Links between natural capital and ecosystem services

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Ecosystem service providers (ESPs)

Entire community or habitat

Functional group

Species

Biotic attributes

Habitat area, age, structure, etc.

Abundance of functional group

Species abundance, size, etc.

Abiotic factors

Temperature, precipitation, wind, etc.

Natural capital

Ecosystem services

Food crops
Water
Freshwater fish
Timber

Atmospheric reg.
Air quality reg.
Water flow reg.
Mass flow reg.
Water quality reg.
Pollination
Pest control

Recreation
Aesthetic landscapes
Biotic attributes

- Presence of a specific community/habitat type
- Community/habitat area
- Community/habitat structure
- Community/habitat/stand age
- Successional stage
- Primary productivity
- Aboveground biomass
- Belowground biomass
- Stem density
- Litter/crop residue quality
- Landscape diversity
- Species richness
- Functional richness
- Functional diversity
- Species population diversity
- Presence of a specific functional group
- Abundance of a specific functional group
- Presence of a specific species type
- Species abundance
- Species size/weight
- Population growth rate
- Life span/longevity
- Mortality rate
- Flower-visiting behavioural traits (pollination)
- Predator behavioural traits (biocontrol)
- Other biotic
- Presence of a specific community/habitat type
- Community/habitat area
- Community/habitat structure
- Community/habitat/stand age
- Successional stage
- Primary productivity
- Aboveground biomass
- Belowground biomass
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- Species size/weight
- Population growth rate
- Life span/longevity
- Mortality rate
- Flower-visiting behavioural traits (pollination)
- Predator behavioural traits (biocontrol)
- Other biotic

Legend:
- Green: Positive
- Blue: Both (Positive & Negative)
- Pink: Negative
- Grey: Unclear

Number of studies
Abiotic factors

- Temperature
- Precipitation
- Snow
- Water availability
- Evaporation
- Wind
- Water quality
- Nutrient availability
- Soil
- Geology
- Slope
- Other abiotic

Number of studies

- Positive
- Both (Positive & Negative)
- Negative
- Unclear
Water flow regulation
(flood protection)

Line thickness is proportional to number of papers
Water supply

Line thickness is proportional to number of papers
Aesthetic landscapes

Line thickness is proportional to number of papers
### Biotic attributes: positive

| Attribute | Presence of a community/habitat area | Community/habitat/stand age | Successional stage | Productivity | Primary productivity | Aboveground biomass | Belowground biomass | Stem density | Litter/crop residue quality | Landscape diversity | Species richness | Functional richness | Functional diversity | Presence of a functional group | Abundance of a functional group | Presence of a specific species | Species abundance | Species population diversity | Species size/weight | Population growth rate | Life span/longevity | Mortality rate | Wood density | Other biotic traits |
|-----------|--------------------------------------|-----------------------------|-------------------|--------------|----------------------|---------------------|--------------------|--------------|--------------------------|-------------------|----------------|----------------------|-----------------------|----------------------------|----------------------------|----------------------|------------------------|---------------------|------------------|----------------|------------------|
| Freshwater fishing | 12 | 12 | 10 | 1 | 6 | 1 | 2 | 5 | 8 | 1 | 1 | 4 | 2 | 16 | 17 | 4 | 21 | 6 | 1 | 1 | |
| Timber production | 1 | 7 | 2 | 1 | 1 | 2 | 7 | 3 | 35 | 5 | 9 | 6 | 18 | 7 | 4 | 2 | |
| Water supply | 8 | 7 | 5 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | |
| Food production (crops) | 1 | 4 | 2 | 11 | 8 | 10 | 1 | 35 | 4 | 5 | 23 | 9 | 19 | 11 | 1 | 7 | |
| Air quality regulation | 5 | 27 | 4 | 1 | 2 | 5 | 1 | 4 | 1 | 1 | 12 | 3 | 15 | 2 | 1 | 9 | 1 | 18 | |
| Atmospheric regulation | 12 | 17 | 14 | 18 | 8 | 9 | 35 | 25 | 2 | 6 | 16 | 2 | 8 | 6 | 8 | 15 | 4 | 5 | 12 | 8 | 2 | 6 | 1 | |
| Water flow regulation | 5 | 41 | 21 | 10 | 2 | 1 | 2 | 2 | 4 | 3 | 3 | 1 | 3 | 1 | 3 | |
| Mass flow regulation | 34 | 31 | 28 | 5 | 8 | 1 | 11 | 21 | 8 | 14 | 7 | 3 | 7 | 22 | 20 | 1 | 3 | 7 | 1 | |
| Water quality regulation | 40 | 37 | 8 | 3 | 1 | 3 | 5 | 5 | 4 | 3 | 6 | 1 | 3 | 7 | 4 | 17 | 6 | 2 | 6 | 1 | |
| Pollination | 22 | 15 | 19 | 1 | 8 | 25 | 10 | 11 | 32 | 21 | 17 | 20 | 7 | 3 | 15 | 4 | |
| Pest regulation | 17 | 20 | 22 | 1 | 2 | 1 | 2 | 1 | 5 | 5 | 9 | 8 | 7 | 10 | 13 | 4 | 11 | 1 | 1 | 3 | 2 | 11 | 5 | |
| Recreation (species-based) | 4 | 3 | 1 | 1 | 1 | 2 | 7 | 8 | 2 | 1 | 5 | 2 | 3 | 6 | |
| Aesthetic landscapes | 26 | 7 | 34 | 2 | 1 | 1 | 2 | 7 | 8 | 2 | 1 | 5 | 2 | 3 | 6 | |
|---------------------------|----------------------------------|------------------------|-----------------------------|------------------|-------------------|---------------------|-------------------|------------------------|-------------------|----------------|-----------------|-----------------|---------------------------------|-------------------------------|
| Freshwater fishing        | 1                                |                        |                             |                  |                   |                     |                   |                        |                   |               |                 |                 | Presence of a specific species | Presence of a specific species |
| Timber production         | 1 3                              | 4                      | 5 1 2                       | 3 1              | 1                 | 1                   | 1                 | 1                      |                   |               |                 |                 | Species abundance | Species population diversity |
| Water supply              | 20 26                            | 12                     | 2 2 9 1                     | 5 1 10           | 2 5               | 1                   |                   |                        |                   |               |                 |                 | Population growth rate | Life span/longevity |
| Food production (crops)   | 1                                | 1                      | 1                           | 1                |                  |                     |                   |                        |                   |               |                 |                 | Mortality rate | Wood density |
| Air quality regulation    | 1                                |                        |                             |                  |                   |                     |                   |                        |                   |               |                 |                 | Flower-visiting behavioural traits | Other biotic  |
| Atmospheric regulation    | 1                                | 1                      | 1                           | 1                | 1                 | 1                   | 1                 |                        |                   |               |                 |                 | Predator behavioural traits |                     |
| Water flow regulation     | 1 3                              | 1                      | 1                           | 1                | 1                 | 1                   | 1                 |                        |                   |               |                 |                 |                     |                     |
| Mass flow regulation      | 1 1 1 2                          |                        |                             |                  |                   |                     |                   |                        |                   |               |                 |                 |                     |                     |
| Water quality regulation  | 2 1                              |                        |                             |                  |                   |                     |                   |                        |                   |               |                 |                 |                     |                     |
| Pollination               | 1                                |                        |                             |                  |                   |                     |                   |                        |                   |               |                 |                 |                     |                     |
| Pest regulation           | 2 1                              |                        |                             |                  |                   |                     |                   |                        |                   |               |                 |                 |                     |                     |
| Recreation (species-based)| 2                                |                        |                             |                  |                   |                     |                   |                        |                   |               |                 |                 |                     |                     |
| Aesthetic landscapes      | 1                                |                        |                             |                  |                   |                     |                   |                        |                   |               |                 |                 |                     |                     |
How NC provides ES

- **Physical amount of vegetation** within an ecosystem (e.g. habitat area, vegetation productivity, above- and below-ground biomass, species size/weight): important for water flow, water quality, carbon storage etc.

- **Characteristics of particular species or functional groups** (e.g. species size, predation behaviour)

- **Habitat type**: food and shelter to support ESP species

- **Diversity-related indicators** (species richness, species population diversity, functional richness/diversity, structural complexity and landscape diversity): e.g. through niche complementarity or resistance to disease.
Interactions: mass flow regulation

Positive
Negative
Mixed

Line thickness is proportional to number of papers
Interactions: positive

Line thickness is proportional to number of papers
Interactions: negative

Line thickness is proportional to number of papers
Conclusions

There is a large but fragmented evidence base on the way in which natural capital underpins delivery of ES.

Four groups of biotic attributes were identified:
- Physical amount of vegetation
- Characteristics of particular species or functional groups
- Habitat types suitable for supporting ESPs
- Diversity

Many of the interactions between ES are positive: ecosystems can provide multiple benefits.

But there can be trade-offs, especially between provisioning services and regulating or cultural services: these require careful management.
Thank you
Evidence gaps and research needs

- Impact of ecosystem condition on ecosystem service delivery
- Biophysical thresholds beyond which ES delivery is compromised
- Role of functional diversity in delivering services and providing resilience to change
- Synergies and trade-offs between services, and the implications for land use management
- How well-designed management and related policies can protect and enhance ecosystem services and build resilience to change.

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