



Association of Rivers Trusts Autumn Seminar
November 18th 2008
Agricultural Business Centre, Bakewell.

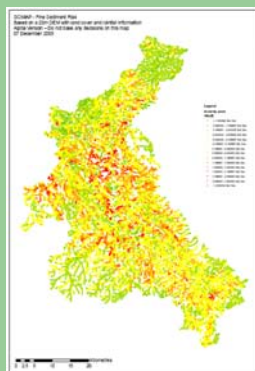
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SCIMAP: Sensitive Catchment Integrated Modelling and Prediction for diffuse pollution identification



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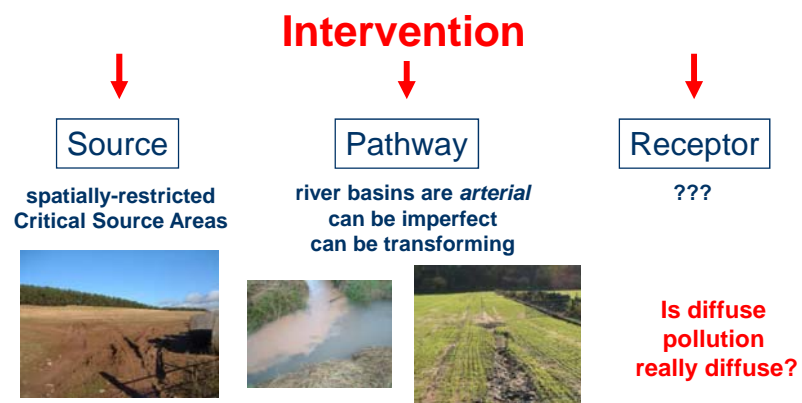
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Eden Rivers Trust, Environment Agency,
NERC

Structure

1. Why are we developing SCIMAP?
2. SCIMAP: the underlying philosophy
3. How does it work?
4. Does it work?
5. How can it be used?
6. What SCIMAP does not do yet *or* may never do

What do we mean by diffuse risks?



Why are we developing SCIMAP?

1. The need to target

- Finite resources need to be focused upon what gives most impact where

Why are we developing SCIMAP?

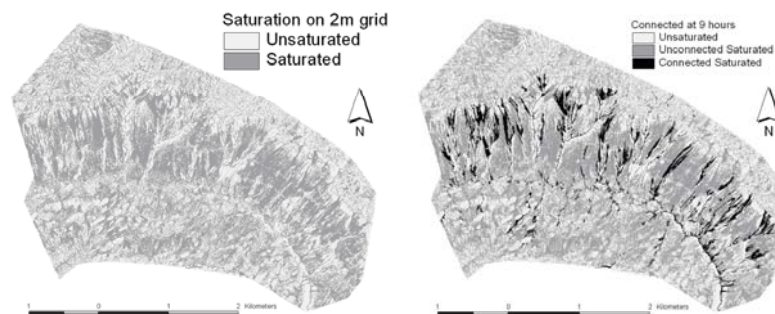
2. Downscaling and upscaling



Why are we developing SCIMAP?

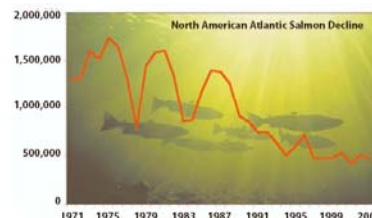
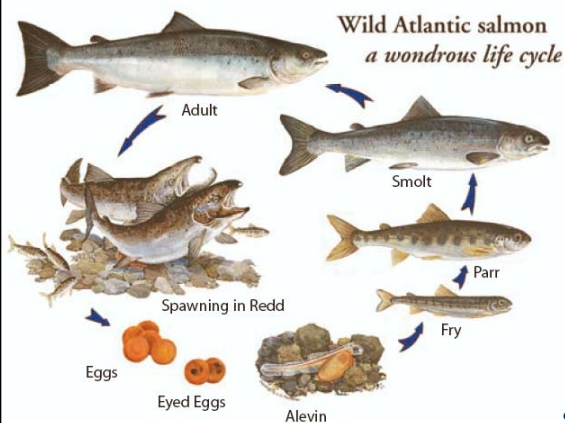
2. Downscaling and upscaling

- Landscapes structure connectivity over spatial scales < 10 m
- DP displays emergent behaviour over 100s and 1000s km



Why are we developing SCIMAP?

3. Do we know what makes a fish (hydrologically) happy?



Source: Atlantic Salmon Federation

Why are we developing SCIMAP?

4. The gap between research and practice



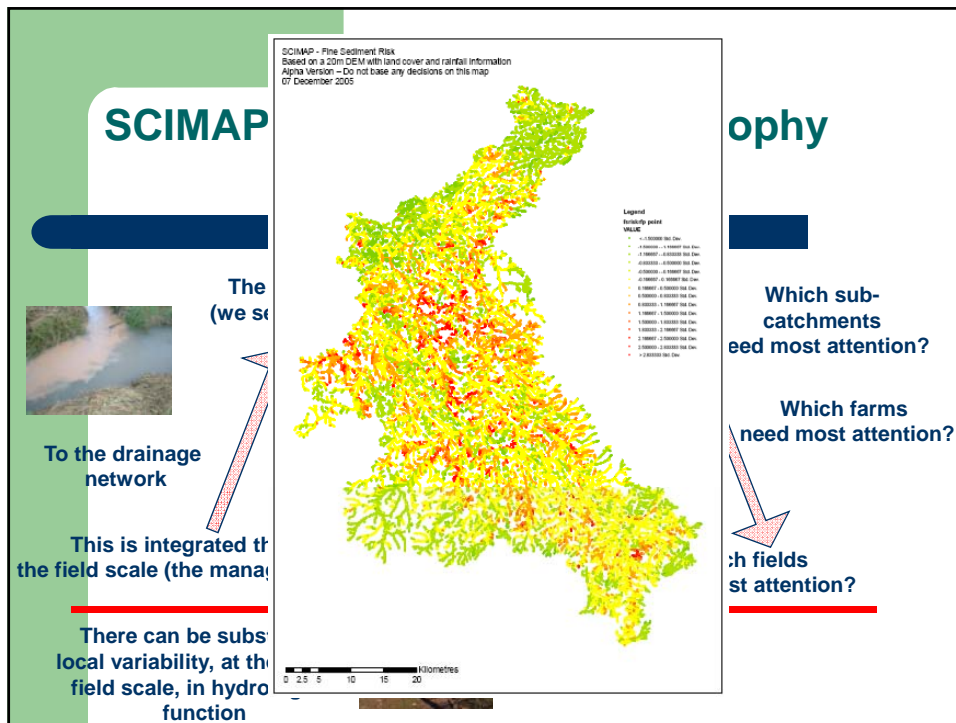
Convention
SCIMAP



SCIMAP: the underlying philosophy

7 key points

1. Models should have *sufficient* science
2. Sources of risk are predominantly associated with distributed patterns of land use: spatial signal
3. Riskiness is controlled by the rate at which risk is acquired by water associated with surface and shallow subsurface flows: catchments are large and complex spatial filters
4. Riskiness is moderated by the level of connectivity along the flow path: the filter is spatially structured through connectivity
5. Establishing risk in absolute terms is a challenge
 - Uncertainties due to exact land management practices
 - Uncertainties in nature of connectivity and process rates
 - Uncertainties due to dynamism and time dependence
6. Connectivity in space and connectivity in time can be related (an ergodic hypothesis): measures of spatial connectivity implicitly have a temporal component
7. Biology is space and time integrating



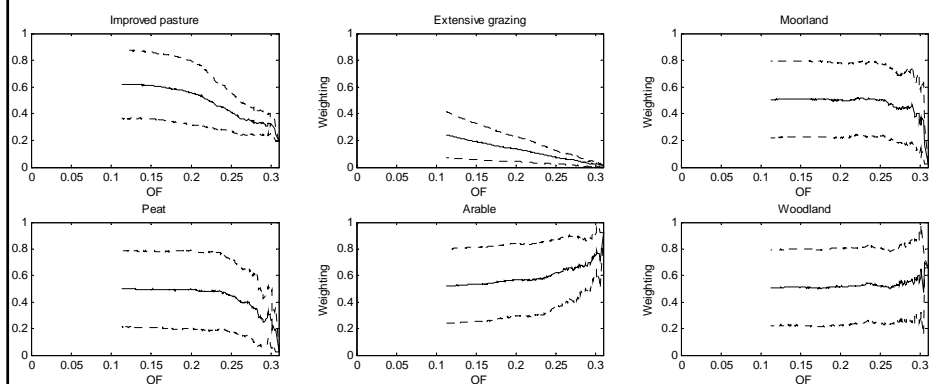
How does it work?: SCIMAP versions

- SCIMAP-S: fine sediment
 - model development complete
 - model testing complete
- SCIMAP-P: phosphorus
 - model development underway
 - model testing to begin
- SCIMAP-N: nitrogen
 - model development to begin
 - model testing to begin

How does it work?

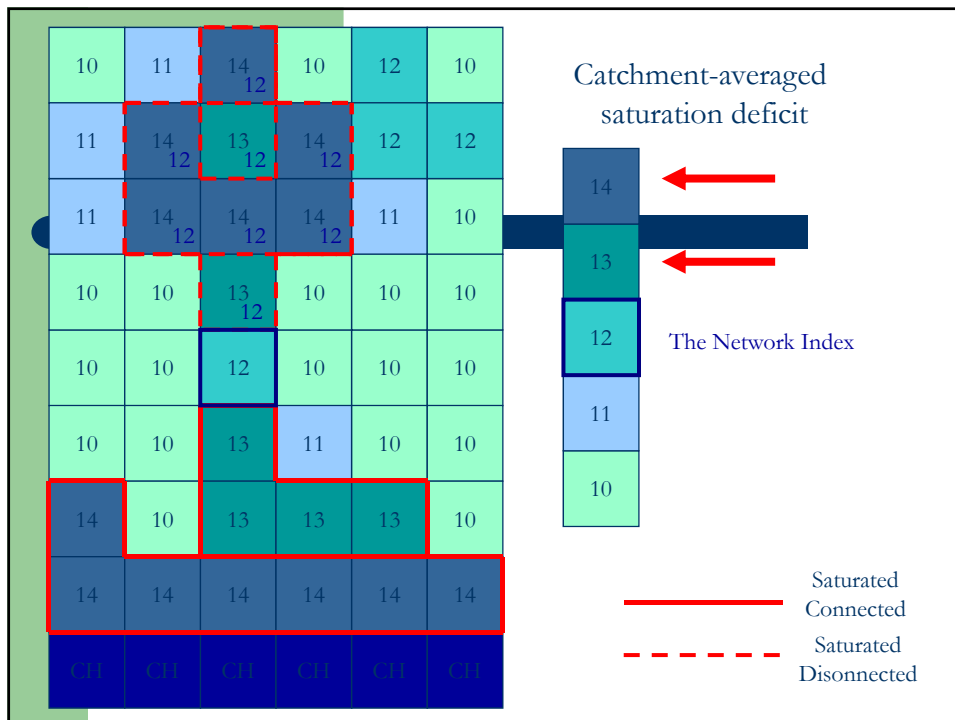
1. Export:
 - As complex as you want it to be (e.g. PIT, PEDAL, PSYCHIC (but care))
2. Connect
 - Based on nationally available topographic and soil data
3. Route, accumulate, dilute
 - Based on nationally available topographic and rainfall data
4. Time
 - integration period is dependent on way export is set up and connectivity is parameterised
 - Current focus is integration to ecologically relevant timescales
5. Typical implementation:
 - Set up: one day per 200 km²
 - Run: minutes per 200 km²
 - Parameterisation depends on available data (but it is a parsimonious model)

How does it work?



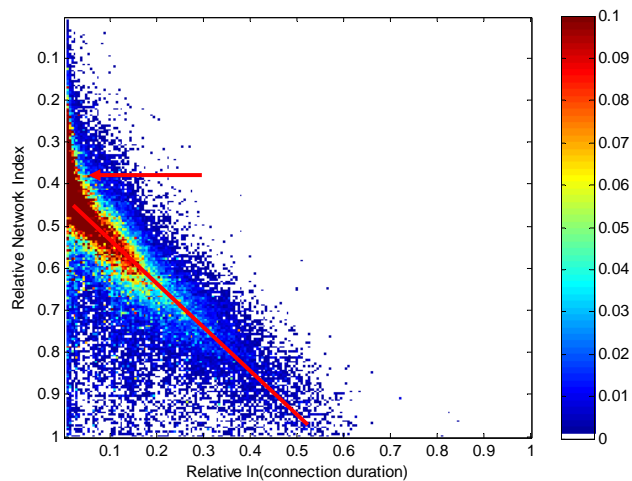
How does it work? connectivity

- The wetness of a point on the landscape is well described by
 - $\ln(a/\tan B)$
- The drier a point in the landscape the more likely water will move downwards rather than laterally
- For the surface and shallow subsurface flow network, lateral connection is critical



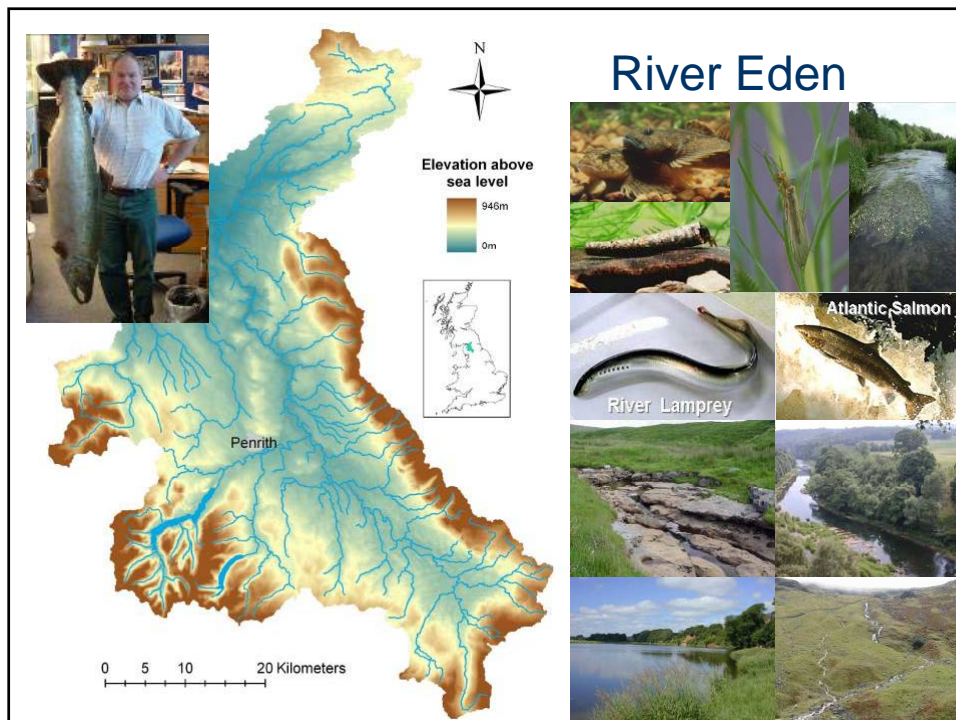
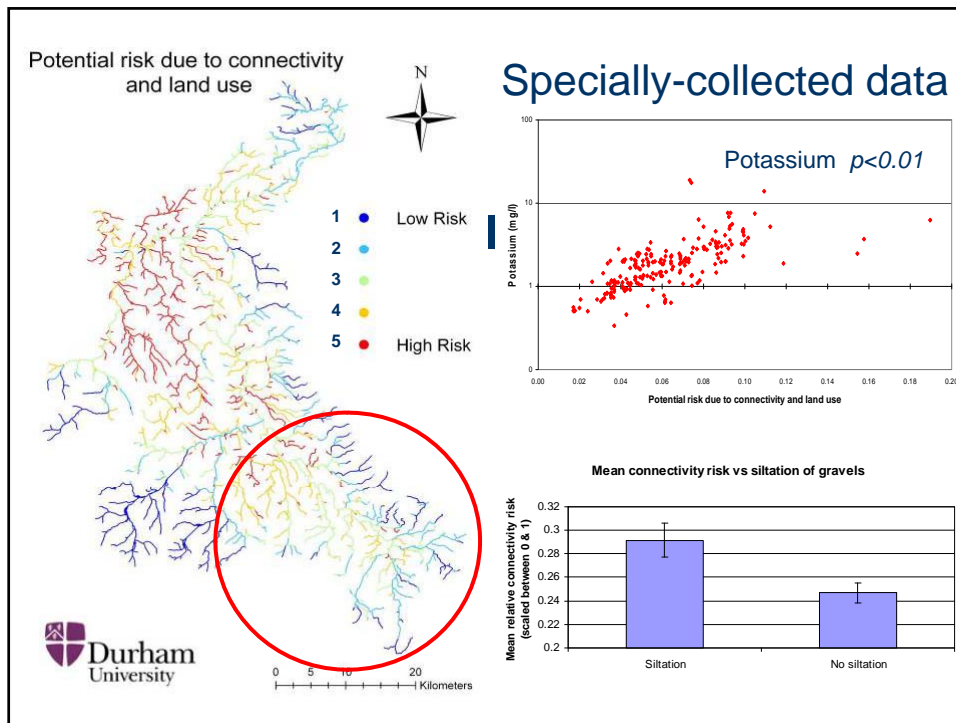
How does it work? connectivity

- Duration of connection – logged, scaled and binned (200)
- Relative Network Index –binned (200)

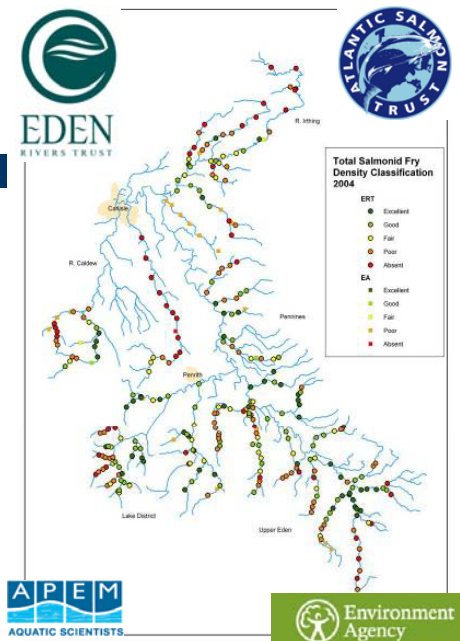


Does it work?

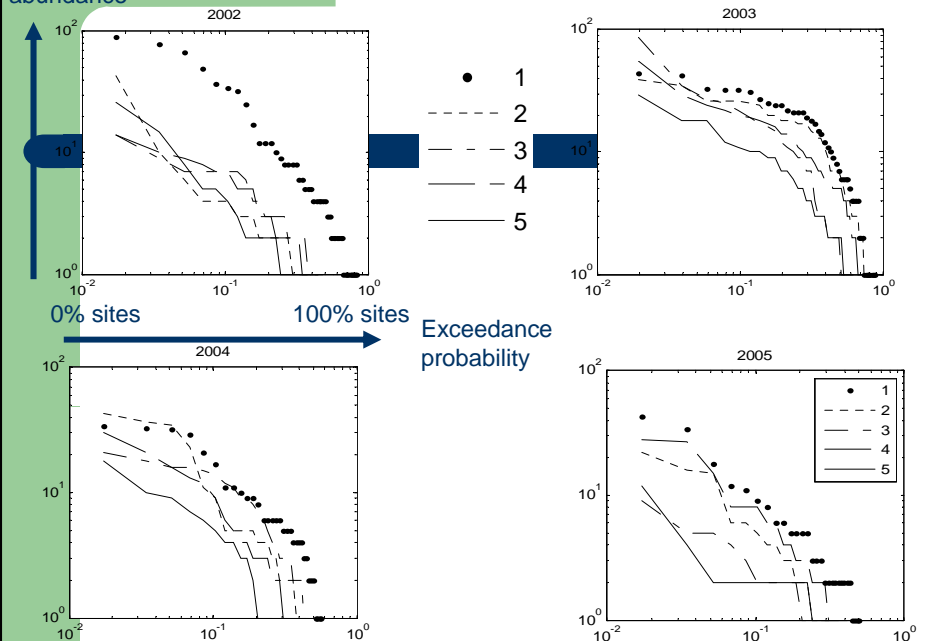
- Assessment of SCIMAP has two broad aims
 1. Assessing its effectiveness against specially collected and nationally collected (routine) monitoring data (EA Science Project)
 2. Assessing its importance in explaining aspects of instream aquatic ecology, notably those hypothesised as sensitive to land management activities (e.g. salmonids)



Semi-Quantitative Electrofishing



Fry abundance Connectivity only: trout fry




Year	p value (t-test)	Trout fry present	Trout fry absent
2002	0.0001	0.238 ± 0.019	0.274 ± 0.079
2003	0.0001	0.260 ± 0.019	0.304 ± 0.085
2004	0.0001	0.243 ± 0.008	0.289 ± 0.009
2005	0.05	0.249 ± 0.024	0.269 ± 0.020

Mean integrated RNI

Standard error

Potentially effect of the January 2005 floods
Trout numbers were reduced in 2005



Brown et al., 2006

Validation

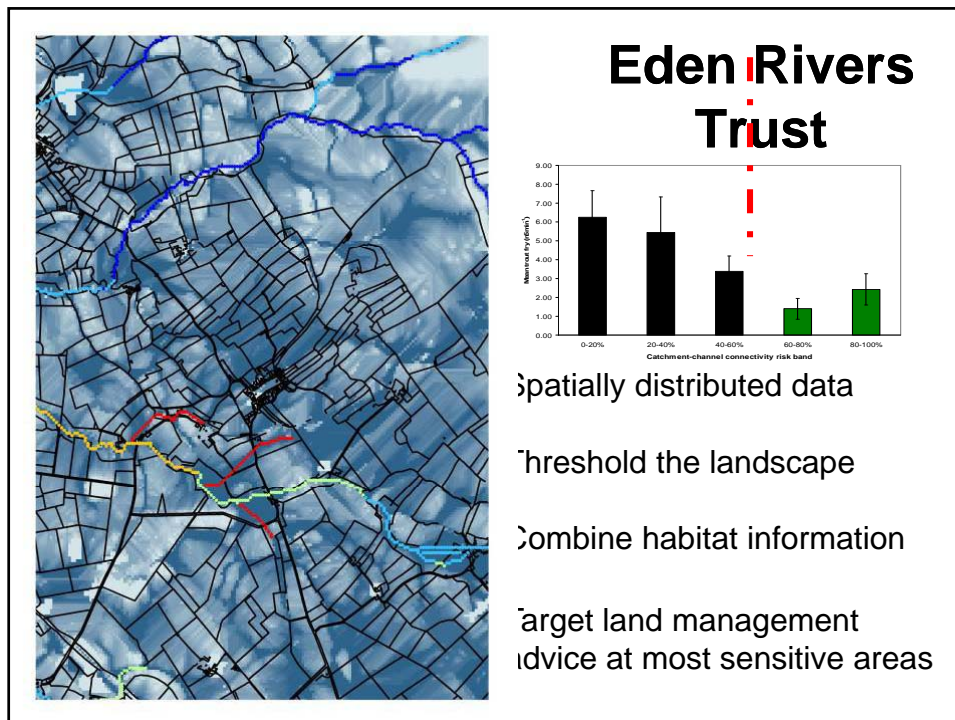
- SCIMAP-S appears to capture the fine sediment delivery process
- Sufficient to detect land management impacts on not only the sediment state of rivers but some aspects of instream ecology
- The ecological debate in the fisheries literature over land use/management impacts follows from an incomplete conceptualisation of how land and water connect hydrologically

How can it be used?

- As a science tool
 - Establishing the role of catchment scale processes as limits on achievement of local environmental targets
 - Testing critical assumptions regarding long term species decline
 - Inference of which land uses cause WQ problems or instream ecological degradation using inverse modelling
 - Assessing climate change impacts on connectivity and ultimately delivery

How can it be used?

- As a science tool
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 - Assessing climate change impacts on connectivity
- As a management tool
 - **Relative prioritisation of what to do where**
 - Within-farm management that is cost averse
 - Optimisation of delivery of agri-environmental schemes
 - Simulation of impacts of policy recommendations



What SCIMAP does not do yet *or* may never do

- Does not do yet
 - P and N (but both imminent)
 - Handle soil types
 - Deal with non topographic controls on connectivity
 - Groundwater
- May never do
 - Predict water quality concentrations
 - Handle discrete events (but it can be looked at by parameterising connectivity)

SCIMAP and Rivers Trusts

- Will be freely available
- Uses open-source GIS software
- Nationally available datasets (have to check licenses)
- Planning a 2 day workshop in Durham in March 2009 – free except for accommodation