Forestry, The Environment and the Role of Science

Hamish Kimmins
Canada Research Chair in Modeling the Sustainability of Forests
Professor of Forest Ecology
Department of Forest Sciences,
Faculty of Forestry

UBC
Forestry, The Environment and the Role of Science

- Forestry is about people, who, without sustainable forestry, are the greatest threat to the world’s forests.

- How do we judge what is “good” forestry?

- What is the role of science in this issue?

- Research at UBC Faculty of Forestry that examines this question.
People – the ultimate problem

Pogo: “We have been out and seen the enemy, and they are us”

World Population: 1950-2050

Source: U.S. Census Bureau, International Data Base 5-10-00.
People’s Needs

Malaysia

NW Thailand

Amazon

Java
Definition of Forestry

• The art (skill), practice, science and business of managing forest stands and landscapes to sustain an ecologically possible and socially desirable balance of values over appropriate spatial and time scales.
The Two Responsibilities of Forestry

1. To change the way in which a forest is managed as the desired balance of values and environmental services from that forest changes.

2. To reject current practices and resist proposed new practices that are inconsistent with the ecology and sociology of the desired values and services over ecologically appropriate temporal and spatial scales.
How do we decide what is sustainable forestry?
Humans: a highly visual and emotional species

- High visual acuity for a mammal
- An emotional species: we judge as much by our heart as our head
- Dislike of change: The Peter Pan Syndrome
Big Trees – “Old Growth”
Which image evokes the strongest emotion?
• “A thing is right when it tends to preserve the **integrity**, **stability**, and **beauty** of the biotic community. It is wrong when it tends otherwise”

**but**

• “The evolution of a land ethic is an intellectual as well as emotional process. Conservation is paved with good intentions which prove to be futile, or even dangerous, because they are devoid of critical understanding either of the land, or of economic land-use”

Aldo Leopold, *The Land Ethic*
Are beautiful landscapes always sustainable?

Are sustainable landscapes always "beautiful"

Are “small” and “gentle” always ecologically appropriate?
Human dominated, "tamed" landscape, Europe
Over-exploited?

British Columbia.
What is the role of science in resolving this issue?

Knowing, understanding, predicting
Components of the Scientific Method

The need to balance description, analysis and synthesis

- Observations, knowledge, experience
- Theory, postulate
- Hypotheses
- Scientific principles
- Scientific laws
- Experimental observations
- Computer model
- Predictions
- Validation
- Deduction
- Induction

Reductionism

- Hypothesis testing
- Direct application of unsynthesized, reductionist science

Experience, Belief systems

Problem, issue, desired outcome

Foundations of Science

Policy, practice, action

Scientific scenario analysis
## Levels of biological organization

<table>
<thead>
<tr>
<th>Levels of biological organization</th>
<th>Levels of biological integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystem</td>
<td>Understanding</td>
</tr>
<tr>
<td>Community</td>
<td>Understanding</td>
</tr>
<tr>
<td>Population</td>
<td>Understanding</td>
</tr>
<tr>
<td>Individual</td>
<td>Understanding</td>
</tr>
<tr>
<td>Organ systems</td>
<td>Understanding</td>
</tr>
<tr>
<td>Organs, tissues</td>
<td>Understanding</td>
</tr>
<tr>
<td>Cell</td>
<td>Understanding</td>
</tr>
<tr>
<td>Sub-cellular</td>
<td>Understanding</td>
</tr>
</tbody>
</table>

The need for the ecosystem level: Prediction

Ecosystem

Community

Population

Individual

Organ systems

Organs, tissues

Cell

Sub-cellular

Prediction

The need for the ecosystem level: Prediction
Conclusion

1. Direct application of unsynthesized, disciplinary (“hard”), reductionist (“jigsaw-puzzle”) science results in “jigsaw-puzzle” policy that works poorly.
2. Policy should be based on a synthesis of “hard” science to the level of complexity and the time and space scales of the policy issue in question.
Sustainability and Stewardship
Research in the Faculty of Forestry at UBC

- New paradigms for forestry
- Ecosystem management modeling – decision support tools
- The need for complexity
- Visualization
Paradigms for a *New* Forestry

- Ecosystem management
- Adaptive management and monitoring
- Zonation
- Variable retention
- Emulation of natural disturbance or natural range of variation
- Results-based vs. regulation-based
Paradigms for a *New* Forestry

- Ecosystem management
- Adaptive management and monitoring
- Zonation
- Variable retention
- Emulation of natural disturbance or natural range of variation
- Results-based vs. regulation-based

All need forecasting tools
What Types of Forecasting Tools?

Stand level ecosystem management models:

**FORECAST**

Non-spatial ecosystem management stand model
Stand-level Visualization

- Dispersed retention
- Aggregated retention
- e.g. Variable retention designs
What Types of Forecasting Tools?

Stand level ecosystem management models:

**FORCEE**

Spatially-explicit, individual tree, ecosystem management model
What Types of Forecasting Tools?

Landscape level ecosystem management model:

**LLEMS**

Local landscape ecosystem management model for complex cut block design – under development

* Is this a clearcut?
* What will the future forest species composition be?
* How will Douglas-fir compete with western hemlock?
* Will shade tolerant hardwoods be able to grow?
LLEMS – A variable retention simulator
What Types of Forecasting Tools?

Spatial, structural and functional complexity at the small to medium-size watershed landscape scale, with polygon (stand) interactions

POSSIBLE FOREST FUTURES:

Multiple value, watershed-scale, forest landscape management and scenario analysis/value tradeoff model
POSSIBLE FOREST FUTURES: watershed landscape management model

LLEMS: complex cutblock simulator

FORCEE: Individual tree, complex stand model

FORECAST
Non-spatial ecosystem management stand model

Visualization software – stand and landscape

LLEMS: complex cutblock simulator

FORCEE: Individual tree, complex stand model

POSSIBLE FOREST FUTURES: watershed landscape management model

LLEMS: complex cutblock simulator

FORCEE: Individual tree, complex stand model

FORECAST
Non-spatial ecosystem management stand model

Visualization software – stand and landscape

LLEMS: complex cutblock simulator

FORCEE: Individual tree, complex stand model

POSSIBLE FOREST FUTURES: watershed landscape management model
DECISION SUPPORT SYSTEM: Modelling Framework

**Projection**
- Forest-level Timber Supply Model (ATLAS)
- Wildlife Habitat Supply Model (SimFor)

**Interpretation**
- Stand-level Model (FORECAST)

- Merchantable Volume
- Ecosystem C Storage
- Snags (>25cm dbh)
- Early Seral Shrub Cover (%)

**Visualization Software**
Landscape Visualization

Forest Practices Code Scenario  Year 25

Zoning Scenario  Year 25
Conclusions

• Forest sustainability cannot be judged solely on visual evidence

• Science has not served society well in defining sustainable forestry

• Knowledge and understanding should be balanced by synthesis
Results of Model Comparison: **Light Only**

**Top Height**

Ref SI: 16
Species: Sw
Regen: 1600 sph

- **FORECAST light only**
- **TIPSY**
- **Ratio**

- Stand Age (y)
- Top Height (m)
- FORECAST/TIPSY Ratio
Results of Model Comparison: **Light Only**

**Stand Density**

![Graph showing stand density over stand age with FORECAST light only, TIPSY, and Ratio curves]

- **Ref SI:** 16
- **Species:** Sw
- **Regen:** 1600 sph
Results of Model Comparison: Light Only

Gross Volume

- Ref SI: 16
- Species: Sw
- Regen: 1600 sph

Legend:
- FORECAST light only
- TIPSY
- Ratio

Graph showing the relationship between stand age (x-axis) and gross volume (y-axis) for different models.
Results of Model Comparison: **Light Only**

**Merchantable Volume** (12.5cm top)

- Ref SI: 16
- Species: Sw
- Regen: 1600 sph

Graph showing the comparison of merchantable volume over stand age (y) between FORECAST light only, TIPSY, and the ratio.
Results of Model Comparison: Adding Biology

Ratio of FORECAST to TIPSY Merchantable Volume

Ref SI: 16
Species: Sw
Regen: 1600 sph
US: Calamagrostis
Results of Model Comparison: **Degree of Understory Competition**

**Ratio of FORECAST to TIPSY**

**Merchantable Volume**

- **Ref SI:** 16
- **Species:** Sw
- **Regen:** 1600 sph
- **US:** Calamagrostis

![Graph showing the ratio of FORECAST to TIPSY over stand age](image)
Comparison for Douglas-fir, 2000 sph, FORECAST at various levels of complexity
Comparison for Douglas-fir at various levels of planting density

![Graph showing FORECAST/TIPSY ratio over years for different planting densities of 3,000, 2,000, and 1,000 plants per acre. The graph indicates that the ratio stabilizes around 0.8 after 100 years.]