Lachlan Riverine System

Water for the environment…….

...and challenges facing Lachlan River Valley

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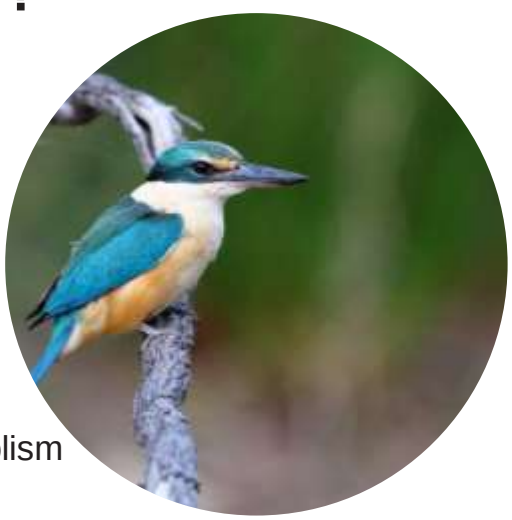
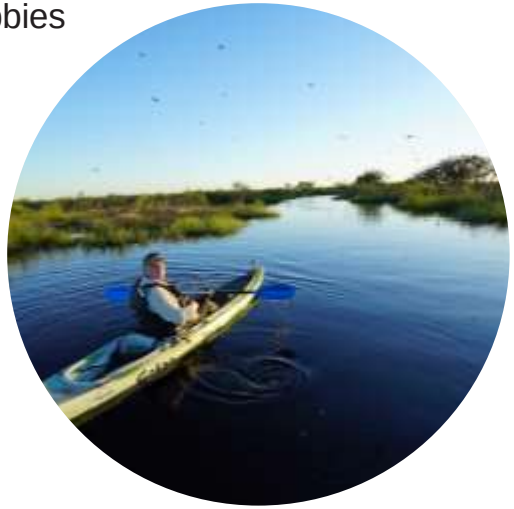
Cowra, OEH

WHAT IS ‘WATER FOR THE ENVIRONMENT’?



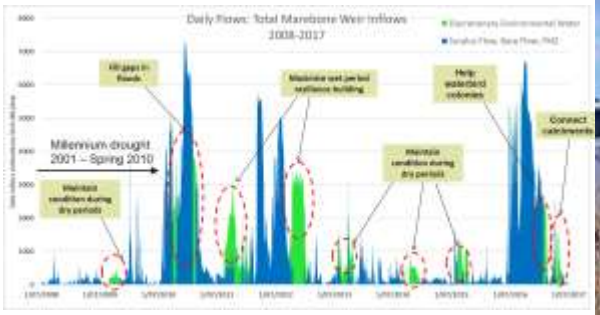
We manage water for a range of environmental outcomes:

- Birds – waterbirds, other flow-dependent birds
- Native fish
- Flow-dependent vegetation (wetlands and riparian areas)
- River processes eg mitigate hypoxic water in some areas, stream metabolism
- Frogs in some catchments
- Other flow-dependent fauna – frogs, water rats, turtles, invertebrates, yabbies etc



- Recognition of other benefits:
  - Supporting cultural values and events
  - Recreational use – fishing, kayaking
  - Economic benefits - Floodplain and wetland grazing, tourism
  - Social values – mental health, crime rates, aesthetics

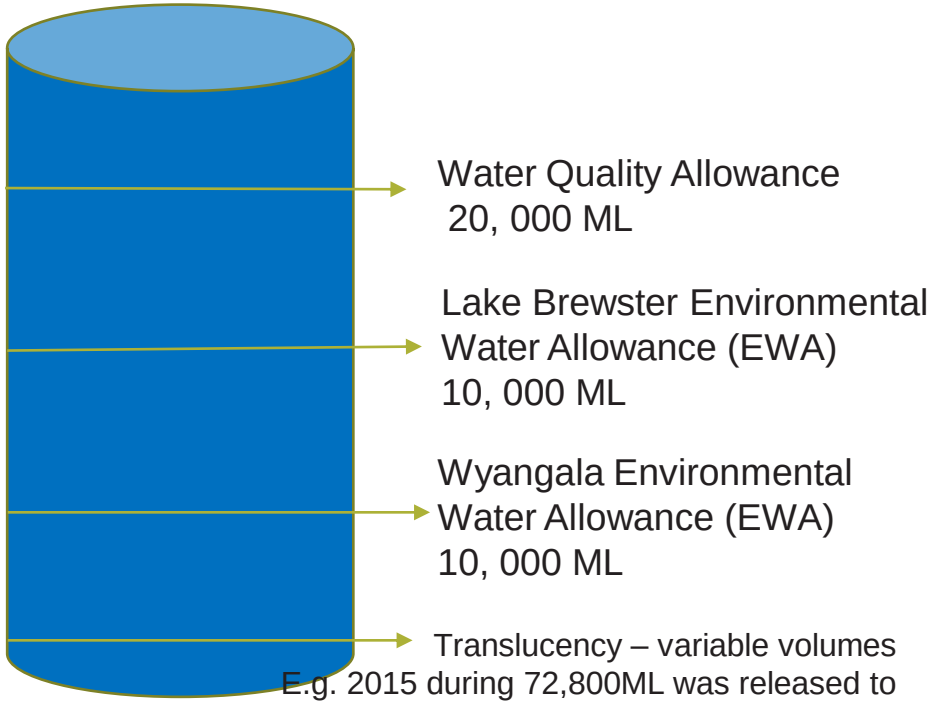
What does an Environmental Water Management Officer do?

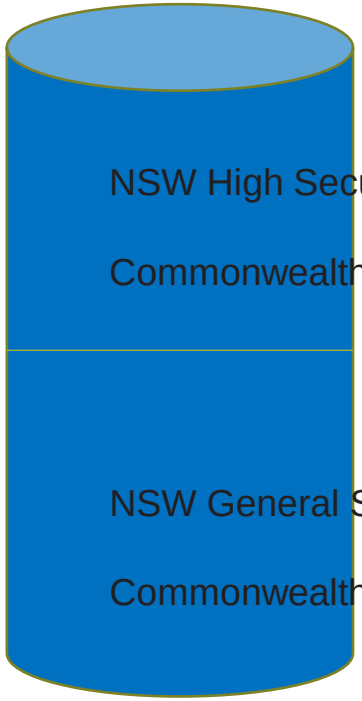


Over 1400 km of river channel + floodplain.. and their communities

What are the main tools at our disposal: Water Sharing Plan & Entitlement

- Planned environmental water
- Held or licenced environmental water





Total GS = 123,569 ML for environment

1 gigalitre = 1000 megalitres (ML)

2.5 megalitre (ML) = 1 Olympic swimming pool

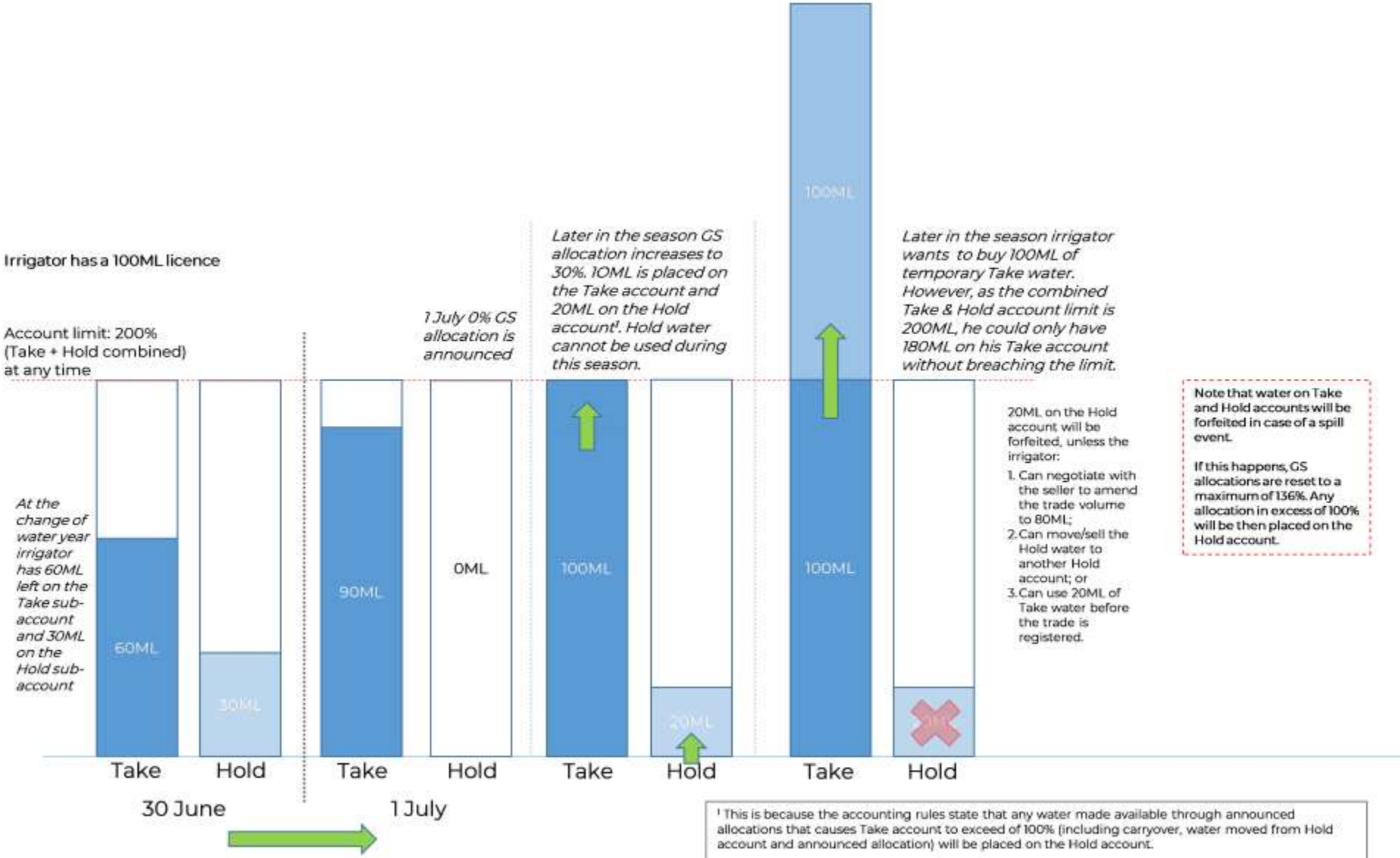
https://www.waterflow.io/blog/lachlan-water-account-management-guide

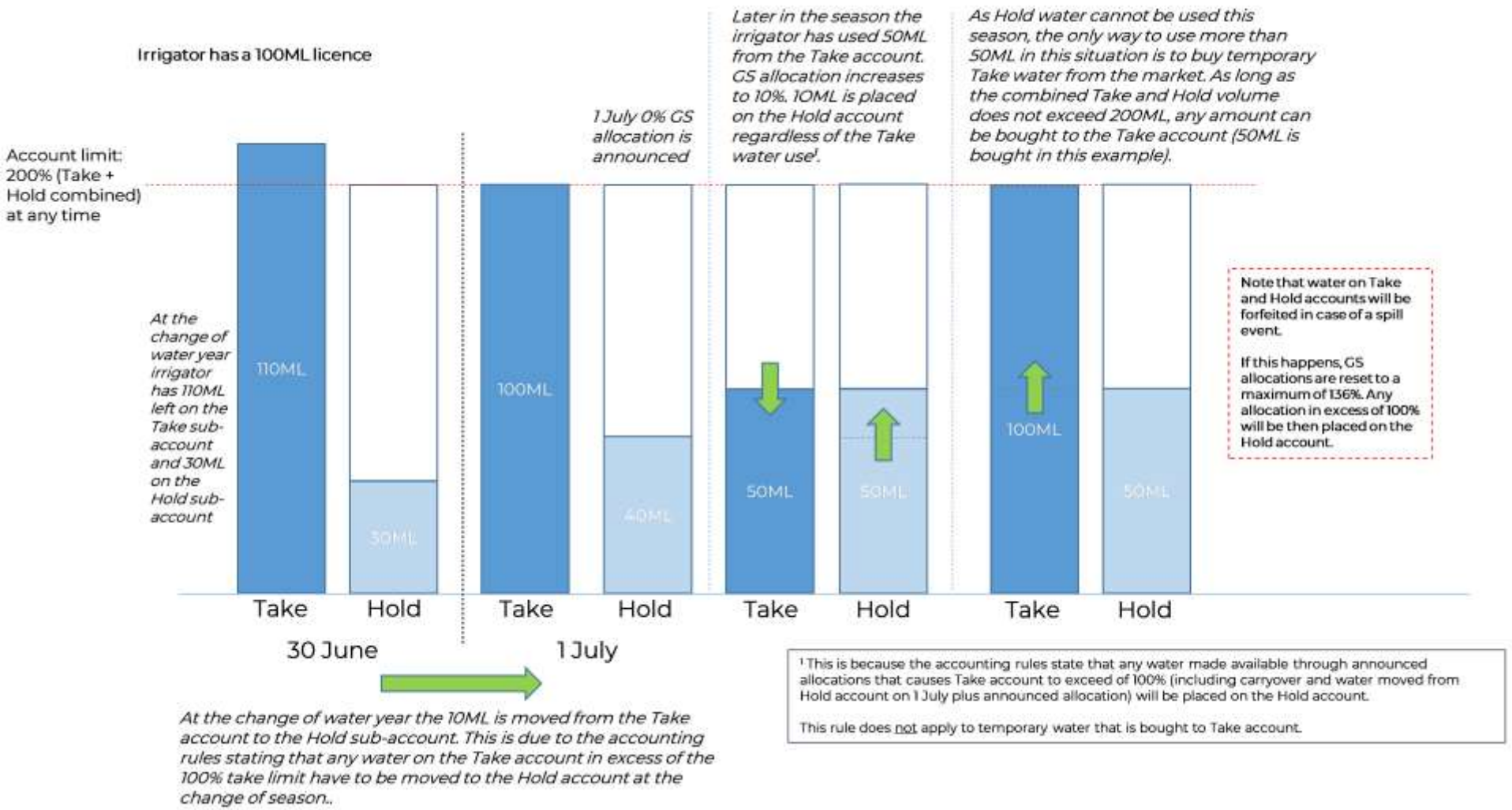
Table 1. Summary of water accounting and carryover rules in the Lachlan.

Catchment	Entitlement class	Accounting method	Carryover allowance	Max. account limit	Use limit	Spill event impact
Lachlan	General Security	Continuous	Unlimited[1]	200% at any time (combined limit between Take and Hold sub-accounts)[2]	100% +/- net temp trade per year	All allocation forfeited and accounts reset to a maximum of 136%
	High Security	Annual	N/A	N/A	N/A	Only Spillable account water forfeited

[1] Effectively limited by maximum account limit

[2] Also, any water made available through announced allocations in excess of 100% (including carryover, allocation + water moved from Hold account on 1 July) will be placed on the Hold Account


Irrigator has a 100ML licence
Account limit: 200% (Take + Hold combined) at any time
At the change of water year irrigator has 60ML left on the Take sub-account and 30ML on the Hold sub-account
60ML
30ML
Take
Hold
30 June
1 July
At the change of water year the 60ML balance rolls over and 30ML is moved from the Hold account to the Take sub-account
1 July 0% GS allocation is announced
90ML
0ML
Take
Hold
Later in the season GS allocation increases to 30%. 10ML is placed on the Take account and 20ML on the Hold account[1]. Hold water cannot be used during this season.
100ML
20ML
Take
Hold
Later in the season irrigator wants to buy 100ML of temporary Take water. However, as the combined Take & Hold account limit is 200ML, he could only have 180ML on his Take account without breaching the limit.
100ML
100ML
Take
Hold
20ML on the Hold account will be forfeited, unless the irrigator:
1. Can negotiate with the seller to amend the trade volume to 80ML;
2. Can move/sell the Hold water to another Hold account; or
3. Can use 20ML of Take water before the trade is registered.
Note that water on Take and Hold accounts will be forfeited in case of a spill event.
If this happens, GS allocations are reset to a maximum of 136%. Any allocation in excess of 100% will be then placed on the Hold account.
[1] This is because the accounting rules state that any water made available through announced allocations that causes Take account to exceed of 100% (including carryover, water moved from Hold account and announced allocation) will be placed on the Hold account.
This rule does not apply to temporary water that is bought to Take account.



At the change of water year the 10ML is moved from the Take account to the Hold sub-account. This is due to the accounting rules stating that any water on the Take account in excess of the 100% take limit have to be moved to the Hold account at the change of season..

[1] This is because the accounting rules state that any water made available through announced allocations that causes Take account to exceed of 100% (including carryover and water moved from Hold account on 1 July plus announced allocation) will be placed on the Hold account.

This rule does not apply to temporary water that is bought to Take account.

Office of Environment & Heritage

Last ‘new water’ was August 2017
Available Water Determination (AWD)

AEW General Security & Conv YTD	Lachlan
Entitlement	37,595.0
Carryover from 17/18	46,626.1
AWD to Date	0
Lost Water	0
Water Transferred [1]	-5,005.5
Water Ordered/Delivered [2]	-10,200.0
Water Reserved [3]	-621.0
Carryover space reserved[4]	0
Hold sub-acct (ML)	9,718.6
Water Available (ML)	21,081.0

- Any water left on the Hold account will be automatically carried over at the end of the season and transferred to the Take account, but ONLY up to 100% of the entitlement volume. Water in excess of that will be placed on the Hold account. **OEH will be below the 200% Take and Hold limit at 30, 799.8 ML**
- The amount of water carried over will effectively limit the amount of current year’s announced allocation that can be received to the Take account (and used during the current season), regardless of how much Take water has been used before the announcement. **So if you thought it would flood next winter you would fill on-farm storages or use for winter crop or watering**

2018-19	High Security	General Security	Drought Stage
Lachlan	100%	0%	Stage 1

Storage levels (as at 12 March 2019)

- Wyangala Dam is 34 per cent full – falling – currently at 409 GL.
- Lake Cargelligo is 85 per cent full – falling – currently at 32 GL.
- Lake Brewster is effectively empty.

Drought stage

The NSW Extreme Events Policy introduced a staged approach to managing extreme events, such as severe droughts or poor water quality events. Currently, the Lachlan regulated river water source is in Stage 1, meaning there are no constraints expected to the deliverability of account water during the current water year.

Although currently in Stage 1, the valley could quickly move through to stage 3 during next water year if winter rains again fail. See below for more details on the indicative outlook for 2019-20 water availability.

Also, further information on the policy and related drought stages can be found at:

Estimated deliverability of carryover under various inflow scenarios

2019-20 Delivery of GS water (ML)	Delivery as % of water held in GS accounts on 1/07/19	Combined inflows required by 1/07/19 (ML)	Chance of receiving these inflows by 30 June 2019	Chance of receiving these inflows by 31 October 2019	Wyangala Dam % capacity on 1/07/19
78,000	45%	1,500 (historical minimum)	99%	99%	27%
122,000	70%	50,000	60%	95%	31%
175,000	100%	110,000	> 40%	> 80%	36%

Note 1: Estimated water held in general security accounts on 1 July 2019 of about 175,000 ML.
Note 2: Water delivery operations in 2019-20 provided under drought contingency planning.

Raising Wyangala Dam wall key step for Lachlan Valley

26 February 2019

WaterNSW welcomes the NSW Government's commitment to progress investigations into the raising of the Wyangala Dam wall and looks forward to getting started on this vital piece of work.

The 10m raising of the wall was identified in WaterNSW's Lachlan Valley Security Study as a preferred option for improving drought and flood management in the region.

The study found that raising the dam wall increases the capacity to hold water in periods of surplus and deliver controlled release when water is needed. Crucially, it provides increased capability to manage flood events.

The Lachlan Valley is one of the most drought and flood prone in the state, having endured the Millennium Drought of the 2000s and significant flooding in 2016. The inability of the water system to mitigate these events has adverse economic, social, and environmental impacts for the region's water-dependent agricultural and mining industries.

As part of any planning process WaterNSW will conduct extensive consultation with the community an stakeholders, both upstream and downstream of the dam.

WaterNSW, the state's bulk water supplier and system operator, has already undertaken preliminary work to examine the prospect of raising the dam wall.

The proposal to raise the Wyangala Dam wall follows the NSW Government's announcement to fund a business case for building a 12km pipeline from Lake Rowlands Dam to Carcoar Dam, which was also identified in the Lachlan Valley Water Security Study.

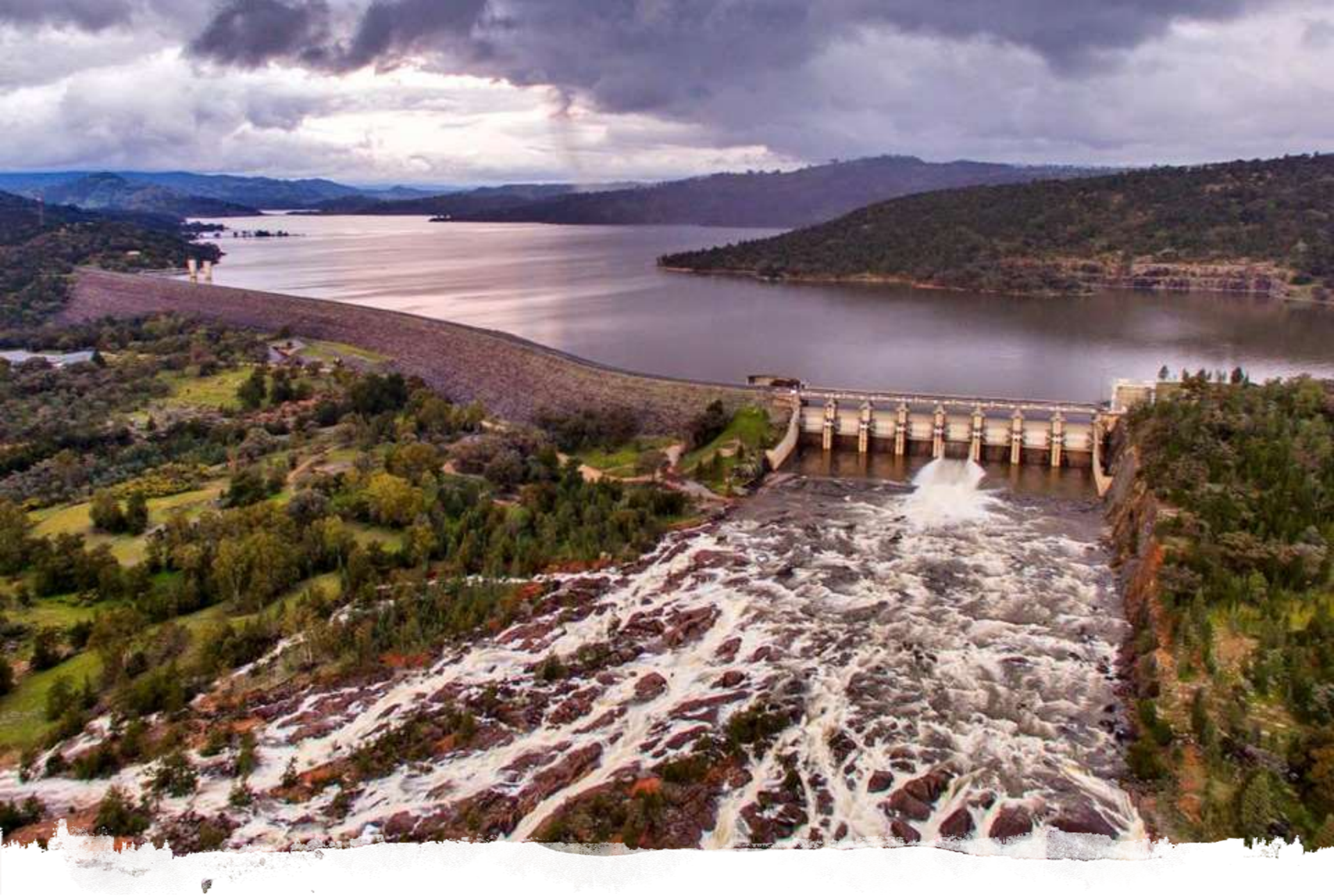
"Raising the Wyangala Dam by 10m would deliver an extra 650GL of storage capacity in addition to the existing storage volume of 1,218GL," said Andrew George, WaterNSW's Executive Manager Water Solutions & Market Strategy.

"The Lachlan Valley Water Security Study identified infrastructure solutions to the water delivery system in Lachlan Valley, which needs improvements in capacity and capability to meet the challenges of drought and flood.

"Our study shows that raising the dam wall at Wyangala increases the capacity to capture and hold water in periods of surplus flows and regulate the release of stored water when it is needed. It also provides increased capability to manage high inflows and flood events."

The Lachlan Valley was identified by the NSW Government in its State Infrastructure Strategy 2014 Review as the first of four 'priority catchments' for the investment and delivery of critical water infrastructure projects over the next decade.

WaterNSW's infrastructure solutions in the Lachlan Valley – including raising the dam wall at Wyangala Dam – aligns with the objective to deliver water security for communities and customers in regional NSW



Transitioning from the Cap to sustainable diversion limits

Water is a limited and valuable resource. Robust and transparent water accounting and compliance are essential to long-term water resource management arrangements that are sustainable, secure and adaptable.

In 1995, the Murray–Darling Basin Ministerial Council introduced the Murray–Darling Basin Cap on Surface Water Diversions (the Cap) to protect and enhance the riverine environment and protect the rights of water users. The Cap introduced long-term limits on how much water could be taken from rivers in 24 designated river valleys.

The Cap also introduced a requirement that Basin states had to work out ways to turn the long-term limits into annual Cap targets that take account of changes in things like the weather conditions and water availability in each year.

Under the Cap, Basin states have to provide data to the Murray–Darling Basin Authority (MDBA) about how much water was actually taken each year compared to the annual Cap targets.

Assessing Cap compliance

Once the MDBA receives annual data from the Basin states, the data is entered into the Cap Register and an assessment of compliance with Cap limits is made.

Lachlan

In the Lachlan the general security account limit is 200% of e
full the general security share of the storages is equivalent t
water held in general security accounts above 136% will be spilled if there is an account spill and reset.

Usage is controlled by way of the Use Limit, and is limited to no more than 100% of entitlement in a year, regardless of how much water has been allocated. The general security account is split into a Take sub-account to hold the water that can be used in the current year, and a Hold sub-account to hold the water that must be used in a future year. The Take account cannot be more than 100% of entitlement unless Take water from another licence is transferred in during the current year.

The Use Limit is set each year by DPI Water based on whether the usage in previous years has been above or below the long term baseline diversion limit. Since the end of the millennium drought the Use limit in the Lachlan has been 100%.

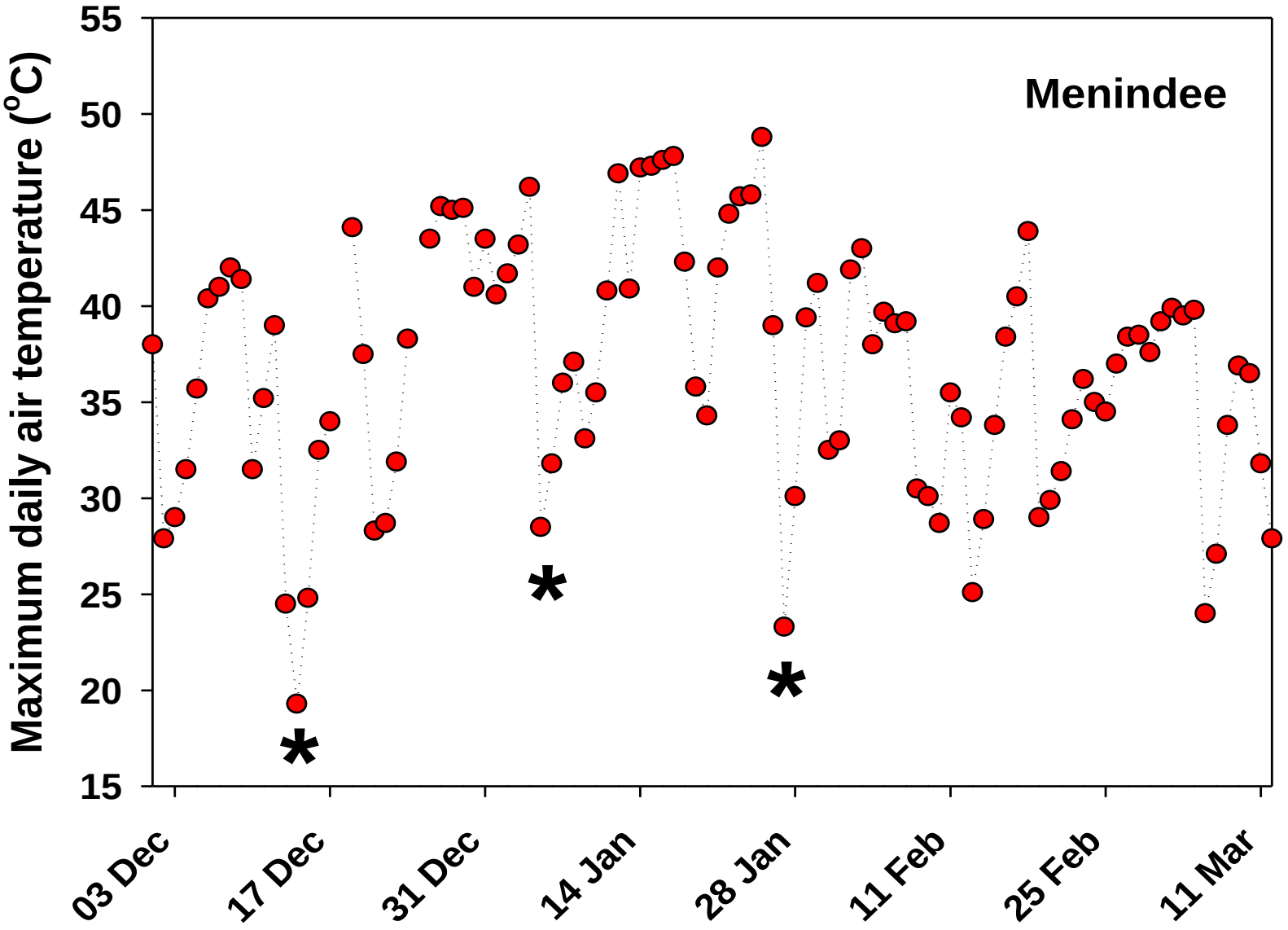
Ecological issues: Blue Green Algal Blooms and consequences for biota in terms of low oxygen availability = fish kills

- Many aquatic organisms rely on oxygen dissolved in the water column for their respiratory needs, therefore it is absolutely critical for the health of aquatic ecosystems.
- Concentration of oxygen in the air is ≈20 %, concentration in water at saturation is ≈ 10 mg/L (i.e. 100,000 fold lower).
- Fish start to stress when DO < 4 mg/L, death occurs when DO < 2 mg/L

- About 5000 fish died in late Jan 2019 in Redbank Weir
- The fish deaths coincided with third fish deaths episode in the Darling River at Menindee
- The fish deaths in Redbank and the 3 events in the Darling River all coincided with cool changes
- Evidence to suggests deaths caused by destratification

Stratification – a primer

- Thermocline – zone in the water column with different temperatures above and below
- Surface mixed layer - the zone above the thermocline
- Oxycline – a zone in the water column with different oxygen concentrations above and below
- Stratification and destratification depend on energy – air temperature, solar irradiance, wind and flow


Menindee
Maximum daily air temperature (°C)
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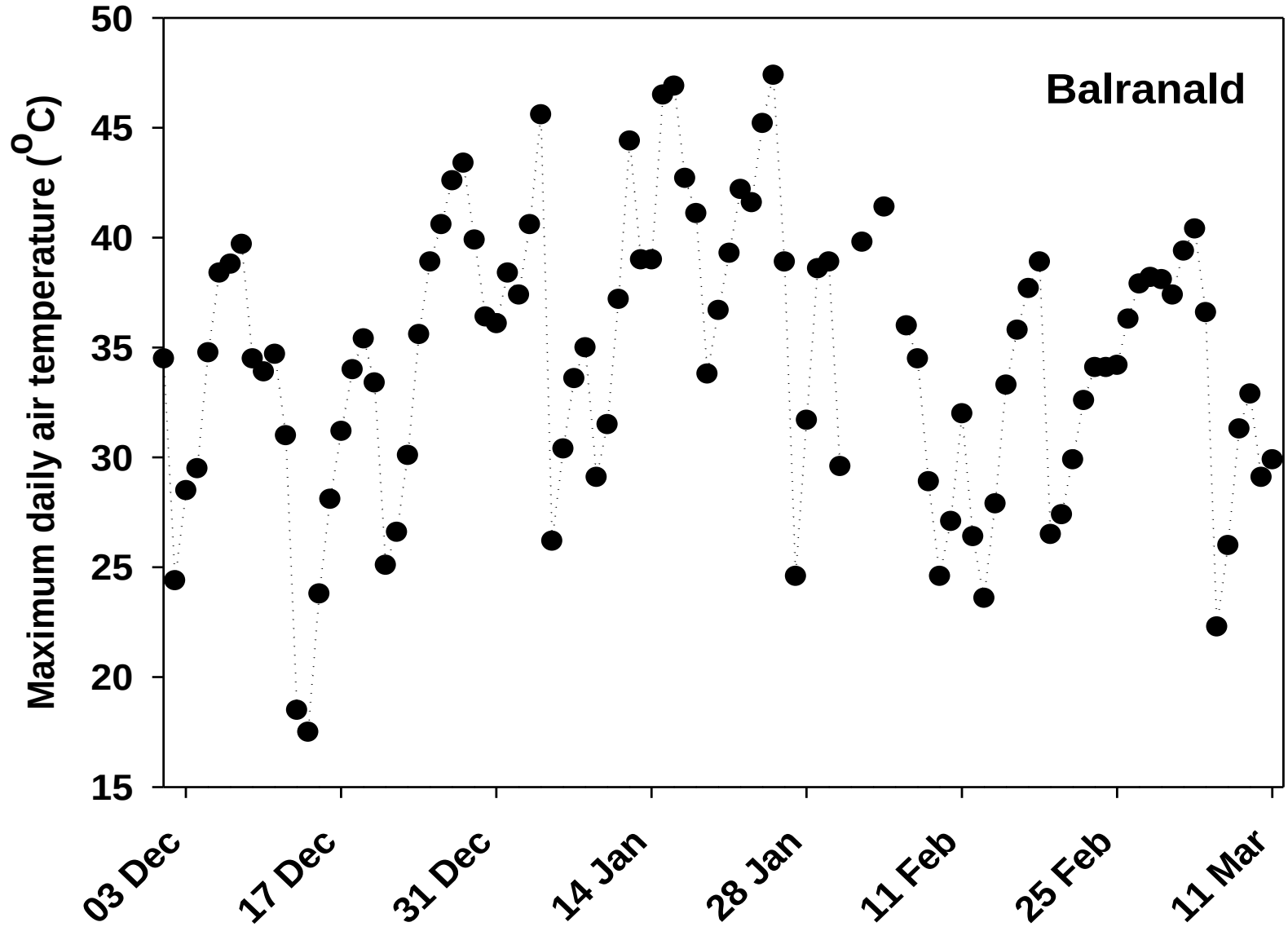
17 Dec
31 Dec
14 Jan
28 Jan
11 Feb
25 Feb
11 Mar


Balranald
Maximum daily air temperature (°C)
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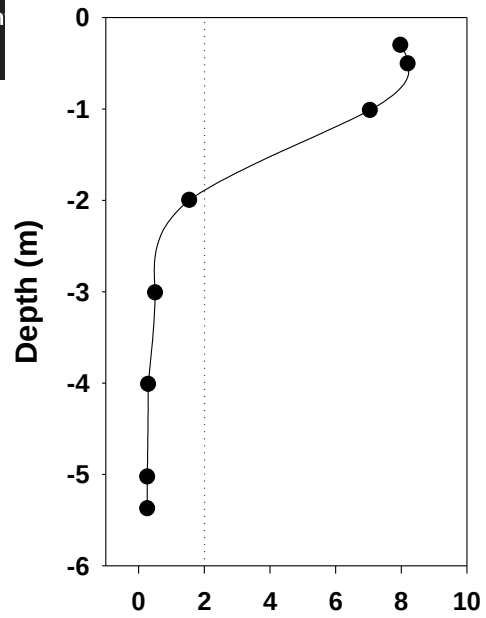
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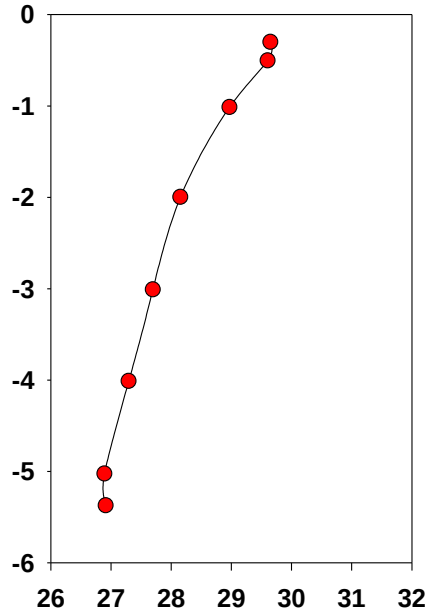
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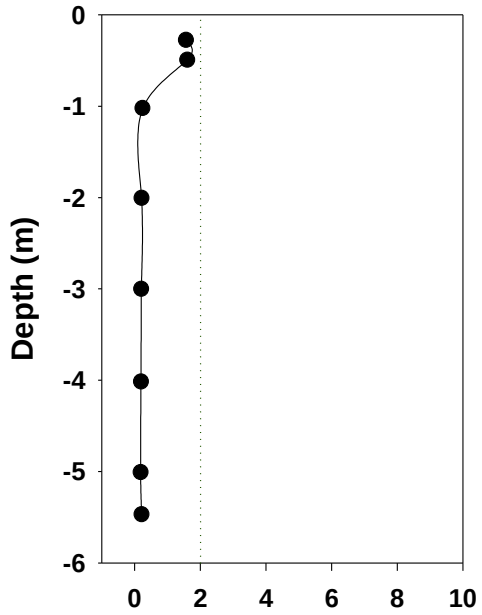
Depth (m)
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0
2
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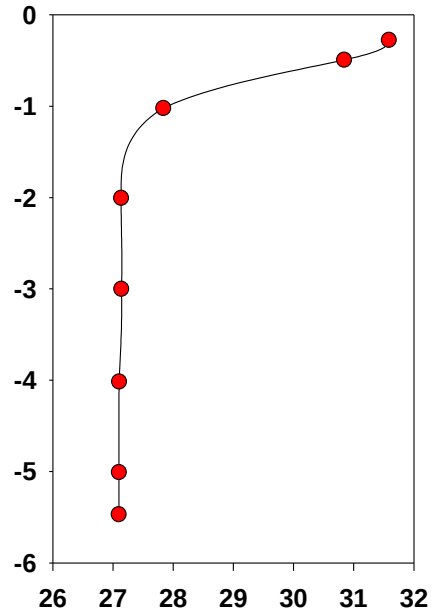
6
8
10
Dissolved oxygen (mg/L)


0
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32
Temperature (°C)

The challenge of complex ecological interactions!

In the case of the Darling River and Murrumbidgee River (Redbank Weir), the high BOD load was created by algae, which died when temperatures dropped. This provided a feast for bacteria, lowering oxygen, which in turn killed hundreds of thousands of fish.

Rivers can replenish their oxygen from contact with the air (why see fish gulping at surface later). However this is a relatively slow process, especially if the water is stagnant (flowing creates turbulence and mixes in more oxygen). So if there is a lot of organic matter present and bacteria are feasting on it, oxygen concentrations in the river can suddenly drop.

Therefore, instead of referring to the concentration of “organic substances”, we more commonly refer to the thing that really matters: how much aerobic respiration the organic substances can trigger and how much oxygen this will cause to be consumed. This is what we call the *biochemical oxygen demand* (BOD) and we usually express it as a concentration in terms of milligrams of oxygen per litre of water (mg/L).

Key risk factors for fish kill

- Prolonged low flow period and weir pools (or when river breaks up into residual refuge pools)
- Shallow, stagnant and warm water – algal blooms tend to start forming in October in inland NSW
- High algal loading (often BGA) is high source of carbon if decomposes
- Dramatic temperature fluctuations – death of algae, high source of

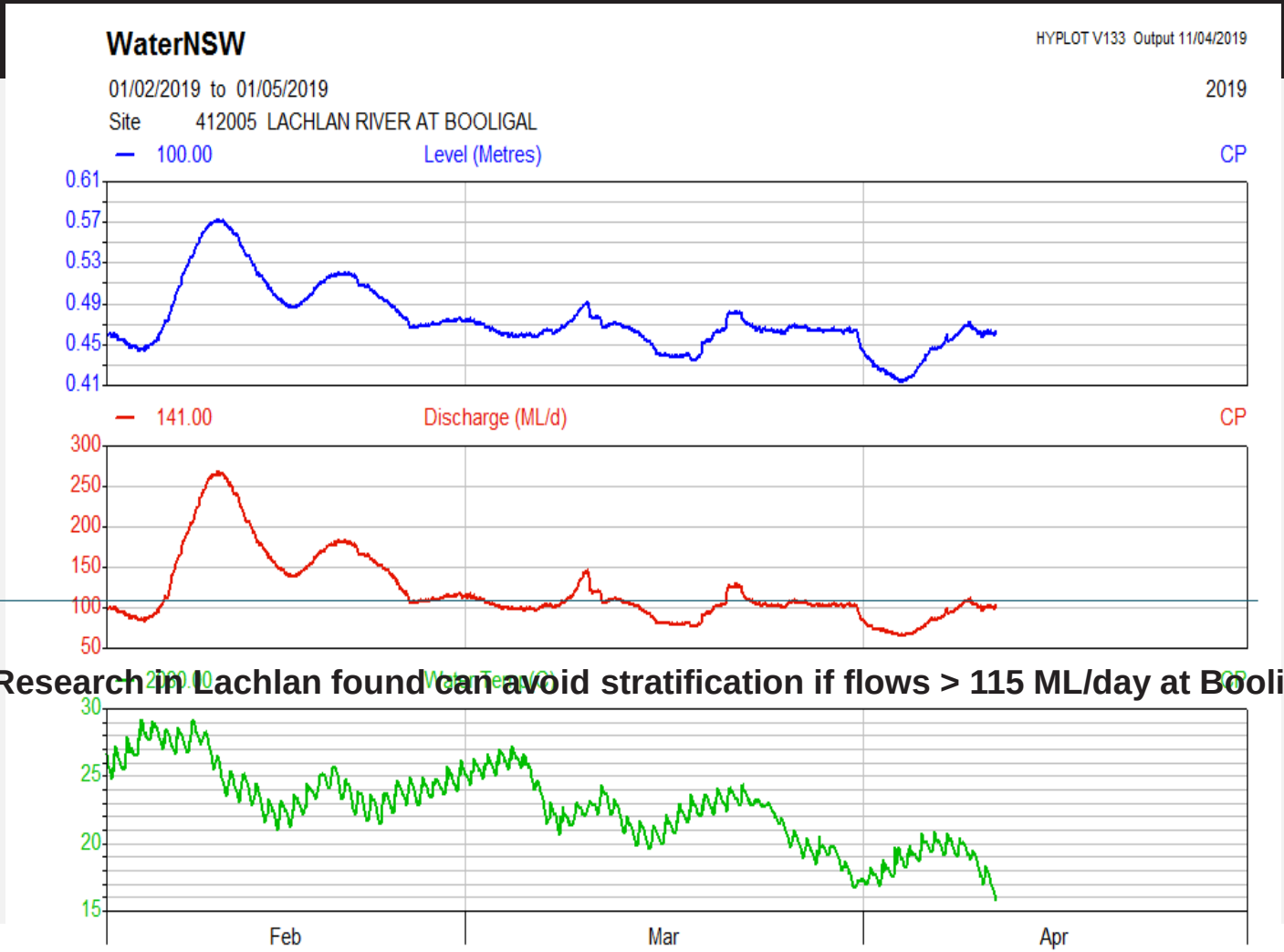
organic carbon = high bacterial activity consuming lots of oxygen

Stratification and destratification – if weir pools turn over from high flows or rainfall event and change in temperatures (remember thermocline).

Complex: At some stages when it gets cool particularly in a pool or deeper environment, will get a turn over bloom occurring. Get pulse of nutrients from bottom coming to surface water as mixed and water temp causes vertical mixing in these systems and get a bloom under those circumstance – temperature determines how long that last.

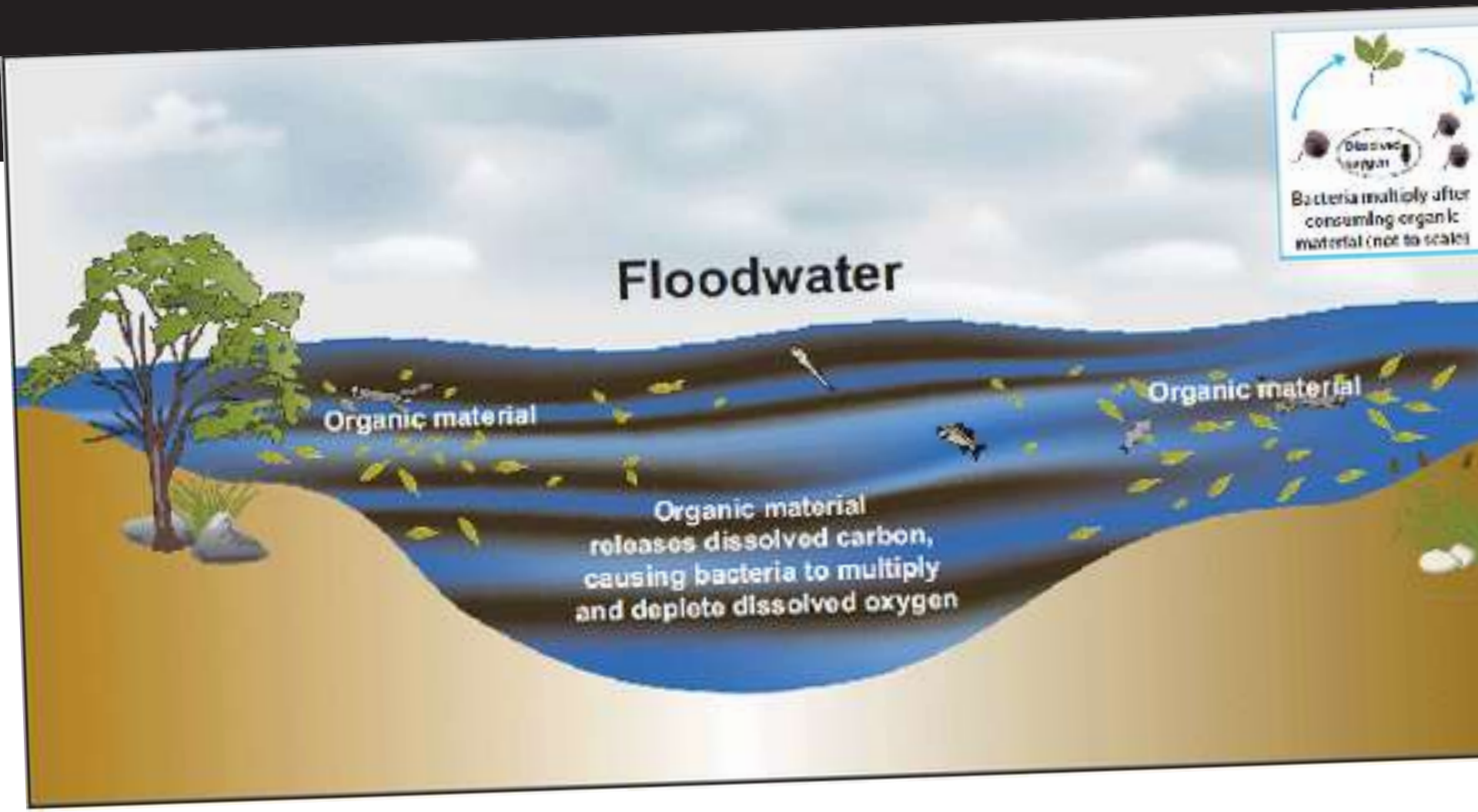
Why the Lachlan is different

We have the tools and were prepared to use them! The Lachlan is the only valley with a Water Quality Allowance (WQA) as in other valleys it became apparent there is a 'gap' in who manages for water quality????



Research in Lachlan found can avoid stratification if flows > 115 ML/day at Booligal

2016 Hypoxic Blackwater events due to prolonged flooding



While water is the key ingredient…we manage for so much more….

Multi-objective watering events and feedback loops

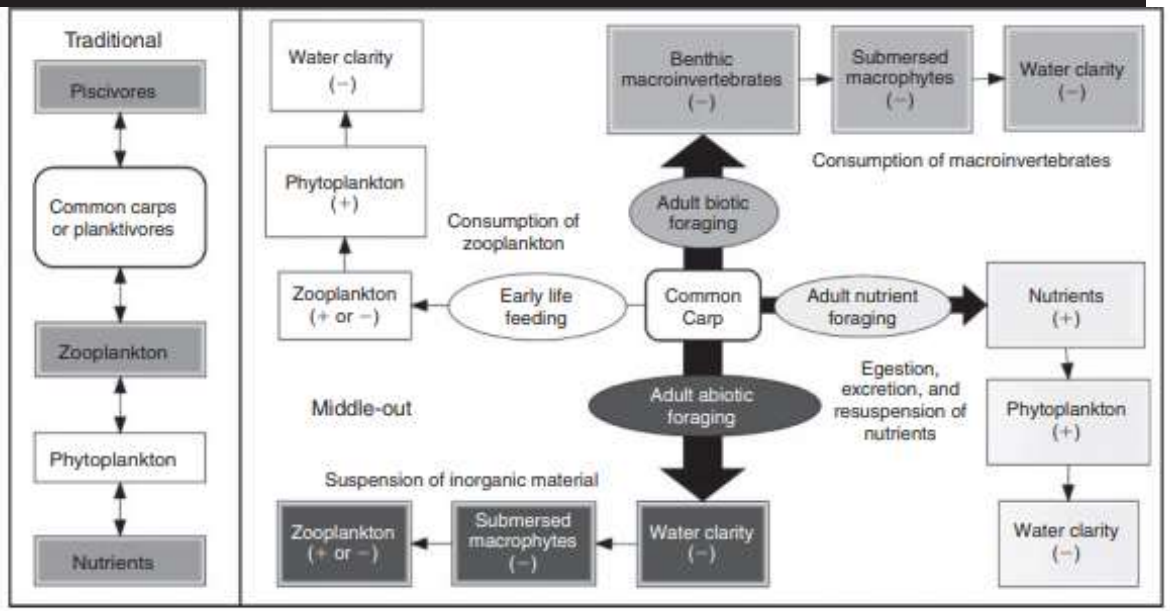
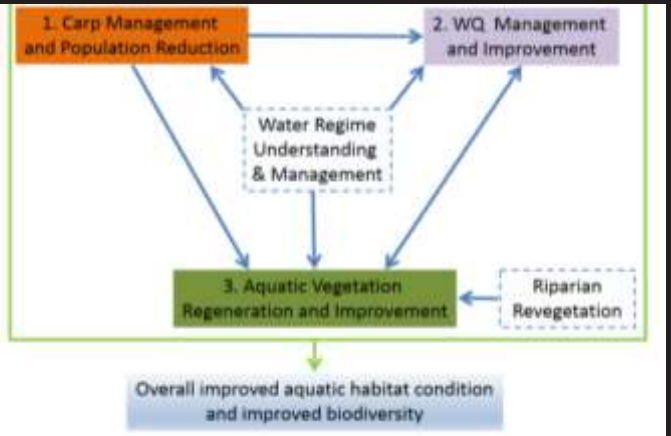


Fig. 1. A schematic demonstrating common carp trophic effects in a traditional (bottom-up, top-down; left) and middle-out (right) framework. A middle-out approach highlights (1) four potential common carp disturbance pathways; (2) direction and trophic position of the pathways; and (3) magnitude (arrow width stemming from common carp, with larger width reflecting a larger disturbance) and potential effect of disturbance (negative sign indicates a decrease; positive sign indicates an increase). Ovals represent the immediate activity and behaviour or process of common carp disturbance. For a summary and review, see Weber and Brown (2009) and Vilizzi *et al.* (2015).



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13 August 2017 ·

Lake Brewster Pelican Banding project
www.environment.nsw.gov.au/topics/water/water-for-the-environment/lachlan/lake-brewster-pelican-banding

Office of Environment & Heritage

Thank you!

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- Surveys approved under NPWS scientific licence SL100100 and NSW OEH Animal Research Authority 091214/01