The Murray-Darling Basin Environmental Water Knowledge Research project

Foodweb Theme

EWKR Forum
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CSIRO

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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.
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
Foodweb Description
River scale field study

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

- $\delta^{15}$N and $\delta^{13}$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 its ‘reference’ system qualities
River scale field study
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

- **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

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 inefficiency
Review and Conceptualisation

Foodweb Description

Integration

Application
Modelling pathways and components

Flow Event

- Flow characteristics
  - Volume
  - Shape
  - Timing

Inundation

- Site-specific
  - Hydrology
  - Infrastructure
  - Topography

Primary Production

- Producers
  - Producer groups
  - Production (gC) per area per time

Food web

- Diet markers
  - Fatty acids
  - Stable isotopes

- Diet estimation

Outputs

- Depth
- Area
- Duration

- Grams C per producer group

- Fish production

Diet estimation

- Fish production

Models

- Passed Outputs

Products

- Comparison of watering scenarios
- Identification of uncertainty and needed data
Inundation scenarios

Food quality
Intermediate groups

Fish biomass

Biofilm
Macrophytes
Detritus
Seston (Green Algae)
Inundation scenarios

- Biofilm
- Detritus
- Macrophytes
- Seston (Green Algae)

Food quality
Intermediate groups

Fish biomass
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.
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
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
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