# ARI Aquatic Quarterly Update – *Influence*

Summer 2021-22


## This update provides three examples of projects which help managers.

They provide:

- Evidence of the oceanic spawning migration of Australasian Short-finned Eels. Significant insights have also been obtained regarding their vertical movement within the water column, their migration routes, response to the lunar cycle and the prevalence of predation.

- Fundamental insights into the population dynamics of four native fish species and how management strategies may need to vary, based on their life histories. This study highlights the importance of understanding the processes which underpin the persistence of fish populations to directly inform targeted management actions.

- Evidence of how adaptive management of environmental flows can support recovery of the fish community of the lower Darling River – Baaka after recent catastrophic fish kills.

### About us

The Applied Aquatic Ecology section aims to generate and share knowledge, through world-class, applied, ecological research, which supports and guides sustainable ecosystem policy and management to ensure healthy, resilient ecosystems. We work collaboratively with national, state and local agencies, research institutes, universities, interest groups and the community.

Our focus:

- To undertake high quality, relevant ecological research.
- To interpret research outcomes and communicate these effectively to key stakeholders.
- To guide and support sustainable ecosystem policy and management.

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# First tracking of the oceanic spawning migrations of Australasian Short-finned Eels

## ISSUE

There are two species of Anguillid eels in Victoria: Long-finned Eel (*Anguilla reinhardtii*) and Short-finned Eel (*A. australis*). Eels have significant cultural values to Traditional Owners and support commercial and recreational fisheries in the state. Populations of Anguillid eels have declined dramatically across much of the world in the last 50 years, with many species now threatened. The migration of eels from freshwater to distant oceans for a single spawning event is a critical step in their life history. However, little is known about these spawning migrations, which hampers the ability to understand how to mitigate threats and identify beneficial management actions.

## ACTION

The oceanic spawning migrations of Australasian Short-finned Eels were tracked using pop-up satellite archival tags during 2019. Sixteen eels were collected from the mouths of the Hopkins and Fitzroy estuaries in south-eastern Victoria and tagged. These tags can record extensive environmental data including water temperature, depth and light.

## RESULTS

Data were obtained from 12 of the 16 eels. The time between the release of the eels and surfacing of the tags ranged from seven days to almost five months. Tags from eels surfaced either because of ingestion by marine predators or failure of the attachment. Significant insights were obtained regarding the vertical movement of eels within the water column, their migration routes, response to the lunar cycle and prevalence of predation.

The eels appeared to access deep water off the Australian coast either directly east via Bass Strait, or south-east around Tasmania, which is the shortest route to deep water. They showed strong diel vertical movements in the water column, alternating between the warm upper (euphotic) zone (about 100-300 m, and 15-20°C) and the mesopelagic zone (about 700–900 m, 6–8°C) during the day. Marine predators, probably lamnid sharks, tuna, or marine mammals, ended at least ~ 30% of eel migrations, largely before the eels had left the Australian continental shelf.

Some eels were tracked about 2620 km from release, and as far north as the tropical Coral Sea off the north-eastern coast of Australia. Two Short-finned Eels migrated to an area near New Caledonia.

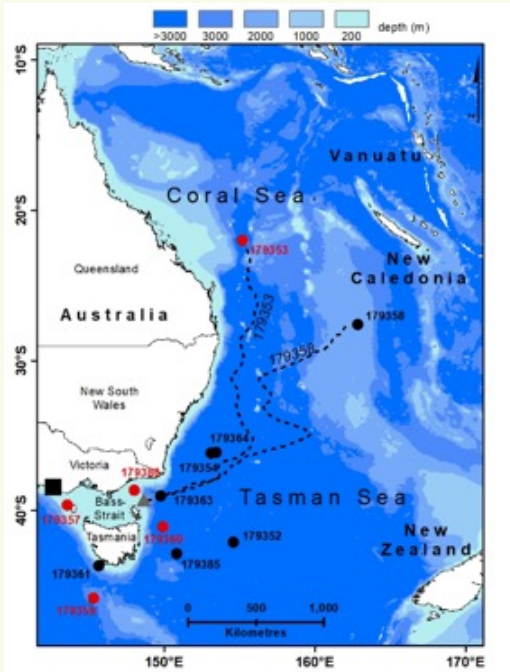



*Figure 1. Map showing location of the study area. Black square denotes tagging location; grey triangle denotes approximate exit point from Bass Strait for eels leaving towards the east; black circles denote end positions of tags with premature ending and sudden rise to the surface. Red circles denote end positions where eels were inferred to be predated. The dashed black lines show the approximate trajectories of eel 179353 and eel 179358.*

## OUTCOME

This work has filled an important knowledge gap regarding the marine migration of Australasian eels, which appears both long and risky. It highlights the need for better information on the processes contributing to eel mortality throughout the life cycle, including the impacts of future changes to oceanic currents, predator abundance and direct anthropogenic disturbances.

## FUNDER

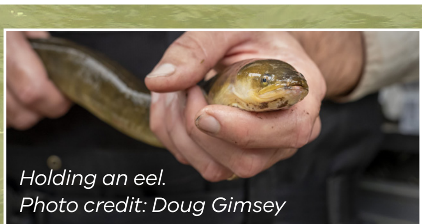
**DELWP**

## CONTACT

**ARI contact:** Dr Wayne Koster Koster et al. (2021)

*This was a collaboration between DELWP and the Gunditjmara Traditional Owners.*

*A satellite tag washed up on a beach*



*Holding an eel.*
*Photo credit: Doug Gimsey*

# Understanding what influences changes in populations of freshwater fish

## ISSUE

Governments invest significant resources to restore fish populations, in particular using environmental water. Understanding how and why the population sizes of fish vary is critical to guide this investment. There has been considerable work regarding how different characteristics of populations (such as age structure, birth and death rates) affect population growth. Less is known, however, regarding what aspects of hydrology drive variation in these factors.

## ACTION

The changes in the abundance and size structure of four native freshwater fish species in the Murray River, south eastern Australia, over a continuous 19-year period were studied. This timeframe spanned dramatic variations in hydrology including a severe persistent drought and several large natural flow events.

The four species were selected to incorporate contrasting life history strategies. Murray Cod (*Maccullochella peelii*) and Trout Cod (*M. macquariensis*) exhibit parental care of a small number (relative to body size) of large, well-developed offspring and can complete their entire life cycle within a river reach. In comparison, Golden Perch (*Macquaria ambigua*) and Silver Perch (*Bidyanus bidyanus*) produce large numbers of small poorly developed offspring that they broadcast spawn into the water column. The latter two species have also been shown to migrate large distances between reaches and rivers to disperse and access suitable habitats to feed and reproduce when environmental conditions are favourable.

Fish were monitored annually and capture–mark–recapture modelling investigated: (1) How did population size change during this period; (2) How were changes in population size related to variability in hydrology; and (3) How were changes in population size driven by different processes (local recruitment or migration events)?

## RESULTS

Populations of all four species varied over time and these differences reflect key attributes of their life history strategies. The results suggested that local recruitment is an important driver of this variability for Murray Cod and Trout Cod that were found to recruit and mature in our study reach in most years. Conversely, we found very little evidence of recruitment of Golden Perch and Silver Perch in our study reach, with large changes in population size driven largely by immigration.

## OUTCOME

This study provided fundamental insights into the population dynamics of these species and how management strategies might need to differ based on their life histories. Management should focus on allowing river connectivity for Golden Perch and Silver Perch, and on promoting local scale recruitment and survival for Murray Cod and Trout Cod. More generally, our study highlights the importance of understanding the processes underpinning the persistence of fish populations, how these processes may vary for different species, and ultimately how this knowledge can inform targeted management actions

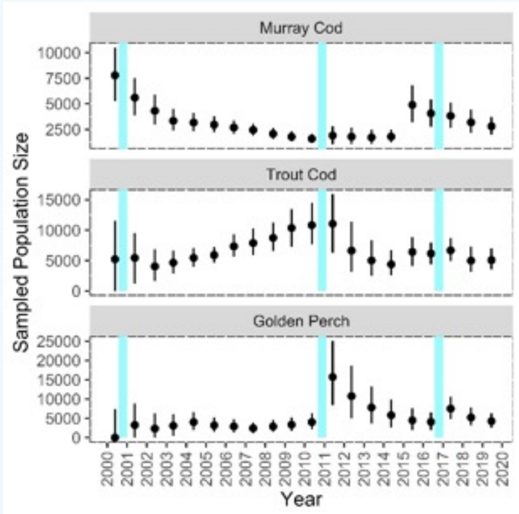



*Figure 2. Predicted change in population abundance (black circles, with 95% confidence intervals) of Murray Cod, Trout Cod, and Golden Perch in the Murray River (2000–2019). Blue lines indicate flood years.*

## FUNDER

**DELWP, ARI, The Living Murray Program and Murray-Darling Basin Authority**

## CONTACT

**ARI contact:** Dr Jarod Lyon   Lyon et al. (2021)

# Environmental flows support recovery of Murray Cod in the lower Darling River-Baaka

## ISSUE

The Darling River – Baaka of eastern Australia is a large dryland river which has been heavily modified. Since 2000, the hydrology in the lower Darling River (LDR) has been transformed from a naturally near-perennial flowing system to an intermittent one by increased water abstraction, prolonged drought and climate change. This hydrological change has placed immense pressure on the native fish populations, including Murray Cod (*Maccullochella peelii*). The catastrophic fish kills of 2018–19 provide stark evidence of this pressure.

In heavily altered river systems, providing environmental flows can help support aquatic ecosystems, prevent fish kills and reinstate elements of the natural flow regime. A sound understanding of ecohydraulic relationships is needed to ensure flow regimes can be designed and implemented in the long term to support fish recovery.

## ACTION

An ecohydraulic conceptual model was developed to guide environmental flows to support spawning and recruitment of Murray Cod in the LDR. An environmental flow based on this model was then released in 2016–17, after 524 consecutive days of continuous zero flows. This flow consisted of an increased discharge in late winter–spring to promote broad-scale lotic (flowing) (i.e. 0.3 m $s^{-1}$) conditions, hydraulic complexity and continuous base flows to maintain connectivity and water quality.

In 2016-17, sampling of larval Murray Cod occurred six times at sites along the 510 km length of the LDR. This monitoring occurred throughout the delivery of the environmental flow from spring to early summer; a period which encompassed the breeding and post-spawning period of Murray Cod.

## RESULTS

Successful spawning and recruitment of Murray Cod and other native fish species occurred. The environmental flow, based on the ecohydraulic model, supported recovery of the local fish community and provided strong proof-of-concept for planning future flow events.

## OUTCOME

The work has helped inform adaptive management of environmental flows to support recovery of the fish community of the LDR after the recent catastrophic fish kills. The monitoring results are significant since they provide justification for refining current water management in the LDR to better support native fish communities.

## FUNDER

**Commonwealth Environmental Water Office and the Murray-Darling Basin Authority**.

## CONTACT

**ARI contact**: Dr Ivor Stuart Stuart and Sharpe (2021)

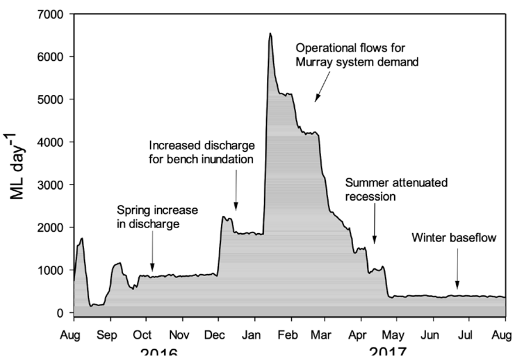



*Figure 3. The designed environmental flow regime delivered to the Lower Darling River in 2016–17 with the important elements that relate to Murray Cod life history indicated.*

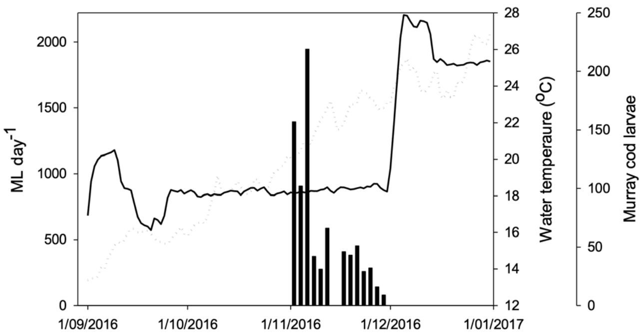



*Figure 4. Daily discharge (solid line), water temperature (dashed line) from Weir 32 gauge and the raw abundance of Murray Cod larvae collected in drift nets in the Lower Darling River in spring–summer 2016–17.*