

Posted for Wed 28 January 2009
6th class meeting

- Biomes
- Species

Please read: [E.O.Wilson Excerpt](#)
Fri: [Extinction Link](#)
Mon: [Science, Scientific Method links](#)



Environmental Biology (ECOL 206)
University of Arizona, spring 2009
Kevin Bonine, Ph.D.
Tuan Cao, Graduate TA
Mary Jane Epps, Graduate TA

-Extra Credit Opportunity

[Current Events Assignment](#)
Due 9am each Friday
-See Syllabus for Details
-See Rubric on Course Website

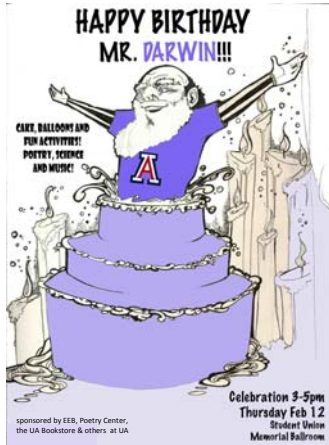
[Evolution & Ecology](#) • [Evidence](#) • [Energy](#) • [Ethics & Equality](#) • [Economics](#)

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Questions 3 (27 Jan 2009)

- How old is the earth? When did life evolve on earth? When did mammals evolve?
 - Approximately what percent of all species are extinct?
 - Define fecundity and its relationship to natural selection and biological evolution.
 - What is a gene? An allele?
 - What is the ultimate source of all genetic variation? Is this source of variation usually beneficial (selected for)?
 - Define fitness and adaptation. Define natural selection and describe its necessary components.
 - What set of islands did Darwin become famous for visiting? Why do we talk about Darwin so much?
 - Distinguish among three different kinds of natural selection and provide one example for each.
 - What is sexual selection? Sperm competition? Explain how you could figure out which sex is acted upon most directly by natural selection.
 - What are biogeography, dispersal, and vicariance?
 - How are oceanic and continental islands different? How does this affect rates of endemism?
- [up to slide 11 from Biogeography & Biodiversity lecture]

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3

Linnaean Taxonomy

- **Taxonomy** is the effort to name and classify organisms.
- In Linnaeus' taxonomic system for classifying organisms, each organism is given a unique two-part scientific name consisting of the **genus** and the **species**.

(1) A **genus** is made up of a closely related group of species.

(2) A **species** is made up of individuals that regularly breed together or have characteristics that are distinct from those of other species.

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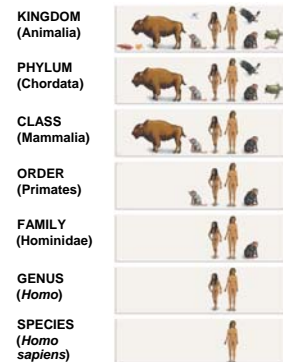
Taxonomic Levels

- Linnaeus' system is **hierarchical** with nested **taxa**. The taxonomic levels from least to most specific are as follows:

domain
kingdom
phylum
class
order
family
genus
species

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Linnaeus' Taxonomic Levels



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Binomial nomenclature

- First name = genus, second = species
- Genus capitalized, species not, both in italics e.g. *Homo sapiens*
- Used all over world to refer unambiguously to the same species
- *Drosophila* spp. means more than one species of the genus *Drosophila*
- *Drosophila* sp. means the identity of the species is uncertain
- When the organism is referred to multiple times, genus is abbreviated, so *Drosophila melanogaster* becomes *D. melanogaster*

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Galapagos Finches



Brassica oleracea



Figure 17-8 A number of common vegetables are members of the same species, *Brassica oleracea*, including cauliflower, broccoli, cabbage, Brussels sprouts, and kale. Artificial selection is responsible for the variation among within this species. (Raymond Tschape)

Solomon et al. 1993

What is a species?

8



Aspidoscelis (Cnemidophorus)
Species vs. Parthenospecies...

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1. Indicator Species
 - migratory birds
 - amphibians
2. Keystone Species
 - top predators
 - key pollinators



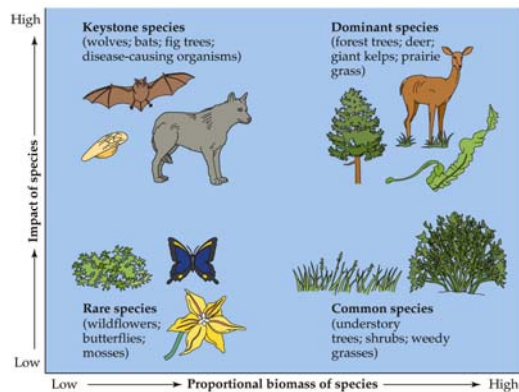
Rana pipiens
Northern Leopard Frog

3. Umbrella Species

Native Species
vs.
Nonnative, exotic, alien



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PRIMER OF CONSERVATION BIOLOGY 4e, Figure 2.6

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Males (columns one and three) and females (columns two and four) of four cryptic species of *Perichares* in dorsal (left) and ventral (right) view

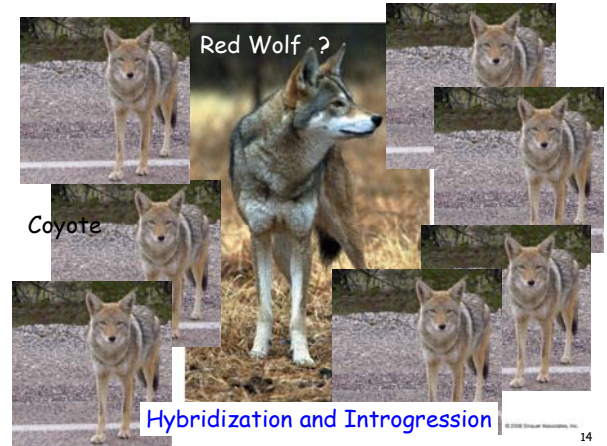
Cryptic Species



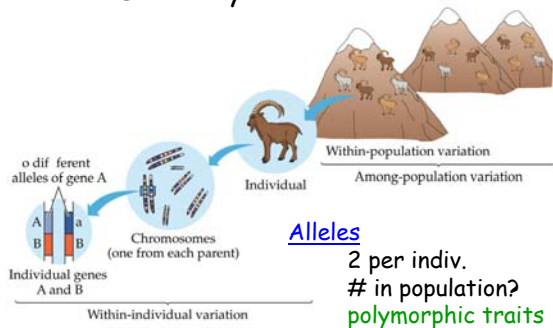
Burns J. M. et al. PNAS 2008;105:6350-6355

PNAS

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Genetic Diversity



PRIMER OF CONSERVATION BIOLOGY 4e, Figure 2.4

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What is a species?

1. Typological species

A group of organisms in which individuals are members of the species if they sufficiently conform to certain fixed properties. The clusters of variations or phenotypes within specimens (i.e. longer and shorter tails) would differentiate the species. This method was used as a "classical" method of determining species, such as with Linnaeus early in evolutionary theory. However, we now know that different phenotypes do not always constitute different species (e.g.: a 4-winged *Drosophila* born to a 2-winged mother is not a different species). Species named in this manner are called *morphospecies*.

2. Morphological species

A population or group of populations that differs morphologically from other populations. For example, we can distinguish between a chicken and a duck because they have different shaped bills and the duck has webbed feet. Species have been defined in this way since well before the beginning of recorded history. This species concept is much criticised because more recent genetic data reveal that genetically distinct populations may look very similar and, contrarily, large morphological differences sometimes exist between very closely-related populations. Nonetheless, most species known have been described solely from morphology.

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What is a species?

3a. Biological / Isolation species

A set of actually or potentially interbreeding populations. This is generally a useful formulation for scientists working with living examples of the higher taxa like mammals, fish, and birds, but meaningless for organisms that do not reproduce sexually. It does not distinguish between the theoretical possibility of interbreeding and the actual likelihood of gene flow between populations and is thus impractical in instances of allopatric (geographically isolated) populations. The results of breeding experiments done in artificial conditions may or may not reflect what would happen if the same organisms encountered each other in the wild, making it difficult to gauge whether or not the results of such experiments are meaningful in reference to natural populations.

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What is a species?

3b. Biological / reproductive species

Two organisms that are able to reproduce naturally to produce fertile offspring. Organisms that can reproduce but almost always make infertile hybrids, such as a mule or hinny, are not considered to be the same species.

4. Mate-recognition species

A group of organisms that are known to recognize one another as potential mates. Like the isolation species concept above, it applies only to organisms that reproduce sexually. Unlike the isolation species concept, it focuses specifically on pre-mating reproductive isolation.

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What is a species?

5. Phylogenetic (Cladistic)

A group of organisms that shares an ancestor; a **lineage** that maintains its integrity with respect to other lineages through both time and space. At some point in the progress of such a group, members may diverge from one another: when such a divergence becomes sufficiently clear, the two populations are regarded as separate species. Subspecies as such are not recognized under this approach; either a population is a phylogenetic species or it is not taxonomically distinguishable.

6. Ecological species

A set of organisms adapted to a particular set of resources, called a **niche**, in the environment. According to this concept, populations form the discrete phenetic clusters that we recognize as species because the ecological and evolutionary processes controlling how resources are divided up tend to produce those clusters.

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What is a species?

7. Genetic species

based on similarity of DNA of individuals or populations. Techniques to compare similarity of DNA include DNA-DNA hybridization, and genetic fingerprinting (or DNA barcoding).

8. Phenetic species

based on phenotypes.

9. Microspecies

Species that reproduce without meiosis or fertilization so that each generation is genetically identical to the previous generation. See also apomixis.

10. Cohesion species

Most inclusive population of individuals having the potential for phenotypic cohesion through intrinsic cohesion mechanisms. This is an expansion of the mate-recognition species concept to allow for post-mating isolation mechanisms; no matter whether populations can hybridize successfully, they are still distinct cohesion species if the amount of hybridization is insufficient to completely mix their respective gene pools.

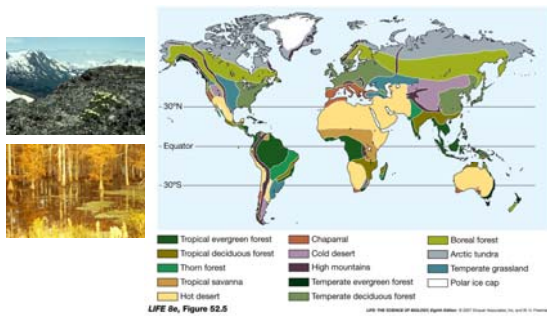
11. Evolutionarily Significant Unit (ESU)

An evolutionarily significant unit is a population of organisms that is considered distinct for purposes of conservation. Often referred to as a species or a *wildlife species*, an ESU also has several possible definitions, which coincide with definitions of species.

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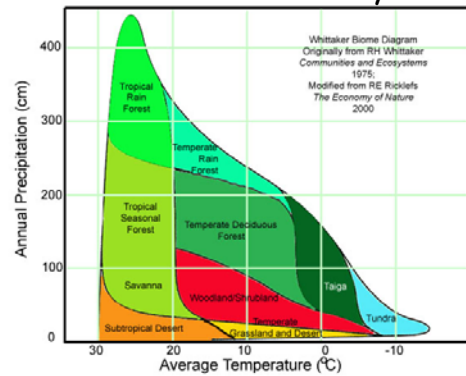
Biomes

- In terrestrial ecosystems, **defined by plant types.**



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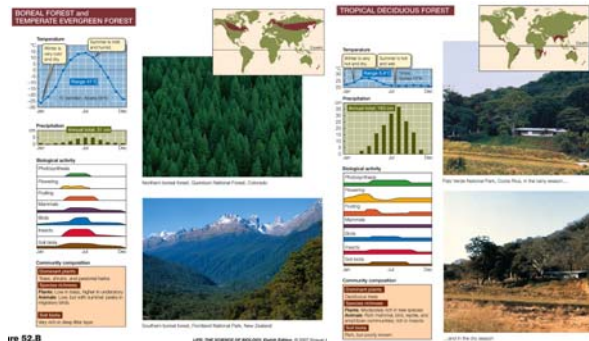
Biome character driven by climate



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Seasonal Activity

Boreal Forest vs. Tropical Forest



ire 52.8

"Drunken Forest"

When Permafrost in Lowland Tundra/Boreal Forest melts

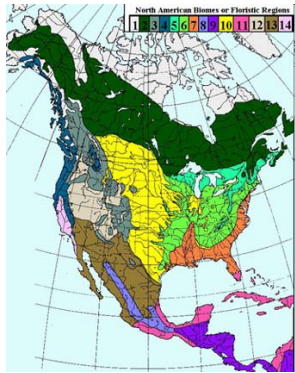


Sequestered Carbon

Climate Change?

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North American Biomes



<http://rst.gsfc.nasa.gov/Sect3/biome1999a.jpg>

25

grasslands



deserts



tundra



forests



Etc.

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Aquatic Environments

- **Marine**
 - Depth (light + temperature)
 - Proximity to shore (nutrient influx)
- **Freshwater**
 - Temperature
 - Age
 - Nutrient Level

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Aquatic Characteristics:

A. Salinity

B. Layers:

1. Temperature
2. Sunlight
3. Dissolved O₂
4. Nutrients

- carbon
- nitrogen (nitrate)
- phosphorus (phosphate)



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Marine Environments

71% earth's surface is ocean

coastal vs. open sea



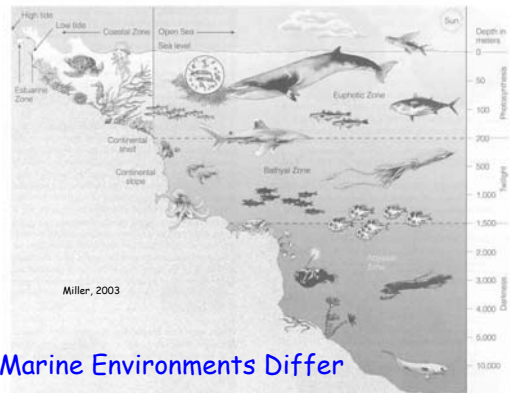
10% area, 90% species
high Net Primary Productivity

- nutrients
- sunlight

1. Estuaries
2. Coastal Wetlands
 - mangroves
 - salt marshes
3. Coral Reefs



Where do people like to live?



Marine Environments Differ

Figure 3-14 Major life zones in an ocean. (Actual depths of zones may vary)

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Freshwater Environments

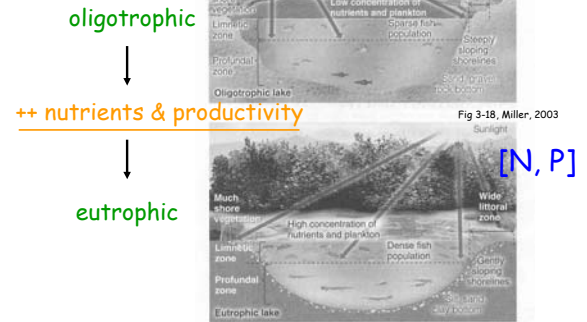
Only 1% earth's surface:

1. Lakes → nutrients, clarity, NPP
- oligotrophic
- eutrophic
2. Streams → - Watershed
- Runoff
3. Rivers → - Erosion
4. Inland Wetlands → Marshes, swamps, floodplains



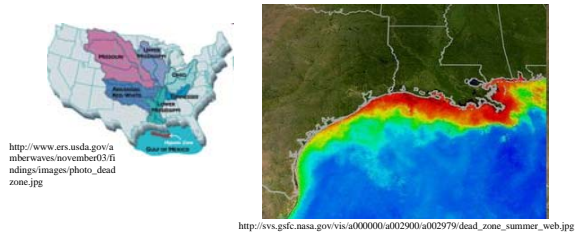
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Freshwater Environments



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Dead Zone & Hypoxia



The "dead zone," also called a **hypoxic zone**, is caused by the growth of massive quantities of algae known as **algal blooms**. As algae die, bacteria feed on them and, in the process, suck up the water's available oxygen. Oxygen levels become depleted to the point that the area cannot support marine life, and sea creatures must swim to other waters or die. 33