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*

Follow this and additional works at: [https://scholarworks.umass.edu/fishpassage_conference](https://scholarworks.umass.edu/fishpassage_conference)
Presenter Information
Paul Brown, David Wood, Iain Ellis, Andrew Greenfield, Warwick Gillespie, and Sascha Healy
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

December 2018
Acknowledgements:

All current and past employees of The Murray–Darling Freshwater Research Centre who contributed to the DAAMMP. Particularly Rick Stoffels and Braeden Lampard.

Kyne Krusic-Goleb and Annique Harris of Fish Aging Services.

The community of the lower Darling and Darling Anabranch land holders.

NSW Office of Heritage and Environment (Paula DSantos, Paul Childs and Nathan McGrath)

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


- Releases down the Great Darling Anabranch started in February 2017
Flows

Lower Darling River

Great Darling Anabranch

Legend

Site locations

Fish sites
Logger sites

Graphs showing discharge rates in Ml/day for Darling River and Great Darling Anabranch with various sites marked on maps.
## Downstream fish passage into the Great Darling Anabranch

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean downstream dispersal rate (fish 24h⁻¹)</th>
<th>Estimated fish passage 13/2/2017–23/6/2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bony bream</td>
<td>517</td>
<td>50,145</td>
</tr>
<tr>
<td>Golden perch</td>
<td>177</td>
<td>30,753</td>
</tr>
<tr>
<td>Spangled perch</td>
<td>33</td>
<td>1360</td>
</tr>
<tr>
<td>Common carp</td>
<td>16</td>
<td>1617</td>
</tr>
<tr>
<td>Goldfish</td>
<td>0.9</td>
<td>109</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>83,984</strong></td>
</tr>
</tbody>
</table>
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 \((n = 43)\)

<table>
<thead>
<tr>
<th>Source</th>
<th>Fulton’s condition factor Mean (± SD)</th>
<th>Golden perch</th>
<th>Bony bream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darling Anabranch</td>
<td>0.21 ± 0.02</td>
<td>0.18 ± 0.03</td>
<td>0.20 ± 0.03</td>
</tr>
<tr>
<td>Murray River</td>
<td>0.22 ± 0.03</td>
<td>0.19 ± 0.03</td>
<td>0.21 ± 0.03</td>
</tr>
<tr>
<td>Darling River</td>
<td>0.23 ± 0.04</td>
<td>0.20 ± 0.04</td>
<td>0.22 ± 0.04</td>
</tr>
</tbody>
</table>

One-way ANOVA, K-Golden perch

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Rivers</td>
<td>0.005</td>
<td>1</td>
<td>17.141</td>
<td>0.000080</td>
</tr>
<tr>
<td>Within River</td>
<td>0.025</td>
<td>87</td>
<td>8.630E-11</td>
<td>****</td>
</tr>
</tbody>
</table>

One-way ANOVA, K-Bony herring

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Rivers</td>
<td>0.018</td>
<td>2</td>
<td>27.402</td>
<td>****</td>
</tr>
<tr>
<td>Within River</td>
<td>0.048</td>
<td>142</td>
<td>8.630E-11</td>
<td>****</td>
</tr>
</tbody>
</table>
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
  - Anabanch > Darling > Murray

Repeated-measures, linear mixed-effects model

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

<table>
<thead>
<tr>
<th></th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>DF (numerator)</th>
<th>DF (denominator)</th>
<th>F</th>
<th>Pr(&gt;F)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>River</td>
<td>3.6186</td>
<td>1.8093</td>
<td>2</td>
<td>56.144</td>
<td>14.799</td>
<td>6.88E-06</td>
<td>***</td>
</tr>
<tr>
<td>DOC</td>
<td>2.404</td>
<td>2.404</td>
<td>1</td>
<td>84.846</td>
<td>19.664</td>
<td>2.75E-05</td>
<td>***</td>
</tr>
</tbody>
</table>
Productivity Pulse

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

Repeated-measures, linear mixed-effects model

\[ \text{Increment width} \sim \text{River} \times \text{DOC} + (\text{CaptureL} | \text{SampleID}) \]

<table>
<thead>
<tr>
<th></th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>DF (numerator)</th>
<th>DF (denominator)</th>
<th>F</th>
<th>Pr(&gt;F)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>River</td>
<td>1.4752</td>
<td>1.4752</td>
<td>1</td>
<td>85.994</td>
<td>13.92</td>
<td>0.000342</td>
<td>***</td>
</tr>
<tr>
<td>DOC</td>
<td>8.172</td>
<td>8.172</td>
<td>1</td>
<td>87.354</td>
<td>77.11</td>
<td>1.22E-13</td>
<td>***</td>
</tr>
</tbody>
</table>
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 Anabranche WAS a **significant corridor for important native fish species** (e.g. Golden perch and Bony bream that recruited to Lake Cawndilla).

- Great Darling Anabranche 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 Anabranche 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 levels benefit first?
  - Improved survival – If growth?
- ‘Bet-hedging’ for partial migrants 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