



Impacts of managed flows on fish spawning and recruitment

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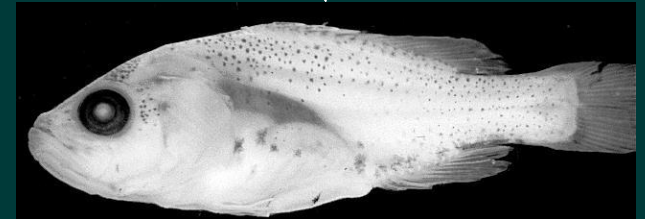
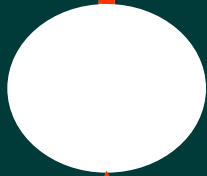
Co-conspirators: Shaun Meredith (MDFRC) and Ivor Grown (NSW DNR)

In the beginning....

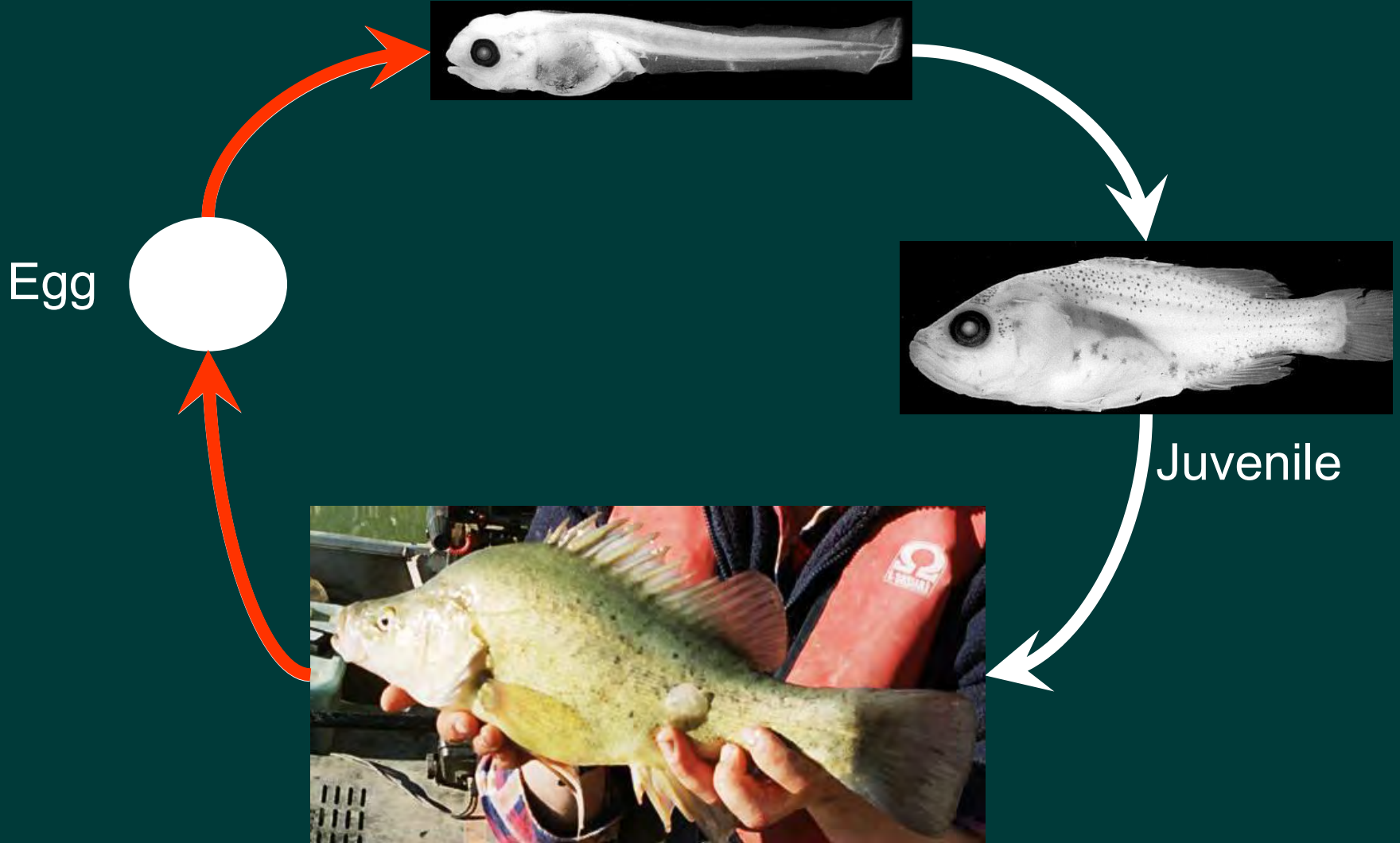
Larva

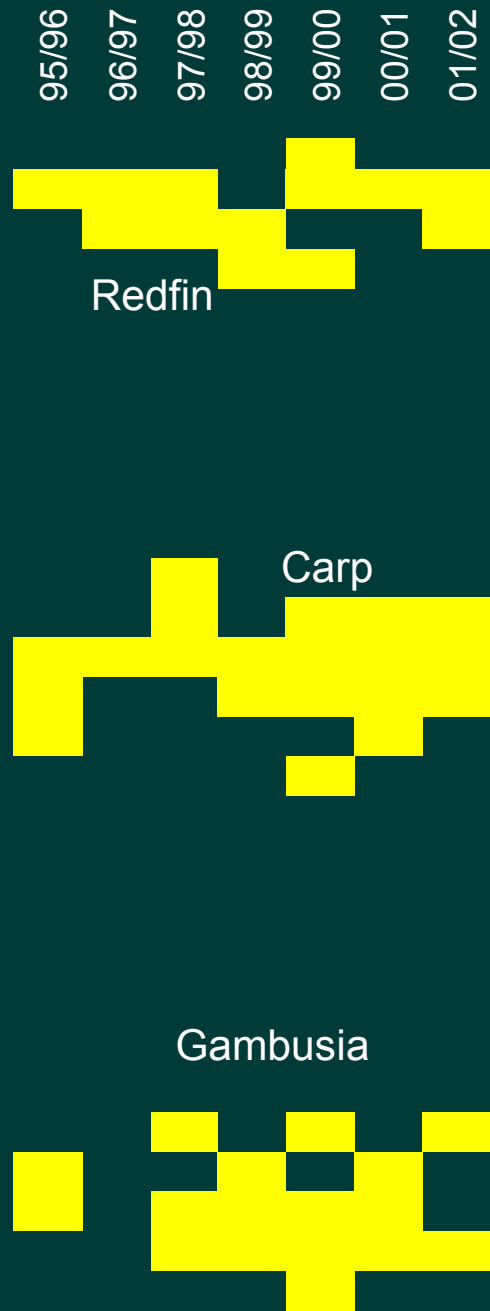


Egg



Juvenile





Spawning of fish in the Campaspe

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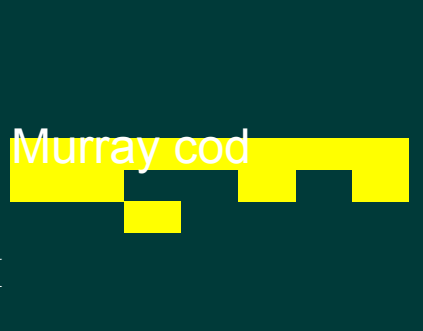
95/96
96/97
97/98
98/99
99/00
00/01
01/02



Australian smelt



Galaxias sp.

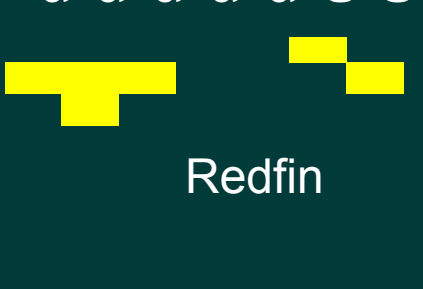


Murray cod

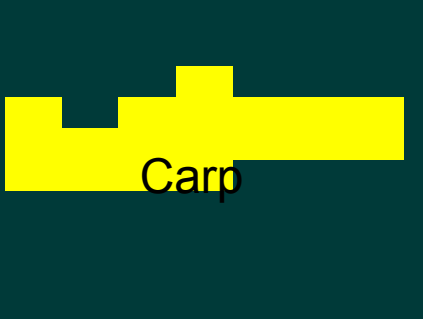


Carp gudgeons

95/96
96/97
97/98
98/99
99/00
00/01
01/02



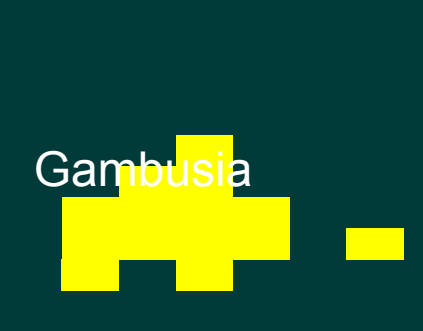
Redfin



Carp



Rainbowfish

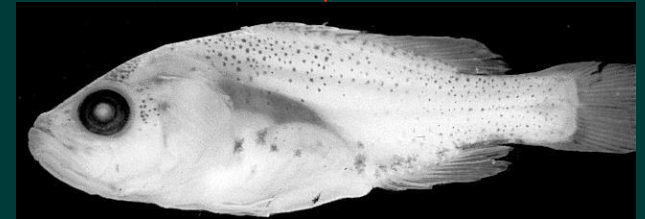


Gambusia

Spawning of fish in the Broken

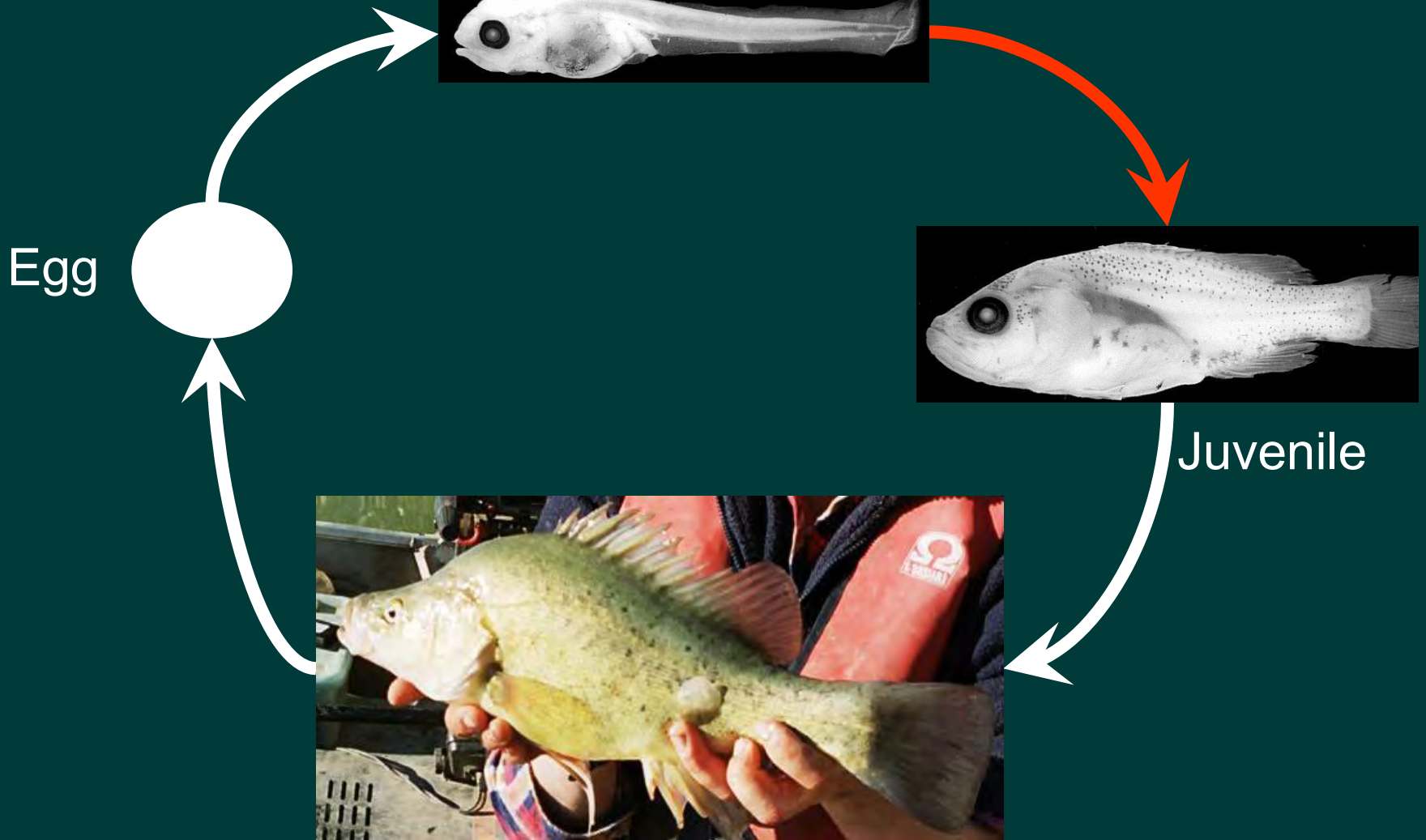
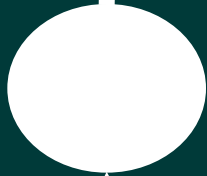
And after a while.....

Larva

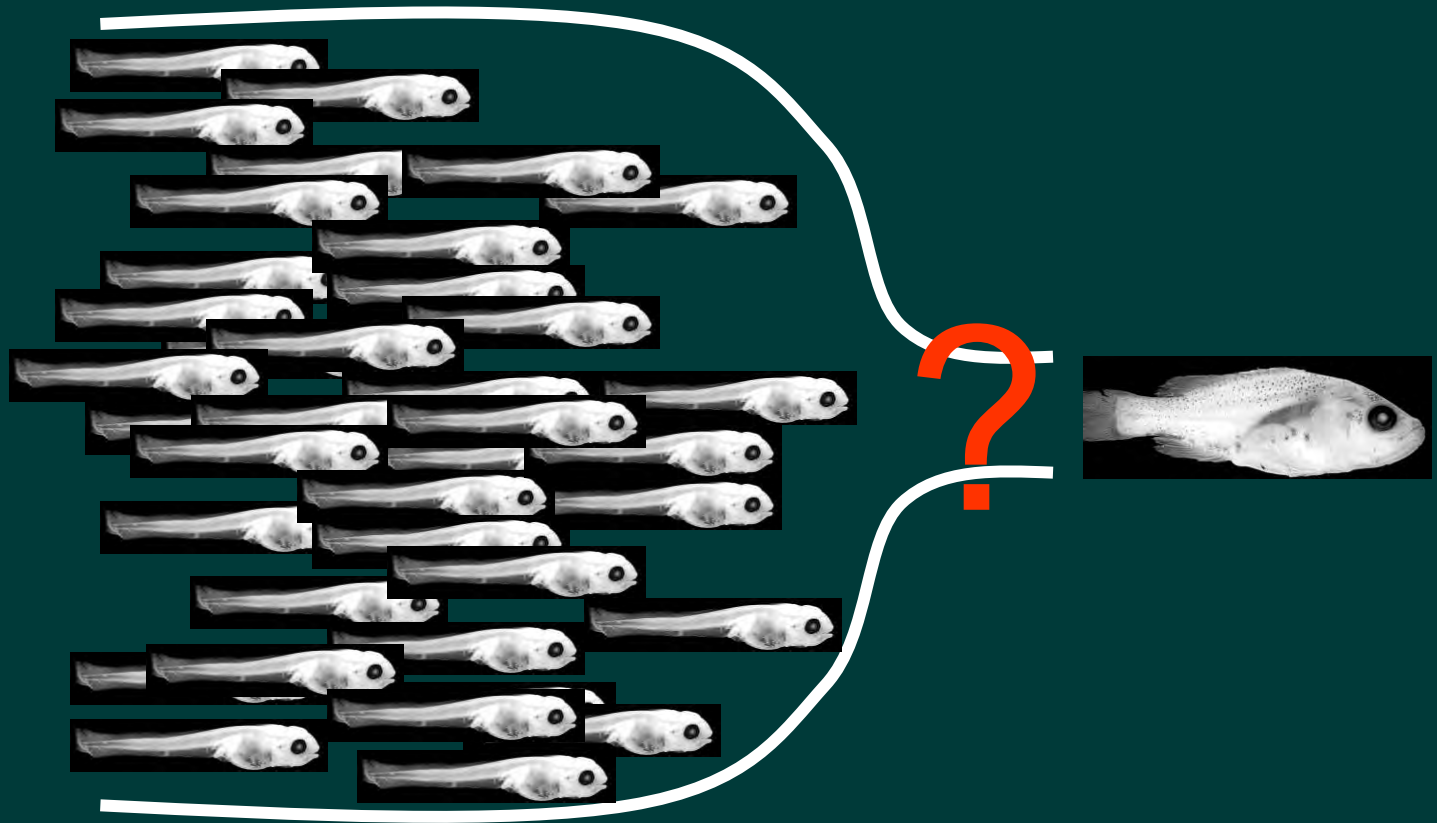


Juvenile

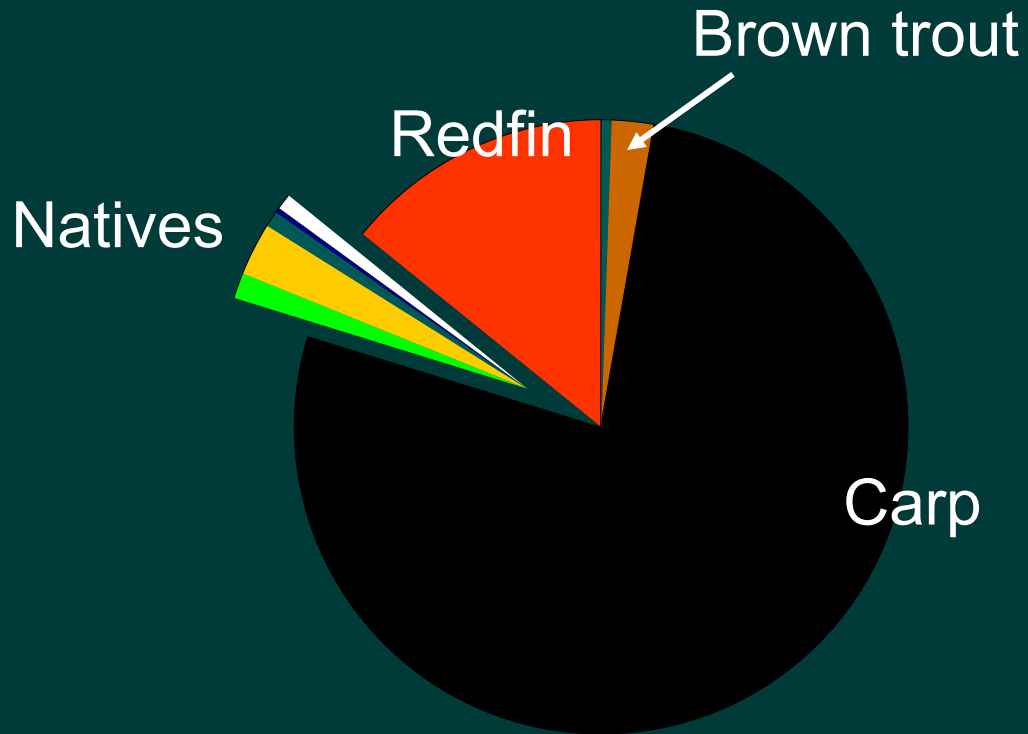
Egg



Larval survival...recruitment



Campaspe River fish fauna: 1995-2003

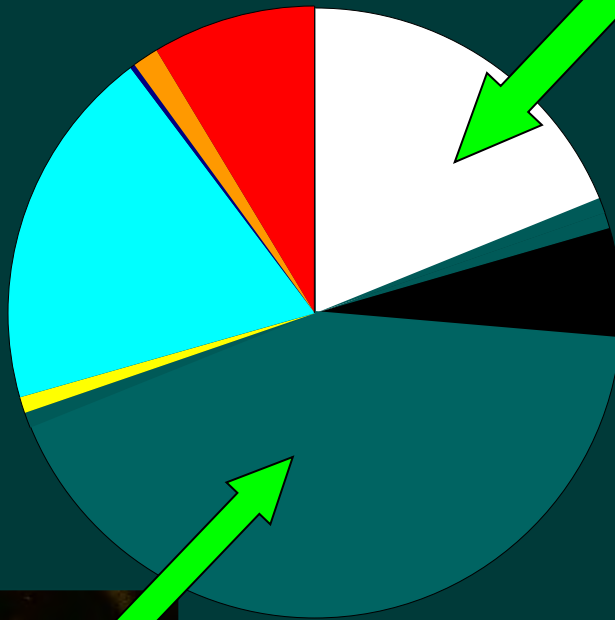


But it's not all bad news.....



Australian smelt

Number



Common carp

Gambusia

European perch

Golden perch

Brown trout



Flathead gudgeon

Life history strategies

Winemiller 1989

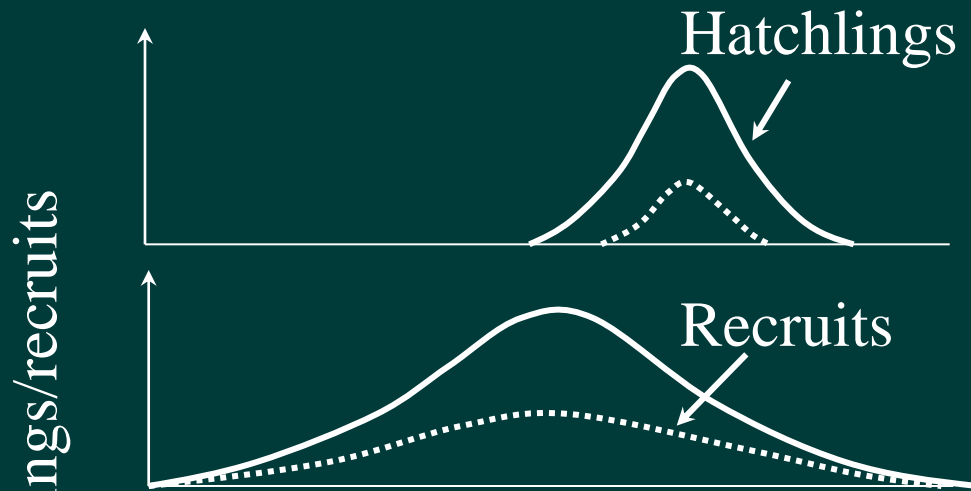
- Equilibrium
 - aseasonal reprod, med-long generation, large young, delayed maturity, protracted spawning
- Seasonal
 - annual reprod, long generation, large number of eggs, small investment per young
- Opportunistic
 - small species, protracted spawning, short generation, small investment per young

Humphries, King, Koehn 1999

- Strategy 1
 - Murray cod, river blackfish
- Strategy 2
 - Golden perch, silver perch, carp, redfin perch
- Strategy 3a
 - Australian smelt, flathead gudgeon
- Strategy 3b
 - crimson-spotted rainbowfish, mountain galaxias



Recruitment scenarios

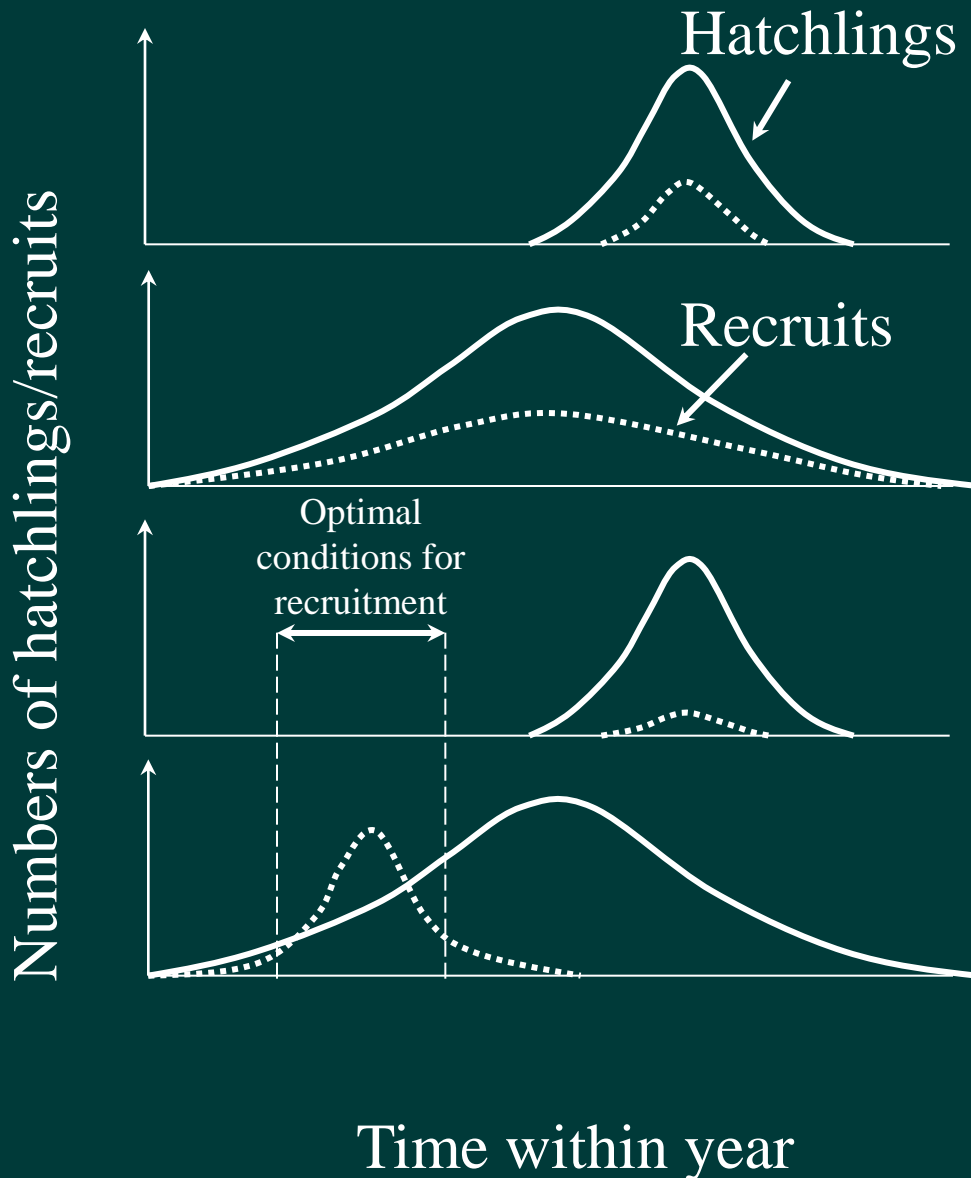


(A) Short spawners
with proportional
recruitment

(B) Protracted spawners
with proportional
recruitment

Time within year

Recruitment scenarios



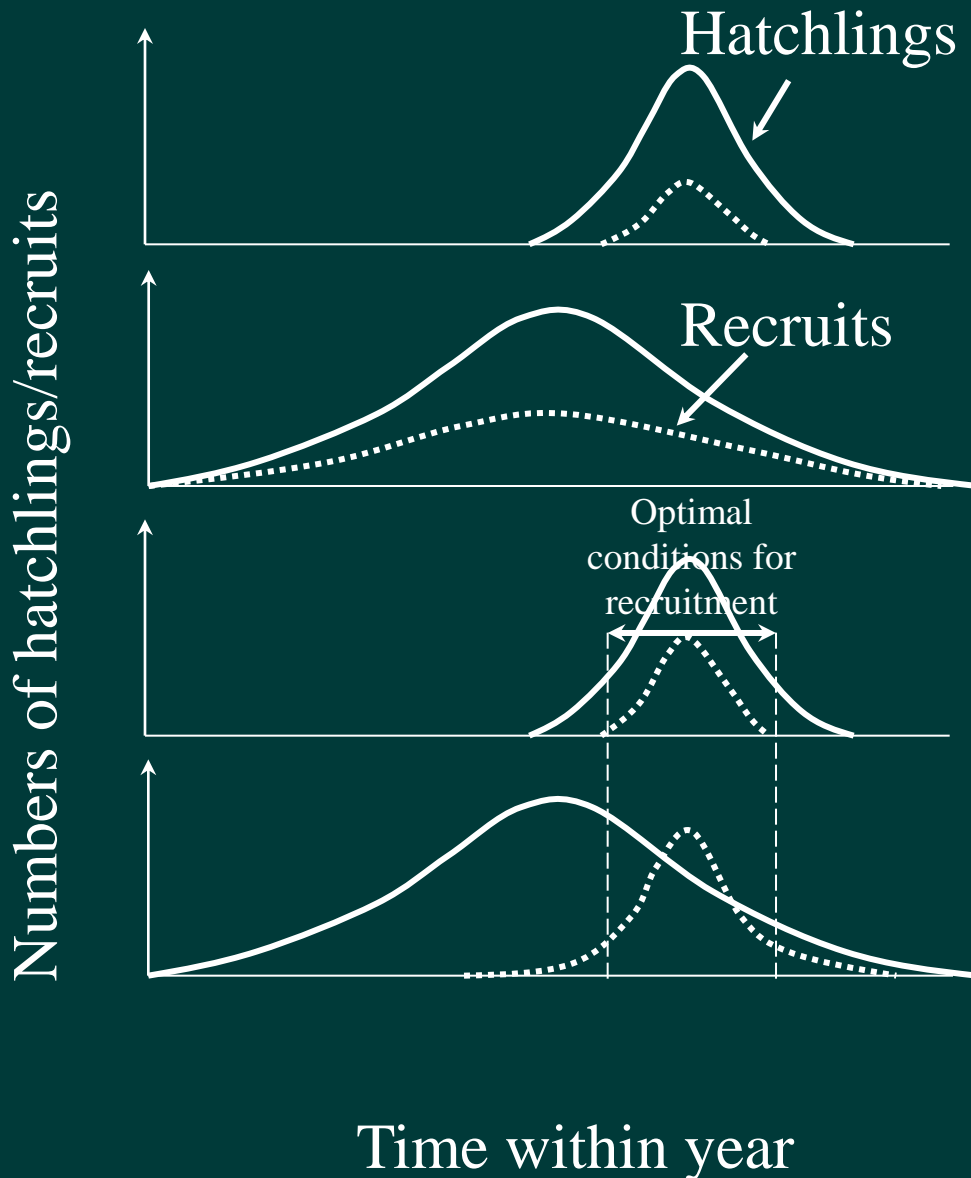
(A) Short spawners with proportional recruitment

(B) Protracted spawners with proportional recruitment

(C) Short spawners with poor recruitment

(D) Protracted spawners with differential recruitment

Recruitment scenarios



(A) Short spawners with proportional recruitment

(B) Protracted spawners with proportional recruitment

(C) Short spawners with good recruitment

(D) Protracted spawners with differential recruitment

'Window of opportunity' hypothesis

Fish that spawn over a **protracted** period, have a recruitment advantage over fish that spawn over a **brief** period. This is because the probability that a proportion of the larvae of '**protracted**' fish will encounter a period when conditions are favourable for recruitment is greater than for larvae of '**short**' fish

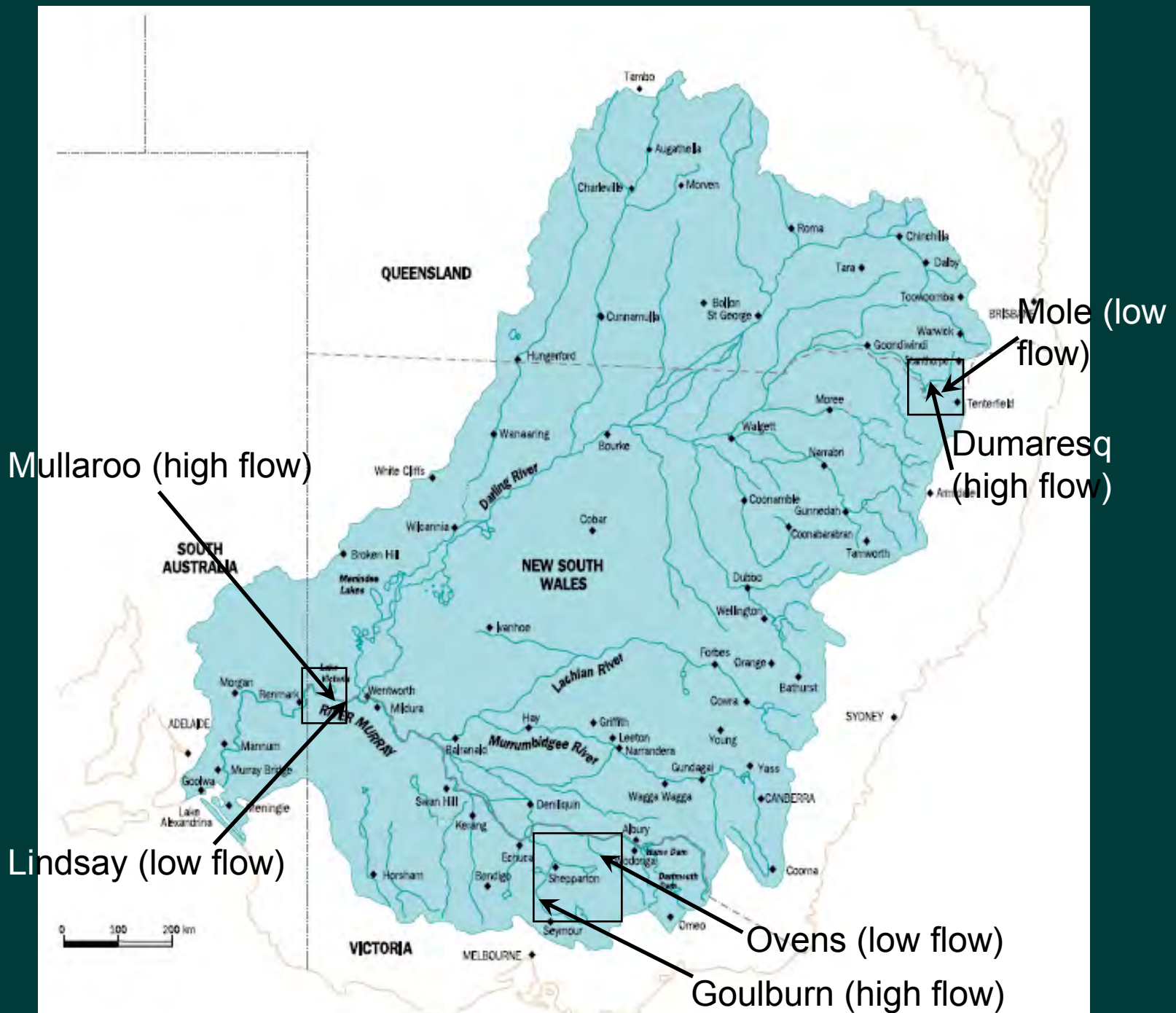
Aims

Investigate the veracity of the WOOH by:

- Determining whether recruitment is proportional or 'disproportionate' for protracted spawners
- Determining whether spawning and recruitment are synchronous between years
- Determining whether timing of peak recruitment is synchronous for protracted and short spawners
- Determining whether spawning and recruitment are synchronous between summer high-flow rivers and summer low-flow rivers

Study design

- Impact/reference
 - High flow over main spawning period
 - Low flow over main spawning period
- 3 regions in the MDB
 - Northern Basin rivers
 - Southern Basin rivers
 - Lower Basin rivers
- Sample larvae and juveniles monthly over two spawning seasons



Mullaroo (high flow)

Lindsay (low flow)

Mole (low flow)

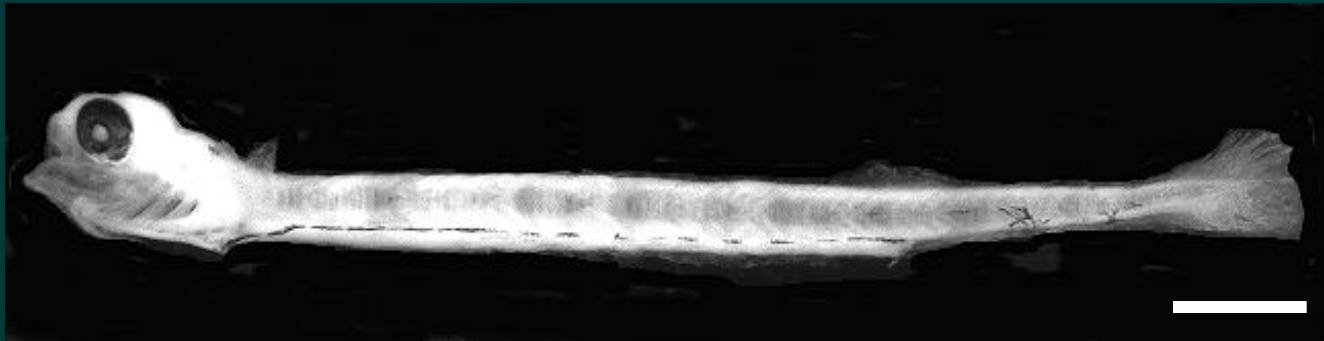
Dumaresq (high flow)

Ovens (low flow)

Goulburn (high flow)

Target species: Australian smelt

Hatchling (protolarva)

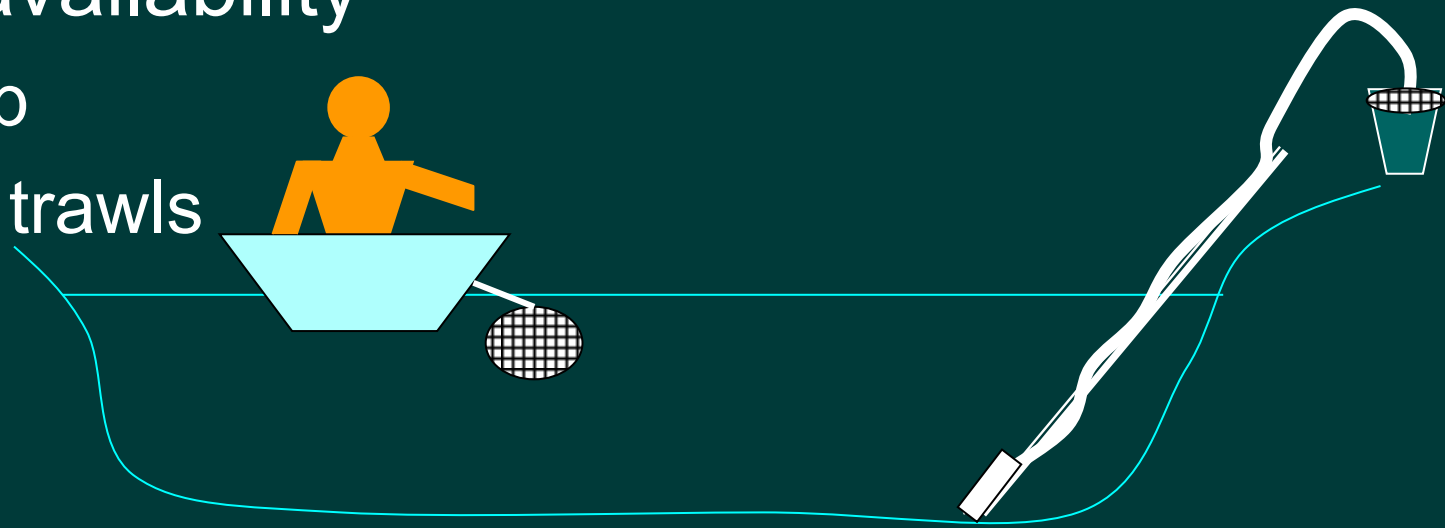


Adult

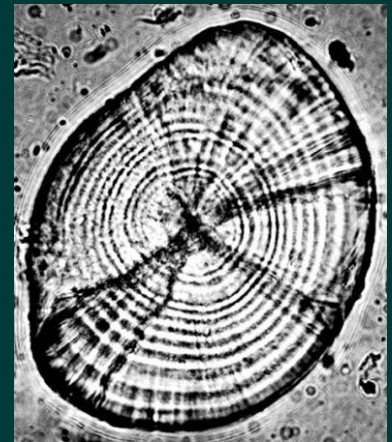
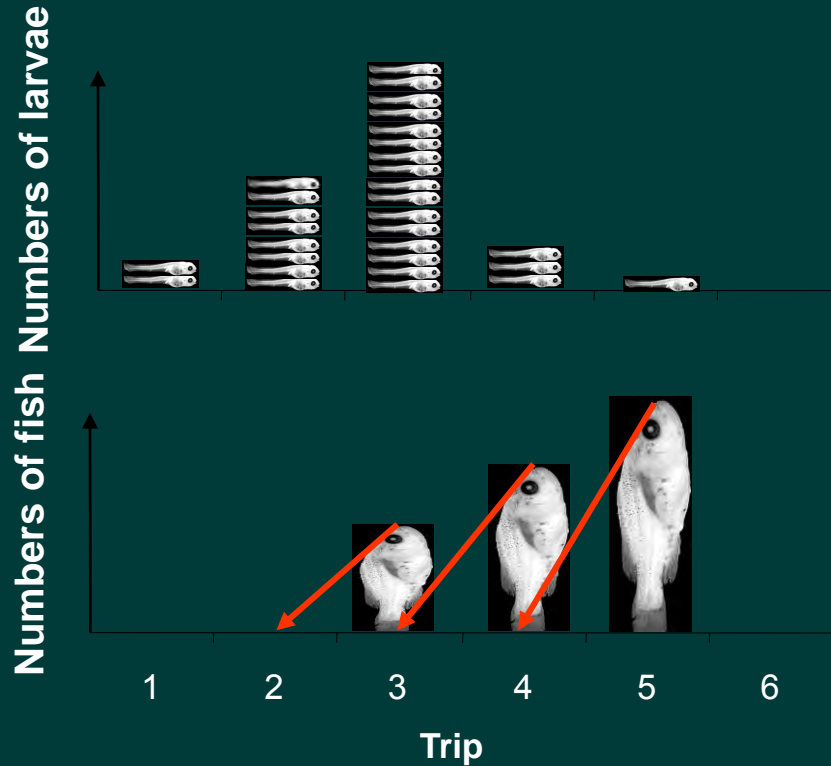


Methods

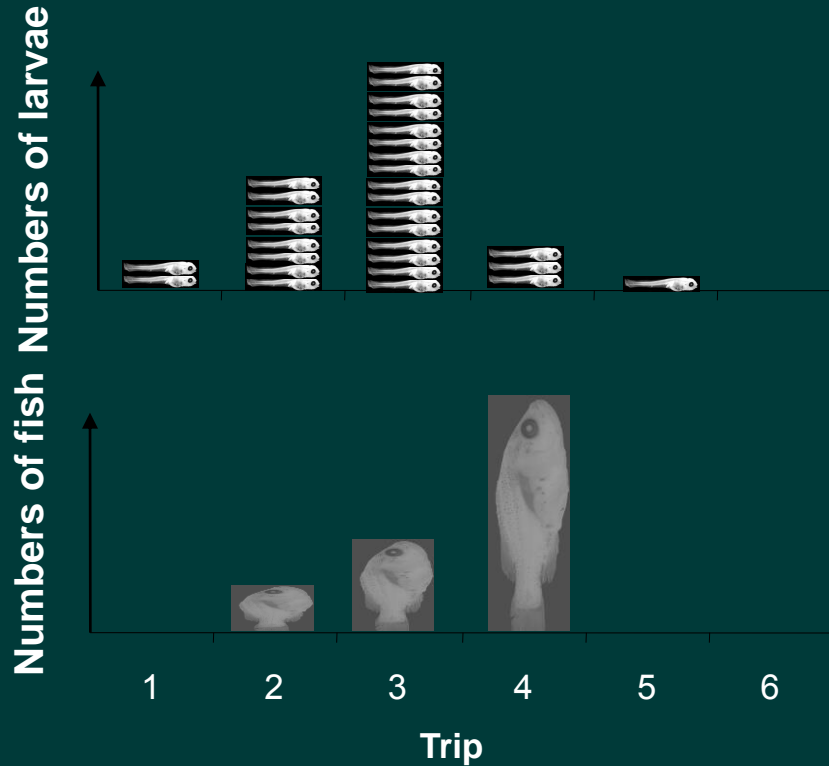
- Fish larvae and juveniles
 - Seines
 - Hand trawls
 - Boat trawls
 - Drift nets
- Food availability
 - Pump
 - Boat trawls
- Environmental vars
 - Temperature
 - Flow
 - Habitat



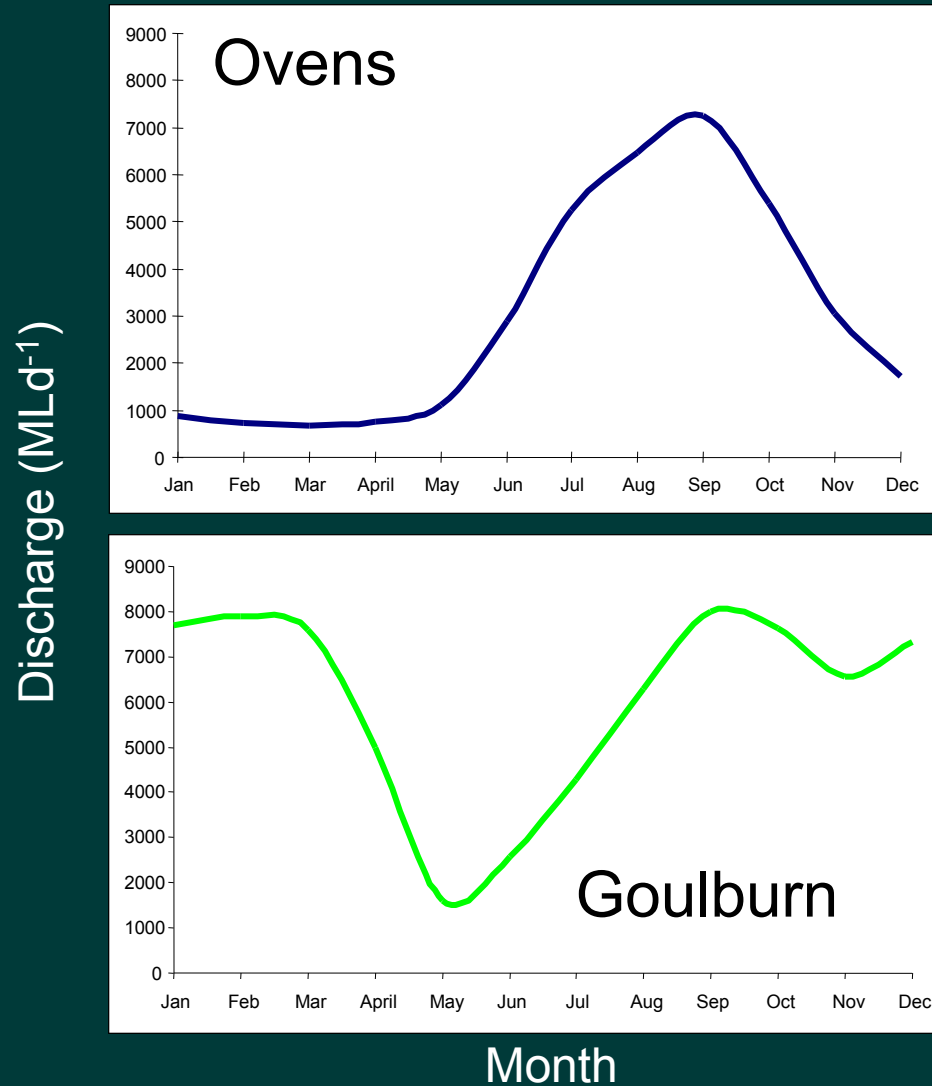
Study design: back-calculate to spawning time



Study design: compare larval and recruit abundance patterns



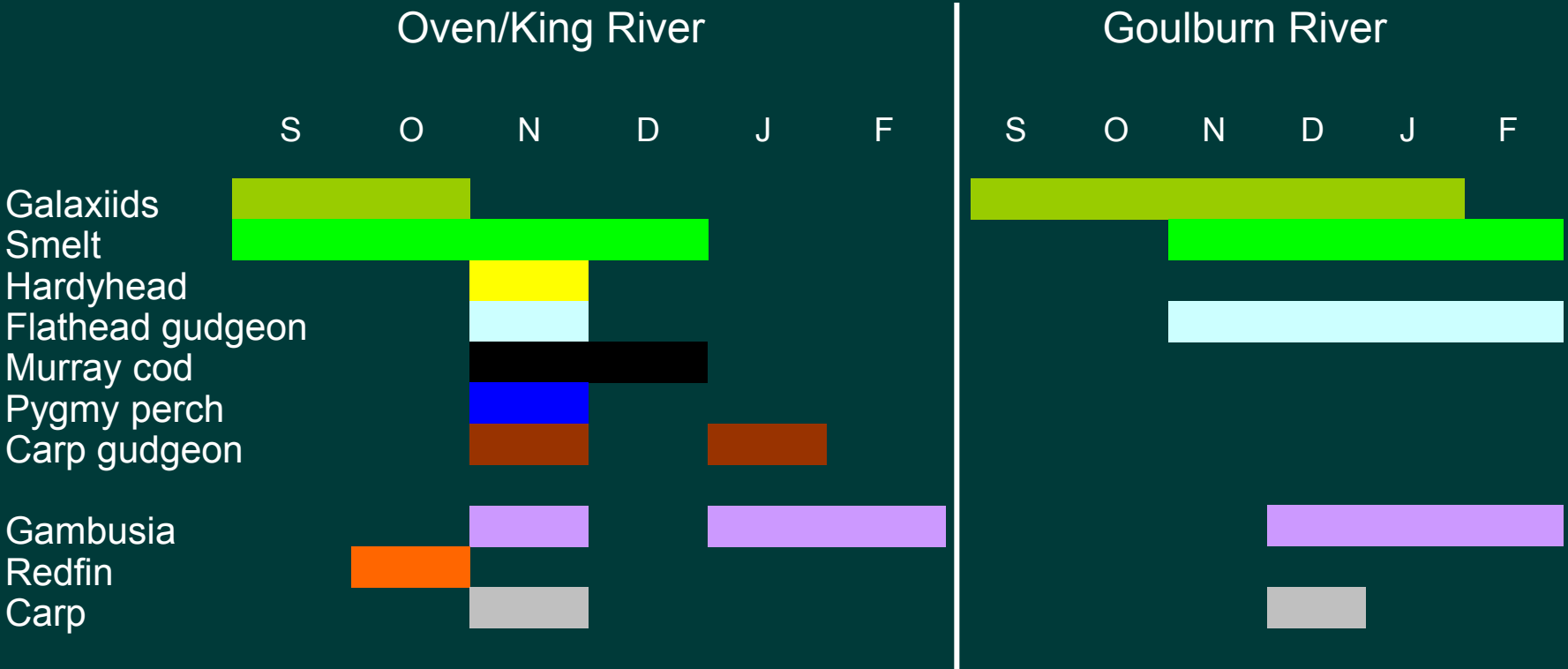
Hydrograph of Ovens and Goulburn Rivers: 1987-2005



Occurrence of larvae 2005/06

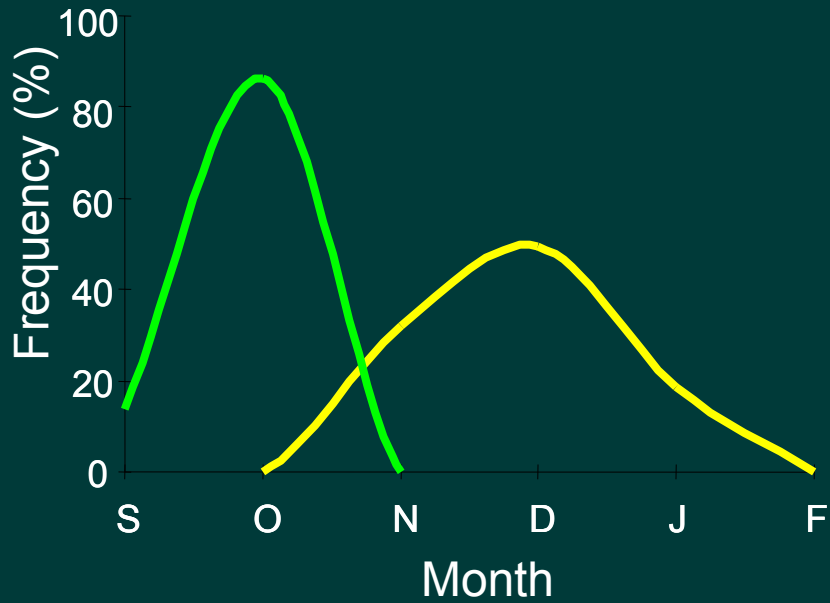
Species	Ovens	Goulburn
<i>Galaxias</i> spp.	✓	✓
Australian smelt	✓	✓
Flyspecked hardyhead	✓	
Murray cod	✓	
Southern pygmy perch	✓	
Flathead gudgeon	✓	✓
Carp gudgeon spp.	✓	
Brown trout		
Redfin	✓	
Carp	✓	✓
Gambos	✓	✓

Duration of larvae

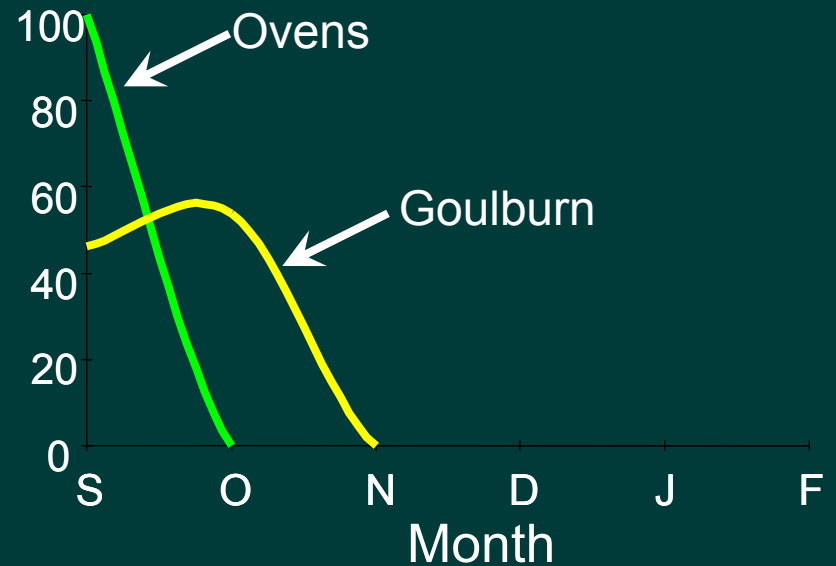


Temporal distribution of smelt and galaxiid hatchlings

Australian smelt



Galaxiids



In summary

- Knowledge of recruitment as a process poor
- Project aims to compare larval abundance with recruit abundance
- Investigate some mechanisms
- Basin-wide comparison
- Gain insight into timing of spawning, recruitment and influence of flow

A wide-angle photograph of a long, straight dirt road stretching across a vast, flat, arid landscape. The road is made of reddish-brown earth and has visible tire tracks. The surrounding terrain is dry and sparsely vegetated with small, scrubby bushes and a few scattered trees. The horizon is flat and extends to the edge of the frame. The sky is a pale, clear blue with a few wispy clouds near the horizon. The overall scene conveys a sense of isolation and the end of a journey.

The end