

The background features a textured, light-colored paper-like surface. In the upper right, there is a silhouette of a mountain range. On the right side, a dark, thin branch of a plant with small, round buds or flowers hangs down.

*Community Ecology –
Cont'd*

Antagonistic (Antibiosis)

- ❖ At least one partner is adversely (negatively) affected
 - Antibiosis: Chemical Interactions between organisms
 - Antibiotics in competing fungi
 - Insects with chemicals unpalatable to prey (Monarch)
 - Plants with chemicals unpalatable to prey (Chemicals in heartwood, Rot resistant)
 - Allelopathy: Antibiosis between plants
 - Root exudates which adversely affect growth and survival of surrounding plants (Walnut Trees)

Antibiosis



Monarch Butterfly

[www.laspilitas.com/
butterflylist.htm](http://www.laspilitas.com/butterflylist.htm)




***Pseudotsuga menziesii*
heartwood**



***Juglans* spp.**
afarmerswife.com/tour.htm

Antagonistic (Competition)

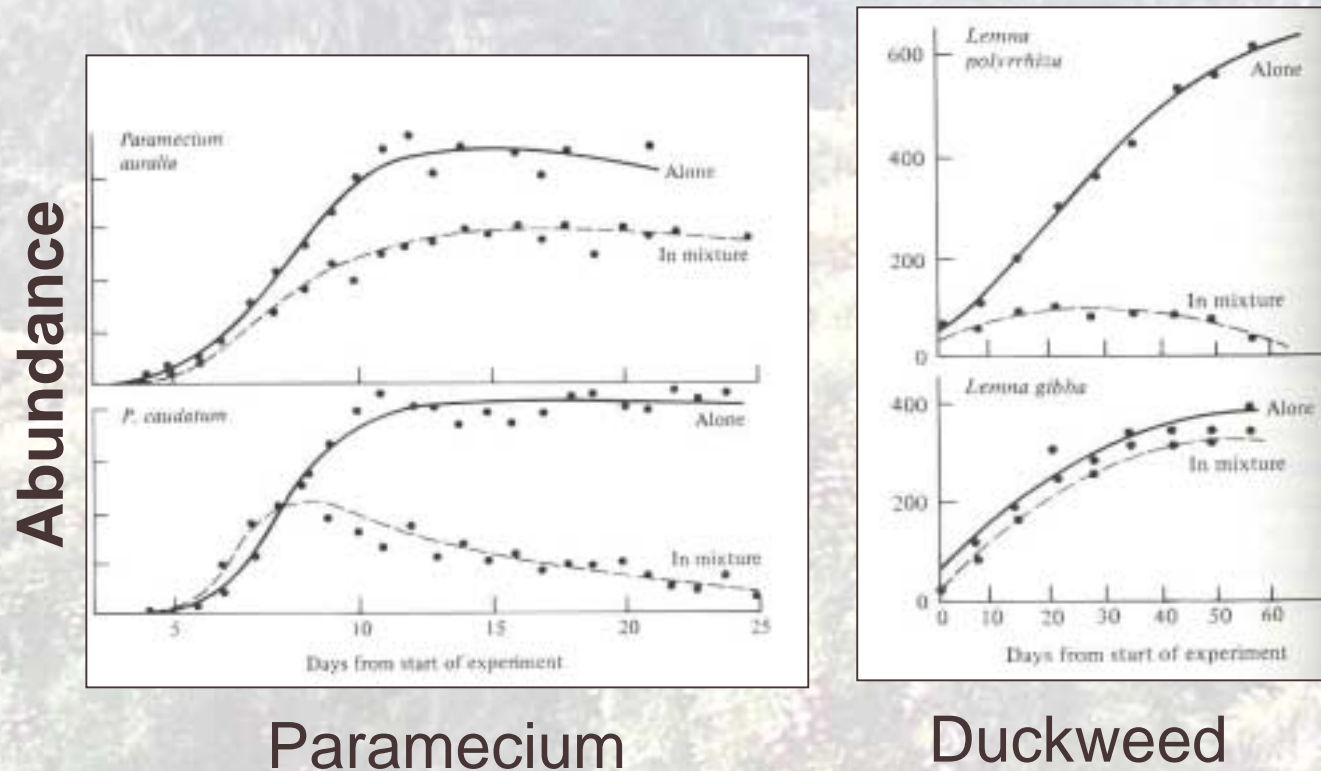
- ❖ Both partners are adversely (negatively) affected
 - Competition – two species attempt to use the same resource
 - Resource in limited supply
 - Resource not limited, competing species interfere with each other's use of it
 - Modified form of the logistic growth equation describes growth of both populations under competition

The background of the slide features a soft, sepia-toned image of a mountain range in the distance and a willow tree branch with drooping catkins on the right side. The text is overlaid on this background.

Competitive Exclusion Principle

Two species competing for the same resource cannot exist indefinitely.

Competitive Exclusion



Paramecium

Duckweed

Fig. 15.6

Apparent Coexistence on a Limited Resource

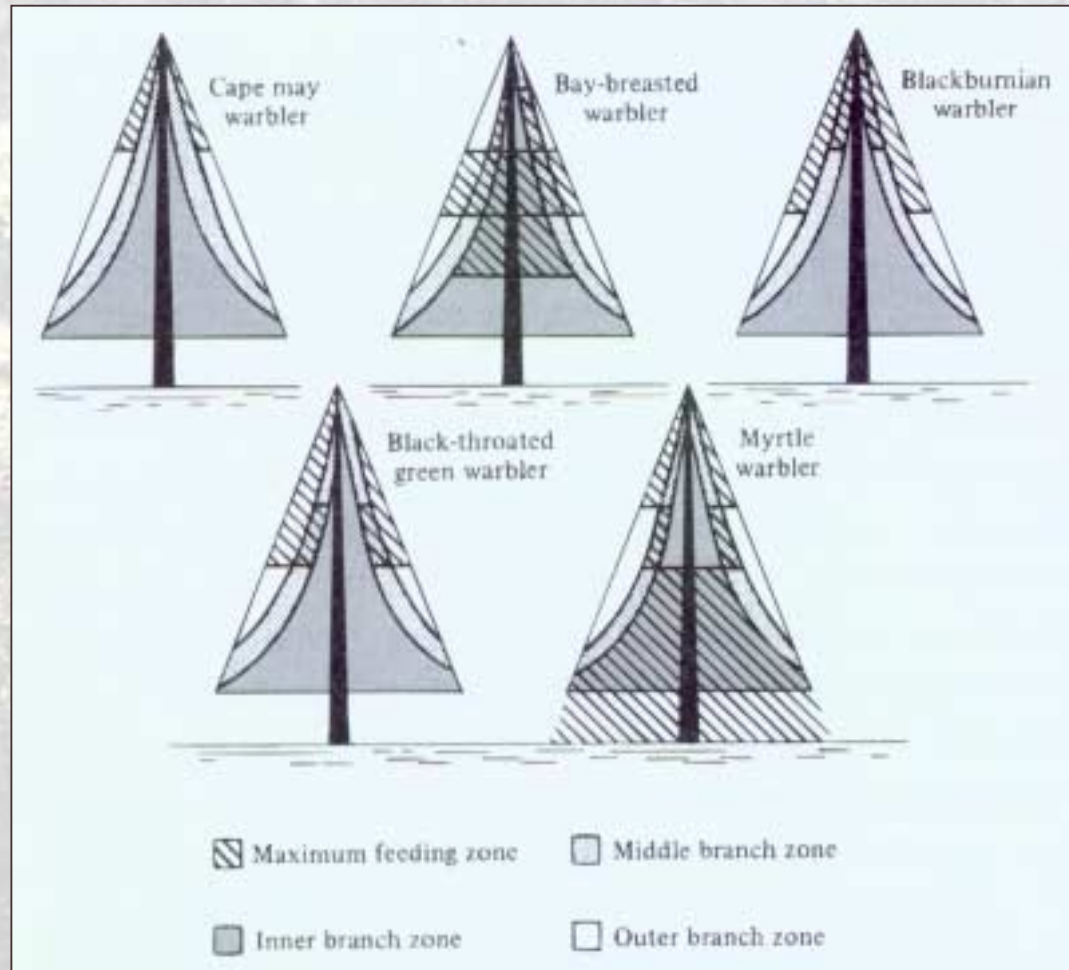


Fig. 15.7

Does Resource Abundance Always Enable Coexistence?

Yes: Natural populations, leafhopper
(*Erythroneura* sp.) and sycamore trees
(*Pseudoplatanus* sp.)

No: Exotic Invasions, White pine (*Pinus* sp.)
and Blister Rust (*Cronartium ribicola*)

Resource Abundance and Competitive Exclusion (natural population vs. invasions)

Sycamore plantation



<http://www.imcc.isa.us/beaufort3.jpg>

Decimation of pine populations



www.fs.fed.us/r2/bighorn/management/blister_rust.htm

Leafhopper



www.uky.edu/Agriculture/Entomology/entfacts/fldcrops/plh.gi

Blister rust infection



students.washington.edu/melliott/diseases/wpbr.html



- ❖ No 2 species with the same set of characteristics can compete indefinitely
- ❖ Coexistence: species do not compete intolerably - Species differ in their set of requirements
- ❖ Led to concept of ecological niche

Ecological Niche

Total role of an organism in the environment.

- Functional - “how it makes its living”, when it does, and how it interacts with other species
- Habitat - factors determining where it is found locally
- Geographic extent

Ecological Niche

- ❖ Fundamental Niche: Maximum niche a species can occupy, competition absent.
- ❖ Realized Niche: Portion of the fundamental niche occupied by the species, competition present.
 - * low disturbance - geographic range will reflect realized niche
 - * post disturbance - may expand to occupy fundamental niche

Realized Niche *(schematic representation)*

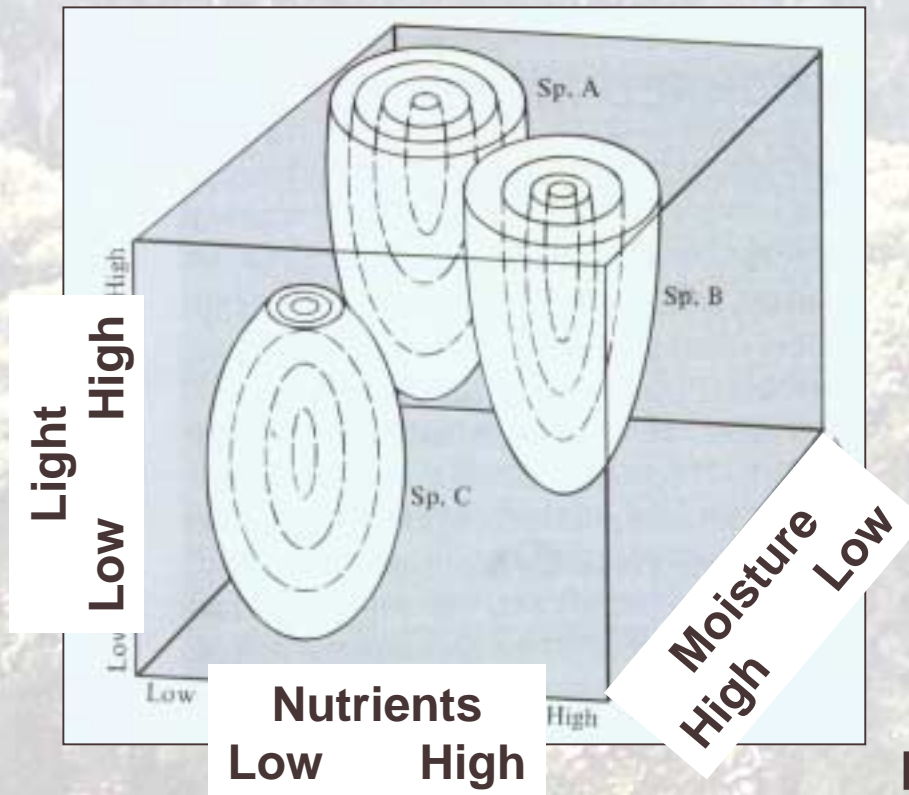


Fig. 15.9

n-dimensional hyper-volume
(n = number of parameters used to characterize the niche)

Regeneration Niche

(plant communities)

- ❖ Requirements for an effective seed set
- ❖ Dispersal characteristics in time & space
- ❖ Requirements for germination, establishment, and growth
- ❖ Regeneration (seed or sprouting)



Biological Diversity

Important Attribute of a Community

How can it be measured?

Genetic Diversity

- ❖ Ecotypes are genetic subdivisions of a species in response to environmental variations within its range
 - example: Coastal vs. Inland Douglas-fir
- ❖ Genetic variation allows a species to adapt to changing environmental conditions
 - example: White pine resistance to blister rust

Local or Stand-Level Diversity

(Alpha Diversity)

- ❖ Species Richness
 - Number of Individuals
 - Loss of Endangered Species
- ❖ Species Evenness
 - Relative Abundance of Different Species
 - Of 1000: 910 one sp., 1 of each other sp.
 - Of 1000: 100 of each sp.
- ❖ Structural Diversity
 - Spatial arrangement of plants (horizontal & vertical)
 - Abundance of: standing dead logs, canopy gaps, age structure, size distribution
 - implications for wildlife habitat niches

Calculating Species Diversity

Shannon Diversity Index (H') = $-\text{Sum } [p_i \bullet \log p_i]$
Where $p_i = n_i/N$

p_i = proportion of individuals for a species (i)
 H' = units are unimportant

**Log is generally natural log (LN)*

Local Landscape Diversity

(Beta Diversity)

- ❖ Across a local landscape, a series of different biological communities, results from:
 - Variation in soil moisture and fertility
 - Variation in disturbance history
- ❖ A species with high alpha diversity can have low beta diversity and visa versa
- ❖ In our lab - percent similarity between two sites is a measure of beta diversity

Calculating Species Diversity

(example)

Community A

Species	Abundance	Proportion (p_i)
Douglas-fir	3	$\frac{3}{4} = 0.75$
grand fir	1	$\frac{1}{4} = 0.25$

$$H' = -[(0.75 \cdot \ln 0.75) + (0.25 \cdot \ln 0.25)] = 0.56$$

Community B

Species	Abundance	Proportion (p_i)
Douglas-fir	2	$\frac{1}{2} = 0.50$
grand fir	2	$\frac{1}{2} = 0.50$

$$H' = -[(0.50 \cdot \ln 0.50) + (0.50 \cdot \ln 0.50)] = 0.70$$

Calculating Percent Similarity

- ❖ Sum of the lowest proportion of each species in two communities.
- ❖ Communities with the same similarity will have 100%
- ❖ Dissimilar Communities will have low %'s
- ❖ $PS = \text{Sum [lowest proportion for each species]}$

Calculating Percent Similarity (example)

Species	<u>Community A</u>		<u>Community B</u>	
	abundance	proportion	abundance	proportion
Douglas-fir	5	$5/7 = 0.71$	2	$2/5 = 0.40^*$
grand fir	1	$1/7 = 0.14^*$	3	$3/5 = 0.60$
big-leaf maple	1	$1/7 = 0.14$	0	$0/5 = 0.00^*$

Big-leaf maple = *Acer macrophyllum*

Calculating Percent Similarity (example)

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*** The lower of the two %'s for each species.
PS = 0.40 + 0.14 + 0 = 0.54 = 54%**

3 other Measures of Biodiversity

- ❖ Regional (Gamma) Diversity
 - Major topographical features (mountains, oceans, large lakes, climate changes w/ latitude (biomes) that result in change in life-form and species composition
- ❖ Ecological Diversity
 - Agents of Beta and Gamma Diversity combined
- ❖ Temporal Diversity
 - Changes over time, growing season lengths, disturbance rates



Global Patterns of Biodiversity

Generalization: alpha diversity decreases for many communities from lowland tropical to high latitude (or high altitude) ecosystems.

Tree Species Diversity *(BC & northern WA)*

- ❖ Highest diversity in the area of climatic transition from coastal to interior.
- ❖ Also increasing with lower latitude.

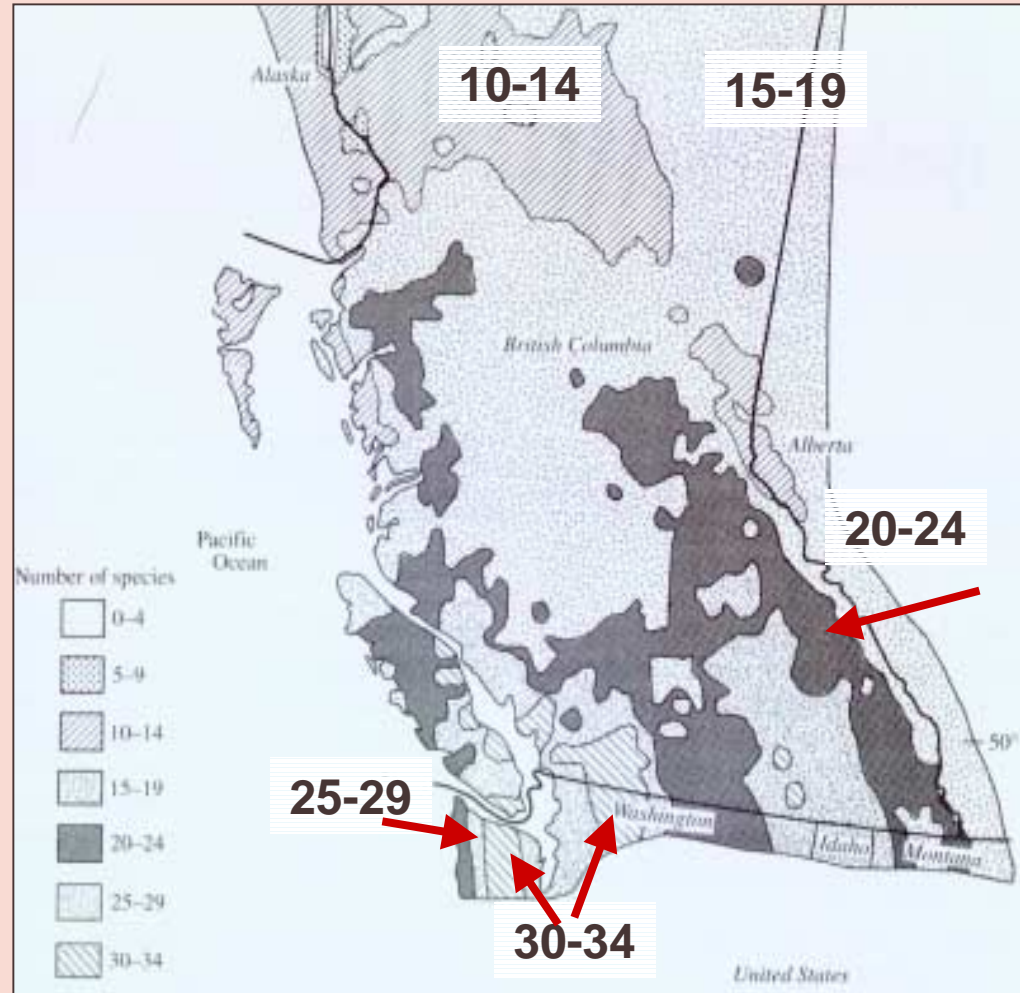


Fig. 15.10

Global Diversity Patterns

(Hypotheses)

- ❖ Time
- ❖ Rate of Speciation
- ❖ Predation
- ❖ Environmental Stability (climate)
- ❖ Environmental Heterogeneity (topography)
- ❖ Size and Spatial Isolation of Islands

Island Biogeography

The study of the distribution and dynamics of species in island environments.

Island Biogeography and Forest Fragmentation

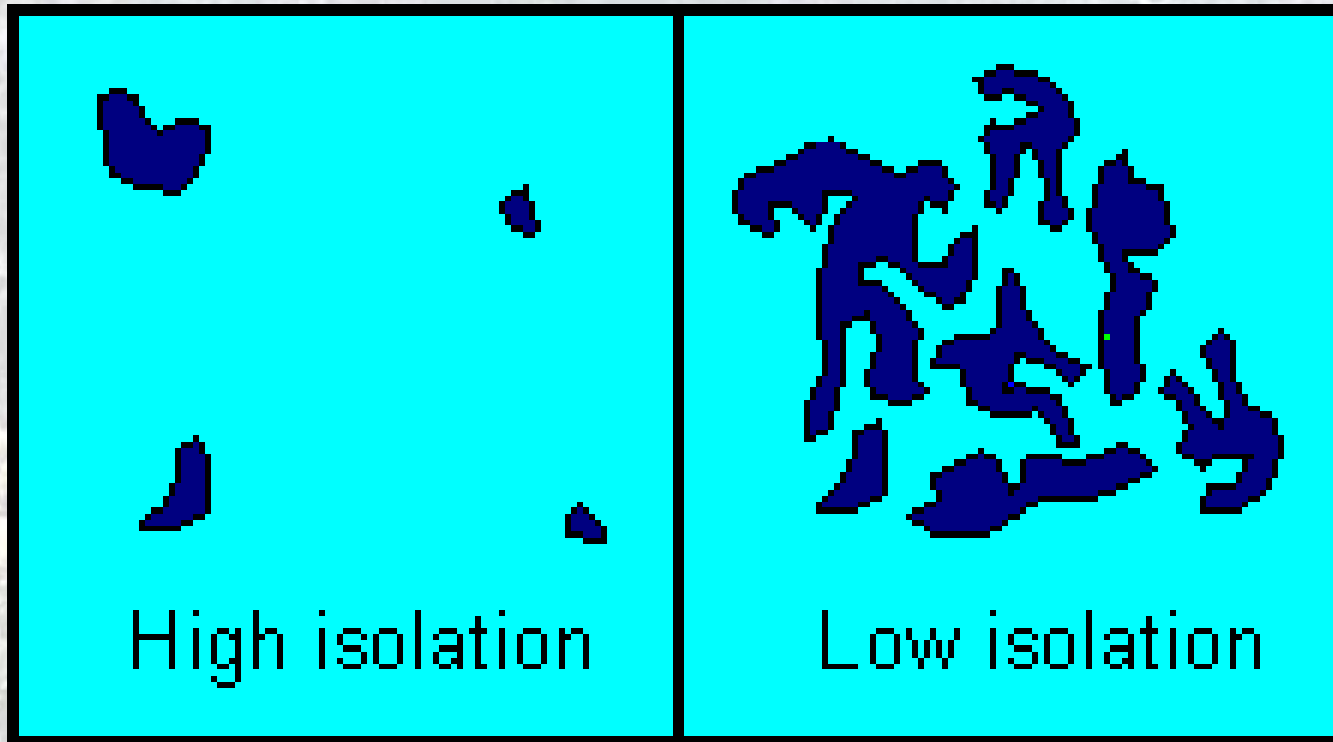
- ❖ Agriculture and Industry creates isolated patches of mature or secondary forests
- ❖ Forest Parks in an Urban Area – What size is large enough for diversity?
- ❖ Forest Reserves embedded in a managed forest – lack of a “hard edge”, hard to find a diversity-patch size relationship.

Metapopulations

*Metapopulation
(composite population)*

Set of local populations within some larger area, where typically migration from one local population or at least some other patches is possible; (definition of metapopulation has broadened in last five years).

Metapopulations



- ❖ Distance/Scale depends on species
 - High mobility – e.g. birds
 - Low mobility – e.g. salamander

Species Diversity and "Islands"

- ❖ Size of the Island (resource abundance)
- ❖ Matrix Land - e.g. western OR - mix of Private industrial and Federal lands - "checkerboard"
- ❖ Distance from the Mainland (immigration)
 - Rate at which Extinction Losses are replaced by immigration

Density Management Study - BLM western Oregon

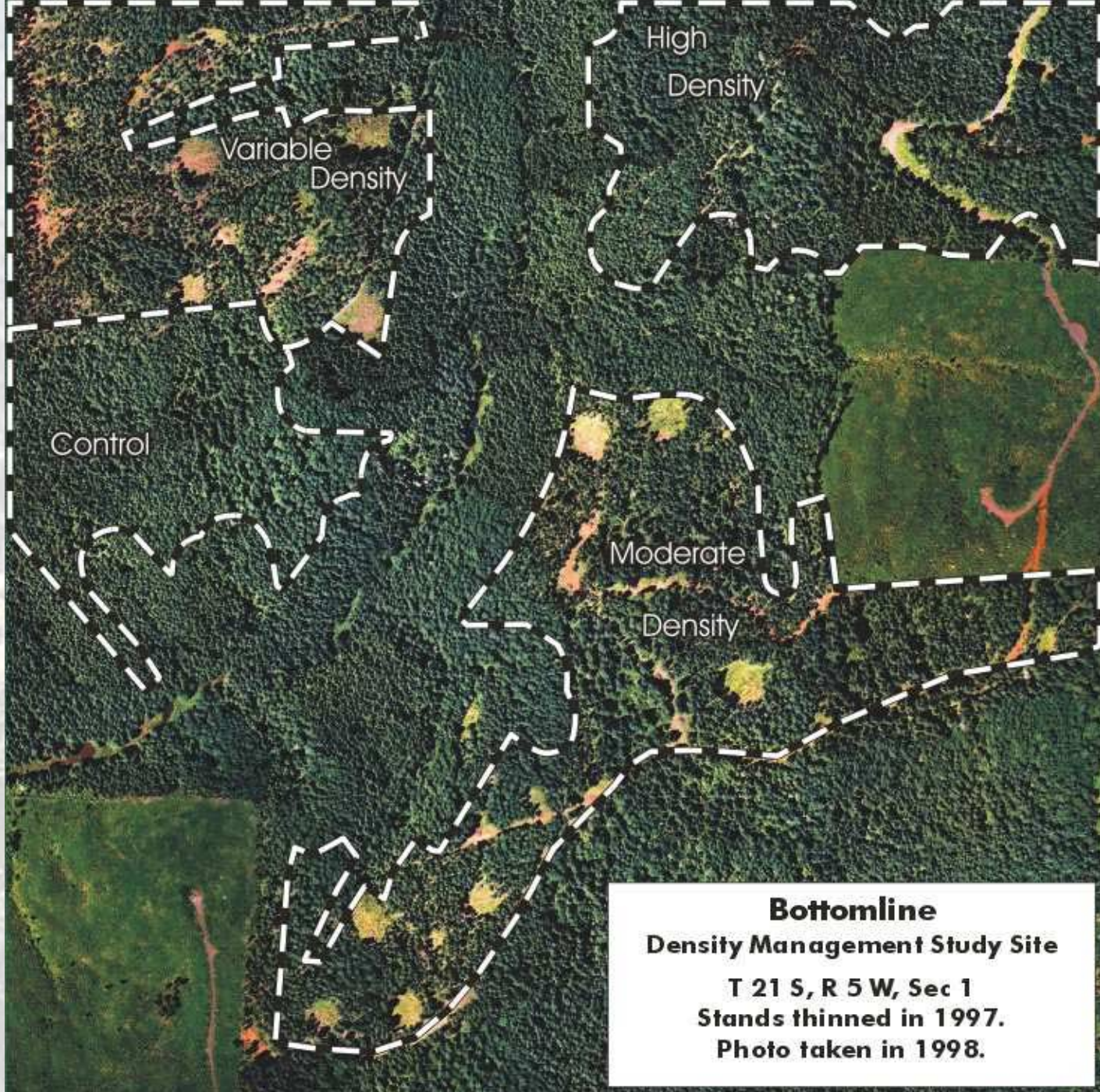
- ❖ The role of leave islands in forest management
- ❖ Protecting low-mobility species for the future forest that will grow up around them
 - invertebrates
 - salamanders, etc. (Wessell in prep)



Douglas-fir - 40-50 yrs old

Four treatments

- **Unthinned Control:** density 200-350 TPA
- **High Density Retention:** 70-75% thinned to 120 TPA, 20-30% unthinned riparian reserves or leave islands
- **Moderate Density Retention:** 60-65% thinned to 80 TPA, 20-30% unthinned riparian reserves or leave islands, 10% circular patch openings
- **Variable Density Retention:** 10% thinned to 40 TPA, 25-30% thinned to 80 TPA, 25-30% thinned to 120 TPA, 20-30% unthinned riparian reserves or leave islands, 10% circular patch openings



Control

Variable
Density

High
Density

Moderate
Density

Bottomline
Density Management Study Site

T 21 S, R 5 W, Sec 1
Stands thinned in 1997.
Photo taken in 1998.

Community Ecology and Forest Management

- ❖ Plant Classification: Recognition of species distributions along environmental gradients (we'll return to this - including in lab this week).
- ❖ Recognizing the importance of inter-specific interactions when developing management plans - competition, herbivory, pathogens, etc. but also the symbiotic relationships
- ❖ Expanding species outside of their realized niche

