the River Restoration Centre

Working to restore and enhance our rivers

Delivering River Restoration: Recipes for Success

13TH ANNUAL NETWORK CONFERENCE

Restoring Europe's Rivers

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How can we link habitat restoration with changes in ecology?

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John Lewis Partnership

NATURAL HISTORY MUSEUM

Stage 1: diagnosis

River Bure, Norfolk

River Wensum, Norfolk

River Manifold, Derbyshire

Biological recovery of rivers: has not always reflected water chemistry improvements shifting the focus to habitat. A shift of scale from catchment to local habitat.

Common problems: impounded and canalised, over-widened and cleared of woody debris and weed

This has led to habitats homogenising: with discrete erosive and depositional areas converging (e.g. gravel silting), limited cover from predation or refugia from flow

Stage 2: the type of restoration

Large Woody Debris (LWD), an ecosystem engineer:

LWD has been routinely removed

Naturally occurring LWD increases habitat diversity

Complex structures that provide refugia from predation and high flow

Re-meandering straight sections

Narrowing over-widened areas

Creating localised high and low velocity areas in impounded, slow sections

Restoration of LWD habitat is straightforward and can be replicated

Stage 3: Monitoring design

Before-After-Control-Impact

River Bure, Norfolk, Before and After restoration

Sampling needs to take place Before and After restoration at both Control and Impact sites so the effects of restoration can be separated from other variation

We have also monitored reference sites with >5 year old LWD structures as targets

River Bure, Norfolk, reference

Stage 3: Monitoring design

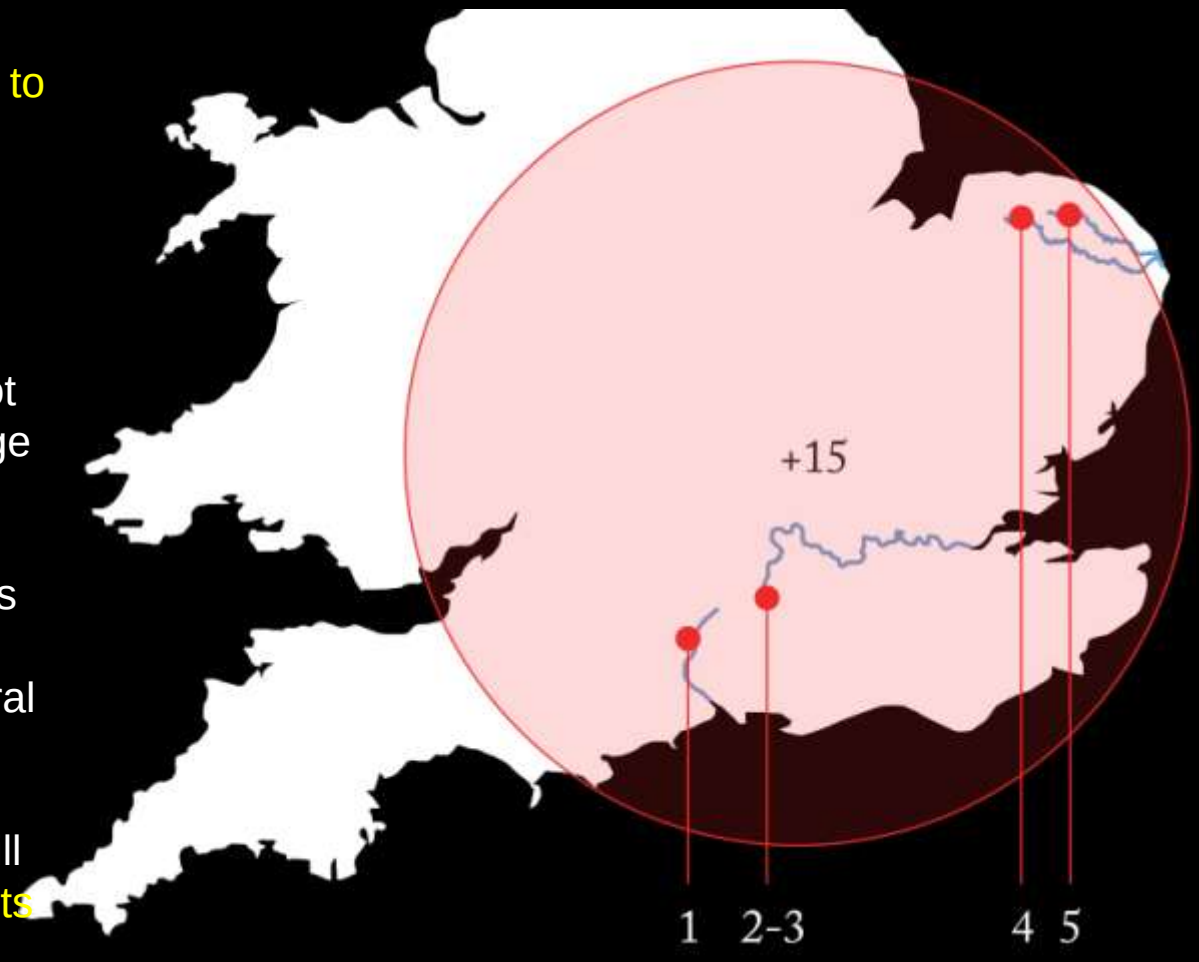
The importance of replication

We sampled 5 chalk streams (replicates) with a BACI design to determine the effects of restoration

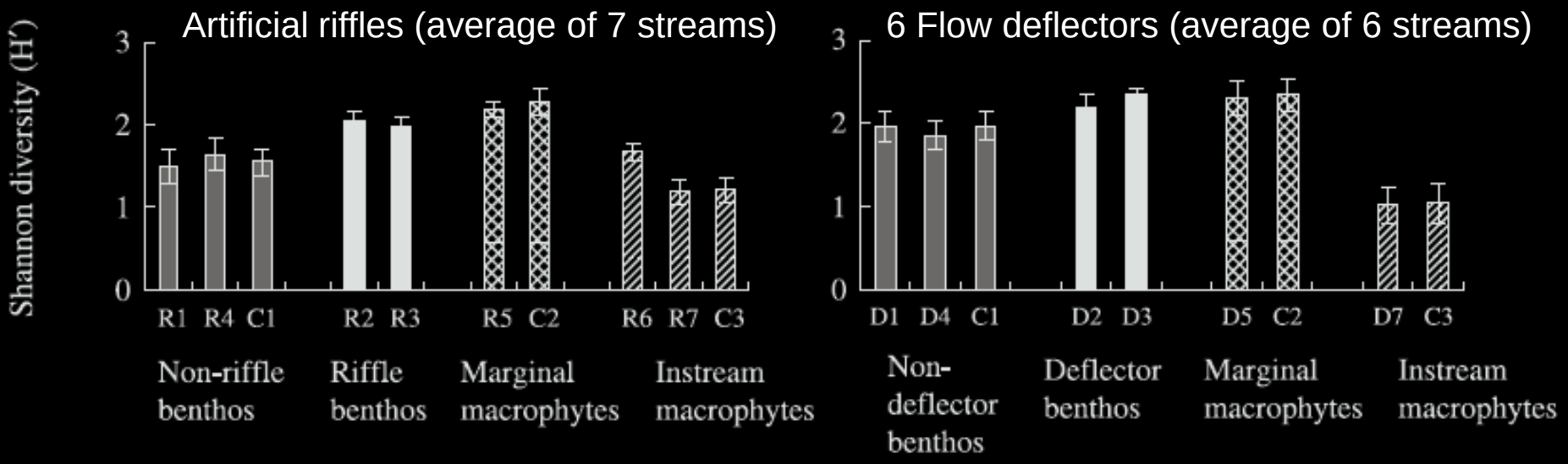
Sampling only 1 stream is like asking one person the same question repeatedly, you cannot use their answers as an average for the population

A further 15 calcareous streams across a large water chemistry gradient were sampled at natural LWD and control sites

The combination of this data will enable us to separate the effects of water chemistry from habitat



Stage 4: detecting and interpreting change



Pretty et al (2003) & Harrison et al (2004): negligible benefits for either fish or invertebrates

Palmer et al. (2010) reviewed 78 independent river restorations, only two instances of a significant positive relationship between habitat diversity and biodiversity

Reach scale restorations are constrained by their catchment's species pool and water chemistry, for instance

Therefore, changes maybe more subtle than an increase in species e.g. shift in species, changes in population density, changes in traits or diet (food web)

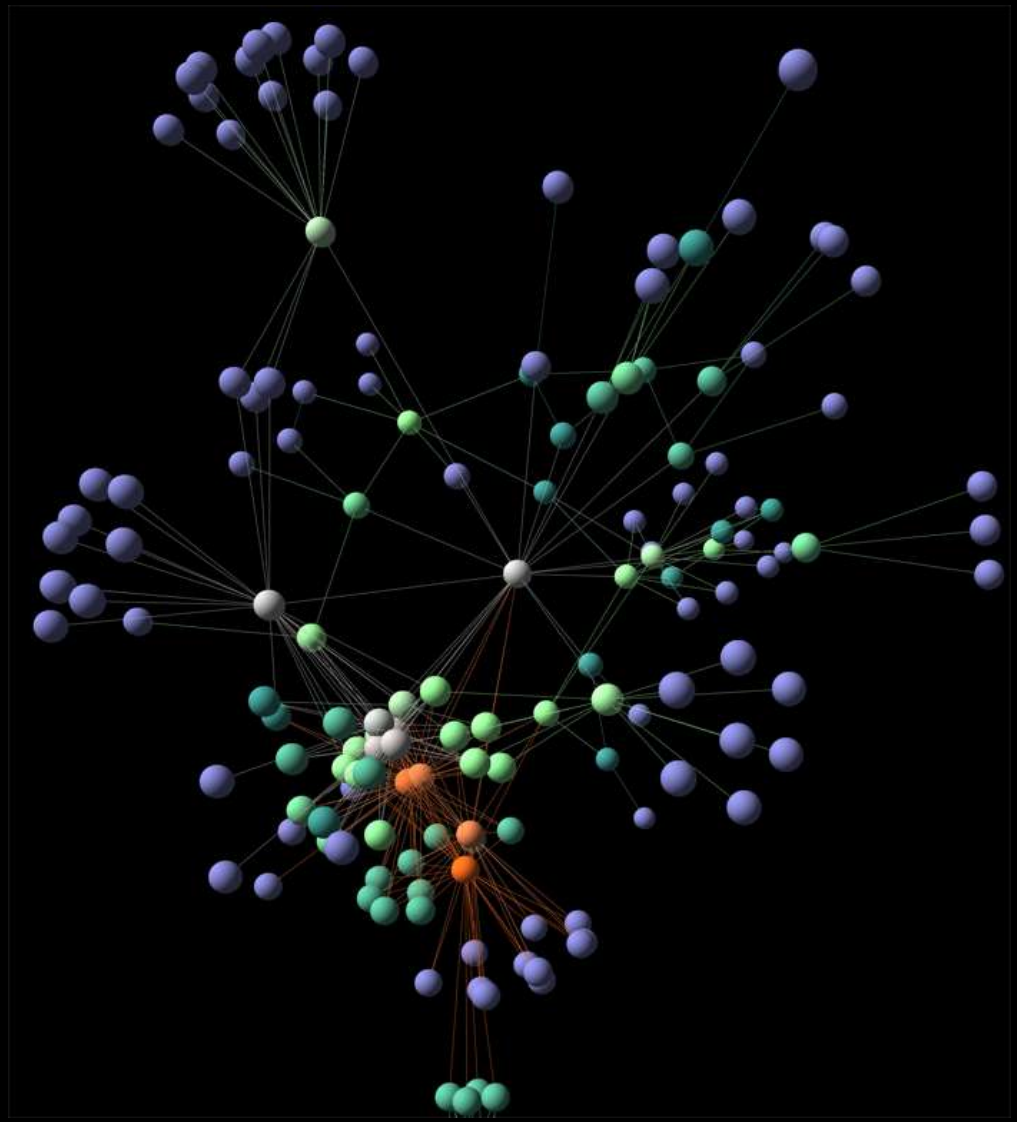
Stage 4: detecting and interpreting change

Studying indicator species or groups alone overlooks community interactions

Food webs enable us to identify biological constraints

Changes in one species population effects it's prey, predators and competitors

How can a community and the interactions be measured?



Stage 5: Sampling the community

Mass, abundance and diversity is estimated for each community and the gut contents of the consumers and predators are analysed to determine energy pathways

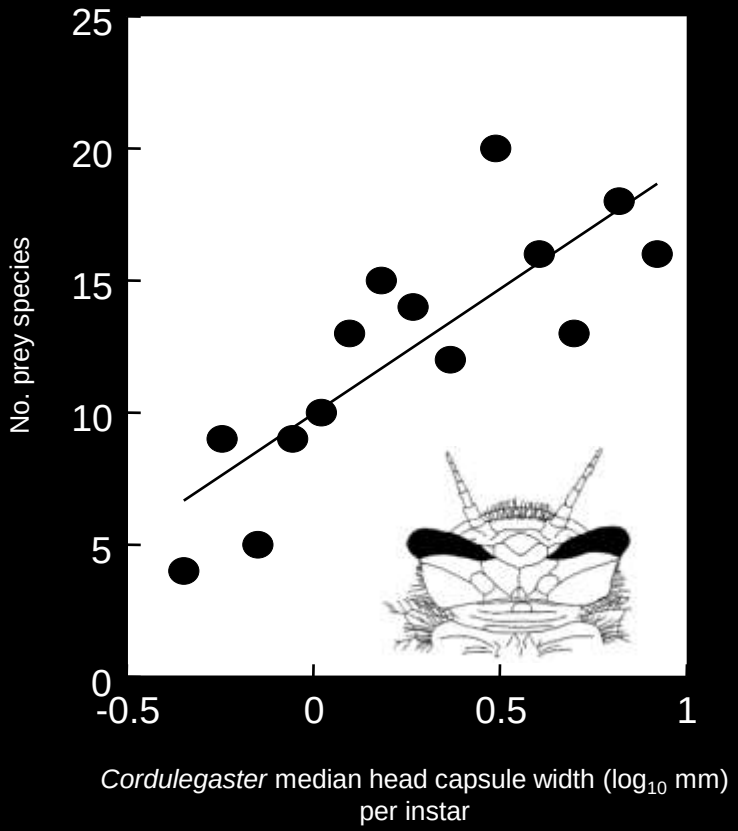
Stones scrapes: algal community

Hess sampler: invertebrates

Electrofishing between stop nets

Stage 6: Analysing the community

Minnow eaten by a salmon parr



Diet width increases with body size

Species identity is not always the best descriptor of an individuals position within a food web.

A small and a large trout will share less diet overlap than a large trout and large pike

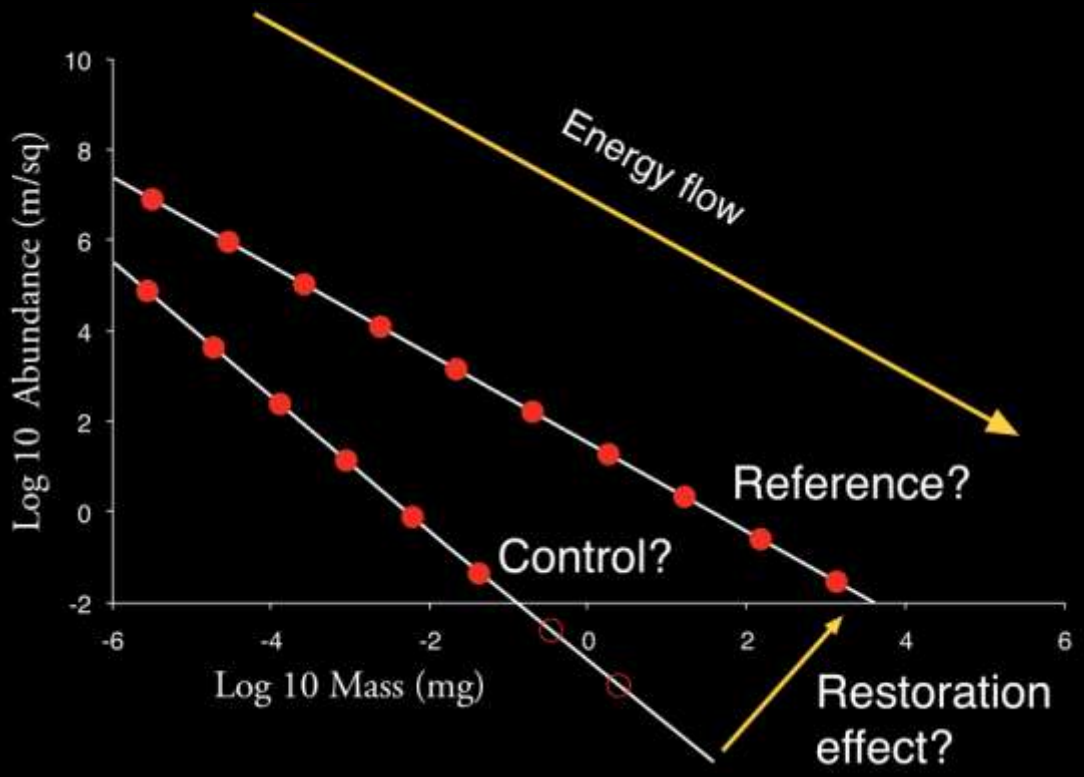
Methods of analysis: size bins

Body size structures food webs meaning: small abundant prey are eaten by larger rarer predators

Individuals are categorized

Stress in overfished marine ecosystems has led to shorter food chains as the top predators are missing

What we might expect around LWD is a lengthening of the food chain with increased number of size classes due to increased abundance of prey and refugia

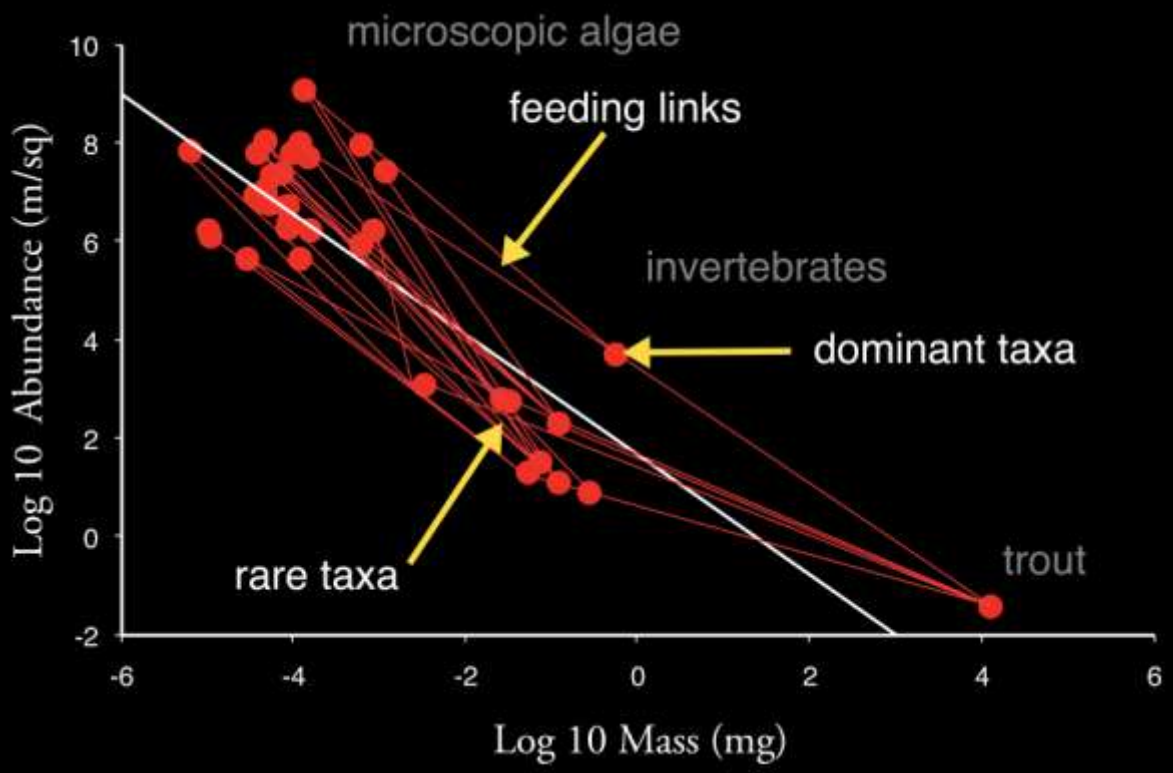


Methods of analysis: species and feeding links

Including species identity can highlight rare and dominant taxa

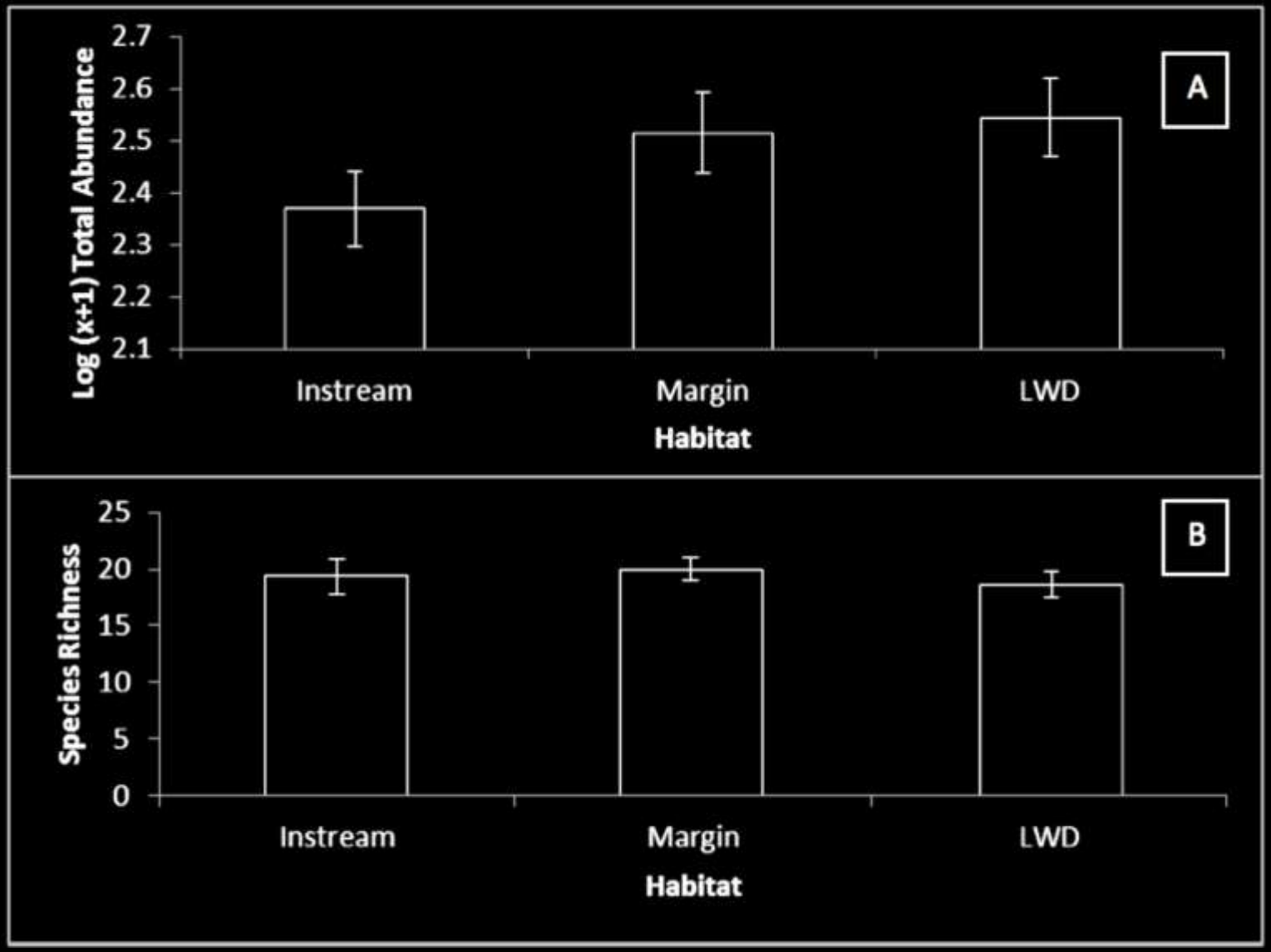
The populations of e.g. riverfly can be assessed: is their abundance lower than their mass suggests?

Subsidies also become clear. Trout are supported by external input and their position represents this



Murray et al (2010) unpublished

Preliminary data: Macroinvertebrate from 19 streams



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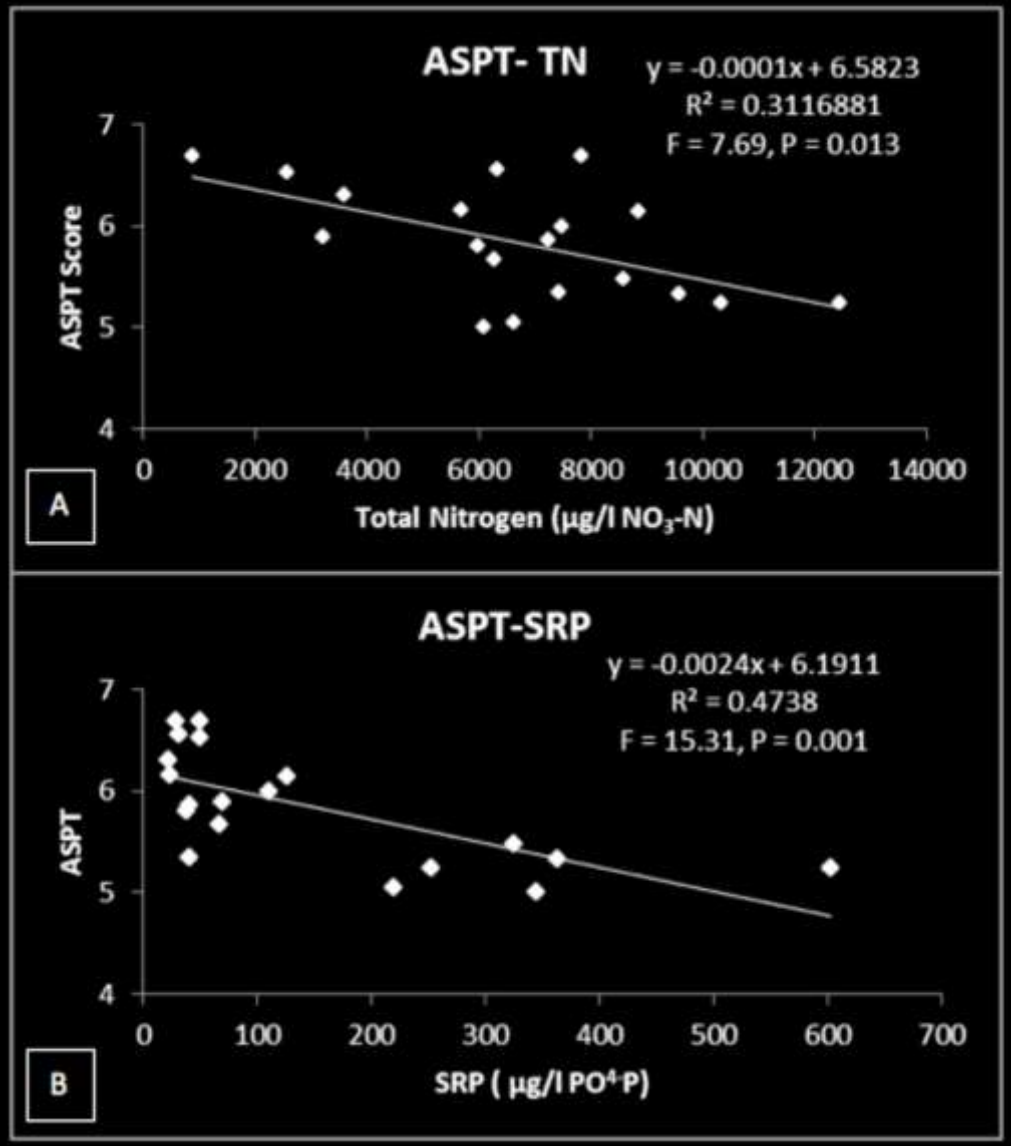

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River restoration monitoring: conclusions

Ultimate aim is to link habitat restoration predictably to ecological recovery so the process can be repeated

In order to do this it is important to:

Use replicated BACI designs and measure both ecology and habitat change

Address appropriate scales for particular questions

Use the appropriate resolution of taxonomy and suitable analysis

Analyse food web interactions to understand and predict causes and mechanisms of change