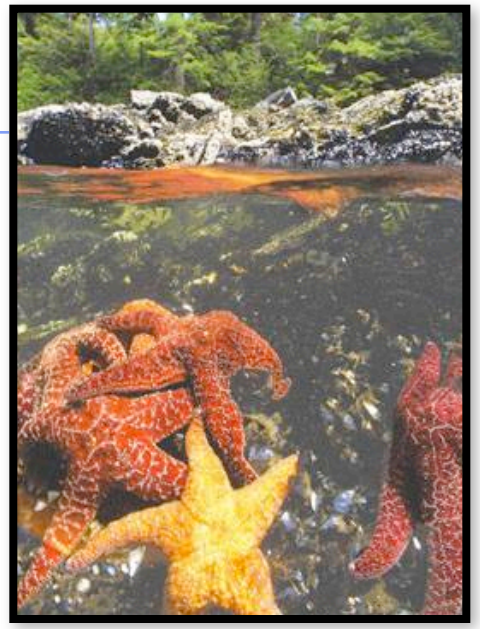
Characterizing a community



- **Community structure includes...**
  1. **Species Diversity or Biodiversity**
     - The variety of different species that inhabit the area
  2. **Species Composition** ***("roles")***
     - Dominant species
       - Most abundant species or contribute the highest to total biomass of a community (total weight)
         - Exert powerful control over the occurrence and distribution of other species
     - Keystone species
       - Not necessarily abundant in a community
         - Exert strong control on community structure by their pivotal critical ecological roles or niches
       - What is the keystone species may change over time
         - (Due to succession)

Species diversity - the variety of different kinds of organisms that make up a community

greater biodiversity = greater stability & resilience in the face of community disturbances

Species diversity involves two variables:

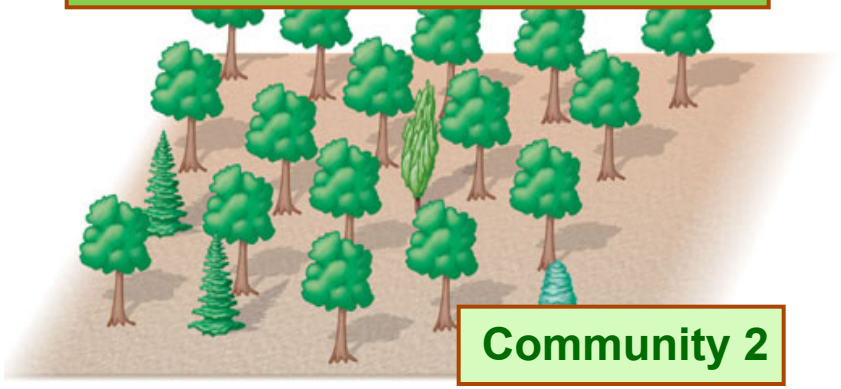
1. **Species richness: # of different specie types**
2. **Relative abundance: Proportion of each species in a community**

Greater biodiversity offers:

- more resources for every species (more sources of energy and nutrients avaialble)
- more habitats
- more resilience (populations can better survive and recover) in face of environmental change or disturbance

Community 1
A: 25% B: 25% C: 25% D: 25%

Which forest is more diverse?



Community 2
A: 80% B: 5% C: 5% D: 10%

Simpson Diversity Index

- **Simpson Diversity Index (D, D_S, or SDI) allows you to quantify biodiversity.**

Simpson's Diversity Index

$$\text{Diversity Index} = 1 - \sum\left(\frac{n}{N}\right)^2$$

  - Takes both the number of species and the population size of each species into account.
    - N = total number of individuals in the community of all species
    - n = the population size of each species
  - The resulting value is always between 0-1.
    - 0 represents NO diversity; All individuals in an area are the same species.
    - 1 represents infinite diversity
      - To See the formula in use:
        - https://www.youtube.com/watch?v=bfxhh7I-LQw

Simpson Diversity Index

Simpson's Diversity Index

$$\text{Diversity Index} = 1 - \Sigma\left(\frac{n}{N}\right)^2$$

- **Simpson Diversity Index value is used to:**
  1. **COMPARE** several different ecosystems
  2. Examine **CHANGE** over time within the same ecosystem

Ex: Scientists are studying how an ecosystem is changing in biodiversity over time. They counted the number of organisms of each species in the community at the start of the study and repeat this process 25 years later. Using the Simpson Diversity Index, report how the ecosystem is changing in terms of its stability and resilience to environmental changes.

Time = 0 yrs

Species Label	Population
A	3
B	5
C	16
D	12
E	8
F	2
G	7
H	3
I	6
J	3

Time = 25 yrs

Species Label	Population
A	4
B	3
C	1
D	2
E	2
F	1
G	3
H	1

- **Ecosystem Time 0 yrs**
  - **Diversity Index = 0.856**
- **Ecosystem Time 25 yrs**
  - **Diversity Index = 0.846**
- **Conclusion**: The ecosystem has decreased in bio-diversity and is, therefore, less stable and resilient to disturbances and change today than it was 25 years ago.

Why Should Biodiversity Matter to Us?

- The more species richness (# of species) and the more abundance of each species is present, the more stable the community in an ecosystem is as the environment change and the more successfully that community can recover from environmental disturbances.
  - https://www.youtube.com/watch?v=-bE-Pydad7U
- Greater biodiversity = more stable, sustainable human populations too!
  - Humans depend on services ecosystems provide:
    - Fresh water (destroying trees destroys the water cycle)
    - Pollination of fruit trees,
    - Natural resources like trees and plants for construction, fuel, and fibers
    - Nutrient cycling & soil fertility for planting crops
    - Plants, bacteria, and fungi as a source of food or medicine
    - Natural systems that counteract and regulate climate change
    - Enjoyment of the outdoors and cultural practices

Why Should Biodiversity Matter to Us?

- **Greater biodiversity = more stable, sustainable human populations too!**
  - **Deforestation destroys biodiversity and results in less CO_2 being fixed and removed from the atmosphere, accelerates climate change**
    - **This allows diseases carried by vectors like mosquitos to extend their geographic ranges (enter new habitats) and infect new population of humans**
      - **Destruction of forest ecosystems responsible for 11% of global greenhouse gas emissions by humans**
    - **Forests and wetlands provide crucial protection to extreme storm surges and flooding related to climate change**
  - **40% of world economy and 80% of needs of the poor are derived from biological resources**
    - **Food, commercial forestry, and ecotourism industries could loose $339 billion per year with biodiversity loss continuing at current pace**
    - **75% of global food crop relies on animals and insects like bees to pollinate them, pollinator population decline putting $235 billion of agricultural products in the U.S. at risk**

The impact of reduced biodiversity:

Communities become fragile: the remaining species being much more at risk of perishing

compare these communities

agricultural "monoculture"

Successful pathogens spread quickly as so many organisms are the same species or even genetic clones if produced asexually

"old fields" - high diversity

- Irish potato famine
- 1970 US corn crop failure
  - Due to fungal pathogen
  - One billion dollars in losses

Dominant Species

- Dominant Species
  - **Most abundant species in a region**
    - Make up the largest amount of biomass (in weight) of that community
      - Exert powerful control over the occurrence and distribution of other species

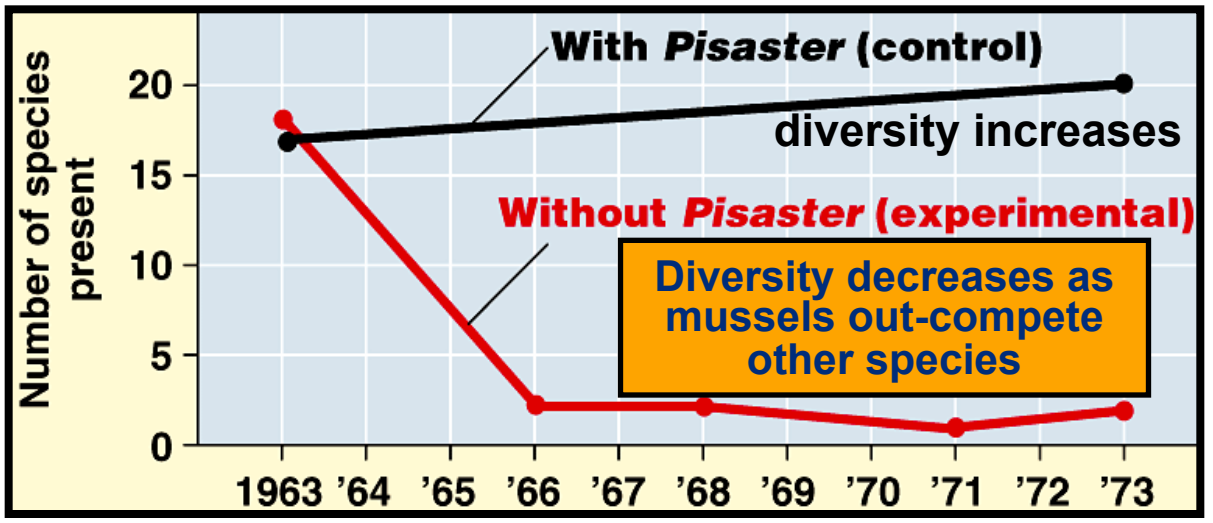
Keystone species

- Hold influential ecological roles
  - exert important regulating effect on other species in community
    - keystone species increases diversity in habitat

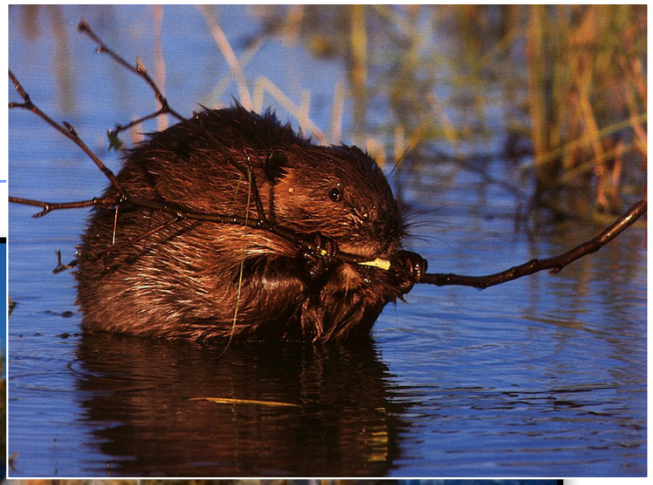
Ex: In West N. America, this sea star preys on mussels, a dominant species and strong competitor for space

Washington coast

Pisaster ochraceous



Foundation Species



Beaver is an "ecosystem engineer"

Animals that exert their influence on communities not through their trophic interactions (what they eat) but by causing physical changes in environments are called Ecosystem Engineers or "FOUNDATION SPECIES"

They are also FACILITATORS, having a positive effect on the survival and reproduction of other species in the community

Dams transform flowing streams into ponds creating new habitat

Ecological succession

- Ecosystems experience disturbances from time to time
  - **Disturbances** = a temporary change in average environmental conditions that causes a pronounced change in an ecosystem
- **Disturbances** prevent communities from reaching a state of equilibrium in species diversity or composition
  - Communities do not usually reach and maintain a relatively constant species composition - species composition changes over time!

AP

Ecological Succession

- Communities experience a sequence of community changes a process referred to as **Ecological Succession**
  - There is a transition in species composition over time
    - May take years or decades for biodiversity to change
      - Each species **alters** the environment (influencing food sources, soil composition, sunlight availability, possible nesting sites, and more) the changed environment better for still newer organisms that then move in and no longer ideal for its previous inhabitants that may see populations drop and disappear.
    - Usually succession most obviously seen after a **disturbance**
      - An event like a storm, fire, flood, drought, overgrazing, human activity that changes a community by removing organisms from it or altering resource availability to orgnisms

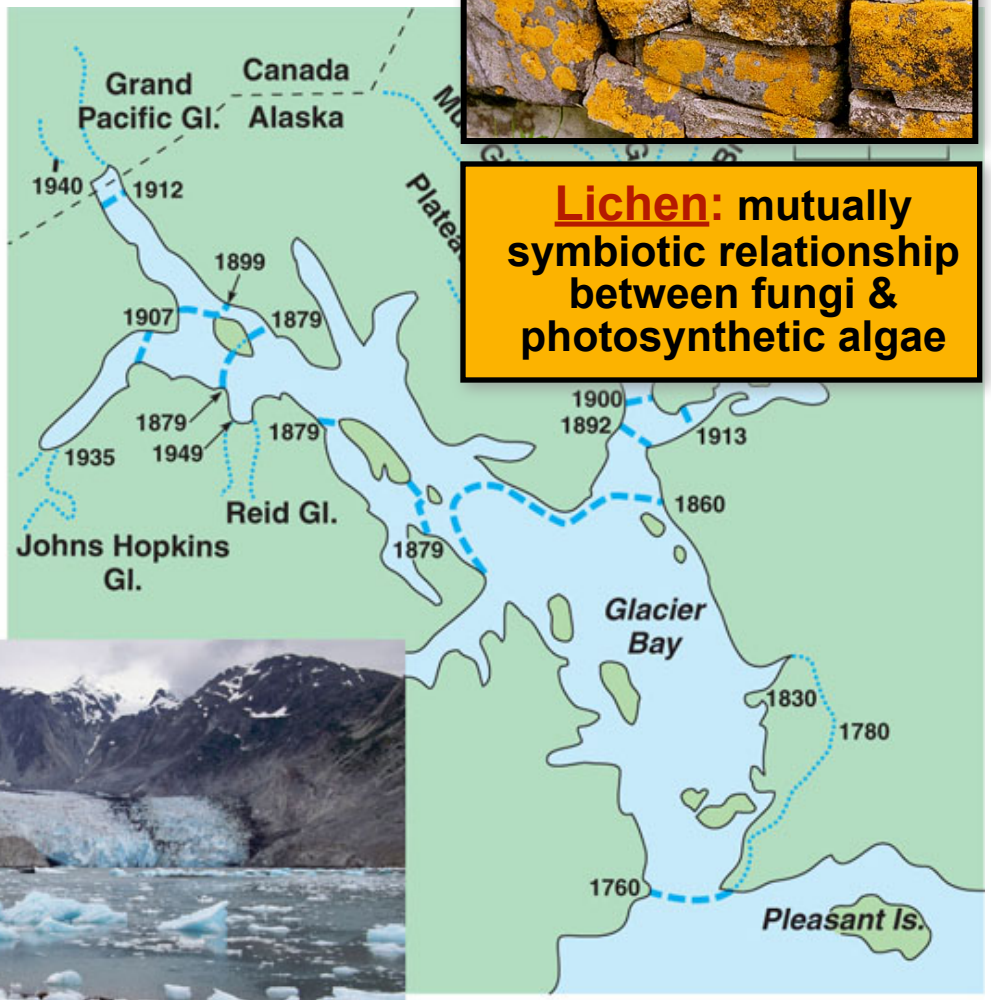
Mt. St. Helens

Primary succession

- Process begins in a virtually lifeless area without soil like on a new volcanic island or on the rubble left behind by a retreating glacier
  - Life-forms present include autotrophic prokaryotes, heterotrophic prokaryotes, and protists

make soil
- bacteria
- lichens & mosses
- Then get grasses, shrubs, and eventually trees move in

Lichen: mutually symbiotic relationship between fungi & photosynthetic algae



McBride glacier retreating

Secondary succession

- Existing community cleared by a disturbance that leaves the base soil is INTACT
  - Herbaceous species that germinate from windblown or animal-borne seeds are usually first to colonize area
    - Woody shrubs may follow and then forest trees

burning releases nutrients formerly locked up in the tissues of tree

the disturbance starts the process of succession over again

Succession of species

pioneer species - 1st to enter

** in primary succession these organisms' make soil: break down rock & their bodies adding organic material*

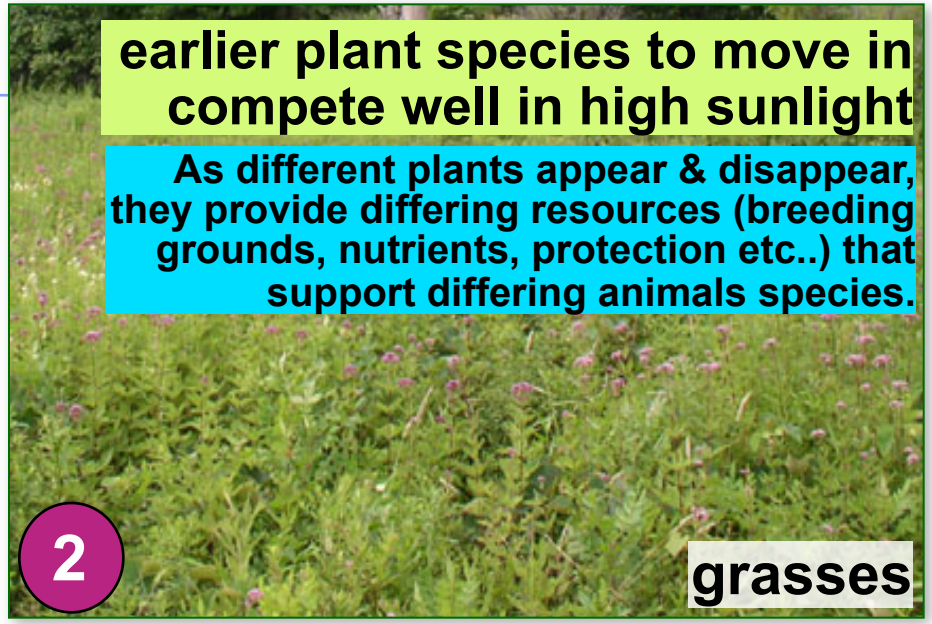
*** change the environment allowing additional species to enter later**

lichens & mosses

1

earlier plant species to move in compete well in high sunlight

As different plants appear & disappear, they provide differing resources (breeding grounds, nutrients, protection etc..) that support differing animals species.



2

grasses

over time more & more shade-tolerant plant species move in

3

The appearance and disappearance of one animal species, affects the presence of other animal species

bushes & small trees

4

climax forest - species function as an integrated unit, a "super-organism"

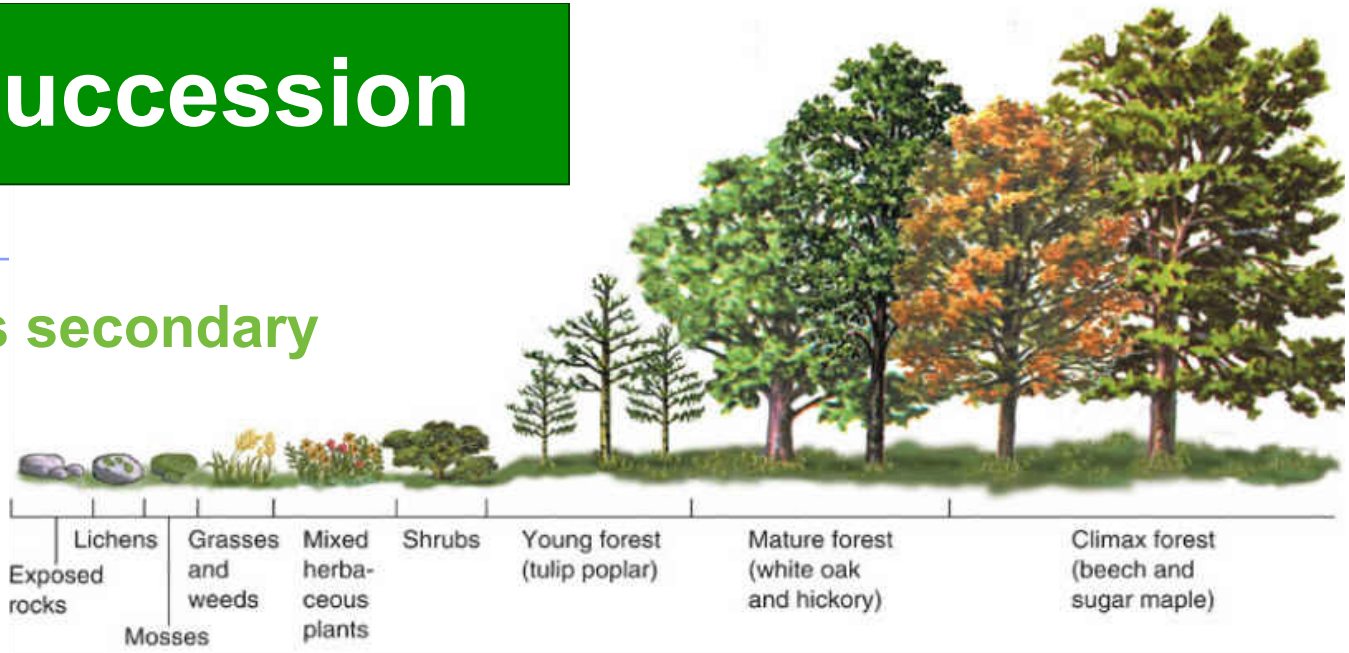
many shade tolerant plant species

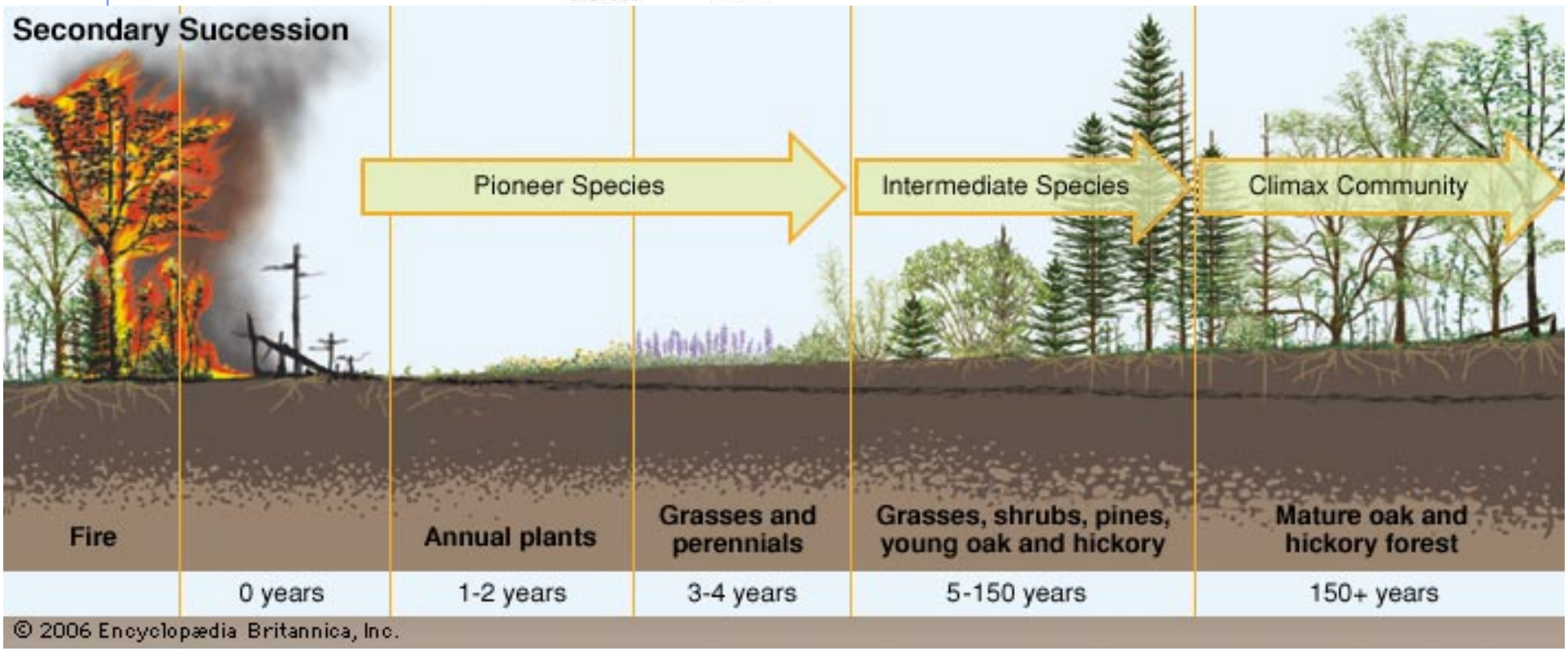
stable community of organisms

trees

Types of Succession

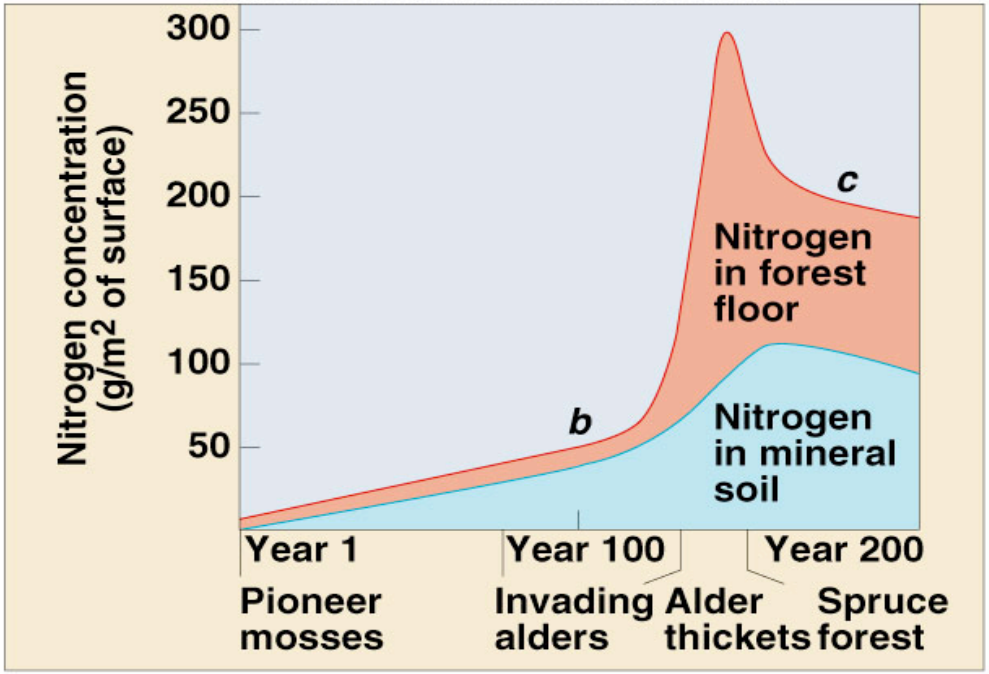
- **Primary versus secondary Succession**



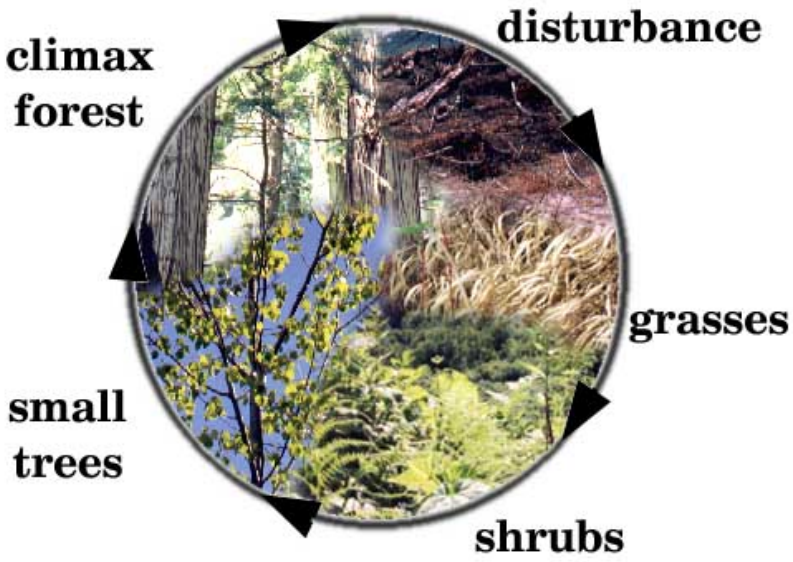


What causes succession?

- **Tolerance of Variable Environments**
  - early species are weedy r-selected
    - tolerant of harsh conditions
    - adapted to maximize the use of abundant resources due to little competition from other species
      - produce a lot of offspring (seeds) with little parental care
- **Facilitation & Inhibition**
  - earlier species facilitate/cause habitat changes
    - change soil pH
    - change soil fertility
    - change light levels
      - allows other new species to out-compete initial pioneers



Climax forest



- Plant community dominated by large trees
  - Representing final stage natural succession for specific location
    - stable plant community
    - remains essentially unchanged in species composition as long as site remains undisturbed
      - birch, beech, maple, hemlock
      - oak, hickory, pine

Climax forest

Taiga (boreal or snow forest) has many evergreen coniferous trees like pine, white spruce, & douglas fir adapted to extreme cold.

The species mix of climax forest is dependent on the abiotic factors of the region such as...

- *solar energy levels*
- *temperature*
- *rainfall amount*
- *fertility & depth of soil*

Temperate deciduous forests:
has species like birch, beech, maple, oak

Disturbances as natural cycle

- **Disturbances are often necessary community development & survival**

- can create patches of different habitats
- releases nutrients from organisms
- promote seed germination
- increases biodiversity

fire climax forests

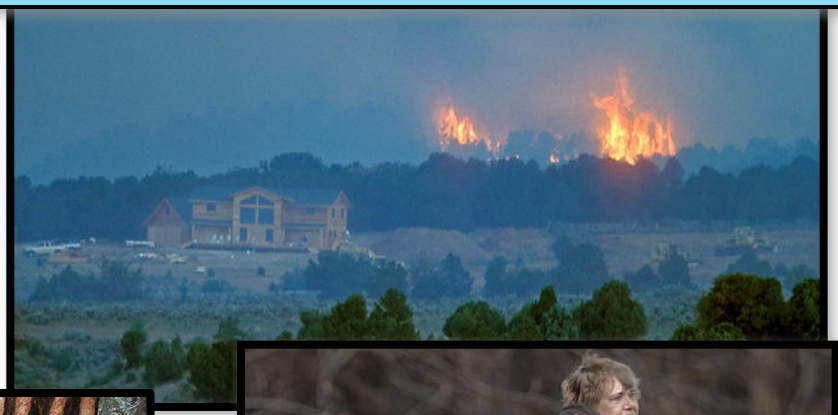
- increases habitats
- rejuvenates community

Fire climax species

We build homes in fire climax zones…

Have adaptations to survive and reproduce in areas that experience frequent fires

But preventing fires makes next year's fire much worse because more flammable litter accumulates on the ground!



Don’t blow your top*!* Ask Questions*!*

2007-2008