

Community and Ecosystem Ecology

by Dr. W.

Keystone Species

- *Keystone species* are species whose presence in an ecosystem has a very large effect on overall species diversity—out of proportion to their numbers.
 - A keystone species may be an *apex predator* but doesn't have to be—or have to be a predator at all.
- The loss of a keystone species "ripples" through an ecosystem and changes it fundamentally.

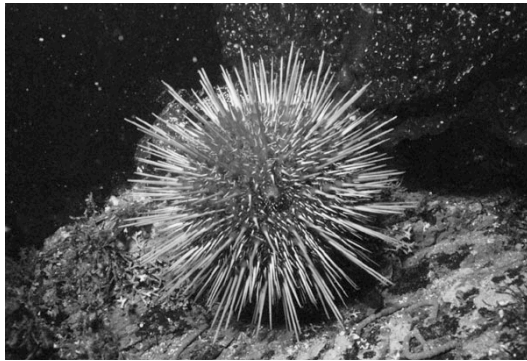
The term is a metaphorical reference to the keystone of an arch—if the keystone is removed, the entire arch collapses.



Case Study: California sea otters are marine mammals that feed on clams, snails. . .



. . . and sea urchins. Sea urchins graze on *kelp*, a giant seaweed attached to rocky ocean bottoms. . .



. . . and kelp "forests" are home to a great many species of fish and other animals.

So when sea otters were driven almost to extinction by hunting for fur (down from as many as 300,000 to about 1,000 by the year 1911), the urchin population exploded, the urchins destroyed the kelp, and the ecosystem became much more barren!



Another example: In 1995, wolves were reintroduced to Yellowstone National Park, where they had been wiped out years ago. The wolves' main prey is elk. . .



To avoid the wolves, the elk in Yellowstone have started moving to higher ground, away from river valleys. Without elk grazing, riverside plants like willow and aspen trees are becoming more abundant—creating habitat for beavers, moose, and other animals. . .



And elk killed by wolves are a major source of food for scavengers—from ravens to grizzly bears to bald eagles. Wolves are a *keystone species* because their presence—or absence—has effects that ripple through the whole ecosystem.



Hydrologic Cycle

- **Major driving force:** Solar energy, which causes water to evaporate from oceans and other bodies of water
- Water leaves the atmosphere as rain, snow, hail, etc.
 - It eventually returns to the oceans, either by falling directly in them, or as surface runoff (e.g. rivers)
 - Some water may leave the active cycle for a long time, such as groundwater (e.g. springs, seeps, etc.), glaciers, or icecaps

Rainfall over the Pacific Ocean: a brief but complete hydrologic cycle in one photo!



Carbon cycle

- **Major driving force:** Photosynthesis takes CO_2 out of atmosphere
 - Plants and other producers are able to “fix” carbon— take it out of CO_2 and put it into more complex compounds that they need
- *Respiration* of consumers and decomposers eventually puts CO_2 back into the atmosphere
- Fires also put CO_2 back in the atmosphere
- Some “new” CO_2 is added by volcanoes, and some is removed by geological processes such as weathering of silicate minerals

Death and burial of once-living organisms takes CO_2 out of the cycle for millions of years. If these remains become *fossil fuels* (coal, oil, natural gas), the burning of fossil fuels releases that ancient carbon back into the atmosphere as CO_2 .



Nitrogen cycle

- **Major driving forces:** Lightning, plus certain *nitrogen-fixing* bacteria, convert nitrogen gas in the atmosphere into usable compounds (ammonia and nitrates).
 - There is lots of nitrogen gas in the atmosphere (78%), but it's in a form (N_2) that most organisms can't use
- These nitrogen compounds are taken up by producers, which are eaten by consumers, etc.
- "Denitrifying" bacteria break down these nitrogen-containing compounds and re-release nitrogen gas back into the atmosphere.



Most legumes (the family of plants that includes beans, peas, alfalfa, clover, etc.) have nodules on their roots packed full of symbiotic nitrogen-fixing bacteria. These not only nourish the host plant, but ultimately make fixed nitrogen available to other plants and animals.



Most of the nitrogen fertilizer used in agriculture (100 million tons per year) is artificial—made from atmospheric nitrogen and a hydrogen source such as natural gas

Phosphorus cycle

- **Major driving force:** Erosion of rocks
- When rocks erode, phosphorus is released, to be taken up by producers, consumers, and so on. . .
- Ultimately, phosphorus moves to the oceans in runoff, where it may stay for millions of years in marine sediments
- The very slow processes of geologic uplift (mountain building, etc.), forming new exposures of rocks on land, returns phosphorus to the cycle

The phosphorus needed for agriculture is primarily mined from areas that are rich in phosphate rock. This rock is ground and added to soils. Unfortunately, world supplies of phosphates are projected to start collapsing in the next thirty years. . .



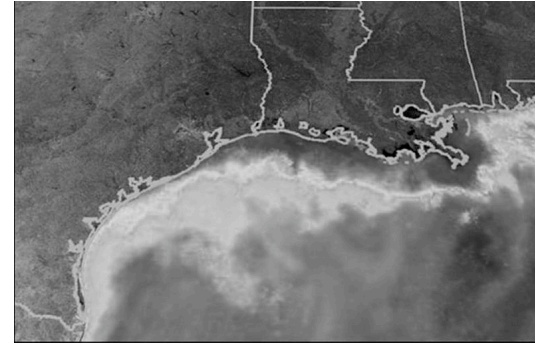
In modern industrial agriculture, nitrogen and phosphorus aren't cycled. They're added to fields each year, and what the plants don't use washes out of the soil and runs into rivers and lakes. . .



When a body of water receives a rich input of nutrients, algae and bacteria “bloom”. These consume oxygen by their respiration and their decay, so the water becomes so oxygen-depleted that nothing can live in it. This is called *eutrophication*.



The Gulf Coast “dead zone” is a huge area of eutrophication, 8500 square miles (one-sixth the size of Arkansas), where animal life cannot survive in the low-oxygen waters. It’s caused by massive nutrient runoff from the Midwest, down the Mississippi.



The point of organic farming and gardening is to “minimize inputs”—to cycle nitrogen and phosphorus, for example, instead of constantly needing to apply new fertilizer. Composting is one very important way of doing this.

