Marine Ecosystem Flashcard
Background Information

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Unit: Marine Ecology: Connections & Cascades

For use in lessons
"Building Marine Food Webs"
"Ecosystems and Stable States"

This document contains details on the species and food webs represented in the associated sets of flashcards. Each set contains 10 to 12 "major players" for a classic marine ecosystem, i.e. species that play an important role in the overall structure of the ecosystem.

Marine ecosystems represented (n=5):
Kelp forest
Coral Reef
Salt Marsh
Rocky Intertidal Zone
Hydrothermal Vent

Using these flashcards with the lesson plans listed above, students will become familiar with new ecological concepts (including food webs, ecosystem services, and alternate stable states) as they become familiar with the concrete example of one of these ecosystems. In fact, rather than apply new concepts to the world, they will extract the new concepts themselves from these real world examples.

In the following pages, for each ecosystem we provide…
1. The species included in the flashcard sets
2. The trophic relationships among species
3. Which species perform which ecosystem services
4. The communities the typify different stable states of this ecosystem.
5. The kinds of perturbations that bring these about these different conditions (biological, physical, and human), and mechanisms that might cause the stable state to switch back.
5. Helpful links and diagrams for more information about the ecosystem.

Kelp Forest

California & Alaska

Species: (n=12)
Giant Kelp *(Macrocystis pyrifera)*
Red Wiry Algae (Red Turf Algae, *Gelidium*)
Purple Sea Urchin *(Strongylocentrotus purpuratus*),
Jewel top snail (*Calliostoma annulatum*),
Red Abalone (*Haliotis rufescens*),
Spiny brittle star (*Ophiothrix spiculata*)
California spiny lobster (*Panulirus interruptus*)
Garibaldi (*Hypsypops rubicundus*)
California sheephead (*Semicossyphus pulcher*)
Sea lion (*Zalophus californianus*)
Sea otter (*Enhydra lutris*)
Orca (*Orcinus orca*)

Ecosystem Services

Keystone species –
Alaska: otter;
California: lobster, sheephead, and otter

Ecosystem Engineers – Kelp
Foundation species – Kelp
Umbrella species -- Otter
Indicator species – Sea urchin, kelp
Flagship species – Otter, Orca, Sea Lion, Garibaldi

Stable States

Keystone Present: Kelp Forests: Sheephead. Sea Otter. Kelp Forest. Lobsters. Purple Sea Urchin. Sea Lion.

Keystone Absent: Urchin barren: Purple sea urchin dominates. Brittle stars. Sunflower starfishes. Red Wiry Algae (Red Turf Algae, Gelidium)

Swing: The keystone species are the predators of the urchin. In Alaska, that is solely the otter. In California, it is the sheephead-lobster-otter complex. Remove these species, and the urchins eat all the kelp off at their holdfasts, and the kelp forest is lost. The Red Wiry Turf Algae begins to dominate, and kelp can no longer colonize on the rocky substrate. Urchins outcompete all the other grazers, and abalone can't keep up. Brittle stars and starfishes blossom in urchin barrens.

Biological swing: Orcas switch to hunting otters
Physical swing: Water warms up, not enough nitrogen in solution for kelp

Human swing: Whaling (and orca prey switch and subsequent cascade), otter hunting, abalone hunting, urchin eating

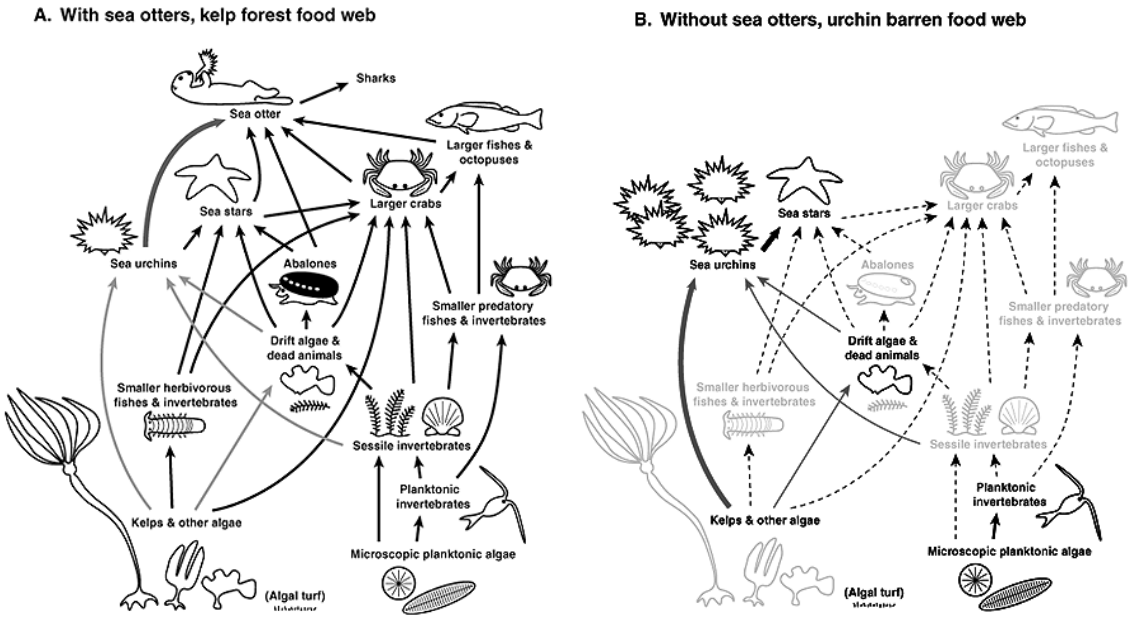
What would swing it back?

Humans eating a bunch of urchins, protecting otters, the return of large whales, some storm event.

Links

http://cbc.amnh.org/crisis/foodweb.html

http://www.montereybayaquarium.org/PDF_files/activities/seasearchers/aquarium_ss_kelpforest.pdf



Coral Reef

Great Barrier Reef

Species (n=12)
Zooxanthellae (Genus *Symbiodinium*, coral symbiont),
Phytoplankton (*Prochlorococcus spp.)*
Heterotrophic nanoflagellates (Genus *Ancyromonas*)
Herrmann's Sea cucumber (*Stichopus herrmanni)*
Corals (Class Anthozoans)
Parrotfish (Scaridae)
Crown-of-thorns starfish (*Acanthaster planci*)
Sea squirts (Class Ascidiacea)
Triton shells (*Charonia*)
Humphead/Napoleon/Maori wrasse (*Cheilinus undulatus*)
Periwinkle snail (Genus *Littorina*)
Sickle-fin lemon shark (Negaprion acutidens)

Ecosystem Services

Keystone species – Coral, or possibly the sea cucumber.
Engineer species -- Coral
Foundation species – Coral (its symbionts, at least)
Umbrella species – Coral
Indicator species – Coral
Flagship species – Parrotfish, Wrasse (esp.), Shark, Coral.

Stable States

Keystone Present: Coral reef. A huge diversity of life is sustained, with a very complex food web. Some is based on low, constant phytoplankton production, but much comes from the coral reef (whose symbionts are primary producers). The food web is complicated and not cut-n-dry.

Keystone Absent: No coral, a rocky starfish barren. Lemon shark is still around, however, eating bottom dwelling fish.

Swing: Many possible swings:
Biological change: Crown-of-thorn invasion reduces coral.
Physical change: Ocean acidification or warming causes bleaching.
Human impact: Cucumbers are lost, reducing the calcium carbonate in the water, preventing coral formation.
What would swing it back? Removal of Crown-of-thorn, return to cooler temperatures, and a lot of time.

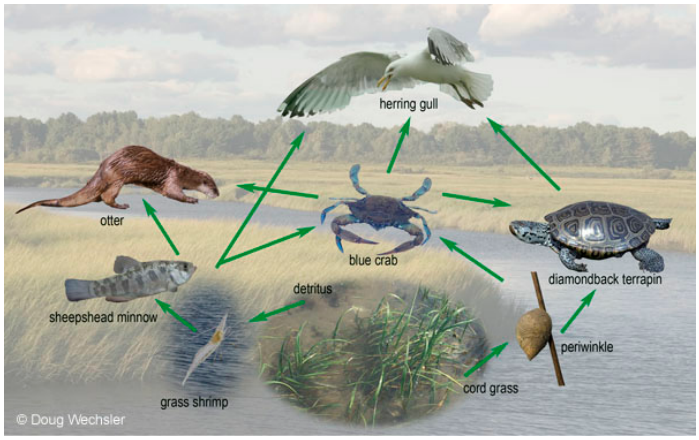
Links

http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/BDM/30/BDM30_41_Eriksson.pdf
http://www.sciencedaily.com/releases/2011/12/111222152018.htm

Salt Marsh

Atlantic coast

Species (n=12)



Cordgrass (Genus *Spartina*)
Epiphytic algae on *Spartina* cordgrass
Fiddler crab (Genus *Uca*)
Ribbed mussel (*Aulacomya ater*)
Periwinkle (Genus *Littorina*)
Grass shrimp (omnivores) – (*Palaemonetes* spp.)
Blue crab (*Calinectes sapidus*)
Sheepshead minnow (*Caprinodon variegatus*)
Raccoon (*Procyon lotor)*
Diamondback terrapin turtle (*Malaclemys terrapin*)
Osprey (*Pandion haliaetus*),
Alligator (*Alligator mississippiensis*)

Ecosystem Services

Keystone species – Fiddler crab
Engineer species - Spartina
Foundation species - Spartina
Umbrella species – Alligator, blue crab
Indicator species – Spartina, terrapin turtle
Flagship species – Alligator, turtle

Stable States

Keystone Present – Cordgrass salt marsh.
Keystone Absent – Salt pan. Anoxic conditions (when detritivores and sediment cyclers like fiddler crabs and ribbed mussels are absent) prevent the growth of cordgrass. Alternatively, wrack can smother plants and expose the ground. Areas that are already prone to dryness will be evaporated further, and when water evaporates it leaves its salt behind. They area becomes too salty for anything to grow, and it becomes a permanent salt-pan.

Swing:
Biological: Overpopulation of seagulls (from dumps)
Physical: Wrack piles smothering areas
Human: draining wetlands (causing evaporite pans), causing debris, hunting blue crabs (swing back, releases fiddler crabs),
What swings it back? Prolonged inundation, removal of fiddler crab predators.

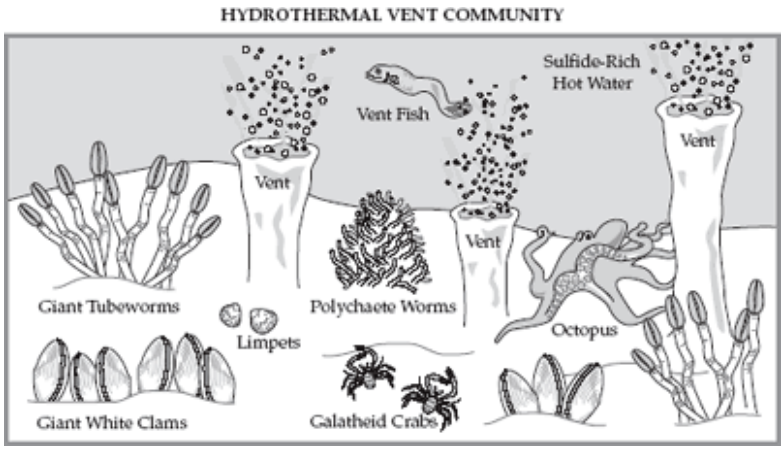
Links

http://saltmarshlife.com/salt-marsh/ecology.html
http://life.bio.sunysb.edu/marinebio/spartina.html

Hydrothermal vent

These vents were only discovered in 1977, and scientists are still unsure about the trophic dynamics of their residents. Invite kids to do some imaginative thinking and give their best hypotheses about how it is working. This is an example of a work in progress.

Species (n=10)
Chemoautotrophic bacteria
Limpets (feed on bacteria) (*Lepetodrilus* and *Eulepetopsis*)
Giant tube worms (*Riftia pachyptila*)(NOT shipworms!)
Vesicomyid bivalve clams (*Calyptogena magnifica*)
Vent shrimp (*Rimicaris exoculata*)
Hydrothermal vent crabs (*Bythograea thermydron*)
Yeti crabs (*Kiwa hirsuta*)
Zoarcid fish (the top predators) (*Ophthalmolycus macrops*)
Octopus (*Vulcanoctopus hydrothermalis*)
Deep-sea Pompeii worm (*Alvinella pompejana*)



Ecosystem Services

Keystone species – the guild of species that eat the sulfur-fixing bacteria.
Engineer species – Giant tube worms and clams
Foundation species – the guild of species that eat the sulfur-fixing bacteria
Umbrella species – Zoarcid fish (because to protect it, you need to protect all the inhabitants; the jaguar of the vent)
Indicator species – Any bacteria fixer with few predators
Flagship species – Yeti crab?!?

Stable States

Keystone Present – Active hydrothermal vent
Keystone Absent – Inactive/dead vent

Swing: Change in local tectonic activity (doesn't always have to be biological!). This ecosystem seems to break the mold. Because so little is known about this ecosystem, invite the students to do critical thinking to make best guesses of ecosystem roles. After all, who is the flagship species of a hydrothermal vent? A yeti crab?!? Let the students speculate and wonder, as long as they support their claims thoughtfully.

Links

http://www.botos.com/marine/vents01.html
http://www.csa.com/discoveryguides/vent/review.pdf
Food web credit: http://mdk12.org/instruction/clg/public_release/biology/G3_E5_I2.html

Rocky Intertidal

Species (n=12)
Macroalgae and crustose algae (e.g. *Fucus* and *Ulva*)
Rhodophyte algae (*Endocladia muricata*)
Ochre starfish (*Pisaaster ochraeus*)
Common mussel (*Mytilus californicus*)
Purple sea urchins (*Strongylocentrotus purpuratus*)
Lined shore crab (*Pachygrapsus crassipes*)
Leather star (*Dermasterias imbricata)*
Anemone (*Anthopleura xanthogrammica*)
Limpet (*Lottia pelta*)
Barnacles (*Balanus glandula* and *Pollicipes polymerus*)
Sea otters (*Enhydra lutris*)
Ring-billed gulls (*Larus delawarensis*)

Ecosystem Services

Keystone species – Ochre stars
Engineer species – The algaes, the mussels
Foundation species – The algaes
Umbrella species – Ochre star
Indicator species – Mussels, Leather star
Flagship species – Starfish, Sea otters

Stable States

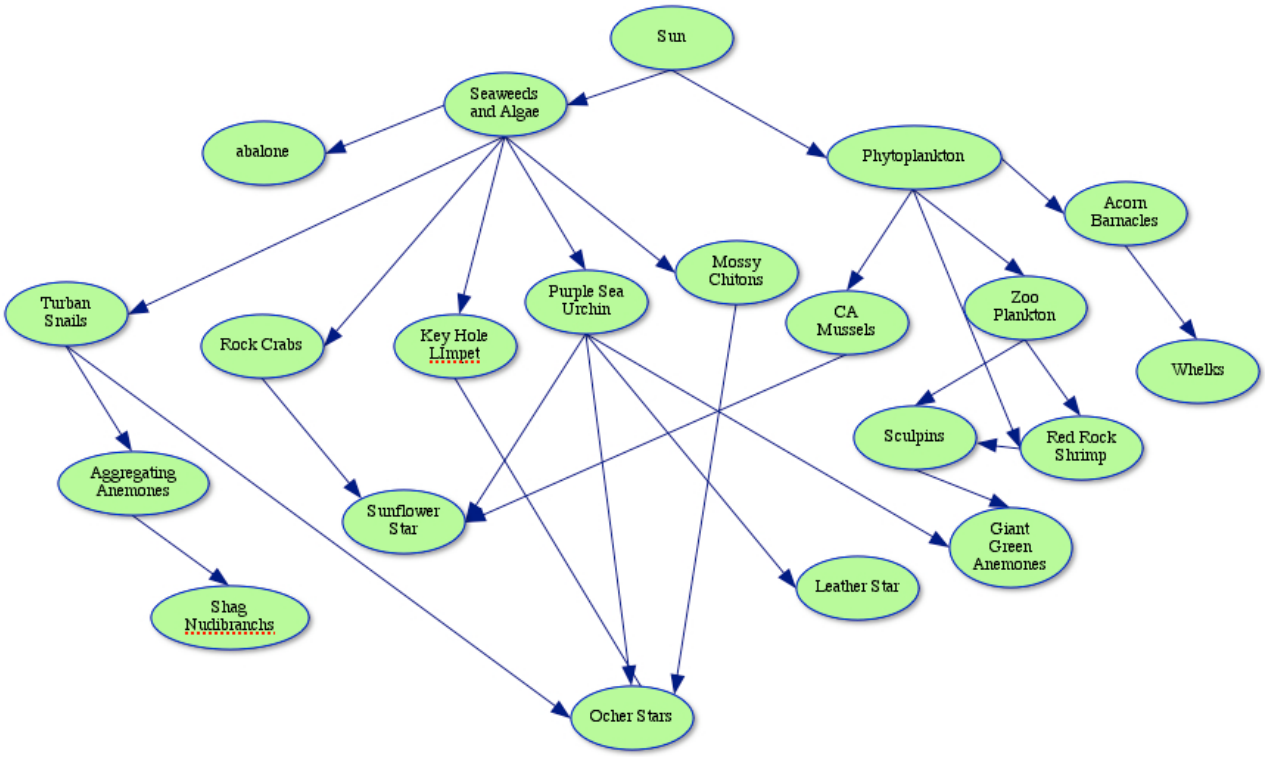
Keystone Present: Ochre stars abundant –
The Ochre star eats limpets, who eat *Endocladia* algae. In doing so, *Endocladia* algae are free to grow, and mussels eat it, and the ochre star eats the mussel. By keeping mussel populations low, more space is available to other algae and other filter feeders. Different animals eat these other filter feeders, and a very diverse community can occur. The anemones depend on the starfish to dislodge their own prey.

Keystone Absent: Ochre stars absent –
Without the ochre star, there is nothing controlling the mussels, and they out-compete all the other filter feeders. The result is a rocky habitat dominated by mussels and low diversity.

Swing:
Biological: Ochre stars go absent (otter predation, birds).
Physical: Warming? Harder storms?
Human: Mussels harvested. Ochre star predators removed.
What would swing it back? Sever storms removing mussel beds, human harvesting.

Links

http://faculty.washington.edu/wgold/bes489/012109.pdf
http://life.bio.sunysb.edu/marinebio/rockyshore.html



http://suite101.com/article/three-marine-keystone-species-a75928