Habitats

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Habitats

- **A habitat is the home of a species.**
  - Living organisms have evolved through natural selection over millions of years to a specific set of conditions.
  - A living species cannot exist outside of an environment that supports these needs and adaptations.
  - A habitat is an environment in which the specific needs of a living species are met.

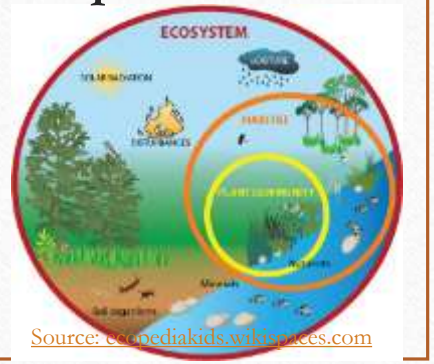
- **When a habitat is destroyed, changed, or degraded, the species that live there are affected.**
  - Currently habitat loss/degradation represents one of the greatest causes of extinction on the planet today.

Source: http://www.globalchange.umich.edu/globalchange2/current/lectures/biodiversity/biodiversity.html

The Needs of Species

All species depend on habitats for three things:

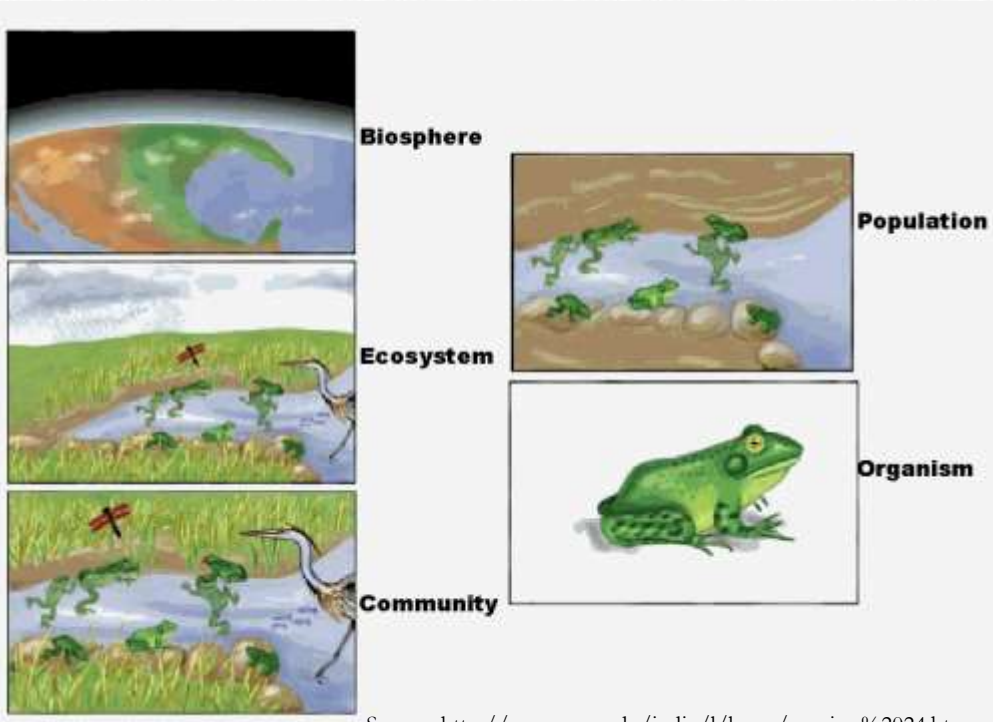
- **1. Shelter: physical structures that a species lives near, around, on top of, or inside of.**
  - It could be a specific structure as specific as a log, nest, or burrow.
  - It could also refer to cover, or the assortment of plants, rocks, water, decomposing matter, in which an organism can remain protected or hidden.
- **2. Physical needs: water, food, oxygen, adequate temperatures, sunlight (plants), etc.**
- **3. Space: all living species have a limit to how closely they can be crowded. Living species need adequate space in order to have adequate access to the previously-listed components.**
  - For example, too many trees in one area would limit their access to light and their ability to photosynthesize.
  - Too many animals in one area would result in starvation and disease outbreaks.
  - Every habitat has a carrying capacity for every kind of living species.



Source: ecopediakids.wikispaces.com

Populations

- **A carry capacity is the maximum population that can be sustainably supported by a habitat.**
  - A population is a group of living organisms of the same kind living in the same place at the same time.
  - All of the populations of living species interact and form a community.
- **A community is group of interacting living species sharing the non-living resources of a specific area**
- **The interaction of the living species of the community and the non-living resources is an ecosystem**



Source: http://www.csus.edu/indiv/l/loom/preview%2024.htm

Niches

- **Every living species occupies a niche, or particular *role* in a habitat**
  - E.g. bees fill a reproductive niche for flowers
  - Wolves fill a predatory niche that improves the genetic quality of a herd of elk
  - A habitat has a limited amount of niches to fill.
  - Because of this, different kinds of interactions will occur between the living species of an environment in order to create the functional ecosystem.

anniekatec.blogspot.com

Kinds of Niches

- **<u>Competition</u>: when multiple species compete for the same resources.**
  - E.g. when multiple species of trees compete for space, sunlight, and the ability to reproduce.
- **<u>Predation & Parasitism</u>: when one species benefits at the harm of another species.**
  - E.g. when wolves attack a wounded deer; when mosquitoes suck blood from a person.
- **<u>Mutualism</u> (or cooperation): when multiple species interact in a way that is beneficial to all involved.**
  - E.g. humans and milking cows benefit from their cooperation (the humans get food, the cow gets cared for; note: neither are dependent on the other to exist).

Kinds of Niches

- **<u>Symbiosis</u>: when two species cooperate to the extent that they each become completely dependent on each other**
  - E.g. bacteria in a cow's rumen; both need each other to function – one cannot survive without the other.
- **<u>Commensalism</u>: when one species benefits without affecting another species.**
  - E.g. when maggots decompose a carcass, the carcass was already dead and therefore is not affected.
- **<u>Amensalism</u>: when one species harms another species without any gain or impact to itself.**
  - E.g. pine needles reduce the ability of other plant species to grow by changing the pH of the soil.

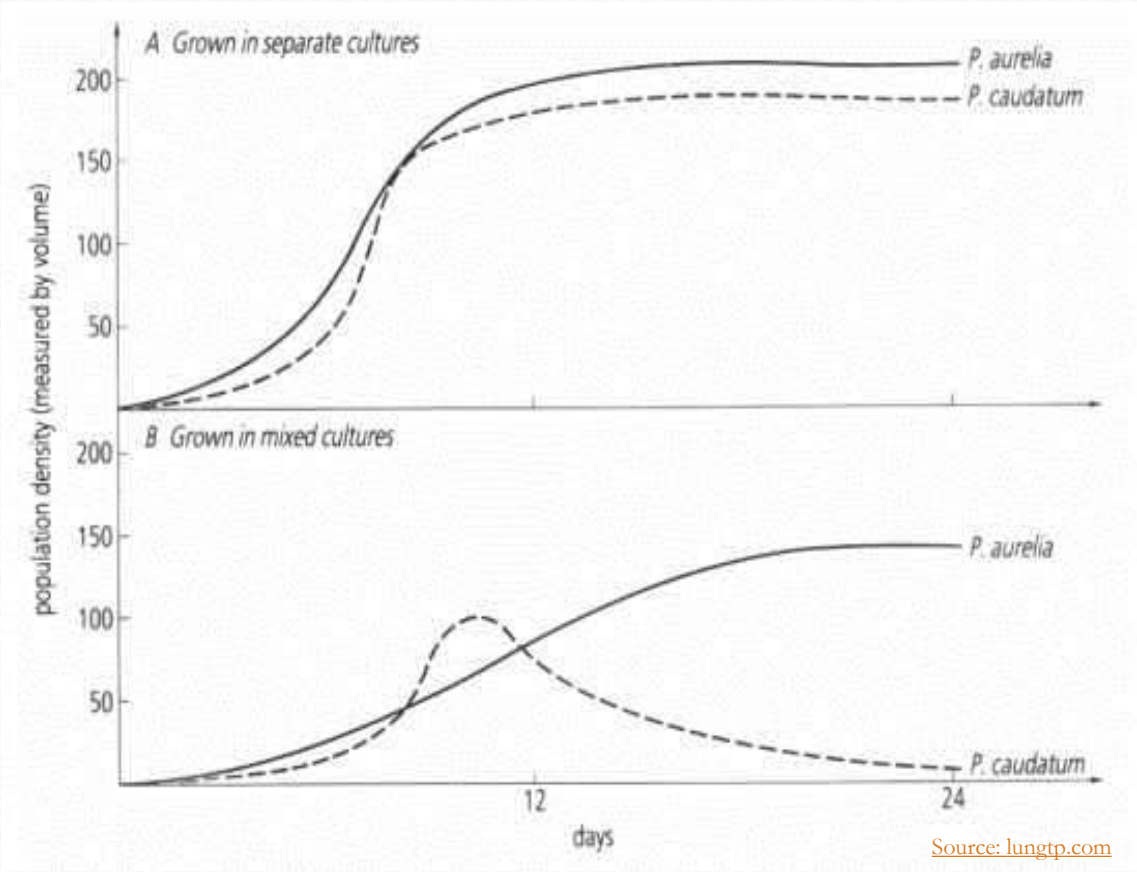
Competitive Exclusion Principle

- **The <u>Competitive Exclusion Principle</u> states that if two competing species occupy the same niche in the same habitat, one species will eliminate the other over time.**
  - This concept becomes very important when considering how a species will respond to a habitat disturbance (later slides).
  - For example, if an invasive species is introduced that occupies the same niche as a native species, the native species may be outcompeted and may go extinct in that particular habitat (especially if the invasive species has no predators).
- **A species with a very narrow niche is called a <u>specialist</u>.**
  - Specialist species are usually dependent on a very small number of other species and/or on very specific environmental conditions.
  - For example, spotted owls only live in the cavities of trees that are 200 years older or more – if all old-growth trees are cut, the spotted owl cannot survive.
    - Many endangered species are threatened because they depend on a specific set of environmental conditions which are affected by human development.

Source: gorgenewscenter.com

The Competitive Exclusion Principle.

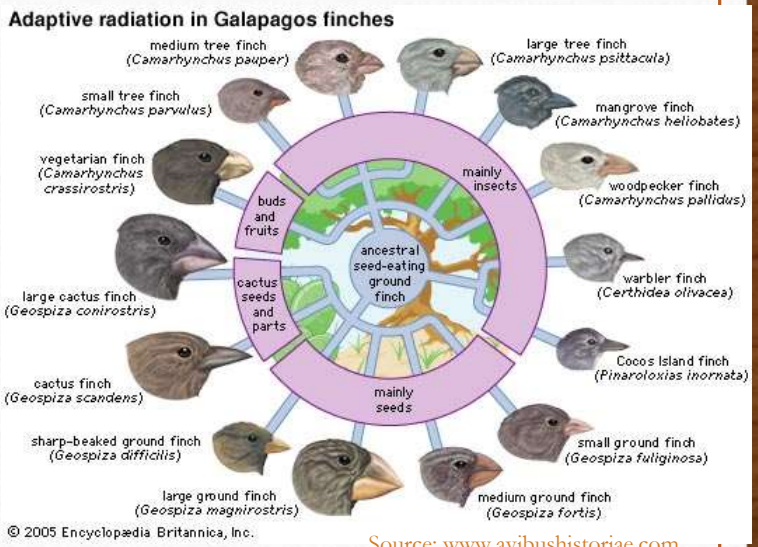
- **The graphs here show the results of the original 1930s Gause experiment where two single-celled paramecium species were grown in a media solution.**
  - When two species that occupy the same niche are grown in separate optimal conditions, they will both thrive (top).
  - However, when those same species occupy the same optimal conditions, they will compete with each other, with one species becoming eliminated (bottom).



Source: lungtp.com

Habitat Extinctions

- **Specialist-niches occur because of the competitive exclusion principle – if a species cannot specialize, they may be outcompeted by another species occupying the same niche.**
  - An example of this are Darwin's finches – those finches that survived did so because they were able to adapt to a specific food source.
  - Some species are able to adapt to many different environments. A species that can adapt to many different conditions is called a habitat generalist.
  - If a habitat generalist is introduced by human activity to a new habitat, the introduced species may eliminate an existing species from its niche.



Source: www.avibushistoriae.com

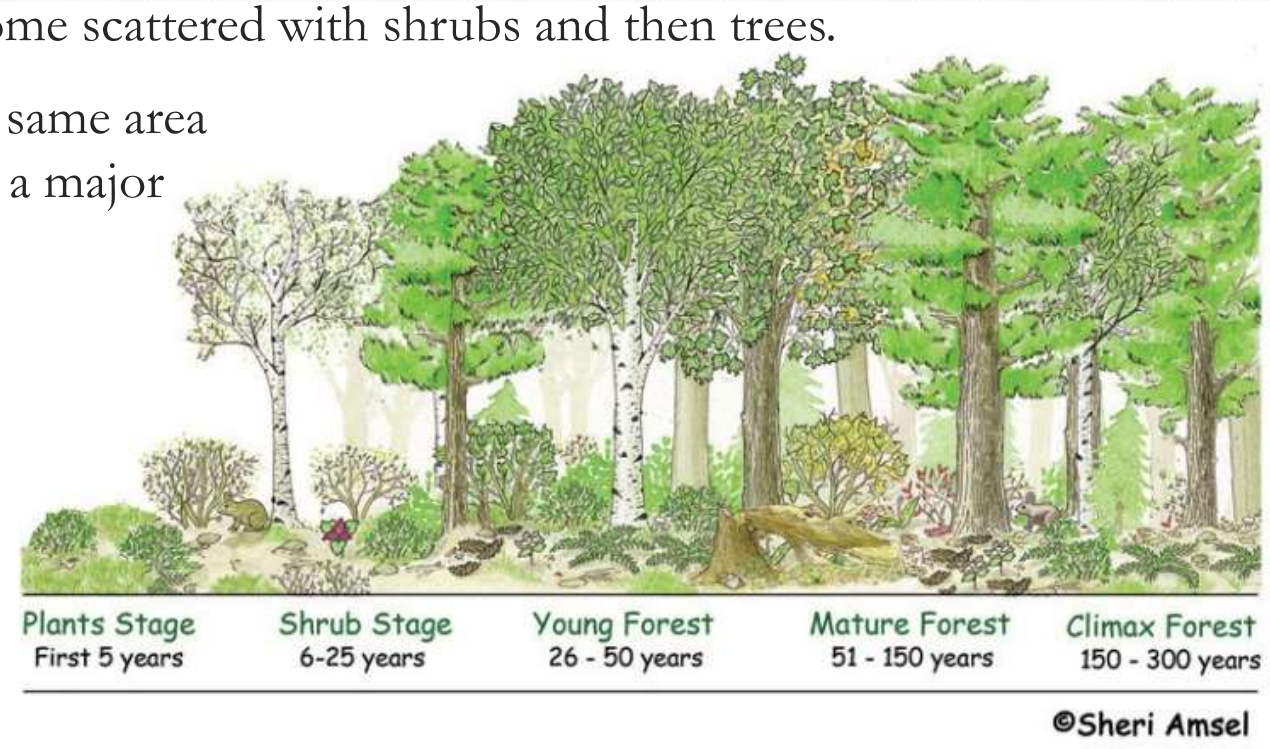
Habitat Loss = Increase in Extinctions via CEP

- **As habitats become smaller and more sparse, the impact of the Competitive Exclusion Principle increases.**
  - As habitat is lost around the world, more species will compete for fewer resources, resulting in an increase in habitat-specific extinctions.
- **As species become more scarce, the impact of the Competitive Exclusion Principle increases.**
  - When resources are abundant due to high biodiversity, the effects of competition are less pronounced.
  - However, as biodiversity decreases and as ecosystem services become more scarce, the impact of the CEP is more likely to be observed.
  - This effect becomes even more observable with the introduction of non-native species who compete to occupy the same niche.

Source: en.wikipedia.org

Succession

- **Succession is the natural process of change and transition in a habitat**
  - E.g. a pond will eventually fill in with sediment to become a marsh. The marsh will eventually dry into a meadow. The meadow will become scattered with shrubs and then trees.
  - Eventually a full forest will occupy the same area and may remain until it is destroyed by a major natural process (fire, flood, glacier, volcano, etc.)
- **Succession occurs over thousands of years**
  - It is a slow process that spans many generations of living species.



Succession vs. Disturbance

- **A habitat disturbance is when the normal function of a habitat is disrupted by an outside force.**
  - This could be human-caused or could be the result of a natural disaster such as a tornado or fire.
- **Succession is very different from human disturbance.**
  - Succession is slow and enables populations to move over time to new habitats that are more suitable.
  - Disturbances reverse the process of succession, causing an ecosystem to revert to an earlier successional stage or even causing an ecosystem to change into a different type.
- **Habitat destruction is the greatest cause of extinction.**
  - The more disturbances to a habitat, the greater the likelihood of extinctions to living species.

worldtwitch.com

Positive Effects of Disturbances

- **Disturbances are a part of the natural cycle of a habitat.**
  - Naturally-occurring disturbances are often a way to "re-set" the succession of a habitat.
  - For example, aspen trees rely on disturbances for their shade-intolerant seedlings to be able to compete for sunlight and nutrients.
  - Jack Pine trees depend on forest fires for their seed cones to open and disperse.
- **Human disturbances tend to differ from natural disturbances largely on the basis of their length of impact.**
  - While a forest fire or tornado causes damage, this damage tends to be rapid and temporary.
  - On the other hand, human-based disturbances such as pollution, invasive species, or outright habitat destruction (such as building a road or urban sprawl) tend to last much longer.
  - The prevents the eventual return of species that otherwise would have re-populated the habitat.

Disturbances & Human Activity

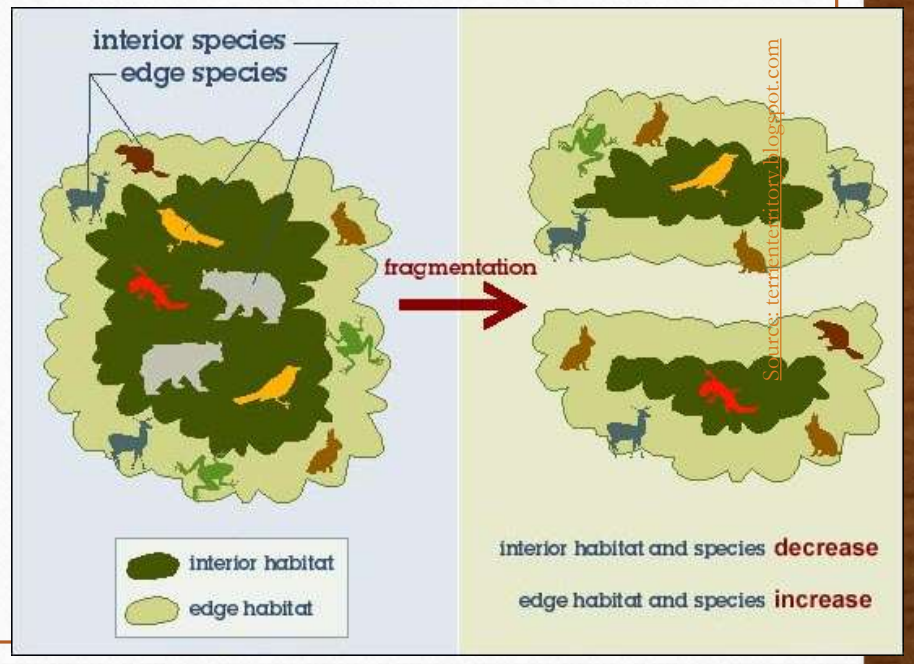
- **Disturbance is a natural part of all systems.**
  - All ecosystems undergo continuous pressures to change – a disturbance is simply an impact that delays or partially reverses the process of succession.
  - The disturbance may be very small (e.g. only affecting a small clump of trees) or large (e.g. a fire or tornado that destroys a large tract of forested area).
- **It is important to understand succession & disturbances from a "resilience perspective".**
  - Resilience is the ability of a habitat to return to its previous state after a disturbance occurs.
  - The greater the diversity of species and ecological processes, the more likely a system is to return into the type of system it was after it experiences a disturbance.
  - If native species and processes are lost, a landscape will be more likely to change into a different ecosystem as the result of a disturbance.

Resilience & Biodiversity

- **When biodiversity is lost, habitats become less able to recover from disturbances.**
  - Human activity can both increase the number of disturbances to an ecosystem as well as increase the damage to a habitat from each disturbance.
- **One of the most direct indicators of whether a habitat is being negatively affected by a disturbance is biodiversity.**
  - The greater the biodiversity, the healthier and more resilient a habitat tends to be.

Measures of Habitat Health

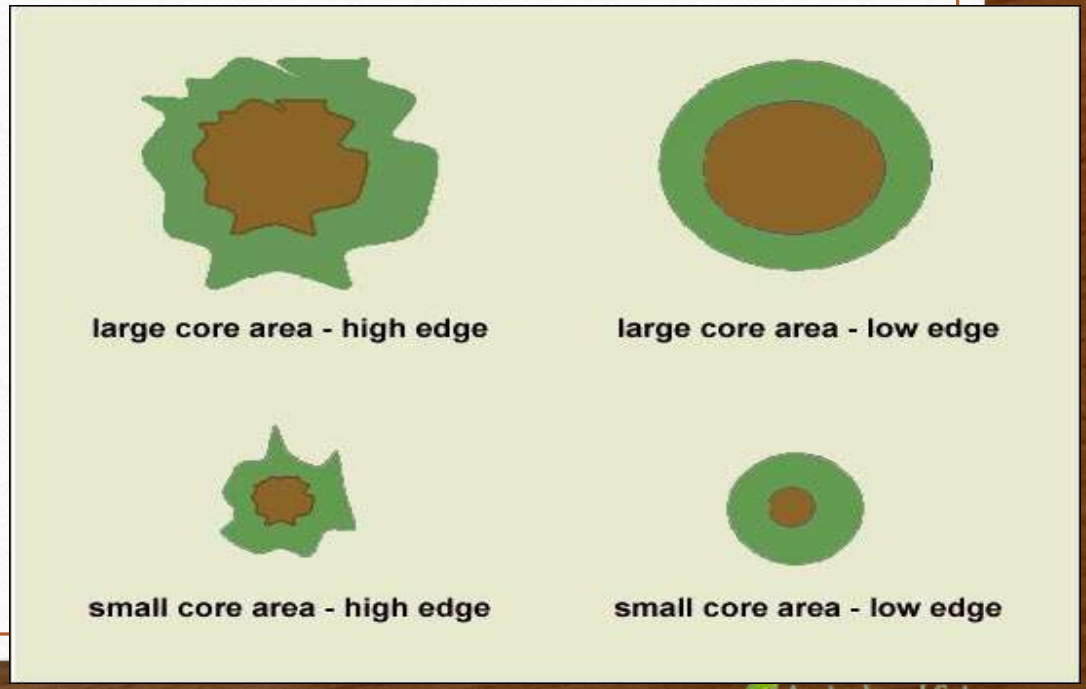
- **Another method for measuring overall habitat health is fragmentation.**
  - Habitat fragmentation is when a large habitat is broken into multiple smaller isolated habitats.
  - Biodiversity is maximized when habitat size is maximized. As habitats are reduced in size, biodiversity is also reduced.



- **Habitat fragmentation has two components:**
  - Patchiness – how many 'pieces' the habitat is broken into (fewer pieces are better than more).
  - Edge – how much border a habitat has (less edge for the same area is better than more).

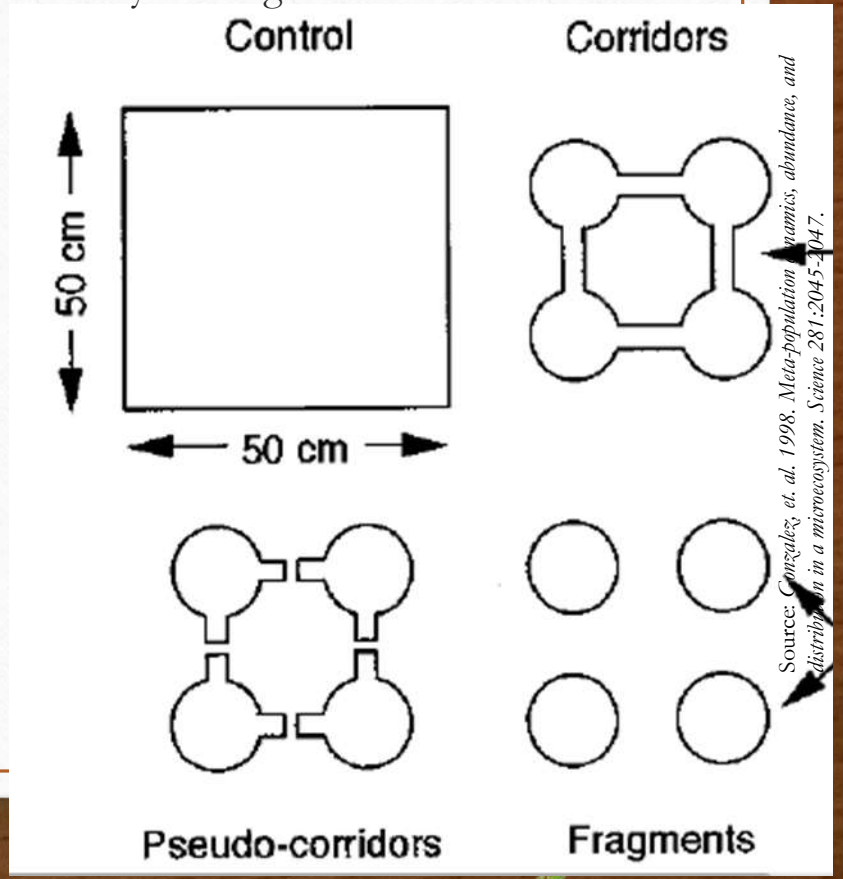
Detrimental Edge

- **The habitat edge is usually the most altered and damaged portion of a habitat. For example…**
  - Edge is the most likely to be affected by disease. E.g. Emerald Ash Borer
  - The edge has the greatest temperature changes
  - Edge has the most invasive species
  - Edge is the most affected by pollution
  - Edge is the most damaged in storms
  - Edge is the most likely to be lost in fire



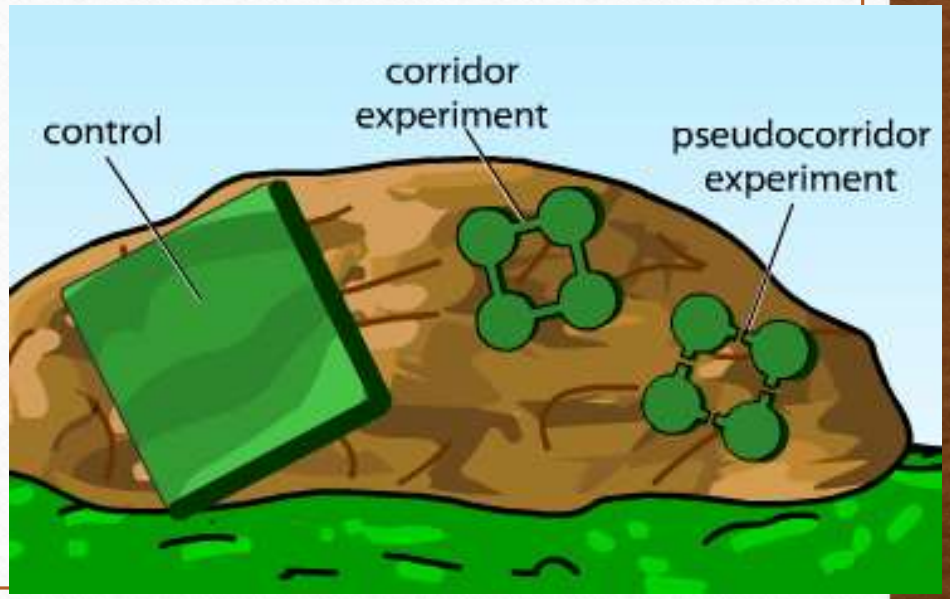
Mossy Rock

- **For example, an experiment by Gonzalez, et. al. in 1998 (published in the research journal *Science*) sought to demonstrate the effects of edge and patchiness in fragmentation.**
  - Gonzales' research team used mossy rocks to simulate what happens to habitats when they are fragmented.
  - These rocks served as a habitat for bacteria, fungi, algae, and insects.
  - The mossy rocks were sort of like micro-habitats but were affected by the same principles as much larger habitats (while being much easier to study).
- **Before beginning the treatment, species richness and abundance were measured on different moss-covered rocks. Moss was then scraped off in one of four ways:**
  - A) A large area of moss was left as one solid piece (this was the control).
  - B) The moss habitat was broken into smaller individual pieces.
  - C) The same area of moss was broken into smaller individual pieces connected by small corridors (a corridor is a strip that connects two habitats).
  - D) The same area of moss was broken into smaller individual pieces connected by small broken corridors.



Mossy Rock

- **After 6 months, species in the large fragments remained largely unaffected.**
  - However, 41% of the species in the isolated patches and patches with broken corridors went extinct.
  - In the habitats with continuous corridors, only 14.5% of the species went extinct.
- **Gonzalez's experiment showed that habitat fragmentation results in a nearly universal decline in the number of species in a habitat and in the populations of those species.**
  - Even if the same amount of habitat is available, if that habitat is broken into pieces through fragmentation, native species will most likely go extinct.



Source: http://bcs.whfreeman.com/thelifewire/content/chp54/5402004.html

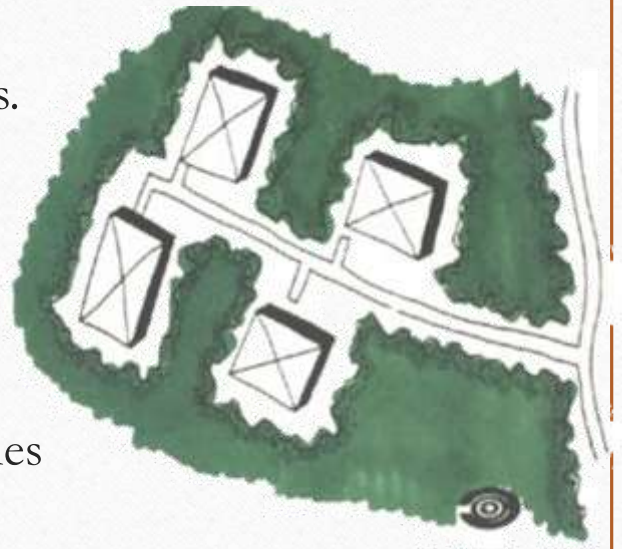
Problems Created by Fragmentation

- **Populations decrease: because there is less habitat available, the habitats have a lower carrying capacity.**
- **Inbreeding: because populations are isolated from each other, the availability of breeding mates is reduced, increasing the risk of inbreeding and loss of genetic biodiversity.**
- **Increases of predators, parasites, and competitors: as the amount of edge in a habitat increases, so does the exposure to species that reduce native populations.**
- **Changes to the physical environment: increases in edge also change the temperature, exposure to wind, rate of water loss, etc. of a habitat.**
- **Elimination of species with large spatial requirements: e.g. wolves and grizzly bears tend to depend on large tracts of unobstructed habitat.**
- **Increased risk of extinctions: all of these factors together contribute to an increased likelihood that species will be lost.**

Causes of Habitat Fragmentation

- **Human Development: urban sprawl replaces habitats and corridors with houses and parking lots, but can also change the niche of a species.**
  - For example, as human populations encroach on habitat in North America, species like deer and bear are more likely to become dependent on human activity for food.

- **Road-building: roads affect biodiversity in the following ways:**
  - They create barriers to movement of species, isolating breeding populations.
  - The create easier access to populations by predators.
  - They increase the spread of disease and invasive species.
  - They increase the likelihood of species loss by vehicle collision.
  - Areas the supply different needs to a species may be separated by the road (e.g. if a breeding ground and a feeding area are separated by a road, a species may be lost in that area).

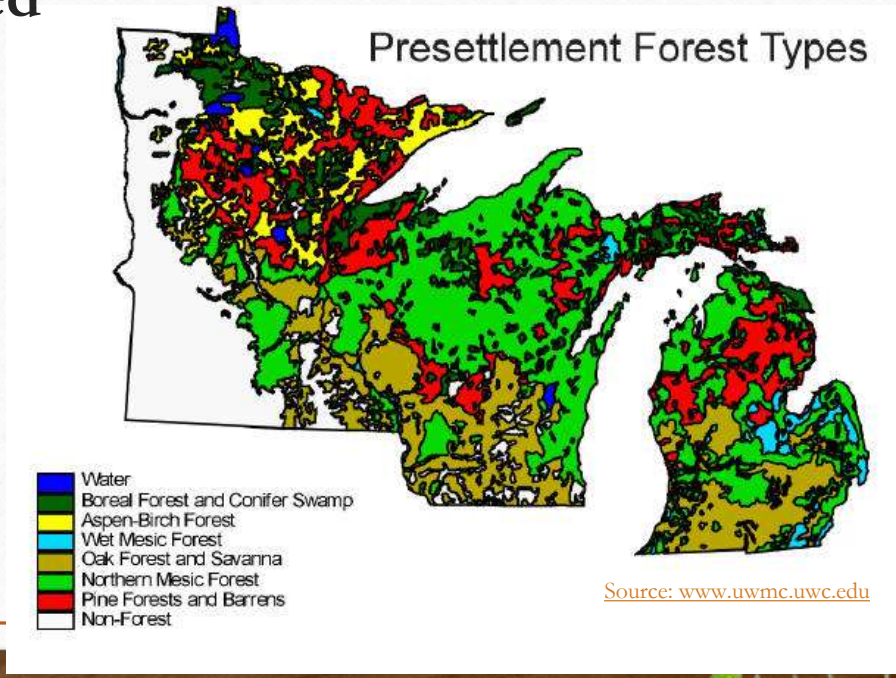


Minimally disturbed development

Source: Metropolitan Washington Council of Governments

Causes of Habitat Fragmentation

- **Deforestation: when logging is performed by poorly-planned clear-cutting (especially if corridors are not provided), it can increase patchiness and edge while giving invasive species a chance to become established.**
- **Conversion: when natural habitats are converted for non-natural uses (including agriculture, pasture, developed parks, etc.).**
  - For example, over 99% of North American prairies were lost since European settlement.
  - Most of this was converted to monocultural fields.



Source: www.uwmc.uwc.edu

Structure & Habitat Health

- **Habitat health is not just a matter of size but also quality.**
  - A large habitat that lacks biodiversity can be as harmful as a small habitat with high biodiversity.
  - For example, moose populations in eastern Canada were wiped out by clear-cut forestry. Research found that moose could not tolerate the loss of more than 0.5 square miles of their habitat (Peek).
  - However, even the loss of a specific kind of species (without removing the rest of the vegetation) could cause losses in moose populations.
    - E.g. only removing coniferous trees was still harmful.
- **<u>The greater the size of a habitat and the greater the biodiversity, the healthier a habitat will tend to be.</u>**
  - The most effective ways to manage a habitat are to increase the size of the habitat and minimize native species losses.

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