Problem formulation step for ERA:
Deriving specific protection goals

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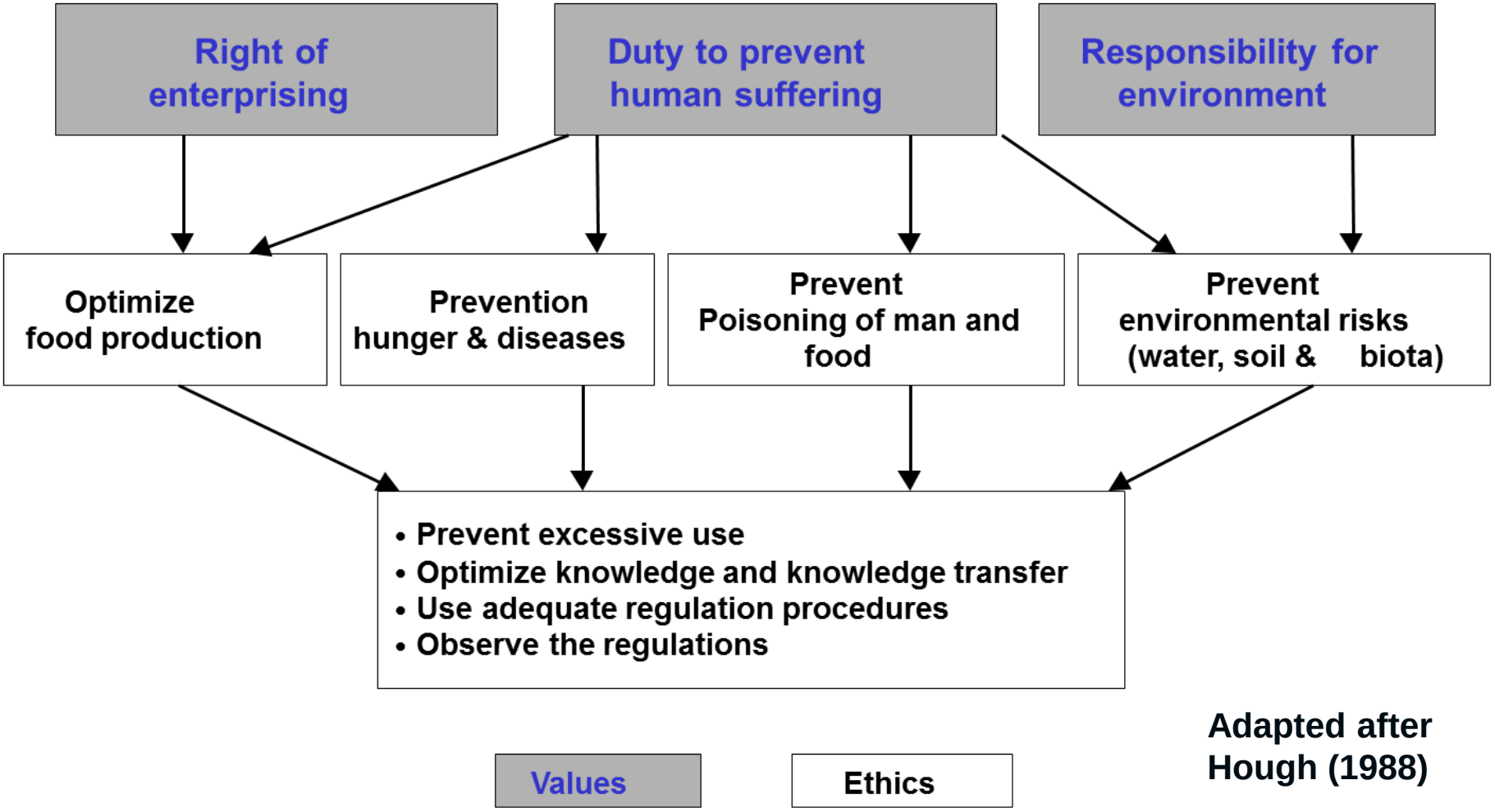
Pesticides and conflicting interests



Adapted after Hough (1988)

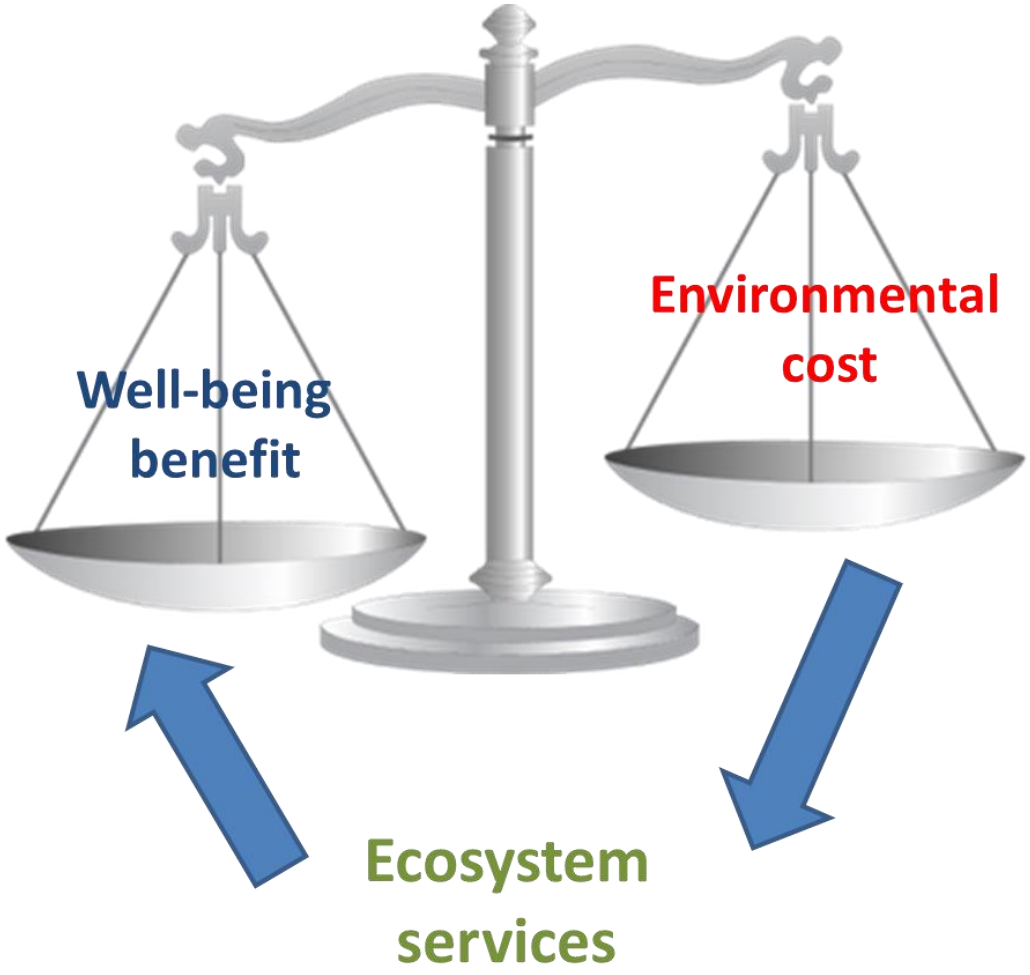
Robust and efficient environmental risk assessment procedures require clear protection goals specifying what to protect, where to protect it and over what time period.

Protection goals in legislative documents

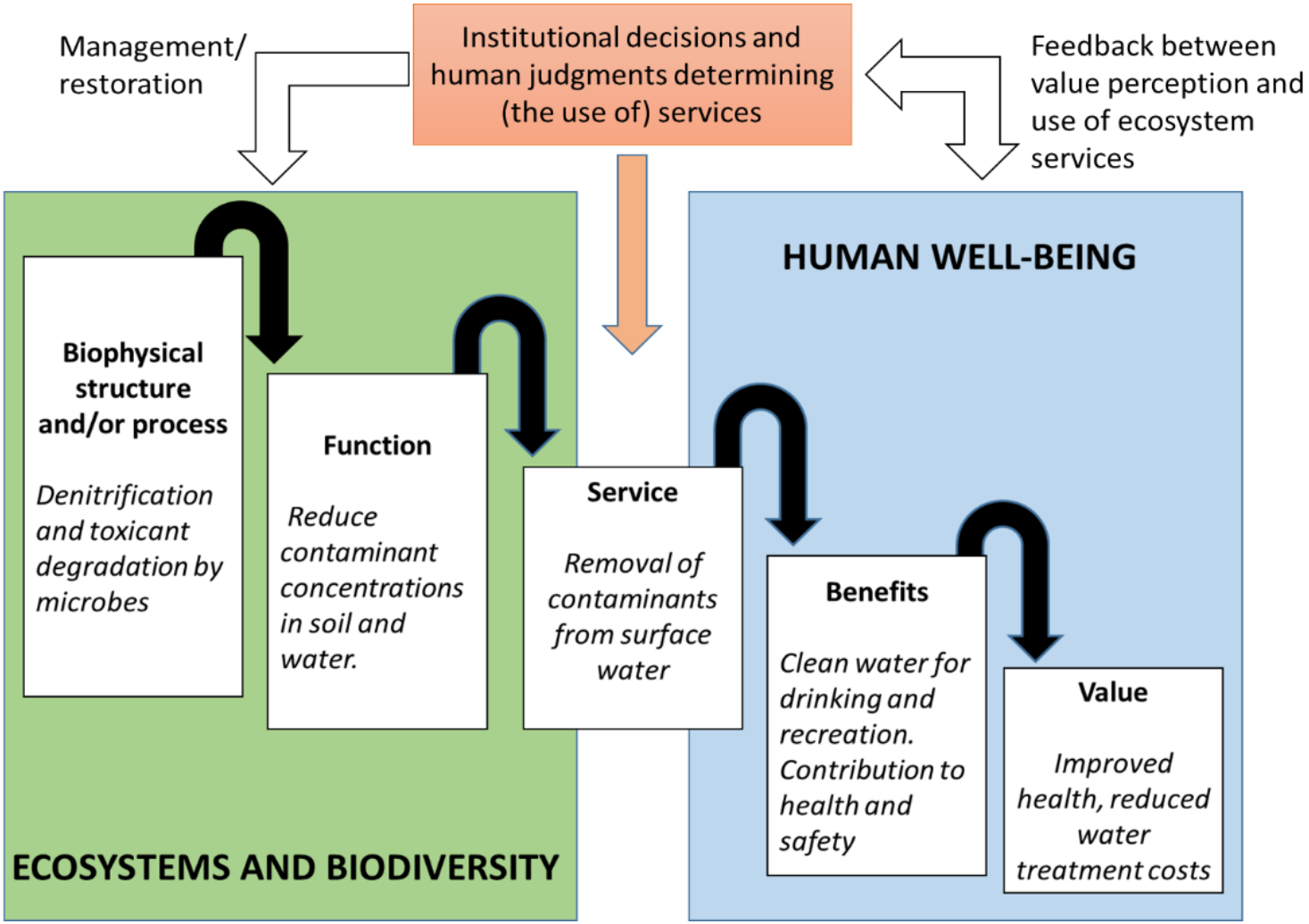
*"shall have **no unacceptable effects** on the **environment**.....**non-target organisms**.... **biodiversity** and the **ecosystem**"*

It usually is not operationally defined what is an unacceptable environmental or ecological effect

Balancing well-being benefits and environmental costs

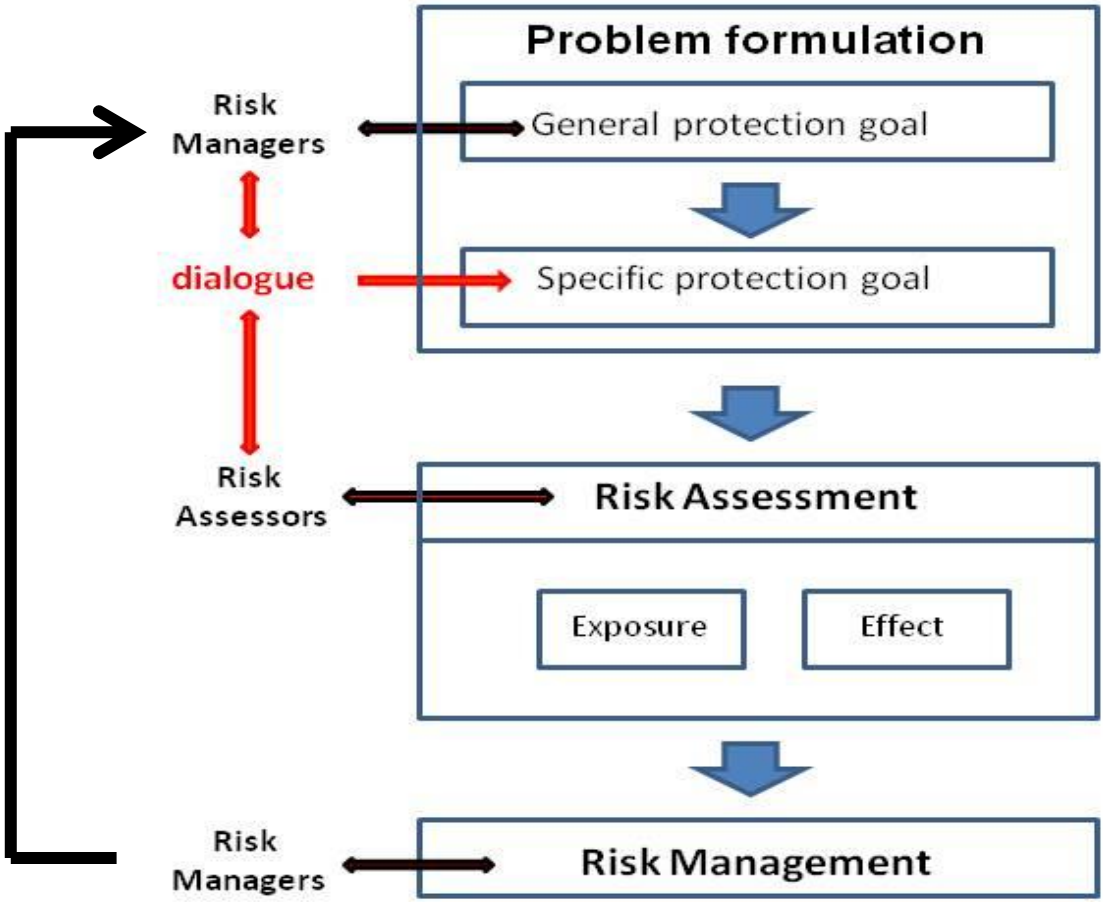


Ecosystem services



Based on the cascade model (Haines Young & Potschin, 2010) and adapted from Braat and de Groot (2012) and Maltby (2013)

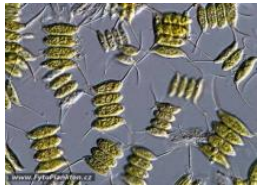
The ERA process

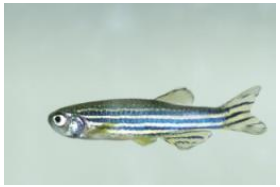


The general protection goals need to be made operational (*link between risk assessment and risk management process*)

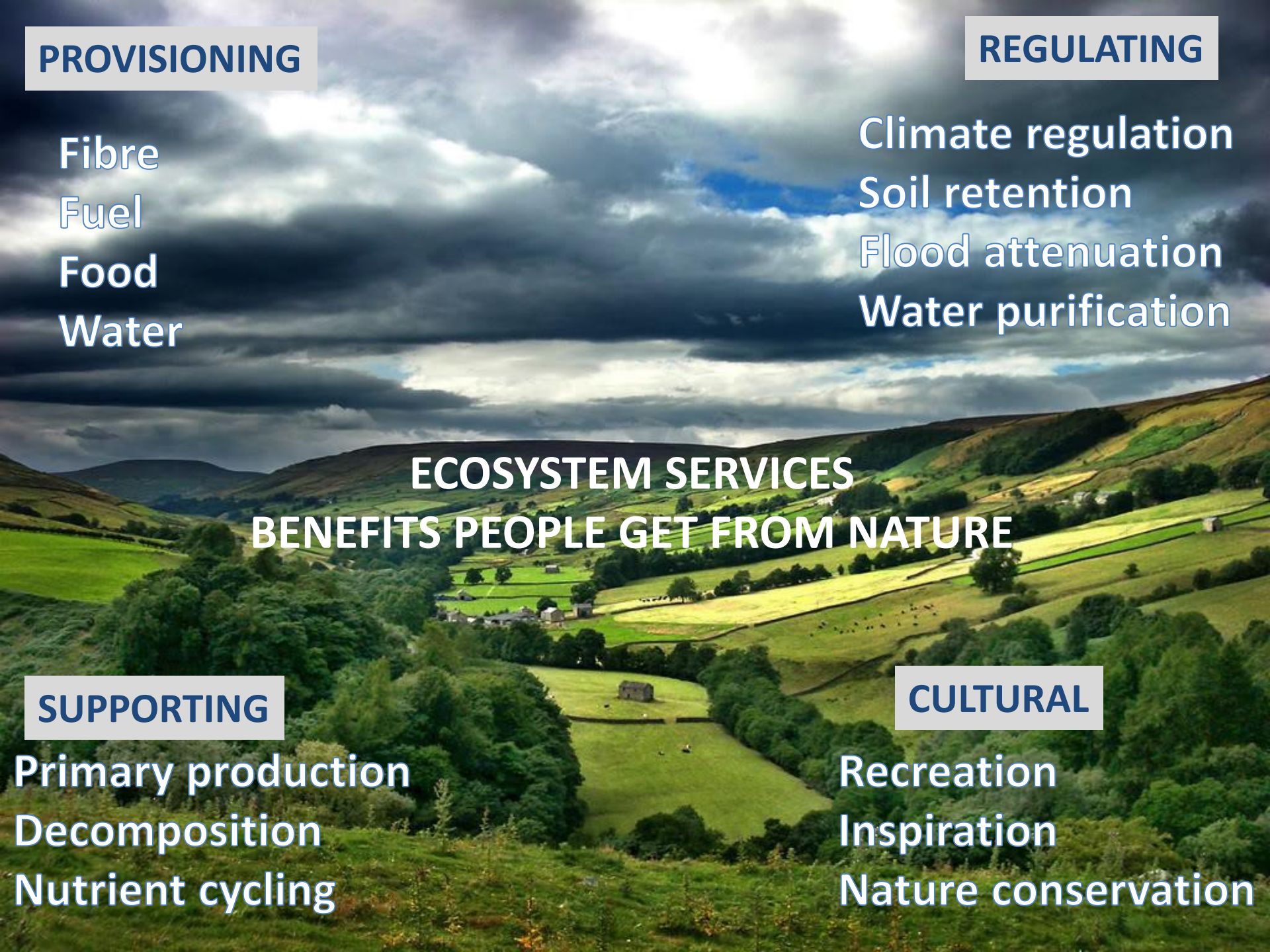
Protection goals for aquatic and terrestrial organisms?

- **Ecosystem services concept**
  - Functions of and provisions from ecosystems that are useful for and available to humans
  - Allows to address trade-offs, societal demands and spatial-temporal scales






- Choice of tested species governed by practicality (needs link to protection goal and legal data requirements)


PROVISIONING
Fibre
Fuel
Food
Water
REGULATING
Climate regulation
Soil retention
Flood attenuation
Water purification
ECOSYSTEM SERVICES
BENEFITS PEOPLE GET FROM NATURE
SUPPORTING
Primary production
Decomposition
Nutrient cycling
CULTURAL
Recreation
Inspiration
Nature conservation

Freshwater provisional services

- Food
- Fibre, fuel
- Water
- Energy







Freshwater regulatory services

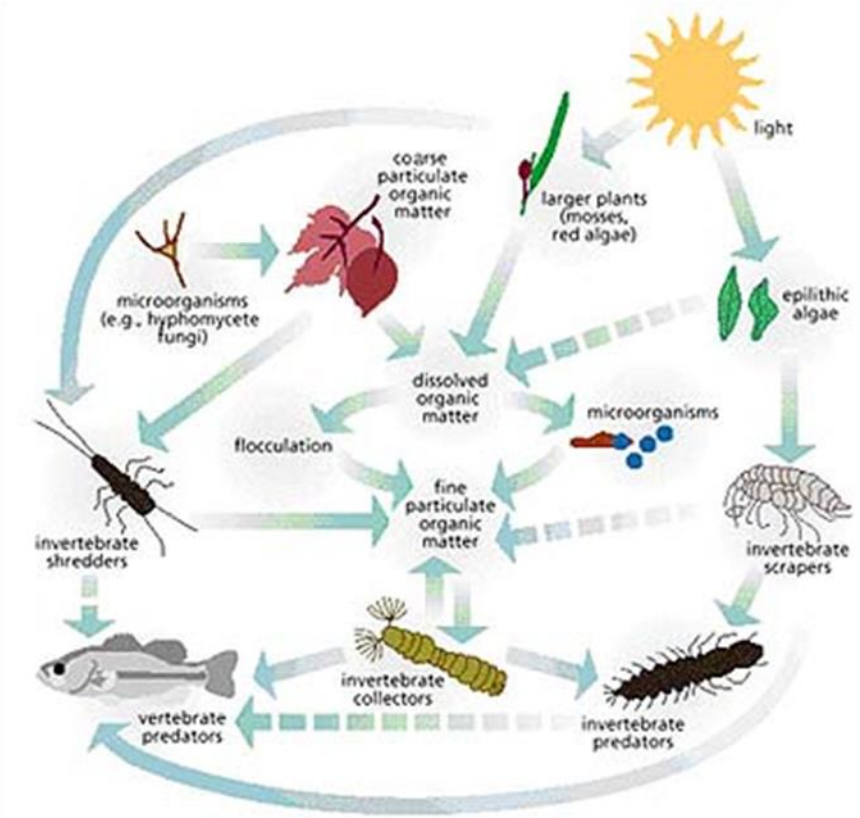
- Climate regulation
- Water regulation
- Erosion regulation
- Water purification/ waste treatment

Freshwater cultural services

- Spiritual value
- Education/ inspiration
- Recreation
- Heritage
- Aesthetic

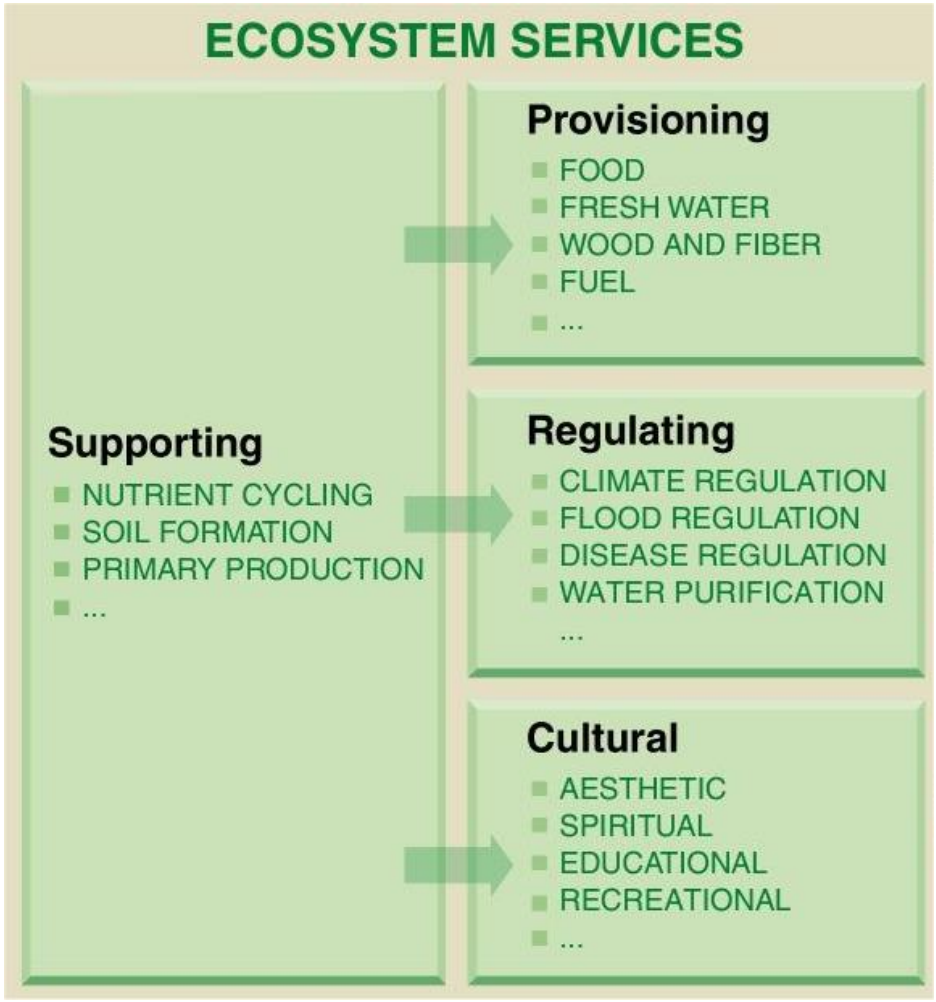
Freshwater supporting services

- Production
- Photosynthesis
- Habitat provision
- Nutrient cycling



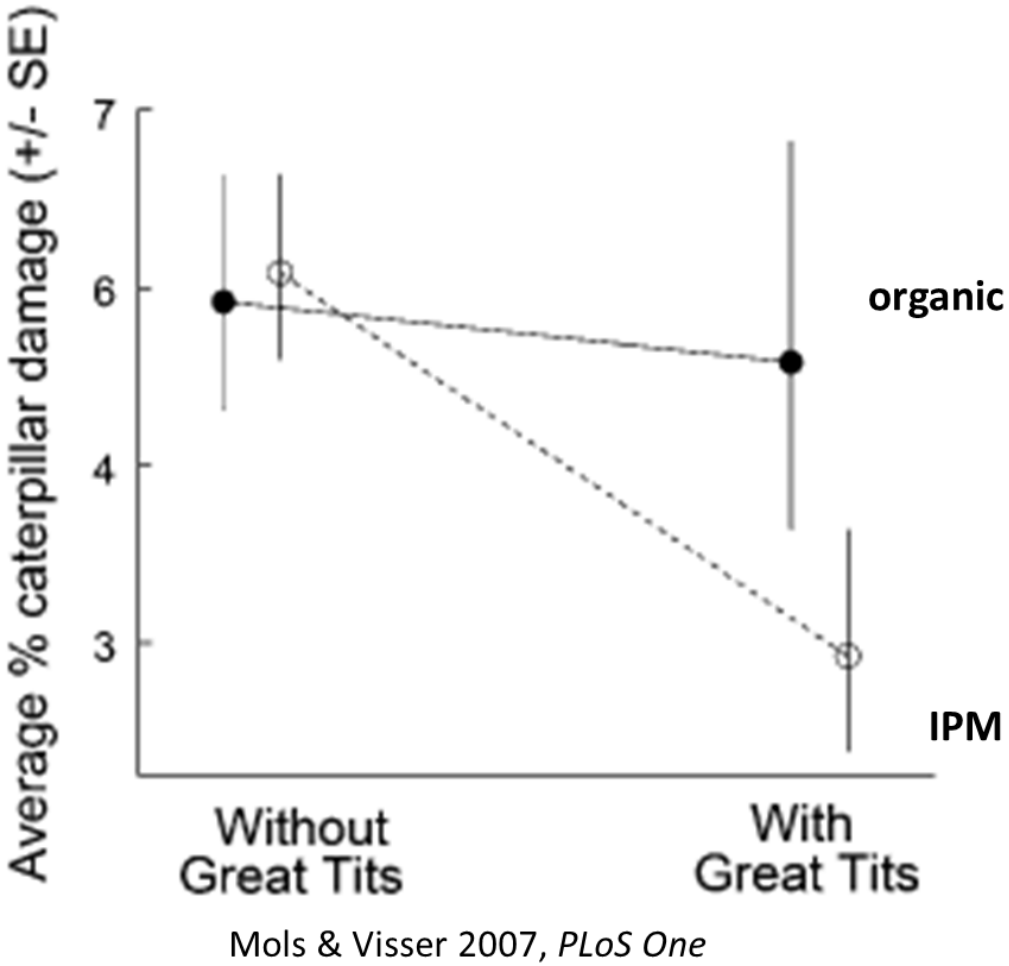
Why use the ecosystem services concept?

- Can be applied to all ecosystems (and all environmental compartments)
- Can be applied at different spatial and temporal scales
- Strong communication tool
- Allows systematic and transparent assessment for detecting all important species that have to be protected



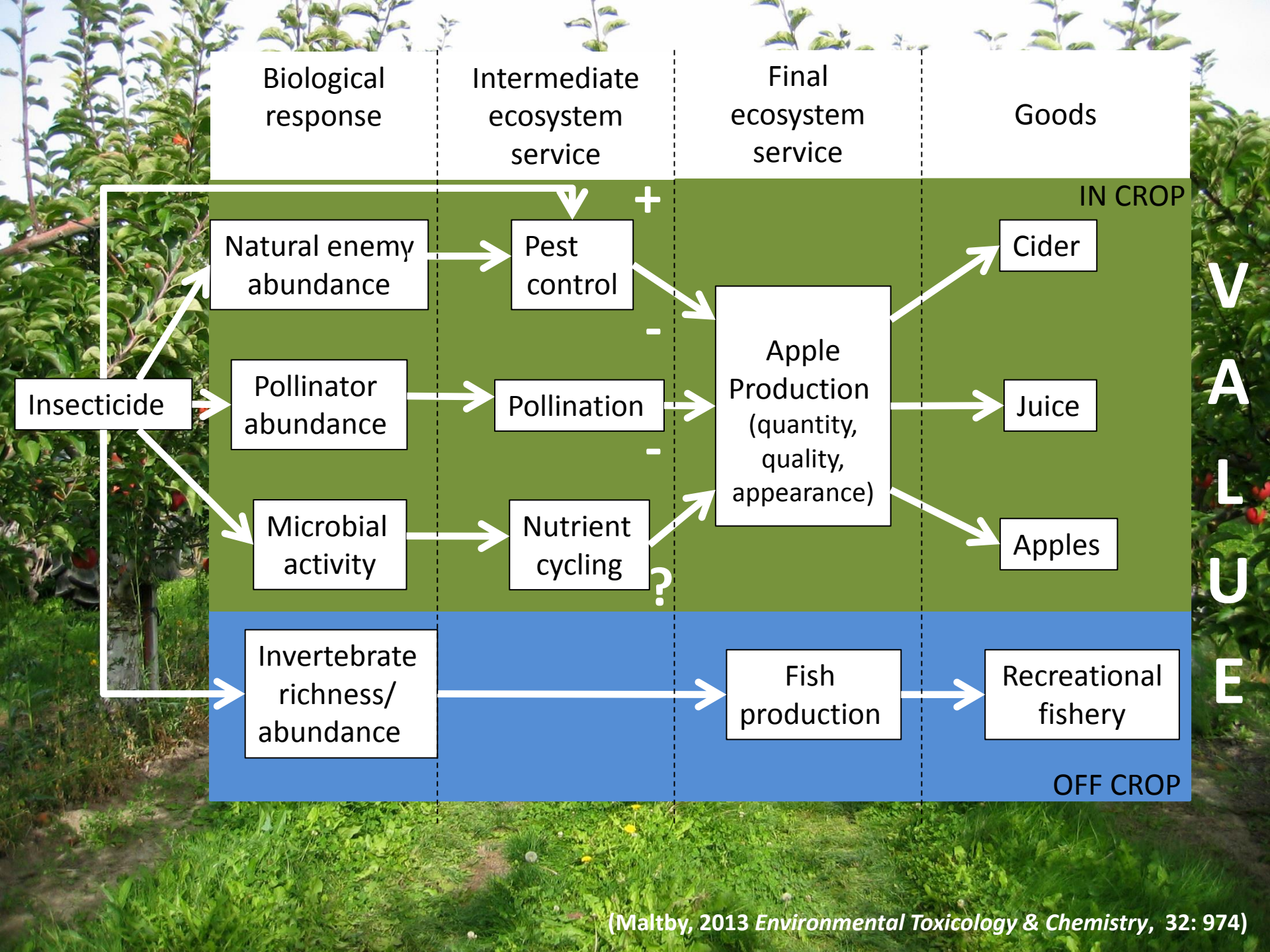
Millennium Ecosystem Assessment (2005) Ecosystems and Human Well-being: Synthesis. Island Press, Washington DC, 160 pp

Ecosystem service example



Mols & Visser 2007, *PLoS One*

one breeding pair every 2 ha.



(Maltby, 2013 *Environmental Toxicology & Chemistry*, 32: 974)

Biodiversity and ecosystem services

- Biodiversity of what, measured how?
  - Taxonomic diversity v functional diversity
  - Genetic diversity, species diversity (local, regional), habitat diversity
  - All taxa or specific groups.
- Equating biodiversity with ecosystem services
  - Managing one will automatically enhance the other.
- Biodiversity as an ecosystem service
  - Intrinsic value for biodiversity.
  - “conservation perspective”
- Biodiversity can be a:
  - regulator of intermediate services, final ecosystem service, good

(Mace et al 2012, *Trends in Ecology & Evolution*, 27, 19-26)

Steps in the EFSA procedure

List of Ecosystem Services (ES)

(**Millennium Ecosystem Assessment; MEA**)

↓

Identify **ES affected by potential stressor**

↓

Identify **key drivers/service providing units** for these ES (i.e. representative and important species or functional groups)

↓

Development of **specific protection goals**: identify "**5 dimensions**" for the key drivers / ES combinations

More recent classification: Common International Classification of Ecosystems Services (CICES)

Relevant ecosystem service providing species should be assessed for different types of (agro)ecosystem at risk

EFSA PPR (2010): EFSA Journal 8(10):1821; Nienstedt et al. (2011). Sci Total Environ
EFSA SC (2016): Draft guidance Document to define protection goals for ERA

Example: Identification of important key drivers for ERA

Ecosystem service	Organisms	Legal requirement	Desired protection goal
Pollination	Honey bee, wild bees, hover-flies, butterflies	No unacceptable lethal and sublethal effect. No effects on ongoing behaviour	No to small effects on biodiversity, abundance and foraging behaviour
Soil formation	Soil invertebrates, microbes, vascular plants	No unacceptable lethal and sublethal effects.	No to temporary impacts on functional groups
Water purification	Microbes, algae, aquatic vascular plants	No unacceptable lethal and sublethal effects.	No to temporary impacts on functional groups
Genetic resources	All species, and their wild relatives potentially used by man	No unacceptable lethal and sublethal effects.	No decline in biodiversity

The organisms potentially affected and that perform the ecosystem services can be grouped in service providing units

Main key driver groups identified by EFSA PPR (2010)

- Microbes
- Algae
- Vascular plants (aquatic and terrestrial)
- Aquatic invertebrates
- Terrestrial non-target arthropods (incl. honey bees)
- Terrestrial non-arthropod invertebrates
- Vertebrates (aquatic and terrestrial)

The main taxonomic groups identified by EFSA PPR that play an important role as service providing units (SPU) can be used for risk assessment of most potential stressors that fall under EFSA's remit.

For each SPU and ecosystem type representative standard test species and "vulnerable" field taxa should be identified

Specific Protection Goal-dimensions for each key SPU

Ecological entity:
individual – (meta)population – functional gr. – community – ecosystem – landscape

Attribute:
behaviour – survival – growth – abundance/biomass – process – (funct.) biodiversity

Magnitude:
negligible effect – small effect – medium effect – large effect

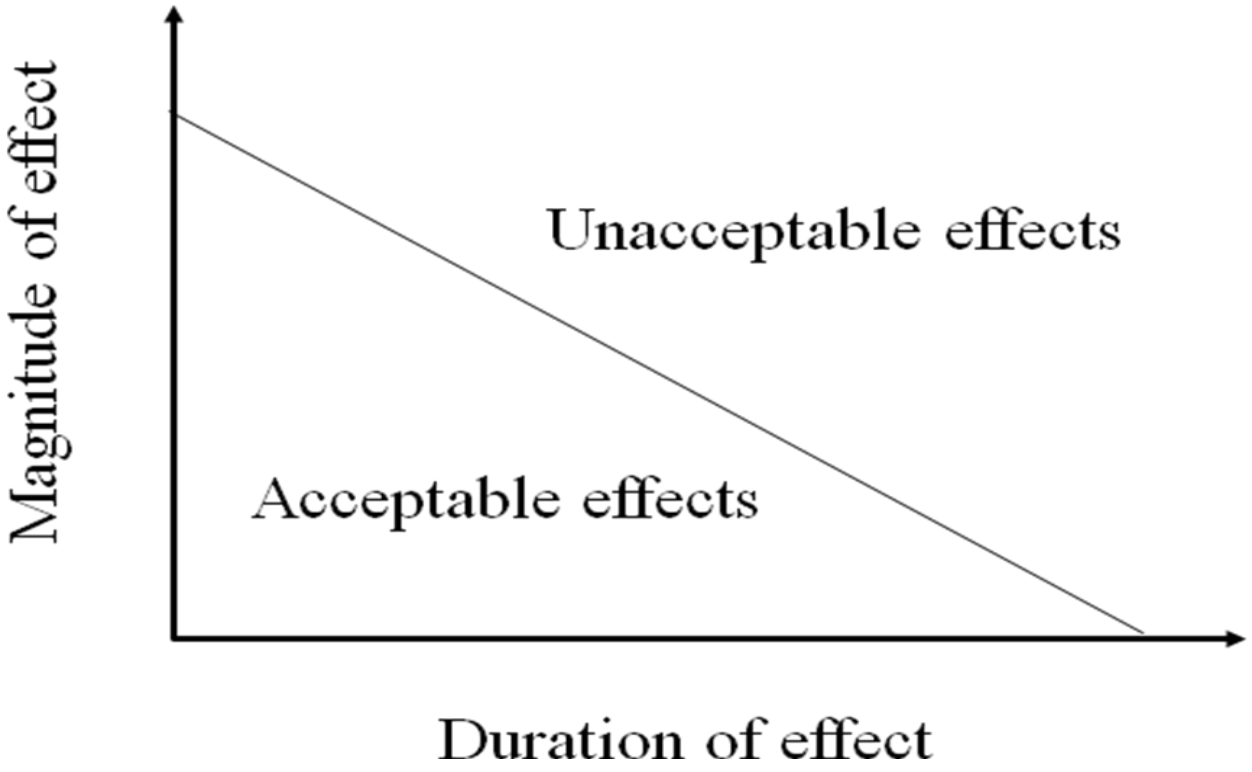
Temporal scale:
<days – days – weeks – months – seasons – > 1 year

Spatial scale:
field – edge-of-field – farm – landscape – region – continent

For each key SPU one (range of) point(s) on each dimension must be chosen, and then defined in precise enough terms to be measurable

Multi-dimensional nature of SPG

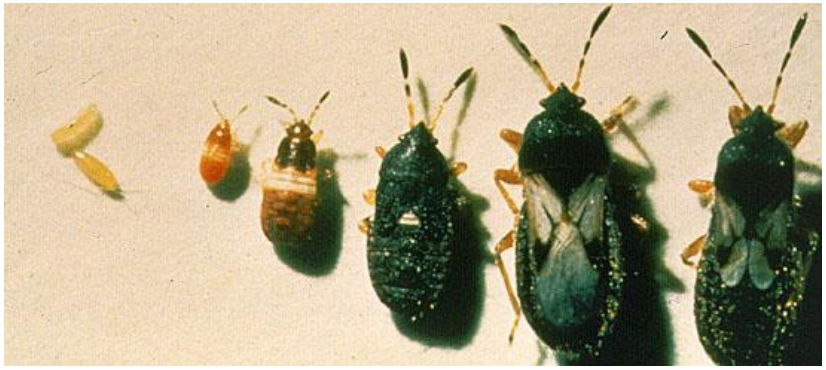
Example of interdependency of dimensions

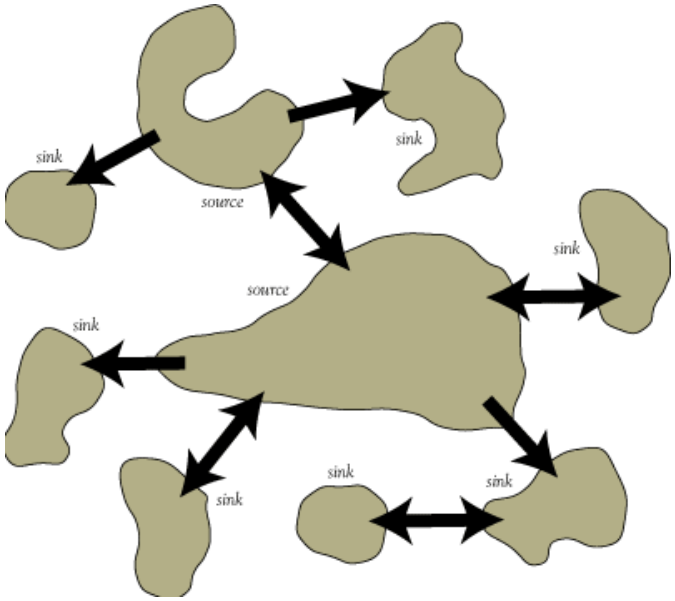


SPG-dimension: Ecological entity

Ecological entity: Relates to level of biological organisation
individual – (meta)population – functional gr. – community – ecosystem – landscape

A population is an aggregate of interbreeding individuals of a species, occupying a specific location in space an time

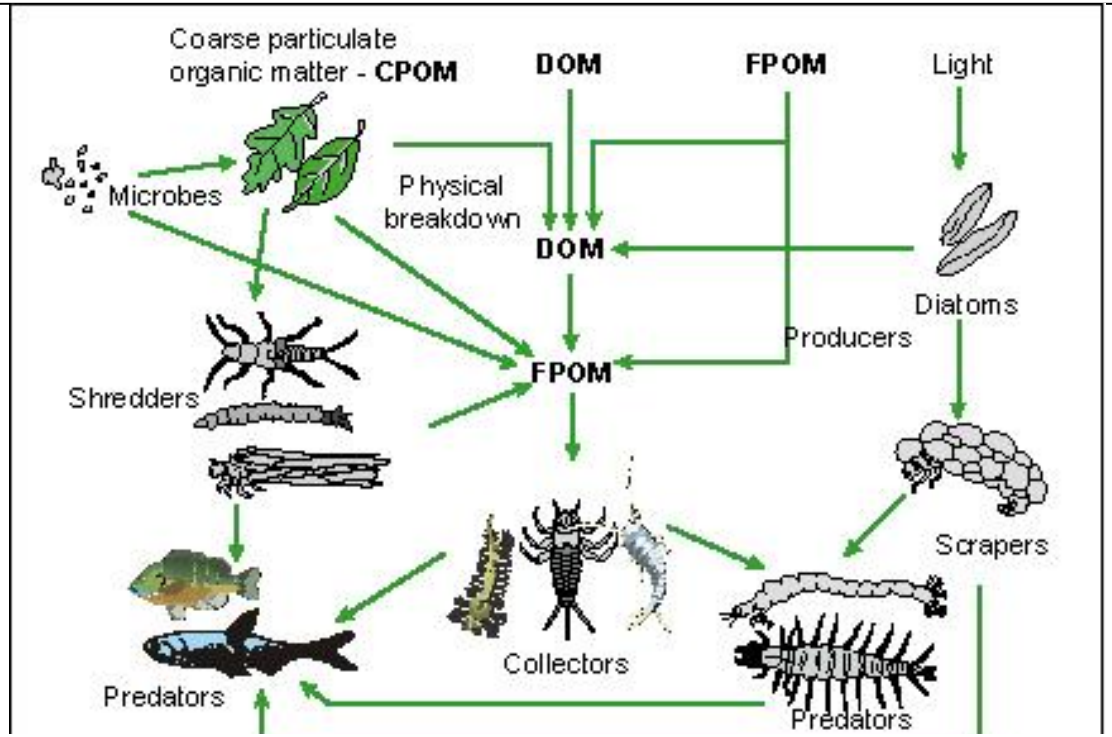




A metapopulation is a 'population of populations' of the same species connected through immigration and emigration *(important for external recovery)*

Ecological entity:

individual – (meta)population – functional gr. – community – ecosystem – landscape



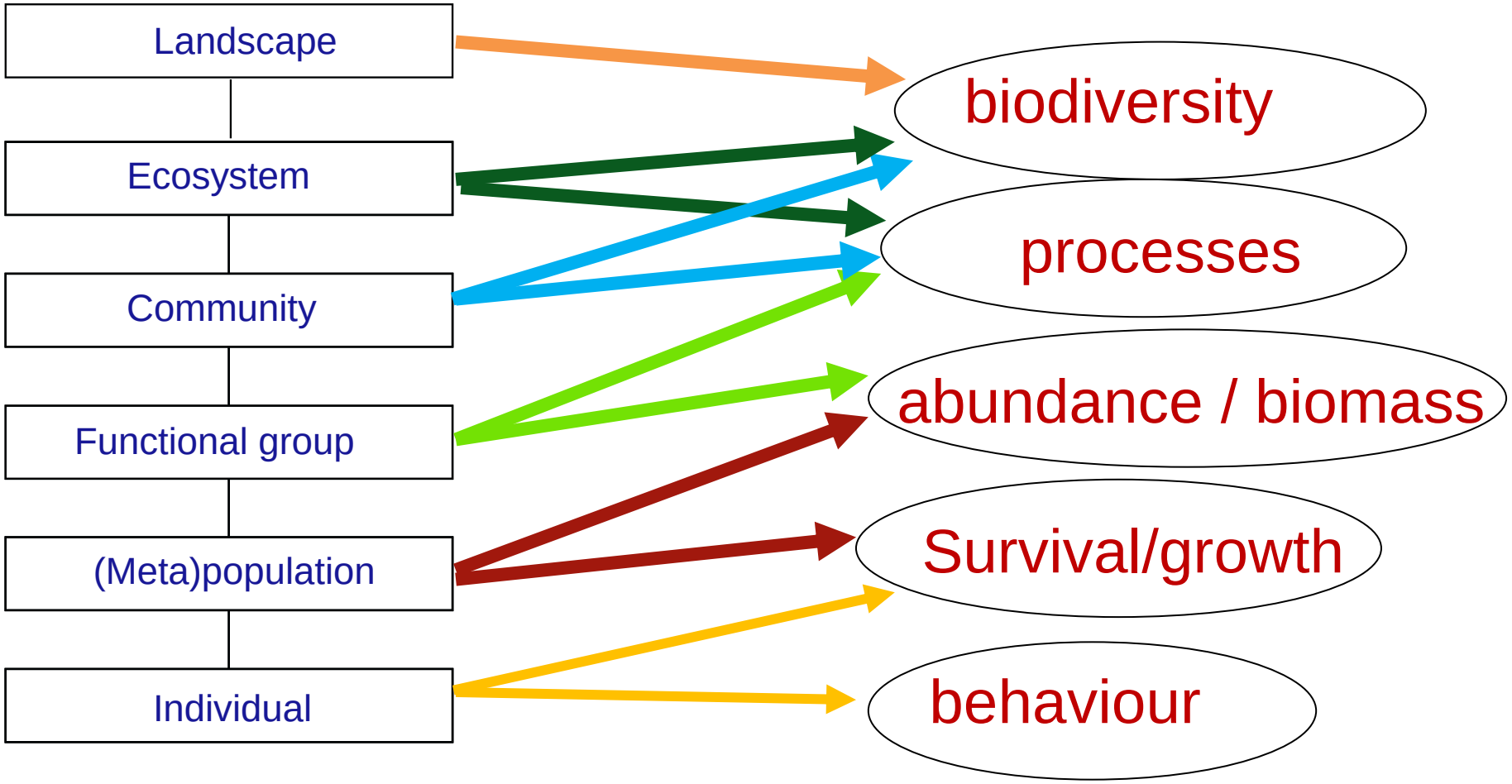
Functional group is a collection of different species in a biological community that perform the same functions in the ecosystem *(also providing the same ecosystem service)*

A biological community consists of different species of plants, animals and microbes occupying the same area at the same time (*together with its abiotic environment it forms the basis of an ecosystem*)

Specific Protection - Attribute

Attribute: Measurable property of ecological entity

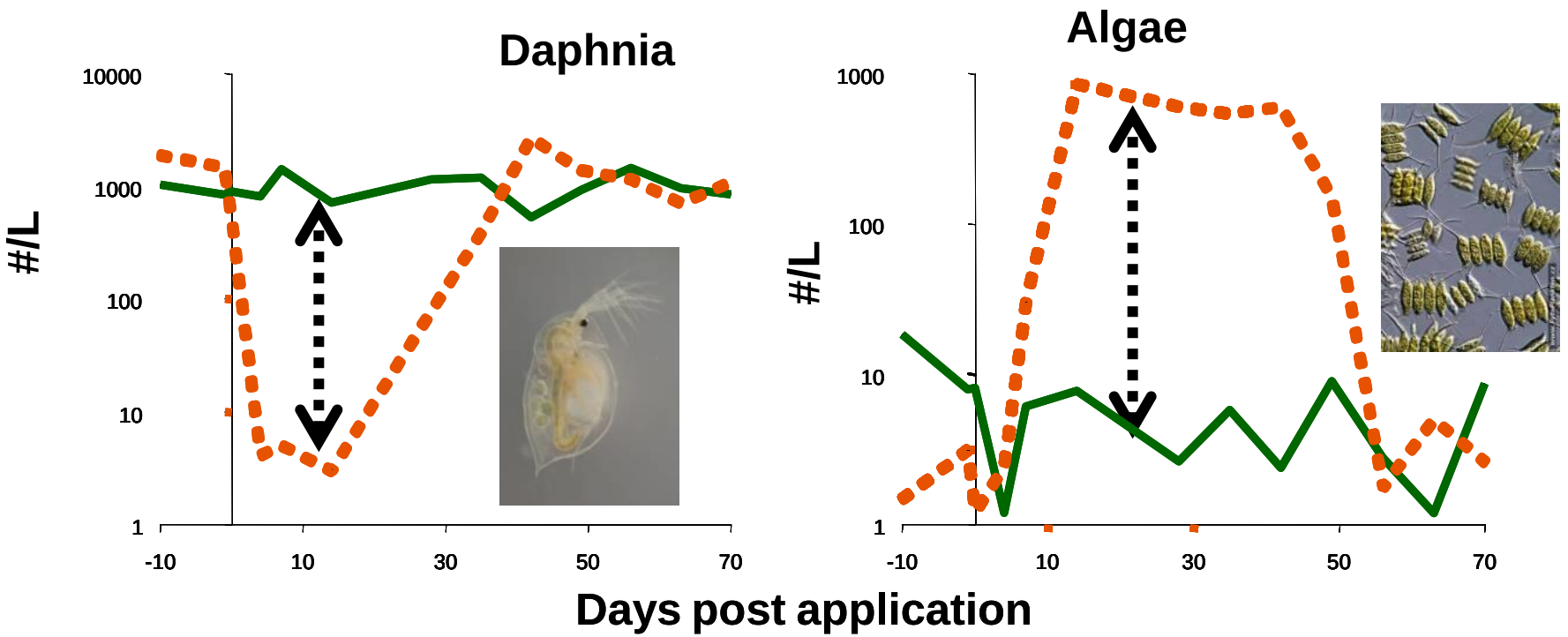
behaviour – survival – growth – abundance/biomass – process – (funct.) biodiversity



Specific Protection Goal - Magnitude

Magnitude: Tolerable reduction or increase of effect

negligible effect – small effect – medium effect – large effect

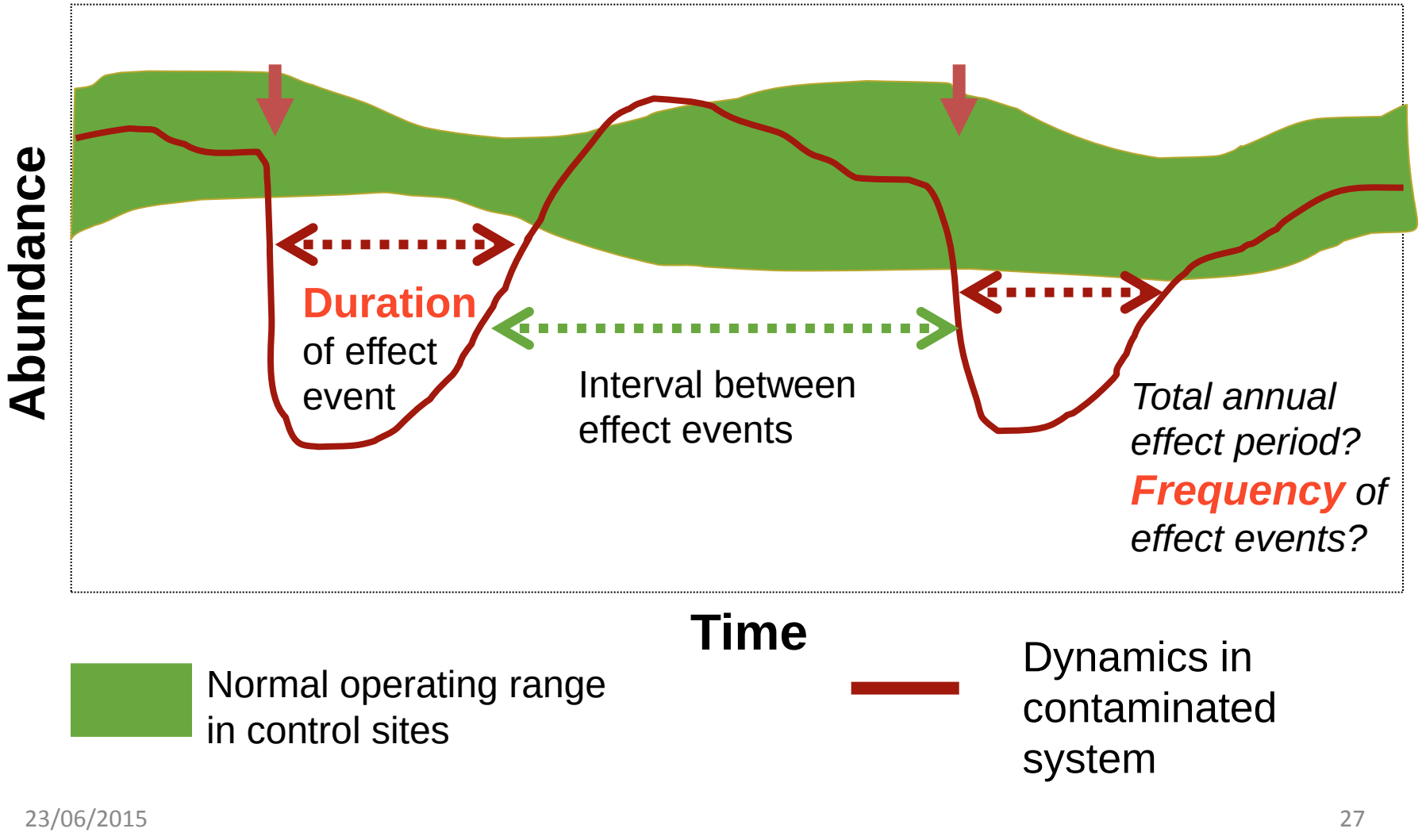


May include decreases and increases due to indirect effects

Specific Protection Goal – Temporal scale

Temporal scale: Duration of effect

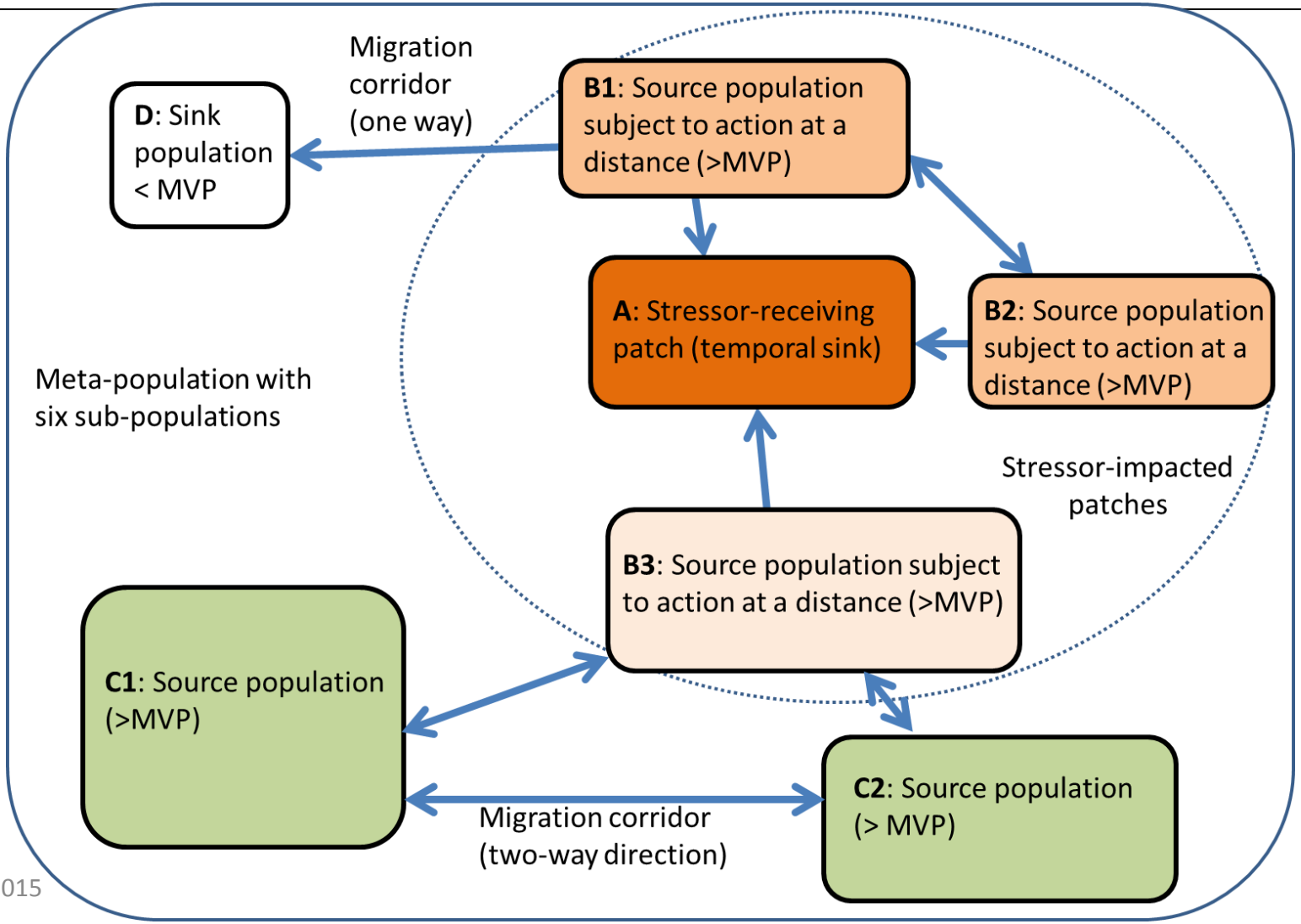
<days – days – weeks – months – seasons – > 1 year



Specific Protection Goal –Spatial scale

Spatial scale: Area-size of tolerable effect

field – edge-of-field – farm – landscape – region – continent



Possible SPG definition for non-target plants and invertebrates

Ecological threshold option

Ecological entity:

individual – (meta)population – functional gr. – community – ecosystem – landscape

Attribute:

behaviour – survival – growth – abundance/biomass – process – (funct.) biodiversity

Magnitude:

negligible effect – small effect – medium effect – large effect

Temporal scale:

<days – days – weeks – months – seasons – > 1 year

Spatial scale:

field – edge-of-field – farm – landscape – region – continent

Possible SPG definition for non-target plants and invertebrates

Ecological recovery option

Ecological entity:

individual – (meta)population – functional gr. – community – ecosystem – landscape

Attribute:

behaviour – survival – growth – abundance/biomass – process – (funct.) biodiversity

Magnitude:

negligible effect – small effect – medium effect – large effect

Temporal scale:

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Spatial scale:

field – edge-of-field – farm – landscape – region – continent

Possible SPG definition for non-target plants and invertebrates

Ecological recovery option

Ecological entity:

individual – (meta)population – functional gr. – community – ecosystem – landscape

Attribute:

behaviour – survival – growth – abundance/biomass – process – (funct.) biodiversity

Magnitude:

negligible effect – small effect – medium effect – large effect

Temporal scale:

<days – days – weeks – months – seasons – > 1 year

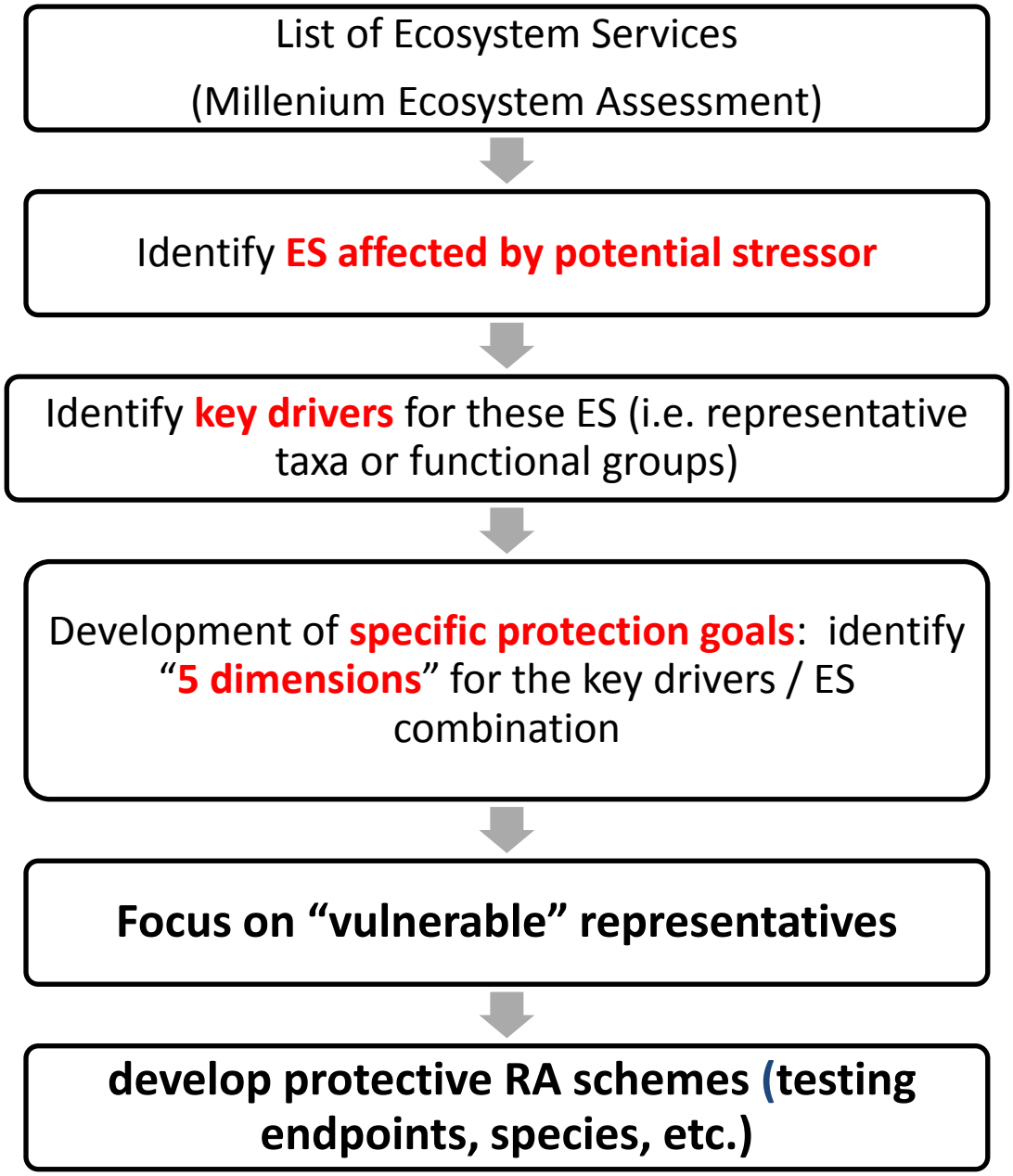
Spatial scale:

field – edge-of-field – farm – landscape – region – continent

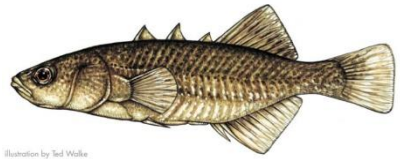
Possible SPGs for regulated products

- The ecological entity to be protected for non-target organisms usually is the (meta)population
- Vertebrates may be protected at the individual level (aesthetic considerations)
- For certain services provided by microbes, algae and invertebrates the ecological entity of concern may be the functional group
- Maintenance of biodiversity at the landscape/watershed level for all key drivers
- Temporal effects on local non-vertebrate populations may under certain well-defined conditions be acceptable (e.g. in-field and edge-of-field)

Further steps in the procedure (developed by EFSA)



Particularly for the recovery option

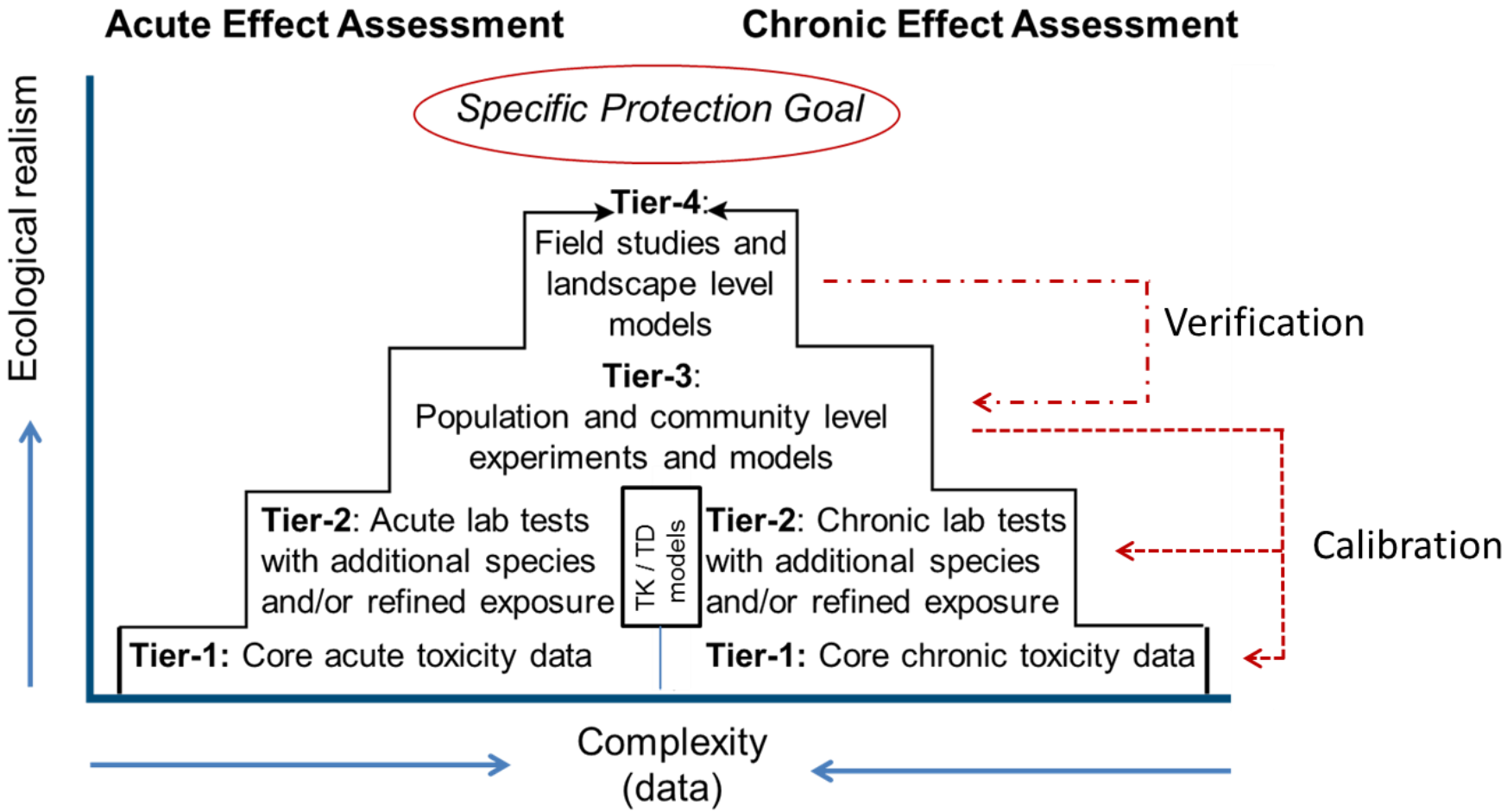


Ecological vulnerability

In ecosystems the vulnerability of populations to toxicants is influenced by:

1. Exposure and sensitivity to direct (toxic) effects
2. Indirect effects due to shifts in species-interactions
3. Recovery potential
   - *Life cycle characteristics*
     - Number of generations per year
     - Resistant life stages
     - Dispersal ability
   - *Ecological infrastructure* (connectivity between stressed and non-stressed ecosystems)

SPGs and tiered risk assessment schemes



For all tiers the same specific protection goal is applicable but higher tiers address the problem with a higher degree of realism and complexity

Conclusions

- Ecosystem services concept is suitable to develop specific protection goals
  - helps in deciding what, where, and at what scale to protect; helps to decide in case of trade offs; includes different societal demands
- The SPG-options can be used in the ‘acceptability’ debate
  - Transparent communication between stakeholders
  - Decision making by risk managers

Thank you for your attention
Questions ?