Establishment of the Paired-Plot Density Management network: 2013-2018

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IFC Goal & Membership

**Goal:** Improving vigor and adding value to managed forests of the diverse Inland Northwest landscape.
Obvious need to test site-specific silvicultural options in the INW
Categorize forest site quality throughout the Inland Northwest

• Define tree and stand responses to treatments across the range of forest site conditions
• First focused on site factors that define maximum stand density
• Density management creates lasting improvements to stand condition
Utility of Density Management

• Improves stand structure and development through density management
• Enhances resistance to fire, drought, pests & disease

Forgone or delayed thinning:
• Growth opportunity loss
• Extends rotation
• Increases mortality risk
Stand density relative to normal stands defines thinning prescriptions for highest stand vigor.

- 100% - Normal
- 60% - Eminent mortality
- 35% - Lower Management Zone
- 25% - Crown closure
Density Management Research

1. Carrying capacity analysis
   • Characterize maximum density across the INW
   • Species specific

2. Spacing Trials
   • Validate maximum density models
   • Compare growth response to thinning among site classes
   • Determine how stand development affects thinning response
Maximum density frontier models

Density x Diameter depends on:
Topography
Geography
Climate
Soil

Kimsey et al 2019

Geospatial representation of maximum Stand Density Index
Spacing Trials

• Identify how stage of stand development affects thinning response
• Measure thinning response across site productivity classes
• Compare among dominate species
Total stand productivity should reach a broad optimum following canopy closure.

Growth phases:
I. No competition
II. Growth decline
III. Constant wide optimum
IV. Competition-caused decline

Langsaeter’s Curve

\[ \frac{\Delta G}{\Delta GS} = 0 \]
\[ \frac{\Delta G}{\Delta GS} < 0 \]
To plateau or not to plateau

• Uncertain width of plateau
• Uncertain effect of site quality
• Gross vs Net production
• Typically noisy data causes uncertainty
Site class vs. growth

- Stand growth of thinned stands may exceed that of no-thin on high sites.
- Growth of thinned trees will always exceed no-thin trees; difference may be greatest on high sites.

![Graph](image)
Paired Plot Density Management (PPDM) Objectives

1. Describe growth-density function shape
2. Identify optimal time of thinning for small diameter stands
3. Evaluate site effects on thinning response
4. Thinning effects on light, water, and nutrients
101 PPDM study locations

Thinning operations throughout the Inland Northwest

- 4 site classes x 3 density classes
- Divided among three forest types

<table>
<thead>
<tr>
<th>Density</th>
<th>Site Productivity Class</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>I</td>
<td>1</td>
<td>13</td>
<td>13</td>
<td>8</td>
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<td></td>
<td>II</td>
<td>10</td>
<td>15</td>
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<td>4</td>
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<tr>
<td></td>
<td>III</td>
<td>2</td>
<td>8</td>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>
### 10-yr increment estimates

**Site productivity**

<table>
<thead>
<tr>
<th></th>
<th>DF</th>
<th>PP</th>
<th>WL</th>
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</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>15</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>25th</td>
<td>19</td>
<td>14</td>
<td>22</td>
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<tr>
<td>Mean</td>
<td>23</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>75th</td>
<td>26</td>
<td>23</td>
<td>27</td>
</tr>
<tr>
<td>Maximum</td>
<td>31</td>
<td>27</td>
<td>30</td>
</tr>
</tbody>
</table>
Matrix grid evenly classified site conditions

- Corners were hard to fill
- High density larch not available
- Represents range of forest stand conditions
PPDM within site plot
Design

- 3-4 plots at each location
- No-thin
- Operational thin
- Alternative thin
Establishment results

- Stand structure
- Density distribution
- Dependent site factors
Structure modified by thinning

- Removal of ingrowth
- Shift mean diameter right
DF examples
Composition modified by thinning

- Increased composition of target species to almost 90%
- Little additional effect between spacing levels
- PP was less affected than others
Stand metrics among experimental factors

• Basal Area
  • Reflects experimental design
    • Increases with density class in no-thin plots
    • Decreases with thinning
  • BA is not affected by productivity class
Stand metrics among experimental factors

- **Stand Density**
  - i.e. Curtis’ RD
  - Increases with density class
  - Thinning decreases density
  - RD is not affected by site productivity class
Stand metrics among experimental factors

- Stand Density
  - i.e. Portion of SDI_max
  - Increases with density class
  - Thinning decreases density
Comparison among density metrics
Stand metrics among experimental factors

- Diameter
  - Low in stand density class I
  - Thinning increases mean diameter, thinning from below
Ten-year Site Productivity explained by Climate and Topography

- Moisture
- Temperature
PPDM Establishment
Summary

• Rotation-long study designed to validate SDI\text{max} estimates
• Addresses where and when to most effectively thin stands
• Includes full range of productivity and stand densities
• Data analyzed through regression analysis or with analysis of variance
• Plot network will serve many purposes