Forest ecosystems have been dramatically altered by logging. Scientific insights have been integral in refining forestry practices to more effectively weigh the ecological costs of logging with the economical benefits.

Habitat fragmentation—changing a larger contiguous habitat to a series of isolated patches.

Patch—the habitat that is good for the organism

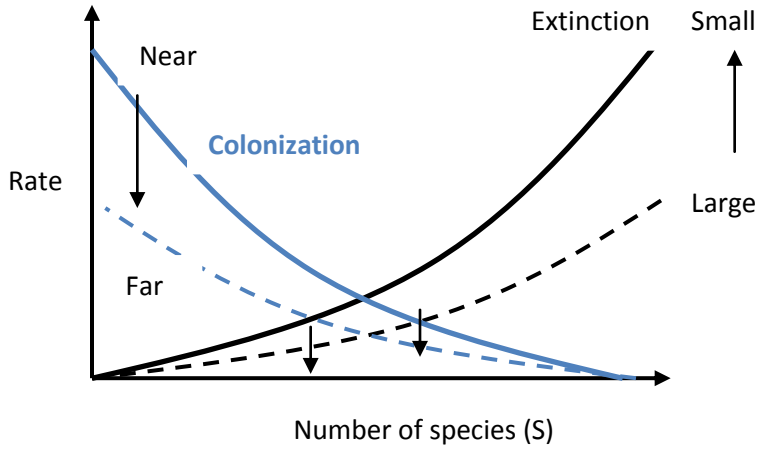
Matrix—the area surrounding the patch that an organism would have to move through to get to another good patch.

COMMUNITIES

Equilibrium theory of Island biogeography theory

The species composition of a patch is a balance of **colonization** and **extinction**.

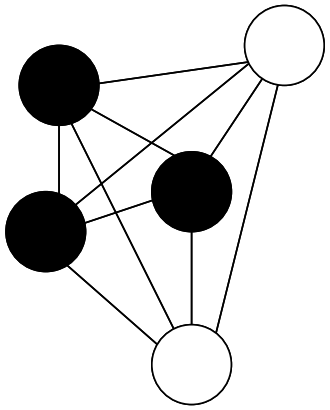
Larger patches contain more species.



Thus, fragmentation to smaller patches should lead to more extinctions. For example, the number of "natural" extinctions in national parks is higher in smaller parks than in larger parks.

POPULATIONS

Metapopulation (in theory)



--a population of populations

--a series of spatially isolated populations that are connected by dispersal.

--In many systems, populations are not totally closed, but rather are influenced by immigration and emigration.

Goal: to quantify the persistence of populations (not the numbers of individuals).

Local extinction—single population disappears. This may be a natural process due to *demographic* or *environmental stochasticity*.

Regional extinction—all populations (entire metapopulation) disappear. Generally not a good thing from the perspective of conservation.

Basic Metapopulation model

p_e = probability of local extinction, probability that an occupied patch goes extinct over a set time step (e.g., 1 year). For example, if p_e = 0.9, then there is a 90% chance that population will go extinct in the next year, and a 10% chance that the population will persist.

P_n = probability of persistence over *n* years of a given patch.

$$P_n = (1 - p_e)^n$$

P_x = probability of regional persistence in a set of *x* patches (over a single time step). The probability that all *x* patches do not go simultaneously extinct.

$$P_x = 1 - (p_e)^x$$

The change in the proportion occupied patches

f = proportion of sites occupied (between 0—no sites, and 1—all sites).

p_i = probability of local colonization

p_e = probability of local extinction

$$\frac{df}{dt} = p_i(1-f) - p_e f$$

Assumptions:

- Homogenous patches
- Each patch can be occupied or unoccupied.
- No time lags
- No spatial structure
- The matrix is unimportant

General lessons from metapopulation theory

1. Unoccupied patches may be important for long-term species persistence
2. Reduced dispersal can cause metapopulation extinction
3. A metapopulation can become extinct before all patches are destroyed
4. Arrangement and connectivity of patches can be just as important as amount of habitat remaining.

Metapopulation (in practice)

- Northern spotted owl (*Strix occidentalis caurina*). A medium-sized owl that has been the center of controversy.
- Required old-growth coniferous forest
    - Nesting—large and old trees/snags with cavities or broken tops.
    - Food—e.g., flying squirrels and woodrats.
- Populations decreased as logging increased.
- Listed as threatened under the US endangered species act.
- Logging industry—"habitat for spotted owls was plentiful because some stands of old-growth forest were empty of owls" (what is wrong with this statement?)
- HCA (habitat conservation areas)—must be big enough to support 20+ breeding pairs of owls and be separated by no more than 19.3 km.

SCIENTIFIC INSIGHTS AND APPLICATION TO FOREST MANAGEMENT

Scientific insight	**Management implication**
Stand complexity is important for wildlife	Leave some large trees to speed to recovery of complexity
Dead trees play important ecological roles • Downed timber—nurse logs • Standing timber—wildlife habitat	See above
Large wood creates habitat for salmon	Don't remove wood from channels Leave riparian buffer strip
Fragmentation can decrease wildlife movement	More aggregated cutting plans