



Virtual Academy of Sustainability

Lecture 3: Ecosystems and Human Wellbeing

Episode 2: Ecological Integrity

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[Civic Ecology: A Pathway to Sustainability]

Lecture 3: Ecosystems and Human Wellbeing • Episode 2: Ecological Integrity • Prof. Vicente Lopes

Overview of the Lecture

Episode 1: Ecosystem Services

Episode 2: Ecological Integrity

Episode 3: Interview



Learning Outcomes

- You will understand current threats to ecosystem services.
- You will know the concept of ecological integrity and its relationship to ecosystem services.
- You will learn the attributes of ecological integrity.



Structure of Episode 2

1. Threats to Ecosystem Services
2. Defining Ecological Integrity
3. Conclusion



Threats to Ecosystem Services

- Ecosystem services are so fundamental to life that they are easy to take for granted and so large in scale that it is hard to imagine that human activities could destroy them.
- Nevertheless, many human activities disrupt, impair, or reengineer ecosystems every day including:
 - Runoff pesticides, fertilizers, and animal wastes
 - Pollution of land, water, and air resources, introduction of non-native species, destruction of wetlands, overgrazing, soil erosion, and deforestation.
- Of the twenty-four ecosystem services assessed by the MA, fifteen (70%) were found to be under stress.



Threats to Ecosystem Services

- Environmental stress refers to physical, chemical, and biological constraints on the productivity of species and the development of ecosystems.
- When stressors increase or decrease in intensity, they elicit ecological responses.
- Stressors can be natural environmental factors, or they can be associated with human activities.
- Some environmental stressors are relatively local in their influence, while others are regional or global in scope.



Threats to Ecosystem Services

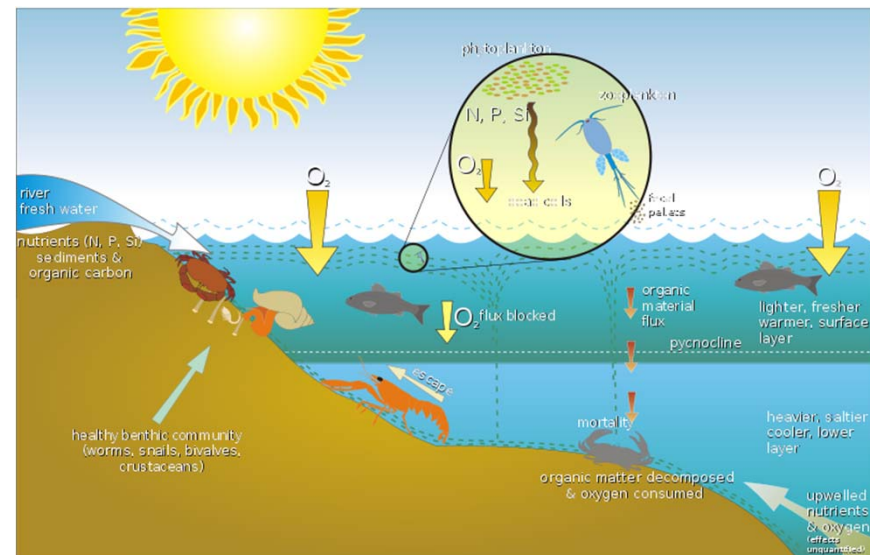
- Species and ecosystems have some capacity to tolerate changes in the intensity of environmental stressors, an attribute known as resilience.
- However, there are limits to resilience, which represent “thresholds of tolerance”.
- When these thresholds are exceeded, substantial ecological changes might occur in response to further increases in the intensity of environmental stress.





Threats to Ecosystem Services

- **Wildfire** - a disturbance during which much of the biomass of an ecosystem combusts, and the dominant species may be killed
- **Pollution** – occurrence of chemicals in concentrations large enough to affect organisms, and thereby cause ecological change.
- Toxic pollution can be caused by gases such as sulfur dioxide and elements such as mercury and arsenic, and pesticides.
- Nutrients such as phosphate and nitrate can distort ecological processes such as productivity, causing a type of pollution known as eutrophication.





Threats to Ecosystem Services

- **Climatic stress** - caused by excessive or insufficient regimes of temperature, moisture, solar radiation, or combinations of these.
- Tundra and deserts are climatically stressed ecosystems, while tropical rainforests occur in places with relatively benign climate.



Source: www.wikipedia.com by Nepenthes



Source: www.wikipedia.com by Ansgar Walk

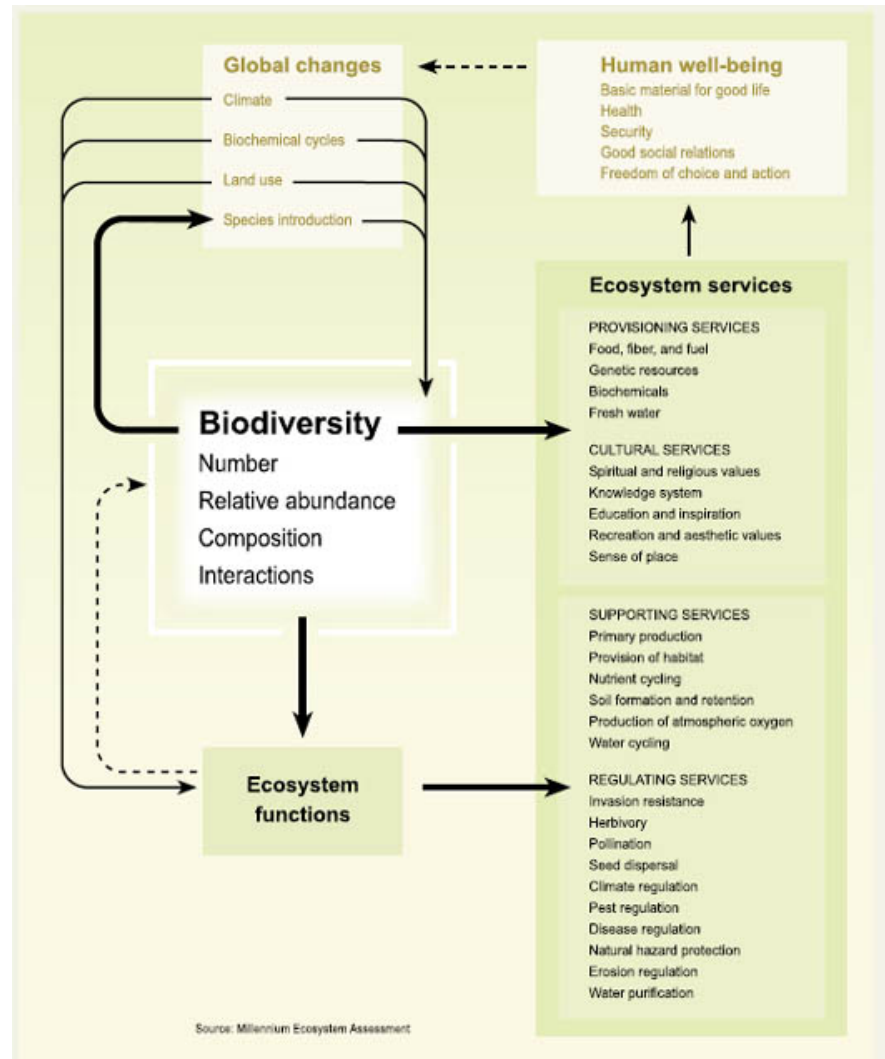


Threats to Ecosystem Services

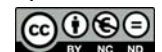
- **Biological stress** - associated with the complex interactions among organisms of the same or different species (competition, predation, parasitism, disease)
- Harvesting and management of species and ecosystems by humans is a type of biological stress.



Threats to Ecosystem Services



Source: Millennium Ecosystem Assessment Synthesis Report, <http://www.maweb.org/en/Products.Synthesis.aspx>





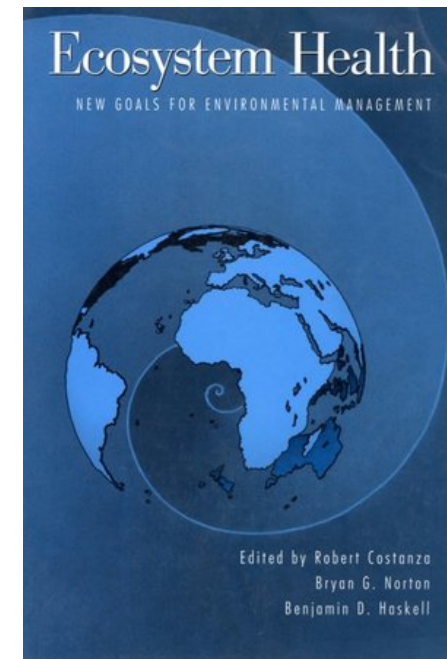
Ecological Integrity

- Ecological integrity is the condition in which the ecological processes and biological communities of an ecosystem function in a relatively self-sustaining equilibrium.
- Exhibiting the autopoietic (self-creative) capacities of life to organize, regenerate, reproduce, sustain, adapt, develop, and evolve over time at a specific location (Source: Westra 2003:32).
- Currently, human activity is presenting a challenge to ecological integrity, and therefore to the ecosystem services upon which we depend for survival.



Ecological Integrity

- The notion of integrity is analogous to that of human health.
- However, the metaphor of human and ecosystem health is imperfect in some important respects.
- Health refers to individual organisms, while ecological contexts are much more complex, involving many individuals of numerous species, and both living and nonliving attributes of ecosystems.
- Ecological integrity is closely related to resilience, biodiversity and ecosystem structure and function.



Source: Ecosystem Health: New Goals For Environmental Management by Robert Costanza, Bryan G. Norton, Benjamin D. Haskell (http://books.google.ca/books/about/Ecosystem_Health.html?id=opzqx56nBkMC)





Ecological Integrity

Resilience

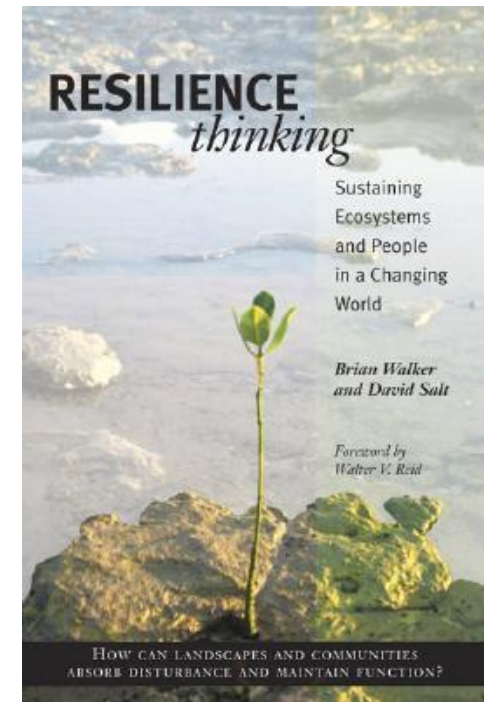
- Ecosystems with greater ecological integrity are, in a relative sense, more resilient or resistant to disturbances.
- In the ecological context, resilience refers to the capacity of a system to tolerate increases in stress without exhibiting significant responses.
- The greater the resilience of an ecosystem, the greater its ability to buffer disturbance and adapt to change.
- Natural systems are inherently resilient but just as their capacity to cope with disturbance can be degraded, so can it be enhanced.



Ecological Integrity

Resilience

- Ecosystem management can destroy or build resilience, depending on how the ecosystem organizes itself in response to management actions.
- Loss of ecosystem resilience can trigger abrupt response, including shifting to a qualitatively different (undesirable) state when subjected to even small perturbations.
- Pollution, climate change, loss of biodiversity, altered freshwater flows, etc. can cause loss of resilience and ecological integrity.



Source: Resilience Thinking
Sustaining Ecosystems and People in a Changing World (2006)
<http://www.publish.csiro.au/pid/5344.htm#sthash.wBAwDcp1.dpuf>

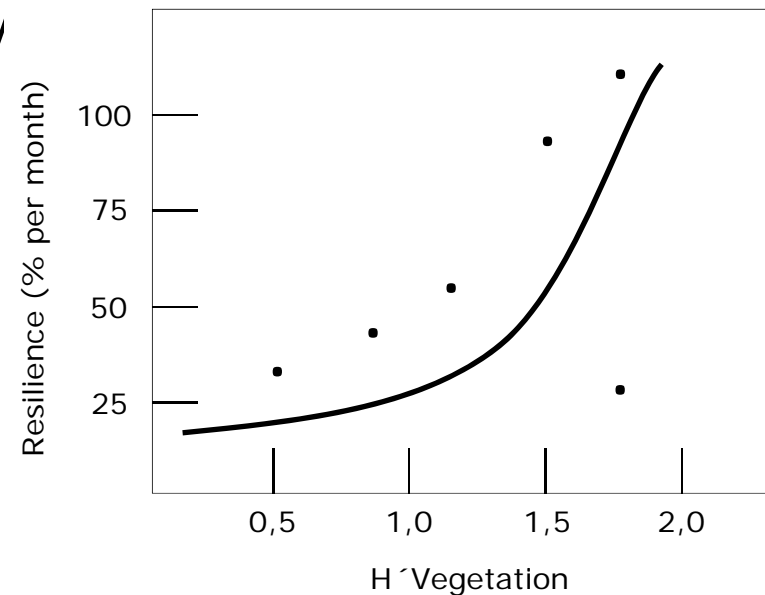




Ecological Integrity

Biodiversity

- Biodiversity refers to the total richness of biological variation, including genetic variation within populations and species, the numbers of species, and the patterns and dynamics of these over large areas.
- Biodiversity (degree of variety within an ecosystem) is key to resilience.
- Experiments in the Serengeti grasslands show that more diverse grasslands recover faster (are more resilient).





Ecological Integrity

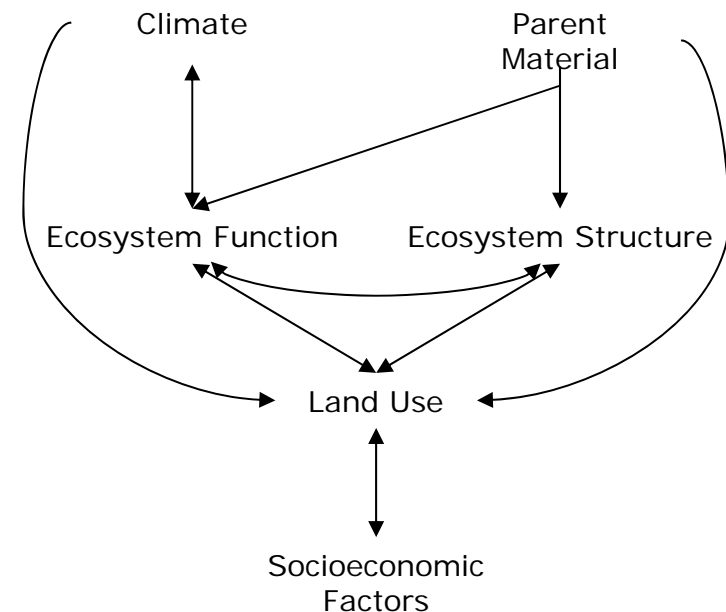
- Several different species in a grassland ecosystem will commonly perform nitrogen fixation, but each species may respond differently to climatic events.
- This will ensure that even though some species may be lost, the process of nitrogen fixation within the grassland ecosystem will continue.



Ecological Integrity

Structural and Functional Complexity

- Structural (form) and functional (process) complexity of ecosystems is limited by environmental stresses associated with climate, soil, chemistry, and human activities.
- As the overall intensity of stress increases (or decreases) structural and functional complexity responds accordingly.





Ecological Integrity

Environmental Indicators

- Many studies have been conducted on the ecological responses of ecosystems to longer-term disturbances.
- The commonly observed patterns of change in these studies are used to develop environmental indicators.
- Indicators are useful in determining whether an ecological condition is improving or being degraded over time.
- Environmental indicators vary widely in their scale, complexity, and intent.



Ecological Integrity

- Sometimes, relatively simple indicators can be used to integrate the ecological integrity of a large and complex ecosystem (old-growth forests).
- In the western United States the viability of populations of spotted owls is considered to be an indicator of the integrity of the types of old-growth forest in which this endangered bird breeds.



Conclusion

- As human population grows, so do the threats imposed on ecological integrity and ecosystem services.
- There is an urgent need to consider the long-term impacts of human activities on ecosystems integrity and the services they provide.
- Yet current efforts to develop and use the goods and services provided by ecosystems have not been well integrated with efforts to protect them.



Exercises for Self-Study

1. Why are ecosystems with greater ecological integrity, in a relative sense, more resilient or resistant to disturbances?
2. How does the loss of biodiversity affect ecosystem services?
3. What is the relationship between sustainable development, human health and ecological integrity?



References

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