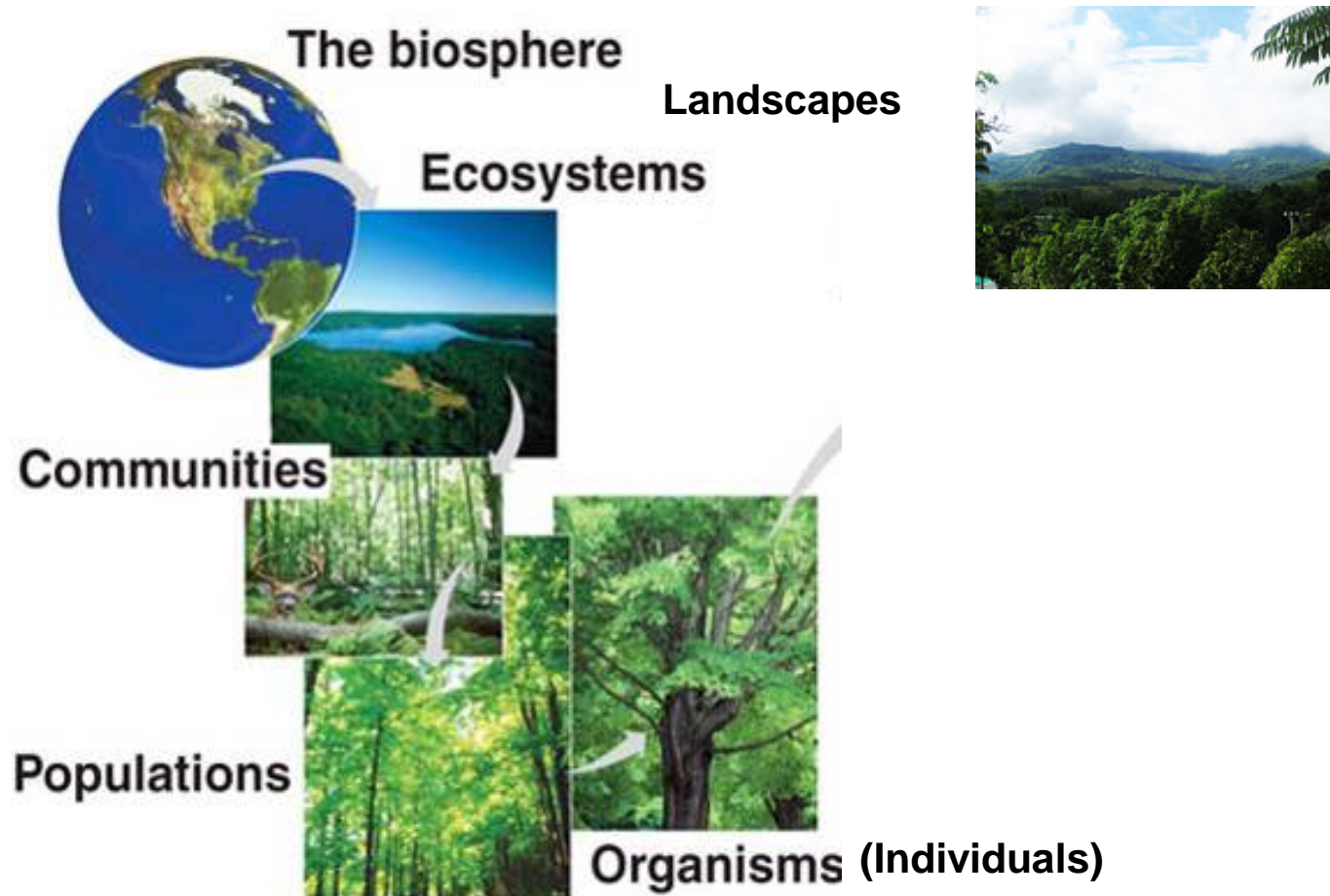


Restoration Ecology - Landscape Perspective

- Objectives:
 - How can the foundations of and theory in landscape ecology ↔ restoration ecology ↔ ecological restoration
 - Landscape Ecology 101
 - Landscape Ecology in a restoration context
 - Macroecology Perspective

Restoration Ecology - Landscape Perspective

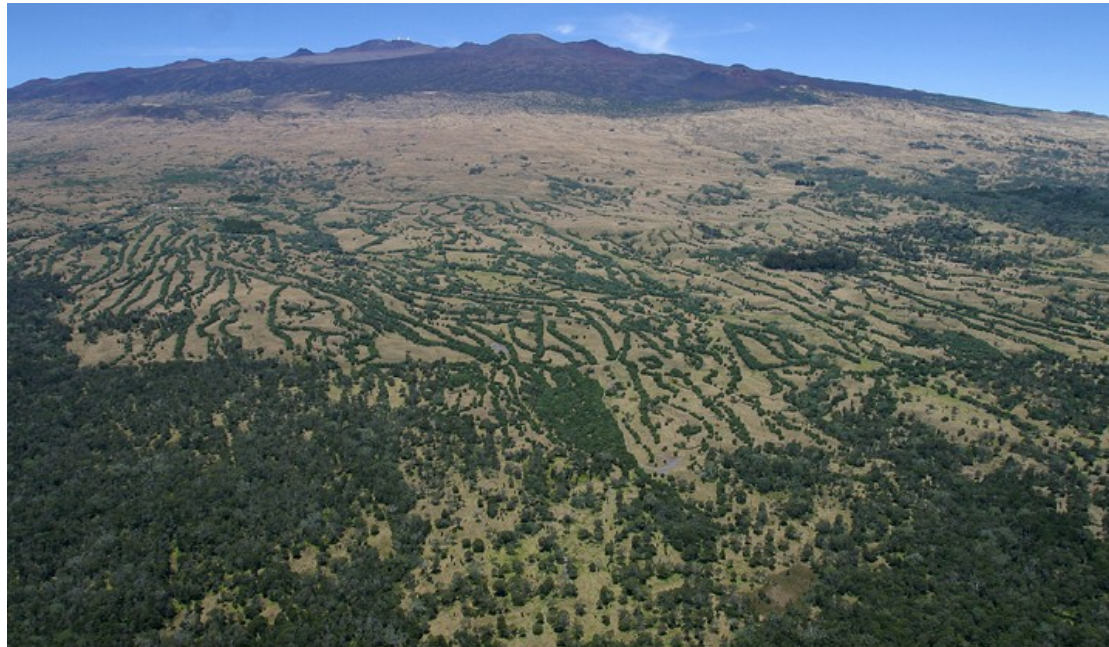
- Ecological Hierarchy



Restoration Ecology - Landscape Perspective

- Landscape
 - heterogeneous region consisting of 2 or more interacting ecosystems (≥ 2 landscapes = region) that exchange organisms, matter, energy, H_2O , nutrients, etc.
 - Mosaic of habitat patches of varying sizes and shapes
 - Characterized by patches, edges, connectivity, etc.

**Windward
Mauna Kea
Landscape**



Restoration Ecology - Landscape Perspective

- Landscape Ecology
 - The ecology of regions; Study of the spatial arrangement of ecosystems & how this affects biotic and abiotic components & processes
 - Integrating discipline incorporating knowledge of ecological systems at all levels

**Windward
Mauna Kea
Landscape**



Restoration Ecology - Landscape Perspective

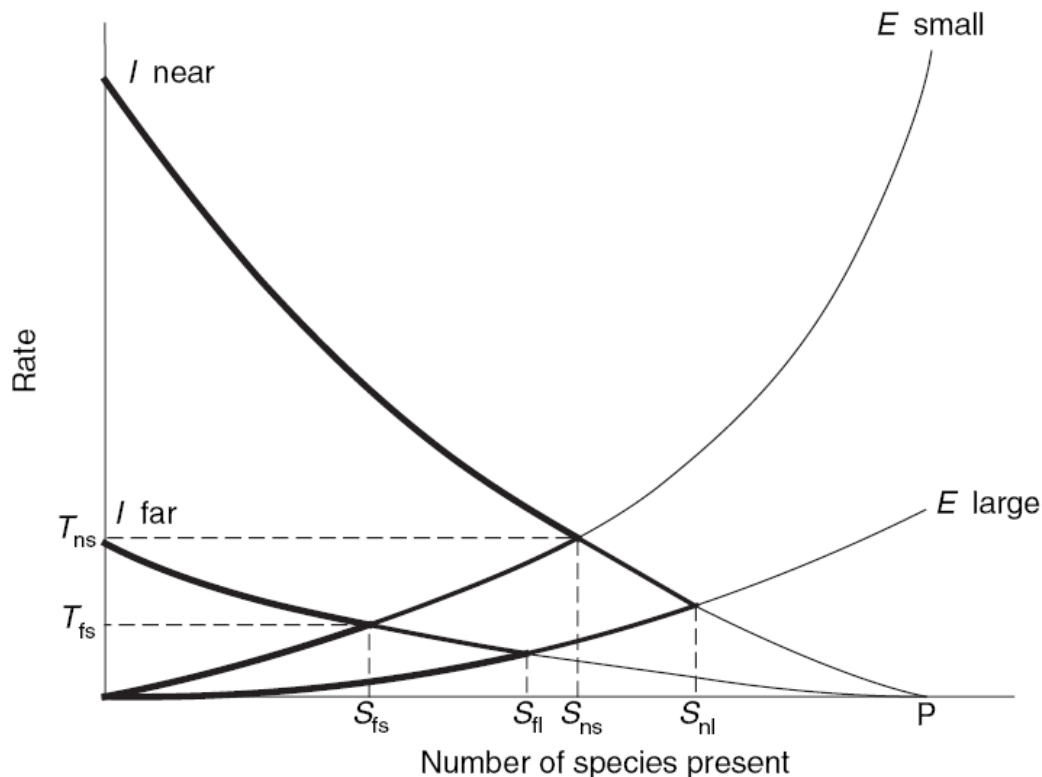
- Landscape Focal Areas
 1. Landscape planning & land use issues in regional development and conservation biology
 - Practical, applied focus
 2. How the ecological world works at large scales
 - How does the spatial arrangement of habitats impact the distribution and abundance of species?
 - How do landscape patterns and interactions affect ecosystem processes?

Restoration Ecology - Landscape Perspective

- Landscape ecology

- Rooted in theory set forth in island biogeography

- Patch size & proximity to recruitment sites → dispersal & diversity
- Need to consider processes maintaining viable populations

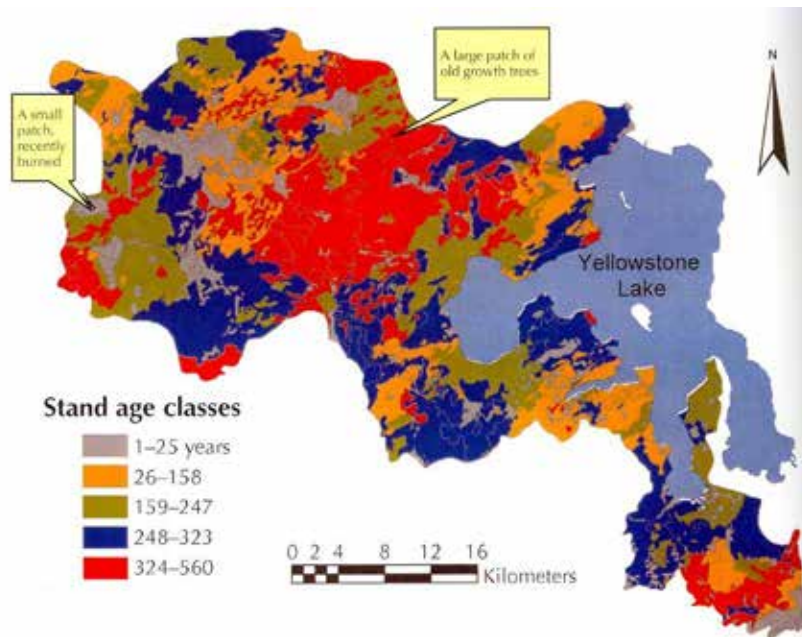


(MacArthur and Wilson 1967)

Restoration Ecology - Landscape Perspective

- Patch

- Area that is relatively homogeneous in structure (e.g., species composition, stand age, etc.)
- Landscapes have several types of patches, the most common = Matrix

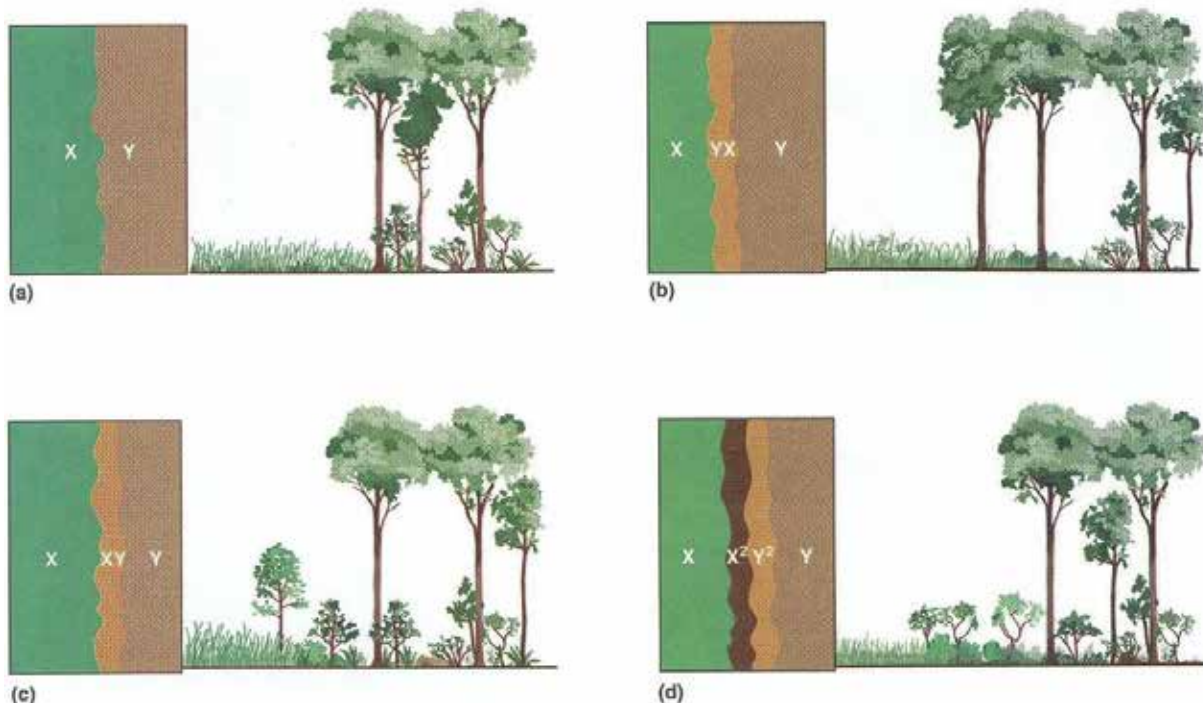


Restoration Ecology - Landscape Perspective

- Patch

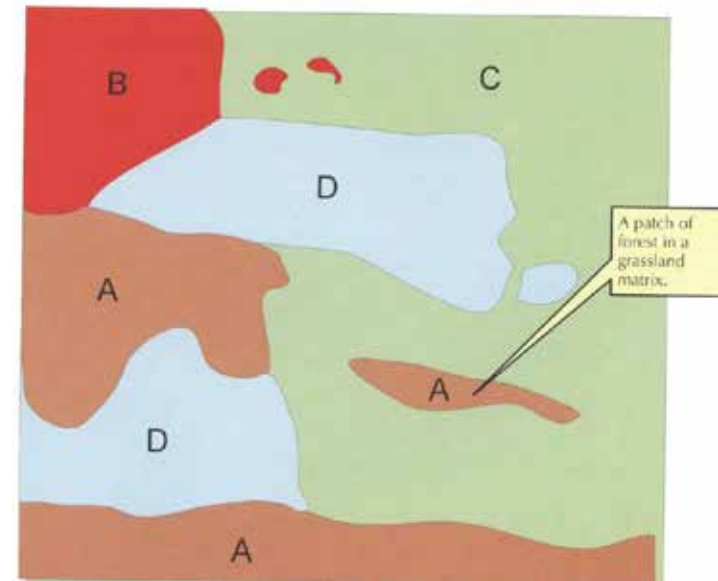
- All patches have edges

- Edges have abiotic environments that are typically distinct from the patch interior → differences in biota & processes
 - The larger a patch, the more interior (core) it contains



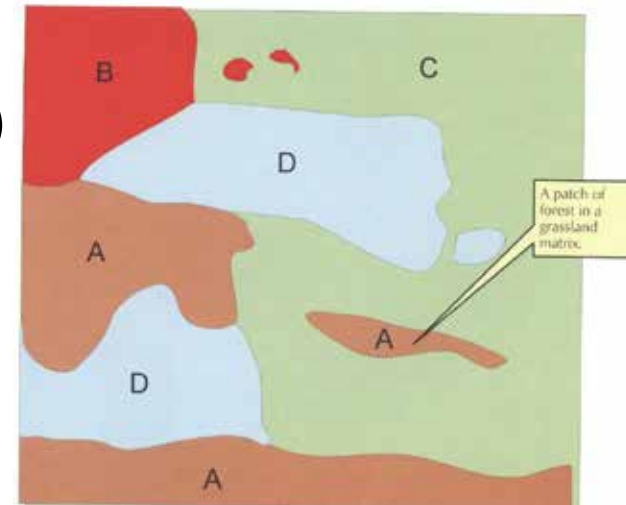
Restoration Ecology - Landscape Perspective

- Characteristics of single patches
 - Type (forest, grassland, lake, etc.)
 - Origin (disturbance, remnant, etc.)
 - Total edge (perimeter)
 - Size (area)
 - Total area vs. core area
 - Shape (perimeter:area)
 - Age (time since disturbance)
 - Proximity (Distance to other patches)



Restoration Ecology - Landscape Perspective

- Characteristics of multiple patches
 - Density (# of patches)
 - Total, or by type/age/size/shape/etc.
 - Cover (% of total landscape)
 - Diversity (richness, dominance, etc.)
 - Texture (contagion; ° of clumping)
 - Spatial pattern (regular, random, clumped)
 - Fractal dimension (complexity of boundaries)



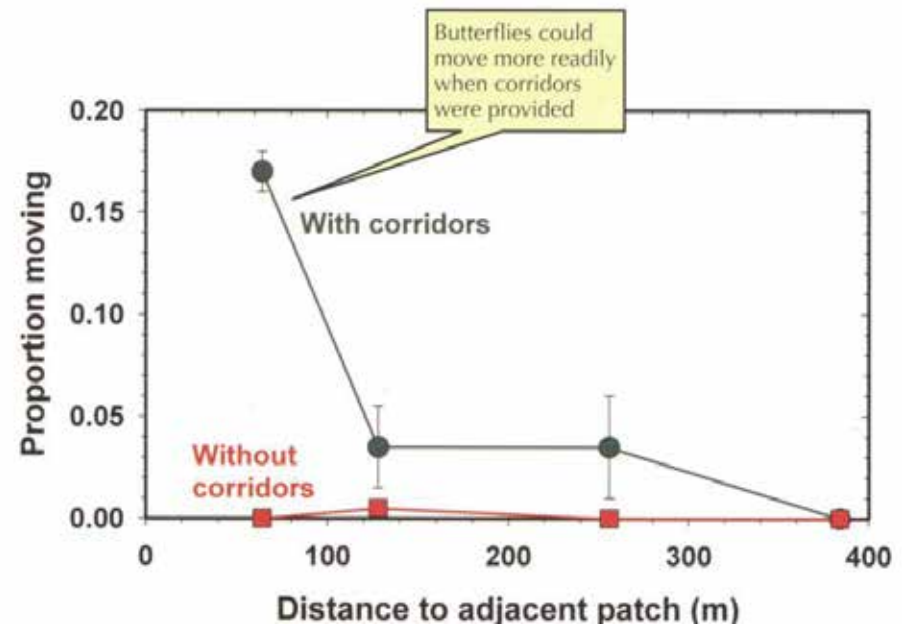
Restoration Ecology - Landscape Perspective

- Connectivity
 - Corridors
 - Provide connections between patches of the same or different types
 - Facilitate the movement of organisms, energy and materials
 - Can also be barriers (e.g., to species movement)



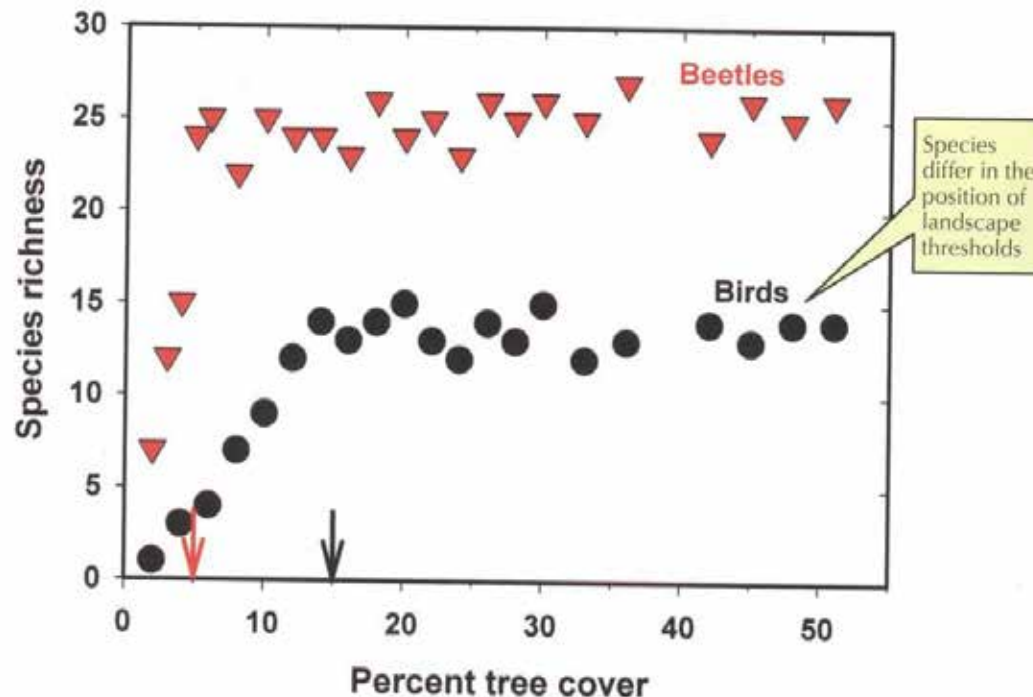
Restoration Ecology - Landscape Perspective

- Corridor characteristics
 - Type (line, strip, stream)
 - Origin (disturbance, remnant, etc.)
 - Total length
 - Width
 - Shape (curvilinearity)
 - Age



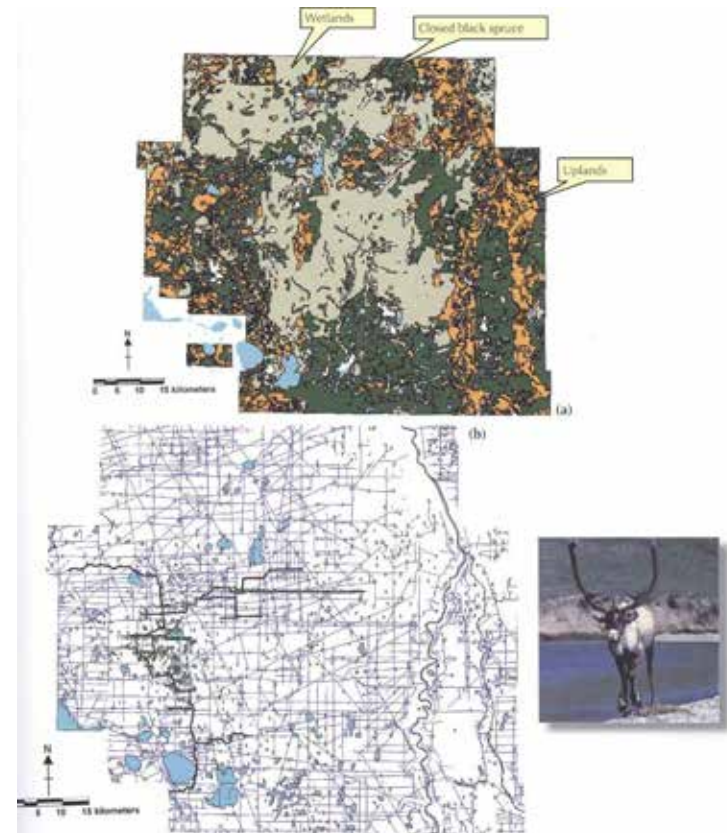
Restoration Ecology - Landscape Perspective

- Landscape mosaic
 - Not all species are created equal
 - Threshold effects, beyond which there is no increase in the variable of interest (e.g., species richness)



Restoration Ecology - Landscape Perspective

- Landscape mosaic
 - The ever-present influence of humans
 - Even modest human activity can have big impacts
 - Landscape dominated by “suitable” habitat
 - » Only 1% occupied by humans
 - But only ~50% of available habitat used by caribou
 - » Dense road and powerline network

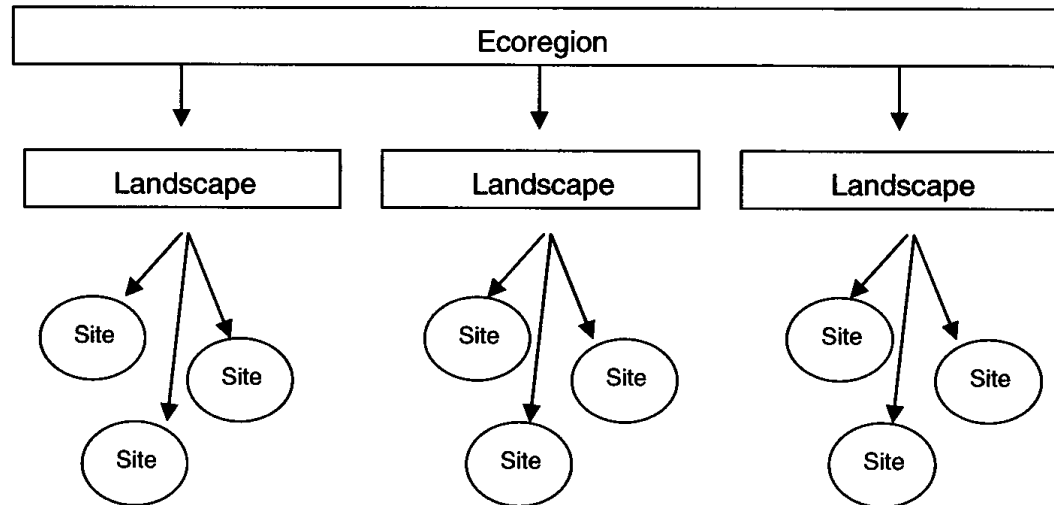


Restoration Ecology - Landscape Perspective

- Implications for restoration
 - Focus is shifting from restoration of small degraded patches to a landscape scale
 - Practical way to restore large, degraded areas
 - Landscape ‘context’ of restored sites has often changed
 - Landscape ecology can aid restoration by providing (Bell *et al.* 1997):
 - Guidance for selecting reference sites, identifying project goals, and monitoring success
 - Suggestions for appropriate spatial configurations of restored sites (e.g., to facilitate recruitment of biota)
 - Assessment of natural spatial heterogeneity → basis for developing strategies that incorporate landscape metrics such as patch configuration and connectivity

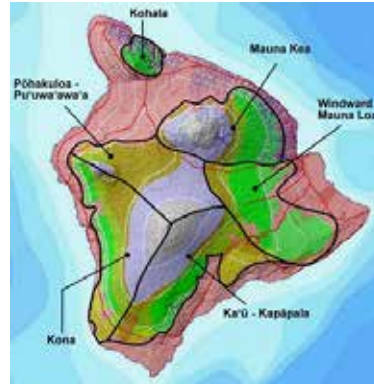
Restoration Ecology - Landscape Perspective

- Implications for restoration (Mansourian *et al.* 2005)
 - Landscape restoration grounded in Ecoregion conservation
 - Planning process designed to restore ecological integrity and enhance human well-being in degraded landscapes
 - Incorporates human needs and biodiversity
 - Restoration often occurs at the site (i.e., stand) level
 - Effectiveness of restoration & chance of sustainability is much greater if local efforts are incorporated into the larger landscape context



Restoration Ecology - Landscape Perspective

Ecoregion
(ID Priority Landscapes)



Landscape
(ID Restoration Goals & Monitoring Mechanisms)



Site
(Eco. Restoration at Ind. Sites)



Restoration Ecology - Landscape Perspective

- Macroecology
 - Structure and function of ecosystems on large spatial scales
 - Considers processes operating at geographic spatial scales
 - Patterns in distribution, abundance & body size (e.g., at continental scales; across latitudinal gradients; etc.)
 - Empirical basis for biological diversity & ecosystem processes at larger spatial scales
 - Many similarities to landscape ecology
 - Patch size and connectivity
 - Species area relationships (SAR)
 - Biodiversity & ecosystem function
 - Island biogeography theory (IBT)
 - Metapopulation theory

Restoration Ecology - Landscape Perspective

- Macroecology
 - Explicitly considers spatial context
 - Ecosystems are defined by what occurs within their boundaries **and** the flow of materials and energy across their boundaries
 - Spatial & temporal scales important to ecological systems often extend beyond political or geographical boundaries
 - Restoration context
 - Large scale context needed to restore at the local level
 - Likelihood of maintaining species diversity in a restored setting is small if larger context not considered
 - If the spatial context has changed in a restoration setting, then important across-boundary dynamics may be missing
 - E.g., Biosphere II Project

Restoration Ecology - Landscape Perspective

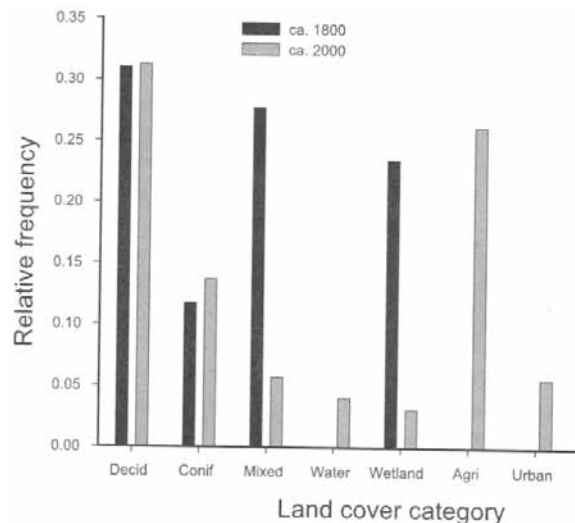
- Macroecology

- Modification of spatial extent of wetlands in MI

- Wetland area reduced from 25% to <5%

- Different ecological context for wetlands today

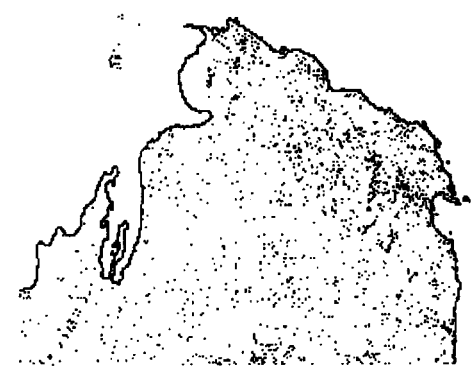
- Patch size and connectivity greatly modified
- Management to replace external transport processes needed



A



B



Restoration Ecology - Landscape Perspective

- Macroecology

- *...a fundamental principle of ecosystem restoration should be to ensure that the restored ecosystem resides within a spatial context that is conducive to providing adequate flows of individual organisms, energy, and materials to maintain ecosystem function over a specified period of time.*

Week 13 Readings/Lecture Slide Highlights

1. A landscape is a heterogeneous region consisting of two or more interacting ecosystems that exchange organisms, matter, energy, H₂O, nutrients, etc. Landscape ecology, in turn, is the study of the spatial arrangement of ecosystems and how this affects biotic and abiotic components/processes.

Week 13 Readings/Lecture Slide Highlights

2. Landscape ecology and macroecology explicitly consider spatial context by examining processes occurring at large spatial scales, and by recognizing that the spatial and temporal scales of ecological systems typically extend beyond political and geographic boundaries. In this context, ecosystems are defined by not only what occurs within their boundaries, but also the flows of materials and energy across their boundaries.

Week 13 Readings/Lecture Slide Highlights

3. Restoration in a landscape ecology/macroecology context recognizes that the chance of restoration success/sustainability is small if the larger spatial context of ecological restoration is not considered during all phases of planning and implementation.

Week 13 Readings/Lecture Slide Highlights

4. If the spatial context for an ecological restoration project has changed from historical conditions, then important across-boundary dynamics may be missing (e.g., dispersal of propagules from the regional species pool). Successful restoration at a local scale under these conditions will then necessarily involve restoring missing across-boundary dynamics in addition to activities focused on a local scale.

Week 13 Readings/Lecture Slide Highlights

5. As the focus of ecological restoration increasingly shifts from scales of small, degraded patches to landscapes, landscape ecology/macroecology can inform ecological restoration by providing information on appropriate spatial configurations of restored sites within the larger landscape.