Forests change, slowly and predictably

Original credit to USDA Forest Service.
Forests change, dramatically and quickly

Glacier National Park, circa 1935

Values and outputs depend on forest and stand conditions

Photo credits: Christopher Webster (cwebster@mtu.edu; 906.487.3618).
Models allow us to assess resources in the future as affected by change

**Projection:** what will the future condition be conditional on the current condition?
- Inventory updating
- Strategic planning
- Tactical planning

**Gaming:** what is the outcome from a given prescription?
- Timber
- Wildlife
- Biodiversity

Change in diameter distribution may be of interest

Source: Davis and Johnson (1987) "Forest Management (3rd ed)."
Change in ecological attributes or indicators may be more important

**TABLE 4.3**
Examples of inventory and growth in ecological outcomes and conditions

<table>
<thead>
<tr>
<th>Outcome and condition</th>
<th>Beginning of period</th>
<th>End of period</th>
<th>In-growth (gained)</th>
<th>Mortality (lost)</th>
<th>Net change (growth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species type</td>
<td>M</td>
<td>M</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Average DBH (inches)</td>
<td>9</td>
<td>16</td>
<td>7</td>
<td>—</td>
<td>7</td>
</tr>
<tr>
<td>Canopy closure (percent)</td>
<td>50</td>
<td>75</td>
<td>25</td>
<td>—</td>
<td>25</td>
</tr>
<tr>
<td>Habitat type*</td>
<td>M3M</td>
<td>M4D</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Number of snags &gt; 12 in.</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Diversity index</td>
<td>0.77</td>
<td>1.16</td>
<td>0.39</td>
<td>—</td>
<td>0.39</td>
</tr>
<tr>
<td>Acres of good deer browse</td>
<td>0.3</td>
<td>0.4</td>
<td>0.2</td>
<td>0.3</td>
<td>-0.1</td>
</tr>
<tr>
<td>Tons of coarse wood debris</td>
<td>1.4</td>
<td>3.5</td>
<td>3.1</td>
<td>1.0</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Source: Davis et al. (2001) “Forest Management (4th ed.).”

Models come in different kinds that suit different purposes

How will this stand change?

Mental models are still models

Photo credits: Christopher Webster (cwebster@mtu.edu; 906.487.3618).
Some examples of model kinds

Graphical model

Picture model

The Forest Vegetation Simulator models the growth of individual trees

- trees are grown in three dimensions
  - basal area increment
  - height increment
  - crown ratio change
- divided into two classes for modelling
  - in the Lake States, large is > 5 in DBH or > 10 feet tall; the others are small
Mensurational history is pervasive

- Probabilistic – keep track of sampling fraction
- Stochastic – record tripling and random deviates
- Uses Site Index – site quality differences are represented by Site Index and translated between species

Regeneration, mortality and increment are simulated separately

Cruise data → Simulate management → Predict increment

More cycles? Y → Predict regeneration → Predict mortality

N → Write output files

optional → Post processors
The NorthPro model simulates changes in stand tables in time.

<table>
<thead>
<tr>
<th>Dbh (in.)</th>
<th>No. (tpa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>31.5</td>
</tr>
<tr>
<td>8</td>
<td>26.2</td>
</tr>
<tr>
<td>10</td>
<td>20.8</td>
</tr>
<tr>
<td>12</td>
<td>15.1</td>
</tr>
<tr>
<td>14</td>
<td>14.2</td>
</tr>
<tr>
<td>16</td>
<td>11.5</td>
</tr>
<tr>
<td>18</td>
<td>6.2</td>
</tr>
<tr>
<td>20</td>
<td>6.0</td>
</tr>
<tr>
<td>22</td>
<td>2.1</td>
</tr>
</tbody>
</table>

*Photo credits: Christopher Webster (cwebster@mtu.edu; 906.487.3618).*
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Michigan</th>
<th>3-year Average</th>
<th>5-year Average</th>
<th>7-year Average</th>
<th>9-year Average</th>
<th>11-year Average</th>
<th>13-year Average</th>
<th>15-year Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (ha)</td>
<td>12.3</td>
<td>12.5</td>
<td>12.7</td>
<td>12.9</td>
<td>13.1</td>
<td>13.3</td>
<td>13.5</td>
<td>13.7</td>
</tr>
<tr>
<td>Shade tolerant species</td>
<td>60%</td>
<td>62%</td>
<td>64%</td>
<td>66%</td>
<td>68%</td>
<td>70%</td>
<td>72%</td>
<td>74%</td>
</tr>
<tr>
<td>Shade intolerant species</td>
<td>40%</td>
<td>38%</td>
<td>36%</td>
<td>34%</td>
<td>32%</td>
<td>30%</td>
<td>28%</td>
<td>26%</td>
</tr>
<tr>
<td>Total Volume (m^3/ha)</td>
<td>150</td>
<td>155</td>
<td>160</td>
<td>165</td>
<td>170</td>
<td>175</td>
<td>180</td>
<td>185</td>
</tr>
</tbody>
</table>

**Graph:**
- **Stand Basal Area by Timber Size**
- **Graph Details:**
  - Large Sawnmill
  - Medium Sawnmill
  - Small Sawnmill
  - Pulp

**Image:**
- Michigan Tech
Case study: managing for bald eagle habitat

Nest habitat features:
• Trees 70+ feet tall
• DBH greater than 17 in
• ≥12 trees per acre

Sec. 30 School Forest
• Northern hardwoods
• Inventory 2002

Resource assessment is straightforward for current stand conditions

>18 tpa over 17 in dbh

>35 tpa over 70 ft tall

NorthPro is unsuitable for assessing future condition

Stand tables and cool diversity index graphs tell you nothing about tree height

FVS can simulate the standard prescription and provides height info

nothing over 17 in dbh

<1 tpa over 17 in dbh
Conclusion: Your forest will change. Will you be able to describe how?