Dec 13th, 3:40 PM - 5:00 PM

Connecting fish, flows and habitats on lowland river floodplains

Paul Brown
School of Biological Sciences, La Trobe University, Mildura, VIC, Australia

David Wood
School of Biological Sciences, La Trobe University, Mildura, VIC, Australia

Iain Ellis
Department of Primary Industries, New South Wales Fisheries, Buronga, NSW, Australia

Andrew Greenfield
Mallee Catchment Management Authority, Mildura, VIC, Australia

Warwick Gillespie
University of Tasmania, Hobart, TAS, Australia

See next page for additional authors

Presenter Information
Paul Brown, David Wood, Iain Ellis, Andrew Greenfield, Warwick Gillespie, and Sascha Healy

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All kinds of clever

Connecting fish, flows and habitats on lowland river floodplains

Paul Brown [1] , David Wood [1] , Iain Ellis [2] , Andrew Greenfield [3] , Warwick Gillespie [4] , Sascha Healy [5]

1. School of Biological Sciences, La Trobe University, Mildura, VIC, Australia
2. Department of Primary Industries, New South Wales Fisheries, Buronga, NSW, Australia
3. Mallee Catchment Management Authority, Mildura, VIC, Australia
4. University of Tasmania, Hobart, TAS, Australia
5. New South Wales Office of Environment and Heritage, Buronga, NSW, Australia

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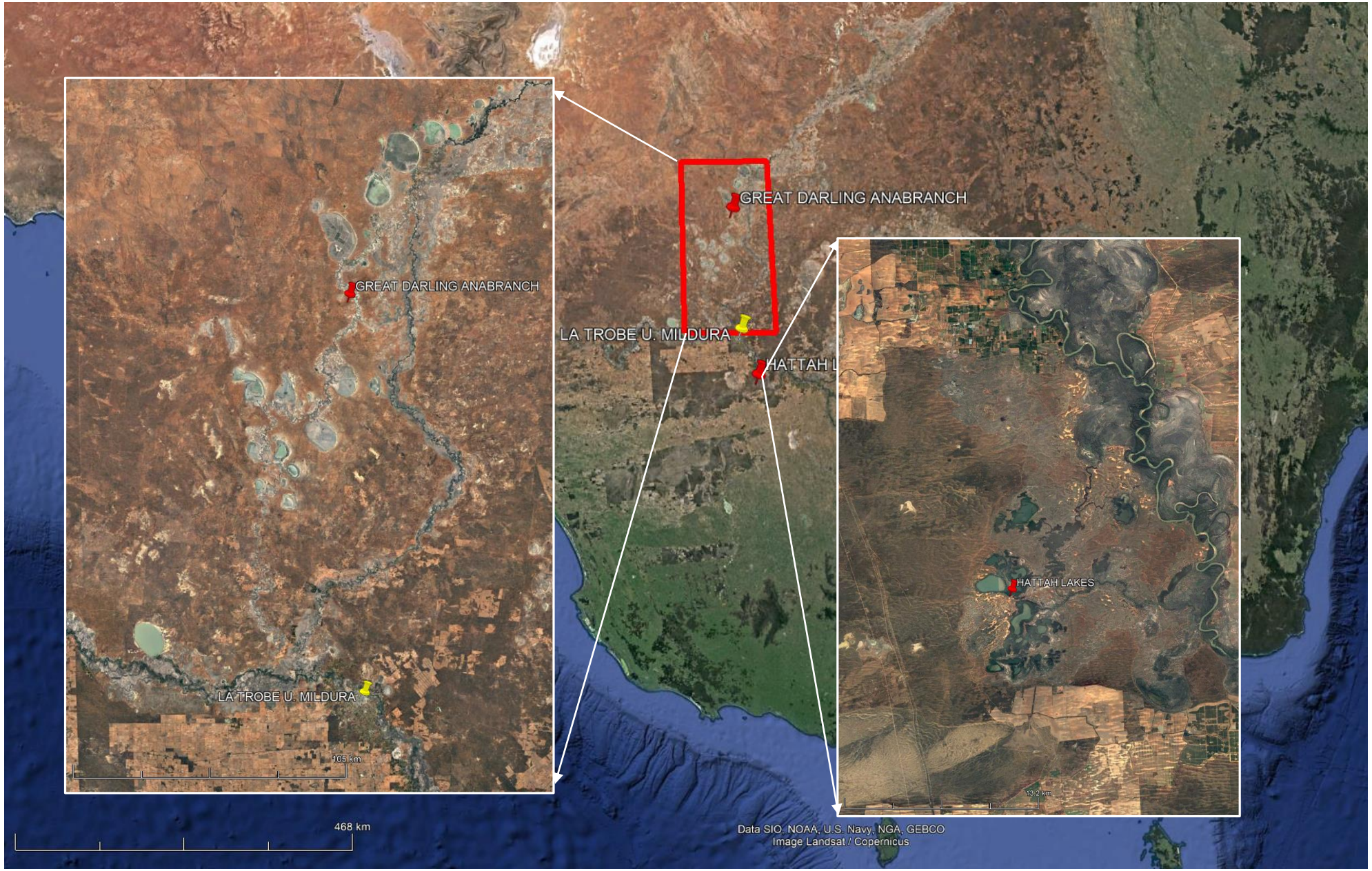
Mallee Catchment Management Authority (Leigh Pyke, James Kellerman)

Two studies of Connectivity

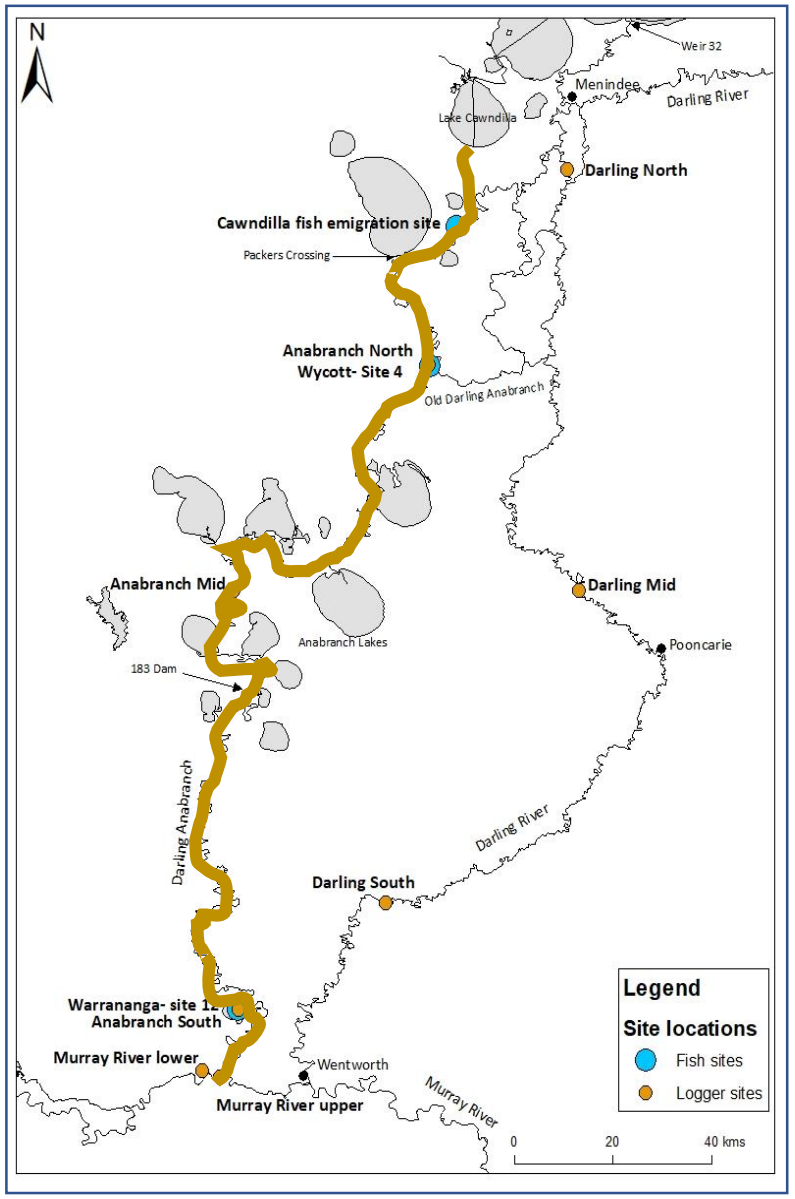
- Great Darling Anabranch – connects the Menindee Lakes (Lake Cawndilla) to the River Murray via an alternate pathway to the Darling River.
- Chalka Creek – connects the River Murray to a series of floodplain lakes and wetland habitats known as the Hattah Lakes.



Research questions

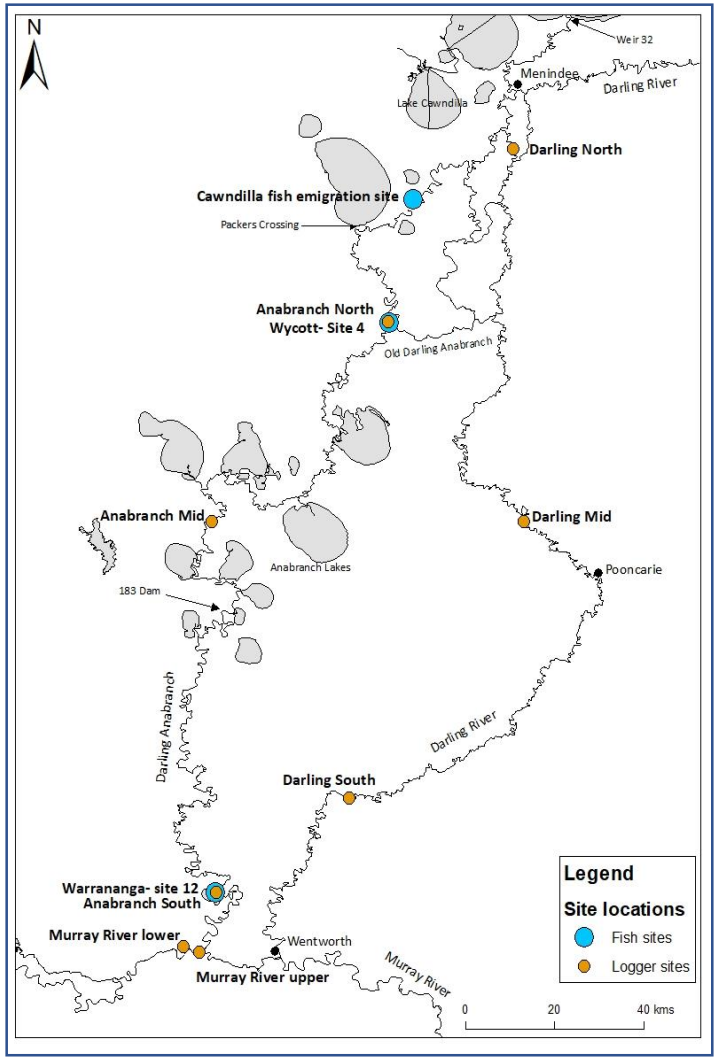
- To investigate if the Great Darling Anabranch is a **significant corridor for passage of important native fish species** (e.g. Golden perch that recruit to Lake Cawndilla (Menindee Lakes).
- To determine if the Great Darling Anabranch **contributes significantly to regional instream productivity**, during times of flow.
- To determine if the Great Darling Anabranch is a **hotspot of native fish processes** with consequences for regional population dynamics.

- How does re-connecting passage between rivers and floodplain lakes stimulate lake-resident fish movement for native species such as Golden perch?

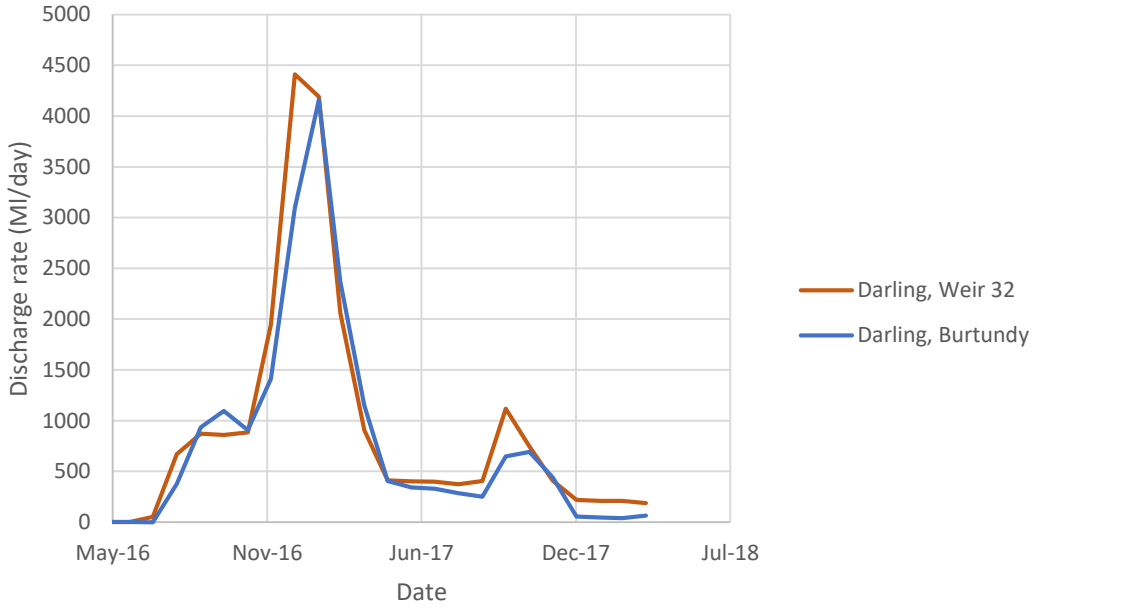


- **Great Darling Anabranch** – connects the Menindee Lakes (Lake Cawndilla) to the River Murray via an **alternate** pathway to the Darling River.
- Almost 500 km of (ephemeral) river channel restored by removal of several low-head dams.
- By summer 2016–17 it had been dry for three years.
- Menindee Lakes system filled 2015–16
- Release down the lower Darling started in July 2016 & peaked January 2017.
- Releases down the Great Darling Anabranch started in February 2017

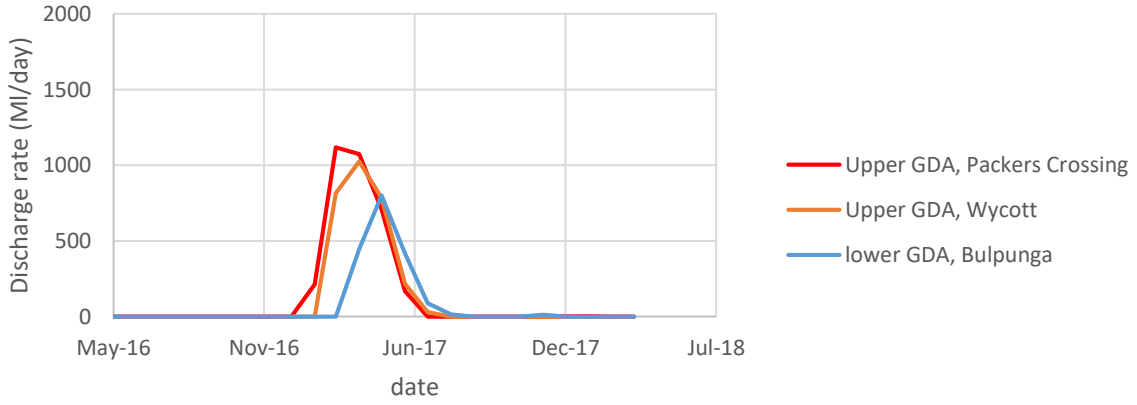
Flows



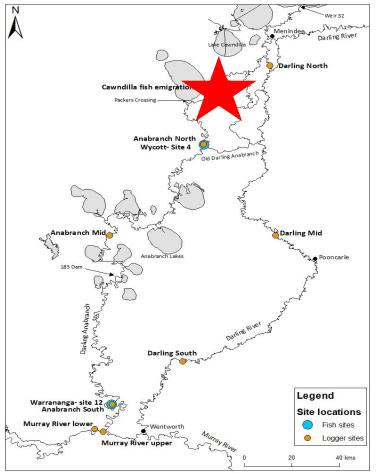
Lower Darling River



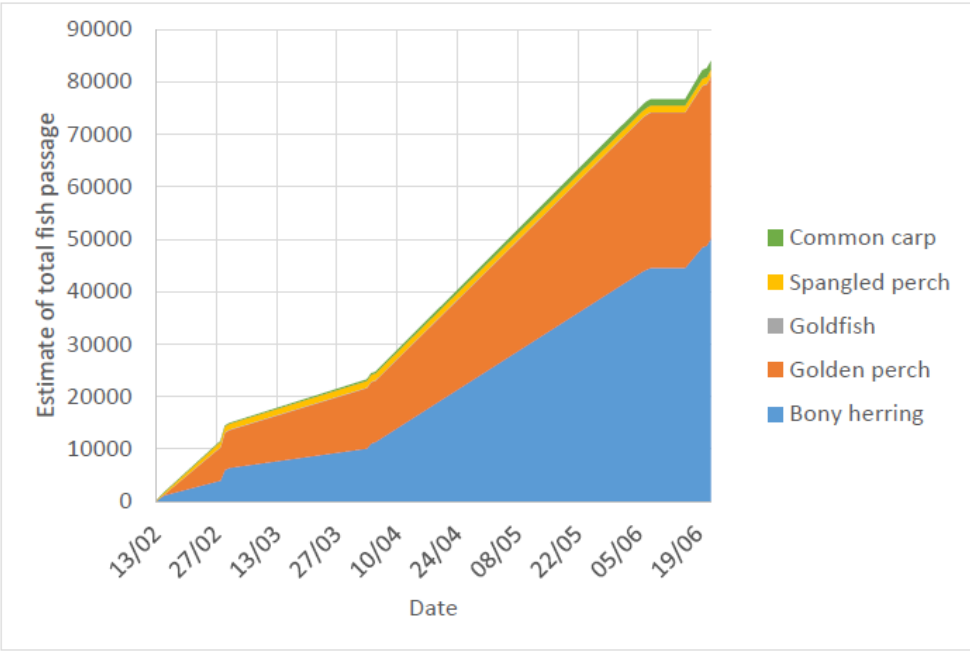
Great Darling Anabranch

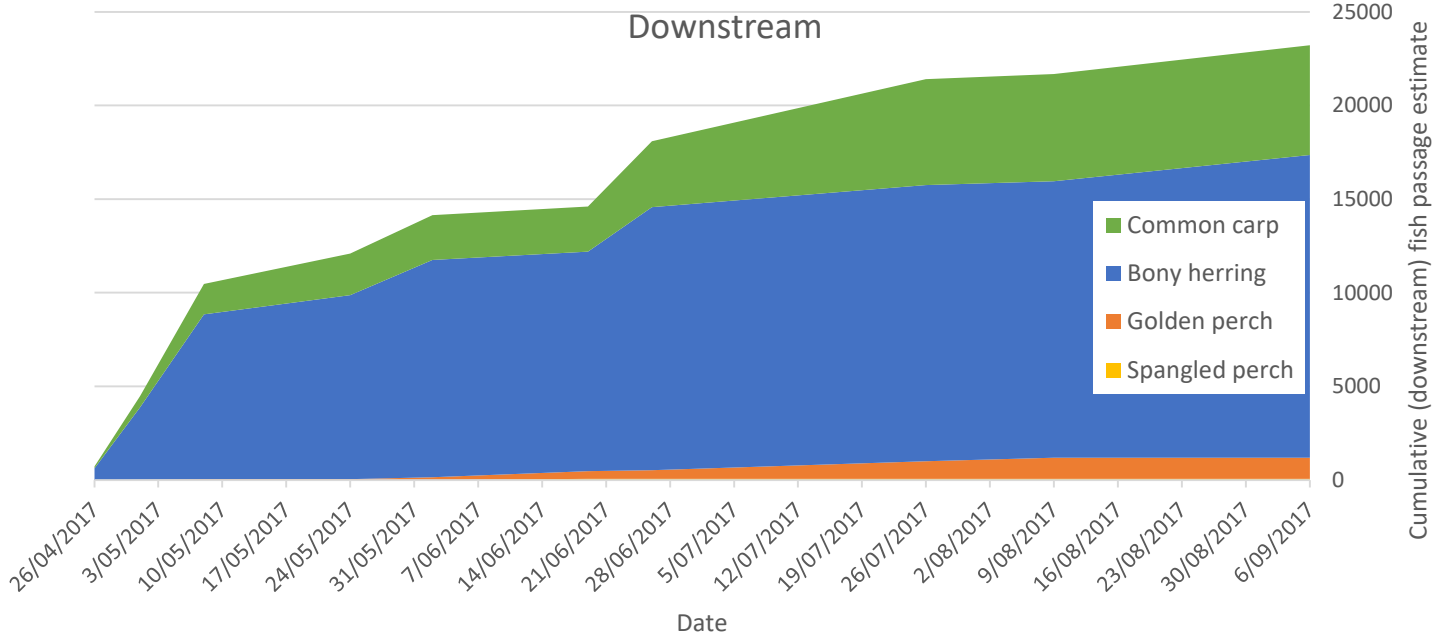


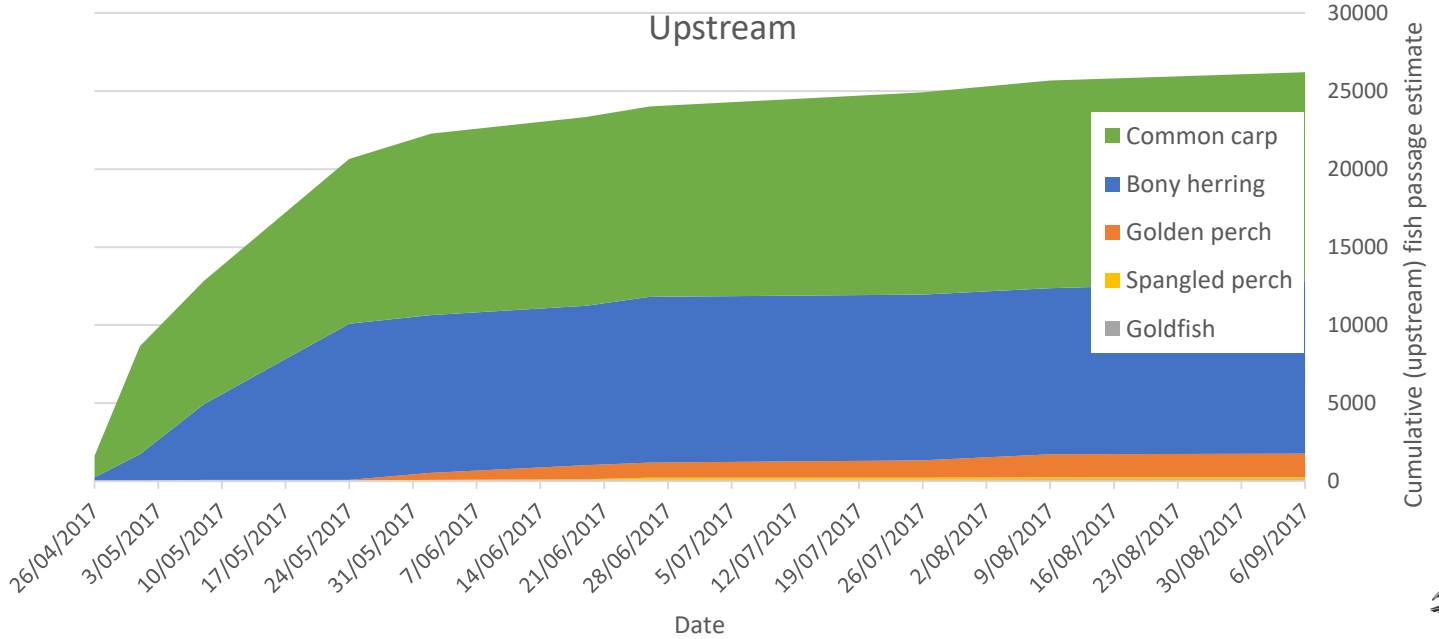
Downstream fish passage into the Great Darling Anabranch

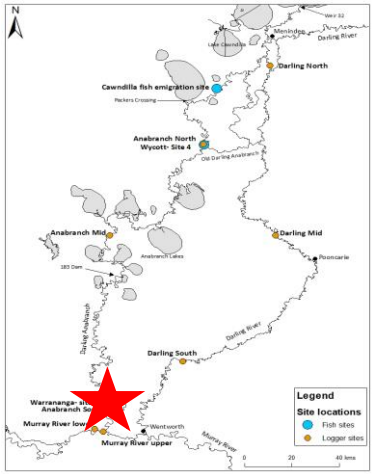


Species	Mean downstream dispersal rate (fish $24h^{-1}$)	Estimated fish passage 13/2/2017–23/6/2017
Bony bream	517	50,145
Golden perch	177	30,753
Spangled perch	33	1360
Common carp	16	1617
Goldfish	0.9	109
Total		**83,984**



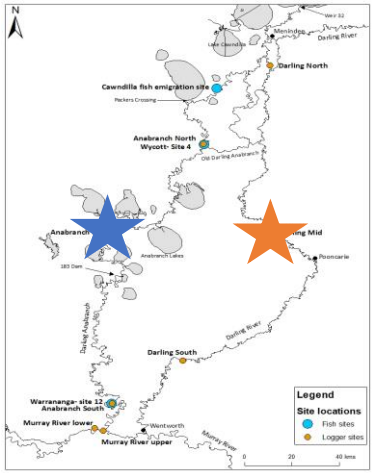


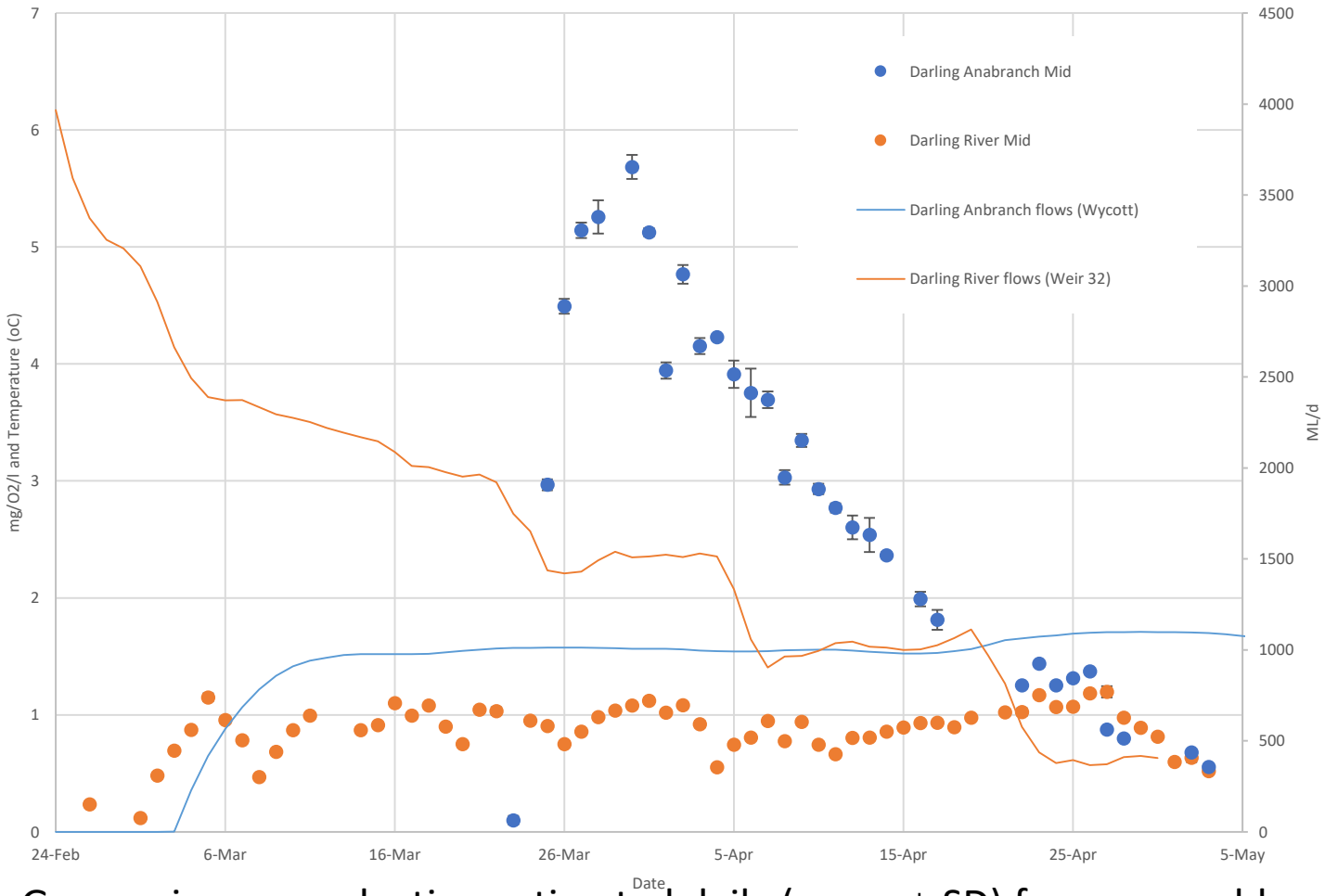




Productivity Pulse

- Whole stream metabolism

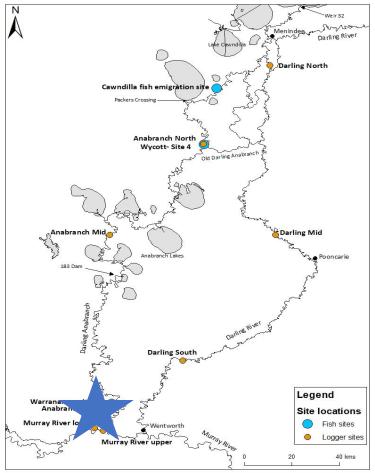


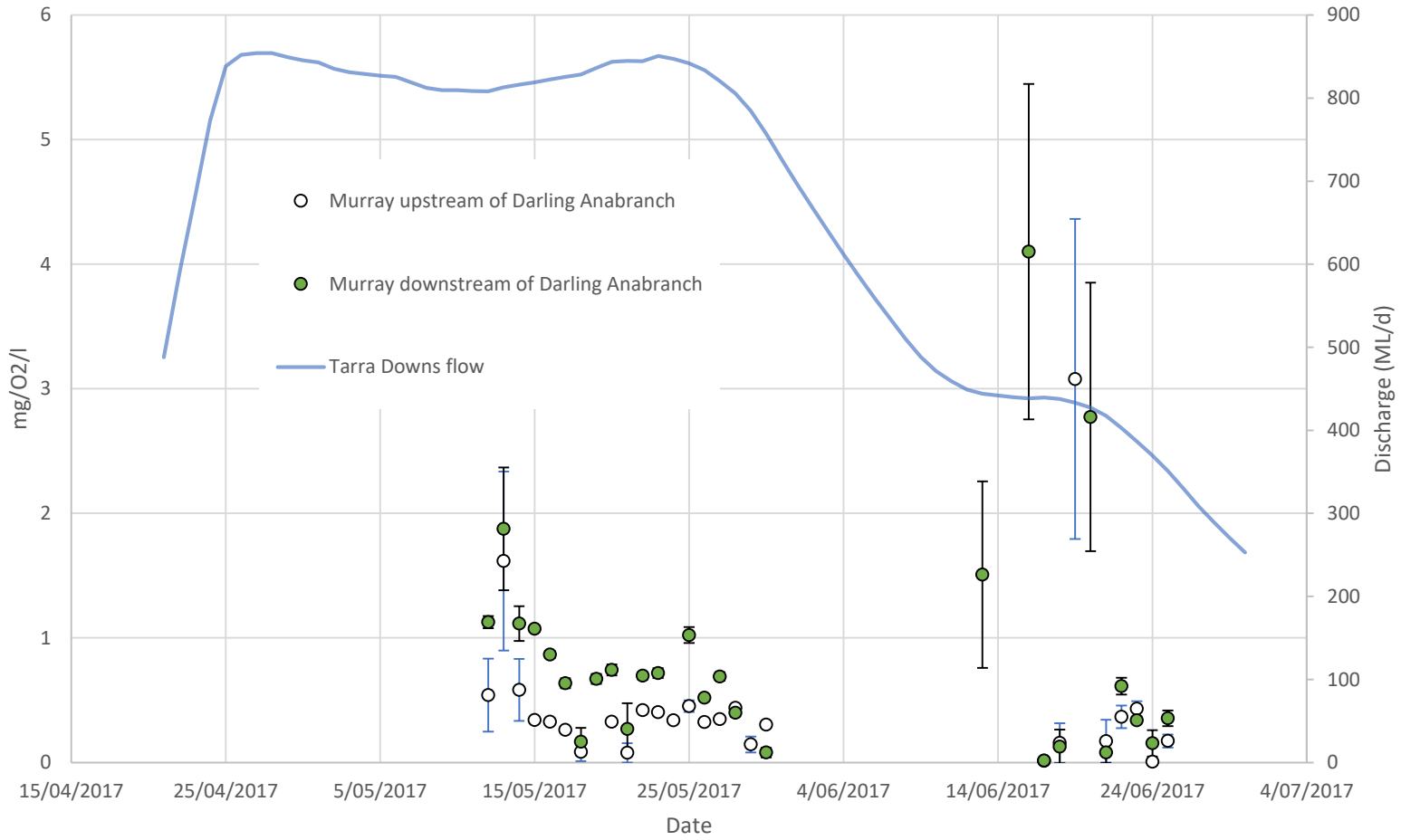


Gross primary production estimated daily (mean ± SD) for comparable sites on the Darling Anabranch (Mid) and Darling River (Mid). Logged River temperature (dashed lines) and flow rate (solid lines) from the nearest gauge upstream, are shown for each stream.

Productivity Pulse

- Contribution to the Murray R.

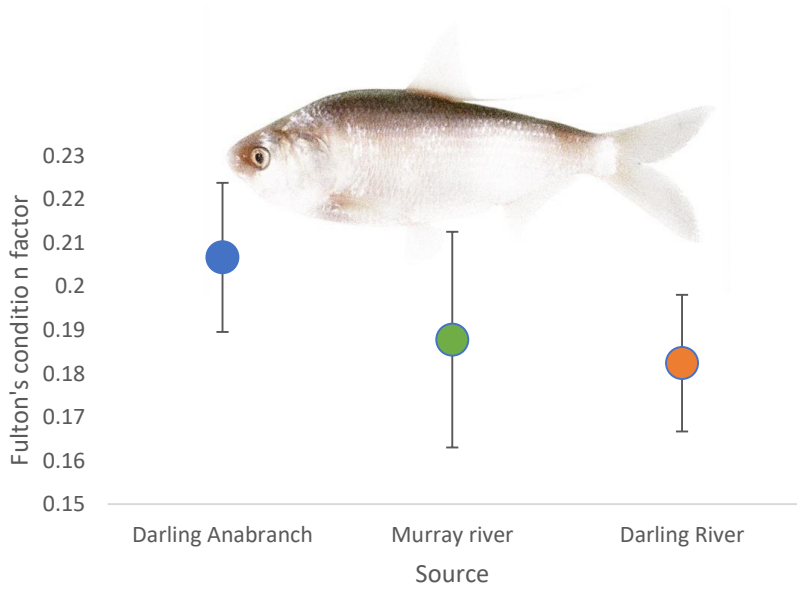




Gross primary production estimated daily (mean ± SD) for comparable sites on the River Murray upstream and downstream of the Darling Anabranch confluence. Gauged flow rate (solid lines) from the nearest gauge upstream, are shown for the Darling Anabranch.

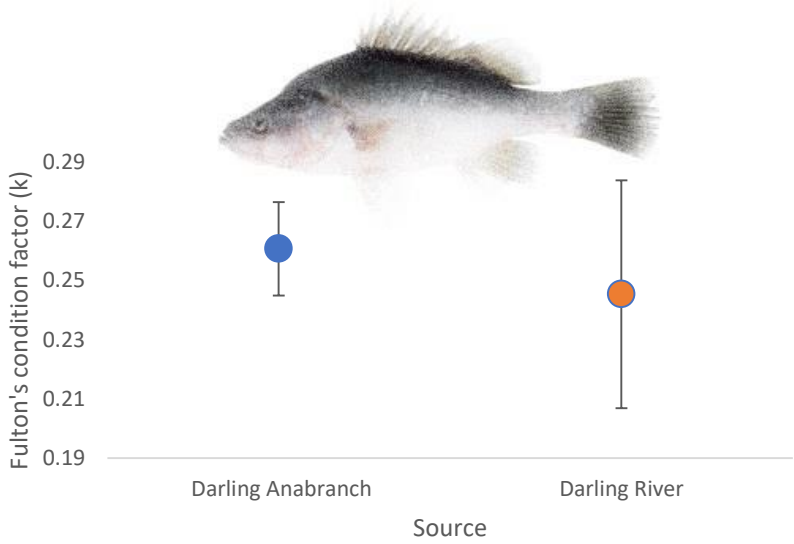
Productivity Pulse

- Fish body condition
  - Golden perch
  - Bony bream



Mean (± SD) condition factor (Fulton's k) for Bony herring from the Darling Anabranch (*n* = 76), River Murray (*n* = 26) and Darling River (*n* = 43)

One-way ANOVA, K-Bony herring	SS	DF	
Between Rivers	0.018	2	
Within River	0.048	142	
F	27.402		
P	8.6307E-11		****

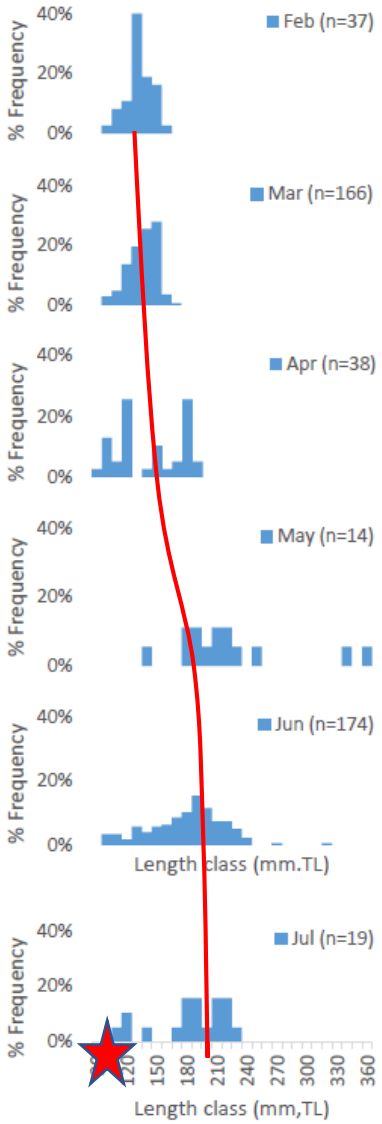


Mean (± SD) condition factor (Fulton's k) for Golden perch from the Darling anabranch (*n* = 54) and the Darling River (*n* = 35)

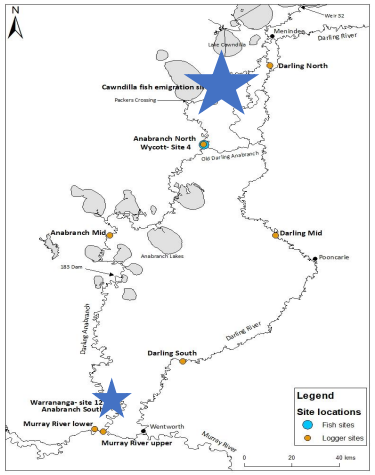
One-way ANOVA, K-Golden perch	SS	DF	
Between Rivers	0.005	1	
Within River	0.025	87	
F	17.141		
P	0.000080		****

Productivity Pulse

- Fish growth in length
  - Golden perch – Rapid!
  - Bony bream – Rapid!



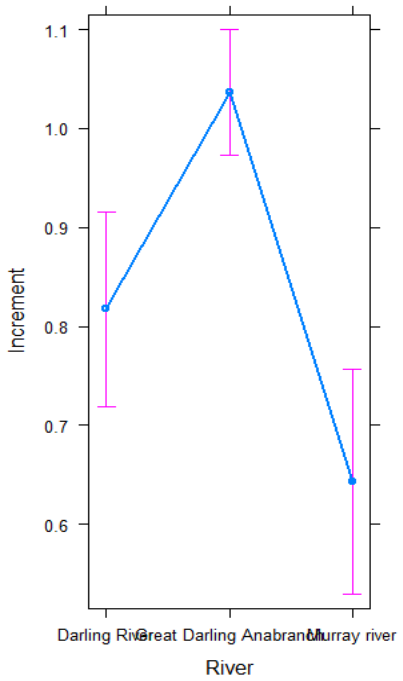
Golden perch ~spawned in October 2016, 5 months old
(Sharpe and Stuart, 2018)

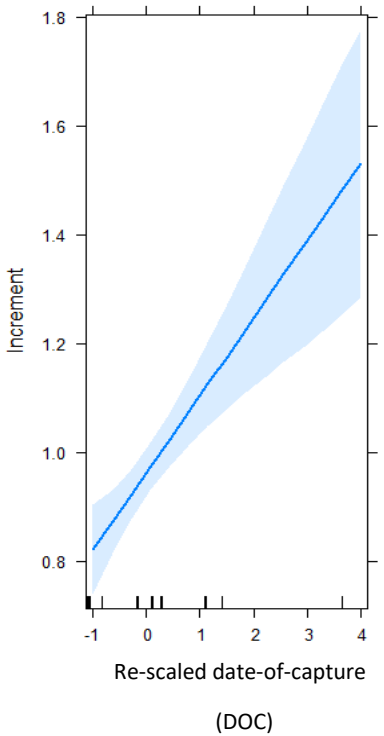


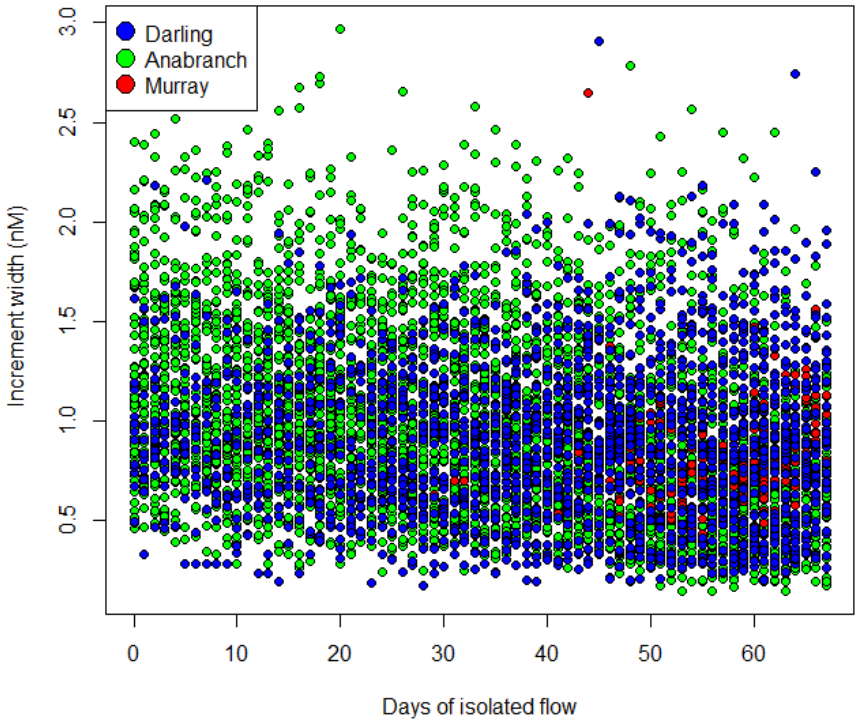
~9 months old

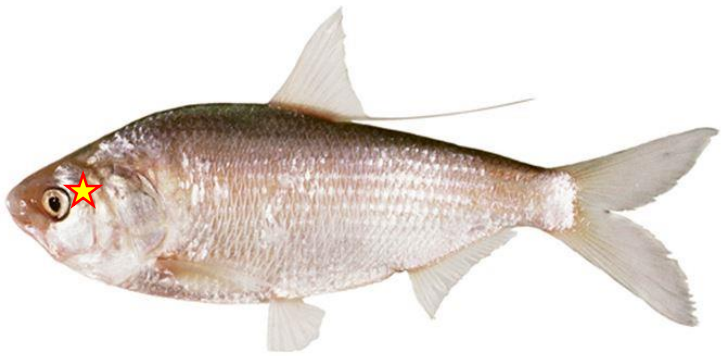
Productivity Pulse

- Fish daily otolith growth rates
  - Anabranch > Darling> Murray









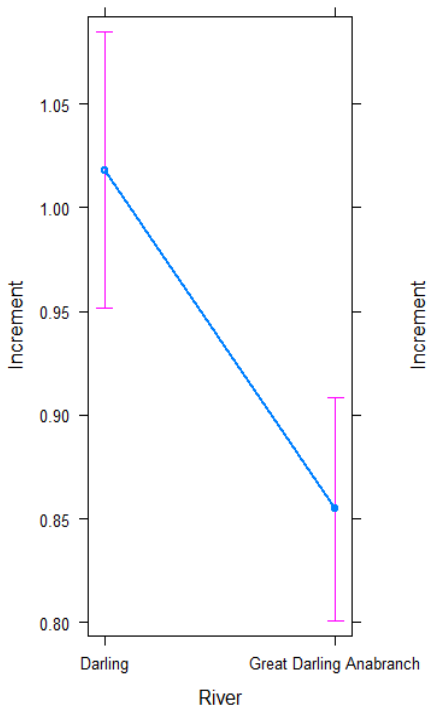
Repeated-measures, linear mixed-effects model

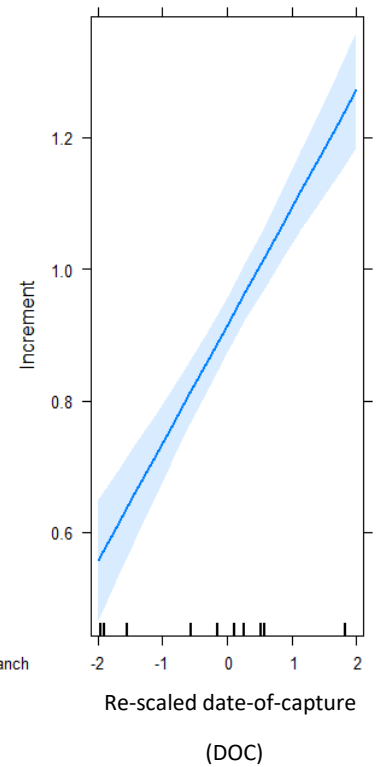
Increment width ~River*DOC + (CaptureL \|SampleID)

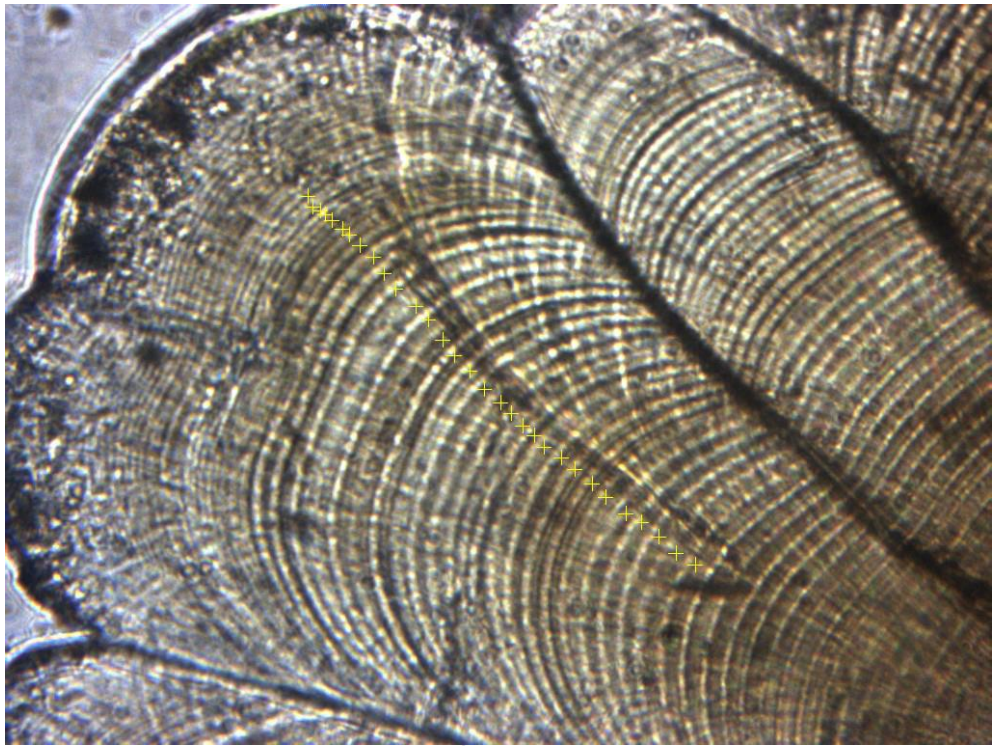
	Sum Sq	Mean Sq	$DF_{(numerator)}$	$DF_{(denominator)}$	F	Pr(>F)	Sig.
River	3.6186	1.8093	2	56.144	14.799	6.88E-06	***
DOC	2.404	2.404	1	84.846	19.664	2.75E-05	***

Productivity Pulse

- Fish daily otolith growth rates
  - Golden perch
  - Darling > Anabranch







Repeated-measures, linear mixed-effects model

Increment width ~River*DOC + (CaptureL \|SampleID)

	Sum Sq	Mean Sq	$DF_{(numerator)}$	$DF_{(denominator)}$	F	Pr(>F)	Sig.
River	1.4752	1.4752	1	85.994	13.92	0.000342	***
DOC	8.172	8.172	1	87.354	77.11	1.22E-13	***

Hattah Lakes environmental watering 2017–2018: How did flows stimulate Golden perch movement?

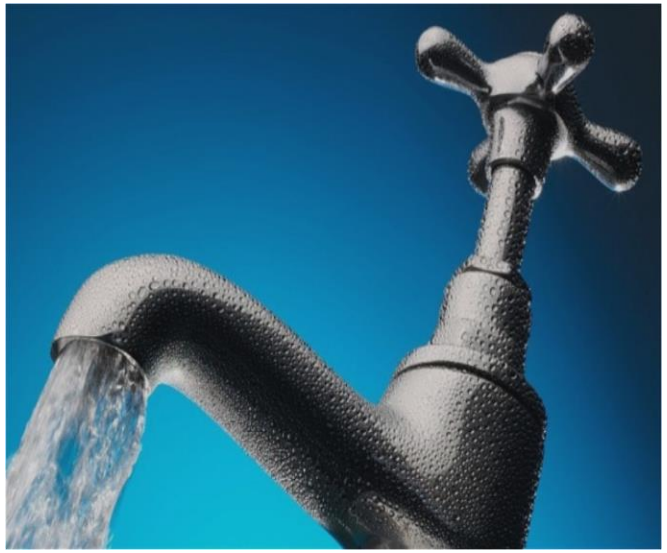
Hattah Lakes environmental watering 2017–2018:

How did flows stimulate Golden perch movement?

Hattah Lakes environmental watering 2017–2018:

How did in-flows stimulate Golden perch movement?

- Resident fish fauna sampled during pumped inflows at four sites using 'directional' netting

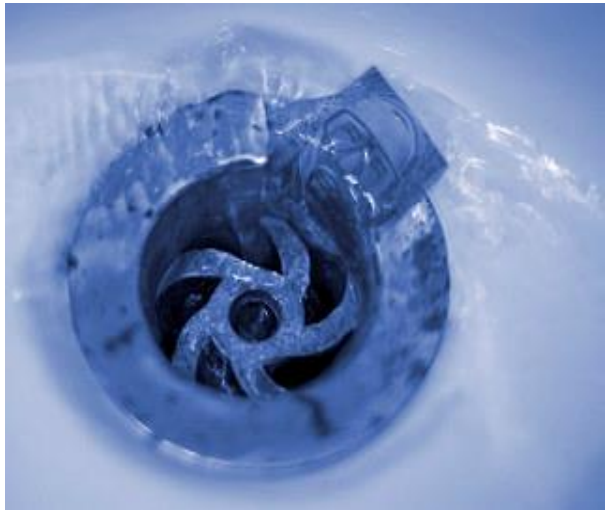


- During inflows, 91% (n=58) of Golden perch sampled were moving 'upstream' from the Lakes towards the pumps (and the Murray River).
- Five of 27 tagged-GP detected (18.5%), showed directional movement during pumped-inflows (4 downstream and 1 upstream). Remainder showed inconclusive directional-movement or no-movement.

Hattah Lakes environmental watering 2017–2018:

How did out-flows stimulate Golden perch movement?

- Acoustic tagging & telemetry used to monitor movements of 34 Golden perch during inflows and outflows



- Five of 16 GP detected (31%) showed directional movement downstream during regulated outflows (all five exited to the Murray River). Remainder showed no directional movement.

How do we continue to learn and adapt?

- How can we maximise fish survival during the ‘migration’ down the GDA?
- How does productivity in the GDA compare with the Darling, in terms of output into the Murray?
- When does fish body-condition indicate quality of the environment and antecedent conditions? How can it be used as a proxy for production in native fish species such as Golden perch.
- Connections facilitate ‘bet-hedging’ strategies for partial migrators, using flow-management; spreading the risk for populations and selfish-genes – we probably shouldn’t expect 100% fish movement off (or onto) the floodplain
- Need to learn more about the trade-offs for native fish, for ‘staying’ or ‘going’, when managing flows in ephemeral habitats

Summary & Recommendations

- Great Darling Anabranch WAS a **significant corridor for important native fish species** (e.g. Golden perch and Bony bream that recruited to Lake Cawndilla.
- Great Darling Anabranch DID **contribute significantly to regional instream productivity**, at least doubling the primary production in the Murray River as the pulse dispersed.
- **As a hotspot of native fish processes** the flows in the Great Darling Anabranch produced conditions resulting in rapid growth in two species of native fish. However the effects of a productivity pulse on growth trajectories, varied by species.
- **The Hattah Lakes** environmental watering CAN be managed to facilitate good fish-outcomes, for the river population of Golden perch.

Benefits of connecting rivers and floodplain habitats

Increased productivity

- Primary productivity ☑
  - Whole stream metabolism ? –**In this ephemeral stream channel the pulse of productivity is predictable**
- Secondary productivity ☑
  - Fish growth (Bigger-faster ?) Species specific. Fish at lower trophic l**evels benefit first?**
  - Improved survival **–If growth ?**
- 'Bet-hedging' for partial migrators facilitated ☑, spreading the risk for populations and selfish-genes
  - Was the scale of migration **ecologically and socially significant? –a portion of Lake Cawndilla and Hattah Lakes fish population survived by moving (good bet).**

Thank you for listening from Fisheries and Wetlands Consulting

Principal Consultant: Paul Brown

Providing natural resource managers with accurate, timely, and relevant information to manage freshwater fish, other aquatic fauna and their habitats.

@fisheriesandwetlands

www.fisheriesandwetlands.com.au

Email: paul@fisheriesandwetlands.com.au Mob: 0427 249 037