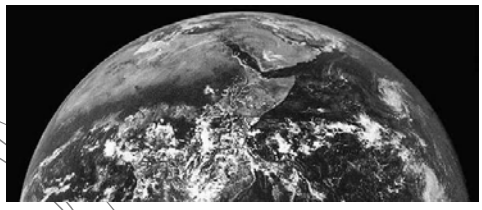
The Importance of Viewing the Earth as an Integrated Whole



Earth System

Returning back to the beginning of the course, recall two fundamental aspects of Earth:

1. Earth is a closed system
2. The Earth system is comprised of multiple integrated parts

Throughout this course, we have also looked at how interactions between Earth's components (especially within the biosphere) have influenced the development of modern Earth.

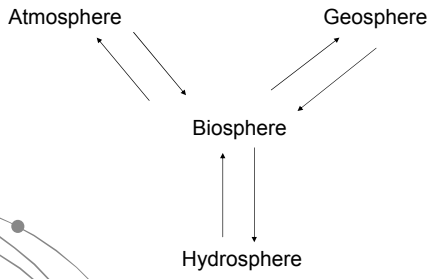
Importance of the Closed System Concept

Changes within the Earth system are essentially self-contained – extraterrestrial factors such as solar luminosity vary so little over millions of years that they are insignificant in the context of Phanerozoic time.

Events such as meteorite impacts are exceptions, but aftermaths is still confined to the Earth system.

The Bottom Line: we are stuck with what we've got in our system !

Multiple Integrated Parts



We've examined how the biosphere has developed and how the biosphere has influenced all other components of the Earth system.

Why Should We Care ?

We are obviously living in a time of great change in biospheric evolution.

We are affecting the biosphere both directly (e.g. via habitat destruction) and indirectly (due to biospheric responses to changes in the geosphere, hydrosphere and atmosphere).

…but we are also AFFECTED by how the Earth system is responding to our activities.

Biosphere Management

Our reactions to degrading biospheric health are commonly focussed on "fixing" the most obvious environmental "problems" – a Band-Aid approach.

For example: How do we reduce greenhouse warming ?

Answer: Have the current population cut down on fossil fuel burning !

But the solution is not always simple.

Feedback in the Earth System

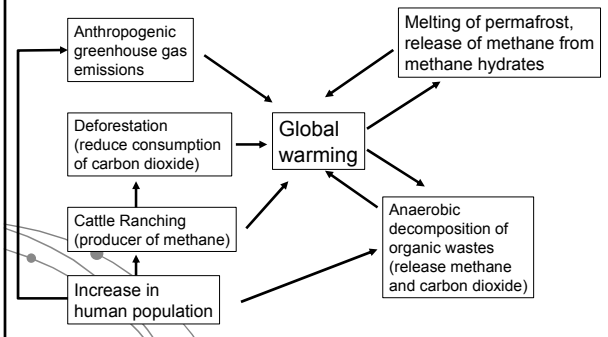
Anti-environmental groups also downplay the seriousness of biospheric degradation, by stating that carbon dioxide emissions exert minimal change in atmospheric composition.

But many ignore the feedback mechanisms in the Earth System.

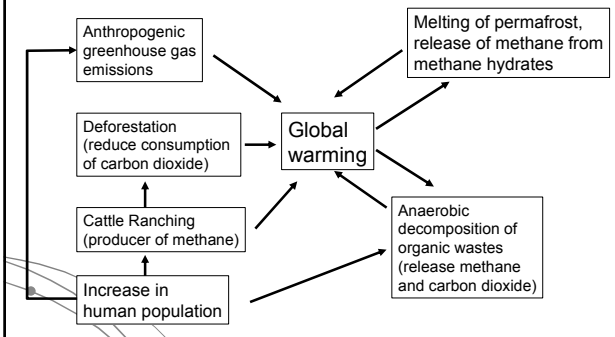
Global warming attributed directly to fossil fuel emissions is the tip of the iceberg !

Little problems can become much bigger problems due to feedback.

Remember This Diagram ?



Note that global warming is not only a function of per capita combustion of fossil fuels. Note also the effects of feedback



The total amount of warming also depends on the size of the global human population and the availability of greenhouse gas sinks (e.g. forests) which are themselves shrinking.

The Future of Biosphere Management (A No-Brainer, Really)

In view of the complex interactions among Earth system components it should be obvious that significant change to biospheric health can only be accomplished through the work of both specialists and generalists in many different disciplines.

That said, it is impossible for humans to have *no* impact on the global environment.

This is why "sustainability" is such a buzzword at present. In a sustainable work humans can use Earth's resources without significantly affecting the environment (through responsible management practices).

How long can humans prolong their existence through sustainable resource management ? Time will tell.

A Few Words on Human Health (A Bit Closer to Home)

Humans, like all other animals, are products of millions of years of evolution.

Organisms do not evolve in isolation (as this course has hopefully demonstrated).

We are obviously interconnected with all of the major Earth system components (we couldn't exist without the atmosphere, hydrosphere, geosphere or other residents of the biosphere).

But our interactions within the biosphere go well beyond the obvious.

Will We Continue to Evolve ? …Or Go Extinct Before We Have a Chance ?

If natural selection continues to work on us, will we look like this ?

Towards the Sixth Big Mass Extinction

"Today, we may be losing up to 30,000 species a year -- a rate much faster than at any time since the last great extinction 65 million years ago that wiped out most of the dinosaurs. If we continue on this course, we will destroy even ourselves."

- M. Novacek, American Museum of Natural History

"Almost a quarter of the world's mammals face extinction within 30 years."

- United Nations report on the state of the global environment.

"Less than 10 per cent of the remaining habitat of the great apes of Africa will be left relatively undisturbed by 2030 if road building, mining camps and other infrastructure developments continue at current levels."

-United Nations Environment Programme (UNEP)

This is where a lecture would normally end…

But lets go one more step…

So if we go extinct…then what ?

1. North & South America offset due to subduction of Caribbean plate
2. Subduction in north Pacific Rim, North America joining with Eurasia
3. Australia is drifting towards Eurasia
4. Eastern Africa is splitting and drifting eastward
5. Africa continues to move northward toward Europe

Life Goes On Without Us, and Plate Tectonics Does its Thing

50 million years after Age of Man

Major features:

1. North America attached to Eurasia
2. South America isolated from North America as an island continent
3. Australia attached to Eurasia (but New Zealand remains isolated)
4. Eastern Africa splits and drifts eastward as Lemuria ?

Hypothetical Scenario 1: Evolution of Grassland Grazers

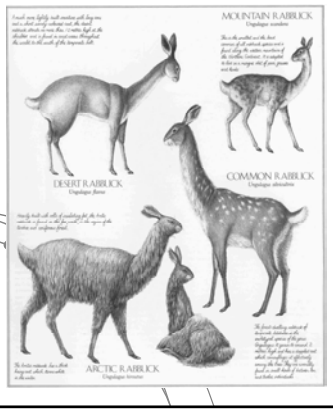
During “Age of Man” grasslands were dominated by large, herbivorous ungulates (hoofed mammals).

Many large grassland-dwelling ungulates domesticated to such a degree that they become dependent on humans and go extinct during the sixth mass extinction.
Remaining wild ungulates (e.g. zebras, gazelles, etc.) driven to extinction by expansion of agriculture, urban development and pollution.

Niche-filling by rodents and lagomorphs (rabbits and hares)

Shortly after sixth big mass extinction, grassland ungulates were replaced by rodents that were tolerant of human activity and could survive on food sources from smaller area.

Grasslands: North America



Major adaptations to suit rabbits to grazing lifestyle:

1. Modification of teeth to grind large volumes of silica-laden grasses
2. Elongation of legs and reduction of toes to allow efficient running on large expanses of plains.
3. Isolation of rabbucks in South America possibly produces forms of different appearance than in main supercontinent.

Grasslands: South America

Meanwhile, in South America (now an island continent),
the maras and capybaras gave rise to stricks and wakkas, exhibiting convergent evolution with the rabbit-derived rabbucks

Hypothetical Scenario 2: Evolution of Grassland Predators

Human expansion, extinction of ungulate herbivore prey, and overhunting drove major predators, particularly the big cats to extinction. Accordingly, scavengers also suffered.

The big cats were replaced by highly adaptable and resourceful - animals that could elude humans.
These animals were the monkeys.
During the “Age of Man,” these animals were omnivorous, but after the sixth major mass extinction, became fully Carnivorous raboons and horranes.

Mongooses, small, unassuming animals whose generalized diet consisted mainly of small prey became scavengers called Gholes.

Grasslands: Africa

Predators (Raboons, Horranes),
and Scavengers (Gholes)

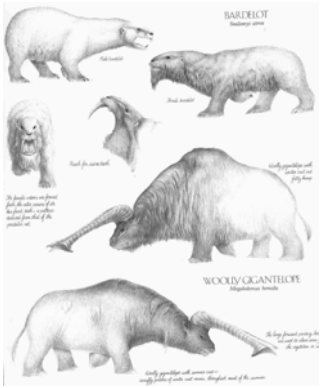
Major adaptations in raboons and horranes:
Growth of large claws and modification of teeth.
Major adaptations in gholes:
bone-crushing teeth and long, bare neck

Life in the Mountains

The Mountains of Eurafrica formed by the collision of Africa with Europe witnessed the further evolution of goats and weasels, both of which lived in sufficiently rugged areas and were hardy enough to escape the destruction by humans. The goat and weasel gave rise to the groath (a herbivorous upland grazer) and the shurrack (a large, fierce predator) respectively.

The Tundra

Antelopes, subject to intense competition by rabbucks were forced into less hospitable Arctic regions. These became modified to produce the lumbering Wooly Gigantelope. Similarly, small cats that dwelled in the forest were forced into the tundra, evolving into the major predator, the Bardelot.

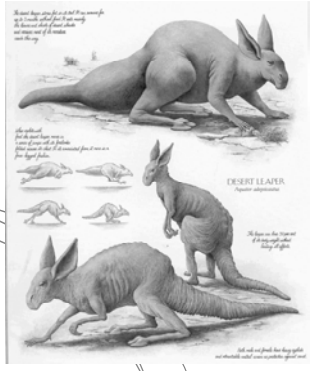


Desert Dwellers

The extinction of the camel during the sixth major mass extinction left a niche that was unattractive to most animals. The camel was remarkable in that it Was able to lose 20 % of its body weight through dehydration without ill effects and stored much of the body fat in one lume, leaving the rest of the body free to radiate hear.

After millions of years of evolution, these features developed again in the desert leaper, a descendent of the jerboas (sand rats). It stores its subcutaneous fat in its tail, which enables the leaper to go for long periods without eating.

Desert Dwellers



The Desert Leaper

Major adaptations:
1. Fat-storing tail
2. Heavy eyelids that guards against abrasion from sand
3. Large ears to permit maximum heat exchange

The Ocean Dwellers

Extinction of the whales and porpoises opened up a niche that was eventually occupied by descendents of the penguins, the Porping and Vortex.

Major adaptations:
Reduction of hind feet to form broad "tail"
Modification of beak for more efficient grasping or straining of food from water

Batavia: An Isolated Bat Utopia (The Former Hawaiian Islands)

Bats were among the first animals to recolonize the Islands of Batavia that were produced by the same hotspot activity that produced the Hawaiian Islands.
Bats, rapidly increasing in numbers, diversified to produce forms like the insectivorous Flooer and carnivorous Night Stalker.

The Bottom Line

The biosphere is weird, wonderful, and complex

Geospheric, atmospheric, hydrospheric…and biospheric processes have all influenced the state of the system that we call Earth (and will continue to do so).

In order to plan our activities for the future, we must first understand the past and present interactions among organisms within the biosphere as well as interactions between the biosphere and the other Earth system components.

We be among the survivors of the next mass extinction ?

END OF LECTURE