Police Lagoons

Police Lagoons are a series of connected semi-arid floodplain tree swamps on the Lower Balonne River floodplain, surrounding the town of Dirranbandi, in the Murray–Darling Basin. The Lagoons are located south of Beardmore Dam and upstream of the Narran Lakes. It is likely the lagoons were once part of the main river channel, and, over time, the river has since cut a new channel to the west, leaving a string of low-lying depressions in the landscape.

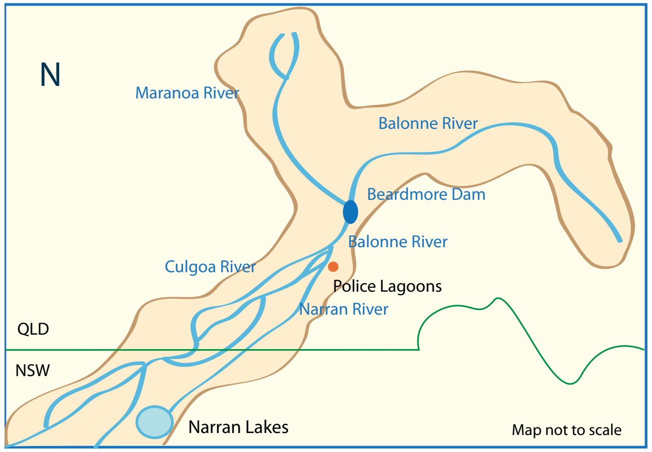
Scar trees surrounding the swamps show long-standing cultural connections with the area.

These are important cultural heritage sites for the local Aboriginal Traditional Owners and have a range of cultural and ecosystem values, including habitat and potential breeding ground for native fish such as the yellowbelly (golden perch).

The Police Lagoons are ephemeral wetlands, going through a natural cycle of flooding, followed by gradual and often complete drying out. Under natural conditions they will remain dry (apart from capturing small amounts of local rainfall) until the Lower Balonne River breaks its banks again and fills these off-stream depressions. The lagoons are therefore heavily reliant on the flow levels of the Balonne River, particularly the peak flood events.

Photo: R. Burnett

Police Lagoons during a wet period

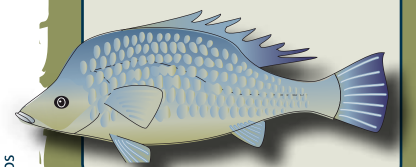


Source: Wetland Maps

Police Lagoons in their landscape context

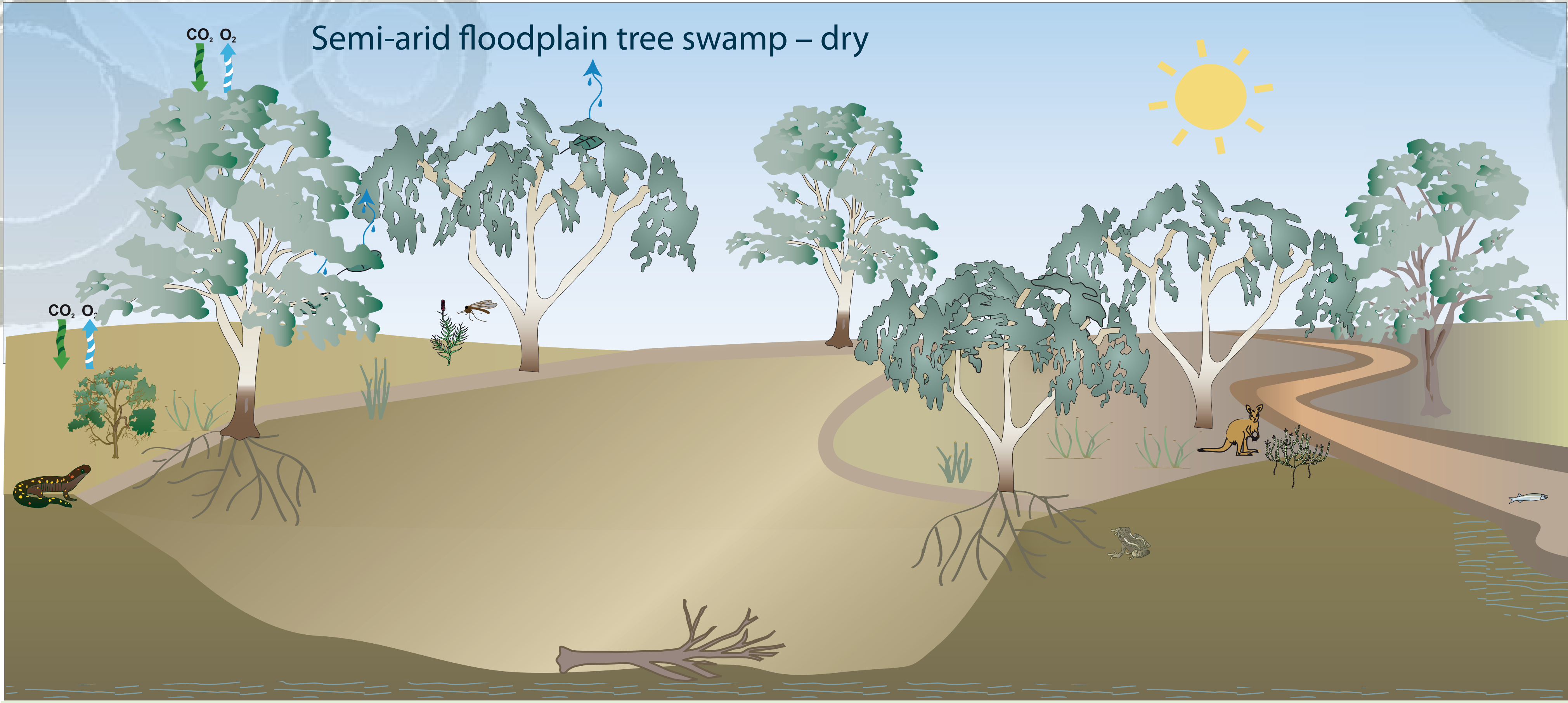
About this case study:

This case study was created by the Department of Environment and Resource Management (DERM) Aquatic Ecosystem Health Science Integration and Capacity Building Team as part of the Queensland Wetlands Program. It aims to synthesise information on the values of Police Lagoons and the existing pressures, particularly on native fish like the yellowbelly. This information contributes to local and regional natural resource managment, providing educational material for landholders, managers and the local community. The input and assistance of the Queensland Murray–Darling Committee and the local Aboriginal Traditional Owner groups, along with funding from by the Queensland Wetlands Program, have been vital to the project's success.



The yellowbelly or golden perch (***Macquaria ambigua***) is native to the Murray–Darling basin and favours turbid, slow flowing habitats like the Police Lagoons.

Semi-arid floodplain tree swamp – dry



Flora

Trees *for example*

Eucalyptus coolabah

Corymbia tessellaris

Casurina cristata

Shrubs *for example*

Acacia sp.

Woody debris

Grasses, sedges, herbs

Range of species of grasses and sedges, including *Eleocharis spp.* or *Agrostis spp.* in more frequently innundated sites tending toward a grassy ground layer in less frequently flooded sites, *for example...*

Muehlenbeckia florulenta

Sporobolus caroli

Agrostis avenacea

Juncus usitatus

Paspalidium jubiflorum

Aquatic species

Marsilea drummondii

Pseudoraphis spinescens

Algae

Microalgae

Cyanobacteria

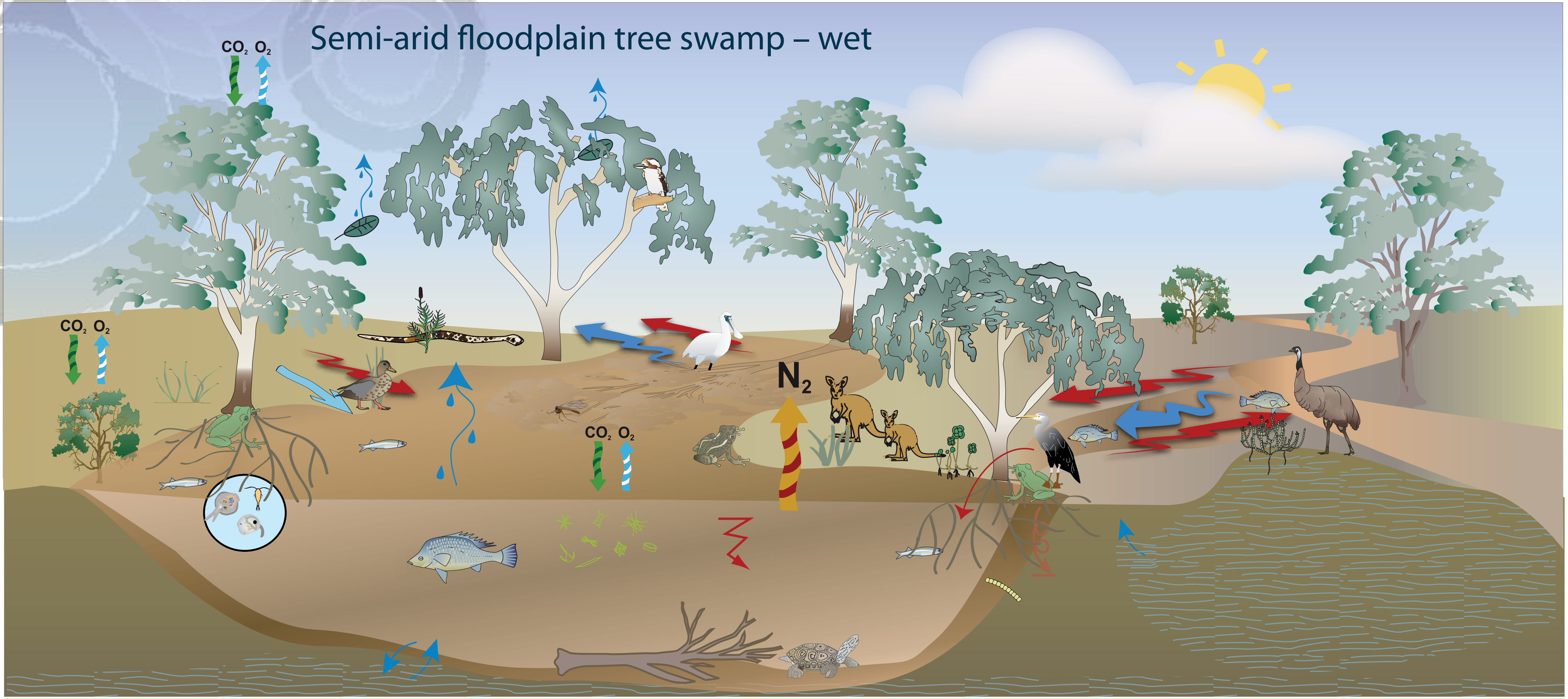
Geomorphology

Occurs in flooded back swamps and old channels (paleochannels) on Cainozoic alluvial plains or levees. Generally clay or sometimes texture contrast soils.

Legend continues on facing page.

Conceptual models from www.wetlandinfo.ehp.qld.gov.au

Semi-arid floodplain tree swamp – wet



Fauna

Microinvertebrates: *Bosmina* sp., Rotifer, Copepod

Insects

Fish: Yellowbelly

Reptiles and amphibians: Snakes, Frogs, Goannas

Birds: Kookaburra, Emu

Waterbirds: Darter, Spoonbill, Wood duck

Mammals: Kangaroos

Flooplain hydrology

Water inputs: Surface water inflow from overbank flow; Surface water inflow from local watershed; Rainfall; Groundwater discharge from water table may occur

Water outputs: Groundwater recharge; Surface water outflow; Evaporation; Evapo-transpiration

Nutrient dynamics

Nutrients (including nitrogen and phosphorus) can enter floodplain tree swamps attached to particles and suspended or dissolved in water entering from floods and run-off and can leave the wetlands during hydrological connections with terrestrial and other waterbodies.

Migratory and mobile organisms like fish and birds can transfer nutrients (as well as genetic material) between wetlands and into terrestrial areas.

N_2 Denitrification (Bacteria break down nitrogen compounds into nitrogen gas.)

CO_2 O_2 Algae, phytoplankton and plant production can be high during times of inundation.

Illustration: DERM

Yellowbelly and floodplain wetlands

The yellowbelly or golden perch (*Macquaria ambigua*) is native to the Murray–Darling basin and favours turbid, slow flowing habitats like the Police Lagoons. Yellowbelly are very long-lived. In the often challenging Australian environment, longevity is a survival strategy which ensures that most adults participate in at least one exceptional spawning and recruitment event. These events are often linked to unusually wet La Niña years and may only occur every one or two decades. The maximum recorded age of a yellowbelly is 26 years, which is pretty old for a fish!

Photo: Jeff Webb

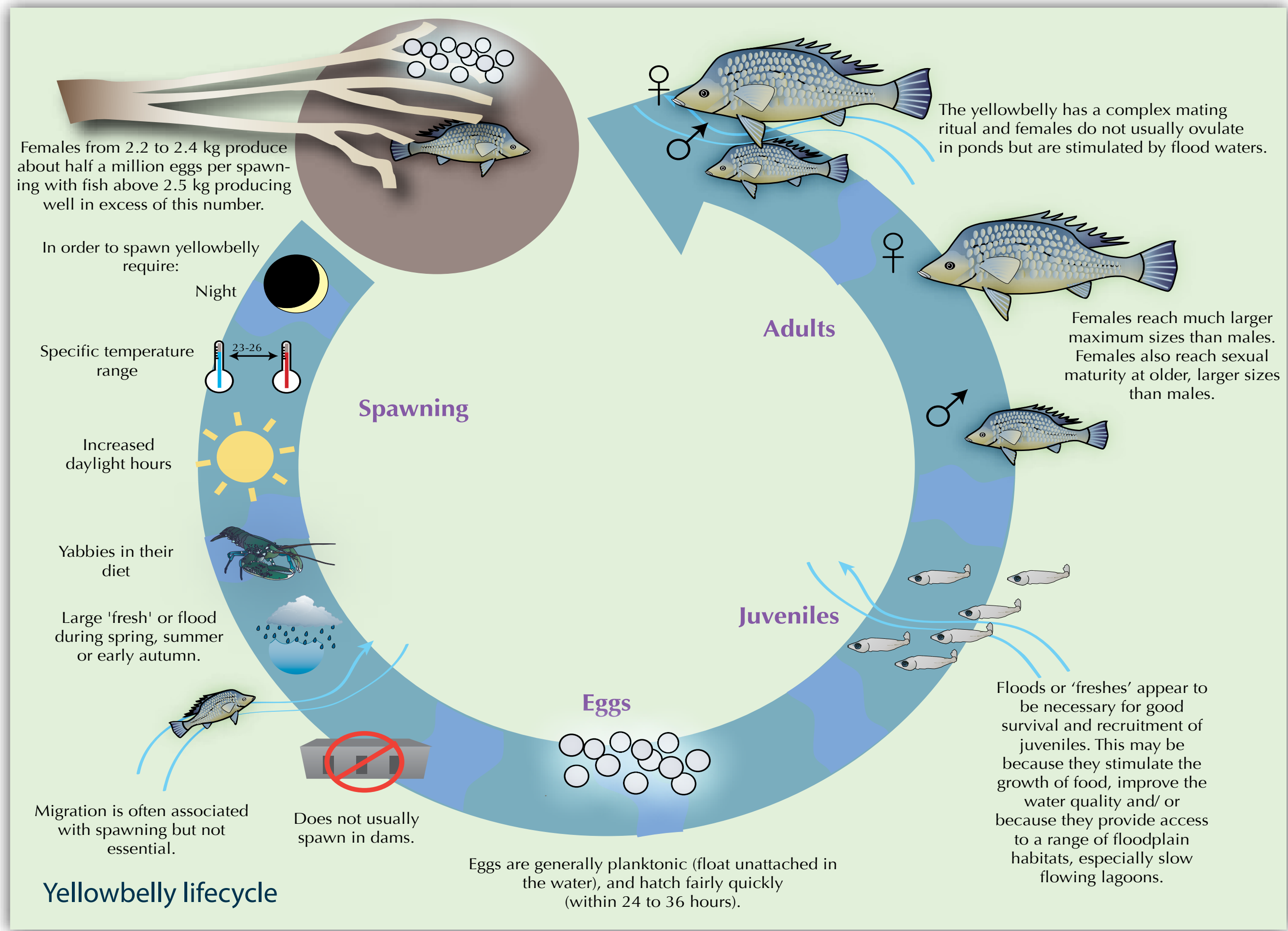
Yellowbelly or golden perch (***Macquaria ambigua***) is a top predator fish in Police Lagoons' food chains.

Photo: J. Scriven

A large 'fresh' or flood in the spring, summer and early autumn is needed to trigger yellowbelly spawning.

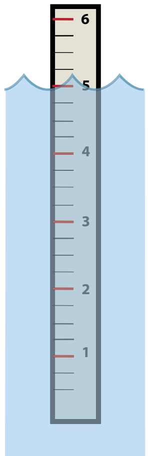
Photo: R. Burnett

Right: Floods allow juvenile yellowbelly to access the slow-flowing lagoons and enhance their chances of survival.



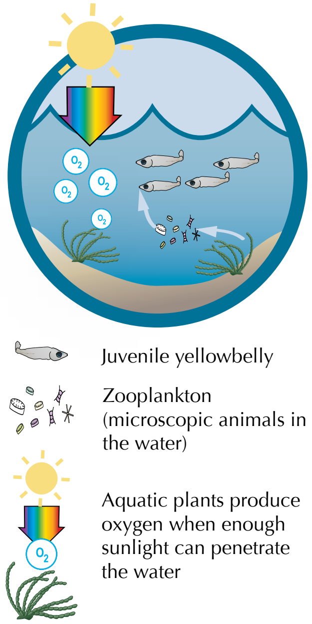
Police Lagoons in flood

Yellowbelly larvae prefer slow flowing, open water sites with limited shade. During floods, yellowbelly larvae move from rivers out onto the inundated floodplains and into wetlands like the Police Lagoons. Water quality factors (particularly dissolved oxygen) seem to determine where most yellowbelly larvae are found and appear to be even more important than food availability.

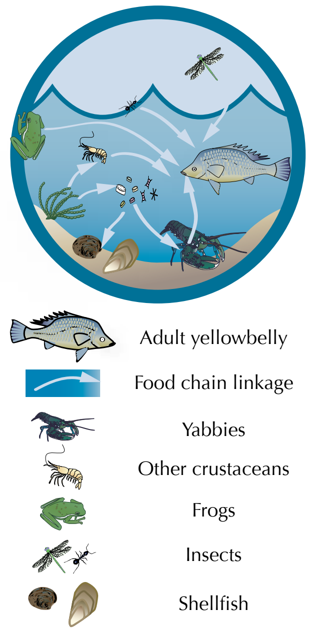


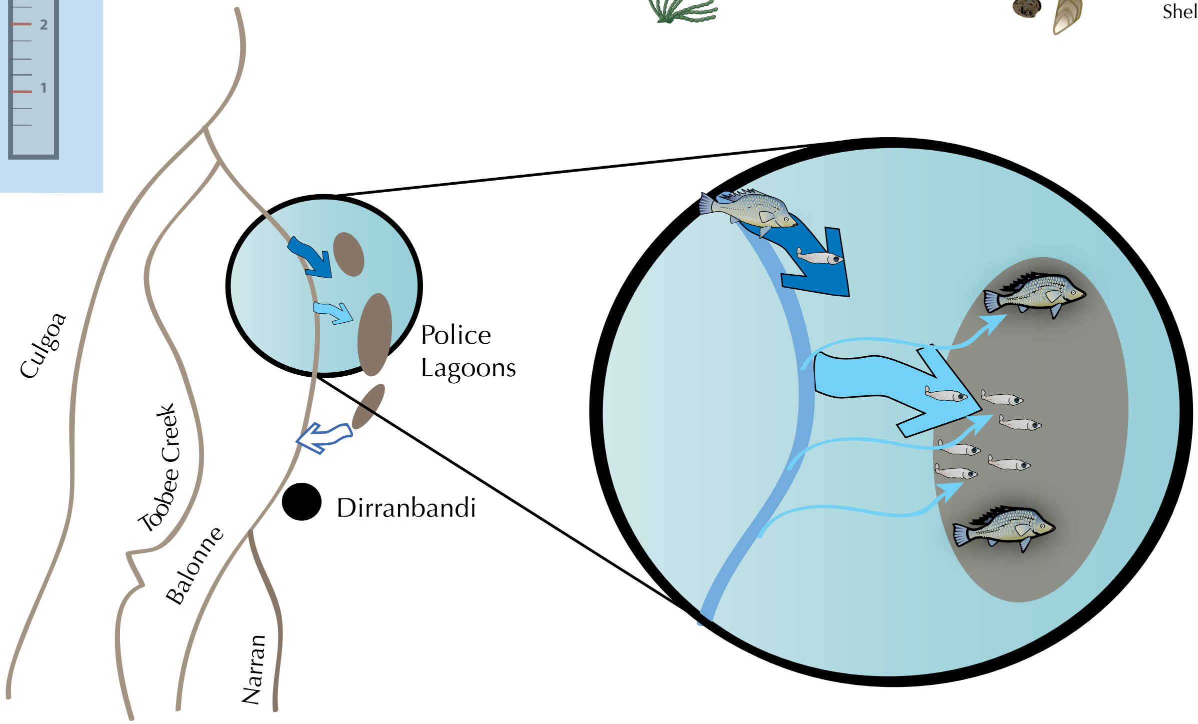
A flood measuring at least 5.06 m on Dirranbandi's flood gauge is needed before water will run into the Police Lagoons.

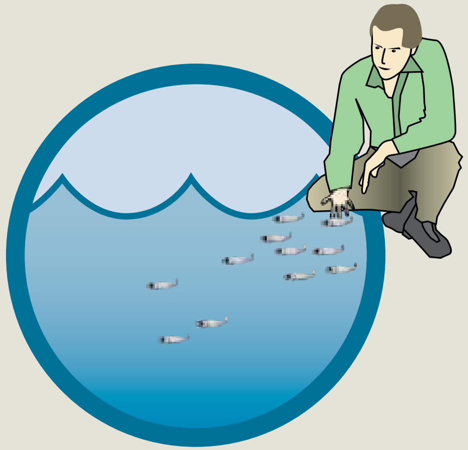
Diet – juvenile



Diet – adult







Restocking has invigorated the yellowbelly population

The local recreational fishing club restocked the Balonne river with yellowbelly fingerlings in the late 1990s. About ten years later, in an annual 'carp buster' competition (to see who could catch the most carp, a pest fish), more yellowbelly were caught than carp. This was a pleasing and unexpected result! However, restocking will only support the long-term future of the Balonne yellowbelly population if sufficient freshwater flows are maintained to foster the fingerling's growth.

Police Lagoons habitat

Under the regional ecosystem classification the Police Lagoons are mapped as *Eucalyptus coolabah* woodlands on alluvial plains. This habitat is classified as 'Of Concern' under the *Vegetation Management Act 2009*. This means only 10 to 30 per cent remains of the pre-clearing extent of this particular regional ecosystem. It is also classified as having an 'Of Concern' biodiversity status due to its importance in maintaining biodiverse habitat.

The coolabah trees are an important part of this wetland, providing a range of habitat functions. They shade the water, lowering the temperature and keeping it at a stable, which in turn helps maintain oxygen levels. They also provide large woody debris and complex root systems that are important for native fish habitat. Studies of the distribution of yellowbelly in different types of habitat show that they have a strong preference for large woody debris.

Photo: DERM

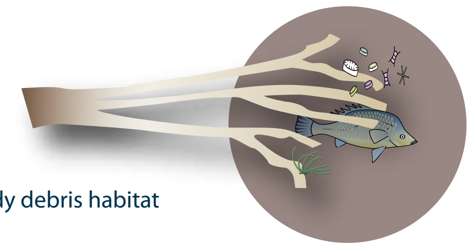
Tree root habitat

Why do fish live in trees?

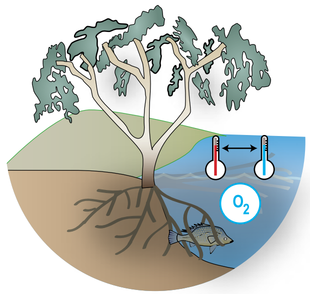
Eucalyptus coolabah tree at the southern end of Police Lagoons

Large woody debris and tree roots provide refuge habitat in slow moving water. They also provide physical structures for the growth of algae and invertebrates that attract, and are a food source for, the fish that adult yellowbelly eat.

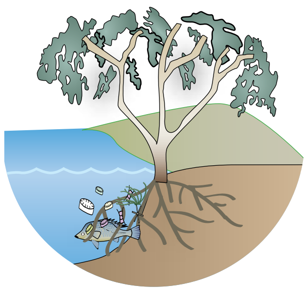
Depending on their alignment with water flow, woody debris can slow down the movement of water and can therefore perform a role in stabilising wetland banks and beds during heavy rainfall and floods. Logs may also bring about scouring and can increase the diversity of aquatic habitats.



Woody debris habitat



Trees shade the lagoons, helping to lower the temperature and increase the oxygen level of the water.

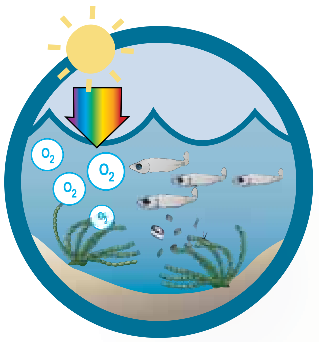


Tree root habitat

Water quality

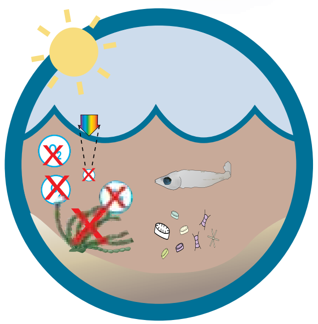
Sediment

The Balonne River that feeds Police Lagoons during times of flood contains high levels of sediment. One significant contributor to this 'turbidity' is land use within the catchment that results in erosion, transporting fine sediments into the river. Improving land use practises, for example by increasing groundcover, can help reduce this input of sediment into streams. Another source of sediment is stream bank erosion, which can be remedied by rehabilitating banks with native vegetation. The action of bottom feeding carp also increases turbidity by resuspending sediment that has settled.



Fish require oxygen to breathe and are typically found in higher numbers in water bodies with higher levels of dissovled oxygen.

Dissolved oxygen is produced by plants when they have access to sunlight.



Suspended sediment blocks sunlight from travelling through the water and therefore inhibits the growth of aquatic plants.

Reduced plant growth means reduced dissolved oxygen for fish to breathe.

Nutrients

Water quality testing found that the concentration of nitrogen in Police Lagoons was 1.5 times the national water quality (ANZECC) guideline value for this wetland type, while phosphorus concentrations were three times higher.

Where are all these nutrients coming from?

Nutrient concentrations in the river water at the St George gauging station, upstream of the Police Lagoons, show a similar pattern to that found in the lagoons. This similarity suggests nutrients flow into Police Lagoons from the river during floods, as well as from local run-off.

How do the nutrients get in the river?

Nutrients enter the river attached to eroded sediments, as part of debris and detritus, and dissolved in run-off from fertilised land.

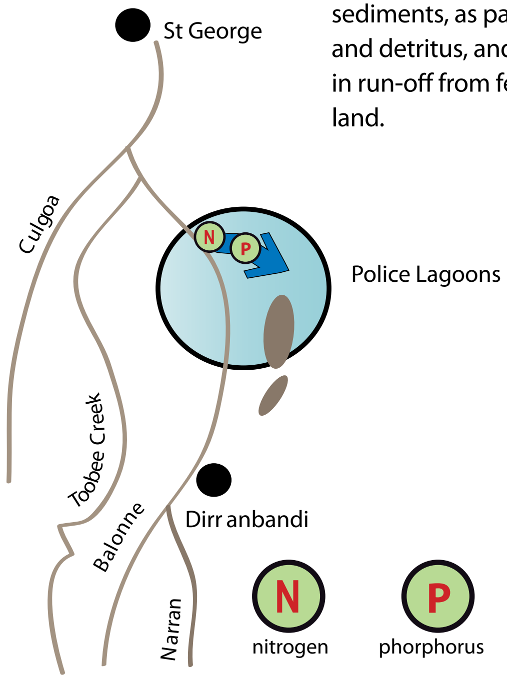


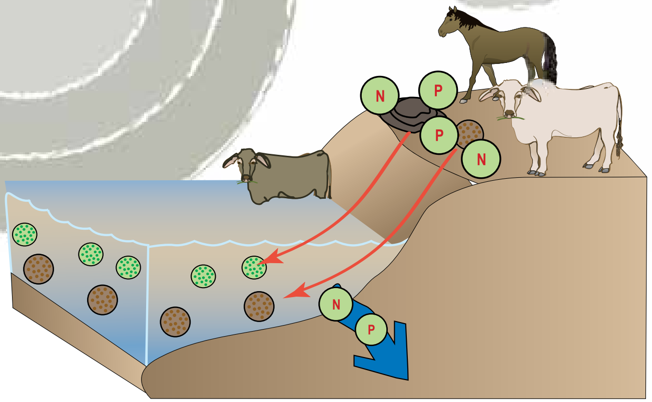
Photo: Brian Yap

The Balonne River at Beardmore Dam (in flood)

The muddy Balonne River

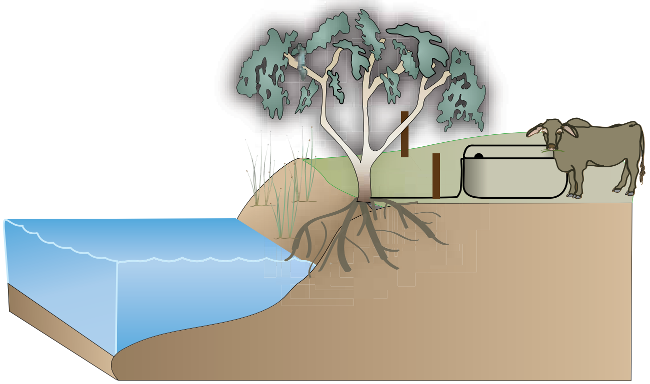
Threats to the Police Lagoons – Erosion

Stock access to upstream waterways and lagoons and high stocking rates in the catchment tend to result in higher sediment and nutrient levels in the water. This is due to the disturbance of soil and vegetaion by stock.



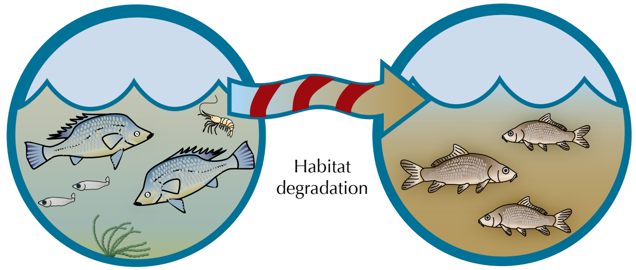
Sediment and nutrients from the eroding catchment and banks enter the water through wind and run off and are carried in flood waters from upstream.

Management practices that maintain a diverse native vegetation cover in the catchment, and on the banks of rivers, lagoons and streams, are essential for reducing sediment and nutrient inputs into waterways. Fencing of banks, the provision of off-stream watering points and the use of climatically adjusted, sustainable stocking rates are all effective ways to encourage and protect this beneficial native vegetation.



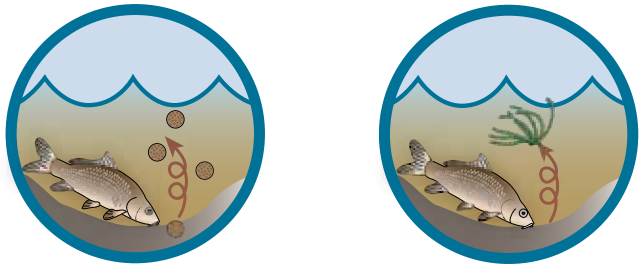
Threats to the Police Lagoons – Carp

Carp are invasive fish that thrive in a wide range of environmental conditions. They have a greater tolerance than most native fish of poor water quality, including low oxygen levels, pollutants, toxicants, turbidity and salinity. The degradation of river reaches and floodplain habitats, changes to water flows, declining water quality and other alterations to aquatic habitats over the past 50 years have negatively affected native fish, while favouring the invasive carp species, which are able to outcompete natives under these conditions.



Carp outcompete native fish

Carp stir up the bottom sediments and uproot plants when feeding, increasing turbidity and degrading the aquatic habitat. They also compete directly with native fish for food and space and have been known to prey on fish eggs and disturb fish breeding sites.



Impacts of carp on native fish

Carp management

Once rivers and wetlands are invaded by carp, management options are limited. Complete eradication of carp populations becomes very difficult. Actions that sustain native fish populations and that help them compete and give them an advantage over carp are therefore very important.

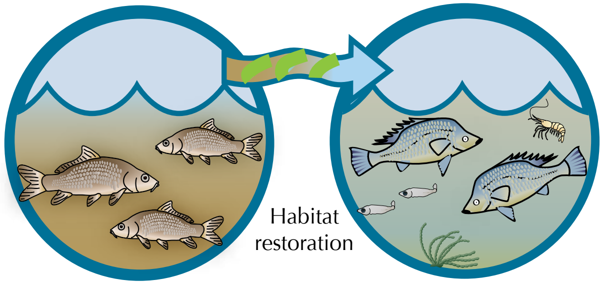
In floodplain wetlands

Following high flow events, large numbers of juvenile carp are often found in inundated floodplain habitats and ephemeral creeks. Studies from the central Murray–Darling Basin show that floodplain habitats are favoured areas for carp spawning. It is suggested that these areas may provide opportunities for targeting and trapping carp, potentially to reduce populations in a wider river reach.

Restoring native fish habitat

As carp have a distinct advantage in degraded habitats, efforts by natural resource management (NRM) groups, fishing and restocking clubs, land managers of riverine and offstream wetland areas (including local government and private), water distribution agencies (SunWater), irrigators, state and federal government, and other members of the public can help restore native fish populations and give them an advantage over carp and other invasive fish. This can be done by restoring ecosystem attributes such as:

- habitat structure and riparian vegetation (especially overhanging and trailing bank vegetation and large woody debris)
- connectivity between habitats
- bed contours
- substrate type
- flow regime
- water quality
- aquatic plants.



Such activities make conditions less favourable for carp and are likely to enhance native fish breeding and survival.

Studies show that physically removing carp can provide significant benefits to native fish, in fact, it can result in an increase in native fish biomass (collective weight of fish) three times greater than the biomass of carp removed. Intensive physical removal may be cost-effective in priority wetlands where re-establishment of carp can be prevented.

Electrofishing and trapping has been identified as the most effective methods for removing carp at a wetland-scale. Carp angling events are part of the process of carp removal but require additional efforts for a sustained benefit to native fish.

Right: Carp spawning – when water quality is poor, carp outcompete native fish and proliferate in Australia's inland waterways.

Photo: D. Spennemann

Below: Off-stream watering points help to maintain water quality in the Police Lagoons and discourage pest fish.

Threats to the Police Lagoons – Water extraction and storage

Ring tanks and turkey nests, dams and weirs, and onsite extraction all reduce the amount of water in the Police Lagoons.

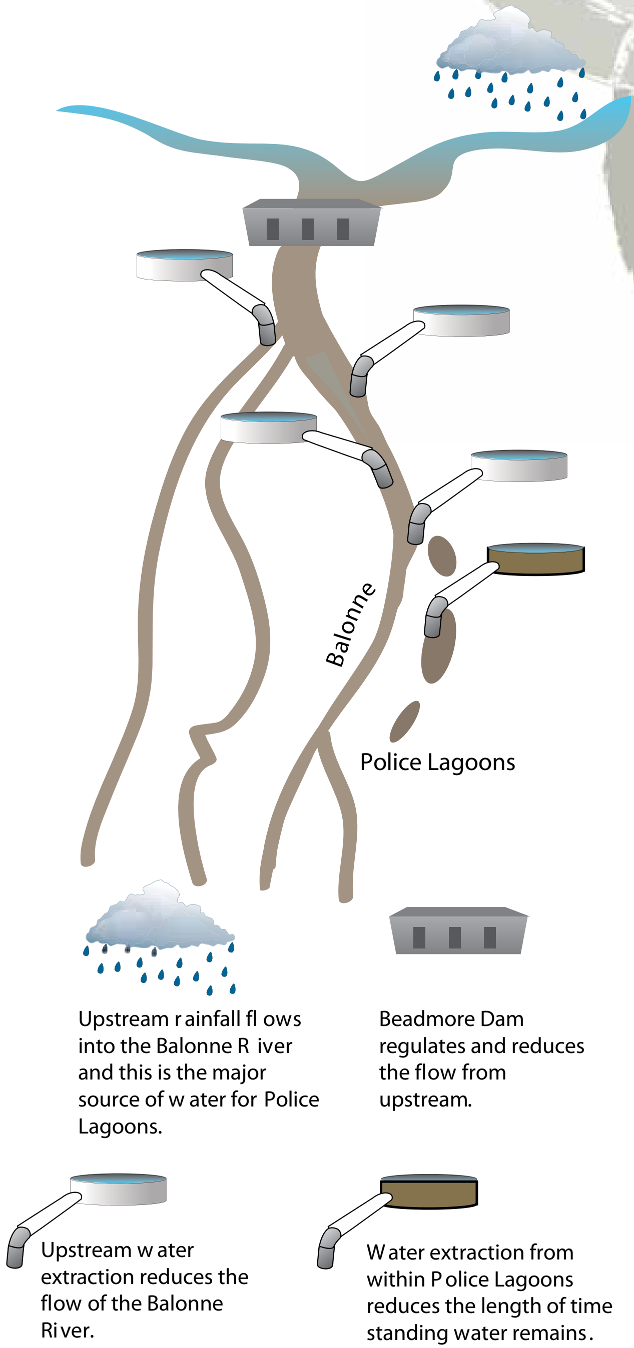
Upstream extraction and storage

Flooding of off-stream floodplain wetlands occurs during times of high river flow (resulting from high upstream and/or local rainfall), when the river breaks its banks and floods the surrounding floodplain. The topography of the floodplain, and climate variations such as droughts, are natural factors that affect the regularity of floodplain wetland filling. In addition to these, upstream water capture in dams, extraction and diversions restricts the amount of water flowing through the river. This in turn reduces the amount of water available to overflow river banks, flood the surrounding landscape and fill off-stream floodplain wetlands.

Generally, as more water is extracted from a river, particularly during low and medium flows, the frequency of floodplain wetland filling decreases, impacting wetland communities of plants and animals that need floods as part of their lifecycles.

Over the last 50 years or so, the Balonne River, and many of the streams that feed it, have experienced increased water extraction and storage. Primarily, this has supported the growth of irrigation-based agricultural industries such as broadscale cropping and supplied town water. For example the Beardmore Dam at St George was constructed in 1972 for this latter purpose.

Using over a hundred years' worth of information from local gauging stations at Wyanbah and St George, and models of stream flow under different climatic conditions, it is possible to estimate what impact the current level of water extraction is having on the filling of Police Lagoons.



What's the impact of extraction?

Under the current level of extraction, the chances of Police Lagoons filling have decreased by about 27 per cent. Records show that before development, Police Lagoons filled once a year on average, while under the current water extraction rates, they now fill every 1.4 years on average. This does not necessarily mean that before water extraction they filled every year. However, it does mean that they would have filled more regularly, more often and required lower amounts of rainfall to do so, as the runoff and river flows would have been more likely to reach the lagoons.

What does this mean for management?

Upstream

The inflow of water from the Balonne River breaking its banks and flooding is the lifeblood of the Police Lagoons. It drives the wetland cycles, the plants and animal communities and also the recreational fishing highly valued by the local community. Managing the impact of upstream water extraction is important for all floodplain wetlands, like Police Lagoons. It requires government, NRM bodies, and property owners and managers to work together to balance the need for water extraction and storage with the needs of the environment. This is being done through water resource planning.

Onsite

Natural on-site wetting and drying processes must also be supported. Water extraction from within the Police Lagoons reduces the length of time they hold water and therefore the length of time they can provide aquatic habitats before drying out completely. It also reduces the potential for the lagoons to connect back to the river and deliver juvenile fish before the pools dry out and the fish die. It is this ability to reconnect that allows the lagoons to act as a nursery habitat for fish rather than as a death trap for the river's fish population.

Floods

Major floods do not necessarily develop in the headwater areas of the catchment but can result from heavy rainfall in any of the large tributaries that enter the main Balonne River. Records of large floods along the Balonne River extend back as far as 1890 at St George with extensive records at several other locations on the main stream. Flood events occur every two years (on average), though this can be altered during periods of extended drought as happened in the last decade (2000–2010). The largest floods occurred in 1942, 1950, 1956, 1975, 1976, 1983 (twice), 1988, 1996 and most recently in early 2010. Major floods generally occur in the first half of the year, although records indicate they may occasionally occur in late spring.

Flooding and fish

A reduction in the frequency, seasonality and amount of floodwater affects many aspects of native fish lifecycles, especially breeding, spawning and the growth of juveniles. These all require or benefit from flood flows, the connection to floodplain areas and the stimulus of the aquatic ecosystems that floods provide.

Barriers to connectivity

Unless equipped with a fish ladder, dams and weirs associated with extraction and storage, and even road crossings, can restrict connectivity of river reaches and prevent fish movement upstream and downstream.

Photo: R. Burnett

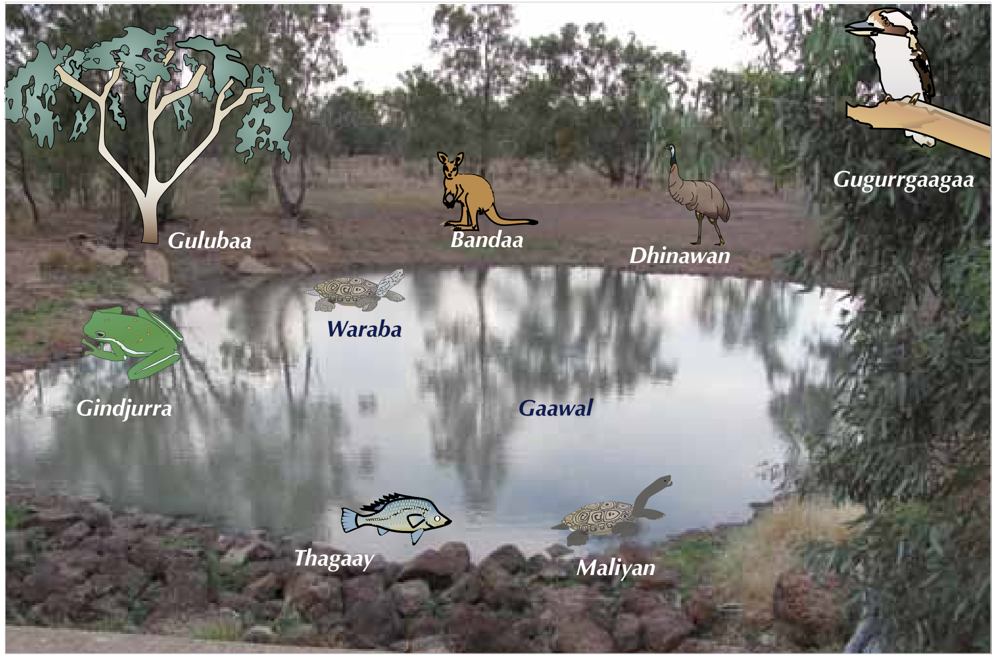
Police Lagoon, dry in October 2009 (far left) and two months after the February 2010 flooding (left).

Living memories of the Police Lagoons

Deep section of the Police Lagoons at the Town Common

Photo: R. Burnett

The Kamilaroi and Kooma Aboriginal people have a cultural connection to the Police Lagoons and surrounds. Aboriginal Elders remember *yilambu* (long ago), the time before water extraction and large scale changes in catchment land use, when fish could be caught all year round – in the river and often in the Police Lagoons. Floods and high water levels seemed to be more consistent and the Police Lagoons provided a place where people were regularly able to gather, swim and catch fish. The most southern lagoon, with the deepest hole, was known for the biggest, most elusive yellowbelly, while the deep lagoon in the middle of the Town Common was the most popular of all. Many of the Elders remember spending time there with their families and fishing equipment, activities they still enjoy at Police Lagoons to this day.



The deep hole on the southern end of the Police Lagoons, a popular spot for catching yabbies

Learning the Kamilaroi language

Coolabah tree–*Gulubaa*

Emu–*Dhinawan*

Frog–*Gindjurra*

Kangaroo–*Bandaa*

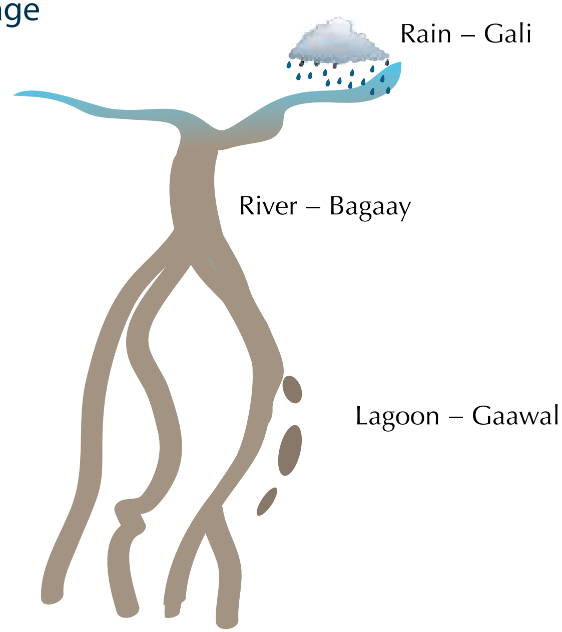
Kookaburra–*Gugurrgaagaa*

Long ago–*Yilambu*

Long necked turtle–*Maliyan*

Short necked turtle– *Waraba*

Yellowbelly–*Thagaay*



Cultural heritage

There are a large number of scarred trees in the Police Lagoons area, which are important reminders of the area's Indigenous cultural heritage. These scars have been created by Aboriginal people for a variety of reasons, through the deliberate removal of bark or wood, providing long-standing evidence of Aboriginal occupation and connection to the area that is preserved in the fabric of living trees.

Bark is a versatile and plentiful material and was used for a wide variety of tasks, including the construction of shelters, watercraft and containers. Other forms of tree scarring include deliberate marking (such as tree carving), for sites of significance. A burial site in the sandy area at the northern end of the lagoon is marked with carved trees.

Scar trees at Police Lagoons (above); goanna shaped scar near the Narran River (top right)

The Police Lagoons are so named because nearby paddocks were used by the police to hold cattle that had ben confiscated for various reasons. An alternative name – Comale Lagoon – is used on some topograhic maps.

In the Kamilaroi language ***gumale*** means a campsite where someone has died. This may be connected to the Police Lagoon's other name.

A sandy section on the northern end of the Police Lagoons, near where a Traditional Owner burial site is located.

References

Arumugapm, T. and Geddes, M.C. (1987) Feeding and growth of Golden Perch larvae and fry (*Macquaria ambigua*), *Trans. R. Soc. S. Aust.* 111(1): 59–65.

Baumgartner, L.J., Reynoldson, N. and Gilligan, D.M. (2006) Mortality of larval Murray cod (*Maccullochella peelii peelii*) and golden perch (*Macquaria ambigua*) associated with passage through two types of low-head weirs. *Marine and Freshwater Research* 57: 187–191.

Boys, C.A. and Thoms, M.C. (2006) A large-scale, hierarchical approach for assessing habitat associations of fish assemblages in large dryland rivers, *Hydrobiologia* (2006).

Crook, D.A. and Robertson A.I. (1999) Relationships between riverine fish and woody debris: implications for lowland rivers, *Mar. Freshwater Res.* 50.

Gehrke, P.C. (1990) Spatial and temporal dispersion patterns of golden perch, *Macquaria ambigua*, larvae in an artificial floodplain environment, *Journal of Fish Biology* 37(2): 225–236.

Gehrke, P.C. (1991) Avoidance of inundated floodplain habitat by larvae of golden perch (*Macquaria ambigua* Richardson): Influence of water quality or food distribution?, *Australian Journal of Marine and Freshwater Research* 42(6): 707–719.

Humphries, P., King, A.J. and Koehn, D. (1999) Fish, flows and flood plains: links between freshwater fishes and their environment in the Murray–Darling River system, Australia, *Environmental Biology of Fishes* 56: 129–151.

Kingsford, R.T. (2000) Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia, *Austral Ecology* 25: 109–127.

Koehn, J., Brumley, A. and Gehrke, P. (2000) *Managing the Impacts of Carp*. Bureau of Rural Sciences (Department of Agriculture, Fisheries and Forestry – Australia), Canberra.

Mallen-Cooper, M. and Stuart, I. G. (2003) Age, growth and non-flood recruitment of two potamodromous fishes in a large semi-arid/temperate river system. *River Research and Applications* 19: 697–719.

Lake, J.S. (1967) Rearing experiments with five species of Australian freshwater fishes. I. Inducement to spawning, *Australian Journal of Marine and Freshwater Research* 18: 137–153.

O'Connor, J. P., O'Mahony, D. J. and J. M. O'Mahony (1983) Movements of *Macquaria ambigua*, in the Murray River, South eastern Australia, *Aust. J. Mar. Freshw. Res.*, 34: 857–71.

Stuart, I. G. and Jones, M. (2006) Large, regulated forest floodplain is an ideal recruitment zone for non-native common carp (*Cyprinus carpio* L.), *Marine and Freshwater Research*, 57: 337–347.

Reynolds L. F. (1983) Migration patterns of five fish species in the Murray–Darling River system, *Aust. J. Mar. Freshw. Res.*, 34: 857–71.

Rowland, S. J. (1996) Development of techniques for the large-scale rearing of the larvae of the Australian freshwater fish golden perch, *Macquaria ambigua* (Richardson, 1845), *Marine and Freshwater Research* 47: 233–242.

Further reading:

Moffatt, D. and Voller, J. (2002) *Fish and Fish Habitat of the Queensland Murray–Darling Basin*, Department of Employment, Economic Development & Innovation, (formally Department of Primary Industries), The State of Queensland.

White, M. E. (2000) *Running down: water in a changing land*, Kangaroo Press, East Roseville, NSW.

Young, W.J. (Ed.) (2001) *Rivers as Ecological Systems: The Murray–Darling Basin* ,Murray Darling Basin Commission, Canberra ACT.

Murray–Darling Basin Regional NRM Plan, which can be downloaded from: http://www.qmdc.org.au/publications/browse/5/plans

© The State of Queensland 2010 (updated 2013)

The Queensland Wetlands Program is a joint initiative of the Australian and Queensland governments.

Australian Government

Queensland Government

Queensland Wetlands Program

Queensland Murray-Darling Committee

Find all your wetland management resources at: www.wetlandinfo.ehp.qld.gov.au