EWKR
Environmental Water Knowledge & Research

The Murray-Darling Basin
Environmental Water Knowledge
Research project

Foodweb Theme

EWKR Forum
21st March 2019

LA TROBE UNIVERSITY

CSIRO

Australian Government
Commonwealth Environmental Water Office

EWKR Food Webs Theme team:


Ashley MacQueen


Barbara Robson


Darren Ryder


Keller Kopf


Darren Baldwin


Nick Bond


Ben Gawne


Ivor Growns


Rebecca Lester


Rob Rolls


Paul McInerney


Kate Brandis


Ross Thompson


Galen Holt

Core question

WHAT ARE THE FOOD WEB PROCESSES WHICH SUPPORT FISH AND WATERBIRDS?

(1) the sources and production of organic matter

(2) transport and accessibility of energy throughout river and floodplain systems

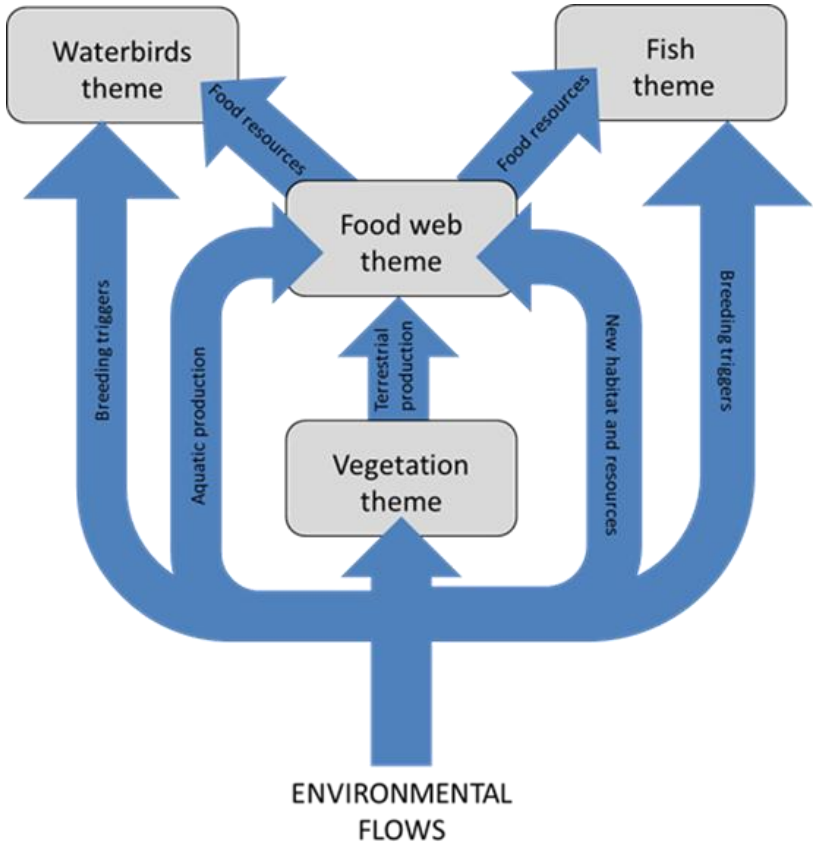
(3) nutritional value of energy resources for consumers

(4) the transfer of energy through food chains to higher consumers

What do we mean by food webs??

FOOD WEBS REPRESENT THE FLOW OF ENERGY BETWEEN COMPARTMENTS IN A NATURAL ECOSYSTEM AND ARE USEFUL FOR:

(1) Conceptualising the relationships between ecological groups of interest



What do we mean by food webs??

FOOD WEBS REPRESENT THE FLOW OF ENERGY BETWEEN COMPARTMENTS IN A NATURAL ECOSYSTEM AND ARE USEFUL FOR:

(1) Conceptualising the relationships between ecological groups of interest

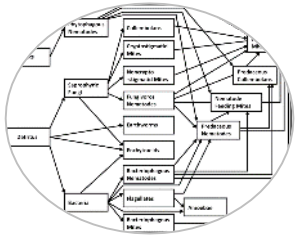
(2) Representing patterns of energy flow through systems

- Does not mean describing every trophic link between every species
- Does not mean that other (non-feeding) interactions aren't important

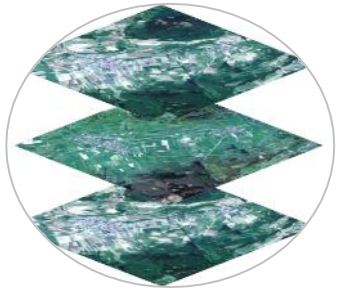
In this project a food web is a map of energy flows used to understand the role of resources in determining the relationship between environmental flows and groups of interest, particularly fish and waterbirds.

Review and Concepualisation

Foodweb Description



Integration



Application

Review and Concepualisation

Foodweb Description

Integration

Application

Conceptualisation phase – peer reviewed articles

Development of 3 manuscripts:

1. A detailed literature review of the existing knowledge on large river food webs

2. Approaches to modelling

3. Potential interactions between environmental flows and energy flows

Water Research 124 (2017) 108–128

Contents lists available at ScienceDirect

Water Research

journal homepage: www.elsevier.com/locate/watres

Review

Modelling food-web mediated effects of hydrological variability and environmental flows

Barbara J. Robson [a, *, 1], Rebecca E. Lester [b, **, 1], Darren S. Baldwin [a, c, d], Nicholas R. Bond [c], Romain Drouart [a, e], Robert J. Rolls [f], Darren S. Ryder [g], Ross M. Thompson [f]

[a] CSIRO Land and Water, GPO Box 1700, Canberra, ACT, 2601, Australia
[b] Centre for Regional and Rural Futures, Deakin University, Locked Bag 20000, Geelong, Vic, 3220, Australia
[c] The Murray-Darling Freshwater Research Centre, La Trobe University, PO Box 821, Wodonga, Vic, 3689, Australia
[d] Charles Sturt University, Thurgoona, NSW, 2640, Australia
[e] Ecole des Mines d'Alès, 6 Avenue de Clavières, 30319, Alès Cedex, France
[f] Institute for Applied Ecology, University of Canberra, Canberra, ACT, 2601, Australia
[g] School of Environmental and Rural Science, University of New England, Armidale, NSW, 2351, Australia

Journal of Environmental Management 203 (2017) 136–150

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Review

A framework for evaluating food-web responses to hydrological manipulations in riverine systems

Robert J. Rolls [a, *], Darren S. Baldwin [b, c, 1], Nick R. Bond [b], Rebecca E. Lester [d], Barbara J. Robson [c], Daren S. Ryder [e], Ross M. Thompson [a], Garth A. Watson [b, c]

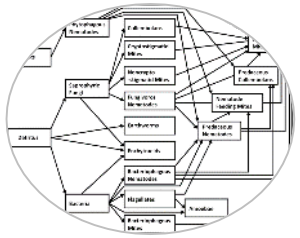
[a] Institute for Applied Ecology, University of Canberra, Canberra, ACT 2601, Australia
[b] The Murray–Darling Freshwater Research Centre, La Trobe University, PO Box 821, Wodonga, VIC 3689, Australia
[c] CSIRO Land and Water, GPO Box 1700, Canberra, ACT 2601, Australia
[d] School of Life and Environmental Sciences, Centre for Integrative Ecology, PO Box 423, Warrnambool, VIC 3280, Australia
[e] School of Environmental and Rural Science, University of New England, Armidale, NSW 2351, Australia

Review and Concepualisation

Foodweb Description

Integration

Application



Review and Concepualisation

Foodweb Description

Integration

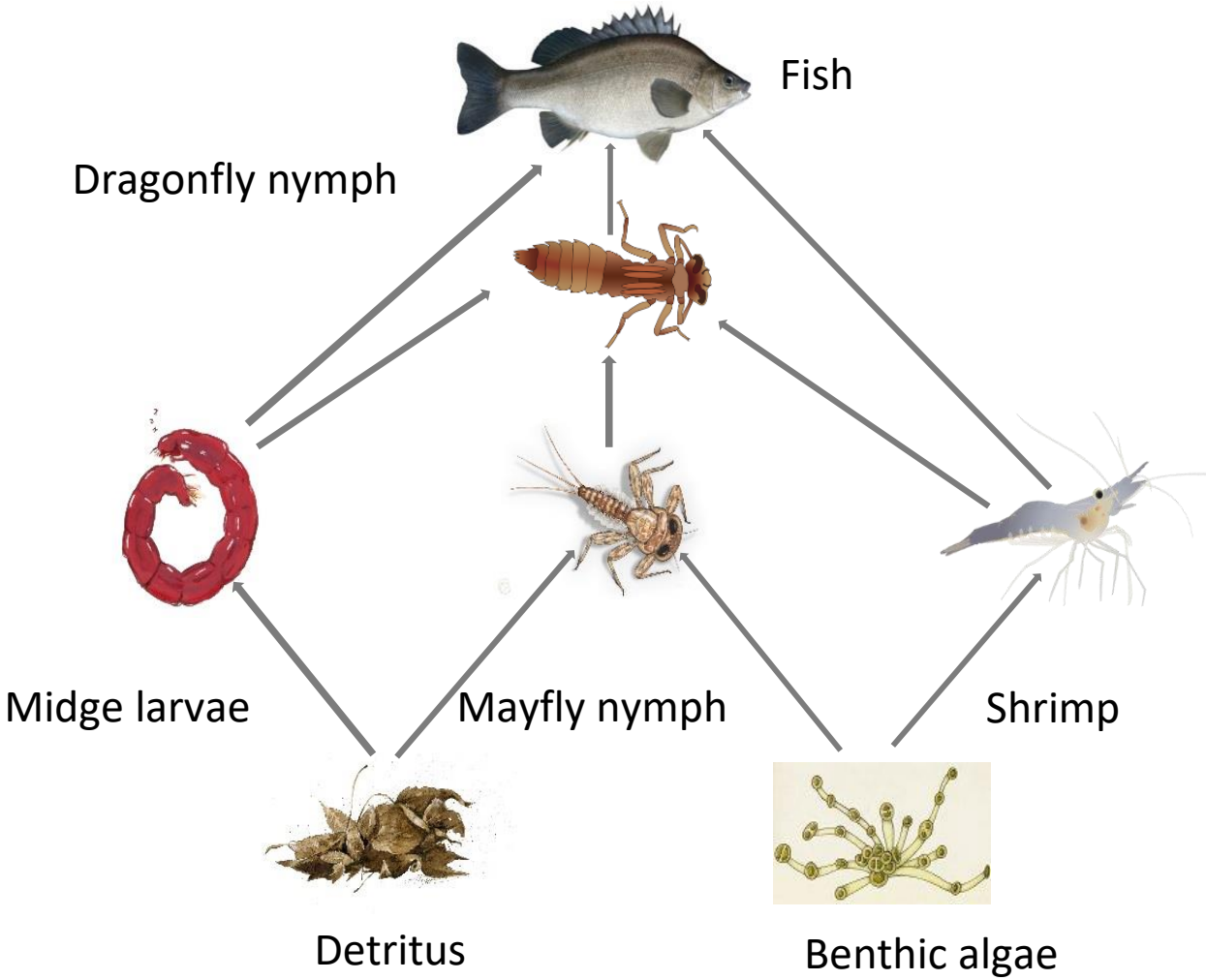
Application

River scale field study

1. What basal resources support fish recruitment and flow of energy between floodplains and rivers?

- δ^{15}N and δ^{13}C to determine origin of food resources

- Fatty acid profiles to determine food quality and energy pathways



River scale field study

- Most animals cannot synthesize ω-3 and ω- 6 PUFAs

- Obtain these molecules from their diet

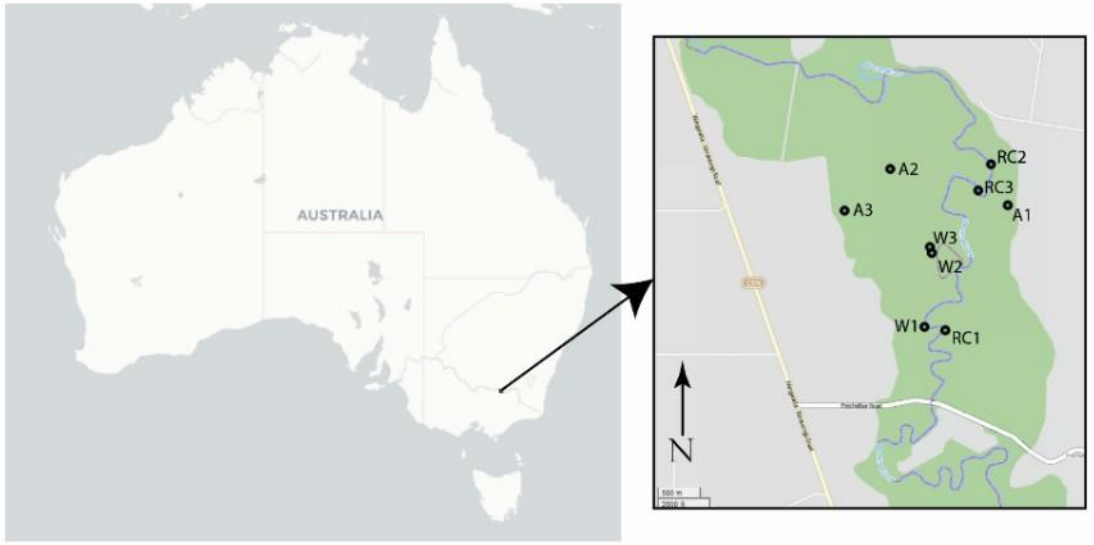
- Some PUFAs are considered to be essential Fatty acids (EFAs), and are primarily synthesised by algae

- Biochemically important, but scarce in nature

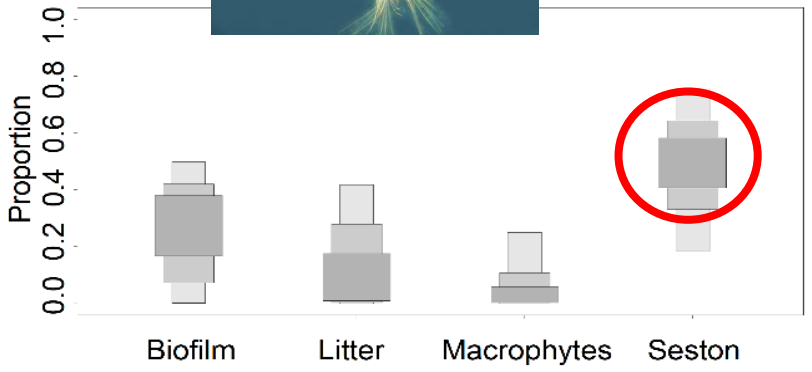
- Energy dense and critical for cell membranes, neural signaling, hormonal regulation

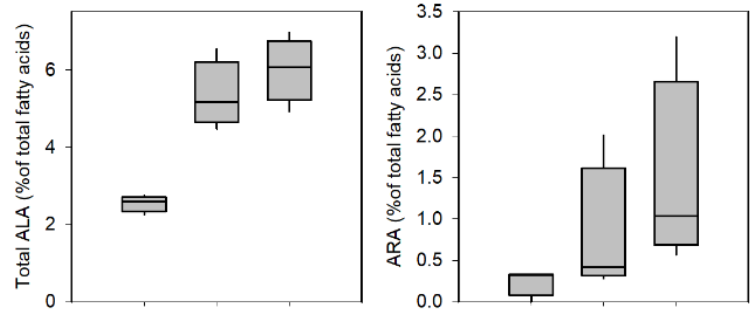
River scale field study

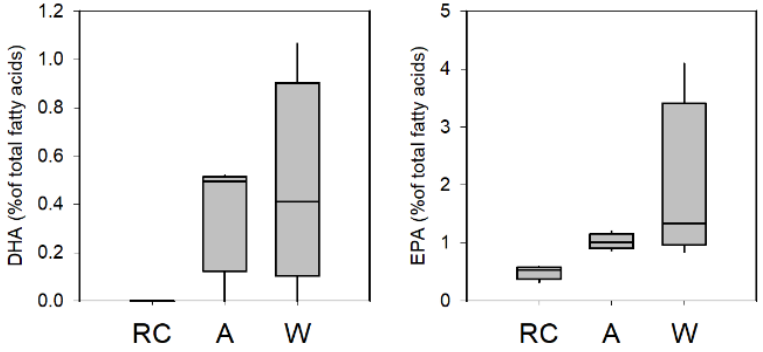
- Ovens River; unregulated
- Flooding usually occurs at least annually in spring
- Selected due to it's 'reference' system qualities

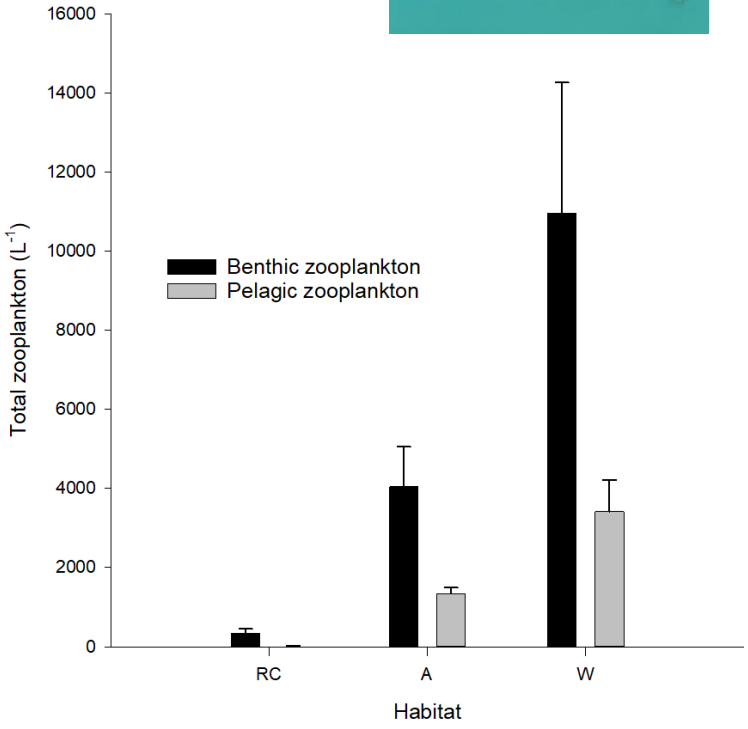


River scale field study









Review and Concepualisation

Foodweb Description

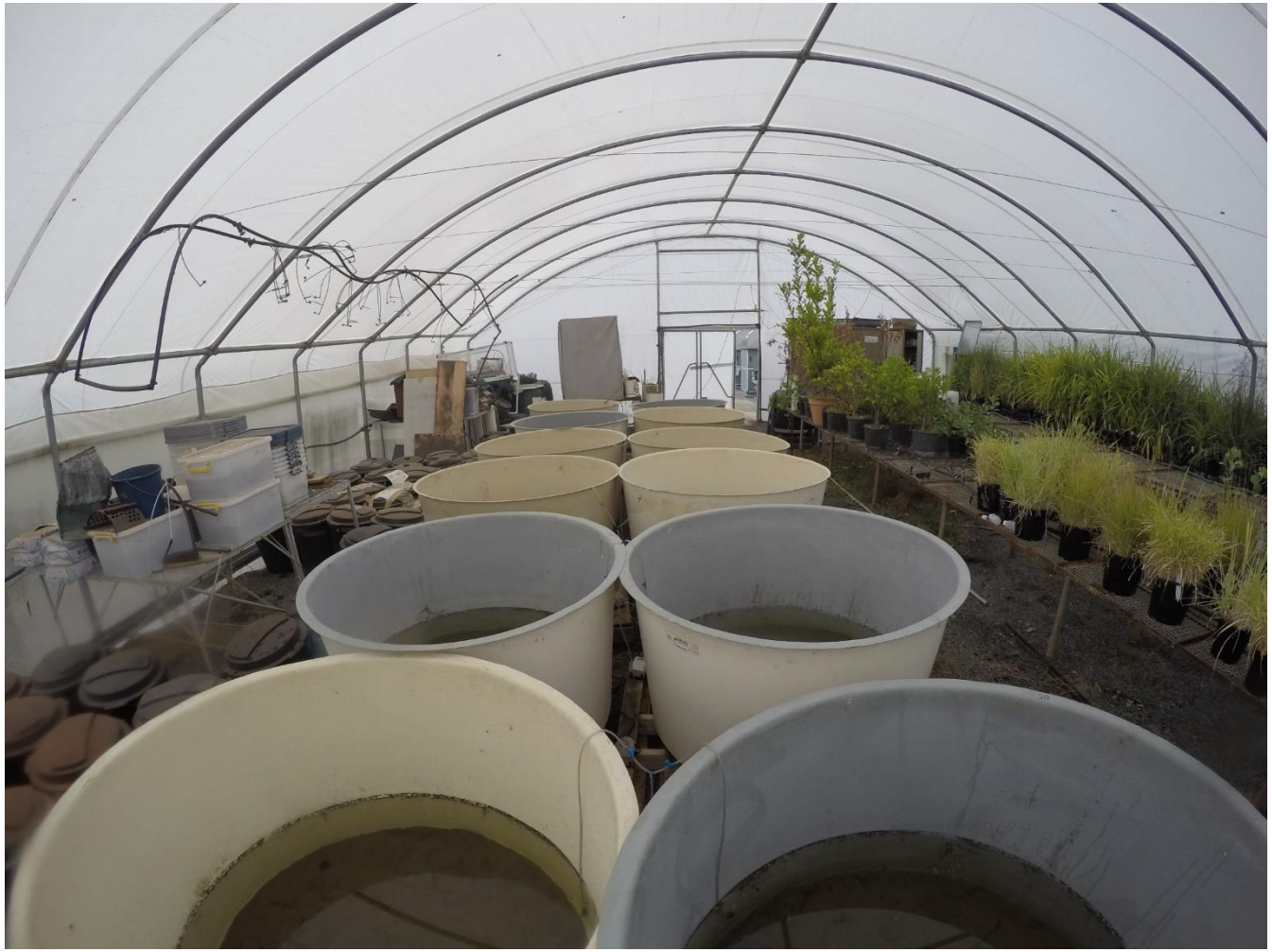
Integration

Application

Mesocosm experiments

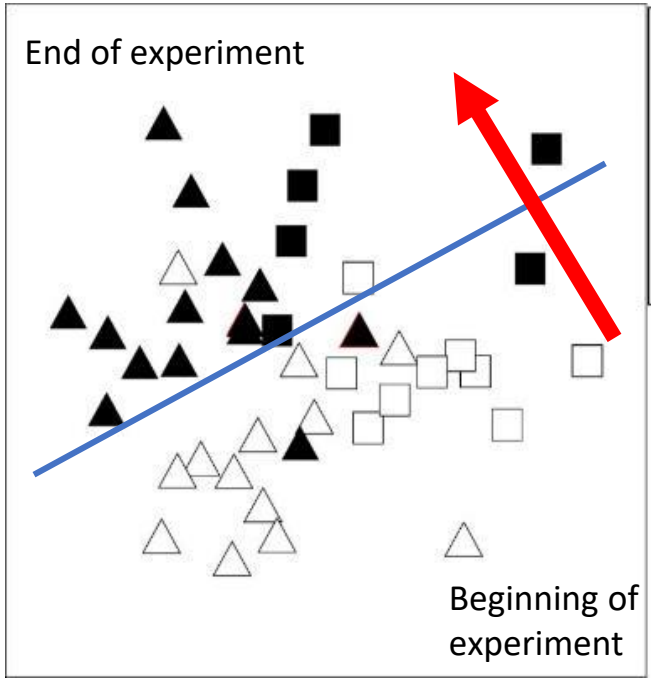
1. What foodwebs support the growth of fish larvae?

2. How is their survival and growth affected by food source availability?



Mesocosm experiments

Fatty Acid profiles



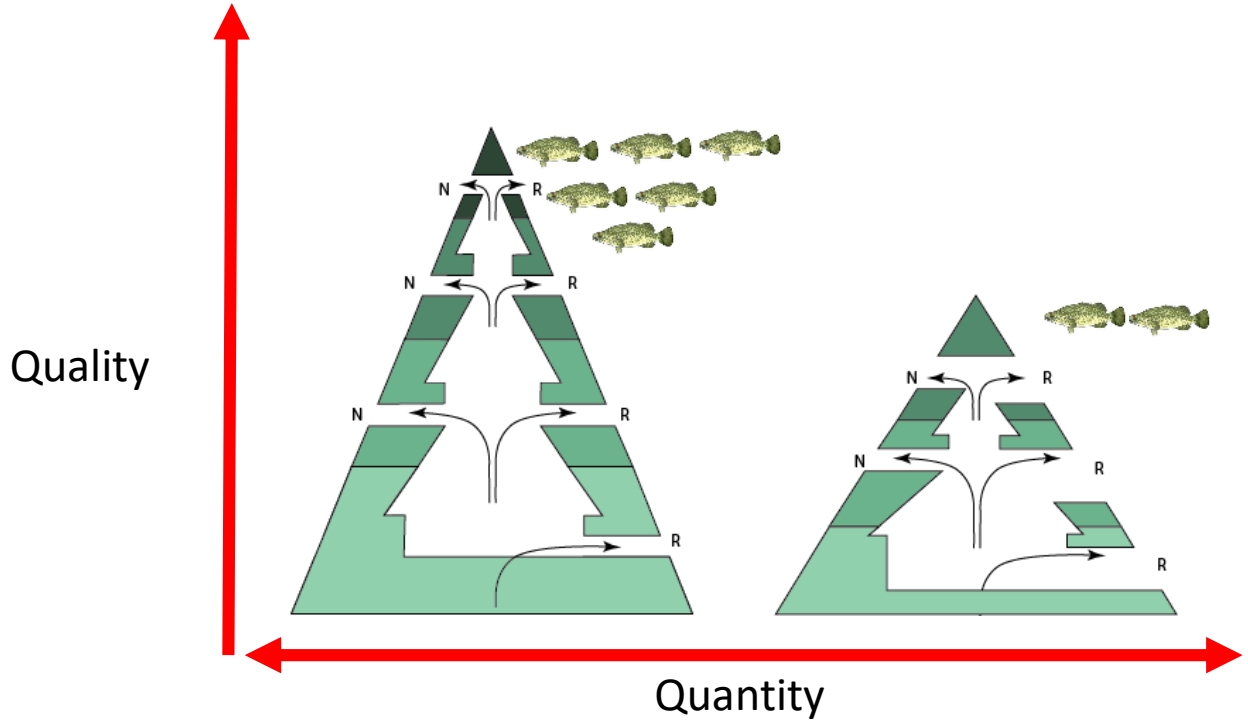
Invertebrates

- **Green Algae are a key resource**
- Largest fish and greatest survival in Algae and Biofilm treatment
- Essential Fatty Acids from green algae traced through foodwebs from invertebrates to fish
- DOC treatment had lowest invertebrate density, richness and lowest fish growth and survival

Mesocosm experiments

Quality and quantity

- Taller the triangle more biomass
- Wider the base the more basal resources
- The gaps are loss through respiration (R) and excretion (N)
- Darker the green higher the trophic level



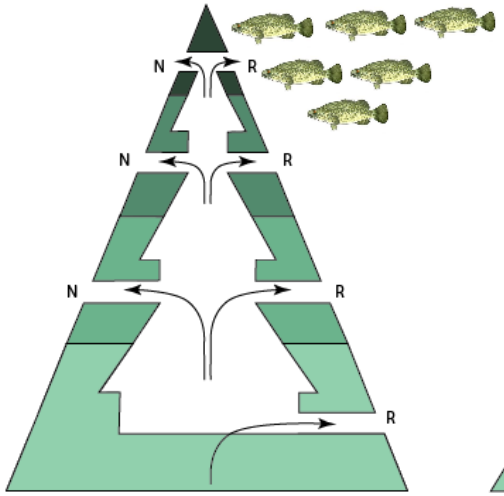
Mesocosm experiments

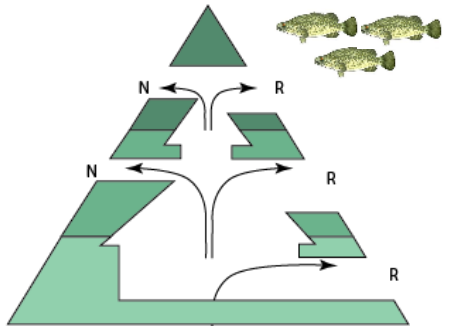
Old Dromana

Increased carrying capacity

- Algae>dissolved and particulate carbon> cyanobacteria

- High quality food
- Essential Fatty Acids for growth
- Trophic efficiency





Reduced carrying capacity

- Dissolved and particulate carbon>cyanobacteria> Algae

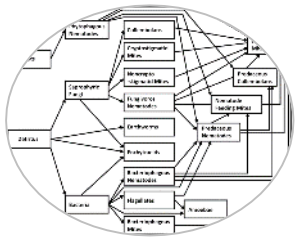
- Low quality food
- No essential Fatty Acids for growth
- Trophic ***in***efficiency

Review and Concepualisation

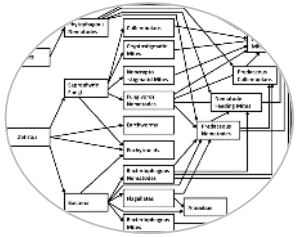
Foodweb Description

Integration

Application



Modelling pathways and components



Flow characteristics
Volume

Shape

Timing

Site-specific
Hydrology

Infrastructure

Topography

Producers
Producer groups

Production (gC) per area per time

Diet markers
Fatty acids

Stable isotopes

Flow Event

Inundation

Outputs
Depth

Area

Duration

Primary Production

Outputs
Grams C per producer group

Diet estimation

Food web

Outputs
Fish production

Products

Comparison of watering scenarios

Identification of uncertainty and needed data

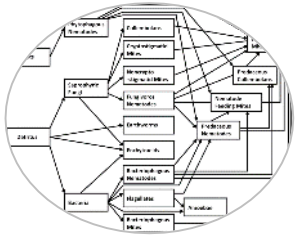
Inputs

Models

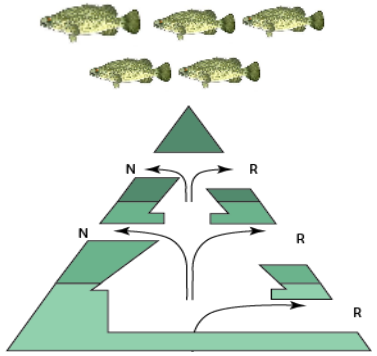
Passed Outputs

Product

Inundation scenarios



Fish biomass



Food quality
Intermediate groups

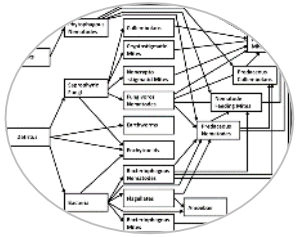
Biofilm

Detritus

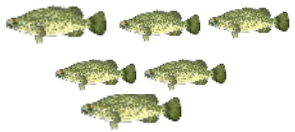
Macrophytes

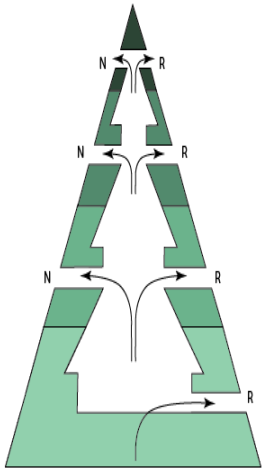
Seston
(Green Algae)

Inundation scenarios



Fish biomass





Food quality
Intermediate groups

Biofilm

Detritus

Macrophytes

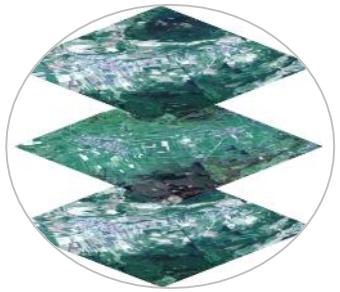
Seston
(Green Algae)

Review and Concepualisation

Foodweb Description

Integration

Application



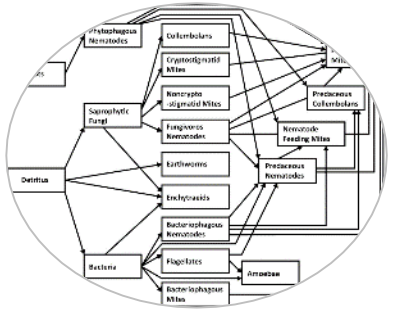
Integration

Field studies have identified the key resources and trophic links within river channels and anabranches

Field studies have identified some key resources for waterbird chicks by species

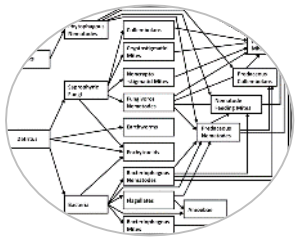
Experimental work has identified which basal resources are of the highest quality in supporting fish growth

An energetics-based model has been developed to characterise key links between basal productivity and higher consumers

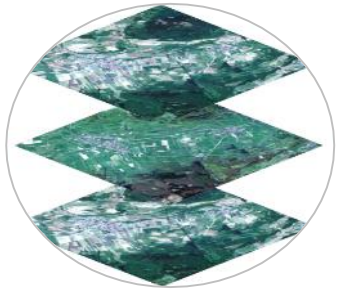


Review and Concepualisation

Foodweb Description



Integration

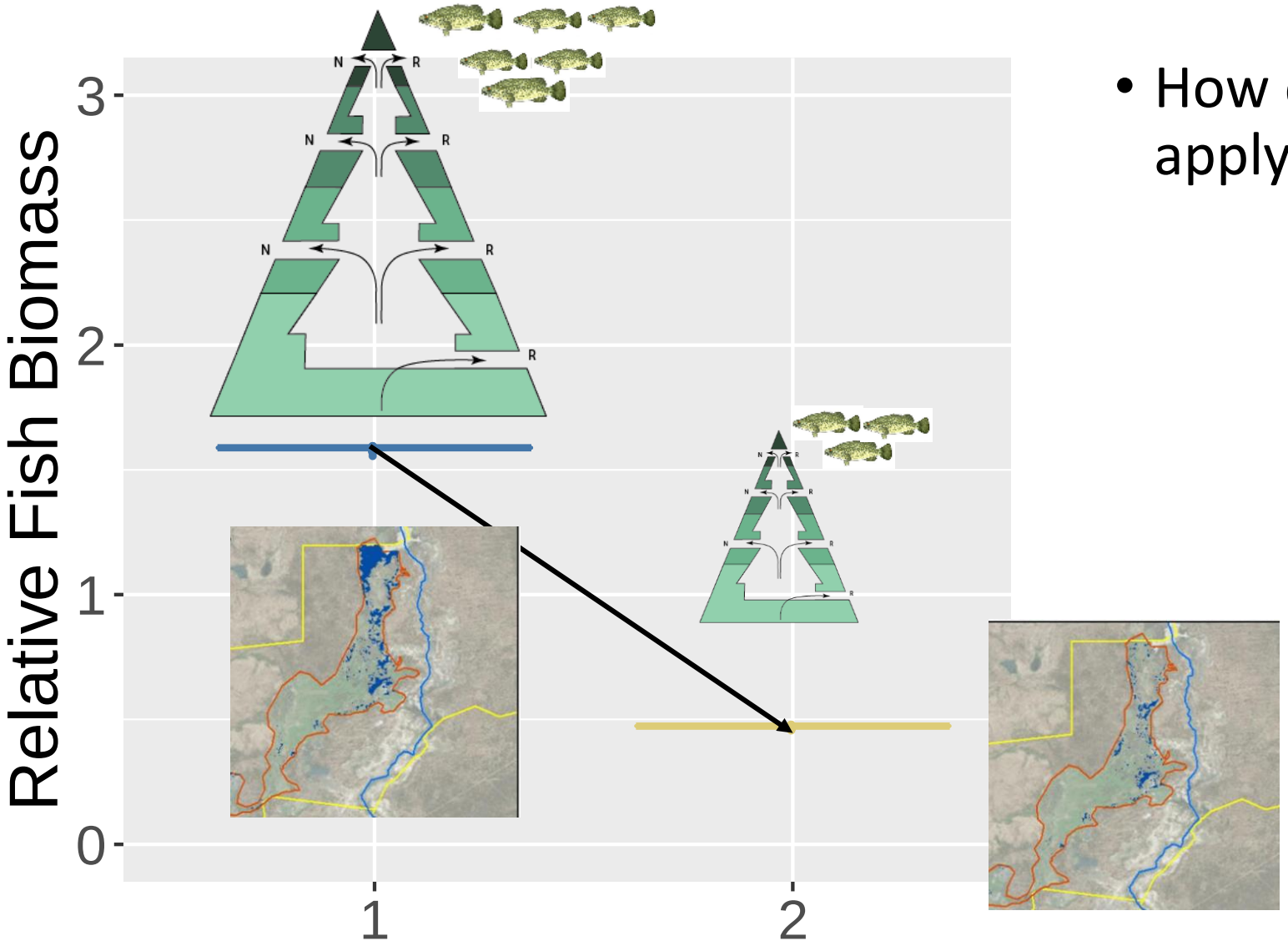


Application

Management Recommendations

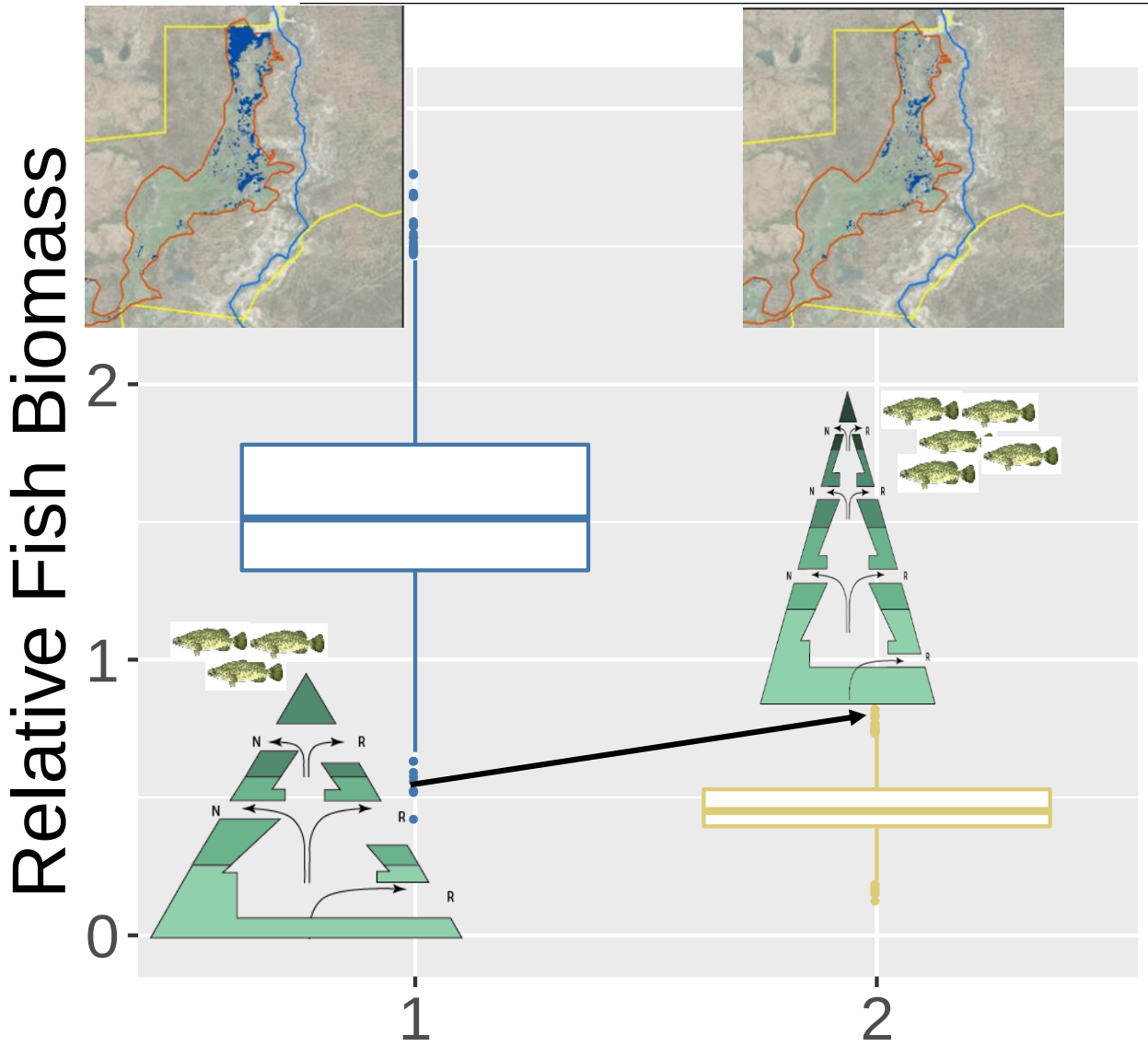
- Environmental water can be used to enhance productivity and potentially consumer responses:
    - Managing for high quality resources spatially and temporally

If watering changes quantity of basal resources….



- How could water managers apply this?

If watering changes quality of basal resources….



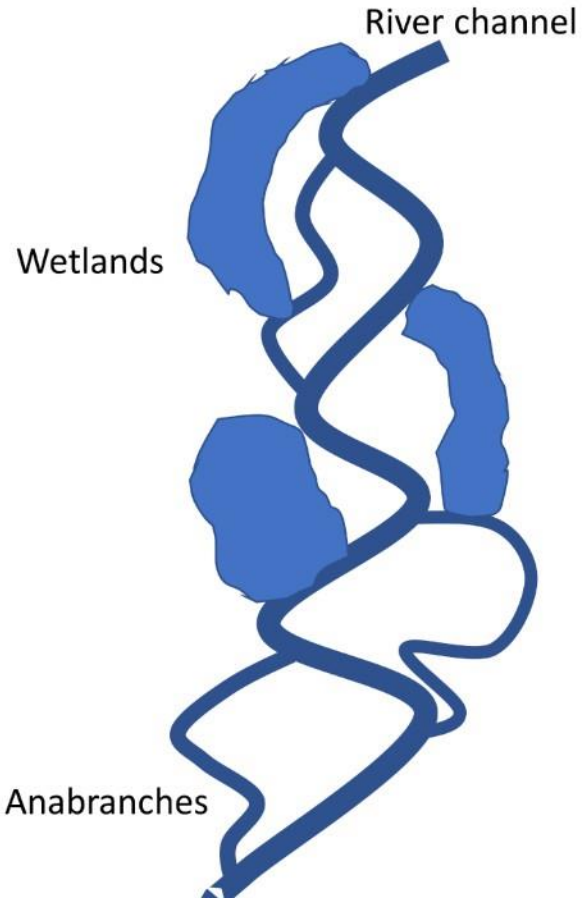
- How could water managers apply this?

Management Recommendations

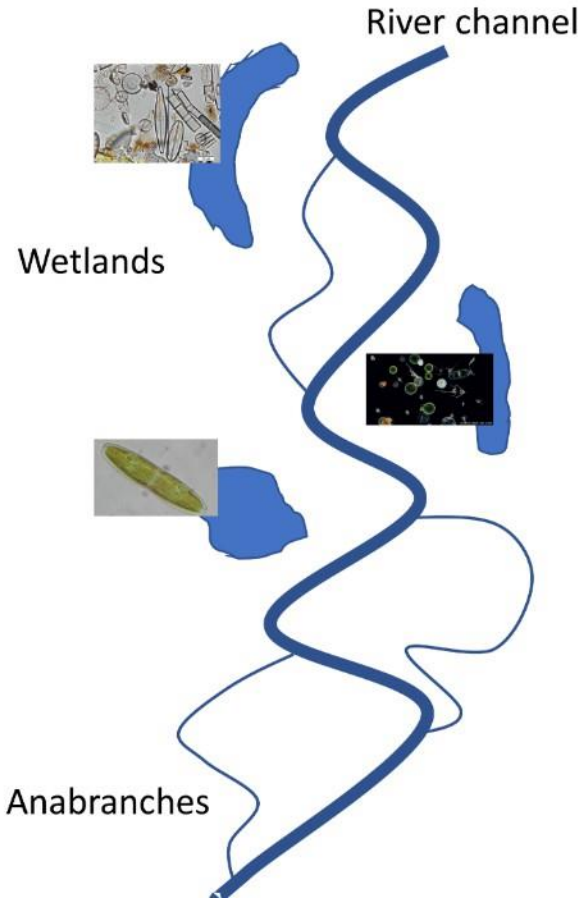
- Environmental water can be used to enhance productivity and potentially consumer responses:
    - Targeting flows to supporting particular basal resources

Foodwebs and water management

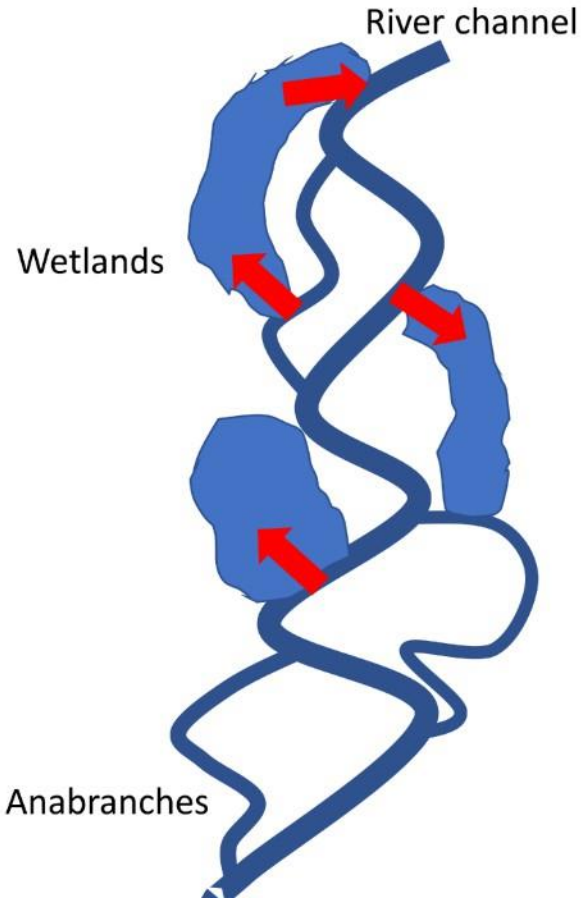
1. Initial flood pulse and floodplain connectivity



2. Disconnection



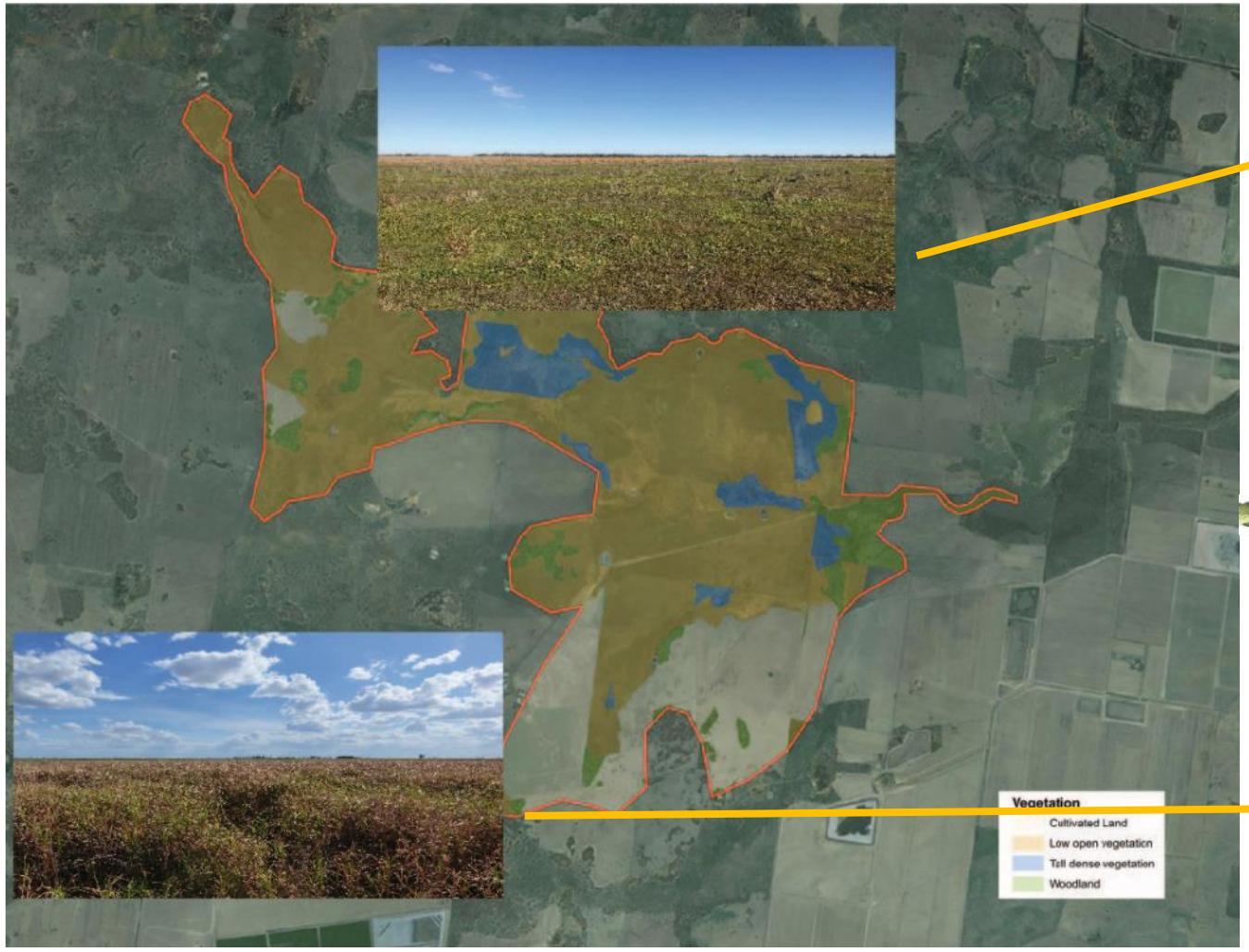
3. Reconnection

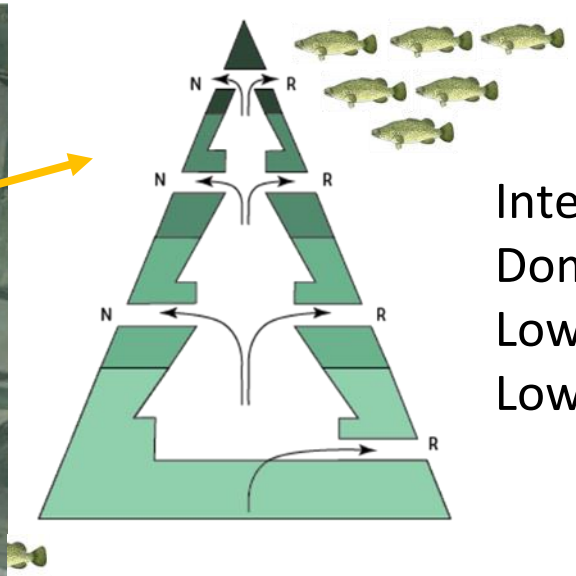


Reconnection important to:

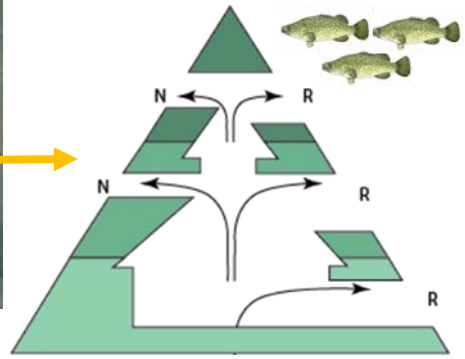
1. mobilise high quality food resources to the main channel
2. afford riverine consumers the opportunity to access high quality resources by moving onto the floodplain

Foodwebs and water management





Intermittently inundated
Dominated by Water Couch
Low shade = high green algae
Low organic matter = Low DOC



Semi-permanent
Dominated by tall reeds
High shade = low green algae
High organic matter = High DOC

Integrated e-water management

Journal of Environmental Management 203 (2017) 136–150

Contents lists available at ScienceDirect

Journal of Environmental Management

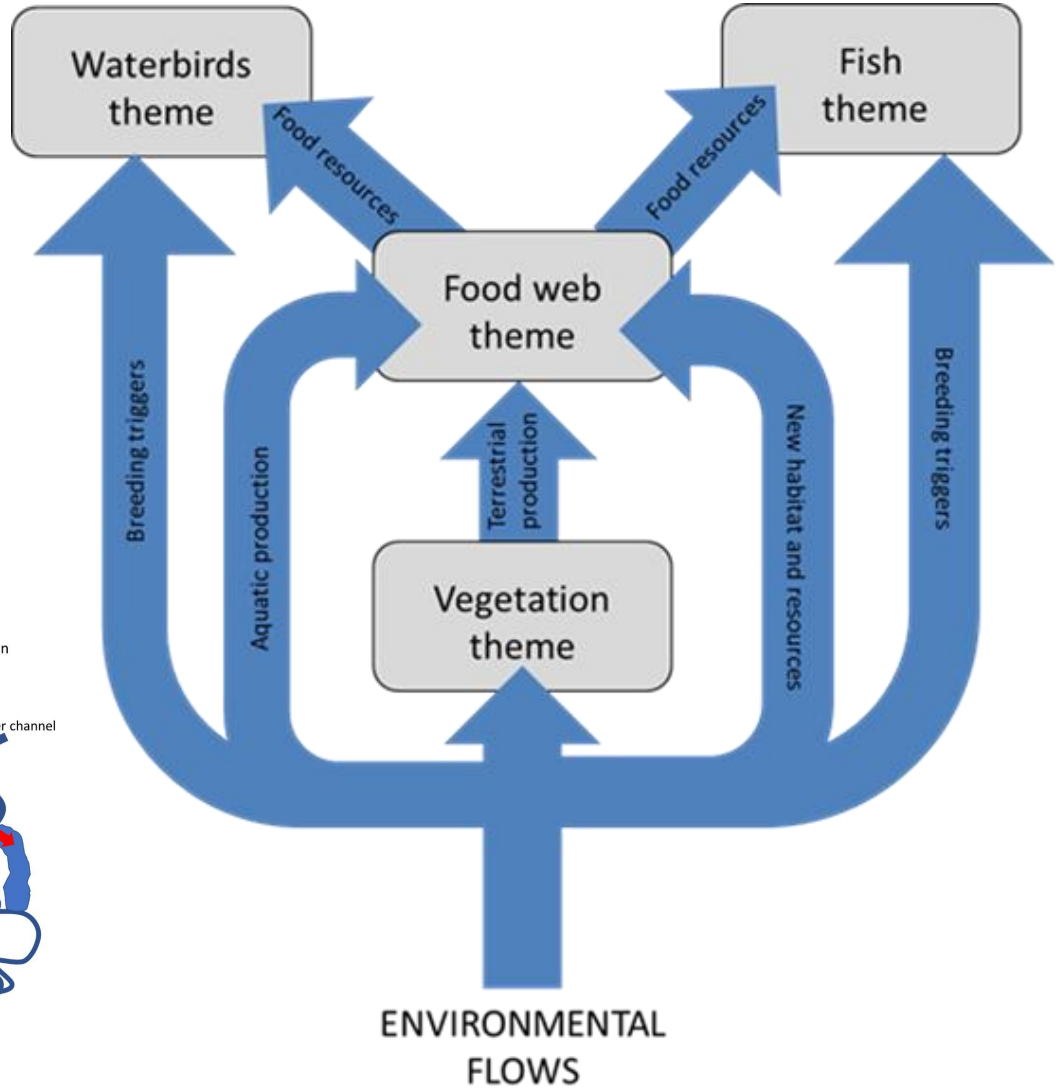
journal homepage: www.elsevier.com/locate/jenvman

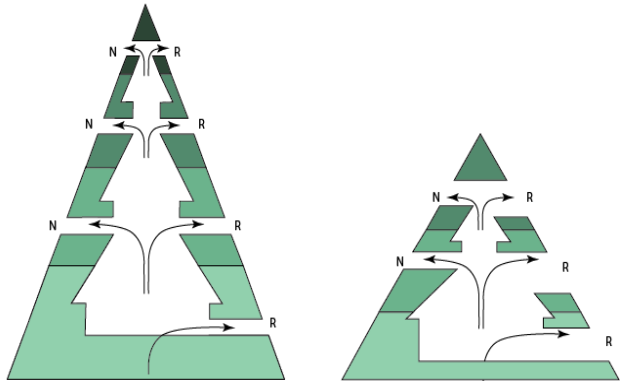
Review

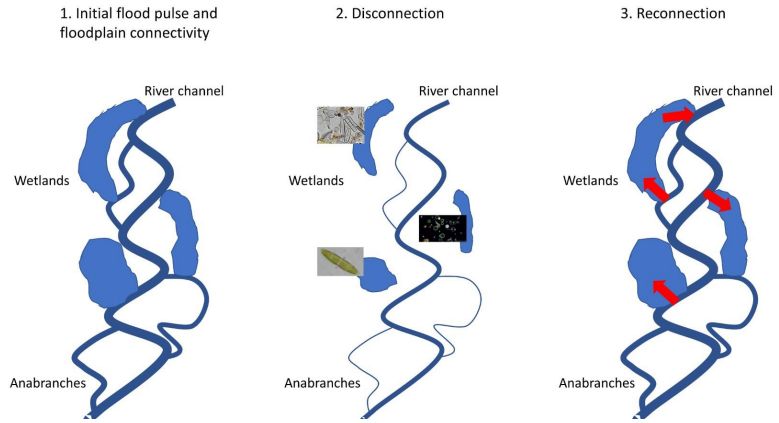
A framework for evaluating food-web responses to hydrological manipulations in riverine systems

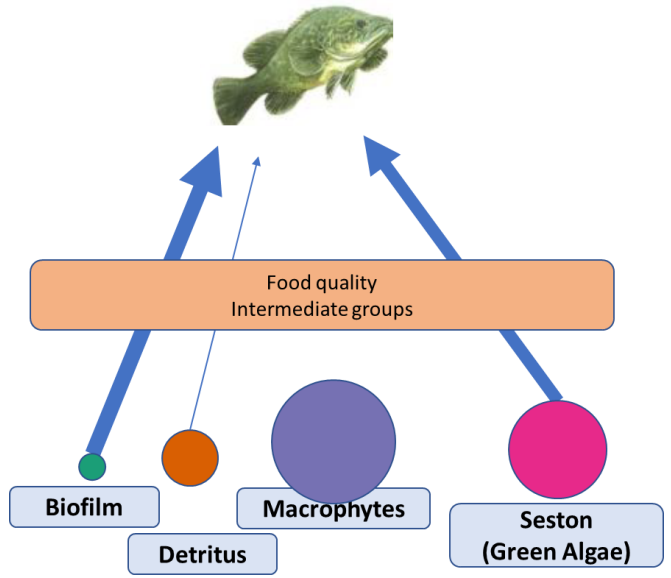
Robert J. Rolls [a, *], Darren S. Baldwin [b, c, 1], Nick R. Bond [b], Rebecca E. Lester [d], Barbara J. Robson [c], Daren S. Ryder [e], Ross M. Thompson [a], Garth A. Watson [b, c]

[a] Institute for Applied Ecology, University of Canberra, Canberra, ACT 2601, Australia
[b] The Murray–Darling Freshwater Research Centre, La Trobe University, PO Box 821, Wodonga, VIC 3689, Australia
[c] CSIRO Land and Water, GPO Box 1700, Canberra, ACT 2601, Australia
[d] School of Life and Environmental Sciences, Centre for Integrative Ecology, PO Box 423, Warrnambool, VIC 3280, Australia
[e] School of Environmental and Rural Science, University of New England, Armidale, NSW 2351, Australia









Thank-you

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

For more information

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

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

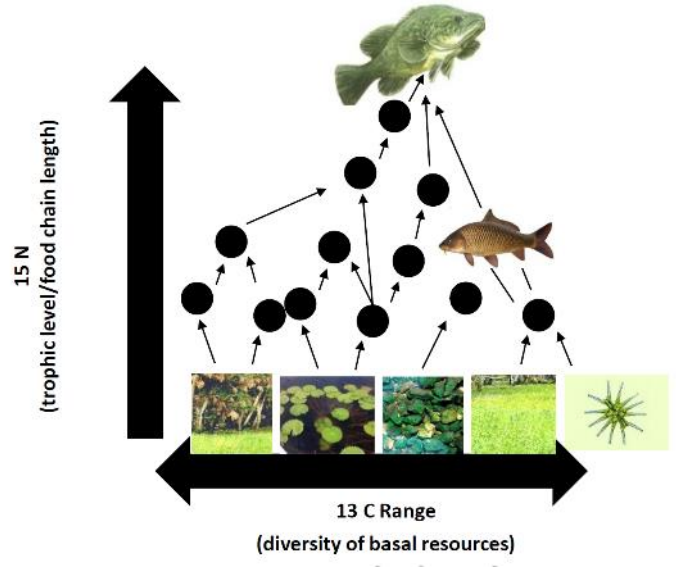
Project Collaborators

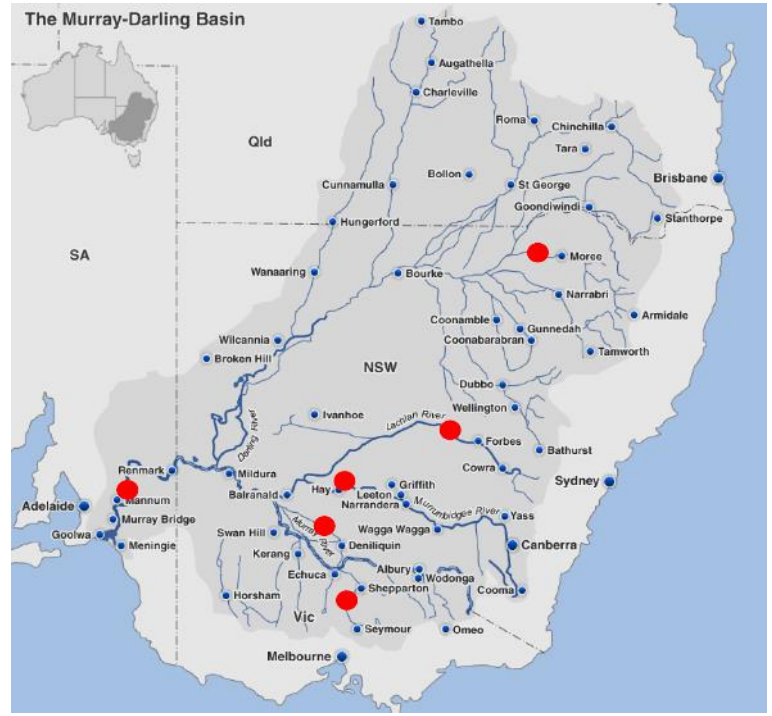
EWKR
Environmental Water Knowledge & Research

Scaling Food webs

Trophic Niche

- The sum of feeding interactions that link species within food webs
- Sensitive to changes in water management
- Cost-effective monitoring tool for linking food webs to flow management





423 tissues, 14 fish species and five basal food (n=172)resources collected from six LTIM sites