# ARI Aquatic Quarterly Update – Influence

WINTER 2023

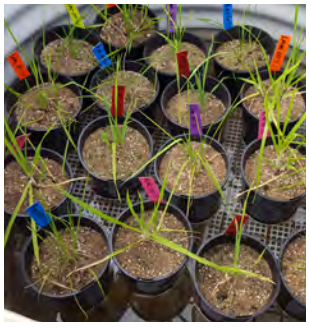
*Dead fish affected by the hypoxic conditions following flooding in 2022*

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

They provide:

- An assessment of the short-term changes in fish communities across northern Victoria, following widespread flooding and hypoxic conditions experienced in 2022. This work helps identify recovery pathways and guide management decisions specific to those areas where major impacts occurred.

- Quantitative published data regarding the tolerance of tufted grasses to cool-season inundation. This information can be incorporated into key environmental water planning documents such as FLOWs studies and Environmental Water Management Plans. It also provides increased rigor to support particular flow recommendations in Victorian rivers.



- Insights into the patterns of downstream migration of adult Common Galaxias, including time of year and links to river discharge.

### About us

The Applied Aquatic Ecology section aims to generate and share knowledge, through world-class, applied, ecological research. This research 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.

# Short-term impacts and potential recovery paths for native fish after floods

## ISSUE

Victorian waterways experienced significant flooding in late 2022. Whilst flooding can be beneficial to riverine ecosystems, there are instances where it can have negative impacts such as reduced recruitment and fish deaths associated with hypoxic water. Hypoxic water events occur when high organic matter loads coincide with high water temperatures, resulting in low dissolved oxygen (DO) levels. Extreme flow and flood conditions can also cause major geomorphic changes by erosion and deposition and modify key habitat features required for key life history processes such as recruitment. Climate change is likely to increase the frequency and magnitude of major flood events.

## ACTION

We assessed the short-term changes in fish communities across northern Victoria, to seek insights into the potential recovery pathway for native fish populations. Data collected before and after the flood was analysed using hierarchical Bayesian modelling to assess changes in abundance and recruitment of fish communities and explore:

- Where and by how much does native fish relative abundance decline after a hypoxic water event?
- Is there poor recruitment of native fish after a major flood event?
- How much does Carp abundance increase after a major flood event?

Data was collated from many existing monitoring projects and fish surveys were carried out in flooded areas. An analysis included survey data across 17 waterbodies, from 2018 to 2023. The 184 sites analysed included 66 sites which experienced hypoxia effects and ranked as either 'high' (DO <1mg/L) or 'moderate' (DO 1-2.5mg/L). The remaining sites were all ranked as 'low' (DO levels >2.5mg/L but experienced flood/high flow events).

## RESULTS

Changes in fish abundance and recruitment varied across species and hypoxia rankings. The largest declines in native fish abundance were apparent in the most hypoxic areas but there were also declines in small-bodied species and recruitment of some species outside of these areas.

Large-bodied species, including Murray Cod, Golden Perch and Trout Cod declined substantially in high hypoxia impacted areas, including sites across the mid Murray River, Broken Creek and Pyramid Creek. Except for Silver Perch, large-bodied species were either stable or showed slight increases in abundance in flooded areas which did not experience hypoxic conditions. This suggests that when river connectivity is adequate, such areas may act as refuges for fish moving away from hypoxic water.

Small-bodied species declined in abundance across all sites, including those that did not experience hypoxic events. Recruitment of native species was low for most species across all sites with young-of-year (YOY) native fish (except River Blackfish) suffering declines in modelled abundance in flood areas regardless of hypoxic events. Reductions in small-bodied species and recruitment of other native species is thought to be due to the extreme flow conditions impacting key habitat features associated with spawning and early life stages.

Carp benefited from flooding, regardless of hypoxic events, with dramatic increases in numbers mainly driven by YOY recruits. There was also strong Carp recruitment in the 2021/22 season.

## OUTCOME

This work showed that multiple waterbodies and fish species were impacted by the 2022 floods. Collating information on what governs population dynamics in these systems will then help identify recovery pathways and guide management decisions specific to those areas where major impacts have occurred.

## NEXT STEP

Available management options can now be considered regarding:

- the use of environmental water to replicate natural flows to facilitate native fish recruitment and increase available habitat in highly regulated systems
- managing waterway connectivity, including through fishways, to source native fish to allow for natural recruitment and maintain genetic diversity
- stocking to increase the rate of recovery for Murray Cod in areas where abundance of adults is low and natural recovery is likely to be protracted
- management options to control Carp abundance.

## FUNDER

This work was funded by DEECA Water and Catchments. Multiple programs and funders contributed data used in the assessment including: Goulburn Broken Macquarie Perch Surveys (Goulburn Broken Catchsment Management Authority, GBCMA), Inter-Valley Trade monitoring (GBCMA and DEECA), Commonwealth Flow Monitoring, Evaluation and Research Program (Flow MER), Mid-Murray Monitoring (Commonwealth Environmental Water Office: CEWO), The Living Murray (TLM, Murray-Darling Basin Authority), Native Fish Report Card, Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) and Wetland Monitoring and Assessment Program (WetMAP) (DEECA)

## CONTACT

Ruby Stoios or Adrian Kitchingman, ARI

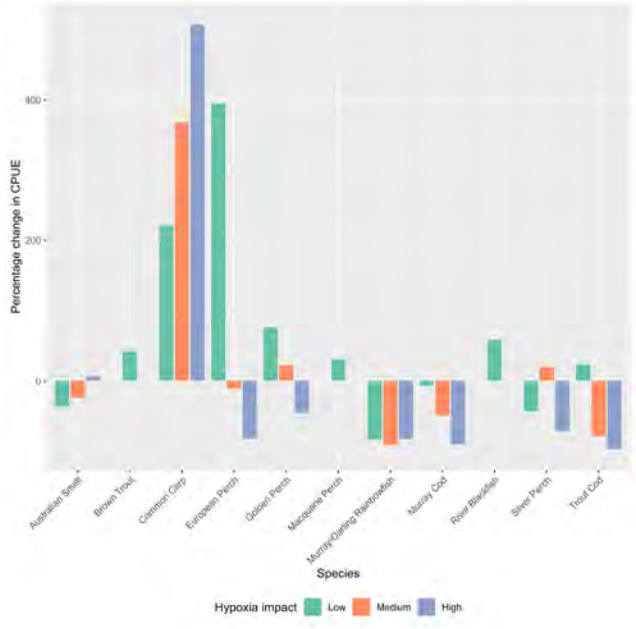



*Figure 1. Percentage change in CPUE of all fish from before to after the 2022 floods by hypoxic category for key species. Note some species not detected in sites subject to all hypoxia rankings.*

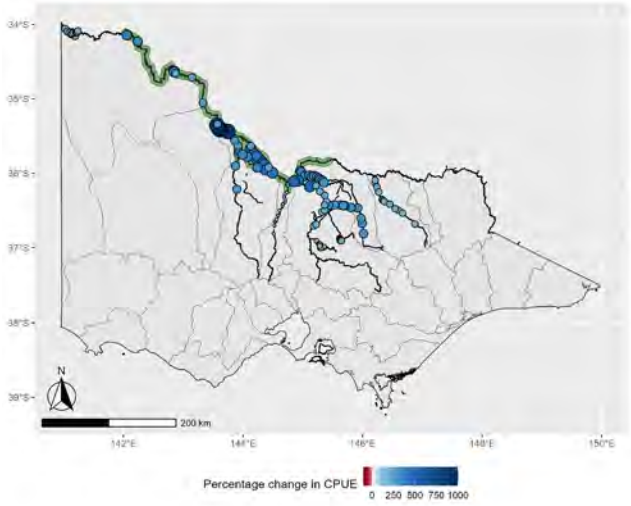



*Figure 2. Map indicating sites their average percentage change in abundance of Carp (green area identifies location of hypoxic occurrences*

*Dead fish in water*

*Dead Murray Cod, Golden Perch and Carp along a river bank*

# Demonstrating plant tolerances of cool-season inundation

## ISSUE

The alteration of flow regimes along many regulated river systems has led to declines in the condition of riparian vegetation communities. In regulated waterways, the naturally high cool-season flows (winter and early spring) are reduced and replaced with smaller environmental flows. Understanding how plants respond to different inundation periods is critical to manage flows in these rivers to improve the extent, abundance and diversity of native riparian vegetation communities.

## ACTION

We conducted three nursery-based experiments to assess the tolerance to cool-season inundation and shading of six tufted grass species of varying flood-tolerances which are commonly found in riparian areas of south-eastern Australia. This included three native species (*Lachnagrostis filiformis, Poa labillardierei* and *Rytidosperma caespitosum*) and three exotic species (*Bromus catharticus, Phalaris aquatica* and *Lolium multiflorum*).

The experiments were conducted in in late winter/early spring because this is the time when environmental flows are commonly released to mimic natural flows. The three treatments were:

1. Inundation of established plants (for up to 35 days), assessing mortality, growth, biomass and flowering
2. Inundation of seedlings (for up to 25 days), assessing mortality
3. Inundation of established plants (for up to 53 days) and shading, assessing mortality, growth, biomass and flowering

## RESULTS

There was a reduction in plant height and biomass growth with increasing inundation duration for all species. Surprisingly, few established plants or seedlings died even at the longest durations, which contrasts with death after shorter durations in warmer seasons.

Seedlings were generally tolerant to inundation, although there was some evidence of increased mortality for the longest treatment (25 days inundation). Shading did not result in greater mortality or reduced height growth of inundated plants. Inundation effects on onset of flowering were limited and varied between species and ranged from earlier to delayed onset.

## OUTCOME

These results suggest that tufted grasses tested are tolerant of cool-season inundation. Mortality of these species has been observed under shorter inundation periods in warmer conditions (late spring and summer). Seasonal timing of inundation therefore appears to be critical in determining plant responses to inundation.

This work provides quantitative published data to incorporate in key environmental water planning documents such as FLOWs studies and Environmental Water Management Plans. It also provides increased rigor to support particular flow recommendations in Victorian rivers.

## NEXT STEP

We suggest that other factors interacting with inundation, and seasonal timing, are likely to be important for determining plant responses to inundation. How these factors interact with the functional and ecological traits of individual species are worthy of investigation. There are also trade-offs between negative impacts on some plants and positive impacts on others during flow events in different seasons that need to be evaluated.

## FUNDER

This work was part of the ongoing Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP), funded by DEECA Water and Catchments.

## CONTACT

Dr Chris Jones, ARI

Kitanovic et al. (2023) Riparian and terrestrial grasses display unexpected tolerance to cool-season inundation. Wetlands Ecology and Management

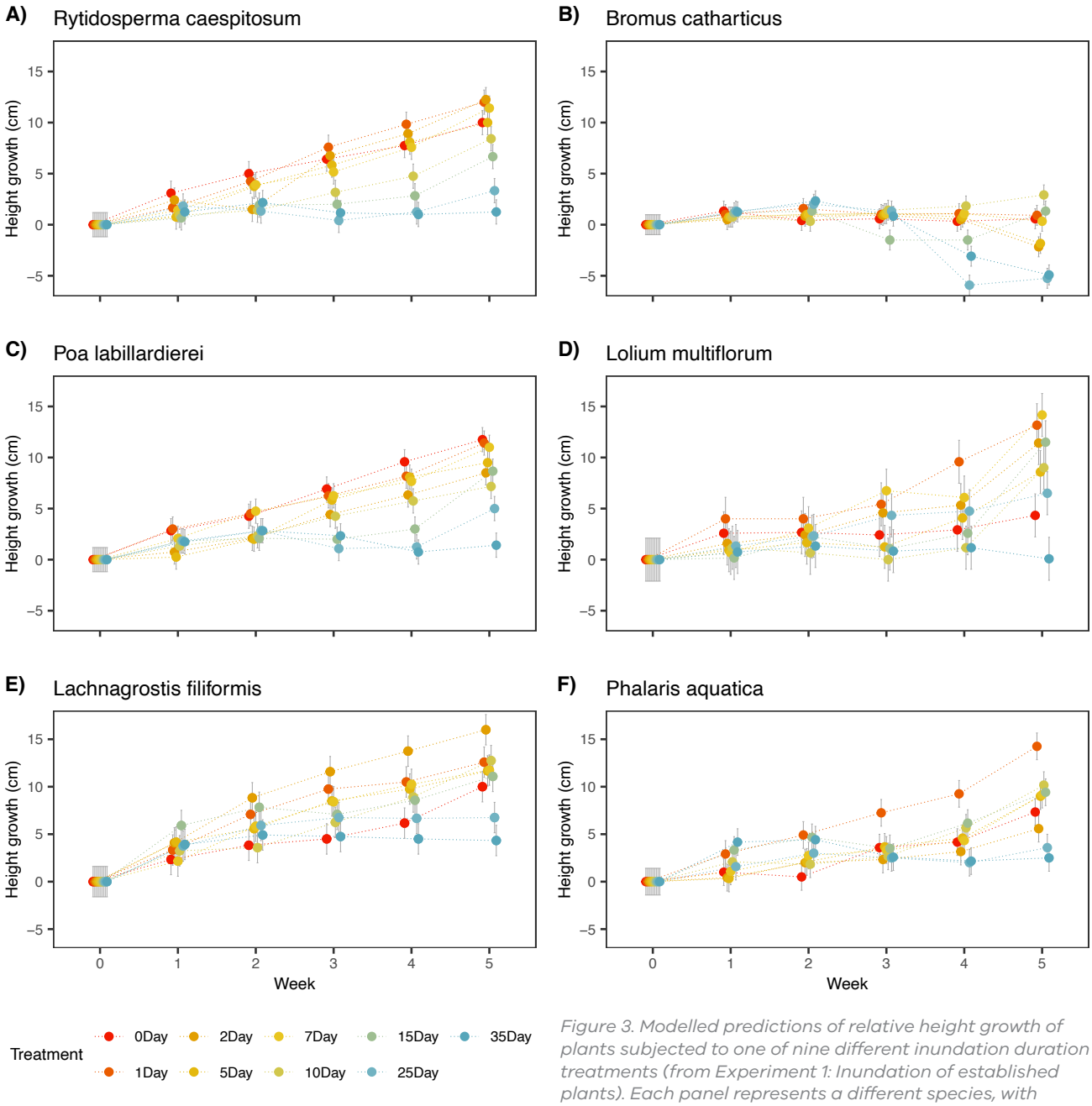



*Figure 3. Modelled predictions of relative height growth of plants subjected to one of nine different inundation duration treatments (from Experiment 1: Inundation of established plants). Each panel represents a different species, with n = 54 plants for each species across all treatments. rror bars indicate the modelled mean ± standard error. Values are offset along the x-axis to improve visualisation.*

*Inundation experiment at Burnley*

*Seedling trays used as part of the inundation experiment*

# Understanding the migration patterns of adult Common Galaxias

## ISSUE

Globally, many migratory fish species are under threat. Effective conservation efforts for these species need a sound understanding of their life-history requirements, such as cues for migration. Migrations to spawn are a critical component of the life cycle of many fishes yet are generally poorly understood.

The Common Galaxias (*Galaxias maculatus*) is a small diadromous* species found in coastal waterways in southern Australia, New Zealand, and southern South America. While some key aspects of the species' biology have been well , the spawning migration behaviour of adults is a knowledge gap.

## ACTION

We studied the downstream migration patterns of Common Galaxias in the Bunyip–Tarago River system, in southern Australia. PIT (Passive Integrated Transponder) tags were placed in 39 fish and fish movement was monitored between February and May 2021.

## RESULTS

Fish undertook rapid (typically 1–3 days) downstream migration (up to 50 km) from the upper reaches to the lowland reaches near the estuary. Migration occurred from March to May during the known spawning period, with peak movement between late April and mid-May. Migration was also related to increased river discharge, with fish being more likely to migrate on days when flow was high compared with the previous two days, and a waxing moon (i.e. increasing illumination).

This work highlighted the importance of maintaining or protecting components of the flow regime, such as 'freshes'. It also showed how flow regulation that dampens natural flow pulses may affect migration behaviours of diadromous fishes such as Common Galaxias.

## OUTCOME

Our results provide important new, and complementary information on the migration ecology of Common Galaxias. The work helps fill a key knowledge gap in the life history of this widely distributed diadromous species. Significantly, the knowledge about the likely drivers of movement can inform management actions such as providing environmental flows in autumn and at appropriate moon phases to trigger the downstream migration of adult fish from freshwater to estuarine spawning areas.

This work could be more broadly applied to understand the movements of other small-bodied fish species.

## NEXT STEP

As part of the continuing study, the influence of environmental conditions on the migration of other diadromous species (Australian Grayling, Tupong, and Short-finned Eels) will also be examined.

## FUNDER

Melbourne Water

## CONTACT

Dr Wayne Koster, ARI

Koster et al. (2023) Downstream migration of telemetry-tagged adult Common Galaxias (*Galaxias maculatus*) in a coastal river system. Marine and Freshwater Research.

**diadromous – a fish that moves between salt water and fresh water as part of its life cycle.*

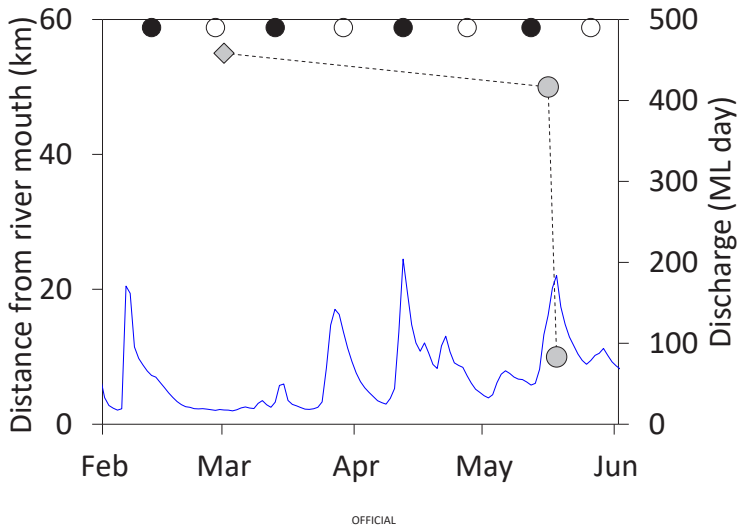



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*Figure 4. Example of downstream movement of individual PIT-tagged Common Galaxias. Grey diamond shows the date and location of tagging; grey circles show detections on PIT readers. Blue line indicates discharge in the Tarago River at Drouin West. Black and white circles show new and full moons, respectively.*

*A Common Galaxias*

*Backpack electrofishing (Photo: Doug Gimesy)*

*The Bunyip River*

*Close up of a Common Galaxias head (Photo: Doug Gimesy)*

We acknowledge Victorian Traditional Owners and their Elders past and present as the original custodians of Victoria's land and waters and commit to genuinely partnering with them and Victoria's Aboriginal community to progress their aspirations.



ISSN 2653-8334 Online (pdf/word)

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