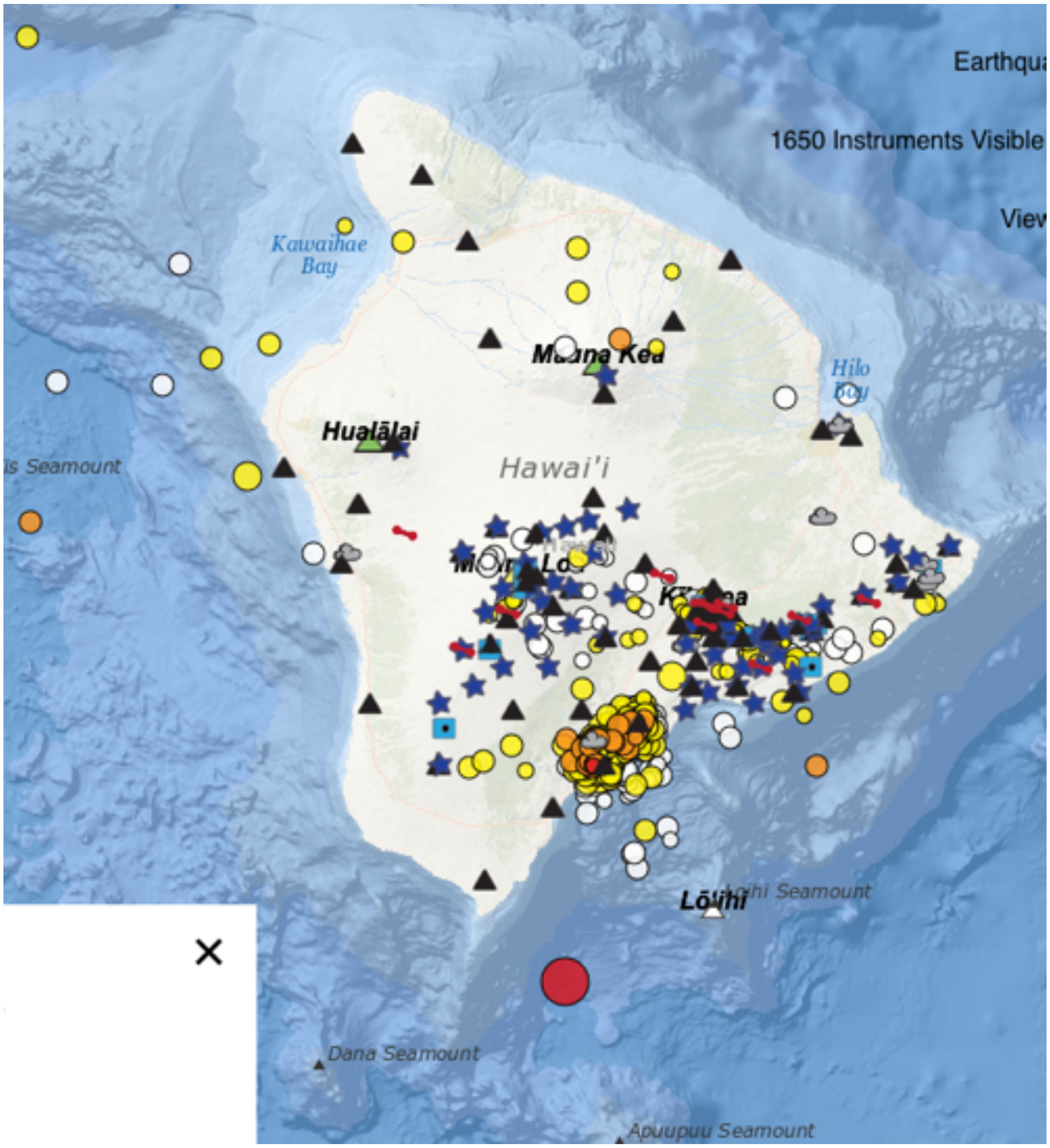
Tags
Edited Oct 13, 2021 9:11 PM by admin...

Mods 14-17 Biodiversity

Sunday Earthquakes 4.3 and 6.2
https://www.usgs.gov/observatories/hawaiian-volcano-observatory/earthquakes



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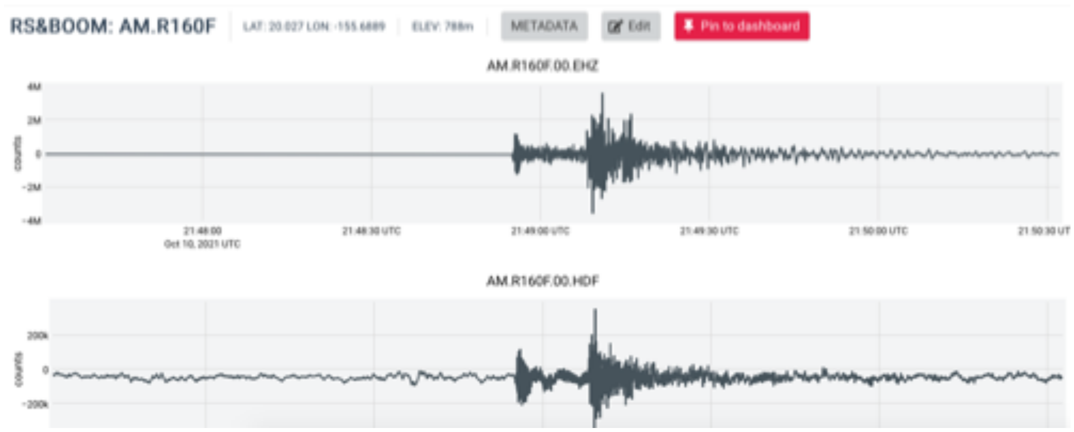
P and S waves:



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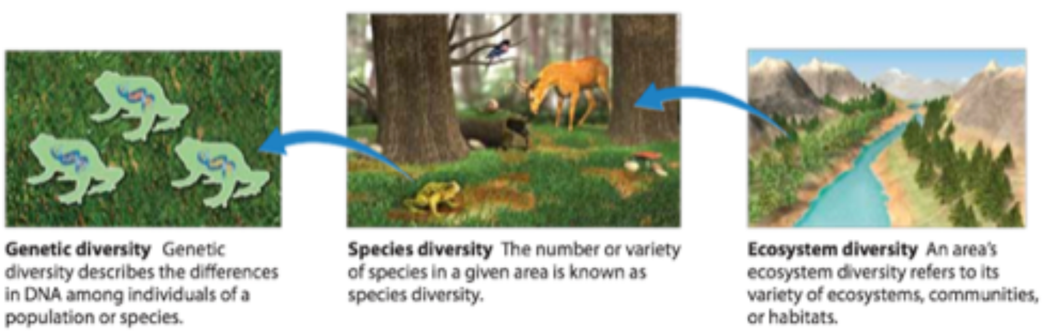
Northern Lights over Scotland: space weather.com
CME event: coronal mass ejection
https://en.wikipedia.org/wiki/Coronal_mass_ejection

Mod 14: Biodiversity: (see also chapter 7 in Froggie book)



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Species diversity:
richness vs. evenness:
richness = number of species,
evenness = balanced proportions

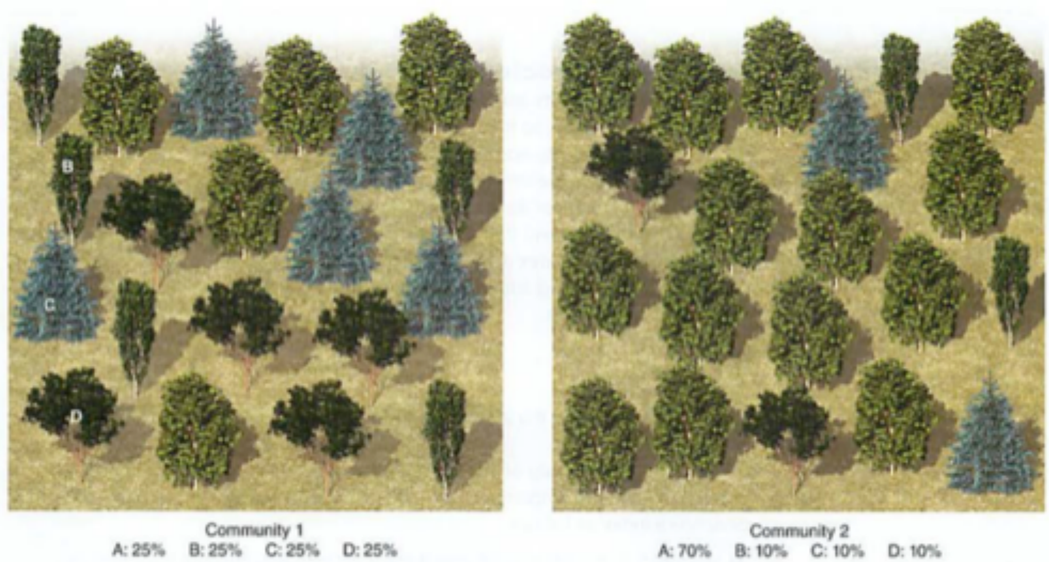

FIGURE 14.2 Measures of species diversity. Species richness and species evenness are two different measures of species diversity. Although both communities contain the same number of species, community 1 has a more even distribution of species and is therefore more diverse than community 2.

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Mod 15: Evolution

Three conditions must be met:

1. genetic variation (mutation)
2. some stress that favors this variation (adaptation)
3. survivors procreate, pass on the variation (reproduction)

Genotype: set of genes (dominant and recessive)
Phenotype: traits expressed in a living creature

Genetic drift-pretty much what it sounds like
Bottleneck effect-VERY important: when a species is almost extinct, there is little variation in the gene pool of the survivors, even if their population rebounds (e.g. whales hunted almost to extinction, the entire gene pool is limited to the diversity of the sole survivors)
Founder effect: random selection of survivors, creating a new gene pool (birds, gilligan)

Questions:

1. If the early atmosphere of our planet was thinner and less developed, it might have allowed more cosmic radiation to reach the surface. How would this impact the natural

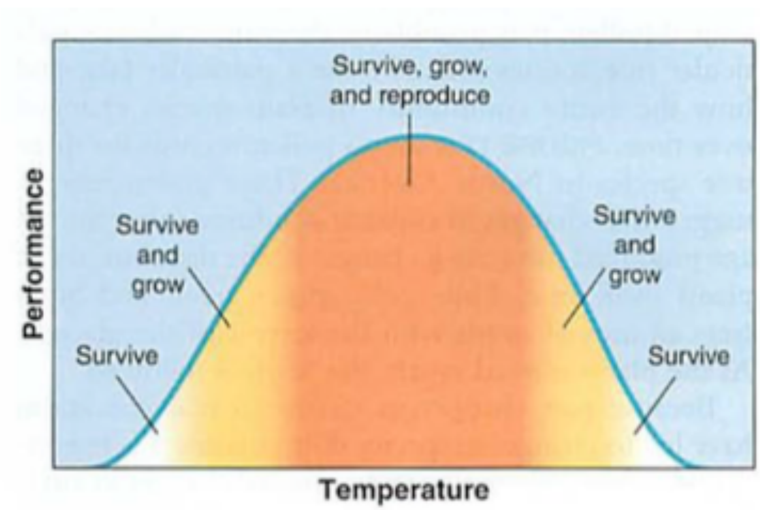
mutation/evolution rate?
2. what would be the impact on an ecosystem of rampant mutation rates?

Mod 16: speciation
Geographic isolation (e.g. Galapagos) also found where we disturb natural habitats with roads
This causes Allo (other) Patric (father) speciation
Eventually reproductive isolation will result: different breeds will not be able to procreate

There is another more rare form of speciation: Sympatric ("same father"), from polyploidy, ("many chromosomes")

GMO: see roundup ready corn and wheat, freeze proof tomatoes and others.
Not to be confused with Dwarf Wheat and Norman Borlaug (see population chapters for more on this).
Dwarf wheat was a simple hybrid, not a GMO.
Look up "gene guns" and CRISPR

Mod 17: niches and species distribution
Check this out:



You'll see another like this in population distributions...
Range of tolerance-where it can survive
Fundamental niche-happy place
Realized niche-de facto place

Distribution-areas where they live (we'll see more of this in the chapter on population distributions: random, scattered, patterned)

Global Biodiversity:

Note biodiversity increases closer to the equator:

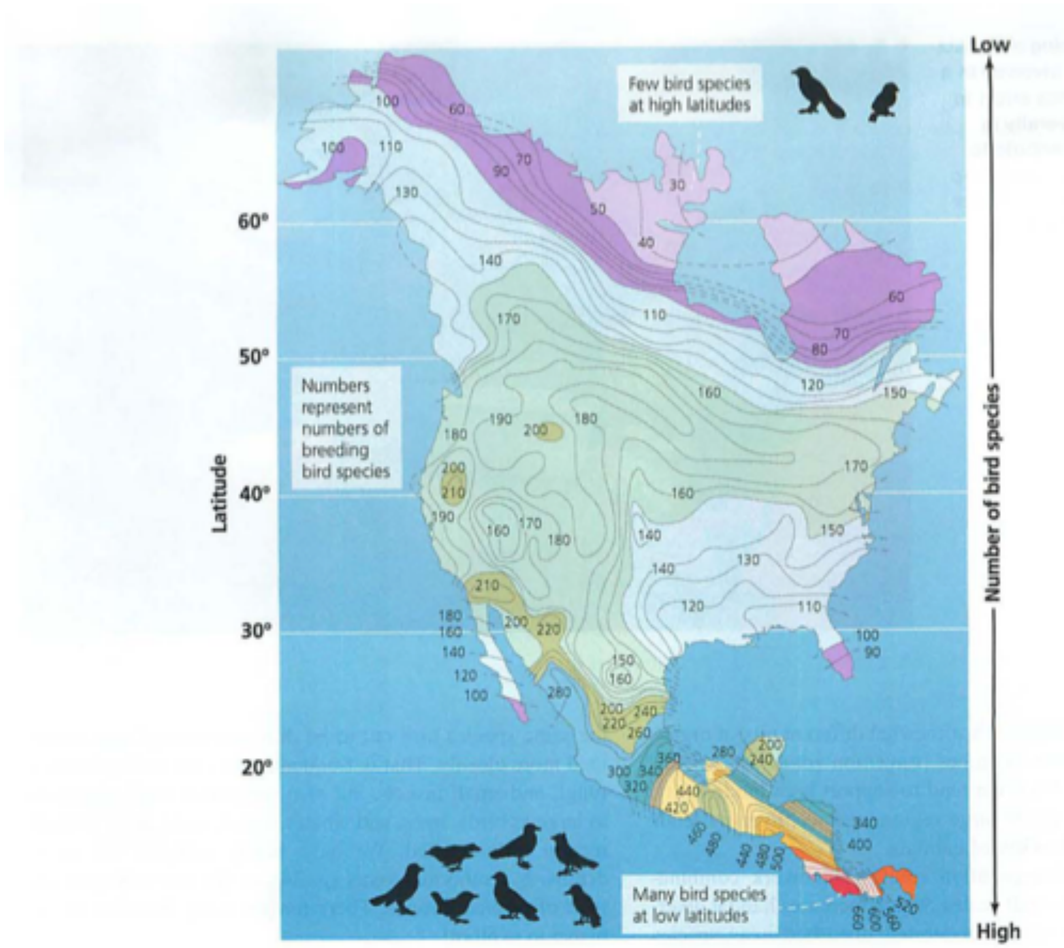


FIGURE 11.5 Species richness tends to increase toward the equator. Birds show a clear latitudinal gradient in species richness. Regions of arctic Canada and Alaska are home to just 30–100 breeding species of birds, whereas areas of Costa Rica and Panama host more than 600. *Adapted from Cook, R.E., et al., 1969. Variation in species density in North American birds. Systematic Biology 18: 63–84. (Originally published as Systematic Zoology.) By permission of Oxford University Press.*

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Biodiversity Hot spots:

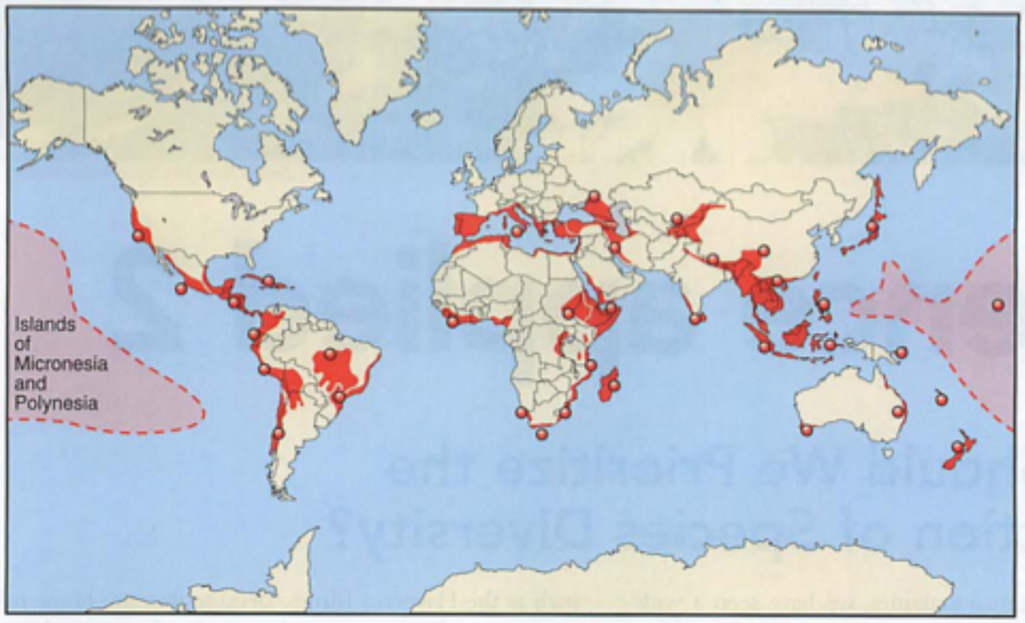

FIGURE SA2.2 Biodiversity hotspots. Conservation International has identified 34 biodiversity hotspots (shown in red) that have at least 1,500 endemic plant species and a loss of at least 70 percent of all vegetation. *(Data from Conservation International at http://www.conservation.org/where/priority_areas/hotspots/Documents/CI_Biodiversity-Hotspots_2013_Map.pdf.)*

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Global warming and biodiversity:

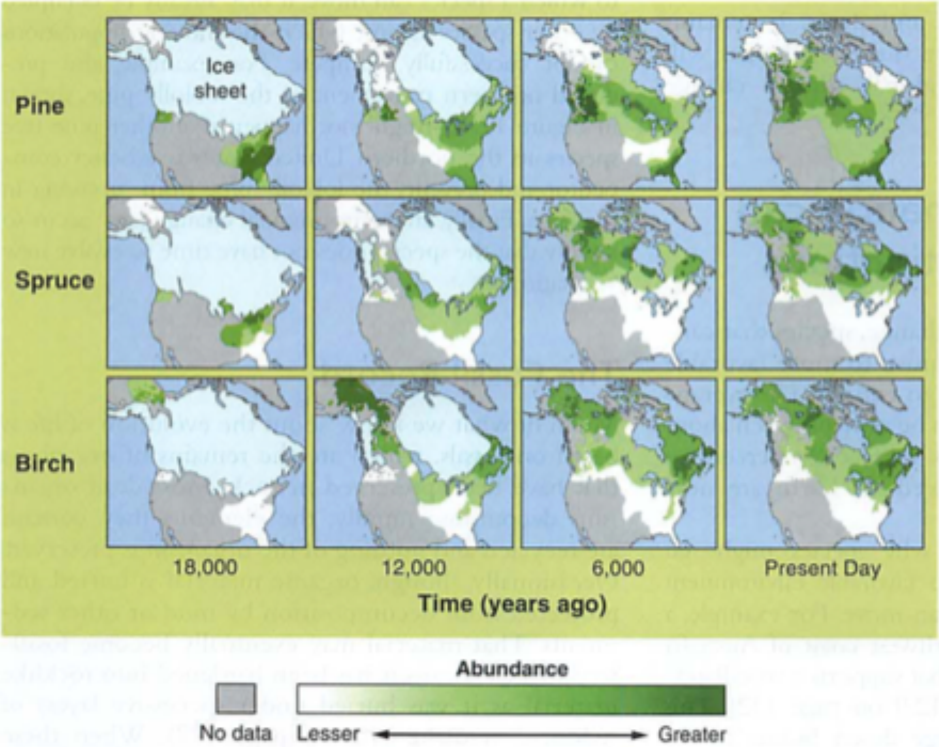

FIGURE 17.3 Changes in tree species distributions over time. Pollen recovered from lake sediments indicates that plant species moved north as temperatures warmed following the retreat of the glaciers, beginning about 12,000 years ago. Areas shown in color or white were sampled for pollen, whereas areas shown in gray were not sampled. *(Data from http://vemages.gsfc.nasa.gov//3453/boreal_model.gif)*

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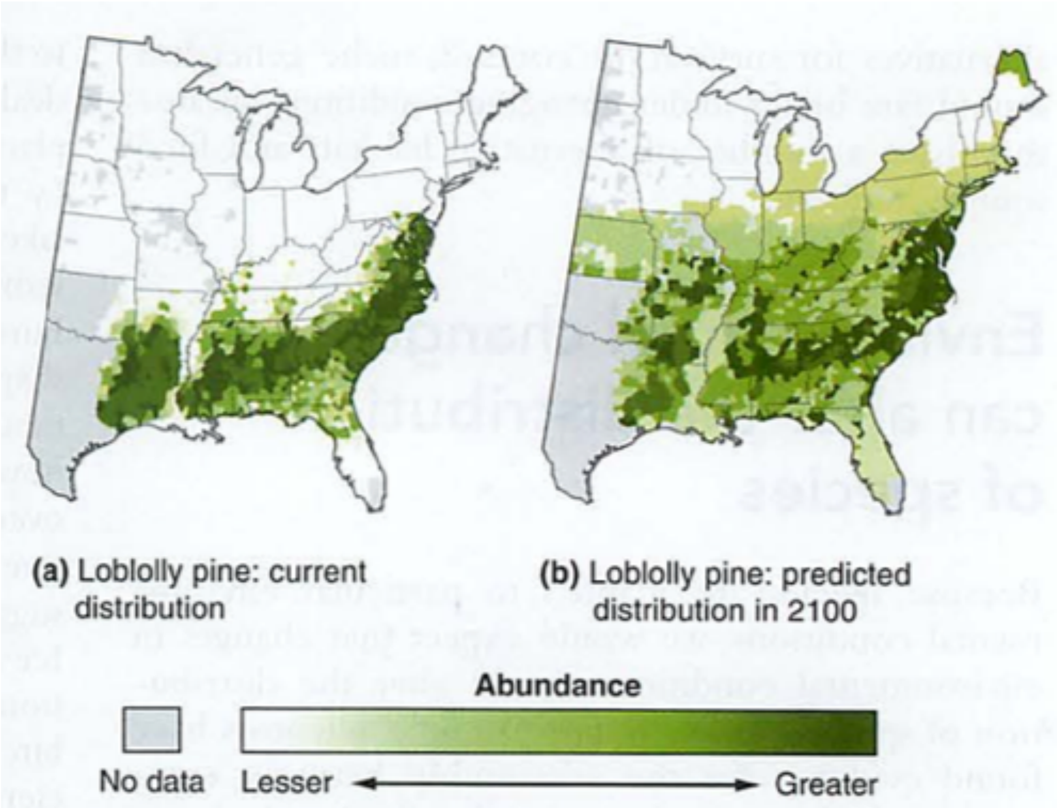

FIGURE 17.4 Predicting future species distributions. Based on our knowledge of the niche requirements of the loblolly pine tree, we can predict how the distributions might change as a result of future changes in environmental conditions. *(Data from: http://www.fs.fed.us/ne/delaware/atlas/web_atlas.html#)*

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Alternates to low biodiversity food sources (e.g. monoculture):

TABLE 11.1 Potential New Food Sources*

	**Amaranths** *(three species of Amaranthus)* Grain and leafy vegetable; livestock feed; rapid growth, drought resistant		**Capybara** *(Hydrochoeris hydrochaeris)* World's largest rodent; meat esteemed; easily ranched in open habitats near water
	**Buriti palm** *(Mauritia exuosa)* "Tree of life" to Amerindians; vitamin-rich fruit; pith as source for bread; palm heart from shoots		**Vicuna** *(Lama vicugna)* Related to llama; source of meat, fur, and hides; can be profitably ranched
	**Maca** *(Lepidium meyenii)* Cold-resistant root vegetable resembling radish, with distinctive flavor; near extinction		**Chachalacas** *(Ortalis, many species)* Tropical birds; adaptable to human habitations; fast-growing

*The wild species shown here are just some of the many plants and animals that could supplement our food supply.
Source: Adapted from Wilson, E.O., 1992. *The diversity of life.* Cambridge, MA: Belknap Press.

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Biodiversity benefits:

TABLE 11.2 Natural Plant Sources of Pharmaceuticals*

	**Pineapple** *(Ananas comosus)* **Drug:** Bromelain **Application:** Controls tissue inflammation		**Pacific yew** *(Taxus brevifolia)* **Drug:** Taxol **Application:** Anti-cancer agent (especially ovarian cancer)
	**Autumn crocus** *(Colchicum autumnale)* **Drug:** Colchicine **Application:** Anti-cancer agent		**Velvet bean** *(Mucuna deeringiana)* **Drug:** L-dopa **Application:** Parkinson's disease suppressant
	**Yellow cinchona** (several species of *Cinchona*) **Drug:** Quinine **Application:** Anti-malarial agent		**Common foxglove** *(Digitalis purpurea)* **Drug:** Digitoxin **Application:** Cardiac stimulant

*Shown are just a few of the many plants that provide chemical compounds of medical benefit.
Source: Adapted from Wilson, E.O., 1992. *The diversity of life.* Cambridge, MA: Belknap Press.

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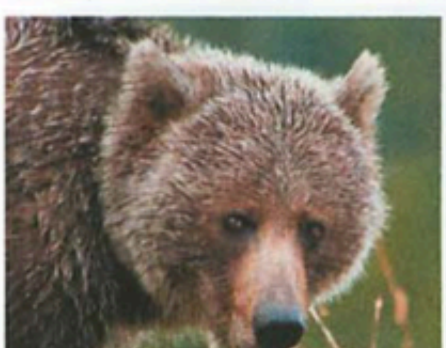
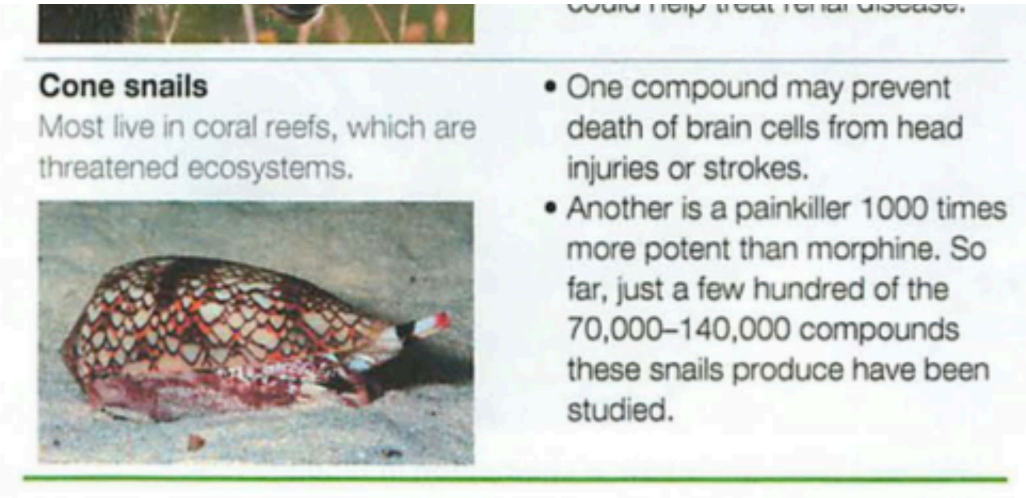
TABLE 11.3 Major Types of Animals at Risk That Offer Potential Medical Uses

SPECIES AT RISK	POTENTIAL MEDICAL USES
Amphibians 40% of all species are threatened with extinction. 	• Known compounds provide antibiotics; chemicals for painkillers, heart disease, and high blood pressure; and adhesives for treating tissue damage. • Ability to regenerate organs and tissues could suggest how we might, too. • "Antifreeze" compounds that allow frogs to survive freezing might help us preserve organs for transplants.
Sharks Overfishing has reduced populations of most species. Some risk extinction. 	• Squalamine from sharks' livers could lead to novel antibiotics, appetite-suppressants, drugs to shrink tumors, and drugs to fight vision loss. • Study of salt glands is helping address kidney diseases.
Horseshoe crabs Overfishing is sharply diminishing populations. 	• A number of antibiotics are being developed. • The compound T140 may treat AIDS, arthritis, and several cancers. • Cells from blood can help detect cerebral meningitis in people.
Bears Nine species are at risk of extinction. 	• An acid from bears' gallbladders treats gallstones and liver disease and prevents bile buildup during pregnancy. • While hibernating, bears build bone mass. If we learn how, it might help us treat osteoporosis and hip fractures. • Hibernating bears excrete no waste for months. Learning how could help treat renal disease


could help treat renal disease.

Cone snails
Most live in coral reefs, which are threatened ecosystems.

- One compound may prevent death of brain cells from head injuries or strokes.
- Another is a painkiller 1000 times more potent than morphine. So far, just a few hundred of the 70,000–140,000 compounds these snails produce have been studied.

Major extinctions leading to the 6th anthropocene (man caused) exctinction:

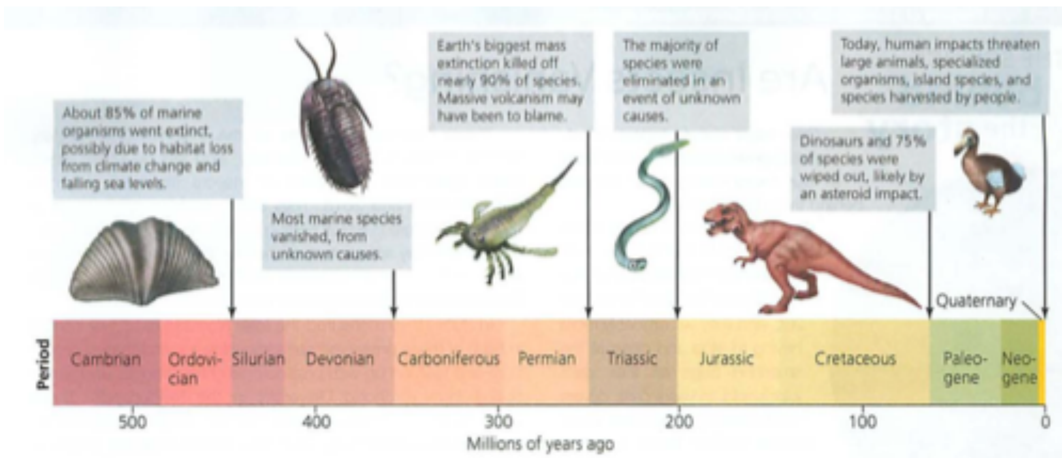


FIGURE 11.11 Scientists have documented five mass extinction events in the past 500 million years. Ongoing study of the fossil record (p. 58) is revealing clues about the causes and consequences of each event.

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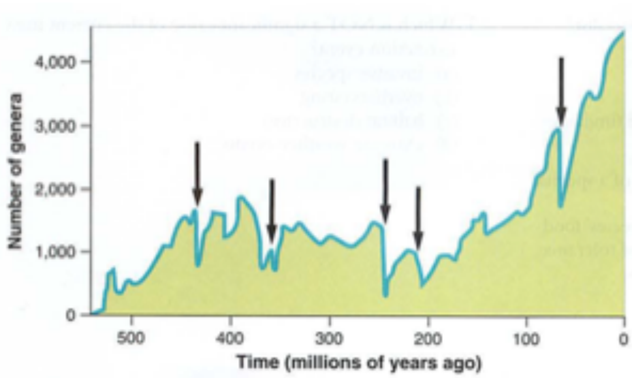

FIGURE 17.6 Mass extinctions. Five global mass extinction events have occurred since the evolution of complex life roughly 500 million years ago. *(Data from GreenSpirit, http://www.greenspirit.org.uk/resources/Timelies.jpg)*

Mass extinction A large extinction of species in a relatively short period of time.

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Past human impact:

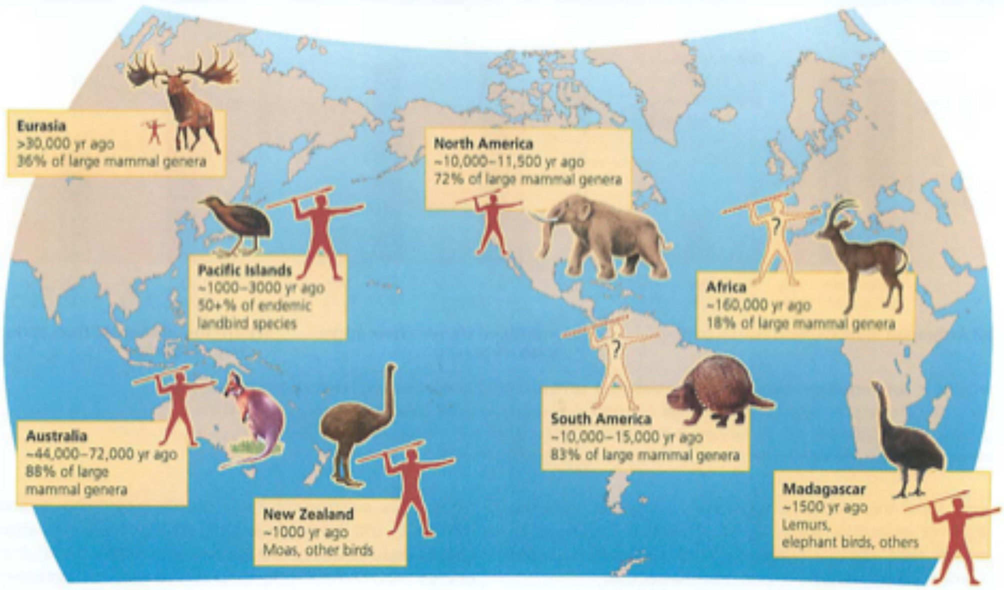

FIGURE 11.12 This map shows when humans arrived in each region and the extent of extinctions that followed. One extinct animal from each region is illustrated. Larger human hunter icons indicate more evidence and certainty that hunting (as opposed to climate change or other factors) was a primary cause of extinctions. Data on hunting for South America and Africa are so far too sparse to be conclusive. *Adapted from Barnosky, A.D., et al., 2004. Assessing the causes of late Pleistocene extinctions on the continents. Science 306: 70–75; and Wilson, E.O., 1992. The diversity of life. Cambridge, MA: Belknap Press.*

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Invasive species:

TABLE 11.6 Invasive Species

European gypsy moth
(Lymantria dispar)

Introduced to Massachusetts in the hope that it could produce silk. The moth failed to do so and instead spread across the eastern United States, where its outbreaks defoliate trees over large regions every few years.

Asian long-horned beetle
(Anoplophora glabripennis)

Since the 1990s, has repeatedly arrived in North America in imported lumber. These insects burrow into wood and can kill the majority of trees in an area. Chicago, Seattle, Toronto, New York City, and other cities have cleared thousands of trees to eradicate these invaders.

European starling
(Sturnus vulgaris)

Introduced to New York City in the 1800s by Shakespeare devotees intent on bringing every bird mentioned in Shakespeare's plays to America. Outcompeting native birds for nest holes, within 75 years starlings became one of North America's most abundant birds.

Emerald ash borer
(Agrilus planipennis)

Discovered in Michigan in 2002, this wood-boring insect reached 12 U.S. states and Canada by 2010, killing millions of ash trees in the upper Midwest. Billions of dollars will be spent trying to control its spread.

Cheatgrass
(Bromus tectorum)

After introduction to Washington state in the 1890s, cheatgrass spread across the western United States. It crowds out other plants, uses up the soil's nitrogen, and burns readily. Fire kills many native plants, but not cheatgrass, which grows back stronger without competition.

Sudden oak death
(Phytophthora ramorum)

This disease has killed more than 1 million oak trees in California since the 1990s. The pathogen (a water mold) was likely introduced via infected nursery plants. Scientists are concerned about damage to eastern U.S. forests if it spreads to oaks there.

Brown tree snake
(Boiga irregularis)

Nearly every native forest bird on the South Pacific island of Guam has disappeared, eaten by these snakes, which arrived from Asia as stowaways on ships and planes after World War II. Guam's birds had not evolved with snakes and had no defenses against them.

Nile perch
(Lates niloticus)

A large fish from the Nile River introduced to Lake Victoria in the 1950s. It proceeded to eat its way through hundreds of species of native cichlid fish, driving a number of them extinct. People value the perch as food, but it has radically altered the lake's ecology.

Kudzu
(Pueraria montana)

A Japanese vine that can grow 30 m (100 ft) in a single season, the U.S. Soil Conservation Service introduced kudzu in the 1930s to help control erosion. Kudzu took over forests, fields, and roadsides throughout the southeastern United States.

Polynesian rat
(Rattus exulans)

One of several rat species that have followed human migrations across the world. Polynesians transported this rat to islands across the Pacific, including Easter Island (pp. 8–9). On each island it caused ecological havoc and has driven birds, plants, and mammals to extinction.

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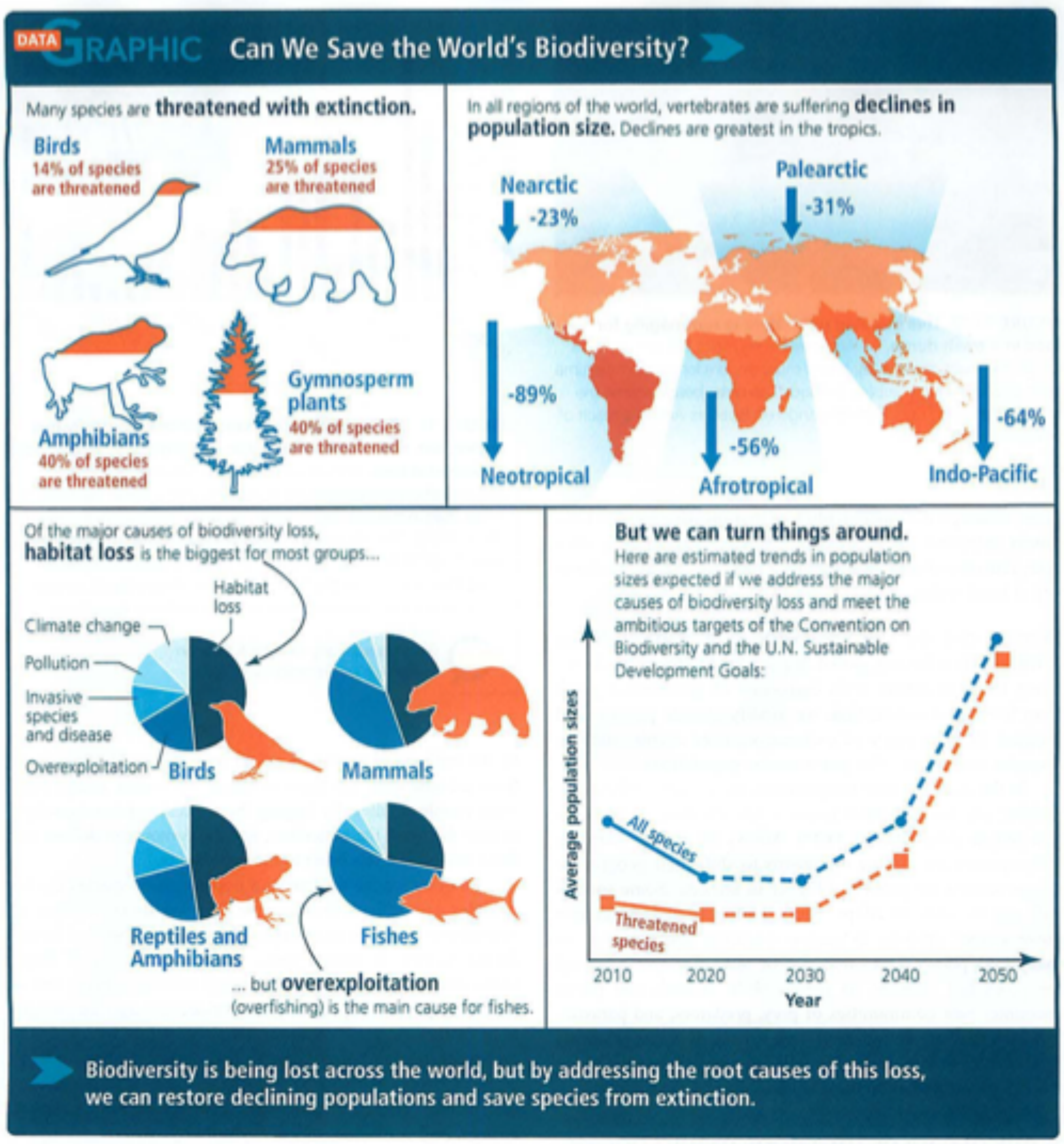

Data from IUCN 2019, The IUCN Red List of Threatened Species, Version 2019-1; and WWF, 2018. Living planet report 2018. Gland, Switzerland: WWF International.

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TABLE 11.4 Characteristics of Winning and Losing Species

WINNERS tend to be	LOSERS tend to be
• Generalists	• Specialists
• Geographically widespread	• Limited to a small range
• Users of open, early successional habitats	• Users of mature, dense habitats
• Able to cope with rapidly changing conditions	• Needing stable unchanging conditions
• Small and fast-reproducing (*r*-selected)	• Large and slow-reproducing (*K*-selected)
• Low on the food chain	• High on the food chain
• Not in need of large areas of habitat	• Needing large areas of habitat
• Mainland species	• Island species
WINNER: The house mouse (*Mus musculus*) is a small, fast-reproducing, generalist mammal that thrives by living and feeding in and near our buildings.	**LOSER:** The tiger (*Panthera tigris*) is a large, slow-reproducing mammal that needs large areas of mature habitat full of prey and free of people.

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We can calculate biodiversity:

Measuring Species Diversity

Environmental scientists are often interested in evaluating both species richness and species evenness, so they have come up with indices of species diversity that take both measures into account. One commonly used index is Shannon's index of diversity. To calculate this index, we must know the total number of species in a community (n) and, for each species, the proportion of the individuals in the community that represent that species (p_i). Once we have this information, we can calculate Shannon's index (H) by taking the product of each proportion (p_i) and its natural logarithm [ln (p_i)] and then summing these products, as indicated by the summation symbol (Σ):

$$H = -\sum_{i=1}^{n} p_i \ln(p_i)$$

The minus sign makes the index a positive number. Higher values of H indicate higher diversity.

Imagine a community of 100 individuals that are evenly divided among four species, so that the proportions (p_i) of the species all equal 0.25. We can calculate Shannon's index as follows:

$$H = -[(0.25 \times \ln 0.25) + (0.25 \times \ln 0.25) + (0.25 \times \ln 0.25) \times (0.25 \times \ln 0.25)]$$
$$H = -[(-0.35) + (-0.35) + (-0.35) + (-0.35)]$$
$$H = 1.40$$

Now imagine another community of 100 individuals that also contains four species, but in which one species is represented by 94 individuals and the other three species are each represented by 2 individuals. We can calculate Shannon's index to see how this difference in species evenness affects the value of the index:

$$H = -[(0.94 \times \ln 0.94) + (0.02 \times \ln 0.02) + (0.02 \times \ln 0.02) + (0.02 \times \ln 0.02)]$$
$$H = -[(-0.06) + (-0.08) + (-0.08) + (-0.08)]$$
$$H = 0.30$$

Because this value of H is lower than the value we calculated for the first community, we can conclude that the second community has lower diversity. Note that the total number of individuals does not affect Shannon's index of diversity; only the number of species and the proportion of individuals within each species matter.

Click for full-size image

Lab: Calculating Shannon's index, using baked goldfish (the cheddar kind, not the ones that stink)

1. wash your hands
2. pour out a random number of different colored goldfish on your plate (your

"pond")

3. determine the number of distinct populations by color, using chopsticks
4. determine the proportion for each population (e.g. 5 red ones out of 20 total would be 5/20 or 0.25)
5. calculate Shannon's index (H) for this "pond"
6. repeat the experiment with a very low biodiversity, calculate H
7. repeat with a very high biodiversity, calculate H
8. eat the contents of your "pond", representing a catastrophic event

Questions:

1. what is the value of biodiversity in any community?
2. what are the benefits and drawbacks of a low biodiversity?
3. how does this play into competition (next chapter)
4. why is it important to determine the number of "distinct populations"?
5. what is the impact of this on a human population, e.g. the census?

Check-in review:
Unit 2 from Cliff notes 2011:

cliff unit 2.pdf

Unit 2 practice exam p. 190

-----NEXT: Population ecology-----------