Beyond Habitat: Conceptualizing the Role of Sediment in Ecosystem Services Frameworks

Developing a framework for Sediment Ecological Risk Assessment (SEcoRA)

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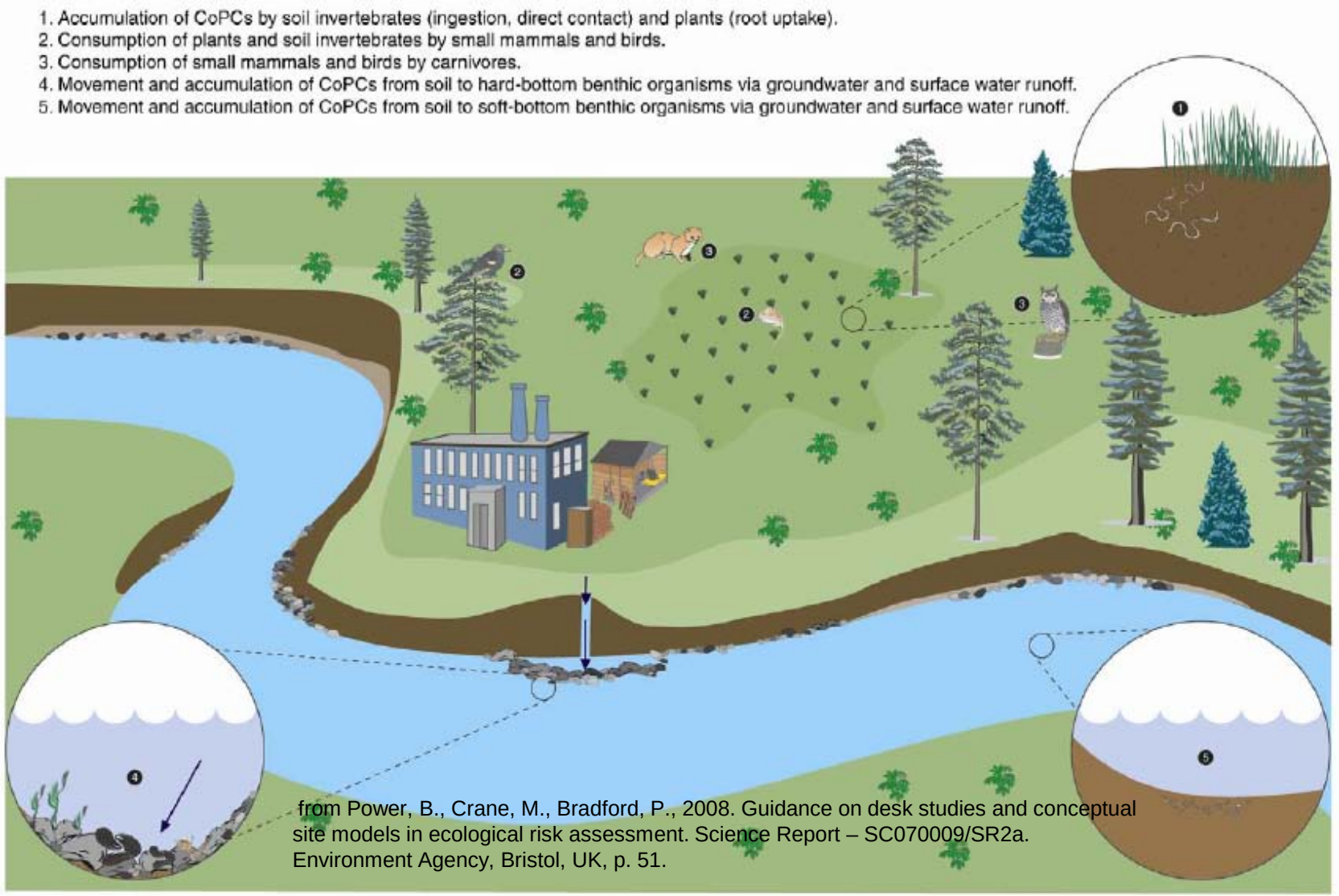
SEA Environmental Decisions

Transform information into action…

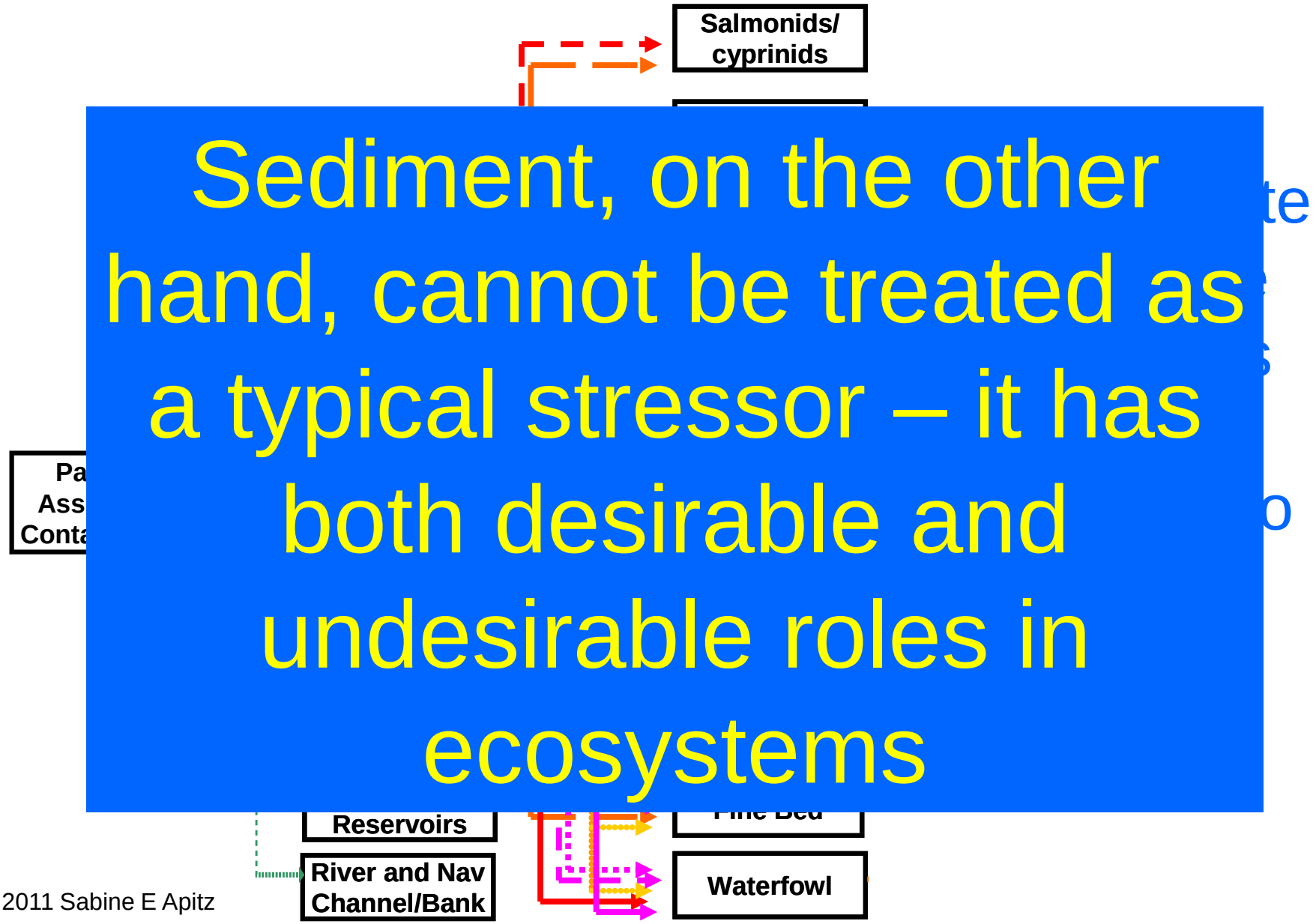
Note: Images and tables from paper in review
Have been removed. For more information, or for
Copies of paper, contact author at drsea@cvrl.org

Ecological risk assessment is the process that evaluates the probability of adverse effects to endpoints as a result of one or multiple stressors



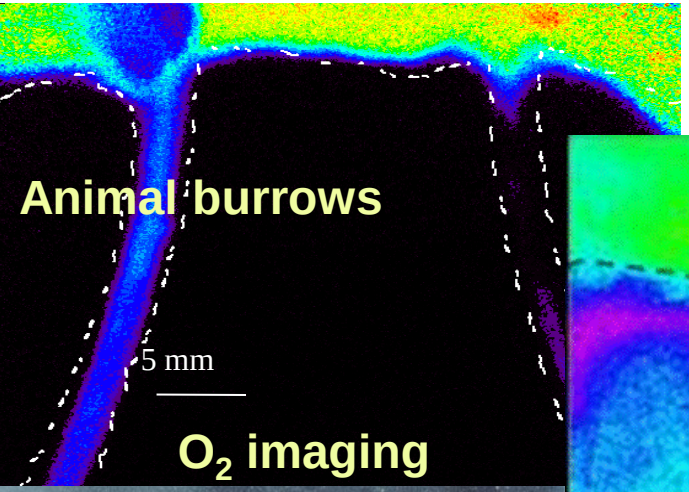
from Power, B., Crane, M., Bradford, P., 2008. Guidance on desk studies and conceptual site models in ecological risk assessment. Science Report – SC070009/SR2a. Environment Agency, Bristol, UK, p. 51.

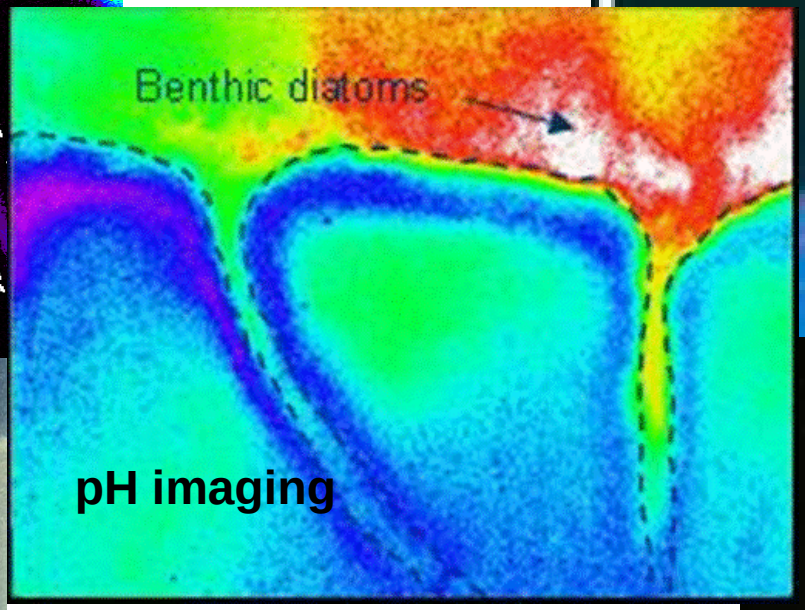
Pathways for **contaminated sediment** impact in a typical EcoRA Conceptual Model

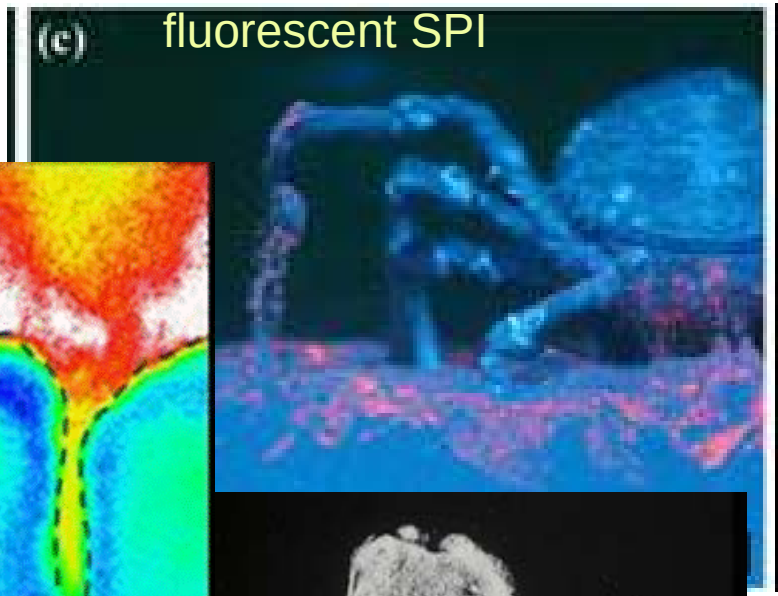


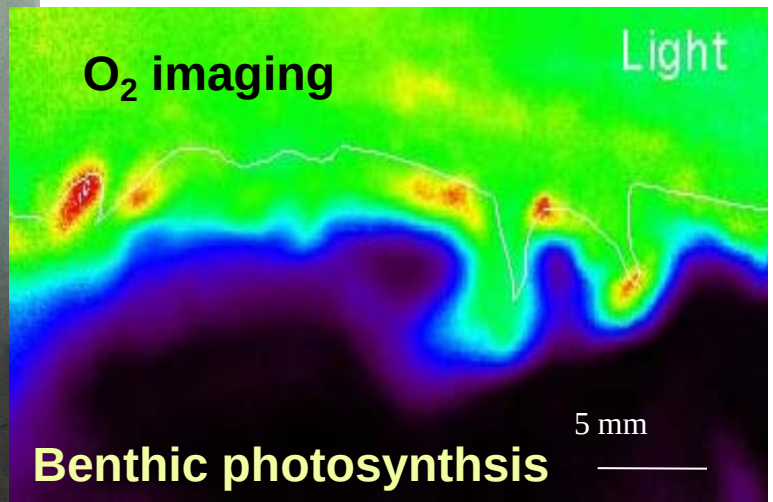
Sediment, on the other hand, cannot be treated as a typical stressor – it has both desirable and undesirable roles in ecosystems

Sediment as Habitat:
Sediment organisms play critical roles in ecosystem functioning

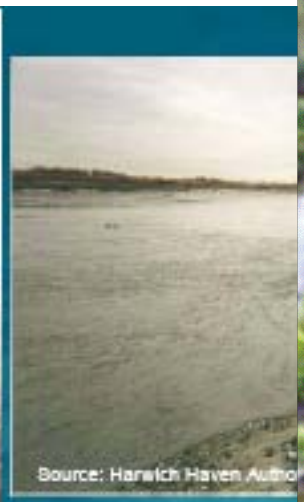








Sediment balance also essential. Sediment lack affects coastal and land defence...

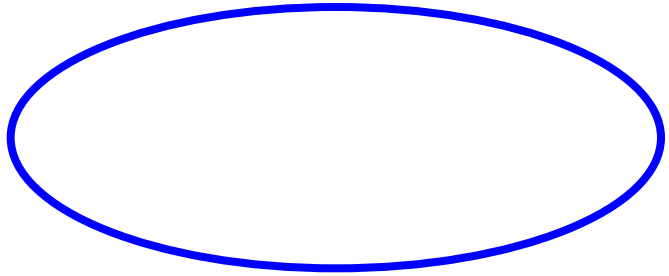


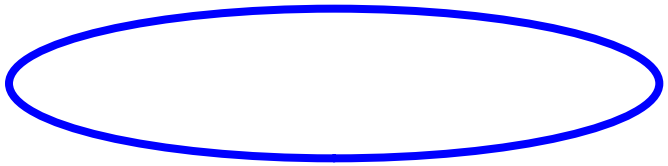
...but sediment excess creates other problems, both when deposited...

From *Sediment Matters*, Atkins Ltd, 2009

There are a range of ecosystem services affected by sediment; these can be reflected by endpoints or ***Service Providing Units***

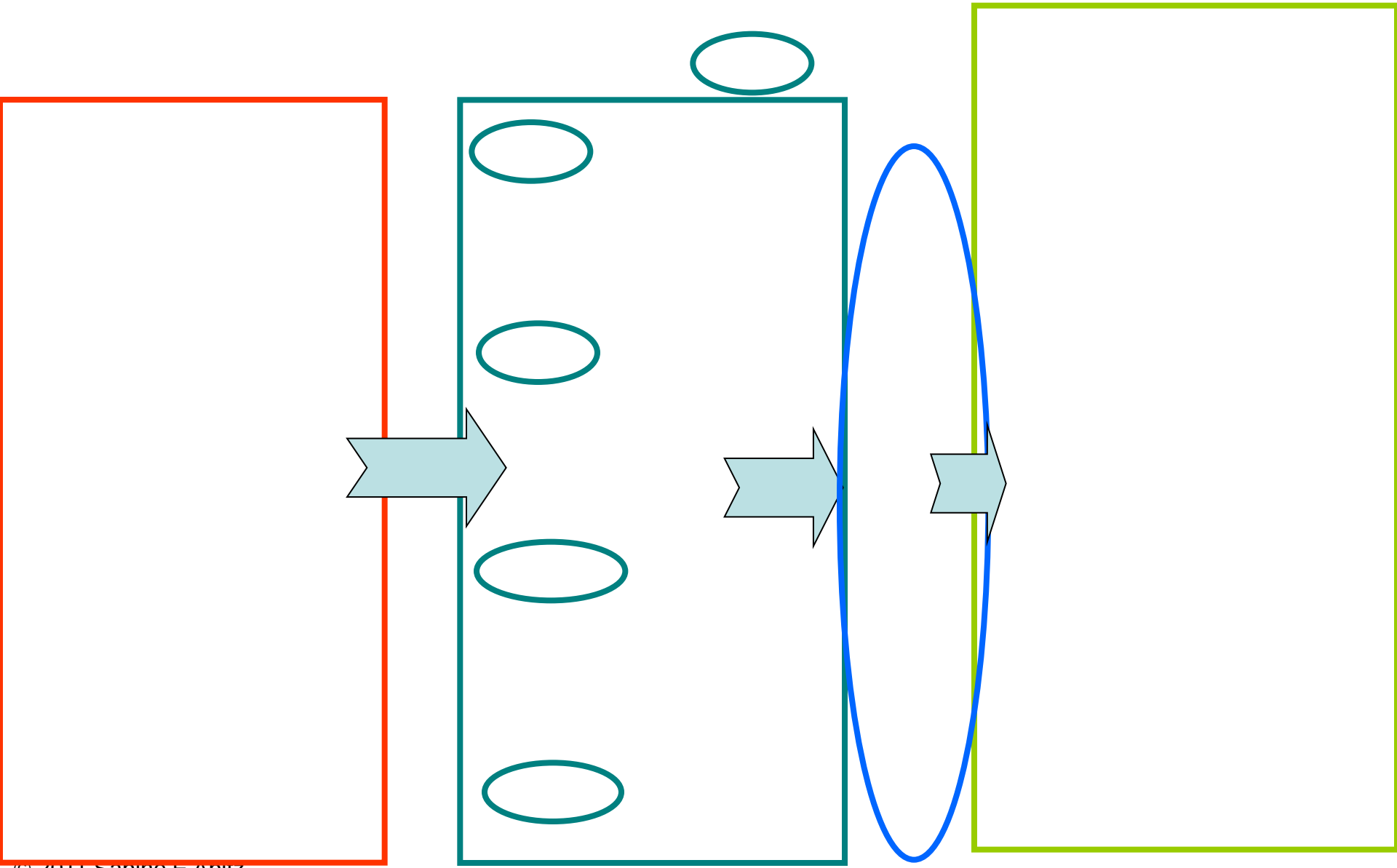
Abiotic Endpoints/ SPUs





Sediment Ecological Risk Assessment (SEcoRA) Must Address Greater Complexity and Different Assumptions Than Does Contaminant EcoRA

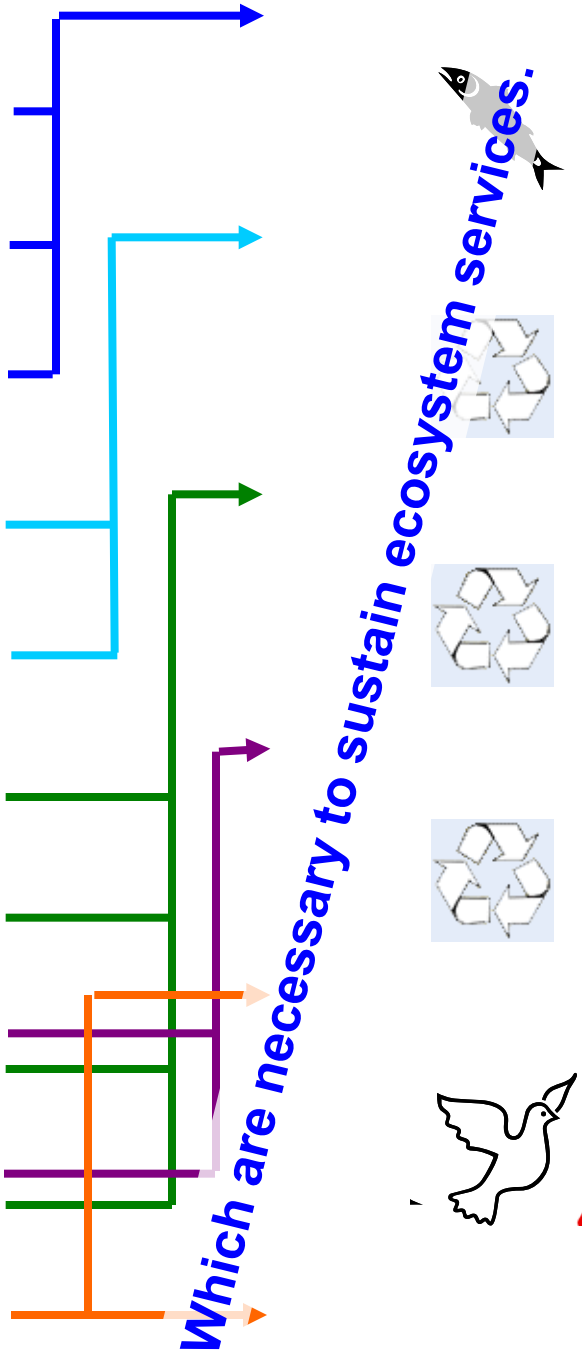
Landscape-scale biophysical conditions define sediment status; sediment role depends upon **endpoint** under consideration



Fine-grained sediment pathways

Arrvies at locations throughout a watershed...

Having positive and negative effects on endpoints...



Which are necessary to sustain ecosystem services.

Pathways for abiotic endpoints – fine-grained sediment

Provisioning/ Water

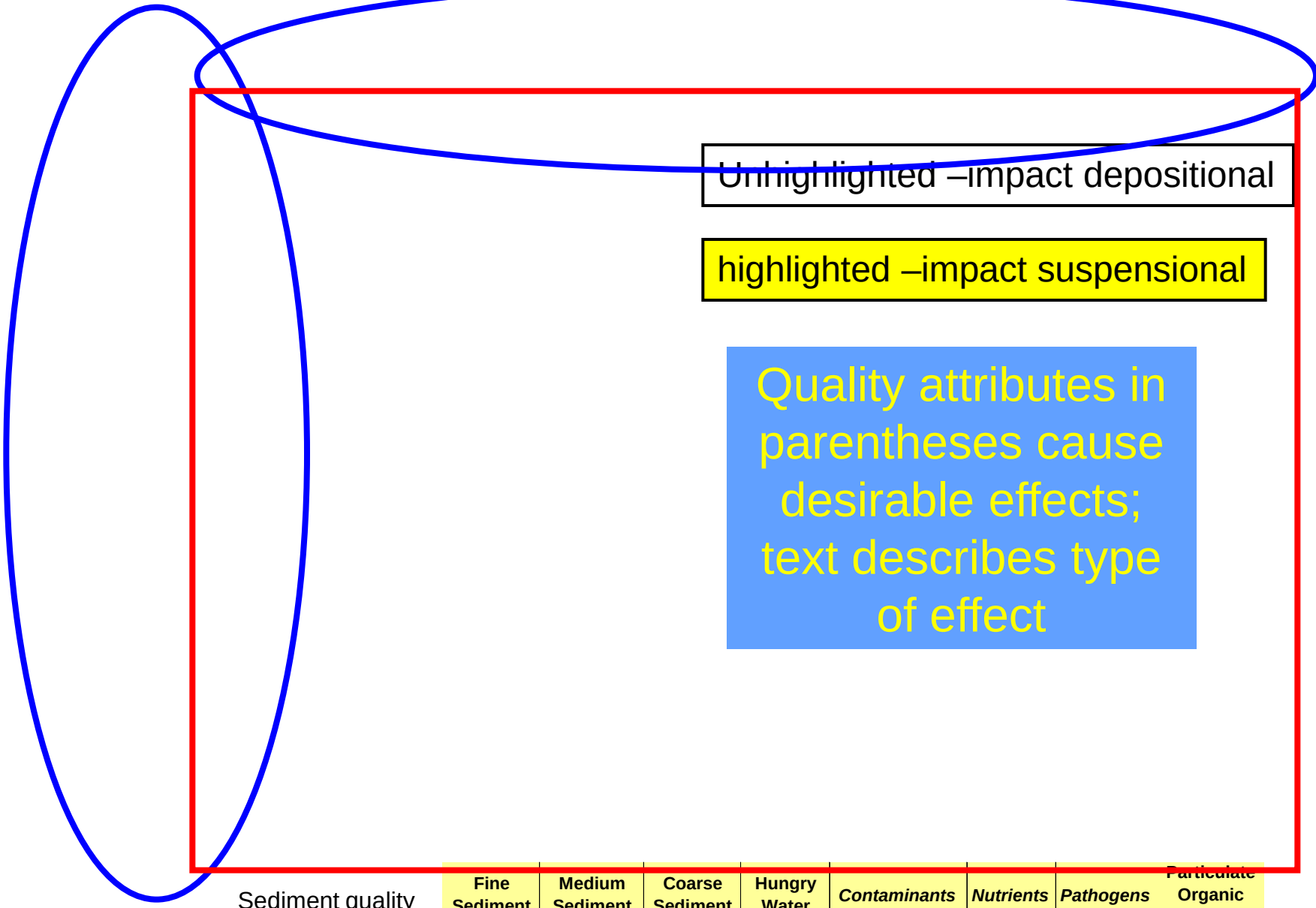
Regulating/ flood Control; stabilization

Resource access/ Transport

Regulating/ Waste Control

Cultural/ Archival

Conceptual tables allow for clearer mapping of effect pathways, considering quality, as well as transport/location factors



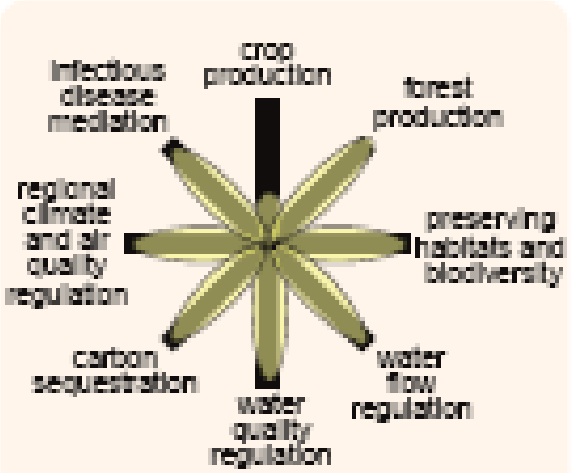
Unhighlighted –impact depositional

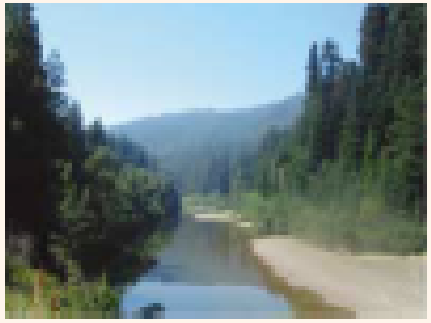
highlighted –impact suspensional

Quality attributes in parentheses cause desirable effects; text describes type of effect

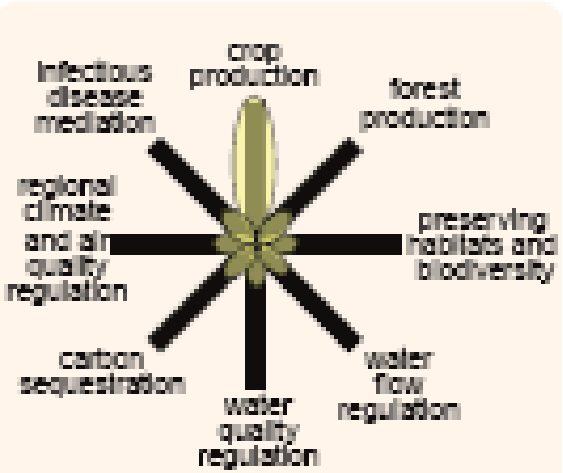
Sediment quality attributes:	Fine Sediment (FS)	Medium Sediment (MS)	Coarse Sediment (CS)	Hungry Water (HW)	*Contaminants (C)*	*Nutrients (N)*	*Pathogens (P)*	Particulate Organic Matter (pOM)

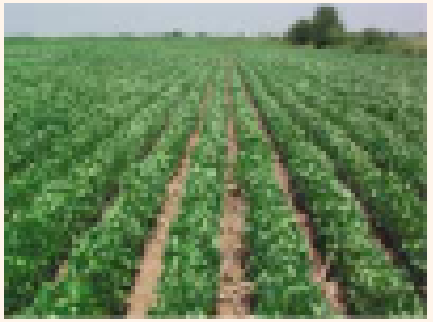
Natural ecosystems provide a “bundle” of services



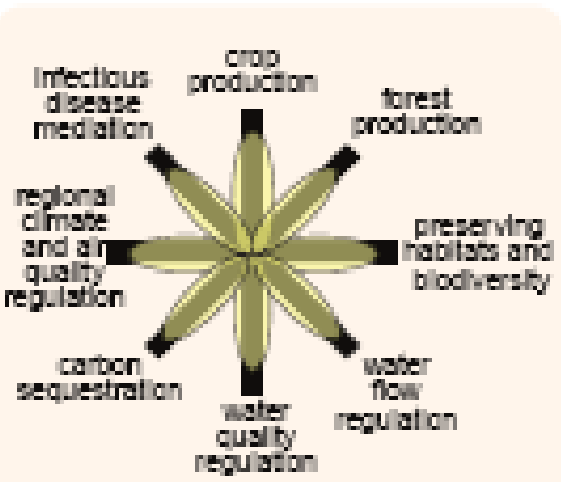


natural ecosystem





intensive cropland



cropland with restored ecosystem services

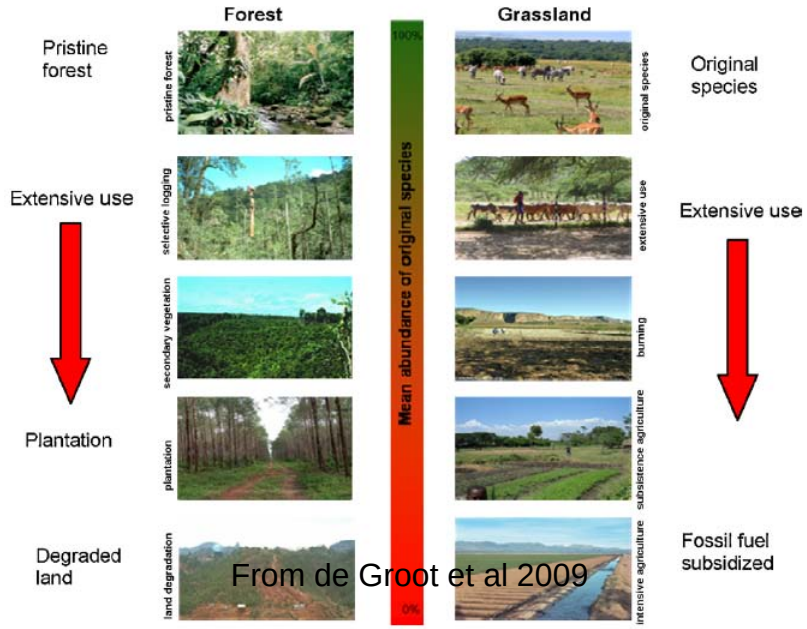
The more intensively we manage land to enhance specific services, the more others suffer

More sustainable management seeks to optimise the bundle of services

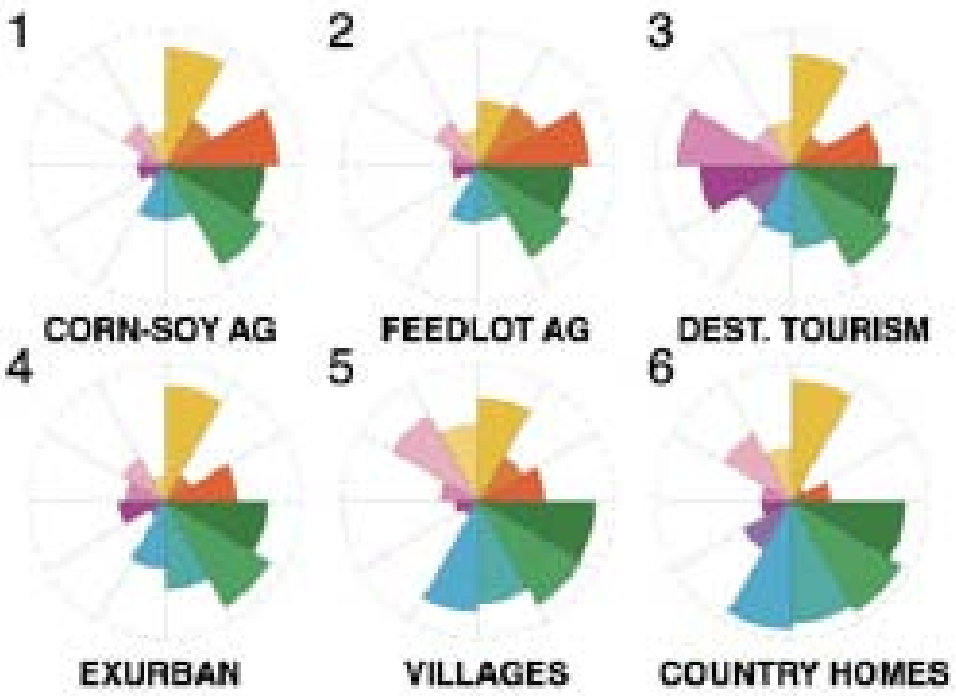
From de Groot et al 2009

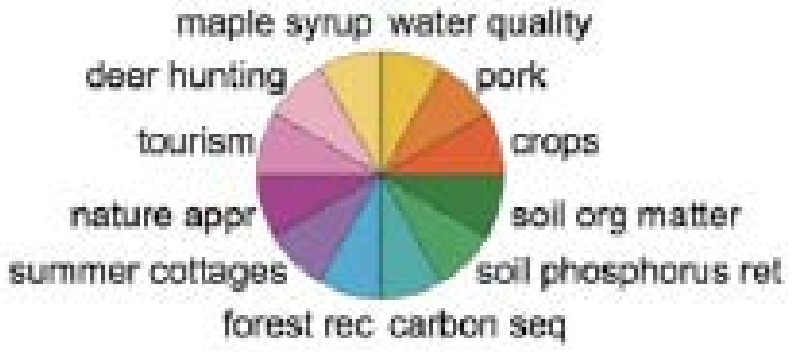
Different land use types result in different ecosystem service bundles

Utilization of ecosystem services on the landscape affects soil, sediment and water status



From de Groot et al 2009





from Rausdepp-Hearne et al 2010

Both intrinsic landscape properties and management activities (service use practices) affect sediment status

Agricultural land use

*From S E Apitz, S Casper, A Angus and S M White (2010) The Sediment Relative Risk Model (SC080018) – A User's Guide.

Sediment status as a result of land use can be modelled using site-specific or probabilistic conditions

Different land uses affect sediments in different ways

Non-agricultural land uses

Land Use-Specific Modules Can be Used To Model Sediment Impacts

*From S E Apitz, S Casper, A Angus and S M White (2010) The Sediment Relative Risk Model (SC080018) – A User's Guide.

The transport/location continuum. In terms of SEcoRA, these are exposure factors, and must be addressed

Exposure issues can be modelled

Calculation module for evaluating river transport issues*

*From S E Apitz, S Casper, A Angus and S M White (2010) The Sediment Relative Risk Model (SC080018) – A User's Guide.

We manage the landscape (on land and in water) to optimize chosen ecosystem services...

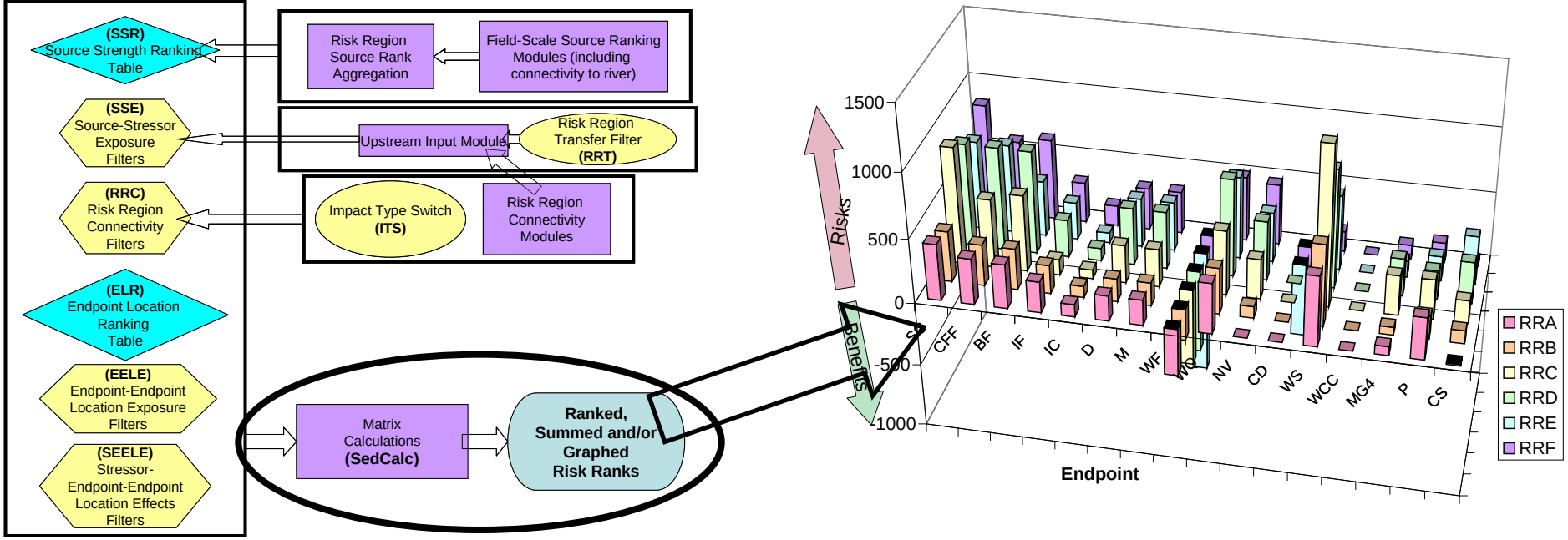
Ultimately, this affects the viability and sustainability of a variety of aquatic ecosystem services

This affects the status of water, soils and sediments at sites and in downstream systems...

This must be assessed and managed in a spatially explicit manner

From S E Apitz (submitted) Beyond Habitat: Conceptualising the role of sediment in sustaining ecosystem services

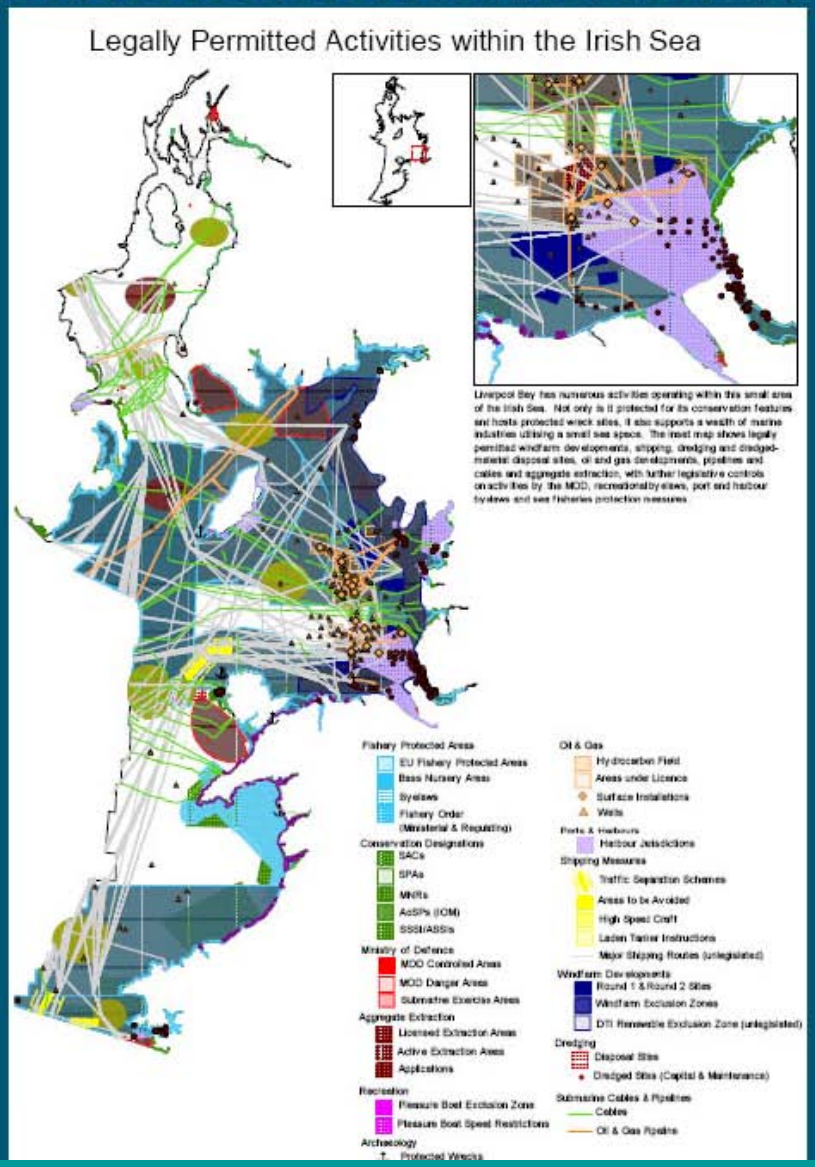
Watershed image from Natural Resources Conservation Service

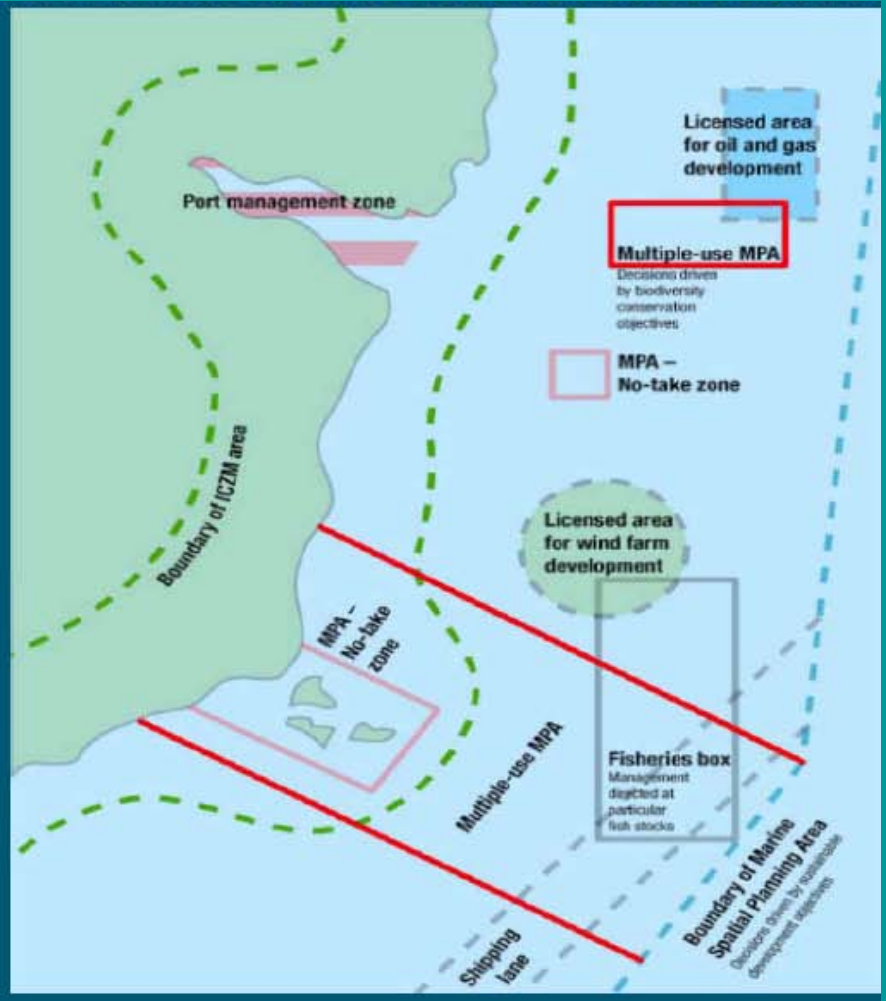


We have been developing models and tools that allow us to evaluate how management choices from the landscape perspective affect downstream aquatic ecosystem services

From Apitz et al (2010) The Sediment Relative Risk Model (SC080018) – A User's Guide

In future, landscape and coastal management should be considered in terms of maximizing ecosystem services while minimizing impacts, at many scales, at sea and upland





Mapping and zoning for Marine Spatial Planning

Conclusions

- Sediment plays a complex role in ecosystem functioning and the provision of ecosystem services
- Landscape biophysical conditions (intrinsic and due to service use) affect attributes of sediment status (quantity, quality, location and transport)
- Risk (or effects) of sediment to a given endpoint/SPU are a function of all aspects of status
- SEcoRA and decision frameworks must balance the benefits of landscape-scale service use against the sustainability of aquatic ecosystem services
  - Sediments themselves are only one component of ecosystems and SEcoRA is thus a component of landscape management
- While this is complex, tools are being developed to aid in such work

For more information...

- S E Apitz (in review) Beyond Habitat: Conceptualising the role of sediment in sustaining ecosystem services, submitted to Science of the Total Environment, Special Issue on Ecosystem Functions, Services and Biodiversity in ERA.
- P von der Ohe, S E Apitz, M Beketov, D Borchardt, D de Zwart, W Goedkoop, M Hein, S Hellsten, D Hering, B J Kefford, A Marcomini, V Panov, L Posthuma, R B Schäfer, E Semenzin and W Brack (in press). Chapter 3. Risk Assessment to Support River Basin Management in J Brils, D Barcelo, W Brack, D Mueller, P Negrel, T Track, J Vermaat (eds), *Towards Risk-Based Management of River Basins*, Handbook of Environmental Chemistry Series, Springer.
- S E Apitz, S Casper, A Angus and S M White (2010) The Sediment Relative Risk Model (SC080018) – A User's Guide. Report to the Environment Agency, SEA Environmental Decisions Ltd and Cranfield University, March 2010 (175p supplemented with a PowerPoint Guide).