

# MRBIR Ecosystem Functions Team Report

## *Ecosystem functions and services*

Missouri River Basin Interagency Roundtable  
August 19, 2015



# Ecosystem functions and services

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*Sodhi and Ehrlich: Conservation Biology for All.*

<http://ukcatalogue.oup.com/product/9780199554249.do>

*Oxford University Press, 2010*

# Ecosystem functions and services

Ecosystem services are

“the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life”

(Daily 1997);

in other words,

“the set of ecosystem functions that are useful to humans”

(Kremen 2005).

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# Climate and Biochemical Cycles

Ecosystem services start at the most fundamental level:  
the creation of the air we breathe  
&  
the supply and distribution of water we drink.

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Global biogeochemical cycles consist of  
“the transport and transformation of substances in  
the environment through life, air, sea, land, and ice”  
(Alexander et al. 1997).

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# Climate and Biochemical Cycles



- As carbon-based life forms, every single organism on our planet is a part of the global carbon cycle.

- Plants play a major role in fixing atmospheric CO<sub>2</sub> through photosynthesis...

- The global carbon cycle has been disturbed by about 13% compared to the pre-industrial era, as opposed to 100% or more for nitrogen, phosphorous, and sulfur cycles (Falkowski et al. 2000).



# Climate and Biochemical Cycles

...the excessive use of nitrogen fertilizers can lead to nutrient overload, eutrophication, and elimination of oxygen in water bodies.



The mining of phosphate deposits and their addition to terrestrial ecosystems as fertilizers represents a six fold increase over the natural rate of mobilization of P by the weathering of phosphate rock and by plant activity (Reeburgh 1997).

# Regulation of the Hydrologic Cycle

Hydrologic regulation by ecosystems begins with the first drop of rain. Vegetation layers...intercept raindrops, which gradually descend into the soil, rather than hitting it directly and leading to erosion and floods. By intercepting rainfall and promoting soil development, vegetation can modulate the timing of flows and potentially reduce flooding.



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# Soils and Erosion



Every year about 75 billion tons of soil are thought to be eroded from terrestrial ecosystems, at rates 13–40 times faster than the average rate of soil formation (Pimentel and Kounang 1998)...

Soil is one of the most critical but also most underappreciated and abused elements of natural capital, one that can take a few years to lose and millennia to replace.



# Soils and Erosion

\* Every year enough rain falls to cover the planet with one meter of water (Shiklomanov 1993), but thanks to soil's enormous water retention capacity, most of this water is absorbed and gradually released to feed plants, underground aquifers, and rivers.



\* However, intensive cultivation, by lowering soil's organic matter content, can reduce this capacity, leading to floods, erosion, pollution, and further loss of organic matter (Pimentel et al. 1995)

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# Soils and Erosion

- > Soil is also critical in filtering and purifying water by removing contaminants, bacteria, and other impurities (Fujii et al. 2001).
- > Per area, soil stores 1.8 times the carbon and 18 times the nitrogen that plants alone can store (Schlesinger 1991).
- > ...excessive wind and water erosion results in the removal of top soil, the loss of valuable nutrients, and desertification.



# Biodiversity and Ecosystem Function

- Many studies have confirmed that increased biodiversity improves ecosystem functioning in plant communities (Naeem and Li 1997; Tilman 1997).
- More biodiverse ecosystems are also likely to be more stable and more efficient due to the presence of more pathways for energy flow and nutrient recycling (Macarthur 1955; Hooper et al. 2005; Vitousek and Hooper 1993; Worm et al. 2006).
- Greenhouse and field experiments have confirmed that biodiversity does increase ecosystem productivity, while reducing fluctuations in productivity (Naeem et al. 1995; Tilman et al. 1996).

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# Mobile Links

“Mobile links” are animal species that provide critical ecosystem services and increase ecosystem resilience by connecting habitats and ecosystems as they move between them



(Gilbert 1980; Lundberg and Moberg 2003; Box 3.4).

Mobile links are crucial for maintaining ecosystem function, memory, and resilience  
(Nyström and Folke 2001).

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# Mobile Links

Some organisms like woodpeckers or beavers act as physical process linkers or “ecosystem engineers” (Jones et al. 1994). By building dams and flooding large areas, beavers engineer ecosystems, create new wetlands, and lead to major changes in species composition (see Chapter 6).



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# Mobile Links

Pollination is a critical ecosystem function for the continued persistence of the most biodiverse terrestrial habitats on Earth. Nabhan and Buchmann (1997) estimated that more than 1200 vertebrate and about 289 000 invertebrate species are involved in pollinating over 90% of flowering plant species (angiosperms) and 95% of food crops. Bees, which pollinate about two thirds of the world's flowering plant species and three quarters of food crops (Nabhan and Buchmann 1997), are the most important group of pollinators (Box 3.3).

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# Summary

- \* Ecosystem services are the set of ecosystem functions that are useful to humans.
- \* These services make the planet inhabitable by supplying and purifying the air we breathe and the water we drink.
- \* Water, carbon, nitrogen, phosphorus, and sulfur are the major global biogeochemical cycles. Disruptions of these cycles can lead to floods, droughts, climate change, pollution, acid rain, and many other environmental problems.



# Summary (continued)



\* Soils provide critical ecosystem services, especially for sustaining ecosystems and growing food crops, but soil erosion and degradation are serious problems worldwide.

\* Higher biodiversity usually increases ecosystem efficiency and productivity, stabilizes overall ecosystem functioning, and makes ecosystems more resistant to perturbations.



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