Characteristics of Complex Forests

Four Key Structuring Processes

- **Crown class differentiation**—Competition among trees of the same age results in dominant, codominant, subordinate, and suppressed trees.
  - **Decadence**—Trees get damaged, infected with fungi, breakdown, and recycle within the ecosystem.
    - **Understory development**—Variability in light, temperature, and soil moisture promotes structurally-diverse growth on the forest floor.
    - **Canopy stratification**—Trees of different ages and growth habits produce multiple layers of vegetation, including a well-developed midstory.

Lead to Complexity in...

Individual structures

- Trees of diverse heights, diameters, branch sizes, and bark characteristics
- Large, dead standing trees (snags)
- Coarse woody debris (stumps and logs) in various states of decay

Stand-scale structures

- Vertical heterogeneity—ever-changing distributions of foliage from the forest floor to the tree tops
- Horizontal heterogeneity—patchiness in the overstory, midstory, and understory

A complex forest is greater than the sum of its parts.

Two Key Processes Influencing Species Composition

- **Development of habitat breadth**—Patchy canopies produce variability in light, temperature, and soil moisture, leading to patches of different types in the understory.
- **Pre-interactive niche diversification**—Expansion in forest structure and plant species composition provides diverse niches for animals, plants, and fungi; additional niche separation occurs after species interact.

Lead to Complexity in...

Composition

High abundance and diversity of...

- Fungi
- Vascular plants
- Forest floor invertebrates
- Aquatic organisms
- Terrestrial vertebrates

Complex Structure and Composition Lead to Complexity in Forest Function

- High carrying capacities for diverse animals
- High productivity for plants
- Effective regulation of nutrients and water cycling
- Healthy, resilient forests

For Further Reading

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For Further Information

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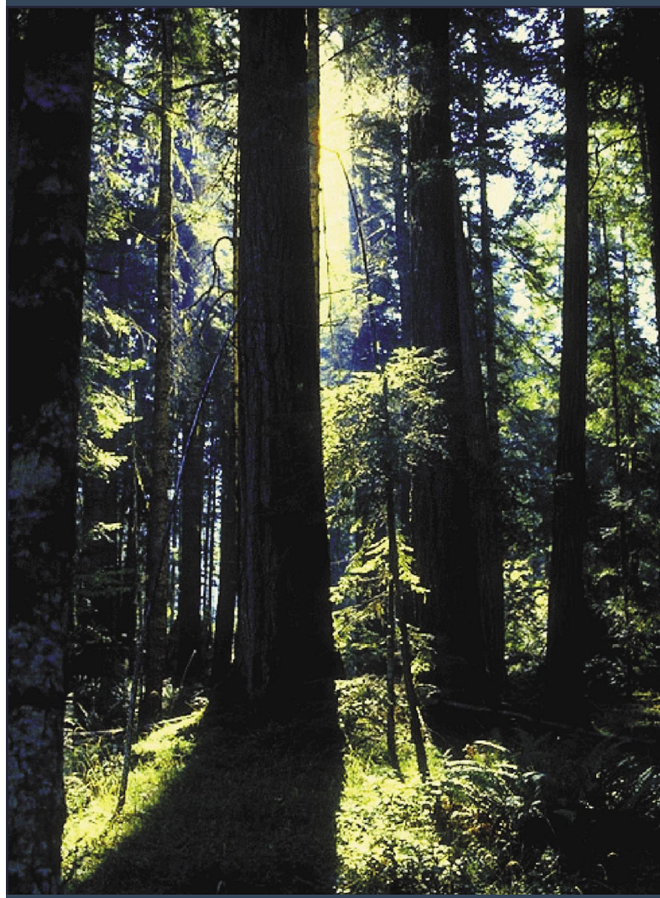
Ecological Foundations of Biodiversity

Promoting Habitat Complexity in Second-Growth Forests



USDA United States Department of Agriculture
Forest Service
PNW Pacific Northwest Research Station

Management Tools for Promoting Habitat Complexity

The following management tools can help meet multiple values —environmental, economic, and aesthetic— when used collectively and according to a well-devised plan.

Cavity-Tree Creation

Many mammals and birds use trees for denning and raising young. Maintaining existing trees (live and dead) with cavities helps to support these animal populations. Cavities can be created by several methods, such as (a) cutting a hole in the tree bole and covering it with a faceplate, (b) topping a tree to accelerate top rot and growth of new leaders, or (c) inoculating trees with fungi to hasten the establishment of decay.

Leads to...

- ✔ Decadence
- ✔ Pre-interactive niche diversification

Coarse Woody Debris Augmentation

Terrestrial amphibians, small mammals, and birds depend on large coarse woody debris for protection and foraging for insects, fungi, and seeds. Felling trees of various sizes adds a mix of coarse woody debris to the forest floor. Leaving unmerchantable wood and minimizing site preparation (such as prescribed burning) after harvests helps to conserve, and contributes to creation of, litter and soil organic matter.

Leads to...

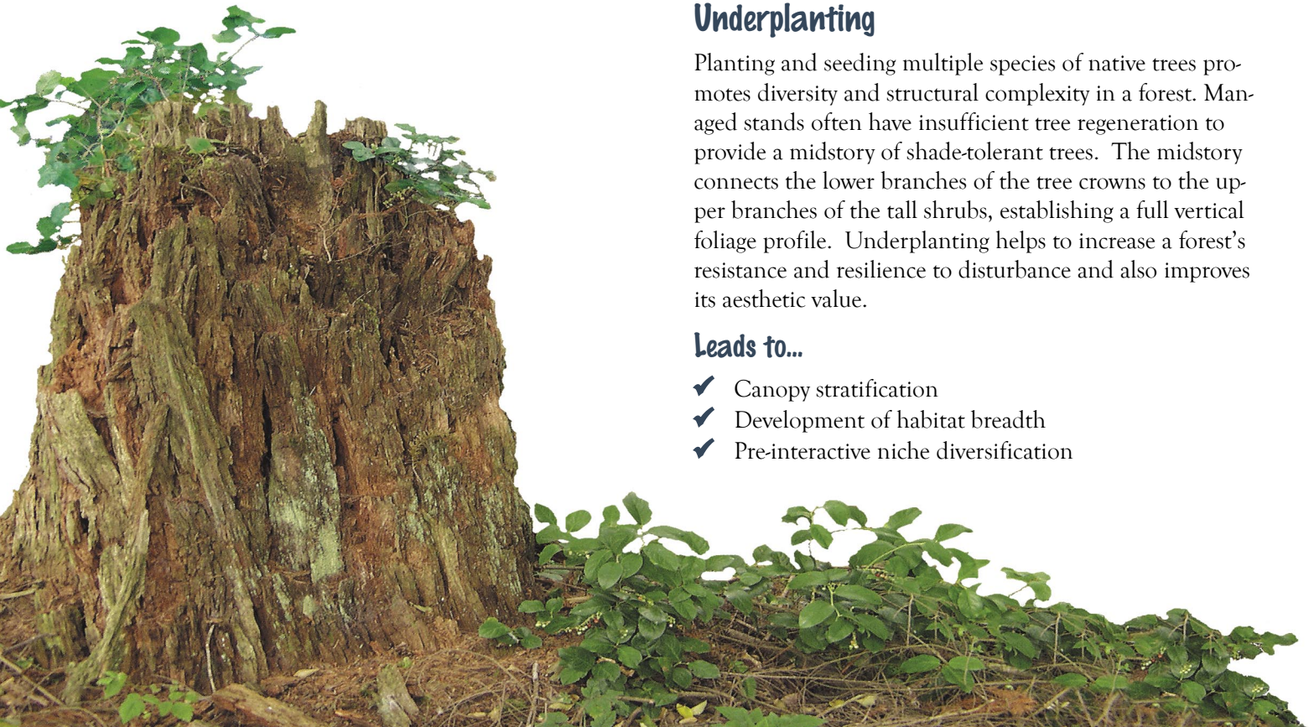
- ✔ Decadence
- ✔ Pre-interactive niche diversification

Underplanting

Planting and seeding multiple species of native trees promotes diversity and structural complexity in a forest. Managed stands often have insufficient tree regeneration to provide a midstory of shade-tolerant trees. The midstory connects the lower branches of the tree crowns to the upper branches of the tall shrubs, establishing a full vertical foliage profile. Underplanting helps to increase a forest's resistance and resilience to disturbance and also improves its aesthetic value.

Leads to...

- ✔ Canopy stratification
- ✔ Development of habitat breadth
- ✔ Pre-interactive niche diversification



Conservation of Biological Legacies

Conserving biological legacies at harvest helps to ensure the continued occupancy or recolonization of a forest by fungi, vascular plants, forest floor invertebrates, aquatic organisms, and terrestrial vertebrates. Legacies include (a) soil organic matter and litter, (b) standing dead trees and coarse woody debris, (c) mosses, lichens, forbs, ferns, shrubs, and live trees of the preceding forest, and (d) ectomycorrhizal fungi. Retaining legacies promotes a multiple-age forest with diverse layers of vegetation. Retaining legacies in patches can also jumpstart the development of complex structures.

Leads to...

- ✔ Decadence
- ✔ Canopy stratification
- ✔ Development of habitat breadth
- ✔ Pre-interactive niche diversification

Variable-Density Thinning

Variable-density thinning involves varying the thinning intensity across an ecologically appropriate scale (¼ to 1 acre in size) to produce a mosaic of unthinned, moderately thinned, and heavily thinned patches. Thinning with skips and gaps can also create this mosaic. Variable-density thinning helps generate complex structures by promoting tree growth at different rates. It also encourages understory development through a diversity of species, a variety of patch types, and growth of tree seedlings and saplings. Variable-density thinning can improve forest health by increasing (a) resistance to disturbance, (b) ability to recover after disturbance, and (c) biological diversity that allows ecosystems to function well through climatic variation.

Leads to...

- ✔ Crown class differentiation
- ✔ Understory development
- ✔ Canopy stratification
- ✔ Development of habitat breadth
- ✔ Pre-interactive niche diversification

Extended Harvest Rotations

Longer harvest rotations can produce healthy, complex forest landscapes. On industrial and private lands, rotations of 40 to 50 years are used to maximize profits and maintain cash flow. Public ownerships, which must consider other values in addition to timber revenues, use rotations of 60 to 80 years or longer. A shift to extended harvest rotations of 70 to 230 or more years has the advantages of (a) producing a variety of tree sizes and wood products over time, (b) improving the age distributions of trees in the landscape, (c) promoting healthier wildlife habitat, (d) increasing carbon storage, and (e) preserving options for adaptive management. Thinnings also help to establish diversity and minimize tree overcrowding.

Lead to...

- ✔ Crown class differentiation
- ✔ Decadence
- ✔ Understory development
- ✔ Canopy stratification
- ✔ Development of habitat breadth
- ✔ Pre-interactive niche diversification