…transform information into action

Quantifying Ecosystem Service Trade-offs at the Catchment Scale: From Landscape Management to Aquatic Protection

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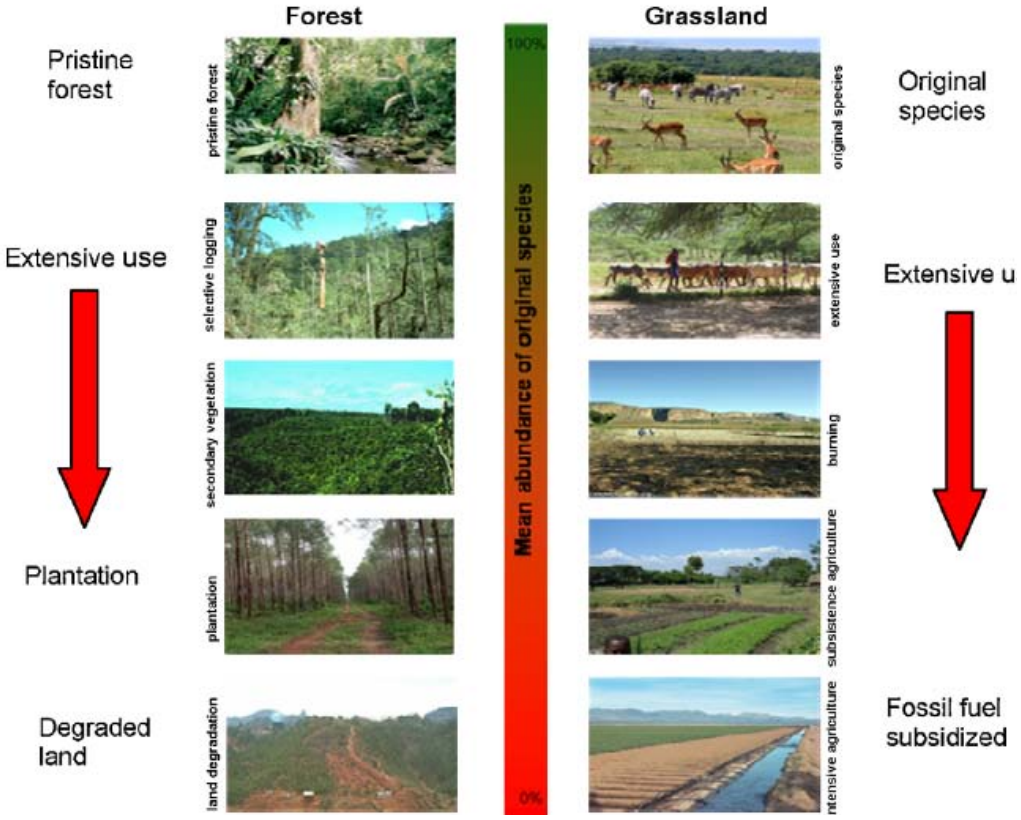
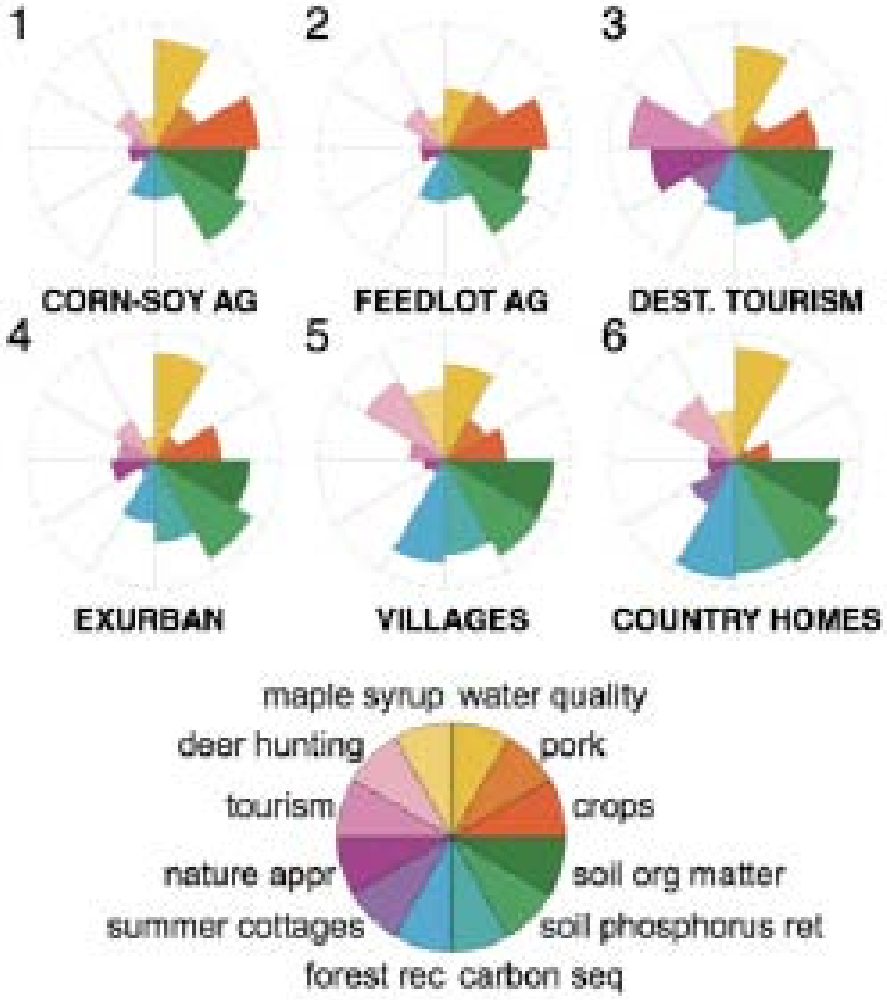
Different land use types result in different ecosystem service clusters

There are both intended and unintended consequences of land management choices

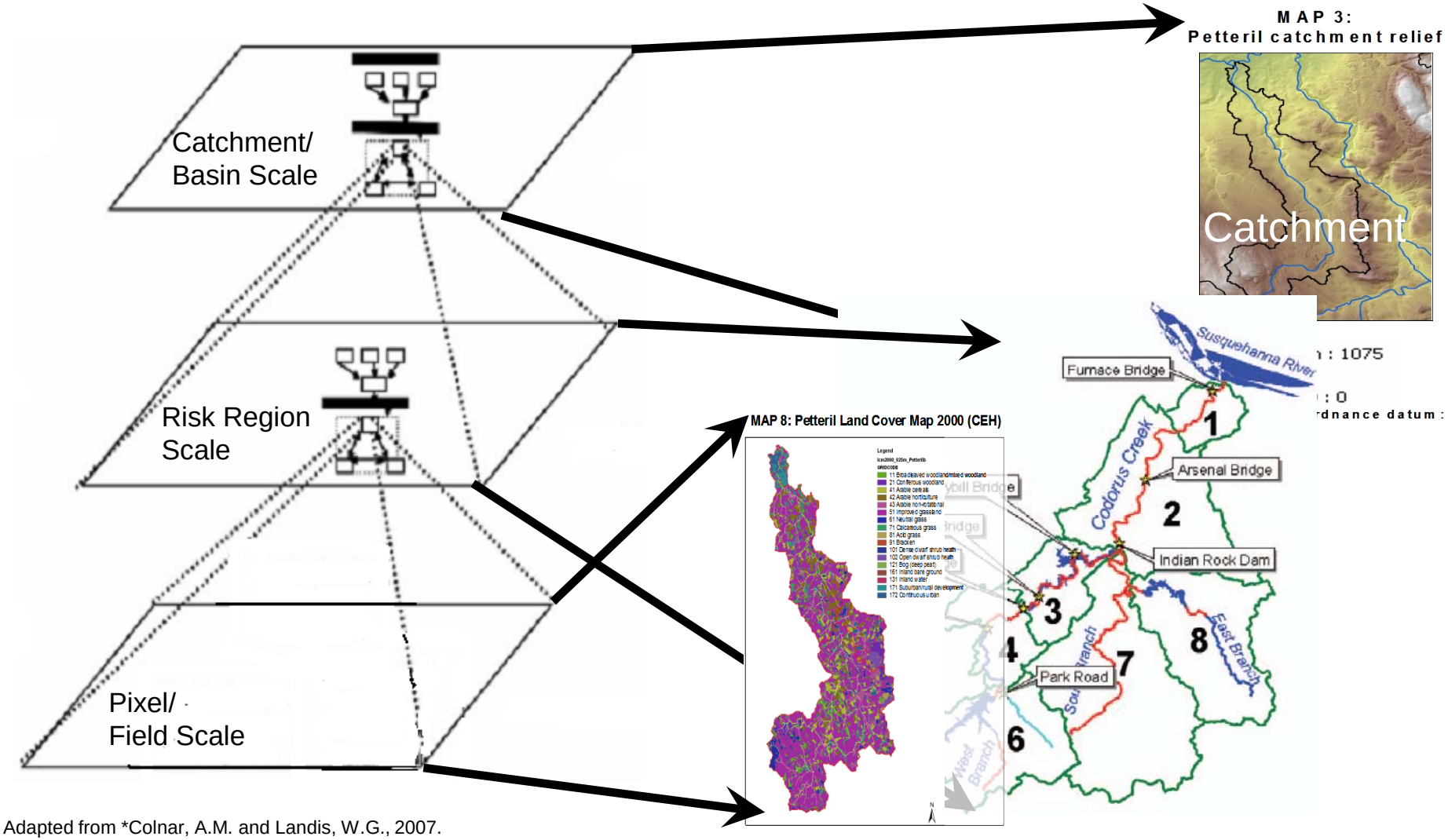


From de Groot et al 2009



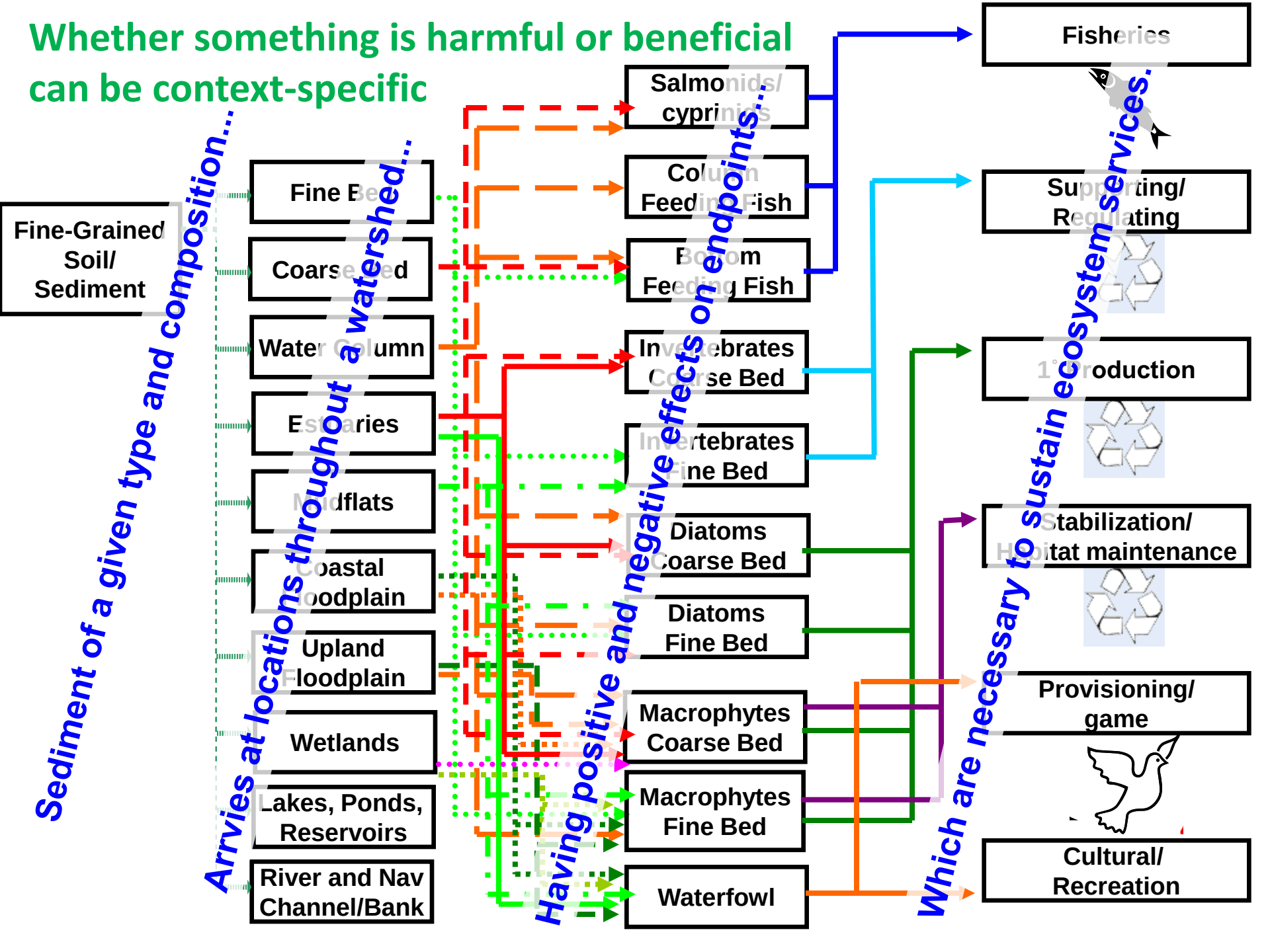
from Rausdepp-Hearne et al 2010

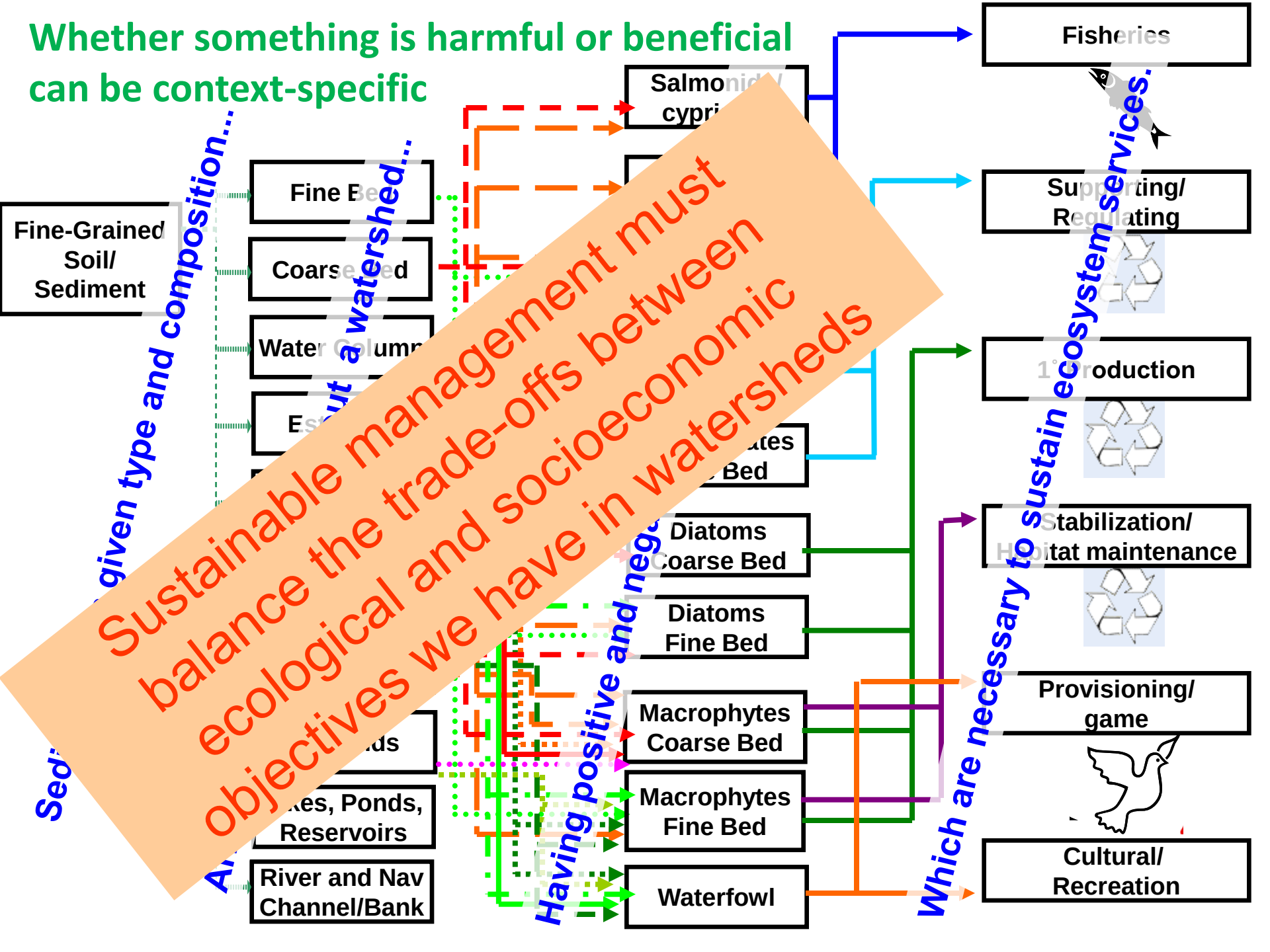
Management of River Basin Objectives Requires Evaluation at the catchment, reach and field scale

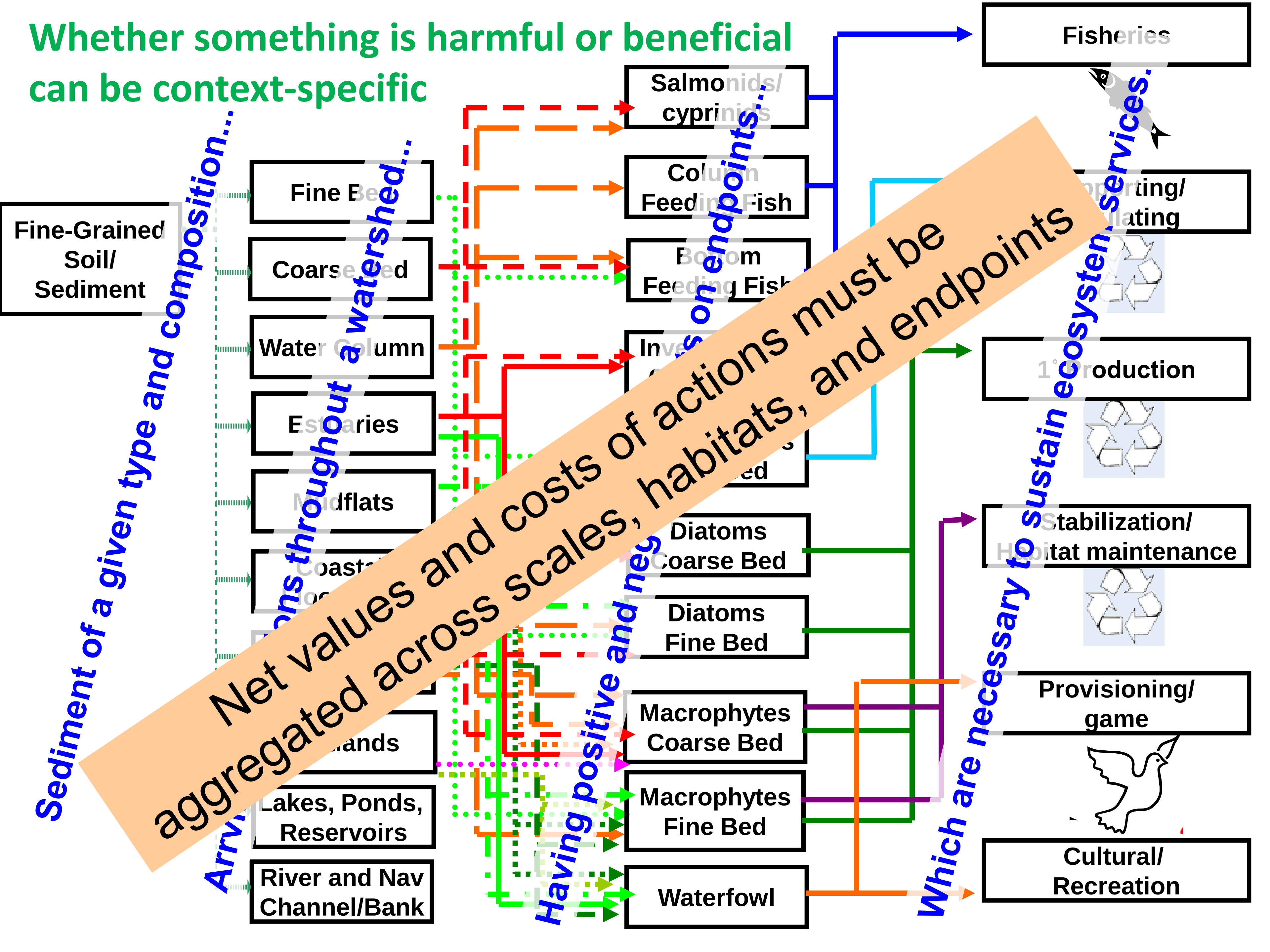


Adapted from *Colnar, A.M. and Landis, W.G., 2007.

Whether something is harmful or beneficial can be context-specific




Whether something is harmful or beneficial can be context-specific
Fine-Grained Soil/ Sediment
Fine Bed
Coarse Bed
Water Column
Estuary
Bed
Diatoms Coarse Bed
Diatoms Fine Bed
Macrophytes Coarse Bed
Macrophytes Fine Bed
Waterfowl
Reservoirs
River and Nav Channel/Bank
Fisheries
Supporting/ Regulating
Production
Stabilization/ Habitat maintenance
Provisioning/ game
Cultural/ Recreation
Sustainable management must balance the trade-offs between ecological and socioeconomic objectives we have in watersheds
Having positive and negative
Which are necessary to sustain ecosystem services.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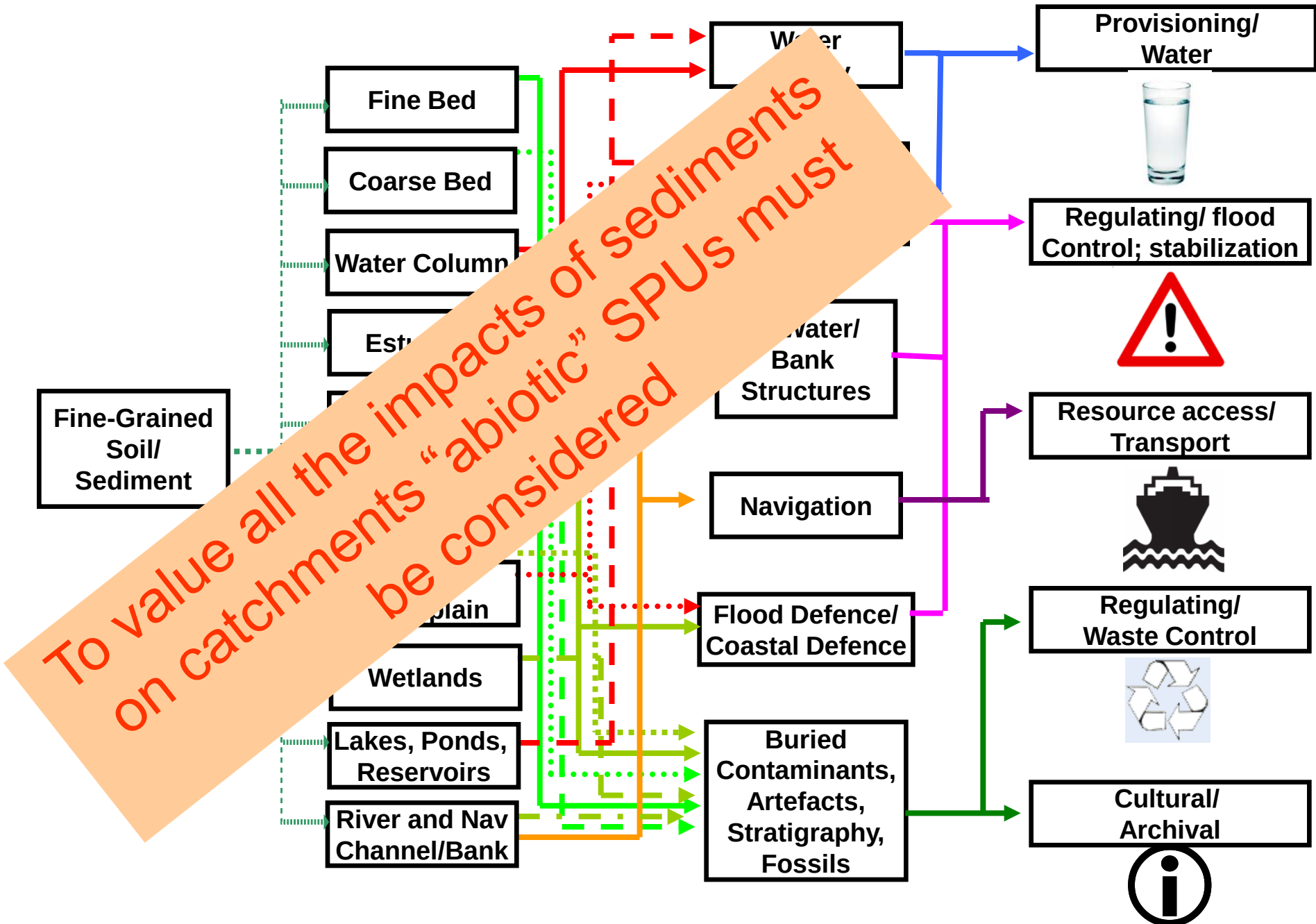
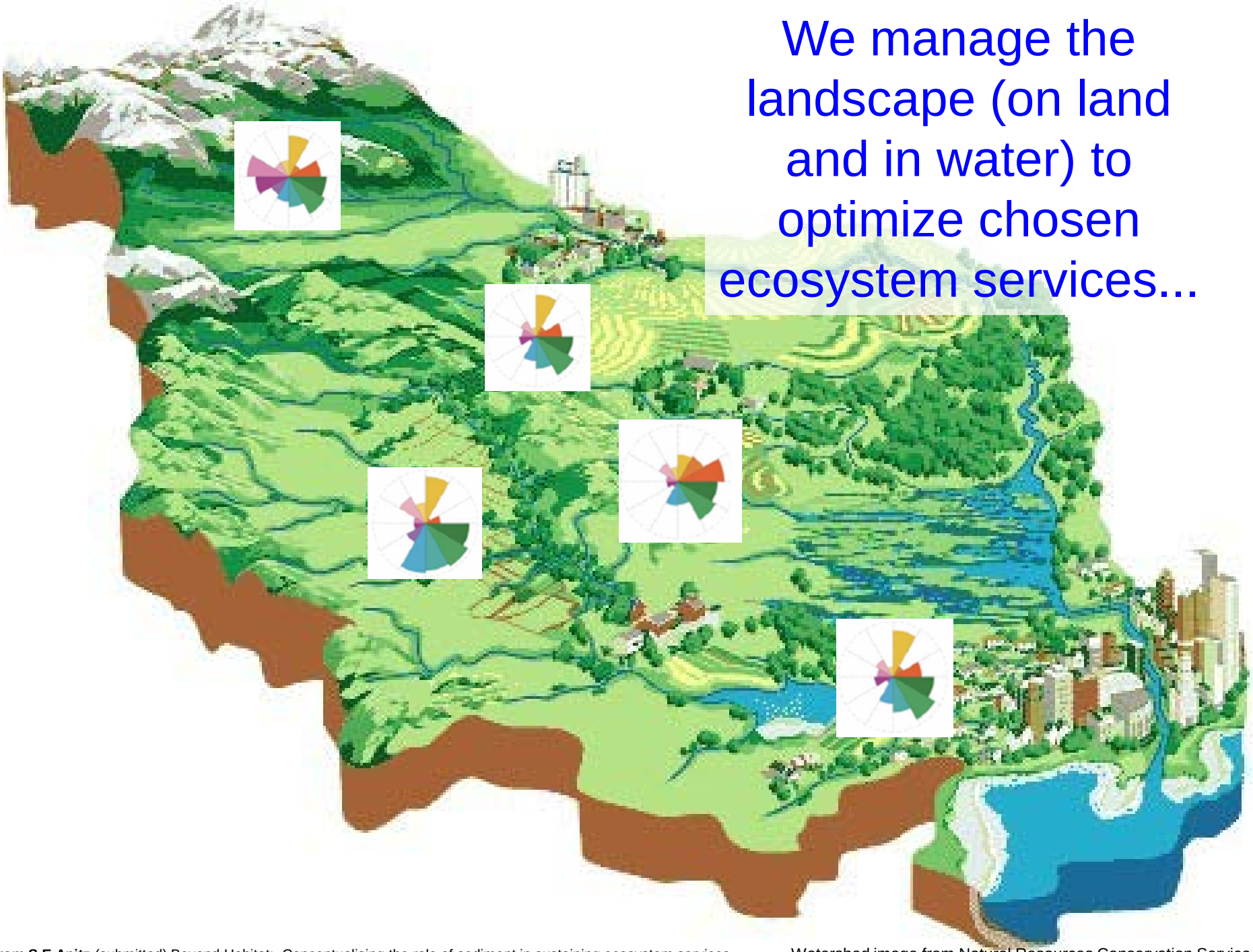
udflats
Coast
lands
Lakes, Ponds, Reservoirs
River and Nav Channel/Bank
Salmonids/ cyprinids
Column Feeding Fish
Bottom Feeding Fish
Inv
ed
Diatoms Coarse Bed
Diatoms Fine Bed
Macrophytes Coarse Bed
Macrophytes Fine Bed
Waterfowl
Fisheries
rting/ lating
1° Production
Stabilization/ Habitat maintenance
Provisioning/ game
Cultural/ Recreation
Sediment of a given type and composition…
Arriv
ons throughout a watershed…
Having positive and neg
s on endpoints…
Which are necessary to sustain ecosystem services.
Net values and costs of actions must be aggregated across scales, habitats, and endpoints

Pathways for abiotic endpoints – fine-grained sediment

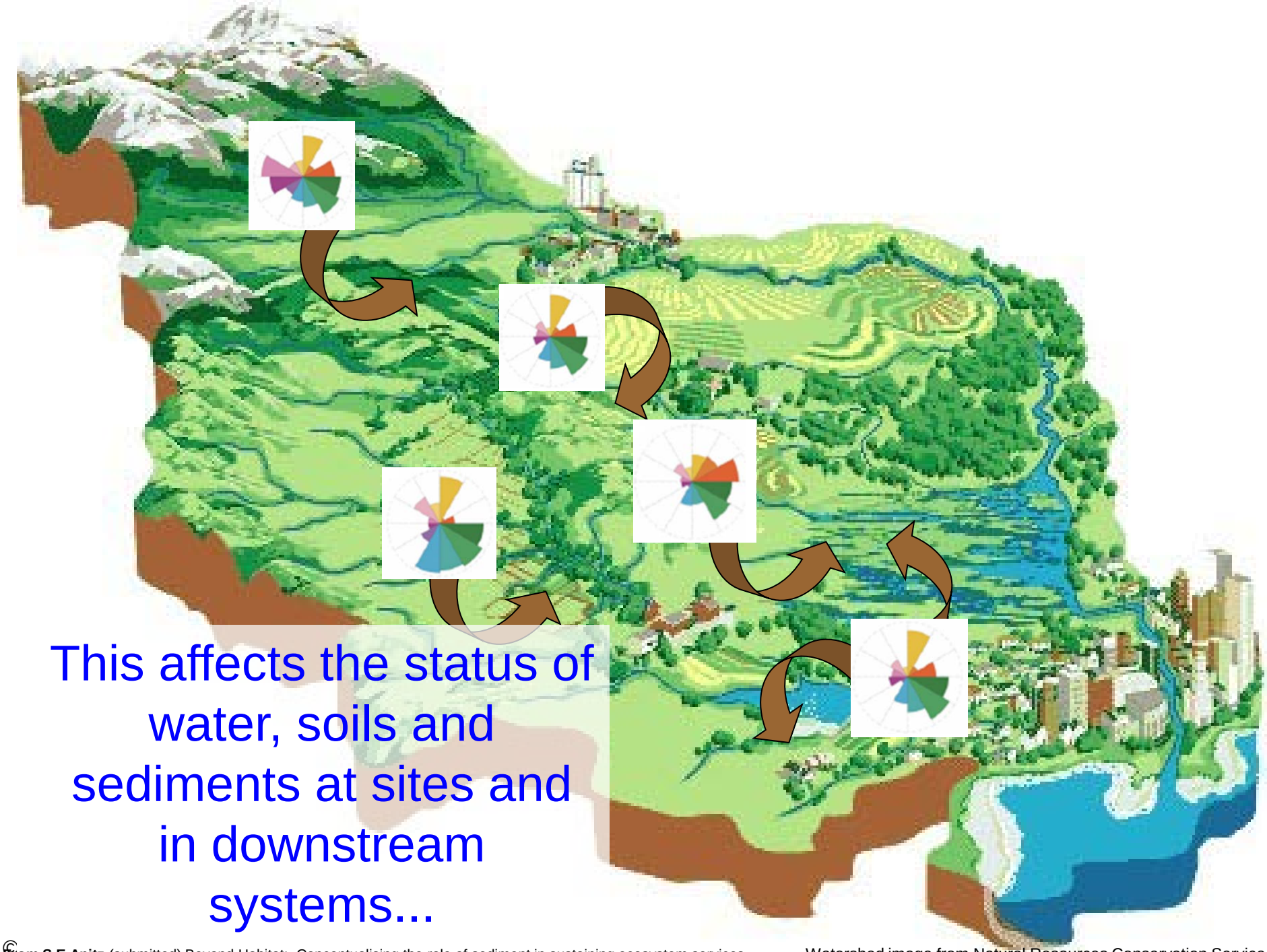




We manage the landscape (on land and in water) to optimize chosen ecosystem services...

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

Watershed image from Natural Resources Conservation Service



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

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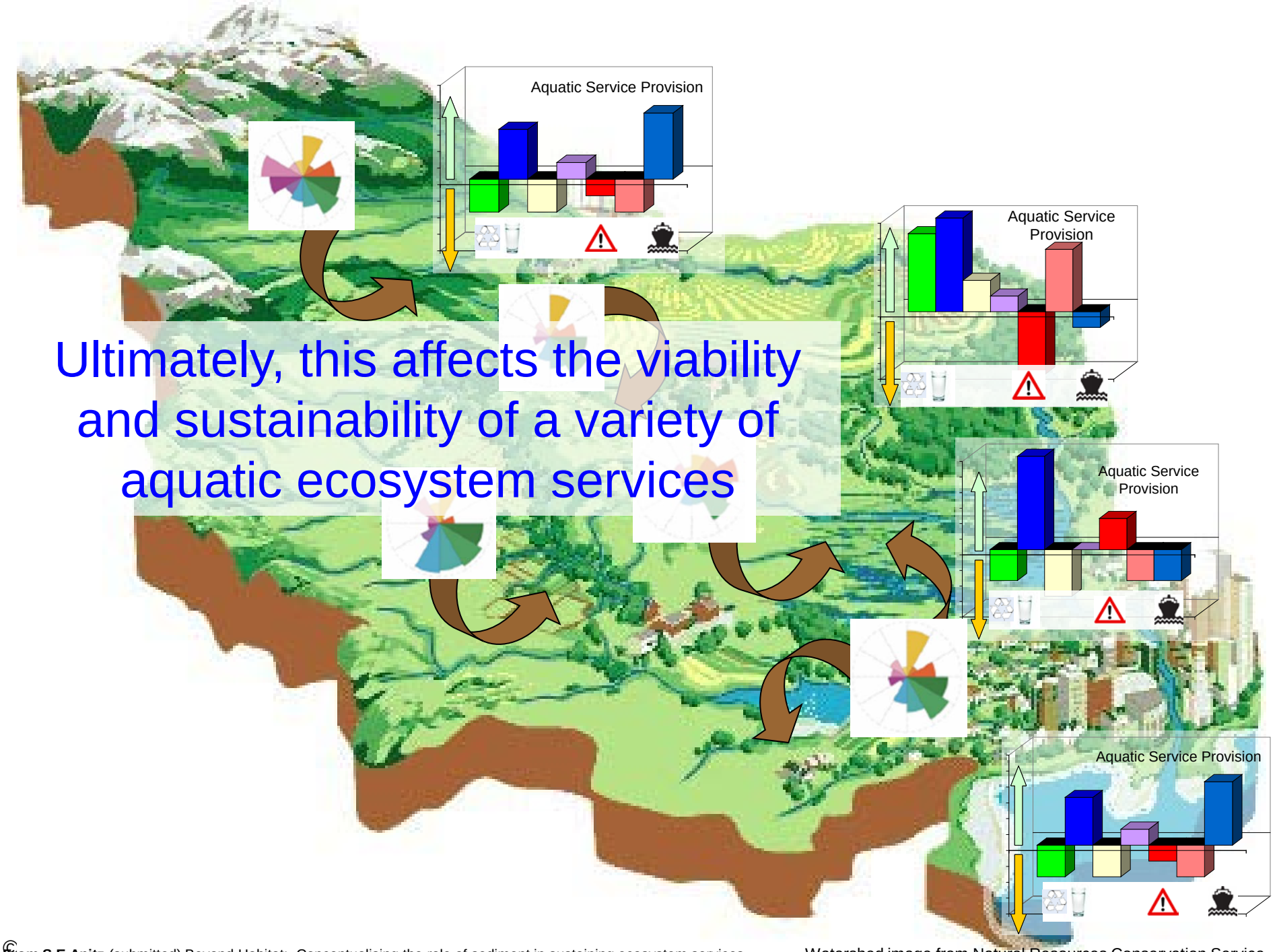
Watershed image from Natural Resources Conservation Service



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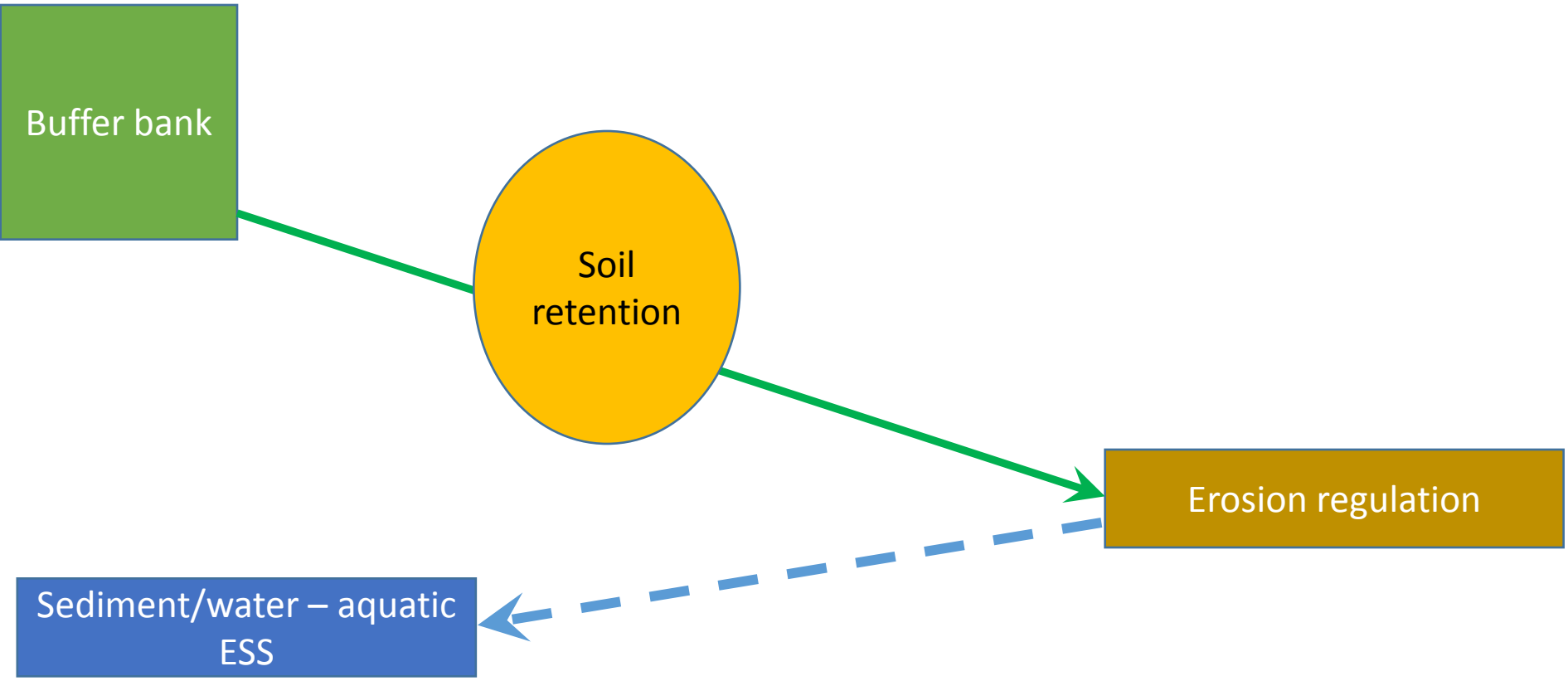
Watershed image from Natural Resources Conservation Service

Example: A well-designed buffer bank (on an agricultural field) can reduce soil loss, reducing sediments which impact aquatic systems.



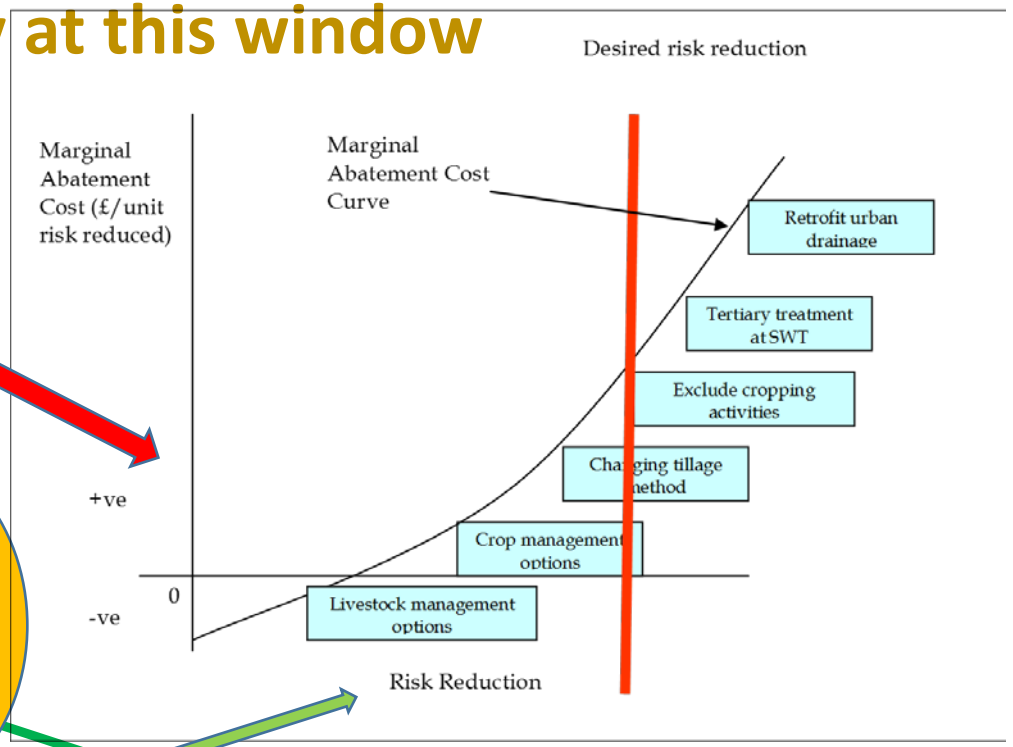
Example: A well-designed buffer bank (on an agricultural field) can reduce soil loss, reducing sediments which impact aquatic systems. A sediment-focused evaluation looks only at this window

Management action (cost)

Buffer bank

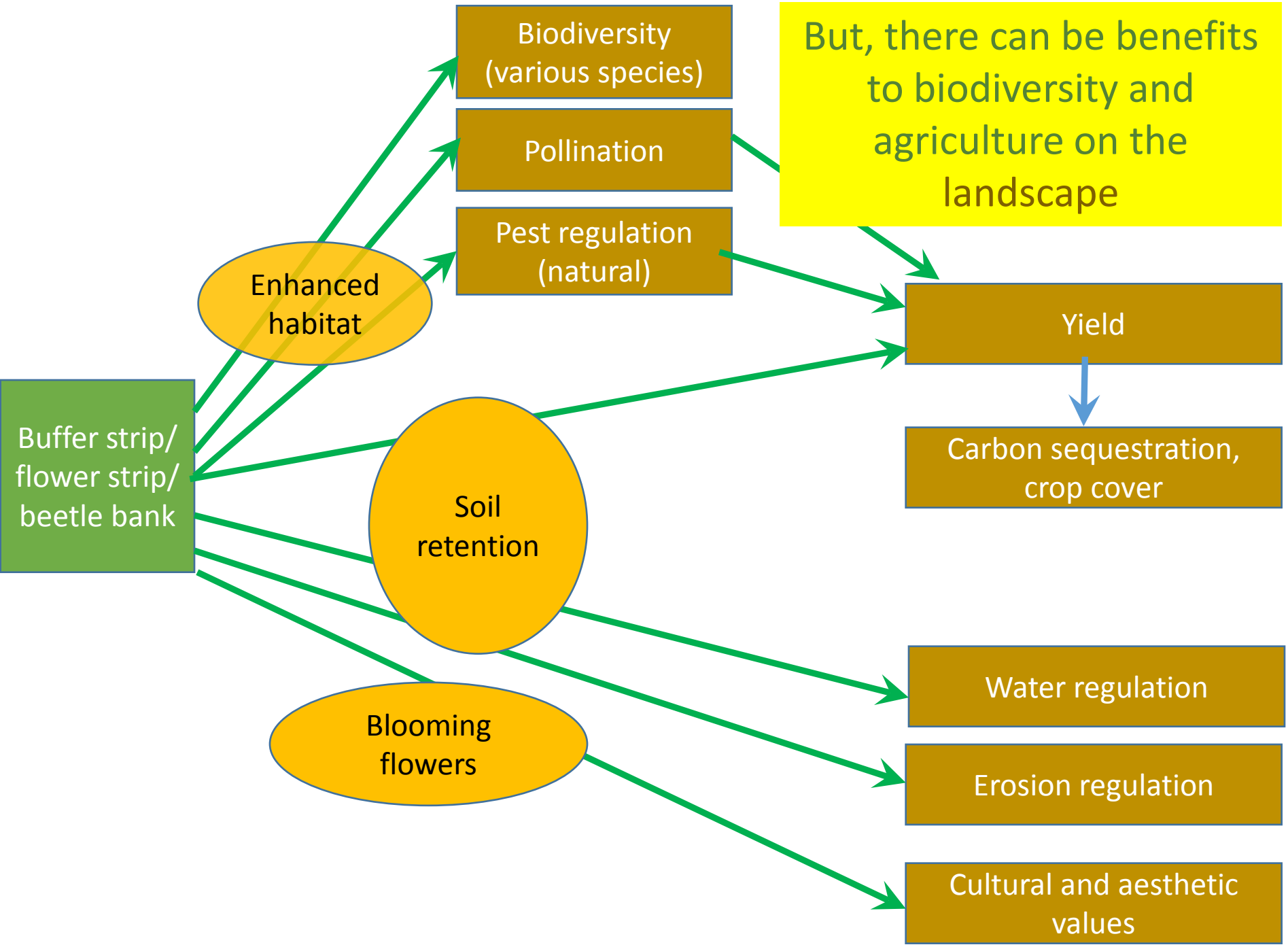
Soil retention

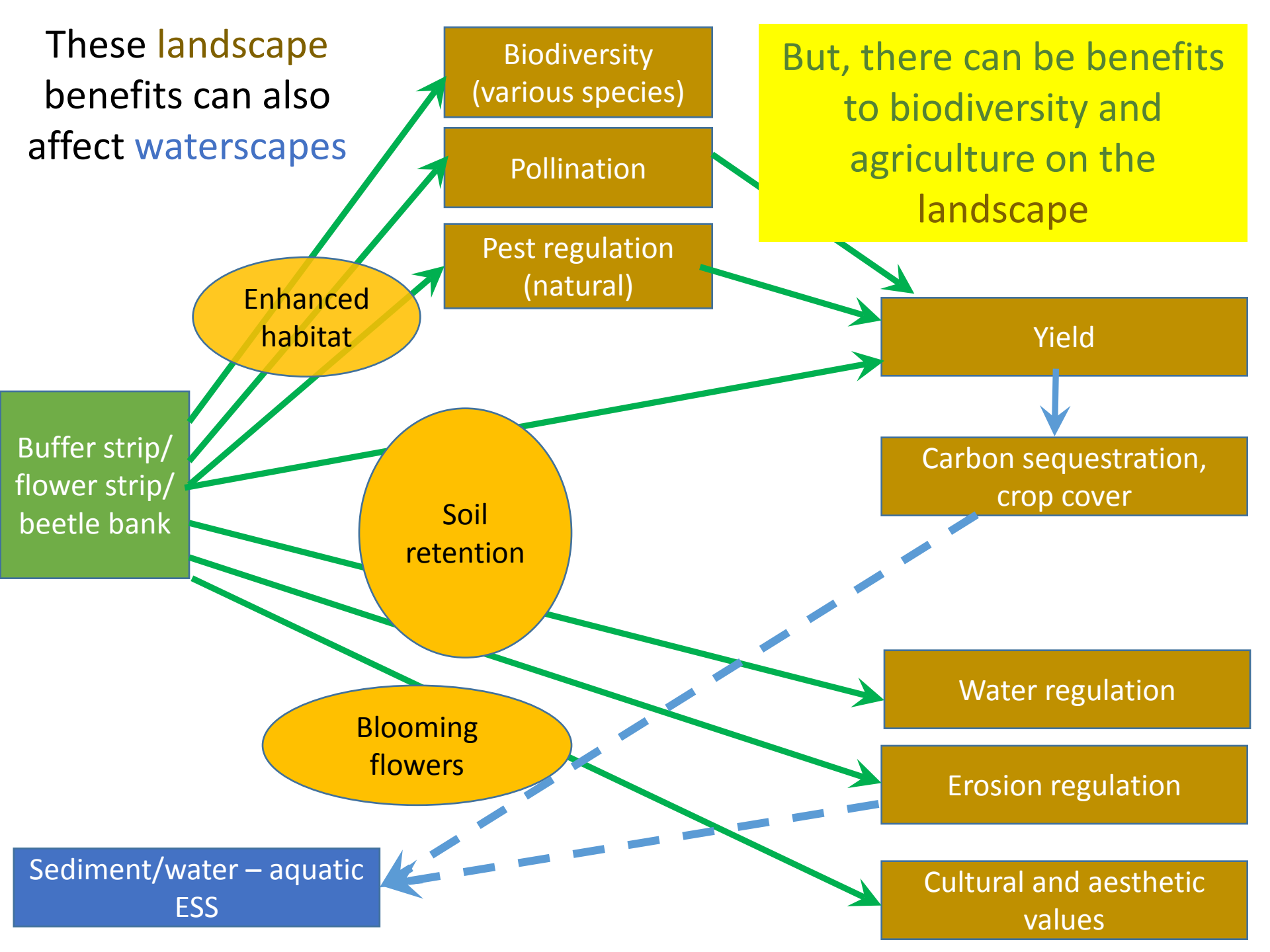
Sediment reduction (benefit - to some SPUs)



Erosion regulation

Sediment/water – aquatic ESS


But, there can be benefits to biodiversity and agriculture on the landscape
Biodiversity (various species)
Pollination
Pest regulation (natural)
Enhanced habitat
Buffer strip/ flower strip/ beetle bank
Soil retention
Blooming flowers
Yield
Carbon sequestration, crop cover
Water regulation
Erosion regulation
Cultural and aesthetic values


These landscape benefits can also affect waterscapes
Biodiversity (various species)
Pollination
Pest regulation (natural)
But, there can be benefits to biodiversity and agriculture on the landscape
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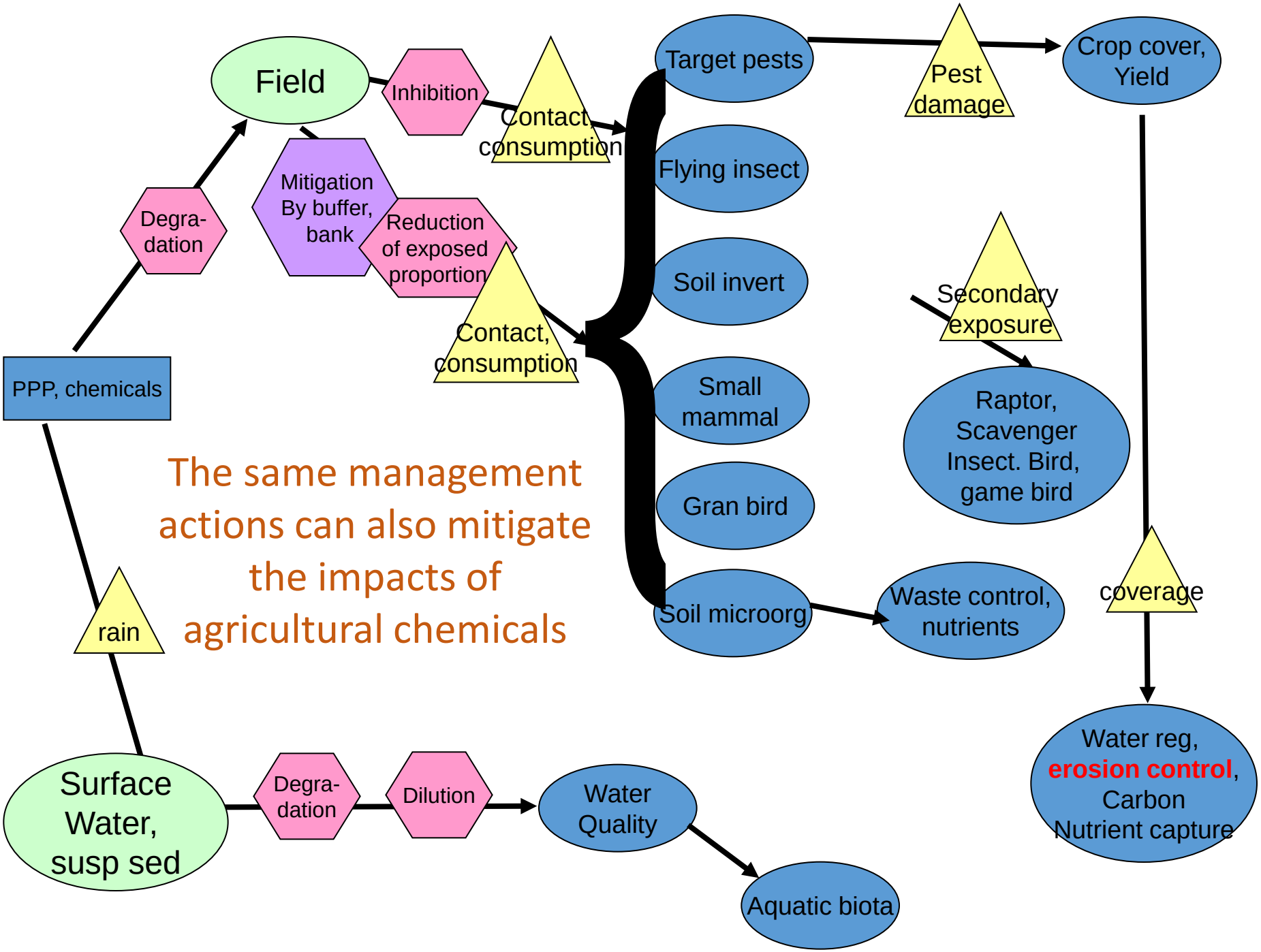
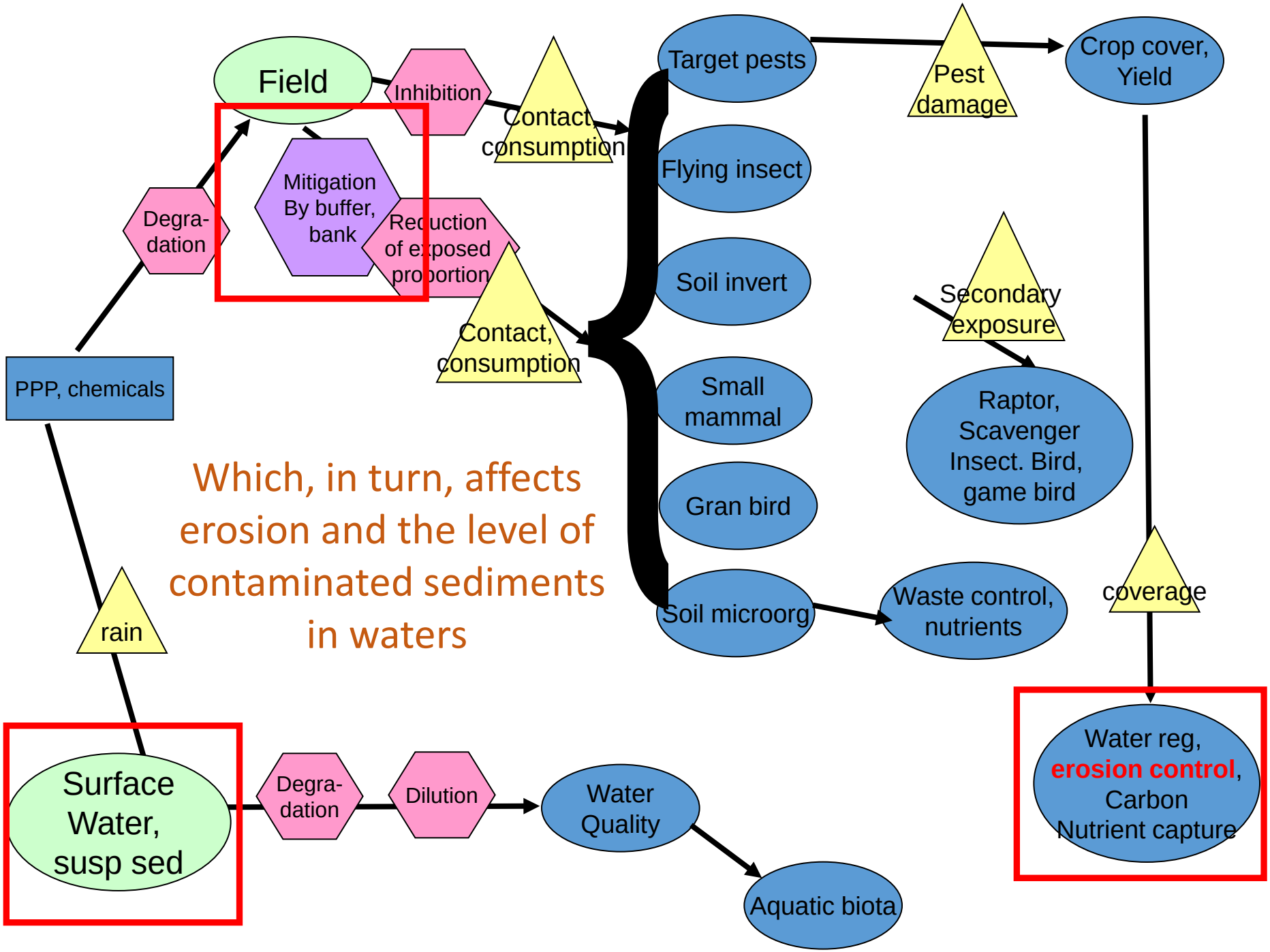
Sediment/water – aquatic ESS
Cultural and aesthetic values


Field
Inhibition
Contact, consumption
Target pests
Pest damage
Crop cover, Yield
Degra-dation
Mitigation By buffer, bank
Reduction of exposed proportion
Contact, consumption
Flying insect
Soil invert
Small mammal
Gran bird
Soil microorg
Secondary exposure
Raptor, Scavenger Insect. Bird, game bird
Waste control, nutrients
coverage
Water reg, erosion control, Carbon Nutrient capture
PPP, chemicals
rain
Surface Water, susp sed
Degra-dation
Dilution
Water Quality
Aquatic biota
The same management actions can also mitigate the impacts of agricultural chemicals


Field
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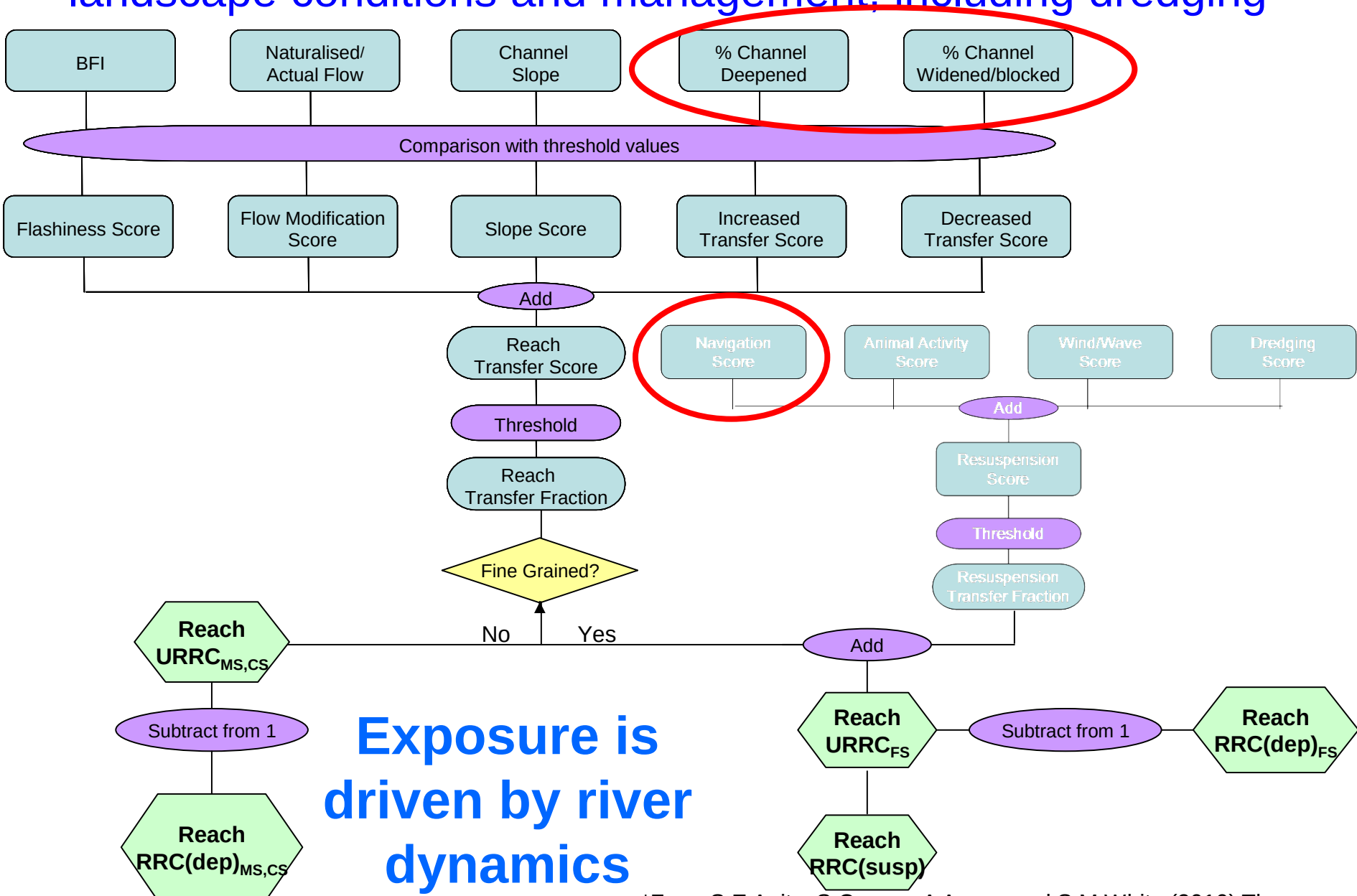
Reduction of exposed proportion
Degra-dation
Flying insect
Soil invert
Contact, consumption
Secondary exposure
PPP, chemicals
Small mammal
Raptor, Scavenger Insect. Bird, game bird
Which, in turn, affects erosion and the level of contaminated sediments in waters
Gran bird
Soil microorg
Waste control, nutrients
coverage
rain
Water reg, erosion control, Carbon Nutrient capture
Surface Water, susp sed
Degra-dation
Dilution
Water Quality
Aquatic biota

The ability of rivers to maintain sediment balance is driven by landscape conditions and management, including dredging



Exposure is driven by river dynamics

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

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

Land Uses, Activities and Services		Affecting...	Quality		Quantity		Transport	
Landscape Use	Service/ Function Optimized		Management Activities	Intrinsic Properties	Management Activities	Intrinsic Properties	Management Activities	Intrinsic Properties
Residential								andscape ctivity, rainfall, opography
STW/CSO								ll, topography
Industry								-
Transport - land								andscape ctivity, rainfall, opography
Transport - navigation								iness, rainfall, graphy, flow
In-channel structures - dams and wiers	control			materials	erosion		damage	iness, rainfall, graphy, flow

e.g., Navigation is a source of impact, a
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Va
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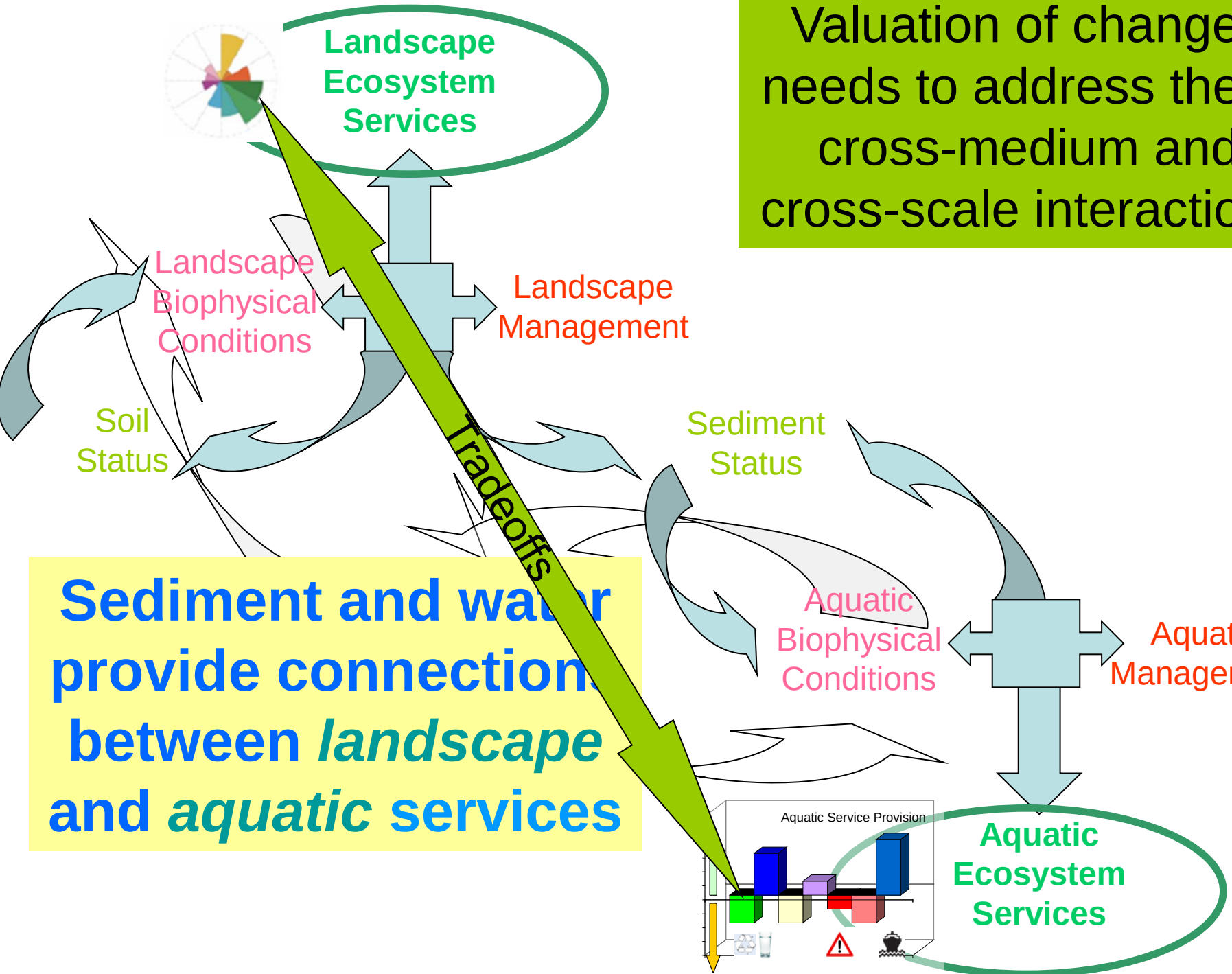
and
downstream)

The benefits of landscape use must be balanced against the impacts

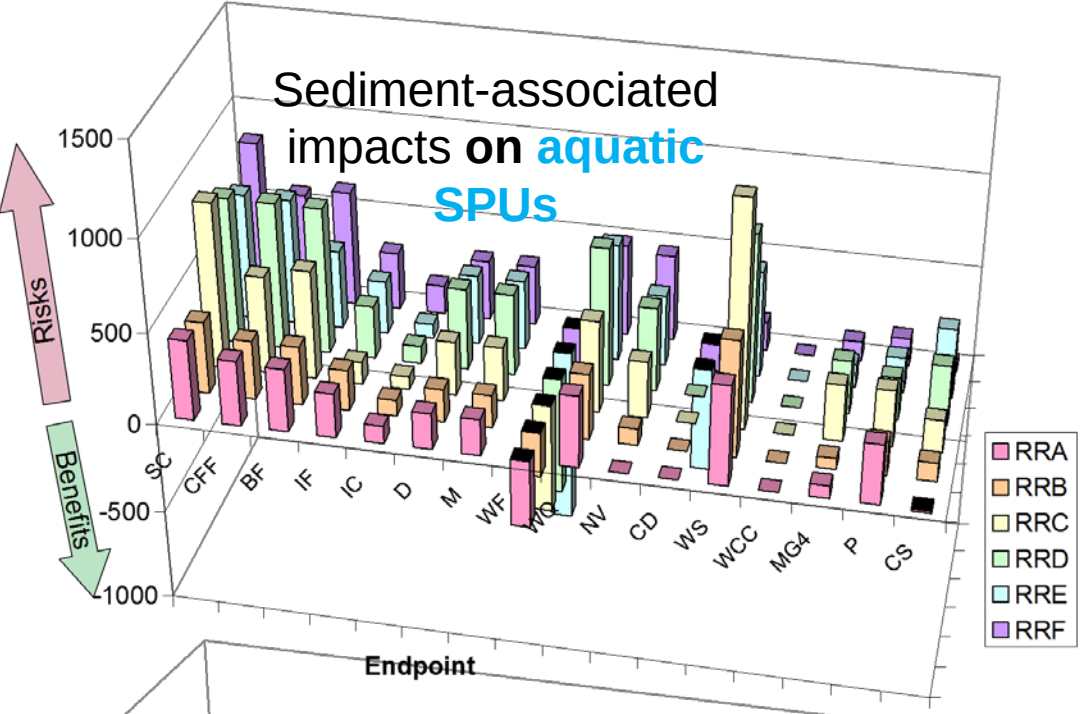
Non-agricultural land and water uses

Valuation of changes needs to address these cross-medium and cross-scale interactions

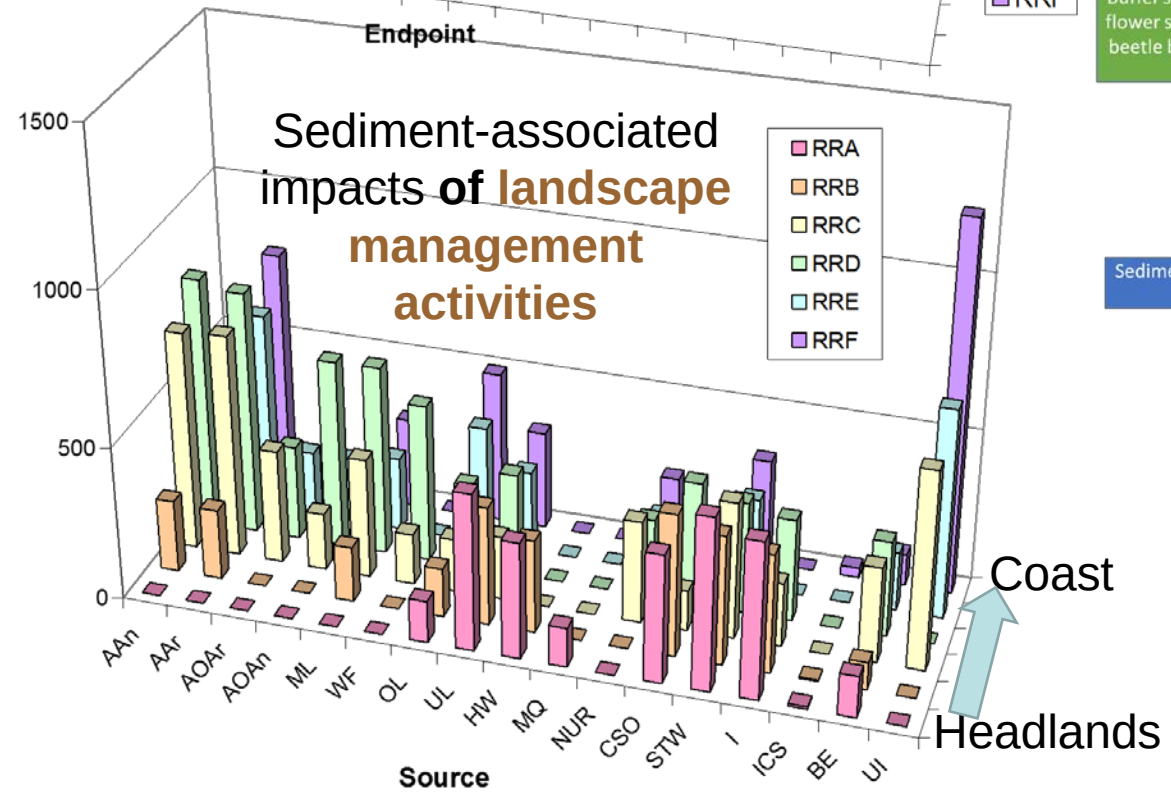


Sediment and water provide connections between *landscape* and *aquatic* services

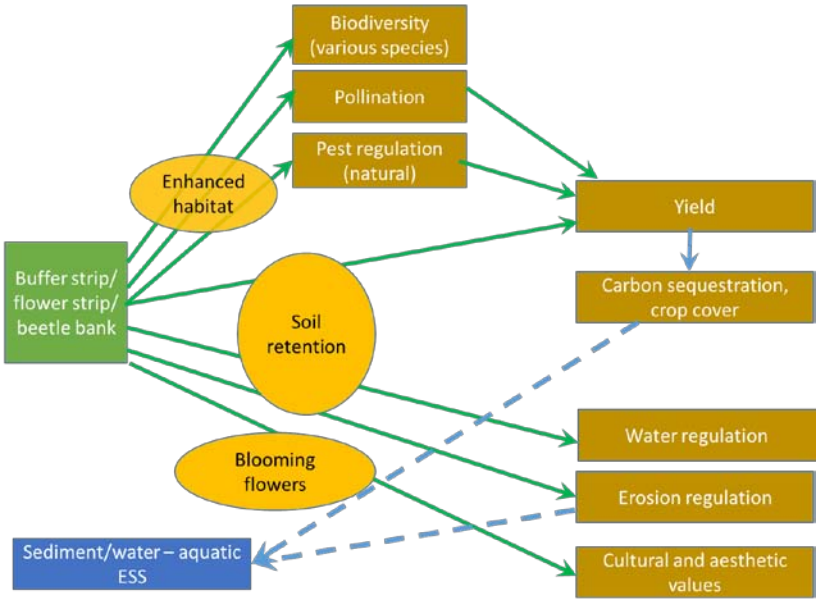
Sediment-associated impacts **on aquatic SPUs**



Sediment-associated impacts **of landscape management activities**



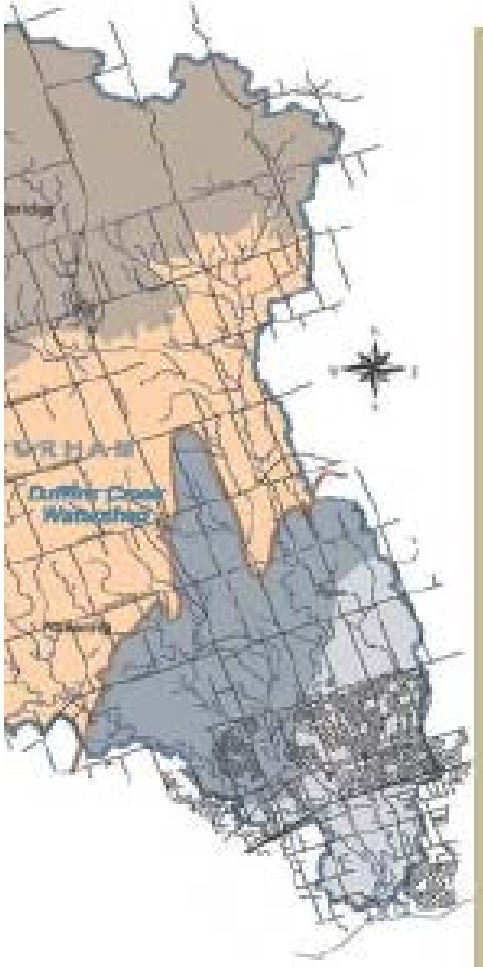
These are all part of the valuation equation

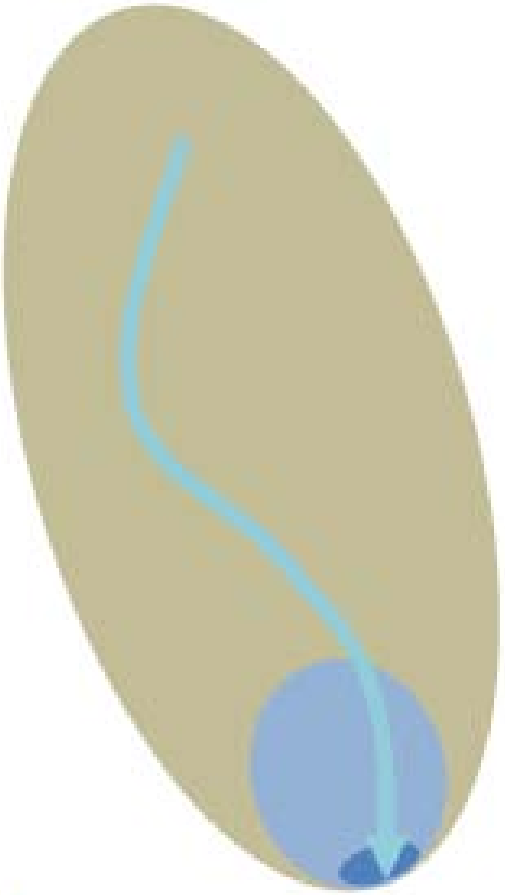


Sediment management-associated impacts **on landscape SPUs (ag)**

EJ - Spatial issues – disparate stakeholders, different priorities

Environmental Challenge:
The Reality of Nested Scales





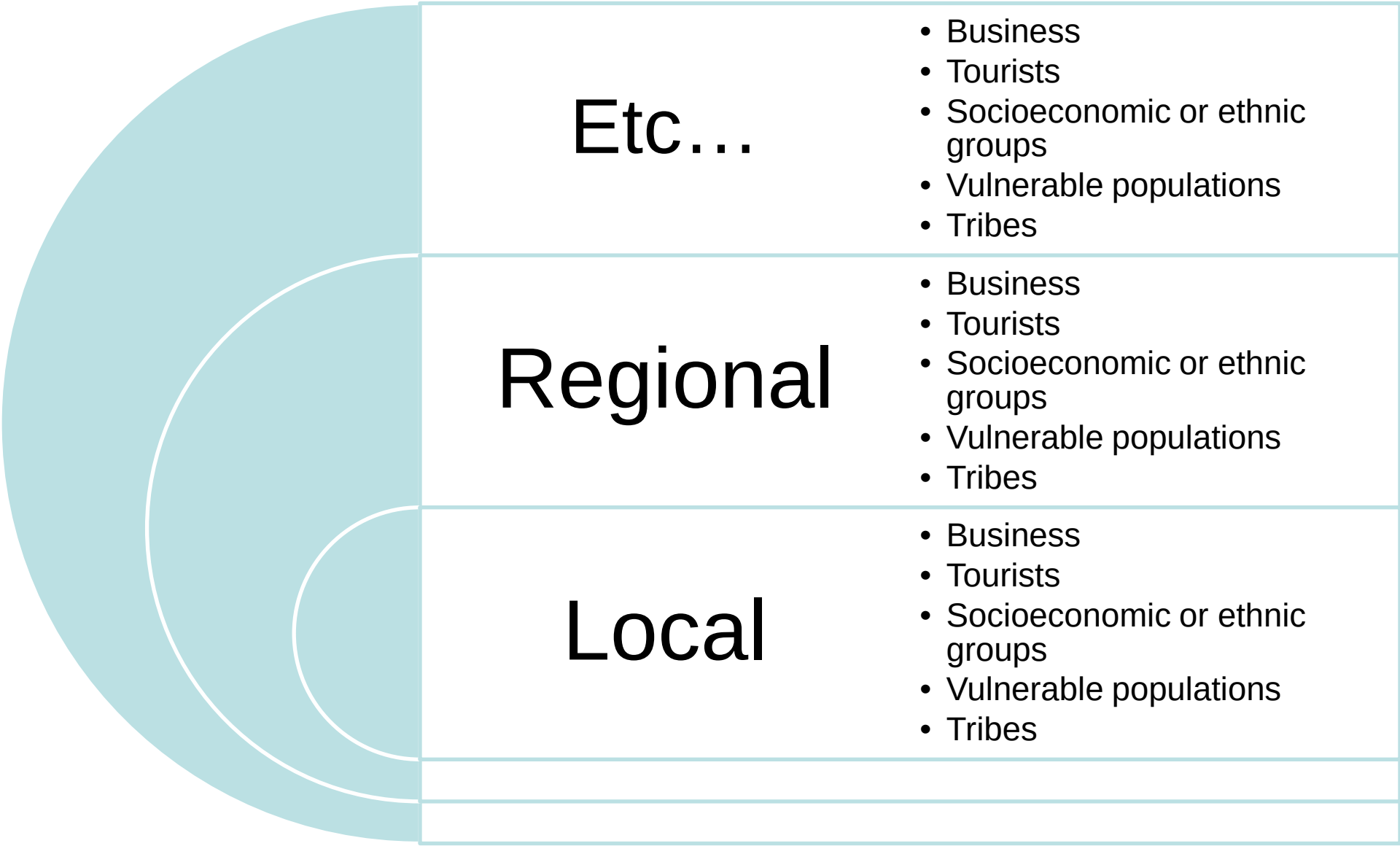
Watershed:
- Agriculture/forestry
- Suburban sprawl
- Golf courses
- Storm water flooding
- Stream bank erosion
- Soil/solids transport
- Municipal wastewater

Urban Landscape:
- Hardscape runoff
- Sewers (CSO, SSO)
- Urban channels
- Industrial discharges
- Unpermitted sites

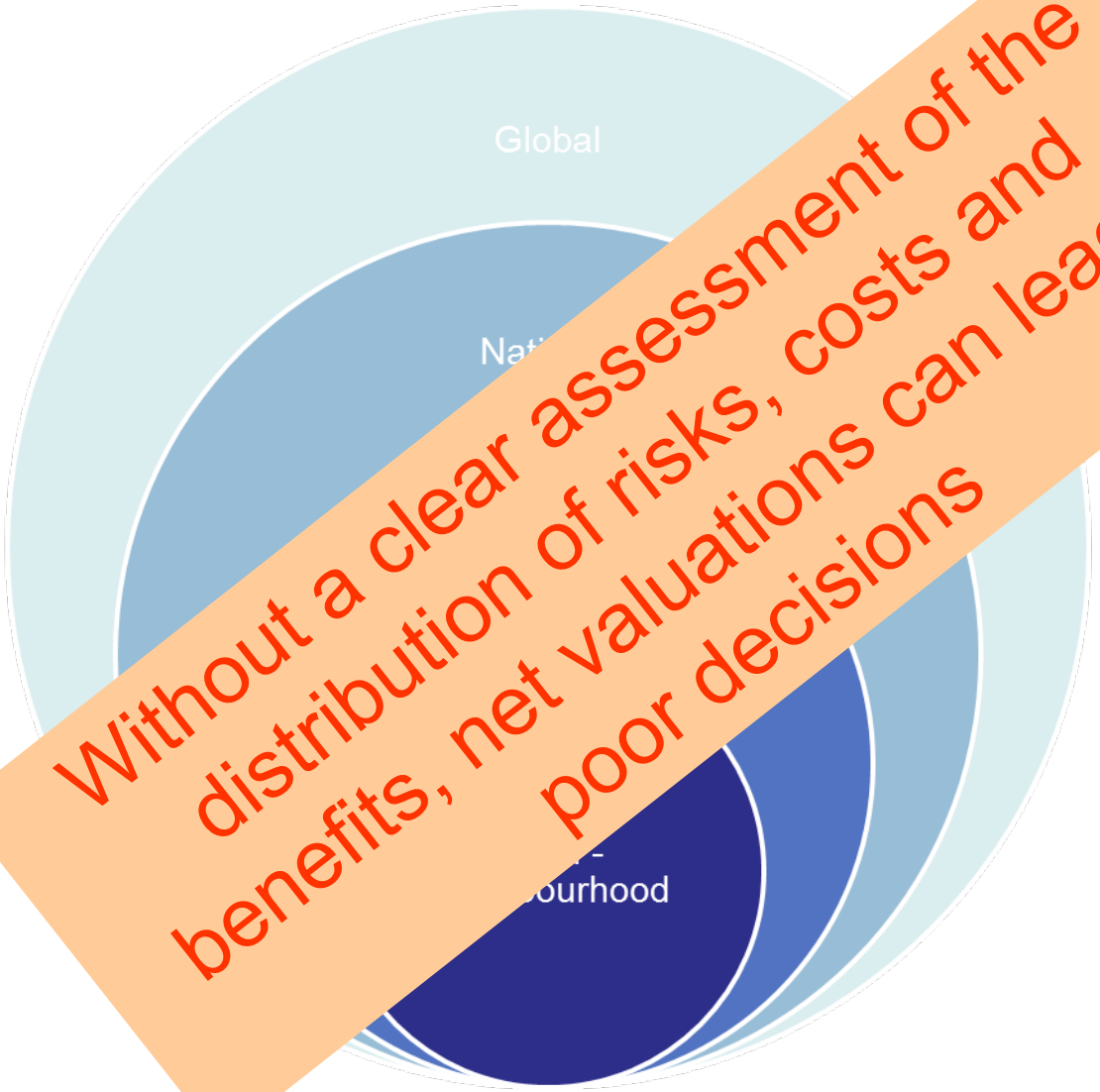
Waterfront:
- Port/harbor mgmt
- Navigational dredging
- Sediment resuspension
- Sed/water quality
- Re-development

From Brown et al 2013

Who bears the costs? Who reaps the benefits? Where and when?



EJ – equity issues: Costs and benefits differ in space

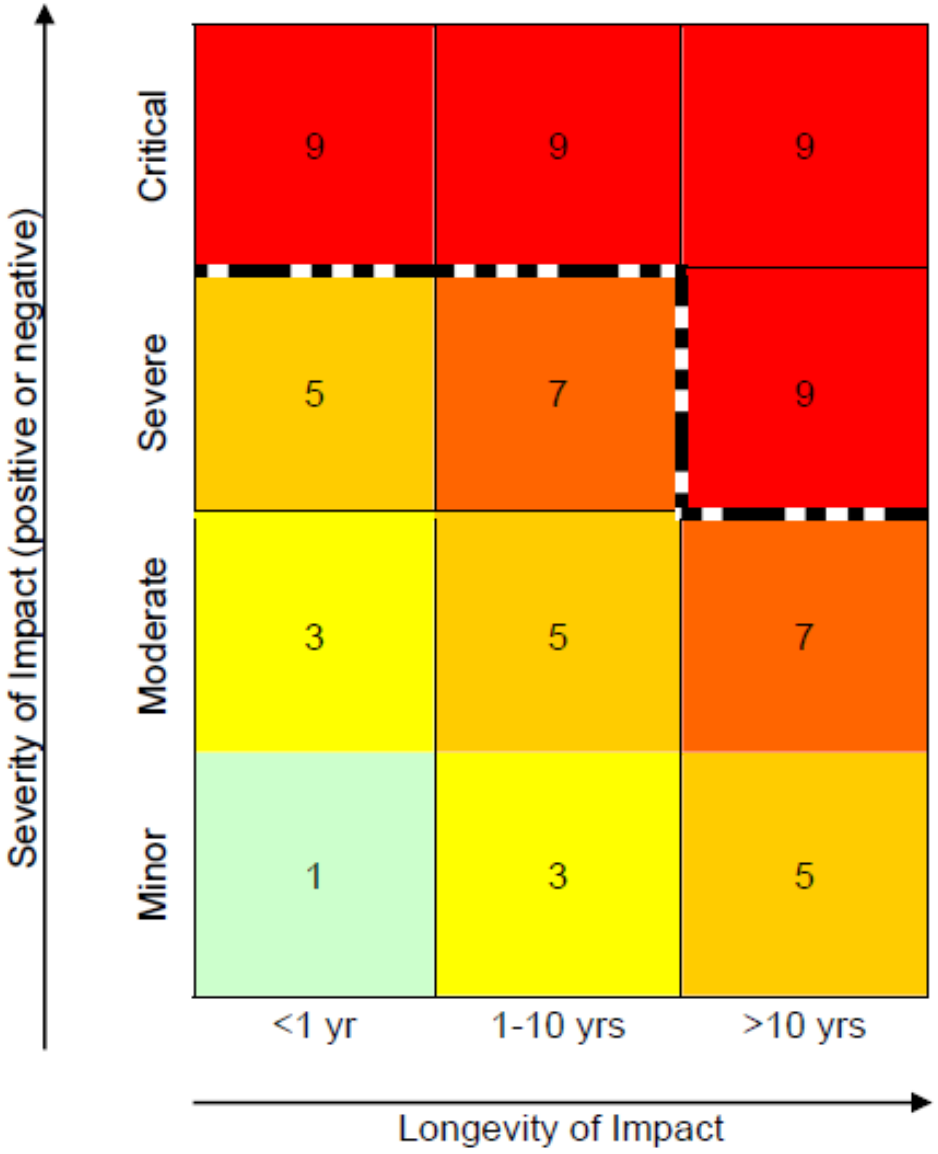


Without a clear assessment of the distribution of risks, costs and benefits, net valuations can lead to poor decisions

- Risks, hazards
- Jobs (lost and ined)
- ystem service ss and uplift
- Parks, green spaces, gentrification
- …

- Exposure?
- Access?
- Lifestyle?
- Education?

EJ - Intergenerational effects and discounting



From CL:AIRE 2011

- For some purposes, discounting ESS over time makes sense
- In other applications, it might not
- Most people expect discussions of sustainability to protect ESS across generations
  - The impacts and implications of discounting and other accounting practices should be clear

Ecosystem Valuation – cross-sectoral tool or greenwashing?

- Whether explicitly addressed or not, all management and policy choices result in EsS trade-offs
- EsS valuation ***can*** provide a thread by which cross-sectoral decisions can be informed
- To support sustainability it is essential to quantify how actions will affect a range of EsS in space and time
  - But simple monetisation has all the issues of any heavily aggregated single indicator for a complex system
  - The approach should fit the application
- EsS valuation should support more informed decisions
  - This requires clarity, transparency and relevance of approaches

Thank you for your time

- I am grateful to many collaborators and colleagues, too numerous to list here (I've tried to credit images and ideas in slides); but also in memoriam, Prof Sue White, who collaborated on much of this
- For more information, drsea@cvrl.org, or:
  - S E Apitz (2012) Conceptualising the role of sediment in sustaining ecosystem services: Sediment-Ecosystem Regional Assessment (SEcoRA), STOTEN 415:9-30
  - S E Apitz (2011) Sustainable sediment management? in Chapman, PM, Learned Discourses: Timely Scientific Opinions, *IEAM 7(4)*:691-693 .
  - 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).