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Sequential fishways reconnect a coastal river

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Meaghan Duncan, Jonathon Doyle, Wayne Robinson, Lee Baumgartner, Jason Thiem, Ivor Growns, Martin Mallen-Cooper and Tony Paull
Fish passage challenges in coastal rivers

Migration between salt and freshwater (diadromy) is a key part of the lifecycle for many species

- Anadromous
- Catadromous
- Amphidromous
- Potamodromous
The Nepean River

- Highly regulated coastal river system
- 11 weirs between Penrith and Maldon and five large dams in the upper reaches
- Supplies 95% of Sydney’s water
- Historically diverse fish community including many diadromous species well into the upper reaches.
## Drown-out frequency

<table>
<thead>
<tr>
<th>Weir</th>
<th>Year of construction</th>
<th>Height of structure (m)</th>
<th>Drown-out frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penrith Weir</td>
<td>1920</td>
<td>1.3</td>
<td>3.0-5.0</td>
</tr>
<tr>
<td>Wallacia Weir</td>
<td>1908</td>
<td>5.6</td>
<td>1 in 100 years</td>
</tr>
<tr>
<td>Theresa Park Weir</td>
<td>1975</td>
<td>3.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Brownlow Hill Weir</td>
<td>1908</td>
<td>1.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Mount Hunter Weir</td>
<td>1908</td>
<td>2.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Cobbitty Weir</td>
<td>1908</td>
<td>2.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Sharpes Weir</td>
<td>1907</td>
<td>3.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Camden Weir</td>
<td>1907</td>
<td>2.2</td>
<td>1.9</td>
</tr>
<tr>
<td>Menangle Weir</td>
<td>1908</td>
<td>0.7-3.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Douglas Park Causeway</td>
<td>1960</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Maldon Weir</td>
<td>1968</td>
<td>16</td>
<td>1 in 100 years</td>
</tr>
</tbody>
</table>
Existing fishways

Theresa Park (rock ramp)

Cobbitty (vertical slot)

Wallacia (pool and weir)

Mt Hunter (rock-ramp)
Vertical slot fishway

Conceptual layout of a vertical-slot fishway

- Slots are full depth of channel
- Protective grismesh covers
- Resting pool
- Not to scale
- Fishway entrance close to weir
- Fishway channel slope varies depending on location (1:18-1:30)
- Trashrack over fishway exit
- Auxiliary water for high tailwater levels
- Diffusing screen
- Notch in weir great to attract fish to fishway entrance

Prepared by Pentograph
Evaluating improvements to fish passage

Research questions

1. Does fish community structure improve upstream of the weirs post-fishway construction (electrofishing)?

2. Are the fishways passing fish from 35mm to 1m in length (trapping)?

3. Have the weirs caused population genetic fragmentation in Australian smelt, and is gene flow restored by the fishways (microsatellite analysis)?
Electrofishing sites
Number of species pre- and post-fishways

Predicted number of species before weirs were installed
After fishway installation
Before fishway installation
Striped gudgeon (amphidromous)
Empire gudgeon (amphidromous)
Cox’s gudgeon (amphidromous)
Freshwater mullet (catadromous)
Sea mullet (catadromous)
Fishway trapping
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of paired samples</td>
<td>24-27</td>
</tr>
<tr>
<td>Number of species in entrance</td>
<td>19</td>
</tr>
<tr>
<td>Number of species in exit</td>
<td>17</td>
</tr>
<tr>
<td>Size range in exit</td>
<td>20-1200mm (better than design specifications)</td>
</tr>
<tr>
<td>Difference in size of fish</td>
<td>Minor</td>
</tr>
<tr>
<td>between entrance and exit</td>
<td></td>
</tr>
<tr>
<td>Missing from exit (or low numbers)</td>
<td>Flat-headed gudgeon, and dwarf flat-headed gudgeon</td>
</tr>
</tbody>
</table>
Penrith

Sea Mullet

Australian Bass

Empire Gudgeon

Australian Smelt

- Chart showing the distribution of Sea Mullet, Australian Bass, Empire Gudgeon, and Australian Smelt with entry and exit points.
- The charts display the number of individuals at different locations, with black squares indicating exit points and white squares indicating entrance points.
Douglas Park

- Cox’s Gudgeon
- Australian Smelt
- Australian Bass
- Firetail Gudgeon
Genetic structure

- 8 microsatellite loci
- 266 samples pre-fishways
- 241 samples post-fishways
Results: Genetic structure

Pre-fishways, 3 genetic populations

Post-fishways, 2 genetic populations

Wallacia Weir
T. Park Weir

Menangle weir

Australian Smelt

Bents Basin

Theresa Park Fishway
Conclusions

- Low-level barriers can be just as significant a problem to fish as large dams.

- In just three years, post-fishways species diversity is increasing upstream.

- Most species successfully use the fishways and all size ranges are well represented at the exit.

- Upstream gene flow has improved, but Australian smelt may be genetically fragmented by natural barrier.

- Fishways cannot overcome all problems associated with barriers, but can make substantial differences when operating efficiently.
Acknowledgements

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