the floodplain, additional species arrive, and in high numbers, to breed in the short period while resources

Black-tailed Native-hen nest and eggs

are abundant. It is critical, however, that water is deep enough and persists long enough for nests to remain in or be supported by water until the young depart the nest and to produce sufficient food for adult and juvenile (dependant) birds. Breeding has been reported to have sometimes failed because water levels were too low or fell too soon; another flood pulse that pushes water levels too high can also cause failure, by submerging nests.

The breeding response time of birds is rapid in the arid zone. Recent surveys have shown that, even with no prior flows for more than 12 months, some waterbirds can build their nests and lay eggs within days or a few weeks of the peak of a moderate/handy flood. The Black-tailed Native-hen ('waterhen') is a classic example of this strategy: incubation lasts barely three weeks; juveniles leave the nest well before they are fully grown; and adults and young presumably eat short new plants that prosper early in the flood cycle.

WATERBIRDS AT HIGH WATER

At first glance, a visitor might see few birds in the swamps at high water. Typical inhabitants include the Hardhead *Aythya australis*, a duck that thrives in flood conditions, Eurasian Coot *Fulica atra*, Little Black Cormorant *Phalacrocorax sulcirostris* and Australasian Grebe *Tachybaptus novaehollandiae*, all of which feed by diving. Family groups of Plumed Whistling-Duck *Dendrocygna eytoni* are widespread. Wading birds such as White-necked Heron *Ardea pacifica* and Red-kneed Dotterel *Erythrogonys cinctus* inhabit the edges and small islands.

However, the local situation can be deceptive. In years when major floods occur, by late summer or early autumn the Channel Country floodplains collectively may hold over a million hectares of standing or only gradually moving water. This creates a window of opportunity for feeding and breeding by enormous numbers of waterbirds, though initially they are widely dispersed. The ARIDFLO project (2000-2003) demonstrated that waterbird densities over these large areas were consistently at least one bird per hectare, generally somewhat higher. Using aerial surveys, ARIDFLO sampled along three river systems and over 3.0 million waterbirds were conservatively estimated to be present on the broad floodplains; estimates increased to 4.0 million

Hardheads (Ian Montgomery, Birdway)

Pink-eared Duck nest and eggs

Red-kneed Dotterel nest and eggs

after birds at breeding aggregations and along river channels were included. A more intensive survey of (only) the contiguous Georgina to lower Diamantina wetlands in March 2001 yielded an estimate of 3.0 million waterbirds.

WATERBIRD BREEDING - DISPERSED

More than half of the Channel Country waterbird species breed as dispersed pairs, at low density. This applies to all of the ducks, the waterhens and crakes, dotterels and stilts though some species may breed in loose clusters. Freckled Ducks *Sticonetta naevosa* build nests in lignum over water 30-50 cm deep; Hardheads do likewise, as well as in dense grass or herbage surrounded by water. Pink-eared Ducks *Malacorhynchus membranaceus* often nest in hollows of trees in the water. Native-hens nest in sparse inundated lignum, often where grass is infused. Red-kneed Dotterels and Black-winged Stilts *Himantopus himantopus* lay in scrapes on the ground on tiny islands. The young of all of these species leave the nest soon after hatching – which enables them to use briefly inundated nesting sites – and stay in the swamps, being nurtured by their parents.

Despite low nest densities, the total collective effort from dispersed breeding over the floodplain wetlands of the Channel Country is nevertheless believed to be significant. As nests are hard to find and few surveys are done at these times of difficult access, systematic estimates of such totals have not been generated; also there is almost no information on breeding success. However, the number of distinctly

Red-kneed Dotterel (Photo: Ian Montgomery, Birdway)

marked immatures of species such as native-hen, which become conspicuous as the system dries out, suggests that from thousands to hundreds of thousands (depending on species) of dispersed broods can be raised here.

WATERBIRD BREEDING - COLONIES

Other waterbirds breed in colonies – clusters of many nests, densely spaced (often within pecking distance) and usually occupying just a few hectares. Each colonial species has relatively few colonies to sustain its entire population and so is inherently vulnerable.

In the Channel Country, there are 16 waterbird species that regularly breed in colonies (Table 1), depending on the distinction drawn between

Egret colony, Eyre Creek floodplain

clustered and colonial breeding. Cormorants and allies, herons, ibises and spoonbills dominate the colonial breeding group. Colonies of a single species are commonplace but so are colonies with mixed (up to 14) species.

The dynamics and ecological requirements of colonies are not fully understood but colonies invariably form when moderate to major floods occur.

Nestling of Eastern Great Egret, lignum swamp

Nestlings, Straw-necked Ibis colony in lignum swamp

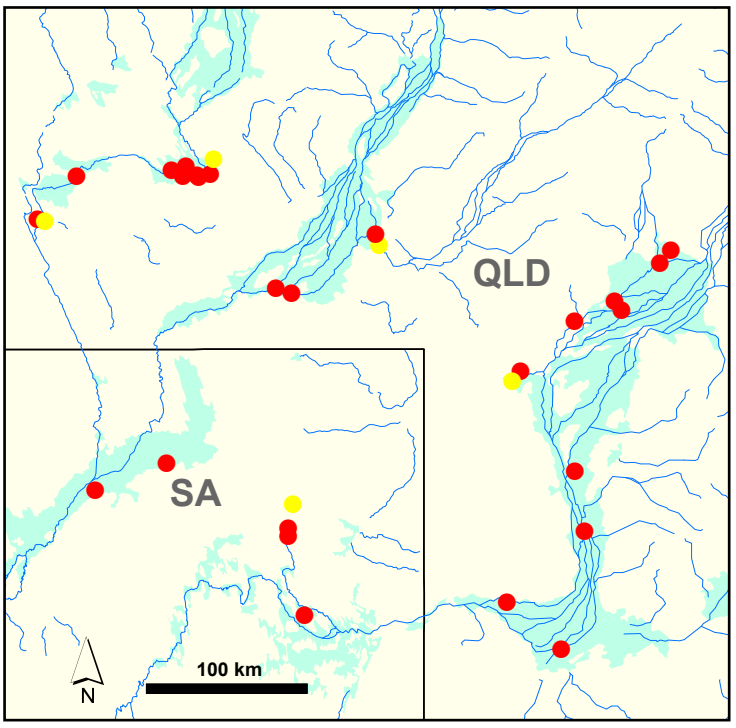
The onset of colonial breeding often occurs at an earlier stage of the flood cycle than in the southern Murray-Darling Basin; perhaps the relatively short inundation period, warm-season timing and explosion of food resources in the Channel Country wetlands are contributing factors.

There are two main categories of nest site: trees or shrubs over water (chosen by most colonial species),

Cormorant colony, Diamantina waterhole

White-necked Heron nest and eggs

and islands (for pelicans and most terns). Meanwhile, several clustering breeders such as Whiskered Tern *Chlidonias hybridus* build semi-floating weed/grass nests in deep water. Importantly, all these sites must remain inundated or surrounded by water long enough for the parent birds to build nests, lay eggs, complete incubation and feed their young till they are free-flying – typically a period of 2–3 months. Some tree-nesting species may successfully complete



Map 3: Major waterbird breeding colonies
Red = mixed species, tree/shrub nesting
Yellow = Pelicans, ground nesting

breeding despite nests becoming dry in the late stages of breeding but the drying indicates a loss of floodplain feeding habitat. Siblicide in the nest, due to intense competition during a decline in food delivered by parents, can be a key cause of infant mortality.

Map 3 indicates the location of over 30 major breeding colonies across three floodplains as recorded in the ARIDFLO project; at least 10 smaller colonies are known and additional colonies are expected to exist. Each floodplain has at least one large colony of mixed species, and one major pelican colony; smaller colonies of mixed species and some major pelican colonies may occur in downstream off-floodplain lakes, at later stages of the flood cycle. Use of colony sites is generally consistent, with shifts to alternative sites if colony habitat has been defoliated through frequent bird use, burnt down (see below), or covered by a huge flood.

On preliminary evidence, the size of a colony tends to vary in proportion to size of flood. Largest mixed-species colonies in lignum-belalie swamps have been documented as comprising at least 46,000 pairs and largest colonies of Australian Pelican *Pelecanus conspicillatus*, over 75,000 pairs. Most colonies are much smaller: information on sizes and numbers of colonies of 14 waterbird species is given in Table 2.

WATERBIRDS IN THE DRYING PHASE

As water levels fall due to slow drainage and evaporation, waterbirds become concentrated in smaller areas of water and their densities increase markedly. Hundreds of Glossy Ibis *Plegadis falcinellus* and other colonial species, including immature birds from the recently active colonies, gather to exploit the concentrations of food in drying marshes. Flocks of native-hen and Purple Swamphen *Porphyrio porphyrio*, including semi-dependent young, congregate in drying canegrass and lignum swamps. Secretive species such as Australian Spotted Crake *Porzana fluminea* and Buff-banded Rail *Gallirallus philippensis* may reveal their presence as they are forced to scamper across mud and residual pools of water between lignum shrubs and tussocks. Some shorebirds may arrive in the wetlands only at this stage, because water depths are now negotiable and food is accessible.

For most of the ducks, which by now have come together in mobs of thousands to tens of thousands on persistent floodplain water-bodies such as the Eyre Creek lakes, the time soon comes where they need to vacate the floodplains. Many will move downriver to the lowest reaches where water is trapped in persistent lakes in sand dune country, notably the

Species	Size class (nests) of biggest colony	Number of colonies	Total effort (nests) over three rivers
Australasian Darter	hundreds	11 - 20	hundreds
Little Pied Cormorant	tens	5 - 10	hundreds
Great Cormorant	hundreds	11 - 20	thousands
Little Black Cormorant	thousands	> 20	> 10,000
Pied Cormorant	hundreds	11 - 20	thousands
Australian Pelican	> 10,000 **	5 - 10	> 10,000 **
White-necked Heron	hundreds	5 - 10	hundreds
Eastern Great Egret	thousands	11 - 20	> 10,000
Intermediate Egret	hundreds	5 - 10	thousands
Nankeen Night-Heron	> 10,000	5 - 10	> 10,000
Glossy Ibis	thousands	5 - 10	> 10,000
Australian White Ibis	thousands	5 - 10	thousands
Straw-necked Ibis	> 10,000	11 - 20	> 10,000 *
Royal Spoonbill	thousands	5 - 10	> 10,000
* over 50,000 nests; ** close to 100,000 nests			
Based on simultaneous major floods in the Cooper, Diamantina and Georgina river systems in one season. Includes colonies in river-fed lakes. Data are from the ARIDFLO project and Wetlands International and associates, over the past 10 years, and include unpublished information.			

Table 2: Waterbird colonies in the Channel Country floodplains

Coongie Lakes. But for the herons, ibises, spoonbills and related species that fed in the vast swamps and wet meadows of the Channel Country floodplains, similar habitat is at a much smaller scale in this lake country. Hence, most of them gradually move away from the Basin, dispersing probably both to northern and southern Australia. After major floods, huge numbers of native-hens may irrupt into southern Australia.

During the dry/drought phase of the flood cycle, only those species that can survive at deeper waterholes remain in the floodplains. There is very little breeding in the river systems apart from small colonies of cormorants breeding in early winter at favoured waterholes where fish stocks may have peaked. Small flocks of ducks may linger through to the next flood season. Some of the major waterholes are refuges for small, outlying northern populations of Musk Duck *Biziura lobata*.

Dense aggregation of waterbirds, Eyre Creek

Australian Spotted Crake (Ian Montgomery, Birdway)

Though seeming unimportant, the dry phase of these intermittent wetlands is essential to setting the scene for the next boom when floods return.

THREATENED AND ICONIC SPECIES

One nationally threatened waterbird, the Australian Painted Snipe *Rostratula australis* (Vulnerable under the EPBC Act 1999), occurs on the Channel Country floodplains. Small numbers have been recorded and nests found on gilgai mounds and other islets in shallowly but frequently flooded lignum swamps, typically with ground cover of nardoo. This cryptic shorebird is nomadic and infrequently recorded but larger numbers possibly occur here.

A non-waterbird, the Grey Grasswren *Amytornis barbatus*, is endemic to the Channel Country floodplains where it resides in lignum and canegrass swamps; the Bulloo subspecies is nationally threatened (EPBC: Vulnerable).

The Freckled Duck is an iconic waterbird, being one of the rarest Australian ducks, with unusual

Nesting habitat of Australian Painted Snipe

Australian Painted Snipe nest and eggs

Freckled Ducks, 3rd, 4th and 7th from left

characteristics including a seasonally red base to the bill of adult male birds. It is widespread in the floodplain systems and breeds in flooded lignum swamps. The Channel Country is considered a stronghold for its breeding and post-breeding aggregations exceeding 10% of the total population size occur in the region's lakes.

MIGRATORY SHOREBIRDS

Shorebirds that migrate between southern Australia and north-east Asia, where they breed during the Arctic summer, make significant use of drying Channel Country swamps and bare floodplain during northward migration (March-April), and drying lakebeds during southward migration (September-November). If floods occur early enough in summer, available habitat may draw migratory shorebirds into the region from coastal regions in mid to late summer. However, shorebird occurrences are opportunistic and are not possible every year. Furthermore, they have not been adequately documented.

Internationally significant numbers (1% of population size: at least 1600 birds) of Sharp-tailed Sandpiper *Calidris acuminata* and (at least 1800) of Little Curlew *Numenius minutus* have been recorded, with important sites for one or other species on each of the Georgina, Diamantina and Cooper floodplains or associated lakes. Smaller numbers of Black-tailed Godwit *Limosa limosa* and Oriental Pratincole *Glareola maldivarum* and many other migratory shorebird species, occur erratically. Migratory species are a Matter of National Environmental Significance under the EPBC Act 1999.

Migratory Little Curlews, Diamantina floodplain, March 2004

SIGNIFICANCE OF WATERBIRD NUMBERS

The notion that the Channel Country floodplains are nationally and globally important for waterbirds, which developed through several big flood events (eg. 1974, 1990), has been confirmed and quantified by research over the last ten years. Habitat is not available every year and the birds mostly are not resident there. But waterbirds are highly mobile, apparently ranging widely across Australia and able to travel into and out of the Channel Country as driven by prevailing conditions. They depend on networks of temporary habitat at the continental scale. And just as the importance of Lake Eyre for fish and birds is recognised despite infrequent filling, so also the importance of the Channel Country is not dependent on this phenomenon occurring annually.

Total numbers of waterbirds in the Channel Country floodplain wetlands as conservatively estimated by the ARIDFLO project are without precedent in Australia outside the tropical Top End floodplains. In even wetter periods such as the mid 1970s, with successive major floods, numbers in the Channel Country probably were more than double the more recent estimates, perhaps over 10 million. Parts of the Murray Darling Basin were formerly outstanding for waterbirds when widespread and frequent floods occurred but now are rarely productive having been starved of water. Even the Top End, despite annual inundation of its floodplains, may decline in importance if local agricultural development expands further at the expense of river flooding and wetland habitat.

This high significance applies also at the 'river reach' level. Data from ARIDFLO aerial surveys also show that sections of swampy Channel Country floodplain only 10 km by 10 km square (10,000 ha) can support over 20,000 waterbirds, which is a threshold for global importance recognised by the Ramsar Convention on Wetlands. Each of the four floodplain systems of the Channel Country incorporates multiple blocks of habitat of this size and the ARIDFLO project has

Flock of Glossy Ibis

identified 11 such reaches that each support over 100,000 waterbirds.

Data are inadequate to address all species, but on present evidence the Channel Country floodplains collectively support at least 1% of the applicable population size of 20 if not 28 waterbird species (see Table 3). For each of these species, such as Royal Spoonbill *Platalea regia*, this is a recognised mark of global importance.

Table 3: Waterbirds for which the Channel Country floodplains are internationally important - in terms of numbers

Confirmed (supported by data)
Plumed Whistling-Duck
Freckled Duck
Australian Wood Duck
Pink-eared Duck
Grey Teal
Pacific Black Duck
Hardhead
Little Black Cormorant
Australian Pelican
Eastern Great Egret
Nankeen Night-Heron
Glossy Ibis
Straw-necked Ibis
Royal Spoonbill
Purple Swamphen
Black-tailed Native-hen
Eurasian Coot
Little Curlew
Sharp-tailed Sandpiper
Australian Pratincole
Likely (extrapolated from data and habitat extent)
Australasian Darter
Great Cormorant
White-necked Heron
Yellow-billed Spoonbill
Australian Spotted Crake
Black-winged Stilt
Red-kneed Dotterel
Whiskered Tern
Data are from the ARIDFLO project and Wetlands International and associates, mainly from the past 10 years, and include unpublished information.
1% levels based on WI (2006), Waterbird Population Estimates 4th Edition.

SIGNIFICANCE OF WATERBIRD BREEDING

In regard to breeding, importance is firstly in terms of total breeding effort. The ARIDFLO aerial surveys, supplemented by ground surveys by Wetlands International, documented over 100,000 breeding pairs in both 2000 and 2001, mostly at colonies. Adding in the huge contribution of dispersed breeding – keeping in mind the estimated total number of waterbirds – the total breeding effort in major flood years across all rivers must be several times, if not an order of magnitude, larger.

Importance for breeding is also in regard to certain species. For dispersed breeders like the Grey Teal and Eurasian Coot, based on preliminary evidence and extent of habitat we can assume the Channel Country floodplains to support many thousands of breeding efforts. For the colonial breeders listed in Table 2, such as Eastern Great Egret *Ardea modesta* and Nankeen Night-Heron *Nycticorax caledonicus*, we have quantified this level of importance. The Channel Country floodplains together with downriver lakes including Lake Eyre itself are by far the prime breeding area for the Australian Pelican.

Though waterbird breeding does not occur every year in the Channel Country, its viability seems more secure than in more densely settled agricultural and coastal regions of Australia where floodwaters are regulated and harvested, rarely allowing major breeding events. Consequently, the Channel Country is among the most important of the remaining waterbird breeding areas in Australia and can be considered a present-day 'engine room' of waterbird production in the continent.

Nestlings of Nankeen Night-Heron

Pelican breeding colony

IMPORTANCE OF THE FLOODPLAIN WETLANDS FOR INDUSTRY

The same floods that are important for waterbirds also support a significant pastoral grazing industry in the Channel Country floodplains. All livestock pasture in this region is naturally occurring: key plants include Cooper clover, channel millet, rat's tail couch and cow-vine. Floods in the cooler weeks of autumn tend to produce longer-lasting pastures (dominated by Cooper clover) of higher quality but of lower yield and durability than floods in hotter months. Forage value (digestibility, protein and energy) has been documented by the Queensland Department of Primary Industries and Fisheries, based on research and grazier experience. It is sufficiently high to encourage cattle companies to truck in large numbers of cattle from more than 1000 km away to exploit the pasture boom after good floods. The region's relatively weed and disease free environment and good pasture growth has also enabled chemical free (organic beef) operations to successfully operate here.

Extraction of oil and gas occurs on the Channel Country floodplains, challenged by periodic floods and remoteness, but these fuels are being successfully delivered to coastal cities. Tourism also faces access and distance obstacles and infrastructure is limited, with visitations mainly in the cooler months. However, tourism is growing steadily with a strong interest in 'seeing the desert in flood' and there is probably scope for developing carefully planned opportunities for visitors to more closely experience the waterbird spectacle in the Channel Country floodplains.

Channel millet

THE RIVERS MUST FLOW FREELY

Flood water is the vital ingredient. Many of the highly prized assets of the Channel Country floodplains would be lost if the rivers ceased to flood, or if the floods were reduced in frequency or volume.

Floods of all sizes are needed and valued: it would be an error to think that only the big floods are important. Minor floods sustain the waterhole refuges for fish and other animals that can later move into floodplain swamps during larger floods, thereby in turn supporting the incoming waterbirds. Graziers also depend on the smaller, more frequent floods to provide their core herds with feed between the years of bigger floods and good local rainfall.

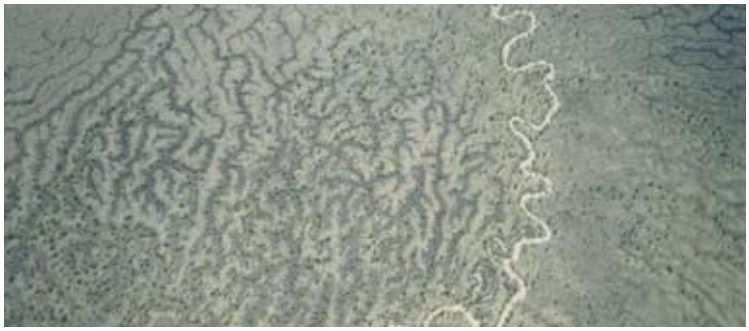
Currently there are no major dams or flow impediments, and no large-scale water harvesting, on the four river systems of the Channel Country. This distinguishes the Channel Country from most of the heavily regulated and degraded Murray Darling Basin.

Nevertheless, losses can be subtle. Some long term residents claim that volumes of low flows reaching the floodplains have been reduced since the advent of numerous farm dams in the upper Cooper Creek catchment in the 1970s. On flat plains, shallow sheet flow of water can easily be diverted by low obstacles such as lines of grader spoil along tracks, or channelled along tracks that are lower than the surrounds. This can alter the distribution of water on floodplains, causing water deprivation in some areas. Roads and cleared exploration lines for mining influence movement of low overland flows on the lower Cooper Creek floodplain. And over-extraction of water from permanent refuge waterholes during drought can cause local extinctions of wetland fauna.

At the local scale, an appreciation of the specific connections between principal river channels and the main swamps is important to understanding and protecting the two-way movements of water and

aquatic animals on the floodplains. Some wetlands have multiple inflow channels; others depend on just one and so are inherently vulnerable to water starvation if that channel is blocked.

Water Resource Plans under Queensland legislation protect flows for all four rivers but allow small water extractions from some rivers. Though small relative to the volumes of major floods, these entitlements provide a persistent 'foot in the door' for possible future expansion of water harvest. Furthermore, there are inconsistencies due to the varied ages of the Plans, with matters such as preventing the harvest of overland flow (sheet water on floodplains)



Dry floodplain swamp

needing more detailed and uniform attention. Some Plans are now under review. Open communication among the Channel Country's diverse interests and resource users is required to ensure fair planning outcomes for all.

MANAGEMENT OF FIRE

In some parts of the Channel Country, shrublands of lignum and belalie are intentionally burnt by graziers to simplify mustering of cattle and encourage greater pasture growth in wet parts of the floodplain. Lightning strike can of course also cause fires but deliberate burns increase the frequency of fire, with more shrubs burning back to ground level or a few sticks. Opinions vary as to the long term effect of increased burning, with some insisting that shrubland will consequently thicken in the long run and that especially dense shrubland tends to die back naturally. In the short term, critical habitat for floodplain fauna in dry and wet times can be lost through excessive burning; this is especially serious at shrub swamps that are regularly used for waterbird breeding colonies.

Burning floodplain swamp

Regrowth of burnt belalie after flood

Cooperative discussion among graziers and scientists has started but funding is needed to develop guidelines on burning. This would include review of Aboriginal and pastoral practice and systematic research that will deliver appropriate long term strategies for managing fire in the wetland shrublands.

MANAGEMENT OF INVASIVE SPECIES

Invasive plants have severely degraded wetlands in many parts of eastern and northern Australia, but so far this has not been a major problem in the Channel Country floodplains. Minor outbreaks of thorny thicket-forming *Parkinsonia aculeata* have been systematically controlled through cooperative projects involving landholders, local government

and Desert Channels Queensland. Monitoring and follow-up will, however, be necessary.

Feral pigs *Sus scrofa* occur at relatively low densities across these floodplains but, especially after wetter periods, can be destructive to wetland soils, plants and wildlife. On Cape York they have been found to consume huge numbers of native frogs. Control must occur across neighbouring properties and along floodplains. Meanwhile, cane toads *Bufo marinus* have recently arrived in the floodplains, with likely short and long-term consequences for native wetland predators unaccustomed to dealing with the toad's toxins.

Thorny parkinsonia stem and flowers

Another group of invasive animals is fish and crustaceans. Only a few fishes have been introduced in the Channel Country and presently are at low levels of impact; there appear to be no European carp *Cyprinus carpio* at present. Native fishes comprised 99% of the fish caught during the region-wide ARDIFLO project whereas their proportion is much lower in the Murray Darling Basin. Red-claw yabby *Cherax quadricarinatus*, a farmed species that is not native to the Lake Eyre Basin, has escaped into Cooper Creek and poses a potential competitive threat to indigenous wildlife.

OTHER MANAGEMENT ISSUES

Present knowledge is not adequate for developing comprehensive plans to manage the floodplain wetlands.

In regard to pastoral grazing, government agencies have provided guidelines and information to Channel Country graziers to supplement their considerable experience in grazing the Channel Country floodplains. It would be desirable to conduct further independent research to provide additional advice on ecologically sustainable regimes for grazing. Wise timing and rates of grazing should enable annual wetland plants to set seed for the next generation of growth and allow sufficient mulch and cover of perennial plants to be retained in order to nourish the soil. In contrast, overgrazing can cause long term loss of vegetation cover, change plant species composition and greatly disturb the soil, with consequences for ecosystem processes, water quality and fauna such as breeding waterbirds.

In regard to waterbirds, recommended actions to address information gaps for the Channel Country floodplains include: aerial surveys of numbers and breeding during major floods; detailed ground surveys of colonies to ascertain breeding effort and success; determination of diet, other ecological requirements and resilience of key species in the Channel Country; and incorporation of information in continent-wide assessments to provide context at the whole-of-population level.

Water along graded track on floodplain

GETTING INVOLVED

Local communities and visitors can help ensure that the great natural resource values of the Channel Country floodplains are retained, to benefit present and future generations. Participation in relevant

activities of the applicable NRM organisations – South Australian Arid Lands NRM Board, Desert Channels Queensland and South West NRM – is a good starting point (contact details below). Information on current issues and activities is posted on their websites and publications, and links are provided to information tools produced by other organisations.

Lignum swamp, Eyre Creek floodplain

Landholders who operate on leasehold land in the floodplains depend on healthy ecosystems for their economic survival and – as there are few formal protected areas in the floodplain country – they are the principal managers of the wetlands. Best possible outcomes for natural resources can result from cooperation between landholders and the wider community, including scientists, water agencies and conservation organisations. Although there is no detailed baseline of condition 100 years ago, it seems that pastoral grazing and high conservation values co-exist in the Channel Country floodplains and, with some adjustment, can both be sustained.

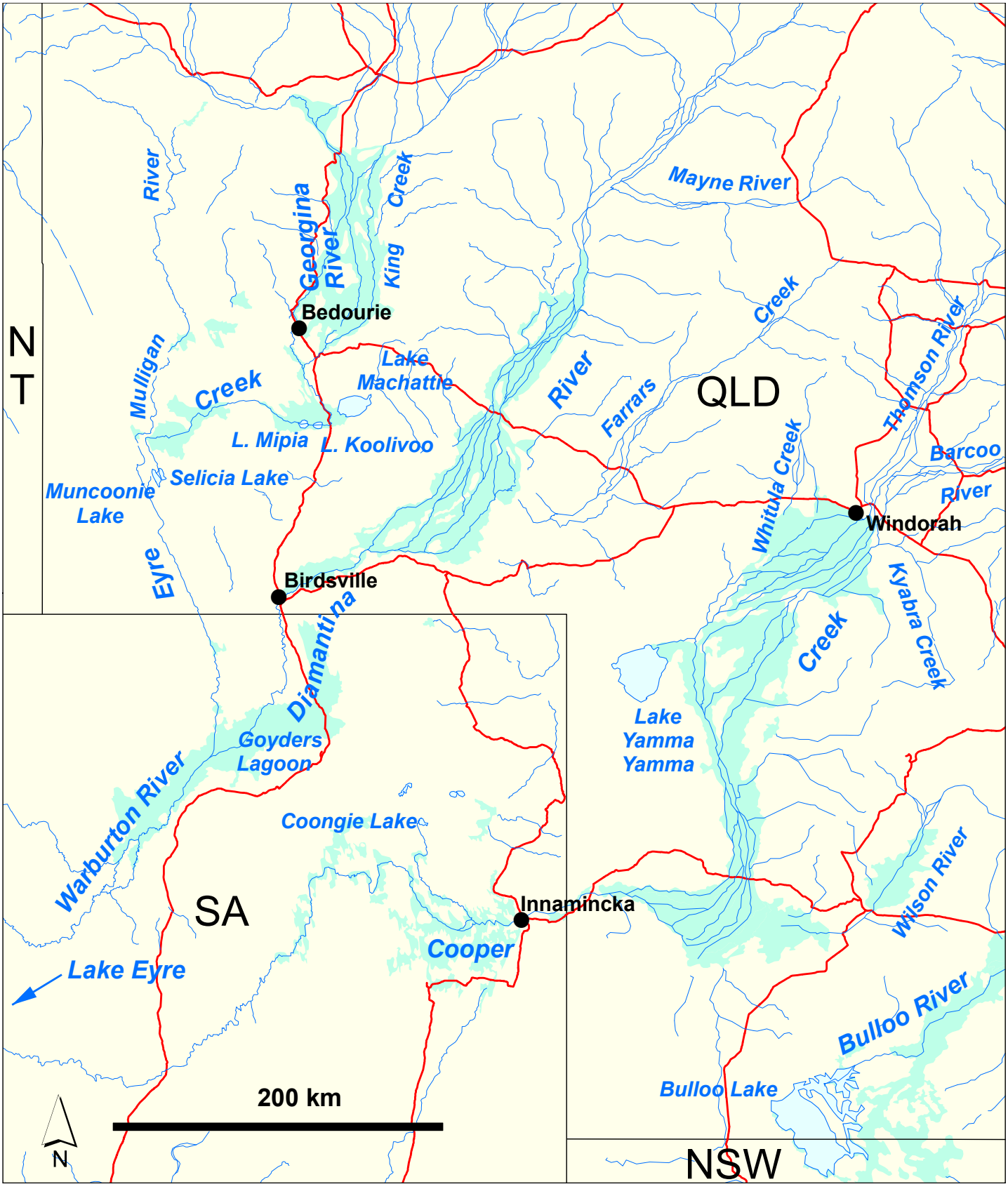
Reticulated swamp, Diamantina floodplain

Tourists and other visitors can care for country by respecting indigenous cultural sites and the operations of grazing enterprises, by keeping their vehicles to public and other approved areas for access, and by not spoiling sensitive areas with waste. Biosecurity is also an issue, and visitors to the region should clean their vehicles and water craft to prevent the introduction of exotic plant and animal species. Fisher people should be discouraged from bringing live bait into the Channel Country as bait animals have the potential to become local pests.

All who have the well being of the Channel Country at heart should promote wider awareness of this impressive and largely unspoilt region and contribute generously to guarantee its future.

Egret colony in belalie and lignum, Eyre creek floodplain, Queensland

Map 4: Detailed map of wetlands on the Channel Country floodplains, emphasising places mentioned in this document



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CONTACT DETAILS – FURTHER INFORMATION

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Desert Channels Queensland: PO Box 601, Longreach QLD 4730; Ph: 07 4658 0600; Fax: 07 4658 0122, Email: info@dcq.org.au , Website: www.dcq.org.au

South West NRM: 66 Galatea Street, Charleville, QLD 4470; Ph: 07 4656 8500, Fax: 07 4654 1600, Email: swnrm@southwestnrm.org.au, Website: www.southwestnrm.org.au

Wetlands International – Oceania: Website: http://oceania.wetlands.org, Brisbane office email: roger.jaensch@wetlands-oceania.org

Waterhole and swamp, Cooper floodplain, Queensland

Lower Diamantina floodplain, South Australia

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Photographs are by Roger Jaensch, Wetlands International, unless otherwise indicated. Published by the South Australian Arid Lands Natural Resources Management Board, January 2009.

Government of South Australia

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desert channels QUEENSLAND

WETLANDS INTERNATIONAL

Lignum swamp around freshwater lake on Eyre Creek floodplain: habitat for waterbird breeding colonies