If we know a few things about ecosystems, we can live in harmony with Earth.
The *Limiting Nutrient* is a requirement for life which in its absence, inhibits growth of plants (and animals).

- What is the limiting nutrient of the Sahara Desert?
“Production” is an ecologist's term for the rate of biomass growth.

- “Biomass” refers to the mass of living organisms if you put them in a net and weighed them.
- Biomass accumulation divided by the time it took to grow is production.
- **How could you measure production?**
- “Primary Production” is the growth of plants.
- “Secondary production” is the growth of the animals that feed on those plants.
The mid-ocean areas away from upwelling are also deserts.

- Upwelling zones provide nutrients of life, the mid-ocean gyres are “deserts” devoid of the necessary ingredients of life.
- Humans are putting in so many nutrients though (from sewage and fertilizer run-off) that already productive areas are becoming too productive.
Too much productivity isn’t good for us.

- How can an area be TOO productive? Isn’t productive good?
- Run-off from Mississippi river farms causes huge bloom of phytoplankton, the grass of the sea.
- They sink to the bottom of the ocean and feeding organisms use up all the oxygen.
- Then there is no oxygen left for the shrimp!
Wetlands are the natural filters of the Earth.

- Wetlands are very, very productive regions which can safely remove nutrients.
- Many animals and birds depend on wetlands for food, water and shelter.
People can accelerate the natural job that wetlands are doing.

- By understanding and working with the forces of nature, we can mitigate the nutrient pollution we create.
- People also restore natural wetlands.
- We will visit a restored wetland tomorrow.
Animals and plants species have become accustomed over millions of years to exploit specific living conditions.

- The particular set of conditions under which a species is able to live define the **niche** of that species.
- For example some species are adapted to live in deserts and some are adapted to live in ponds.
- The niche of the desert beetle is to live with very little water, and be able to escape desert heat by burrowing. The water strider has a very different strategy that involves living on the surface tension of water and eating aquatic insects.
Exotic species can invade because their niches are just a little bit more favorable than those of the Native species.

- Nutria are an exotic mammal from South America that resembles a beaver.
- It eats much the same things as Beavers, but doesn't build a lodge or cut down trees.
- Disease, predators are left behind in S. America.
The species on Earth have a vast array of valuable functions.
The value of ecosystems and species can be calculated.

- Ecological economics is a way to assign a price value to ecosystems.
- The calculated value of basic ecosystem services --such as sewage decomposition-- on Earth is trillions of dollars.
Ecosystem value is real.

- How much would it cost New York City to purify all of its own water if it had to do so?
- How much are the Adirondak watersheds worth by keeping them pristine?

Assume it would cost 0.1 cents per gallon to purify water.
The top predator in a food chain needs a large amount of primary production.

- Each animal in a food chain is a new trophic level.
- At each link in the food chain, only about 10% of the biomass from the previous trophic level gets to the next trophic level.
- How much area does the Osprey require to survive?
- **Carrying Capacity** is the number of individuals of a particular species that an area of land can support.
Real food chains are interconnected networks of animals and plants that depend on each other.

- A foodweb is a network of interconnected food chains.
- There is redundancy in this network.
- If one link fails, there are enough other similar animals that a healthy ecosystem can withstand the temporary failure of a few species.
Build your own FoodWeb!

• We'll go out to the wetlands tomorrow, and you can select species for your microcosms.
Beavers affect wetlands strongly because they engineer the landscape.

- A **Keystone** species is one that affects the lives of other plants and animals disproportionately to its biomass.
- Beavers are keystone species because they change the land they live on dramatically by clearing out trees, clearing vegetation from waterways and sometimes by damming up streams and creating ponds.
- Humans are also a keystone species.
The inside of a beaver lodge is big enough for a person.
Sea otters keep kelp forests healthy.

- Without Sea Otters, sea urchins would eat all the kelp. This would affect all the other species that live in kelp forests. Sea Otters are a keystone species.
- Can you think of any other examples of keystone species?
Human's must take care of the Earth.

- As a keystone species we have a tremendous responsibility.
- We can help maintain landscapes that are healthy and provide food, water and shelter for us and for animals.
- We can do this even in our own backyards.
Animals and plants can be our best teachers.

- Animals like squirrels must find food, water and shelter in the city.
- Where do they go to sleep?
- How could we take the design principles of a squirrel's nest to make our own homes more energy-efficient?
We can find better (smarter) ways to live.

- Beautiful, efficient, earthy.
- Green roof absorbs rain and could grow food.
- Wall made of recycled materials.
With a few skills we can all be “native” americans.

- Camouflage can make us almost invisible to animals.
- Finding brushy areas to hide in can make us very difficult to see.
- Sitting very still for a long time can allow you to see wildlife.
- “Fox-walking” and owl eyes are great ways to see wildlife even while not sitting still.