Introduction to Ecological Forestry

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Educational Assistance

Finding answers and solving problems by learning together.

• Help you learn what you need to know - to decide what is right for you
• Take action – DIY or hired services.
• Improvement – Prevention – Problem-solving
• Depending on your situation and your objectives.
Elements of Ecological Forestry

• mimic natural forest processes
• maintain or increase ecological and financial capital
• native species diversity and forest structural diversity
• maintain or improve the soil
• enhance habitat and biodiversity.
• economic and ecological resilience
• diversified financial value - variety of merchantable timber products and non-timber forest products.
Ecological Forestry 101
Outline

• Ecology of Douglas-fir forests - natural forest development & forest stand dynamics
• Even-aged vs. uneven-aged forest management
• Ecological Forestry - managing for “continuous forest cover”
• Operational considerations in active management.
• Getting the help you need
Ecology of Douglas-fir - Fire is the major disturbance driver
<table>
<thead>
<tr>
<th>Forest Type</th>
<th>(frequency %) Fire Type</th>
<th>Fire Interval (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oregon white oak woodland</td>
<td>(3%) Stand replacement</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>(19%) Mixed severity</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>(78%) Low surface fire</td>
<td>12</td>
</tr>
<tr>
<td>Douglas-fir (Willamette Valley foothills)</td>
<td>(18%) Stand replacement</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>(29%) Mixed severity</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>(53%) Low surface fire</td>
<td>50</td>
</tr>
<tr>
<td>Douglas-fir/western hemlock, dry</td>
<td>(25%) Stand replacement</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>(75%) Mixed severity</td>
<td>100</td>
</tr>
<tr>
<td>Douglas-fir/western hemlock, wet</td>
<td>(71%) Stand replacement</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>(29%) Mixed severity</td>
<td>&gt;1,000</td>
</tr>
</tbody>
</table>

http://www.fs.fed.us/database/feis/fire_regime_table/PNVG_fire_regime_table.html#PacificNorthwest
### Top 12 Trees in W. Oregon (by wood volume)

**Source:** USFS Forest Inventory and Analysis data 2000’s

<table>
<thead>
<tr>
<th>Tree Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas-fir</td>
<td>61.4%</td>
</tr>
<tr>
<td>Western hemlock</td>
<td>11.4%</td>
</tr>
<tr>
<td>Red alder</td>
<td>8.3%</td>
</tr>
<tr>
<td>Bigleaf maple</td>
<td>3.4%</td>
</tr>
<tr>
<td>Sitka spruce</td>
<td>2.7%</td>
</tr>
<tr>
<td>Grand fir</td>
<td>2.4%</td>
</tr>
<tr>
<td>Pacific madrone</td>
<td>1.8%</td>
</tr>
<tr>
<td>Oregon white oak</td>
<td>1.7%</td>
</tr>
<tr>
<td>Western redcedar</td>
<td>1.7%</td>
</tr>
<tr>
<td>Incense cedar</td>
<td>0.8%</td>
</tr>
<tr>
<td>White fir</td>
<td>0.6%</td>
</tr>
<tr>
<td>Ponderosa pine</td>
<td>0.5%</td>
</tr>
</tbody>
</table>
Forest Stand Dynamics - after disturbance
Stand development stages, disturbance dynamics, habitat

Chad Oliver 1981, Franklin and Van Pelt 2004

Stand Initiation
Stem Exclusion
Understory Re-Initiation
Diversification Vertical & Horizontal

•
70
150
250
500
750
Resources required are proportional to tree size.
Many Small = One Large
1: Seedling Stage
2: Crown Closure Stage
3. Crown Differentiation Stage

D = dominant
I = intermediate
CD = co-dominant
S = suppressed
4. Self-thinning Stage
Difference in size due to crown differentiation
– All these Douglas-fir are 37-38 years old
Competitive vs. Agent Mortality
Natural Regeneration
- Understory Establishment Stage

• Seed Source
  • Species, seed year, predation

• Environment
  • Temp, water, light

• Seed bed
  • Soil, competition, mycorrhiza
## Shade tolerance –
### Ranking of western tree species (Daniel et al. 1979)

<table>
<thead>
<tr>
<th>Shade Tolerance</th>
<th>Western hemlock</th>
<th>Pacific yew</th>
<th>Pacific silver fir</th>
<th>Vine maple</th>
<th>Western redcedar</th>
<th>Grand fir</th>
<th>Sitka spruce</th>
<th>Big-leaf maple</th>
<th>Douglas-fir</th>
<th>Western white pine</th>
<th>Ponderosa pine</th>
<th>Lodgepole pine</th>
<th>Red alder</th>
<th>Cottonwoods</th>
<th>Larch</th>
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<tbody>
<tr>
<td>Very tolerant</td>
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<tr>
<td>Tolerant</td>
<td>Western redcedar</td>
<td>Grand fir</td>
<td>Sitka spruce</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>Intermediate</td>
<td>Big-leaf maple</td>
<td>Douglas-fir</td>
<td>Western white pine</td>
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<tr>
<td>Intolerant</td>
<td>Ponderosa pine</td>
<td>Lodgepole pine</td>
<td>Red alder</td>
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<tr>
<td>Very intolerant</td>
<td>Cottonwoods</td>
<td>Larch</td>
<td></td>
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</tbody>
</table>
Mixed-species Forests
Maximum stand density varies by species

<table>
<thead>
<tr>
<th>Species</th>
<th>Biological Max. Trees per acre at 10-inch dbh</th>
<th>Trees per acre at mortality threshold 10-inch dbh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alder</td>
<td>450</td>
<td>246</td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>595</td>
<td>329</td>
</tr>
<tr>
<td>W. hemlock</td>
<td>850</td>
<td>463</td>
</tr>
</tbody>
</table>

Based on Stand Density Index for each species
Even-aged vs. Uneven-aged Management

Even-aged “age-class” System

Uneven-aged Management System
Even-aged Management
common practice with Douglas-fir and many other species
Even-aged Management is a common practice with Douglas-fir and many other species.
Ecological Basis for Uneven-aged Management
Many Types Worldwide
- “Inverse J” Diameter distribution of natural stands driven by small-scale disturbance

Meyer 1952
Uneven-aged Management - Long History & much debate among foresters

• Alfred Möller, 1922 “Dauerwald” in Germany
• Kirkland and Brandstrom, 1930’s USFS
• Continuous Forest Cover, Natural Forestry, Close-to Nature Silviculture

References:
Controversy over clearcutting
http://www.foresthistory.org/ASPNET/Policy/Forest_Management/Clearcutting/timeline.aspx
Selective cutting in Douglas-fir: History Revisited
Managing Multi-aged Stands
Growing Space Allocation –
Trees versus Stands

Volume Growth

Stand Density

Stand

Tree
Growing Space Allocation

- 80% Growing Space In Overstory
- 20% Growing Space In Understory
Managing Uneven-aged Stands

Manage stand density to:
1. Sustain growth of all stand components
2. Maintain stand structure
3. Replace tree mortality and harvest with regeneration

Transformation from even-aged to uneven-aged?
Stand Volume and Rotation in Even-aged System

![Diagram showing the relationship between stand volume, stand age, and rotation age.](chart.png)
Transition to Mixed Age Cutting Cycle

1. Age 40
   200 TPA

2. Age 60
   180 TPA

3. Age 60
   90 TPA

4. Age 80/20
   200 TPA

Stand Density

Stand Age
Cutting Cycle
– cutting cycle length depends on cutting intensity and growth rates

Cutting Cycle Length

Stand Volume - Density

Stand Age

Growth Rate

Removed Timber Volume
Group Selection System
Group Selection System
- Area Control Method of Uneven-aged Management

Activities:
- Group-Selection Harvest
- Natural Regeneration Planting
- Pre-comm. Thinning
- Commercial Thinning
- Understory Thinning
Single Tree Selection
Single Tree Selection
– developing a guide curve from tree count and diameter

Tree Tally by 2 inch Diameter Class

![Bar chart showing tree tally by 2 inch diameter class. The x-axis represents tree diameter in 2 inch classes, and the y-axis represents the number of trees. The chart shows a decline in the number of trees as the diameter increases.](chart.png)
Single Tree Selection

Guide Curve:
At each cutting cycle we thin trees in classes that exceed the guide curve.
Stands at Uniform Density – often close canopy rapidly after thinning

Example: Age 30   200 TPA thinned to 100 TPA grew back to closed canopy within 10 years
With uniform spacing / thinning: dominant trees often close crowns rapidly, little room for intermediate trees or understory layers.

Patchy, variable density spacing / thinning can increase canopy diversity more and for a longer time.

Photos from: http://www.fs.fed.us/pnw/olympia/silv/selected-studies/variable/index.shtml
Variable Density Thinning in Even-aged Naturally Regenerated Second Growth
Uneven-aged Management in Naturally Regenerated Second Growth
Uneven-aged Management
Forest Products – Marketing Product Diversity
Assessing growth and control density of all tree sizes and species in the same stand
Assessment of Growth – Overstory
diameter increment
105 years – thinned 4 times
Assessment of Tree Growth, Vigor, and Stability

- Crown ratio
- Height-diameter ratio
Tree Vigor and Stability

Height : Diameter Ratio  (H and D in same units)
Assessment of Growth – Understory trees

Growth of terminal shoot versus lateral branches - Douglas-fir

Large Gap >30% Light
Small Gap ~20% Light
Under Canopy >20% Light
Understory Growth – Morphological Plasticity

- Noble fir
- Pacific silver fir
- Western hemlock

- Sun and shade foliage
- Terminal vs. lateral growth
- Apical dominance
## Tools For Assessment – Diameter Distribution

### Tree Diameter Tally Sheet

<table>
<thead>
<tr>
<th>DBH Class (Inches)</th>
<th>Plot 1 Count</th>
<th>Plot 2 Count</th>
<th>Plot 3 Count</th>
<th>Sum Tree Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4-8</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>8-12</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>12-16</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>16-20</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>20-24</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>24-28</td>
<td>1</td>
<td>5</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>28-32</td>
<td>4</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>32-36</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>
Tools For Assessment –
Diameter Distribution of Even-aged Stand
Growing Space Distribution
Diameter Distribution of Multi-aged Stand
Permanent Sample Plots

- Species composition
- Size classes
- Stand volume
- Diameter growth
- Height growth
- Mortality
- Harvest
Permanent Sample Plots – Diameter distribution and increment

Inventory Period 1: Diameter distribution

Inventory Period 2: Diameter distribution Diameter class transition
Thinning and Harvest

- Objectives
  - Stocking Control, Regeneration, and Timber

- Timing
  - Recovered previous harvest, market conditions

- Make a plan
  - Long-term plan as Guide not Rule

- Creating habitat
  - CWD, snags, canopy layers
Tree Selection and Marking

- Creating growing space
- Selection guide
- Basal area
- Diameter distribution

Mark your Trees
Harvest Layout

- Units and boundaries
  - Uneven-aged stands are more variable
- Forest Practices
- Roads and trails
  - Long-term planning and reuse
- Collaboration
Planning - Group Selection System

Activities:
- Group-Selection Harvest
- Natural Regeneration Planting
- Pre-comm. Thinning
- Commercial Thinning
- Understory Thinning
Implementation
Harvest Impacts
Summary – managing stand dynamics

• In the absence of disturbance (management) forest stands grow increasingly dense until they reach “carrying capacity” or “self-thinning” density.

•Unchecked competition results in “winners” and “losers” – within species and between species.

•Use assessment tools, judge growing space by looking at crown vigor, crown ratio, and height/diameter ratio.

•For successful management of mixed species and mixed age - give every tree enough growing space/distance from neighbors.
Summary – managing stand dynamics

• With uniform spacing and uniform thinning
  – dominant and co-dominant trees often close crowns rapidly
  – there is little room for intermediate trees or understory layers

• Patchy, variable density thinning can increase canopy diversity more and for a longer time.
Challenges with selective harvesting or partial cutting

- Need to avoid high-grading = removing the best trees and leaving damaged, diseased, genetically “inferior” stock.
- Need to avoid soil compaction, damage to roots, damage to stems and crowns of trees you want to leave for the future.
- Understory shrubs and herbs take over and inhibit understory trees.
- Understory trees are too numerous (too dense) and need to be thinned.
- Requires time, money, care, and dedication.
Keep learning and get the help you need

- You are part of an active and supportive forestry community - learn from each other.
- Field tours, workshops, classes abound
- Use assistance available from many agencies - OSU Extension, Soil & Water Conservation Districts, NRCS, NNRG, Oregon Department of Forestry, etc.
- Get good professional help when you need it – consultants, contractors.
Alternative Forest Management
OSU Extension Publications

• Group Selection Cutting in Mature Douglas-fir Forests - EM 9106
• Two-Aged Stand Management in the Coast Range - EM 9082
• Individual Tree Selection (ITS) in a Northeast Oregon Mixed Conifer Forest - EM 9083
• Mixed Conifer and Hardwood Forest Management in Southwest Oregon - EM 9084

https://catalog.extension.oregonstate.edu/series2