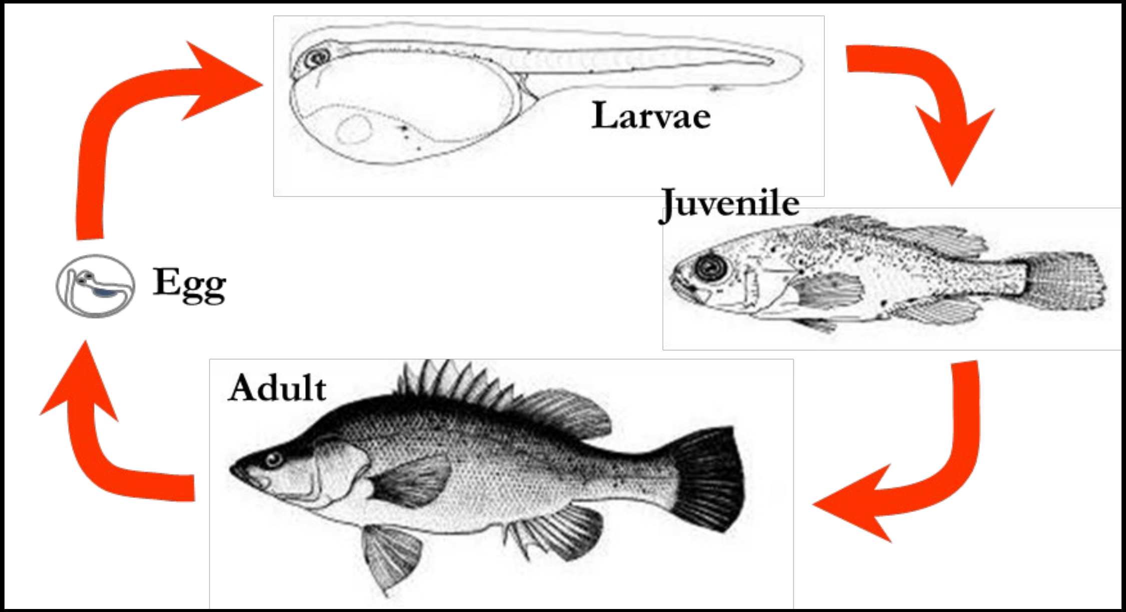
The Murray-Darling Basin Environmental Water Knowledge Research project

# Fish Theme

# Fish Theme Leadership Group

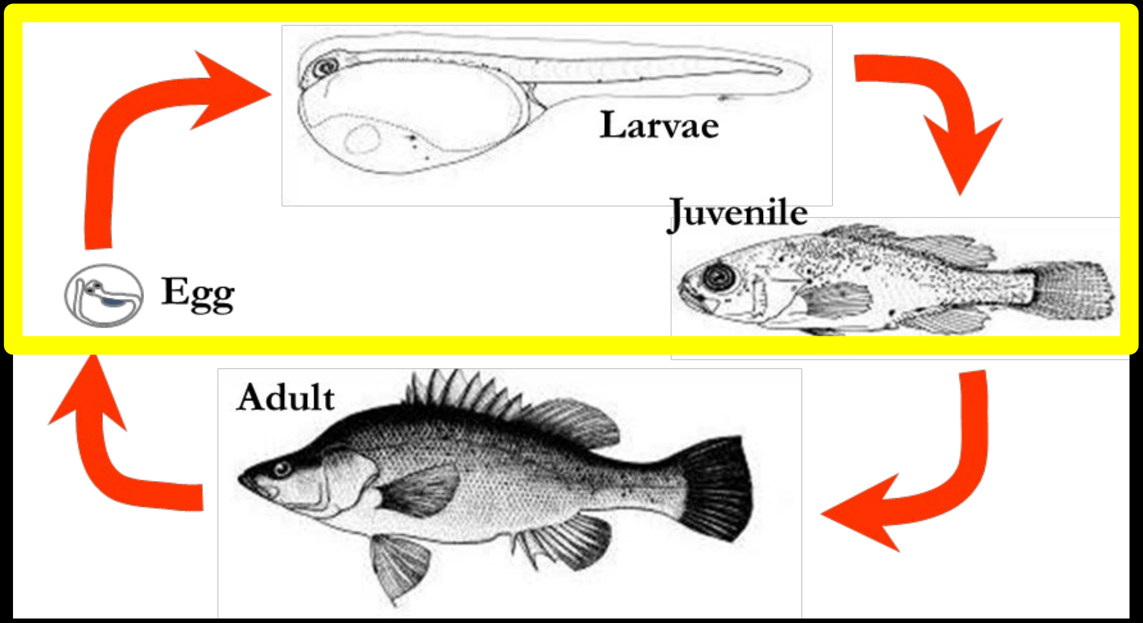
# MDB EWKR Questions – Fish Theme

**Overarching question: What are the drivers of sustainable populations and diverse communities of native fish?**



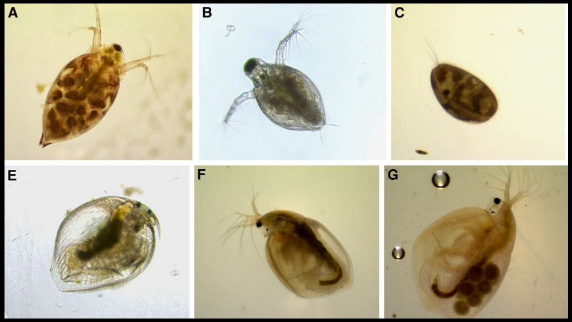
# MDB EWKR Questions – Fish Theme

**Overarching question: What are the drivers of sustainable populations and diverse communities of native fish?**



# Key Drivers – Fish Recruitment

**Food**




**Temperature**

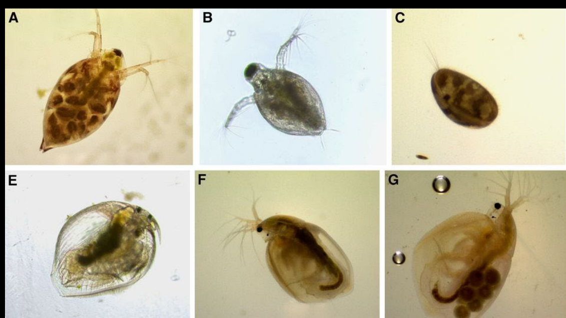
**Predation**

**Dispersal & retention**

**Other sources of mortality**

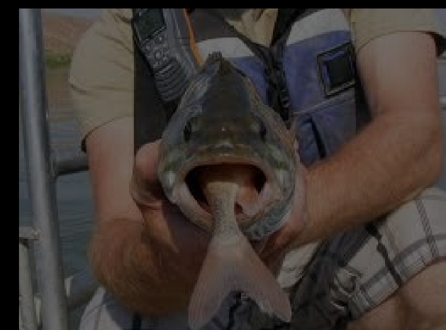
# *Foundational Activity 1:*
# The influence of flow versus non-flow related factors

Food




Temperature

Predation



Dispersal & retention

Other sources of mortality

## *Foundational Activity 2:*
## Knowledge and Management of Flows and Fish in the MDB

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Priority knowledge gaps:

- Population dynamics
- Movement, dispersal and connectivity
- Survival and recruitment

Priority species:

- Murray cod
- Golden perch
- Trout cod
- Silver perch

# *Foundational Activity 3:*
# The Riverscape Recruitment Synthesis Model

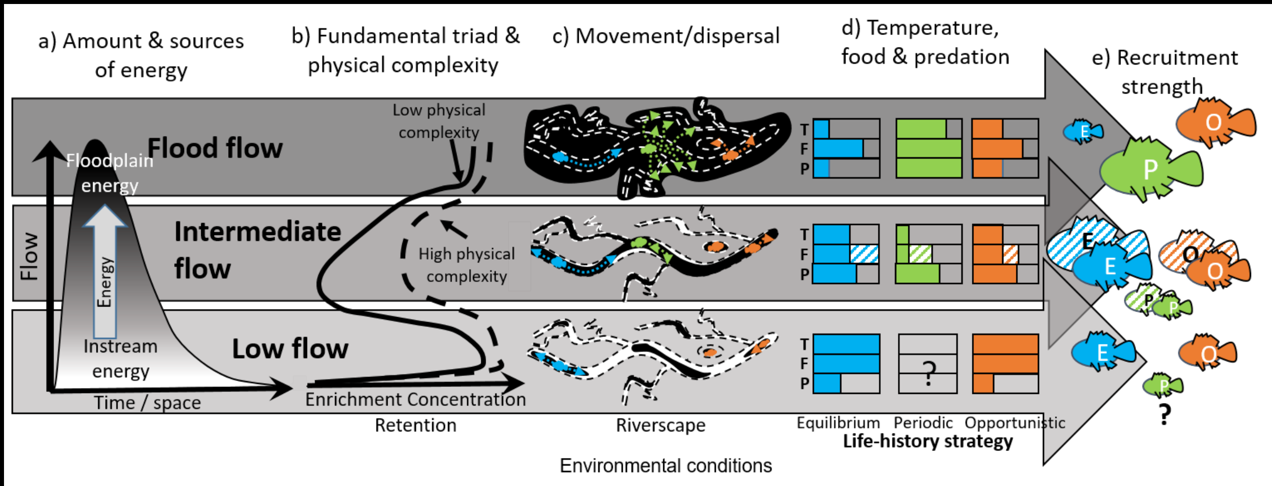
Key Drivers:

- Flow
- Amount and sources energy
- Retention of energy and nutrients
- Physical complexity
- Food availability
- Movement and dispersal
- Temperature
- Predation
- Life-history strategy

Key Output:

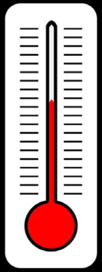
- Ways to predict recruitment strength for different types of species

*Paul Humphries, Alison King, Nicole McCasker, R. Keller Kopf, Rick Stoffels, Brenton Zampatti, and Amina Price, in press, Canadian Journal of Fisheries and Aquatic Sciences.*



# Research Focus

1. What are the food and temperature requirements?



2. Where and under what flows are food and temperature requirements met?

3. How do dispersal and retention influence recruitment?

# Incorporating scale


*$10^{-1}$-10 m*
Food
Temperature


*$10^{1}$ m*
Food
Temperature


*$10^{1}$-$10^{5}$ m*
Food
Temperature
Movement/Retention

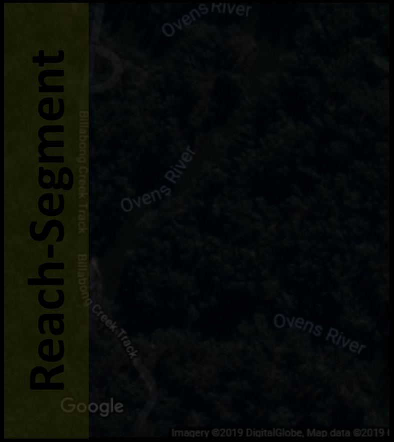

*$10^{5}$-$10^{9}$ m*
Temperature
Movement/Retention

# Incorporating scale


*$10^{-1}$-10m*
Food
Temperature

La Trobe University


*$10^{1}$m*
Food
Temperature




*$10^{1}$-$10^{5}$m*
Food
Temperature
Movement/Retention


*$10^{5}$-$10^{9}$m*
Temperature
Movement/Retention

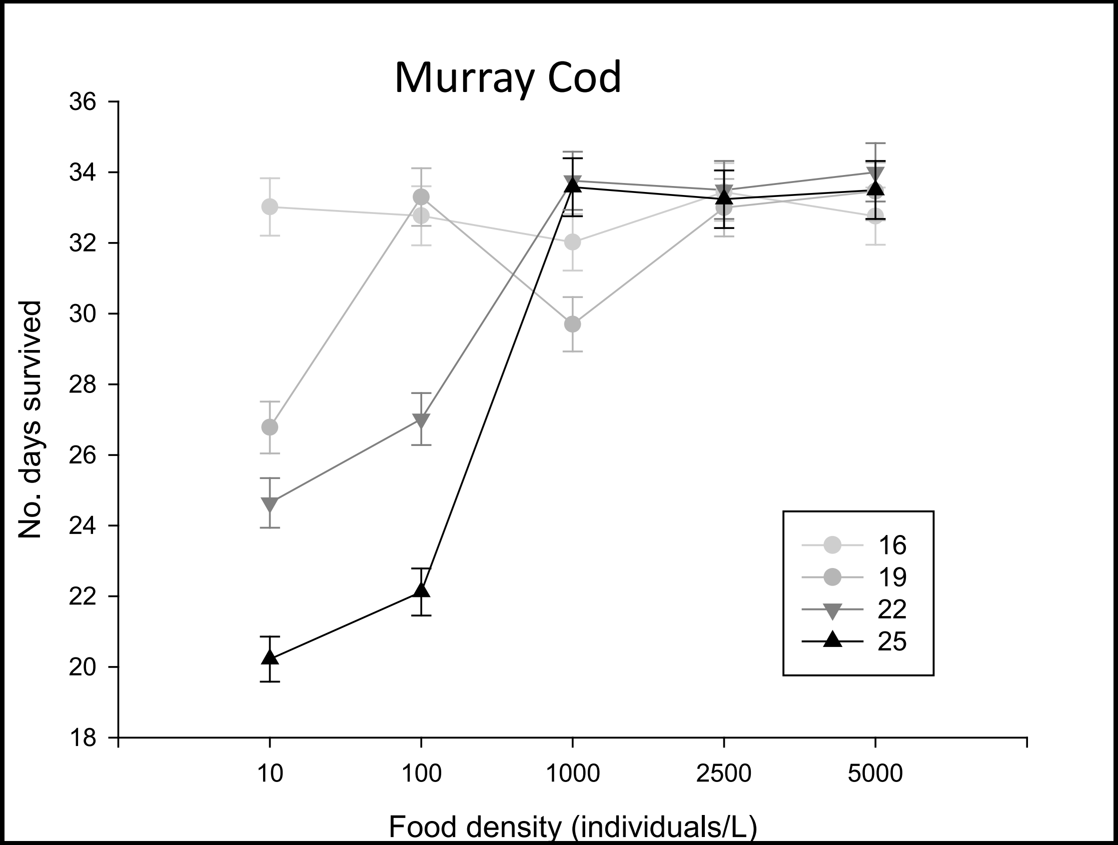
# Approach

Experimentally investigate the relationship between food density and temperature on the growth and survival of the early life-stages Murray cod and Golden perch.

# Design:

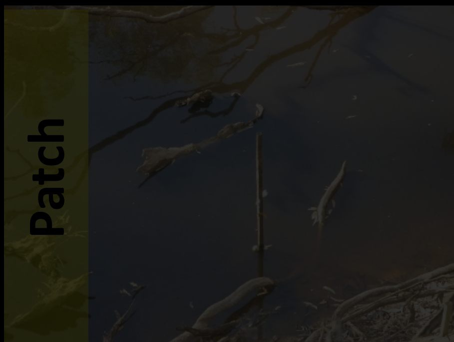
| | Murray Cod | Golden perch |
|---|---|---|
| Temperature | 16°C, 19°C, 22°C, 25°C | 16°C, 20°C, 24°C, 28°C, 32°C |
| Food (density/L) | 10 (6), 100 (60), 1000 (598), 2500 (1495), 5000 (2990) | 10 (6), 100 (60), 1000 (598), 2500 (1495), 5000 (2990) |

# Key findings




- For both species, relatively high densities of zooplankton are required to maximise survival and growth.
- If larvae occur in cold water environments feeding is delayed and growth is limited.

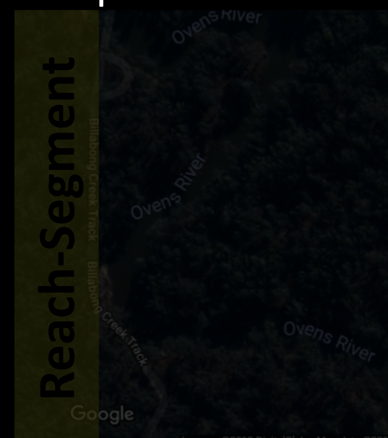
# Incorporating scale




*$10^{-1}$-10m*
Food
Temperature


*$10^{1}$m*
Food
Temperature

**Griffith University**; Qld Government




*$10^{1}$-$10^{5}$m*
Food
Temperature
Movement/Retention

*$10^{5}$-$10^{9}$m*
Temperature
Movement/Retention

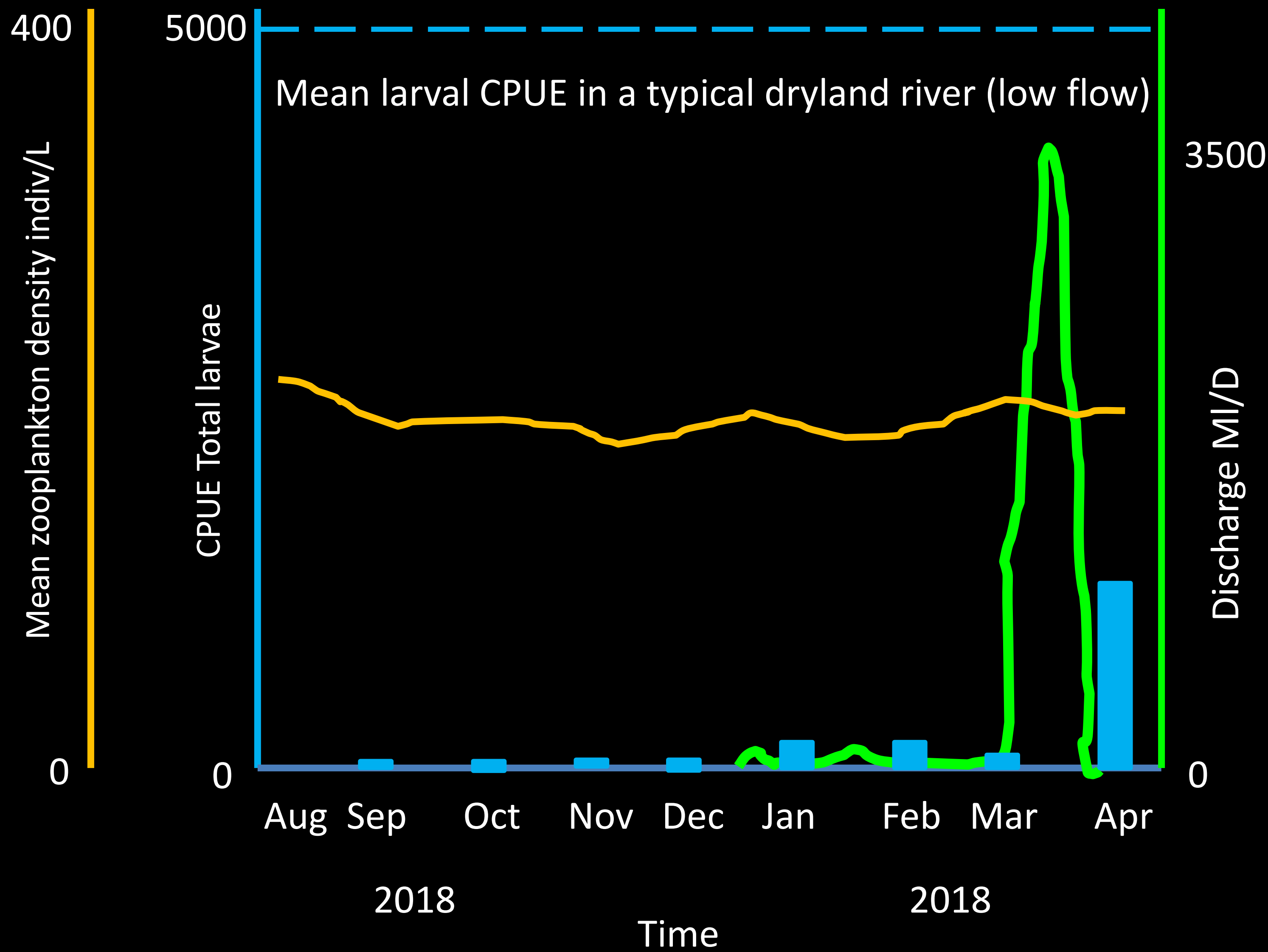
# Approach

Examining larval abundance across 4 drought refuges (disconnected waterholes) in the Lower Balonne system (2 large-permanent, 2 small-temporary)

Culgoa and Narran Rivers (August  2017 – April 2018) – covers breeding temperature window

Food density (zooplankton and phytoplankton), water quality and fish larvae (pelagic plus edge habitats)

# Outcomes

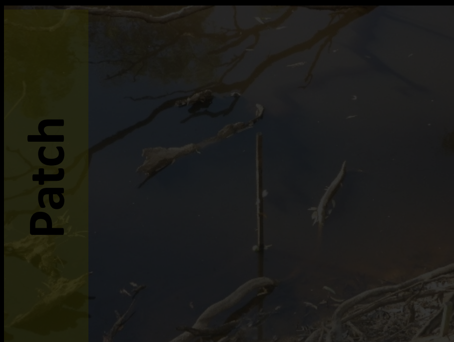


400
0
Mean zooplankton density indiv/L
5000
0
CPUE Total larvae
Mean larval CPUE in a typical dryland river (low flow)
3500
0
Discharge Ml/D
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
2018
2018
Time

# Management considerations

- Recruitment not limited by food or temp but potentially adult pop.
- In extreme dry, *some* waterholes may act as refuges
- System resilience is dependent on:
    - Locating and maintaining priority refuge sites during drought either with top-up flows or extraction limits
      and potentially habitat enhancement
    - Post drought flow management needs to address connectivity issues to allow recolonization by adults

# Incorporating scale




*$10^{-1}$-10m*
Food
Temperature

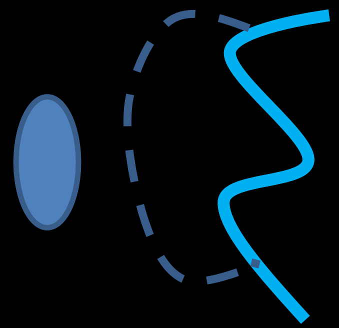

*$10^{1}$m*
Food
Temperature


*$10^{1}$-$10^{5}$m*
Food
Temperature
Movement/Retention

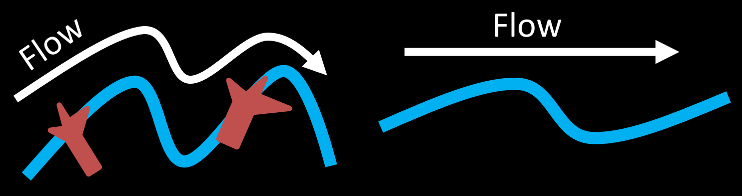
**La Trobe University;**
**Charles Sturt University;**
DPI (Fisheries)
Geoff Vietz

*$10^{5}$-$10^{9}$m*
Temperature
Movement/Retention

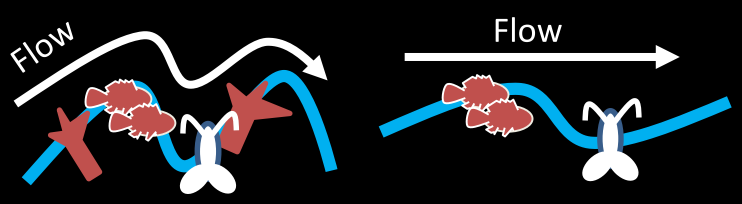
# Approach



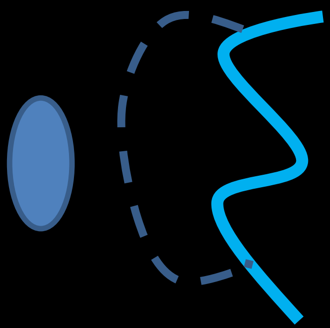
- Lateral comparisons of temperature and food: river, anabranch and wetland




- Reach physical complexity and flow retentiveness
- Retentiveness in lowland rivers
  - Zooplankton assemblage density
  - Murray cod and golden perch larvae

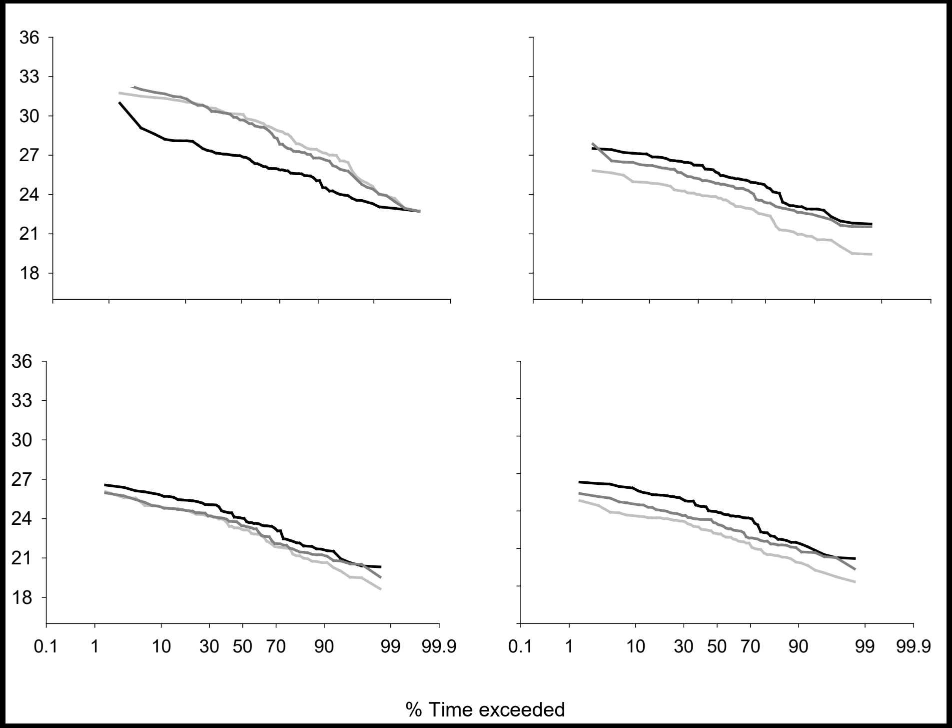


# Lateral comparisons of temperature and food: river, anabranch and wetland

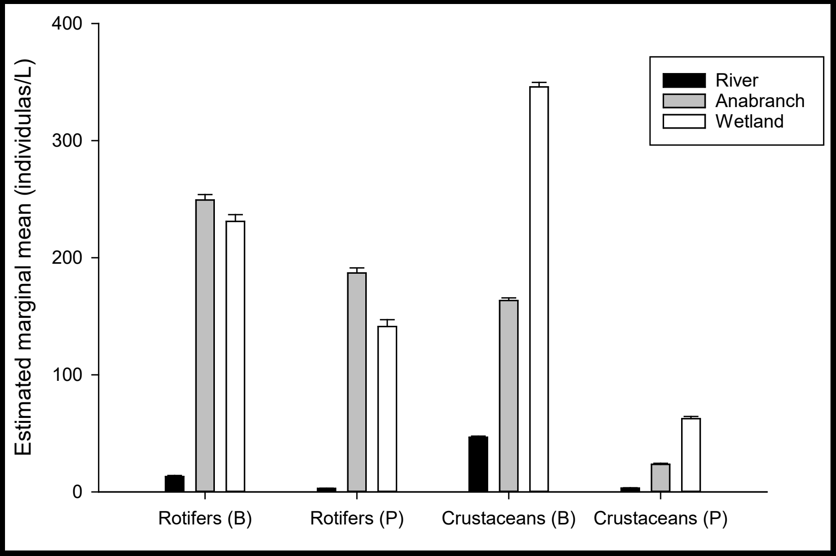


## Temperature

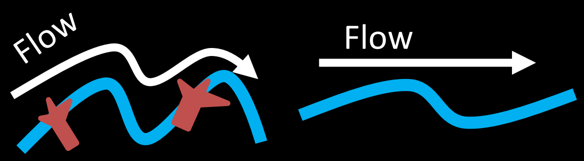
Pelagic | Benthic

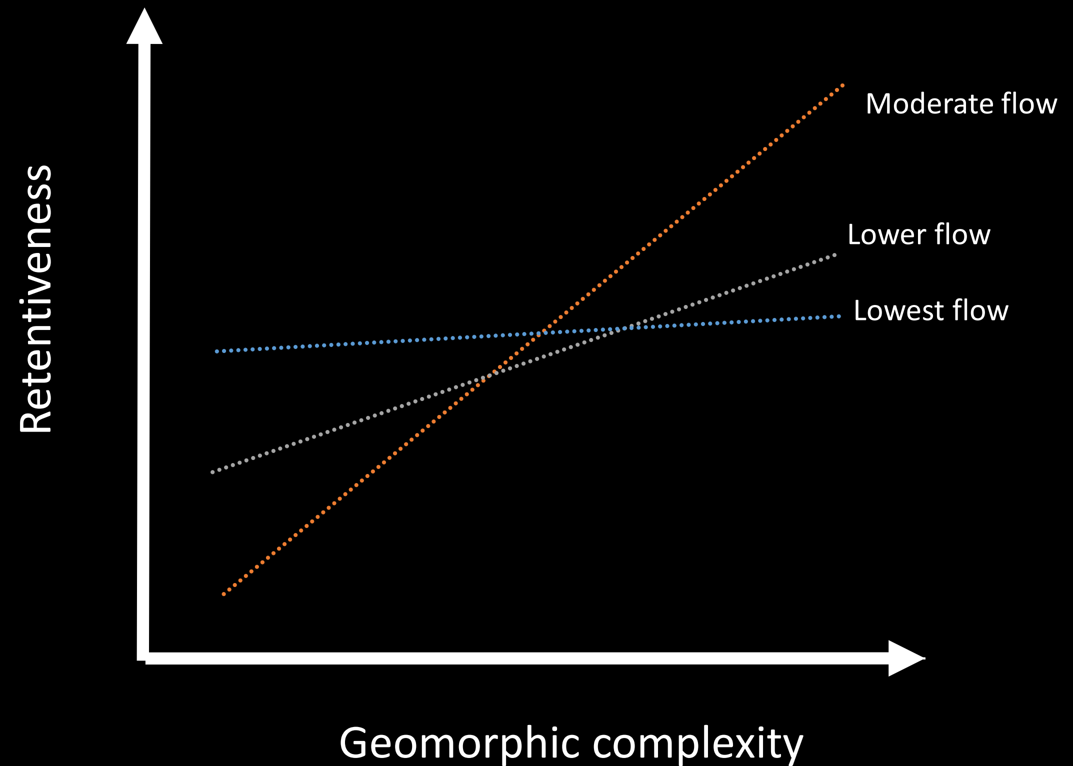



## Food



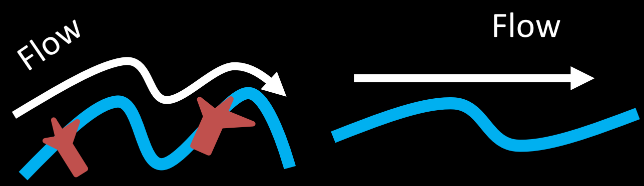
# Reach physical complexity and flow retentiveness

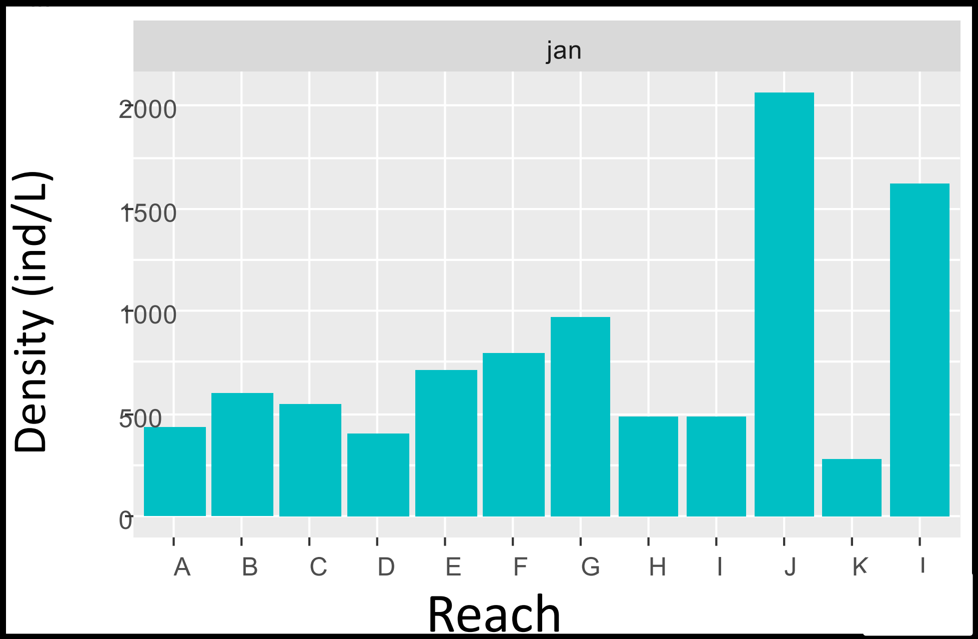



- As flow declines, reach retentiveness of complex reaches decreases
- As flow declines, reach retentiveness of simple reaches increases
- As flow declines, reach retentiveness overall homogenises

# Retention of zooplankton and fish larvae

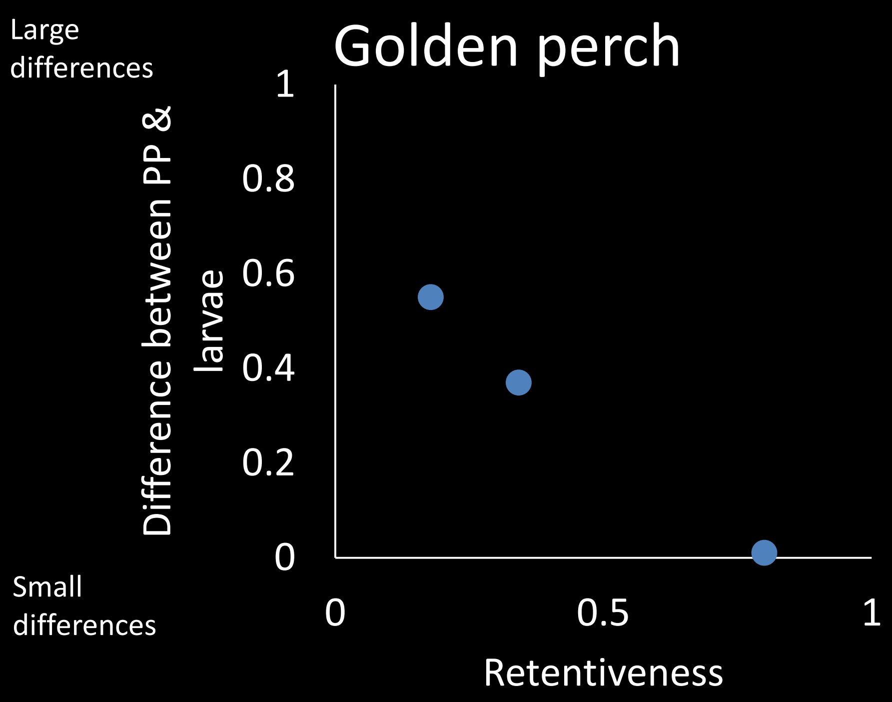


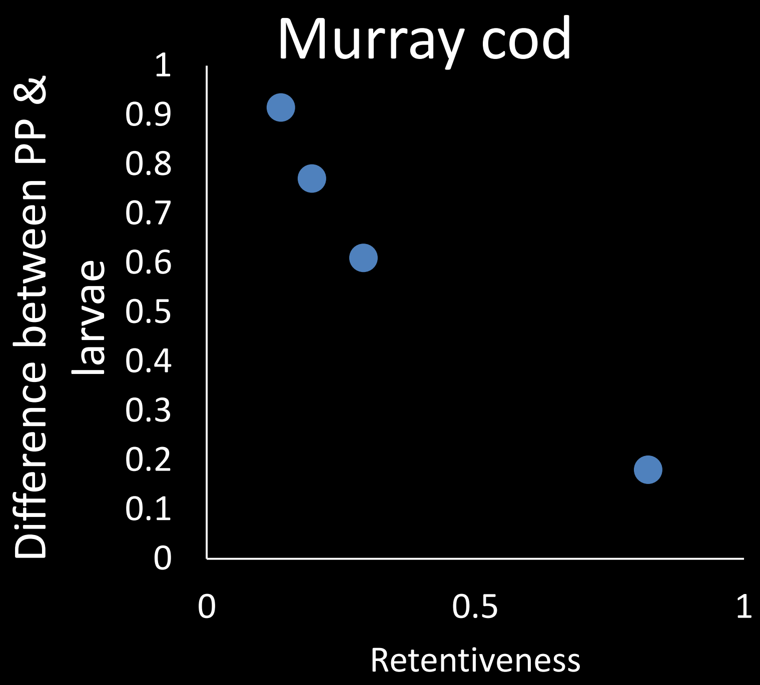




Hypothesis: retention has a statistically significant effect on the density of zooplankton assemblage among reaches

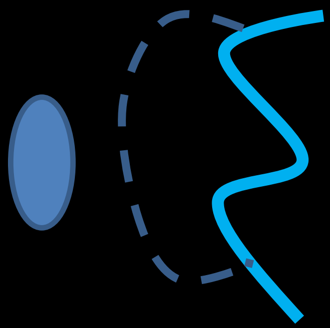
True: Model without retention vs model with retention $P = 0.008$ **

# Flow retentiveness and retention & dispersal of Murray cod and golden perch larvae

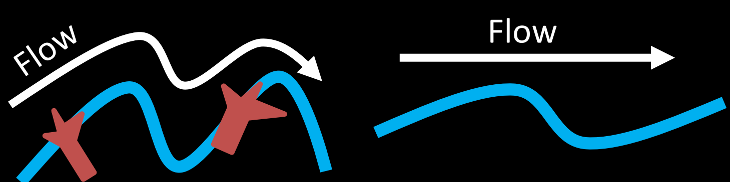


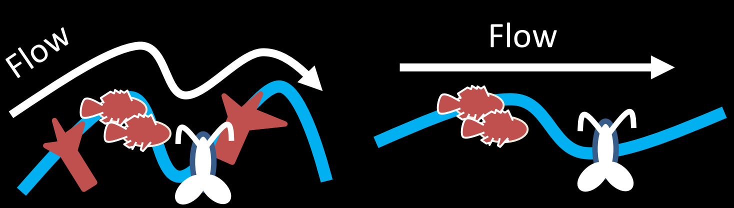
# Management considerations



Provide connectivity between main channel, floodplain wetlands & anabranches

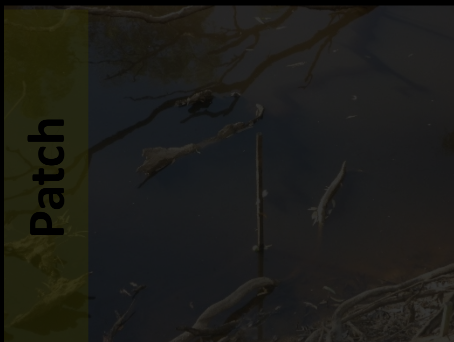



Retention drives food production. Retentiveness varies with flow and physical complexity.




Retention plays an important role in zooplankton density and larval fish dispersal.

# Incorporating scale

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Temperature


*$10^{1}$m*
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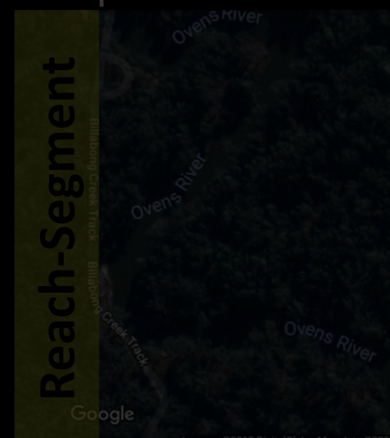
Temperature




*$10^{1}$-$10^{5}$m*
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Temperature
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*$10^{5}$-$10^{9}$m*
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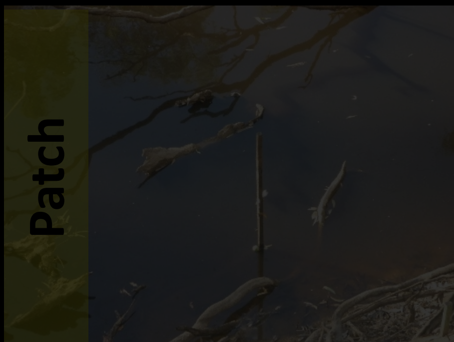
Movement/Retention

**SARDI;**
ARI; DPI (Fisheries); Griffith University; Charles Darwin University; Charles Sturt University; Qld DES

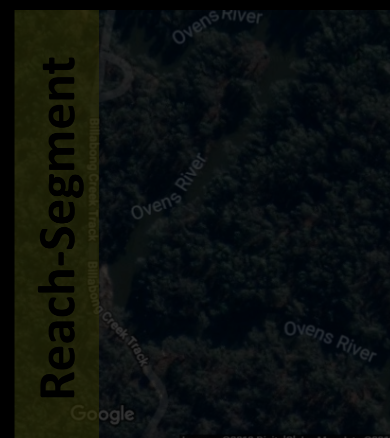
# Basin-scale population dynamics project

- Results currently unavailable

# Flow-mediated diversity across scales



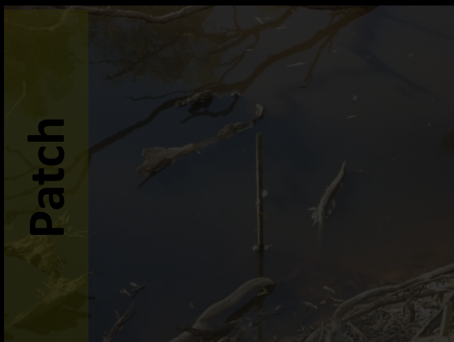





# Flow-mediated diversity across scales




# Flow-mediated diversity across scales

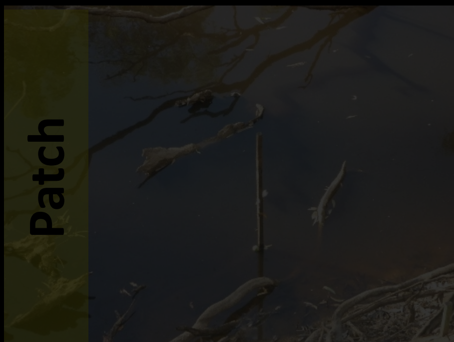




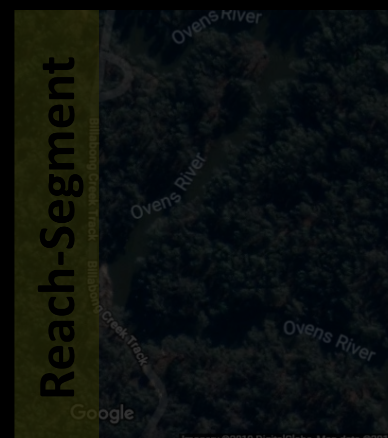

# Flow-mediated diversity across scales




# Management focus across scales



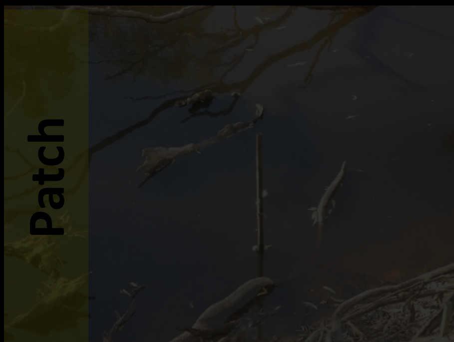






- Sources of recruitment
- Likelihood of spawning and survival
- Prioritisation of watering based on those sources
- Consideration of timing for temperature
- Connectivity to ensure dispersal and movement

# Management focus across scales






- Timing
- Degree and variability of physical complexity
- Longitudinal and lateral connectivity


- Sources of recruitment
- Likelihood of spawning and survival
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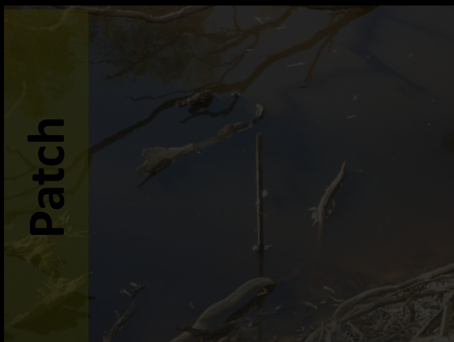
# Management focus across scales





- Food and temperature conditions
- Instream habitat
- Duration of inundation
- Presence of predators


- Timing
- Degree and variability of physical complexity
- Longitudinal and lateral connectivity


- Sources of recruitment
- Likelihood of spawning and survival
- Prioritisation of watering based on those sources
- Consideration of timing for temperature
- Connectivity to ensure dispersal and movement

# Management focus across scales


- Physical and hydraulic complexity


- Food and temperature conditions
- Instream habitat
- Duration of inundation
- Presence of predators


- Timing
- Degree and variability of physical complexity
- Longitudinal and lateral connectivity


- Sources of recruitment
- Likelihood of spawning and survival
- Prioritisation of watering based on those sources
- Consideration of timing for temperature
- Connectivity to ensure dispersal and movement

# Thank-you

EWKR
Environmental Water Knowledge & Research

MDB EWKR is a 5 year, $10 million research project funded by the Commonwealth Environmental Water Office

The project is a collaboration between La Trobe University as lead together with 12 other research organisations

Aim to improve science to support environmental water planning and management

Address gaps in environmental watering information on waterbirds, vegetation, fish and food webs

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For more information

Website: http://ewkr.com.au/

Facebook: https://www.facebook.com/TheMDFRC/

## Project Collaborators

La Trobe University

Charles Darwin University

CSIRO

Charles Sturt University

Government of South Australia, Primary Industries and Regions SA

SARDI South Australian Research and Development Institute

Griffith University