Effects of global change on the functioning of Mediterranean river ecosystems

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Introduction

Human activities increase environmental change
Extensive alteration of water cycle
=>Impacts on biogeochemical cycles and ecosystem functioning

150 years of environmental change around Bilbao
Introduction

Mediterranean rivers are affected by multiple stressors
Stresses multiply

Natural rivers

Modified rivers

Discharge

Drought stress

Thermal stress

Pollution

Girona, 2nd December 2010
WP PROCESS, Project Scarce

Objectives

Identify the effects of global change on:

- **Biodiversity**
  - Bacteria
  - Algae
  - Invertebrates
  - Fish

- **Ecosystem functioning**
  - Organic matter processing
  - Primary production/metabolism
  - Nutrient retention/self-purification
  - Trophic web interactions
Why measure ecosystem functioning?

Because it’s an integral part of river health,
Because it can affect ecosystem structure
Because it mediates many services

Loads of nitrogen and phosphorus (g/s), July 1990
Does not structure inform about functioning?

Often not
Do I get new information?

Measurements of functioning give new insights on ecosystem health

Do extensive eucalyptus plantations impact streams?

Breakdown severely retarded
Organic matter beakdown

Organic matter, a key trophic resource in rivers...

...and a problem in reservoirs

*Ephemerella ignita*
Breakdown in Mediterranean rivers

Methods
Poplar wood tongue depressors
Incubate in 76 sites ≈ 2 months

- Ebro – 24 sites
- Llobregat 14 sites
- Júcar 15 sites
- Guadalquivir 25 sites
Breakdown in Mediterranean rivers

Methods
Poplar wood tongue depressors
Incubate in 76 sites ≈ 2 months
Dry (70 °C), ash (500 °C), and weight
Calculate mass loss rate ($M_t = M_0 e^{-kt}$)
Breakdown in Mediterranean rivers

Results
2009/2010 extremely wet
⇒ Difficult to set up the experiment
⇒ Spatial differences likely reduced
Breakdown in Mediterranean rivers

Results

Breakdown rate in the Ebro basin

K (day-1)
- Very low [< -0.002]
- Low [> -0.002, < -0.005]
- Medium [> -0.005, < -0.0075]
- High [> -0.0075]
Factors affecting breakdown

Results

2010 data still not available
Whole ecosystem metabolism

Approach
Analysis of diel oxygen changes

Diagram:
- O$_2$ (oxygen)
- Diffusion arrows
- Respiration:
  - Production
  - Accrual
Whole ecosystem metabolism

Curve types

Heterotrophic

Low metabolism

High metabolism

Autotrophic

O₂ saturation (%)

Time

0 12 24

0 12 24

0 12 24
Whole ecosystem metabolism

Integrates all ecosystem functioning
Allows for continuous monitoring and historical analyses
Metabolism of Mediterranean rivers

Results
Only exploratory results so far
differences between sites...

River Ebro at Haro

River Arga at Etxauri
Metabolism of Mediterranean rivers

Results
Only exploratory results so far
Differences between sites...
...and between years

Zadorra river (Ebro basin)
2003 the hottest summer in record
2010 one of the wettest
Whole river metabolism

Previous research shows effects of extreme events

Izagirre et al. 2008. *JNABS*
Nutrient retention

The basis for self-purification

![Graph showing nutrient retention over distance]
Retention in Mediterranean rivers

Objectives
Characterize effects of human impacts on nutrient retention

Approach
Net balance of C, N and P over 1-2 km long reaches
Based on diel changes in concentration

Work to start in 2011
Take home message

Functioning is an important component of ecosystem health
Mediterranean river affected by multiple stressors
Ecosystems subject to stress most of the time

Large differences in ecosystem functioning...
...both in space and time

Data still preliminary...
...need to be analysed in depth to seek causal relationships

If you are interested in functions,
then measure functioning