

Forest Restoration Ecology

- Introduction to Restoration Ecology:
 - Definitions
 - Overview of Restoration Ecology and Ecological Restoration
 - Restoration Ecology within the ecological hierarchy



Forest Restoration Ecology

What is Restoration Ecology?

The scientific discipline of developing and/or applying theory to guide restoration

- Requires an understanding of ecological theory
 - restoration can guide theory as much as theory can guide restoration
- Basis for ecological restoration



Forest Restoration Ecology

- What is Ecological Restoration?

The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed

- Attempt to return a system to a historical or reference state
- Value judgment: transformation of a system from less desirable → more desirable
 - Sometimes these values are in conflict!
- *Ecological restoration* assists or initiates recovery
 - Although often requires continued management
 - *Ecosystem management* to maintain the system

Waianae Kai Forest Reserve



Forest Restoration Ecology

- Ecological restoration
 - Continuum of effort needed to restore a system
 - May be as simple as removing an unnatural disturbance (or reinstating a natural disturbance) and allowing nature to take over
 - In most systems, however, ecosystems have been pushed beyond the point of spontaneous recovery
 - Necessitates anything from active outplanting to removal of invasive species to major topographic work (e.g. reclaimed mines, wetlands)
 - Typically involves more than a single treatment or activity in time



Forest Restoration Ecology

- Ecological restoration
 - Continuum of effort needed to restore a system



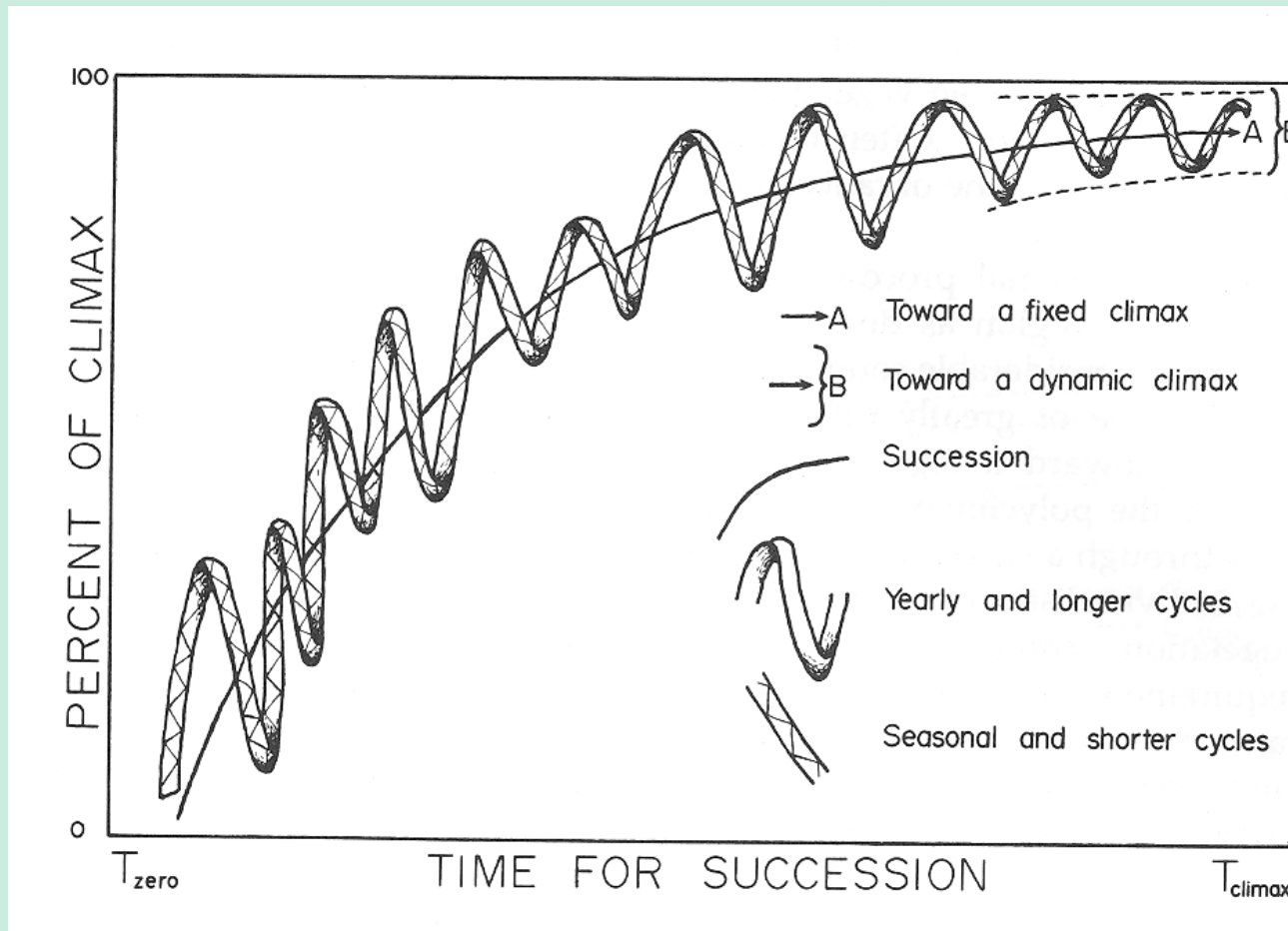
Forest Restoration Ecology

– *Reference ecosystem*

- Model for planning restoration projects
 - Desired outcome
 - Can be an actual site, written description, etc.
- A reference ecosystem may represent only one of many possible natural states
 - Ecosystems are characterized by high temporal variability
 - » Historic range of variation (HRV)
 - In turn, the restored ecosystem can return to any number of possible states
 - » Alternative stable states

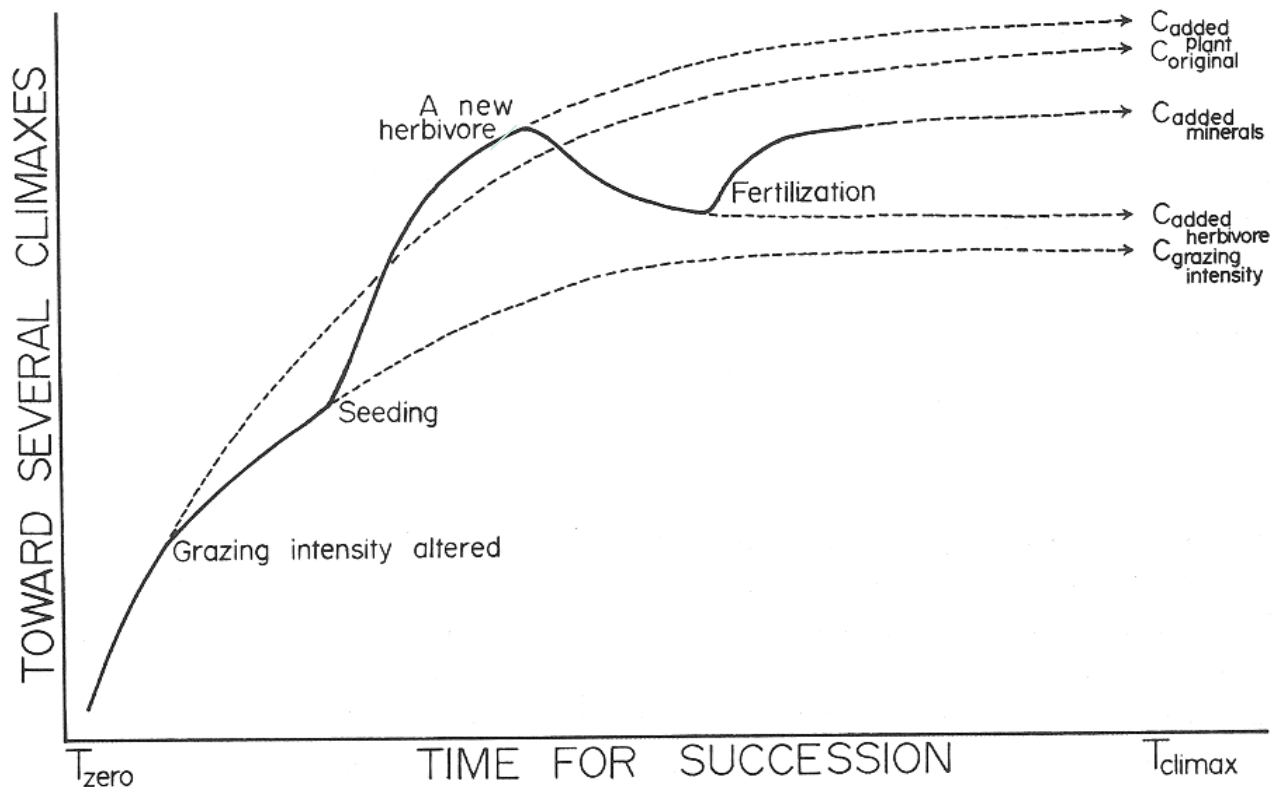
Forest Restoration Ecology

- *Reference ecosystem*



Forest Restoration Ecology

- *Reference ecosystem*



Forest Restoration Ecology

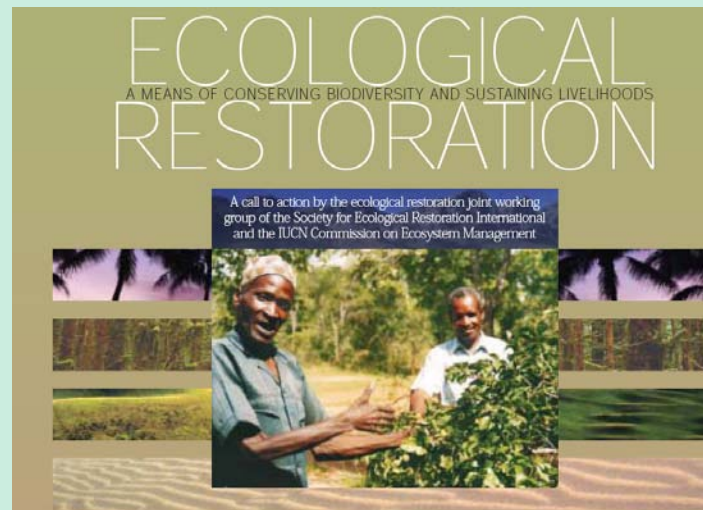
- Where do we find sources of information for reference ecosystems?
 - Ecological descriptions, species lists, etc.
 - Gives clues to pre-degradation condition of the site
 - Remnants of the site to be restored
 - Ecological descriptions & species lists of similar ecosystems in other locales
 - Historical and/or recent photographs
 - Herbarium and museum specimens
 - Historical accounts and oral histories
 - Paleoecological evidence

Forest Restoration Ecology

- **8 essential steps to any ecological restoration project**
 - 1) a clear rationale as to why restoration is needed
 - 2) an ecological description of the site designated for restoration
 - 3) a statement of goals and objectives of the restoration project
 - 4) a designation and description of the reference system
 - 5) an explanation of how the proposed restoration will integrate with the landscape and flows of organisms and materials
 - 6) explicit plans, schedules and budgets for site preparation, installation and post-installation activities, including a strategy for making mid-course corrections (adaptive management)
 - 7) well-developed and explicitly stated performance standards, with monitoring protocols for project evaluation
 - 8) strategies for long-term protection and maintenance

Forest Restoration Ecology

- Human and cultural elements of restoration are crucial to viability of restoration projects in many areas worldwide
 - N. Am. focus on restoring “pristine” systems is unviable in many areas of the world
 - Ecological restoration should encourage, and may often be dependent upon, long-term participation of local people



Forest Restoration Ecology

Conservation biology

- Save it before it becomes damaged, degraded, or destroyed
- As with restoration ecology, based on fundamental ecological and evolutionary principles

Conservation biology vs. Ecological restoration

– “conserving what is left” vs. “restoring what once was”



Forest Restoration Ecology

- Environmental Values of Restoration (SER)
 - 1) retention of precipitation to maintain integrity of the H₂O cycle
 - 2) diversification of habitat
 - 3) stabilization of substrates to prevent erosion & promote formation of topsoil
 - 4) augmentation of habitat, which harbors the genetic diversity required for future adaptability
 - 5) retention and enhancement of biodiversity
 - 6) preservation of land-based cultural traditions for indigenous peoples
 - 7) storage of C and removal of CO₂ from the atmosphere

Forest Restoration Ecology

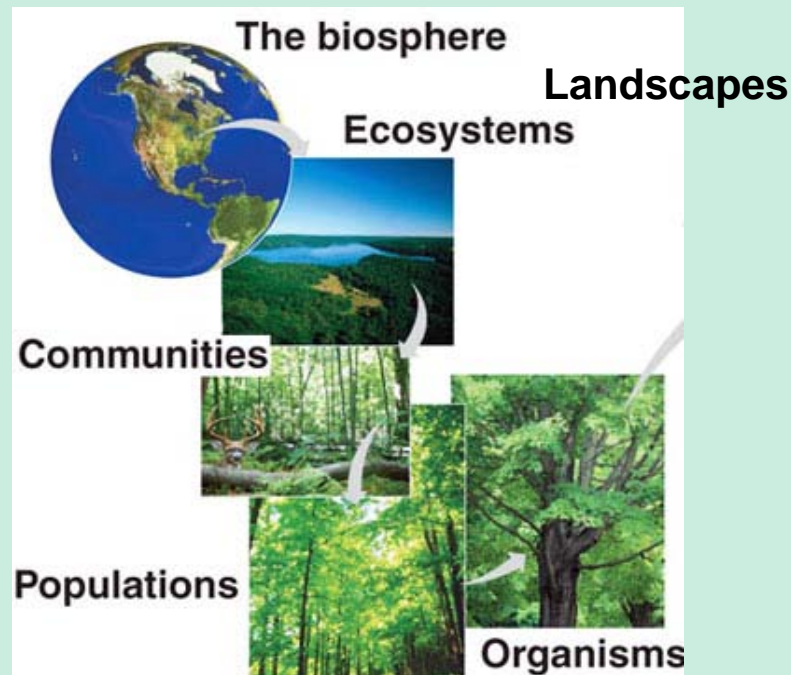
- **What are some characteristics of a degraded ecosystem?**
- **What aspects of structure, function, and/or composition should we consider when restoring an ecosystem?**

Forest Restoration Ecology

- Attributes of restored ecosystems (SER)
 - 1) Contains a characteristic assemblage of **the species that occur in the reference ecosystem**
 - 2) Consists of **native species** to the greatest practicable extent
 - 3) All **functional groups** necessary for the continued development and/or **stability** are represented or have the potential to colonize
 - 4) Capable of sustaining **reproducing** populations
 - 5) **Functions** normally for its ecological stage of development
 - 6) Suitably **integrated into a larger ecological matrix** or landscape
 - 7) Potential **threats have been eliminated** or reduced
 - 8) Sufficiently **resilient** to endure normal periodic stress events
 - 9) **Self-sustaining** to the same degree as the reference ecosystem and has the potential to persist indefinitely within the norms of ecosystem development

Forest Restoration Ecology

- **At what level of ecological hierarchy should restoration focus?**



Forest Restoration Ecology

- How can population biology inform restoration ecology and ecological restoration?
 - Population viability analysis
 - How many individuals are needed to start a new population?
 - Is the restored population sustainable over the long term?
 - Metapopulation analysis
 - What value do individual restored patches have for a species' overall persistence on the landscape?
 - Population and ecological genetics
 - How similar is the source population to the population we wish to restore?
 - Should we combine material from multiple source populations?

Forest Restoration Ecology

- How can community ecology inform restoration ecology and ecological restoration?
 - Restoration often involves multiple species
 - Populations of co-occurring species
 - In this light, restoration must be informed by community ecology theory:
 - Species interactions
 - Habitat and resource dynamics
 - Disturbance theory
 - Succession
 - Community ecology provides the opportunity to integrate across these concepts in restoration

Forest Restoration Ecology

- How can ecosystem ecology inform restoration ecology and ecological restoration?
 - Forces ecological consideration of:
 - Spatial and temporal boundaries
 - Connections to adjacent ecosystems
 - Input, cycling & loss of materials and energy
 - Functional connections among organisms, & between biota and the physical environment
 - Sets limits on the biotic community & important processes
 - Restored site should be self-sustaining
 - “Build it and they will come”
 - Restoration of species does not necessarily lead to restoration of function

Forest Restoration Ecology

- How can ecosystem ecology inform restoration ecology and ecological restoration?
 - Provides conceptual tools to monitor & evaluate
 - Energy & material inputs/outputs
 - Trophic dynamics
 - Productivity & C cycling
 - Biomass pools (live & detrital) & C fluxes
 - Hydrologic cycle
 - Intra-system cycling
 - Decomposition, nutrient cycling, turnover, transfers
 - Disturbance regimes
 - Stability
 - Resistance and resilience

Forest Restoration Ecology

- **At what level of ecological hierarchy should restoration focus?**

**Multiple
Spatial
Scales!**

