Commonwealth Environmental Water Office

Long Term Intervention Monitoring

Basin Matter - Fish foundation report

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Basin Matter - Fish foundation report

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1 Why monitor fish response to flows?

The links between flows and fish population processes make fishes a useful indicator of system responses to managed flows and, within the context of the Basin Plan, biodiversity response to flows. Furthermore, fishes have substantial socioeconomic value, and so information about fish population response is useful to CEWO from a stakeholder communication and engagement perspective.

CEWO needs:

The principle LTIM evaluation question is: **What did Commonwealth environmental water contribute to sustaining native fish at the Basin-scale?**

In particular, CEWO want information on native fish through measures of native fish survival (population strength, condition, cohort strength), reproduction success (spawning), and fish populations and communities.

CEWO are interested in understanding this question from three perspectives:

(a) What did CEWO water achieve at Selected Area's?

(b) What did CEWO water achieve outside of Selected Area's?

(c) Can this information be used to inform future adaptive management at Basin watering sites?

2 Research questions

It follows from the above management needs, that the research questions are hierarchical; such that we need to understand:

- the influence of all flows on native fish sustainability, then if a response is detected, then examine specifically what did CEWO water contribute?

- the influence of flows across all Selected Areas, to determine the variability of fish responses to flow before consideration of the broader utility in unmonitored areas.

We therefore aim to determine:

(i) What is the influence of flow events and flow regimes across all selected areas, on:

(a) Spawning success of native flow-cued species?

(b) Recruitment strength of all native fish species

(c) Population composition (structure and condition) of abundant native species

(d) Native fish community structure and persistence

(ii) Does CEWO water contribute to any flow linked response to these fish metrics?

(iii) Can any detected fish responses to flows be used predict fish response to hypothesised flow events?

The last question will depend on the amount of variation explained by flow and the precision of the predictive models but may enable us to predict the effect of both hypothetical flow delivery scenarios, as well as outside of monitored sites.

3 Analysis Approach

Spawning:
We will undertake quantitative modelling to determine the relationship between the probability of occurrence, and (ideally) density of larvae of key native species, and the characteristics of the spring-summer hydrograph and other relevant non-hydrological factors, within a year across all Selected Areas.

Species: e.g. golden perch, silver perch, Murray cod, trout cod, bony bream
Fish Data: CPUE abundance and presence/absence data
Analytical Approach: quantitative modelling approaches such as Generalised Additive Models or potentially multispecies hierarchical models. We will use data collected from all Selected Areas (Cat 1 and Cat 2, to increase data points) and all sampling years.
Potential Hydrological Parameters: Daily water temperature, change in weekly temperature, daily discharge, change in weekly discharge, number of flood days in last 90 days, number of flow peaks in last 90 days.

Recruitment
We will undertake quantitative modelling to determine the relationship between the number of young-of-year of key native species, and hydrological characteristics of the preceding water year across all Selected Areas.

Species: modelling to be conducted only on abundant species
Fish Data: CPUE abundance
Analytical Approach: quantitative modelling approaches such as Generalised Additive Models or potentially multispecies hierarchical models. We will use data collected from all Selected Areas (to increase data points) and all sampling years.
Potential Hydrological Parameters: Number of flood days in water year, number of 'fresh' days in water year, number of low flow days, incidence of blackwater(https://www.mdba.gov.au/managing-water/water-quality/blackwater), mean water temperature,

Population Composition
We will quantitatively assess the change in population structure and population condition through time and across Selected Areas as related to flow regimes and the use of CEW.

Species: modelling to be conducted only on abundant species
Fish Data: CPUE abundance, length, age and weight of all individuals,
Analytical Approach: we will construct length-frequency, or when known, age-frequency distributions for relevant species at each Selected Area across sampling years. We will test for differences in population structure across years and Selected Areas, and infer any detected population changes to flow regime variations. Mean individual body condition (length: weight) will be compared for key species across years and Selected Areas.

Community Structure
We will determine changes in fish community structure through time and across Selected Areas as related to flow regimes and the use of CEW.

Fish Data: CPUE abundance, all species, all methods

Analytical Approach: we will explore and test for differences in fish community structure across Selected Areas and years, using standard multivariate techniques (NMDS, PERMANOVA). Any detected differences will be qualitatively related to the likelihood of these occurring due to flows.

A note on predictive population modelling: A key objective of LTIM is to improve the capacity to predict ecological response to flow events (hydrographs spanning 1 year or less) and regimes (hydrographs spanning multiple years) (Gawne et al. 2013; Gawne et al. 2014). The approach taken to fish monitoring within LTIM was shaped by the requirement to meet both the quantitative analyses of fish responses to flows at the Basin scale (see above objectives), and to develop predictive population models that will enable forecasting of the response of fish populations to various future flow scenarios. Whilst the development of predictive quantitative population models should still be the overall analysis objective for longer-term understanding of the response of native fish population response, we do not believe it is currently (at Year 5) achievable to build robust predictive population models for key species. This is due to the:

(i) small number of replicate flow years (five) and one fish community sample at each Selected Area in each year,

(ii) small flow variability across years and selected areas seen so far through LTIM monitored years (most monitored years in drought conditions)

(iii) low population abundances of many native fish such that detecting fish population responses to CEWO flows is likely to be difficult

4 Outputs

The outputs of the revised Basin Evaluation for fish will comprise:

Year 4 Basin Summary Report

- A qualitative summary of diversity and occurrence of native fish species collected across Selected Areas
- A qualitative summary of spawning outcomes detected in LTIM monitoring of native fish species collected across Selected Areas
- A quantitative summary of abundance and population composition of native fish species across Selected Areas
- A qualitative summary of any fish flow-ecology relationships through review of above data, and synthesis of selected area reports

Year 5 Models and Synthesis report

- Development of quantitative models to assess the effect of flows, and CEW alone, on native fish across Selected Areas and sampling times
- Assessment, and use if applicable, of these models to predict the effect of potential managed flows on native fish at selected areas, and potentially at unmonitored sites.

- A qualitative summary of any fish flow-ecology relationships through review of above data, and synthesis of selected area reports