



# **SOME PRINCIPLES OF ECOLOGICAL FORESTRY**

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# **Why Ecological Forestry?**

**Profound shift in societal goals and priorities for forest ecosystems**

**Profound expansion in scientific understanding of structure & function of forest ecosystems**







**If your goal is to sustain or restore  
the ecological services provided  
by natural forest ecosystems,  
then...**

**Natural stand development  
processes, including disturbances,  
are the appropriate model**

# **Ecological Forestry applicable where primary objectives of management include:**

- Restoration or maintenance of ecological processes and biodiversity**
- Integration of ecologic with economic and/or cultural objectives**
- Goal of increasing societal options and reducing risk**

**Production Forestry applicable where primary objective of management is:**

- **Efficient production of commercial wood products**

**Within constraints of law and long-term sustainability of site**

# **Ecological Forestry requires an ecosystem perspective:**

- **Structure: Physical architecture, including individual pieces (e.g., trees) and spatial pattern (e.g., level of heterogeneity)**
- **Function: Work ecosystem does, such as production, regulation hydrologic cycle**
- **Composition: Organisms that are present; biodiversity in narrow sense**
- **Includes aquatic as well as terrestrial elements of ecosystem**

# **Most important processes in ecosystem development:**

- **Disturbances and the legacies that they generate**
- **Population dynamics of the tree species (including competitive interactions)**



80

19













**Natural disturbances  
in forests kill trees  
but most do NOT  
consume or remove  
much of organic matter**

# **BIOLOGICAL LEGACIES**

- **Organisms and reproductive structures**
- **Structures and organic matter**
- **Organically-derived spatial patterns**

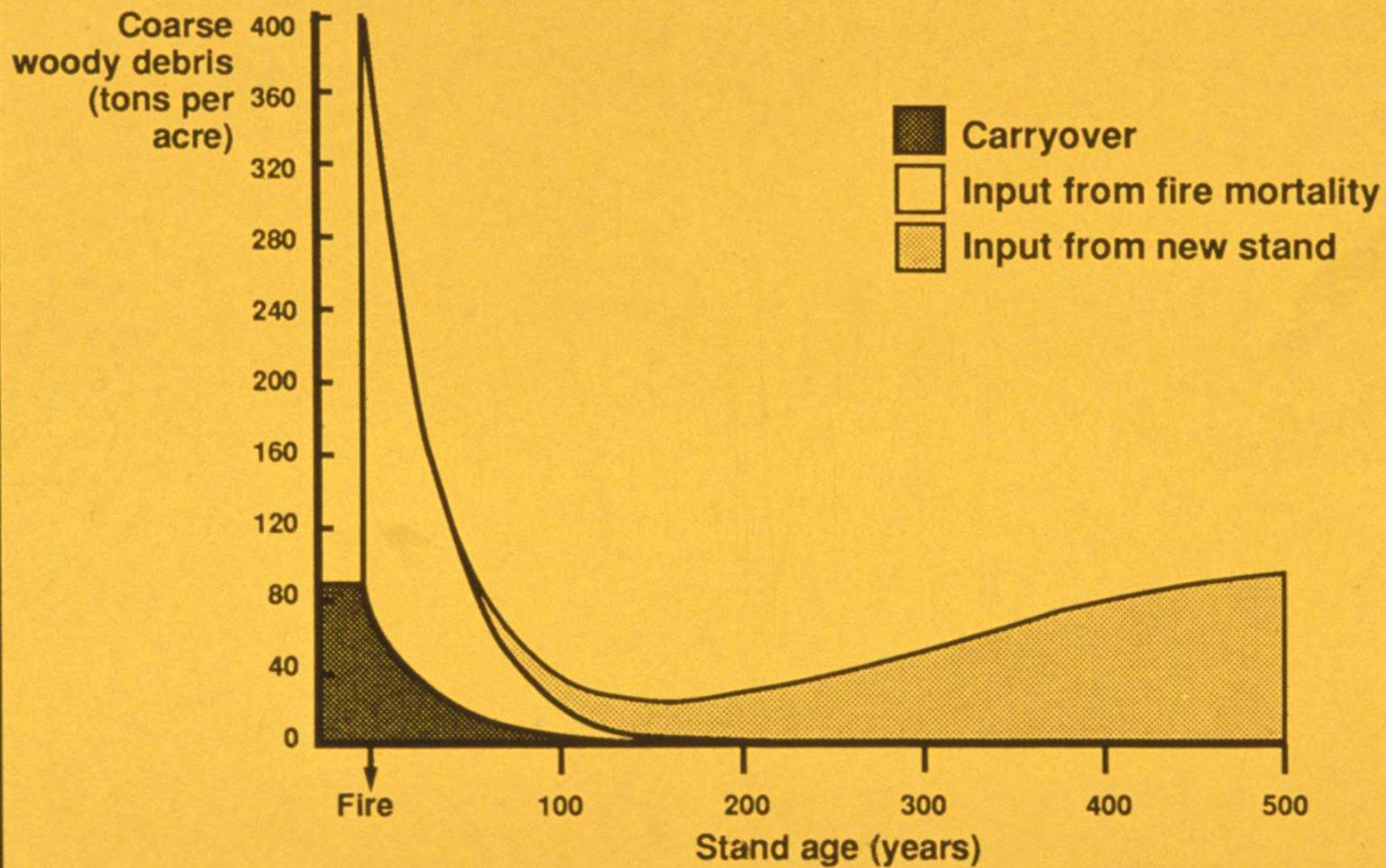


Fig. 1.14

# **Disturbance scale and type are important:**

- **Gradient of disturbance scales**
  - **Tree to gap to stand level**
- **Legacies vary dramatically with disturbance type**







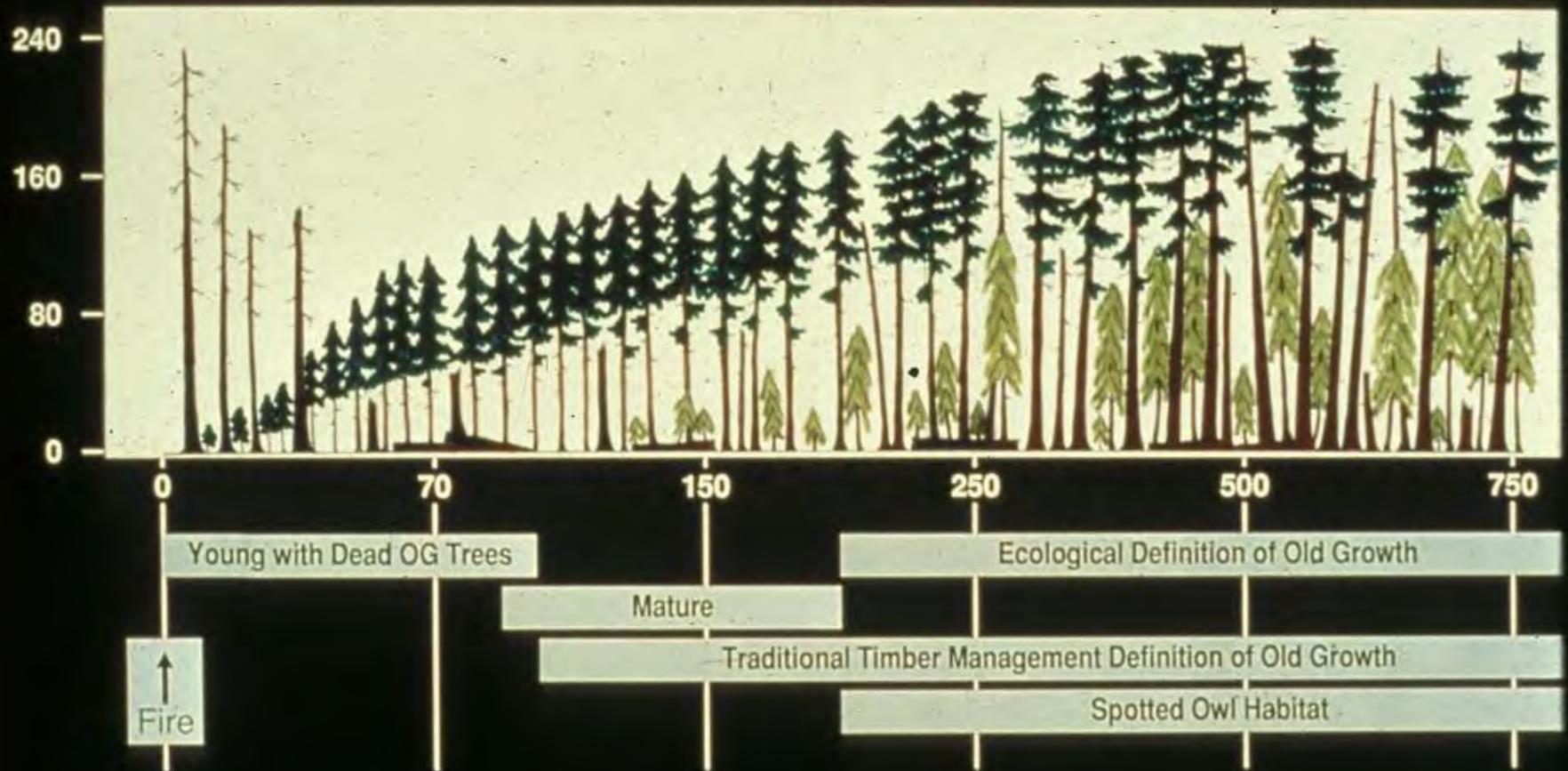
# COMPARISON OF LEGACIES

<b>Legacy</b>	<b>Wildfire</b>	<b>Storm</b>	<b>Clearcut</b>
<b>Live trees</b>	<b>Few</b>	<b>Few</b>	<b>None</b>
<b>Snags</b>	<b>Abundant</b>	<b>Common</b>	<b>None</b>
<b>Logs</b>	<b>Common</b>	<b>Abundant</b>	<b>Few</b>
<b>Seedlings</b>	<b>No</b>	<b>Yes</b>	<b>No</b>
<b>Floor</b>	<b>No</b>	<b>Yes</b>	<b>No</b>



**Forest subjected to  
STAND REPLACEMENT  
Disturbance Regime**

# Natural Forest Development Following Catastrophic Wildfire



# Natural Stand Development

- Disturbance & Legacy Creation Event
- Pre-Forest Stage
  - 20-50 yrs
- Canopy Closure Event
- Young Forest Stage
  - Closure to 100 yrs
- Mature Forest Stage
  - 100-200 years
- Early Old-Growth Stage
  - 200-350 years
- Old-Growth
  - > 350 years
- (Ancient Old-Growth)
  - > 700-100 yrs+

# Disturbance & Legacy Creation

- Originating (stand-replacement) disturbance
- Frees up resources/opens up space
- Leaves elements of the pre-disturbance ecosystem behind - in original (e.g., live) and in modified (e.g., dead) forms



# Preforest Stage (Early Successional Ecosystem)

Talk more about this stage in third session, because it provides one of the ecological rationales for conducting regeneration harvests



# Canopy Closure

- Event second only to the originating disturbance in intense change over relatively short period of time (dramatic!)
- May happen either quickly or gradually (depends on density of tree reprod)
- Ecosystem interior goes *DARK!*
  - Low light, moist, moderated climate
- Many species & processes eliminated or greatly diminished



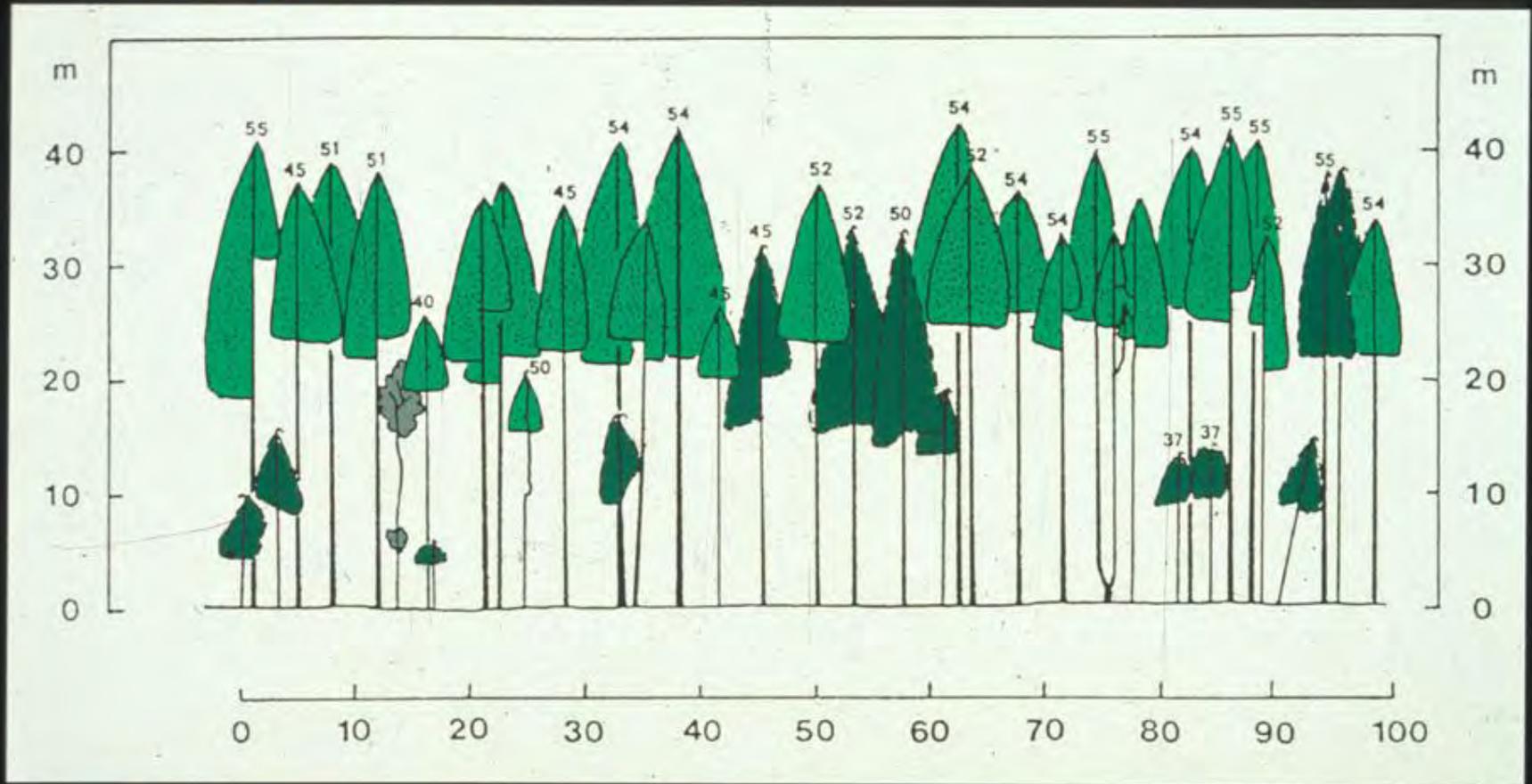


# Young Forest Stage

- **Biomass accumulation**
  - Rapid growth of trees, wood accumulation
- **Intense competitive interactions amongst the tree life form**
- **Competitive exclusion of other species**
- **Density-dependent mortality of trees**
  - Smaller trees
  - More intense, the denser the stand
  - Drives stand toward homogeneity

# Douglas-fir Stand Development

## Canopy Profile



*Humptulips - 55 years*

# *Competitively-based or Density-dependent Mortality*

- \* Smaller diameter trees
- \* Denser the stand, the more intense the competition (mortality)
- \* Creates homogeneity



# Mature Forest Stage

- Understory re-established, including reproduction of shade-tolerant trees
- Pioneer cohort matures--achieve ultimate height & crown spread
- CWD at low point
  - But some big trees beginning to die
- Shift in patterns of tree mortality
  - From competitive to external agents







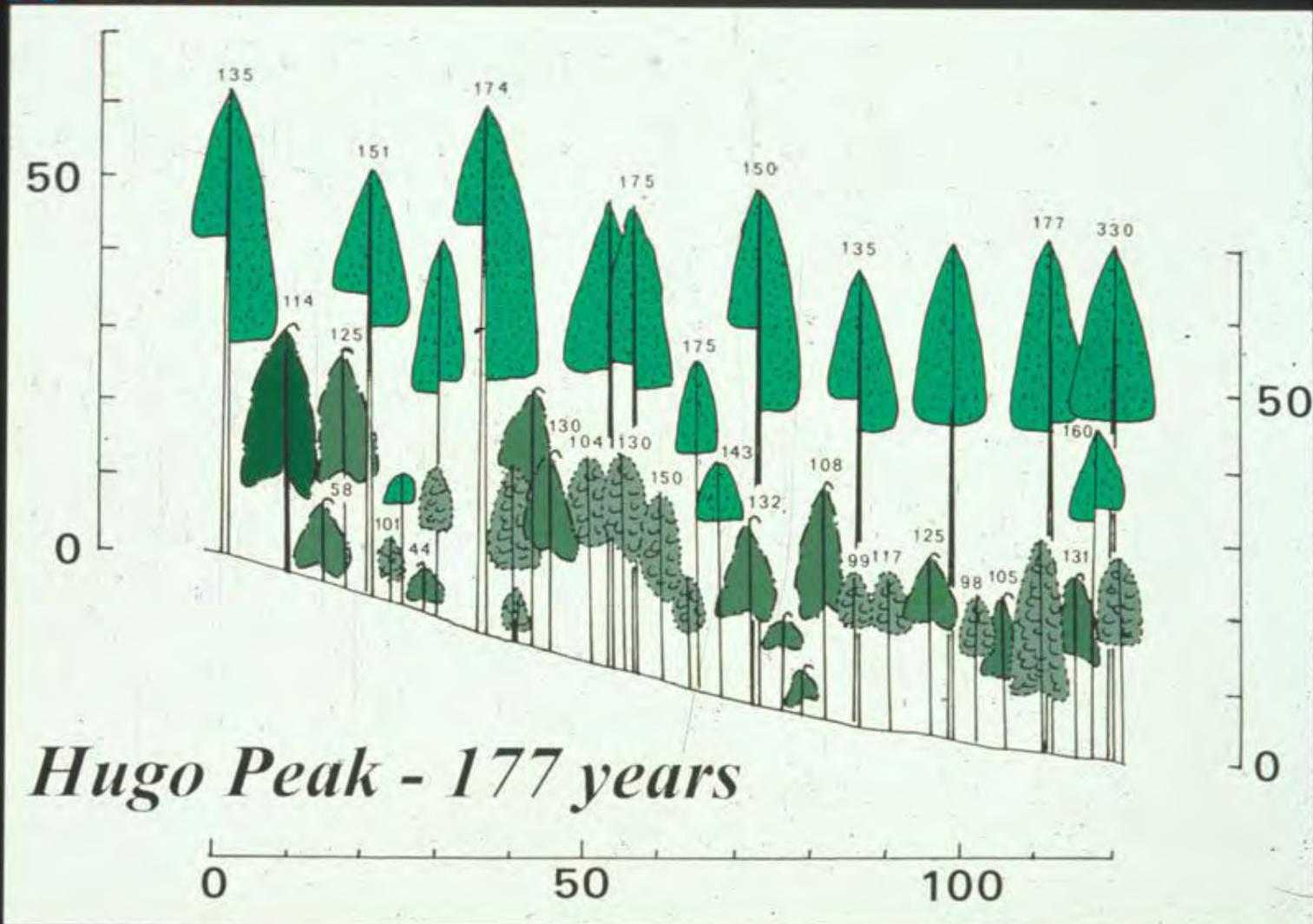
# *Agent-caused Mortality (density-independent)*

- \* Wind, insect, disease
- \* Contagious = spatially aggregated
- \* Kills big (dominant) trees
- \* Makes "gaps" (holes in overstory canopy)



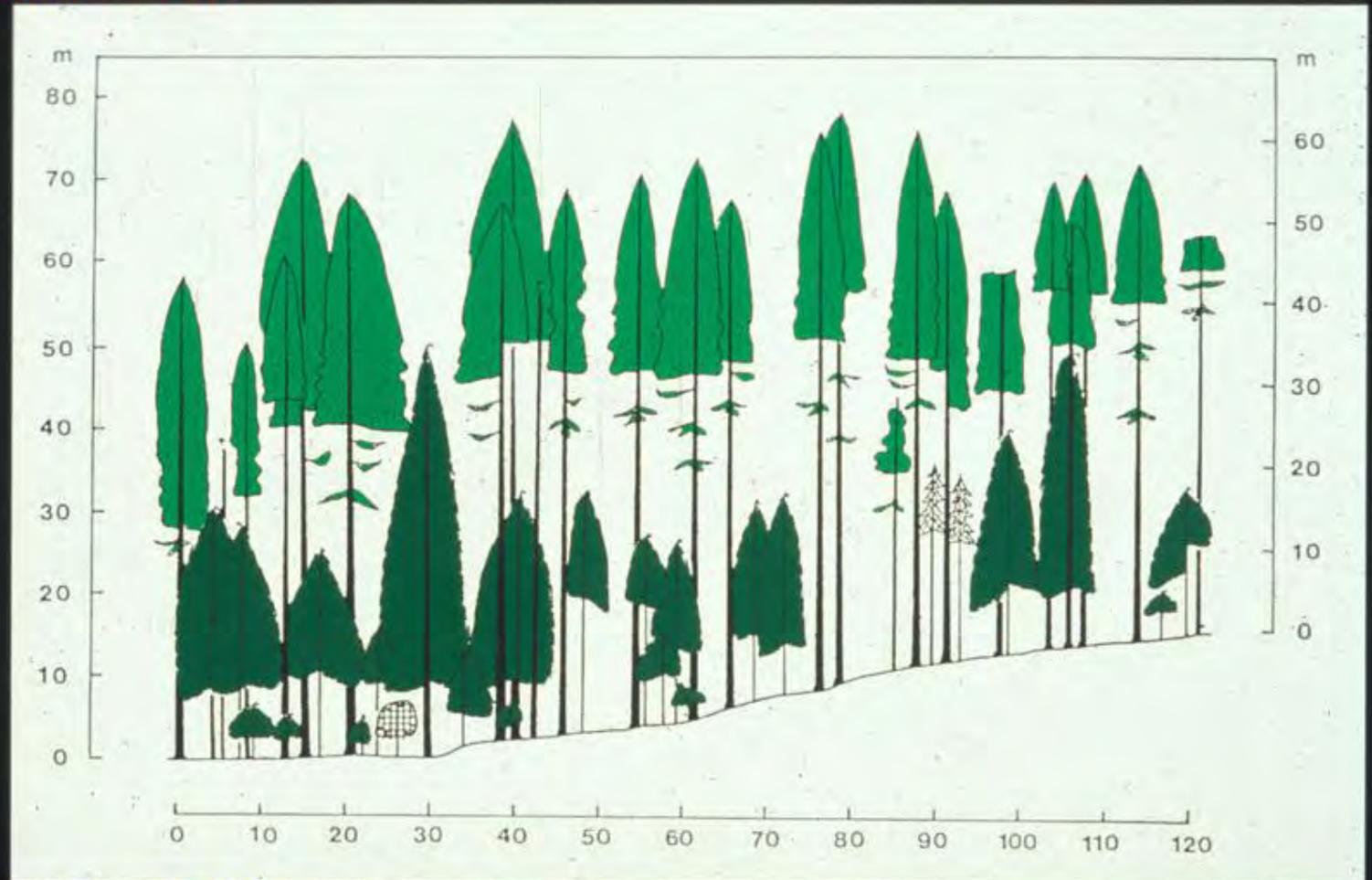
# Douglas-fir Stand Development

## Canopy Profile



# Douglas-fir Stand Development

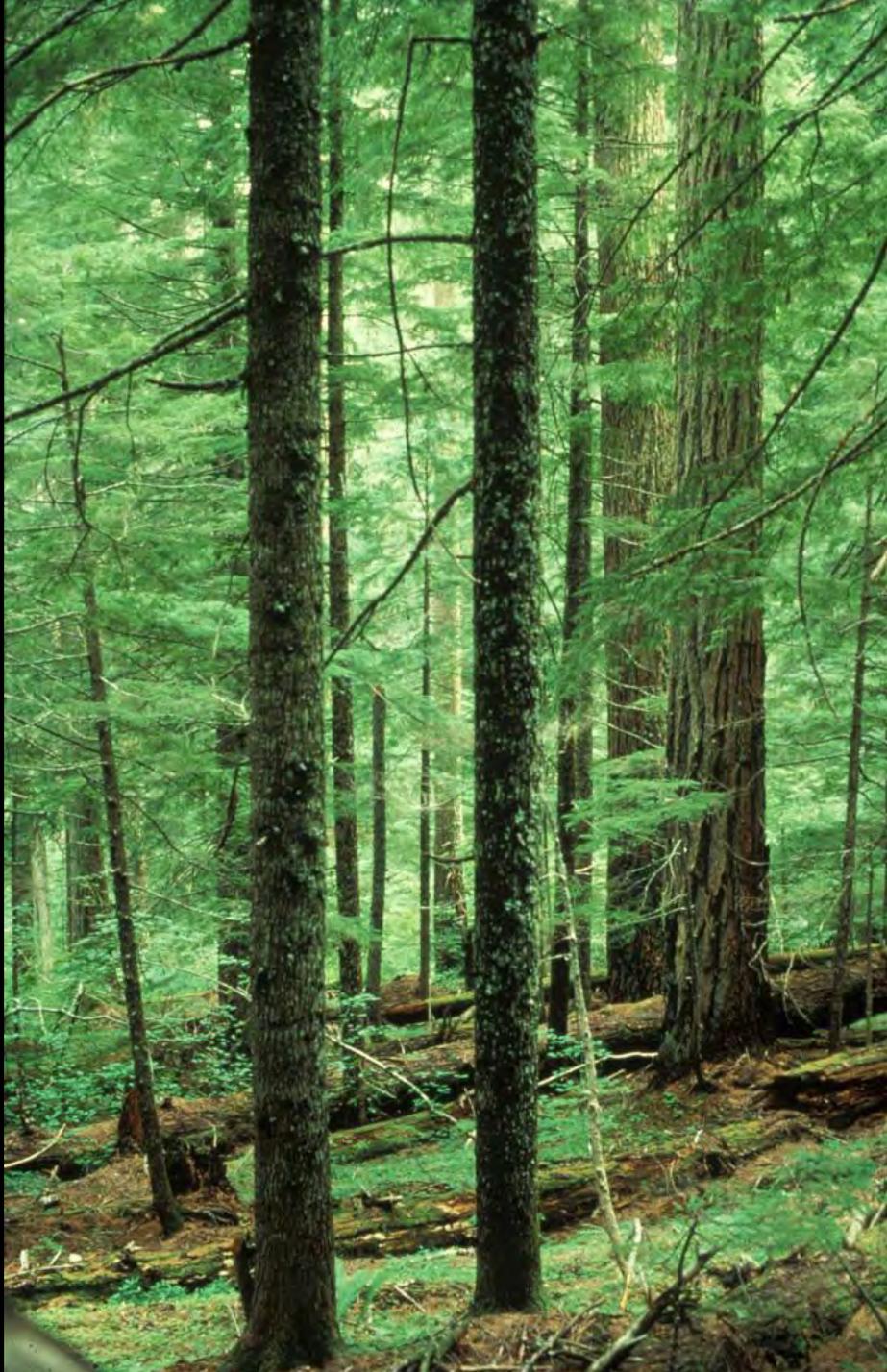
## Canopy Profile



*Ohanapecosh - 250 years*

# Old-Growth Forest Stage

- Overall increase in patchiness of stand due to increase abundance and size of canopy gaps
- Abundant decadence, including CWD
- Abundant large epicormic branches
  - Related development of epiphytic lichens
- Strong representation of shade-tolerants in canopy

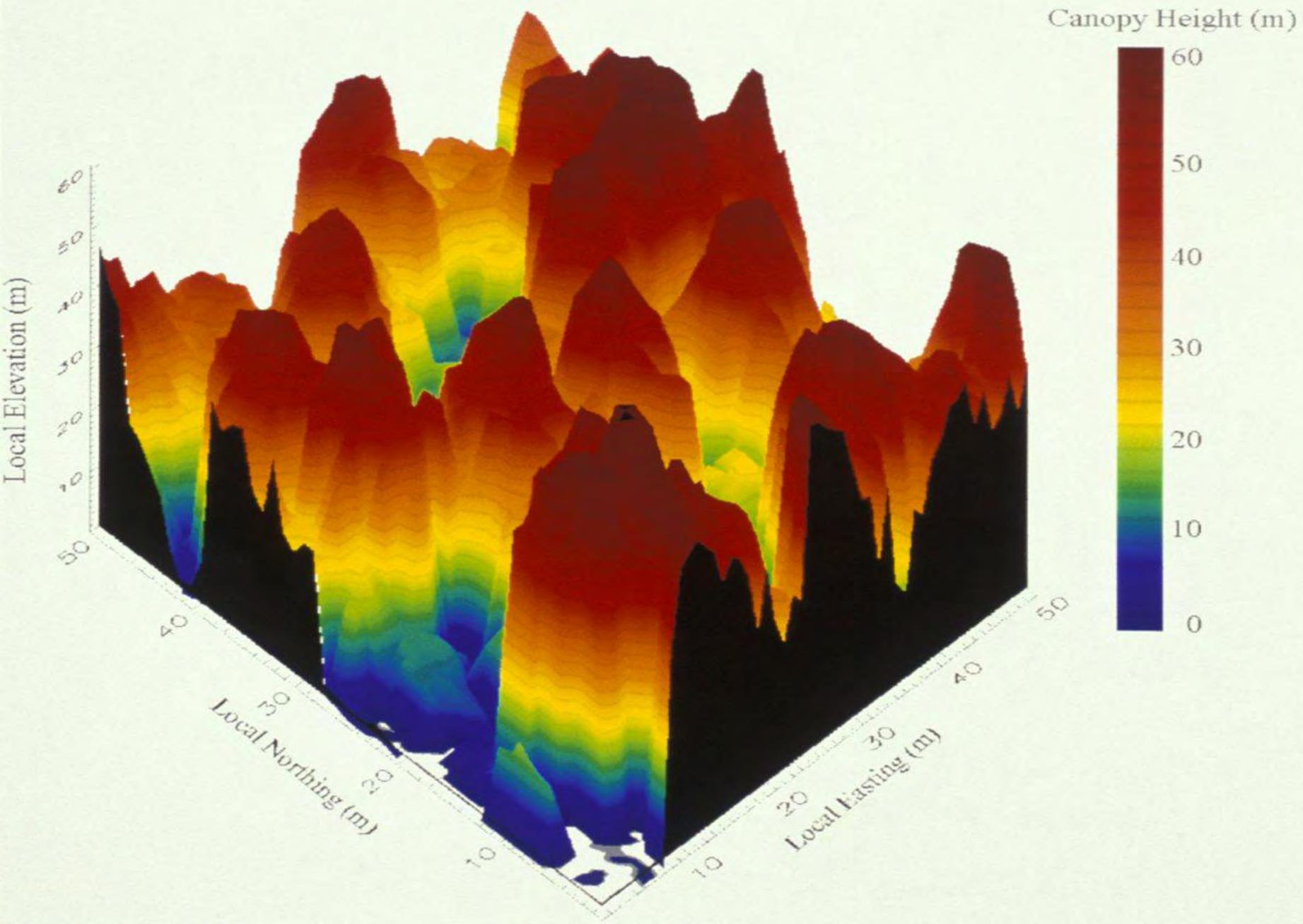














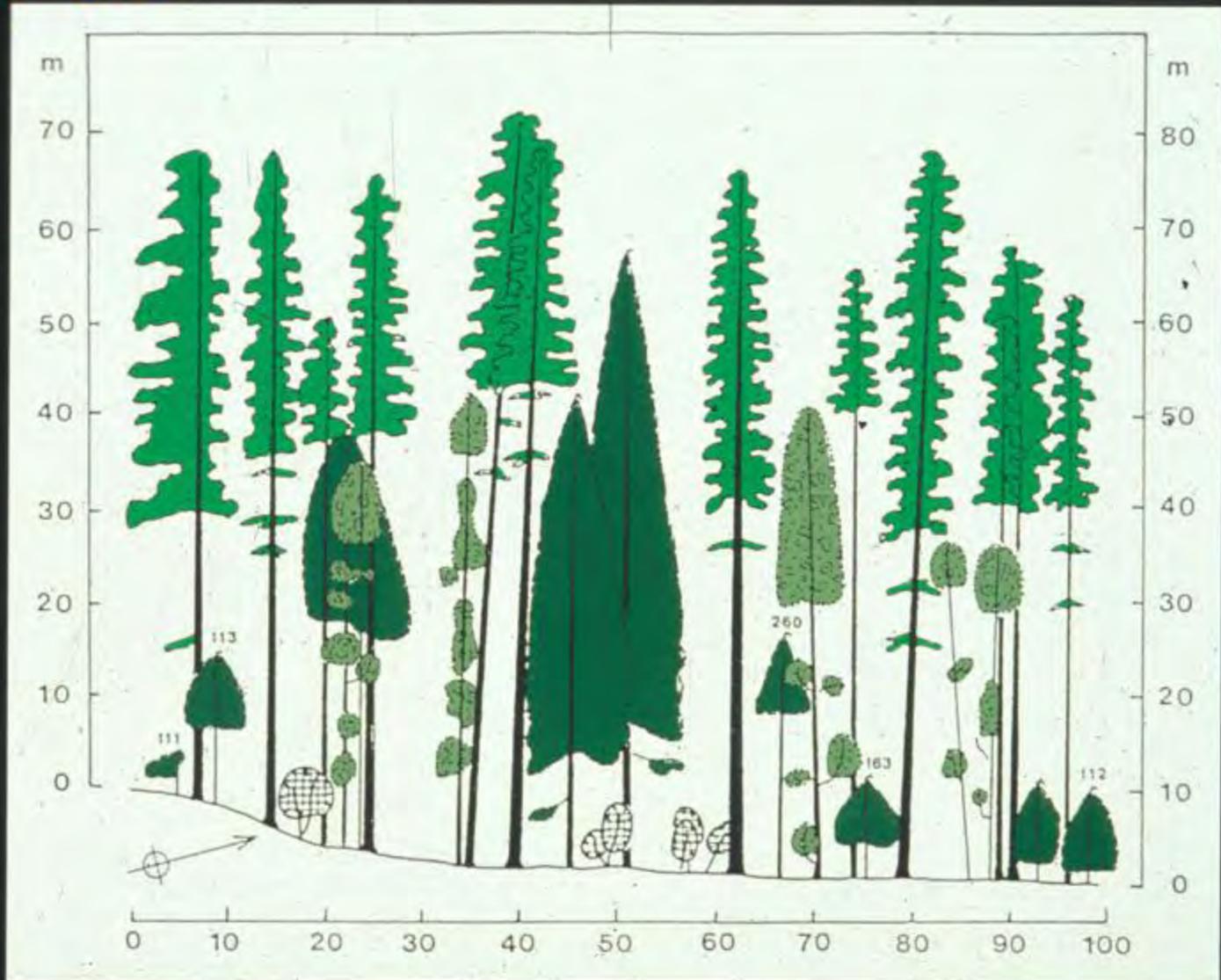






# Douglas-fir Stand Development

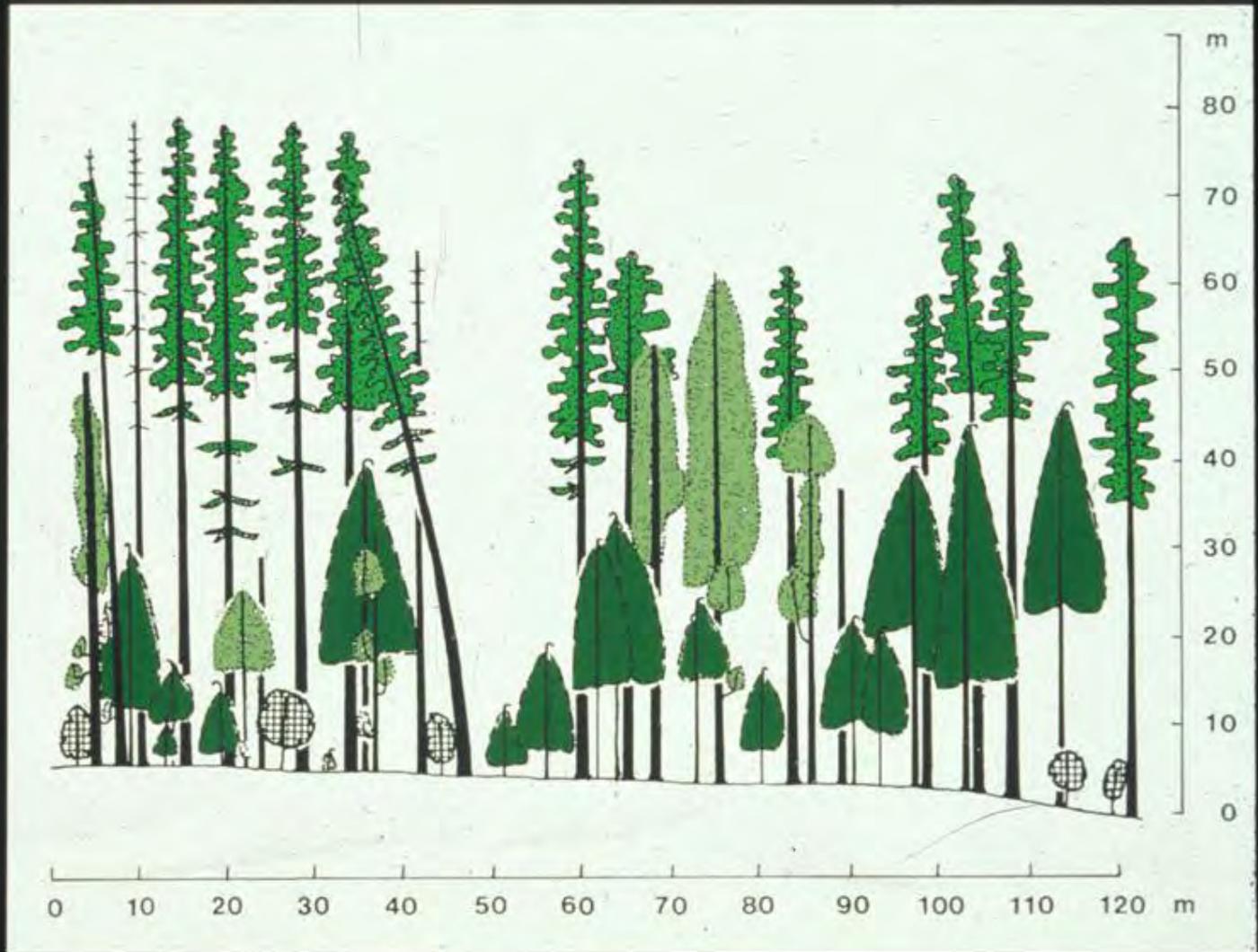
## Canopy Profile



**H.J. Andrews**  
**RS 27**  
**450 years**

# Douglas-fir Stand Development

## Canopy Profile



*H.J. Andrews*  
*RS 30*  
*450 years*

# *Endpoint of stand structural development*

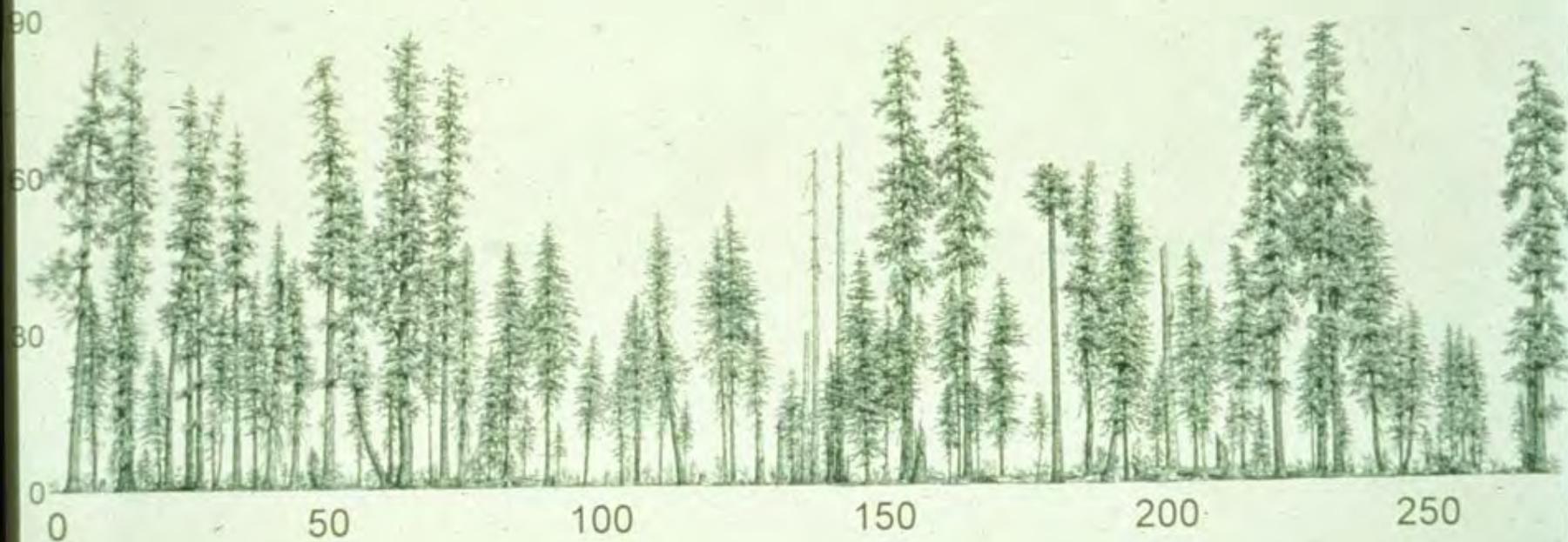
*--in a sere initiated by a stand-replacement event--*

*is a horizontally and vertically diverse forest with a wide array of structures*

# Canopy Profile

*Cedar Flats Research Natural Area*

Transect 3 27 x 270 m



**Stand-replacement disturbance regimes initially produce even-aged stands in which...**

**Ultimately, tree and gap-disturbance regimes ultimately assume dominance**

# Stand Structural Development (SR Sere): Conclusions

- Multiplicity of structures that are important, including legacies from past
- Strong spatial patterning in structure
- Sere is rich in developmental processes
- Sere can continue for centuries or even millenia w/o stand-replacement
- Chronic disturbances come to dominate
  - create & maintain stand complexity

**Forests subjected to  
FREQUENT LOW- to  
MODERATE-SEVERITY  
WILDFIRE  
Disturbance Regimes**











# Structural Cross-section



Canopy Profile

150 m X 20 m

***Blue Jay Springs Klamath Indian Reservation***









Tree and gap-disturbance regimes produce and sustain forests which are multi- or uneven-aged and

Consist of fine-scale patchworks or structural mosaics

# **Why Moist and Dry Forests?**

**Moist Forests are characterized by stand-replacement disturbances, old forests that take centuries to develop and are largely unmodified by fire suppression.**

**Dry Forests are/were characterized by frequent disturbances and have been strongly modified by fire suppression.**





# **Why Moist and Dry Forests?**

**Moist Forest old-growth forests do not require restoration; indeed, activity is likely to destabilize them.**

**Dry Forests with old trees often will require active management to restore more characteristic & sustainable conditions.**

# **Why Moist and Dry Forests?**

**Policy for Dry Forests that permits (but does not require) active management in forests with old trees.**

**“intermediate” or mixed-severity forests are included within the permissive policy because sometimes they will need treatment. With climate change they are even more likely to be needing treatment.**



*The goal IS to understand natural processes and draw upon them in designing a management regime that achieves the ecological and other objectives.*

# Ecological Forestry

Retention Harvest

Stand Manipulation

Appropriate Rotations

# **Ecological Forestry Incorporates:**

- **Legacy concepts into harvesting prescriptions**
- **Natural stand development processes into treatments of established stands**
- **Appropriate recovery periods between regeneration harvests**

# **Ecological Forestry encompasses:**

- Forest practices based on principles of natural stand development, including**
- Roles of natural disturbances in initiation, development & maintenance of forest ecosystems**
- Planned and implemented on temporal and spatial scales appropriate to objectives (i.e., concerned with return intervals, large spatial-scale concerns)**

# **FIRST LEG OF THE STOOL**

**Regeneration Harvests**

**with varying levels and**

**spatial patterns of**

## **STRUCTURAL RETENTION**

**Focus: What you leave behind!**







# SECOND LEG OF THE STOOL

Manipulating established stands to direct their development in desired directions, modeled on an array of natural stand-development processes

- \* Accelerate development structural complexity
- \* Restoration or creation of more sustainable structure

# Incorporating natural stand development processes into treatments of established stands...

- Thinning
  - In great variety, including prescriptions that are spatially variable
- Decadence creation
- Prescribed burning

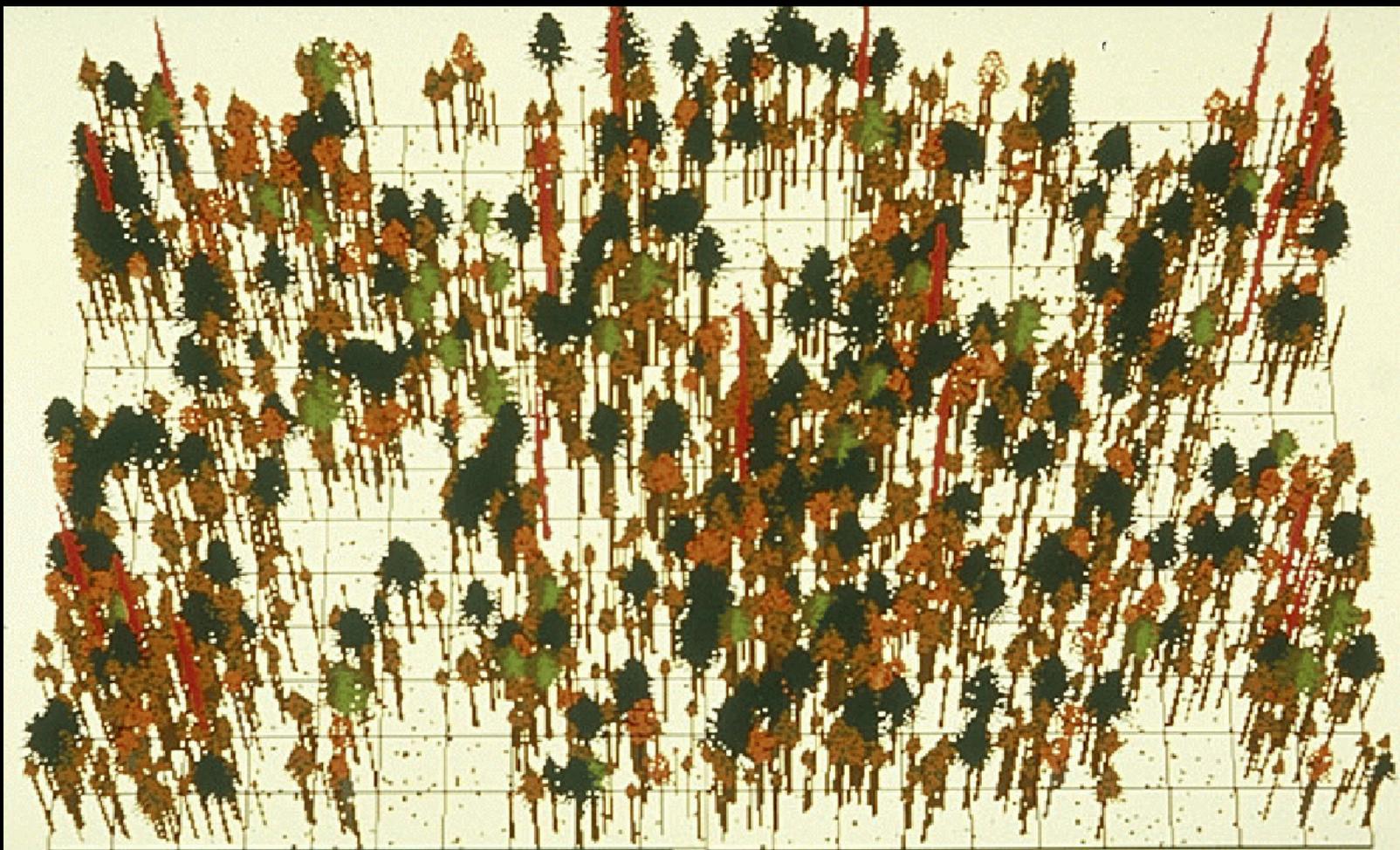
**Accelerating development of  
complexity in simplified young  
stands (plantations!)**







Clavicle 301, S 1/2, Unthinned



Clavicle 301, S 1/2, Thinned



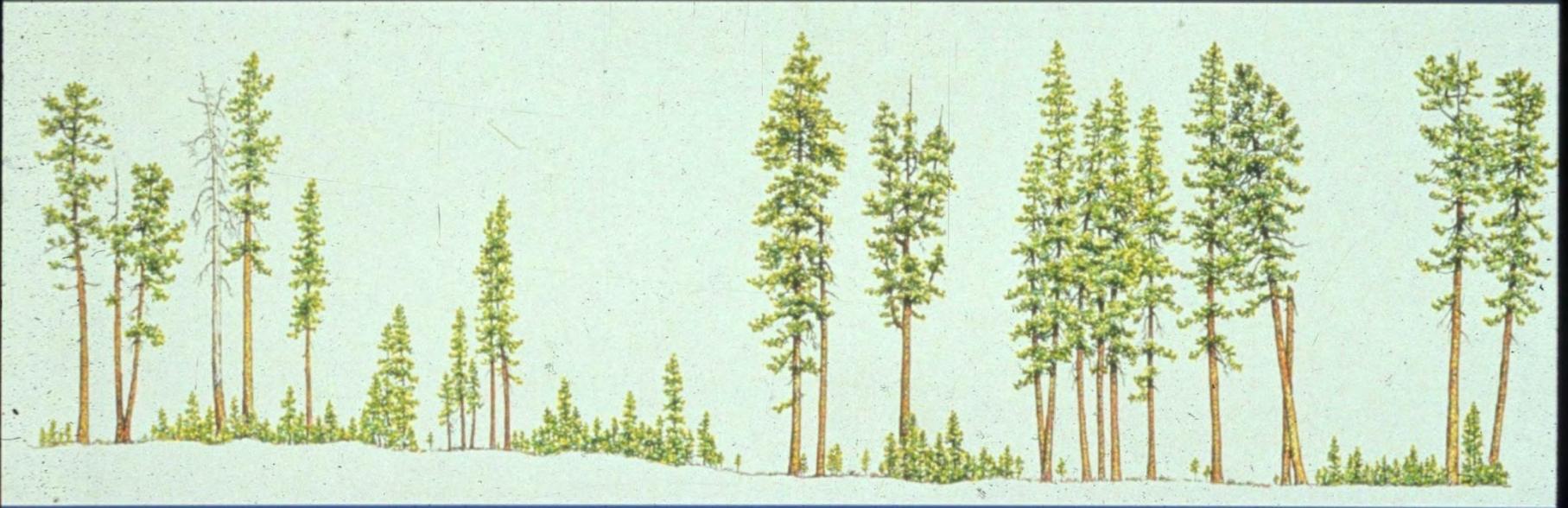
Ecological forestry will typically  
often involve variable density  
thinning as well  
“thinning from above”  
. . . in contrast with traditional  
commercial thinning practices

**Restoring desired and  
sustainable conditions in dry  
forest stands**





# Structural Cross-section



Canopy Profile

150 m X 20 m

**Blue Jay Springs**

**Klamath Indian Reservation**

The Ecological Forester has permission (perhaps an imperative?) to create silvicultural prescriptions that are spatially heterogeneous!

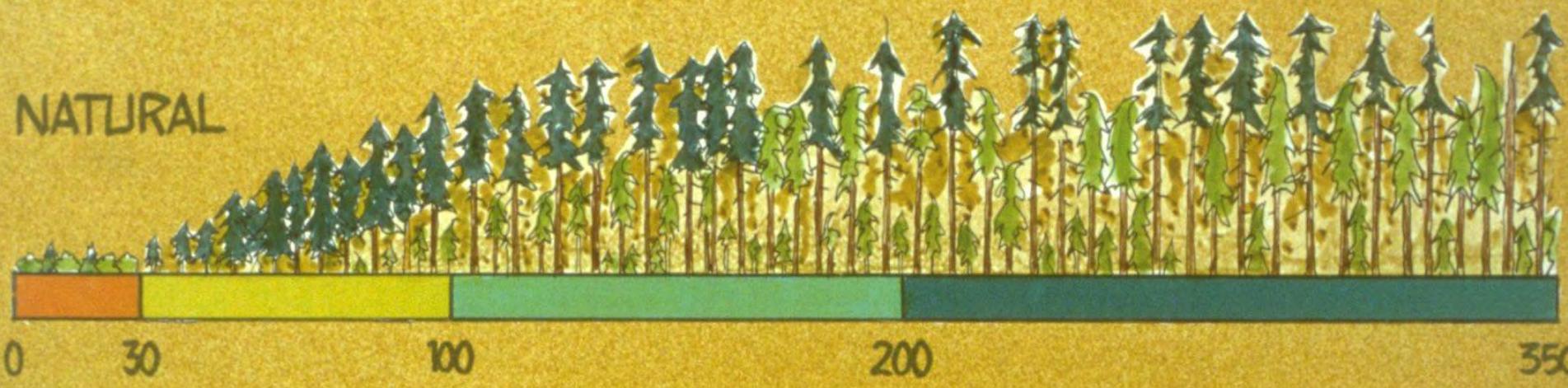
Production forestry focuses on creating spatial homogeneity

# THIRD LEG OF THE STOOL

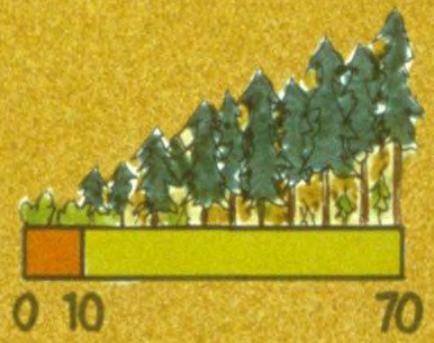
Allow for appropriate recovery periods between stand entries

E.g., longer rotations between regeneration harvests, to allow redevelopment of desired structural conditions

NATURAL



MANAGED



*Important to respond to the  
"opportunities" provided by  
the stand in applying  
spatially variable  
silvicultural prescriptions  
(Is this a no-brainer?!)*

*Ecological forestry is oriented toward forest continuity rather than forest termination!*

*In ecological forestry  
we will (often, typically?) have  
as much focus on the  
understory as on the  
overstory  
(diversity, fuel, etc.)*

# Silvicultural System for Moist Forest

- Variable retention basis for regeneration harvest prescription
- Depend primarily upon natural regeneration (allow significant period for early seral ecosystem)
- Thinning in established stands
- Long rotations (e.g., 120 to 160 yrs) & some older tree structures



# Landscape Checklist

Identifying & managing environmentally  
& culturally sensitive areas

Aquatic ecosystems of all kinds

Specialized habitats/features

Biological hotspots

Migration corridors

Traditional food/medicine sites





# Other Large Spatial-Scale Issues

- **Thresholds**
  - E.g., for cumulative watershed effects
- **Networks**
  - Especially transportation networks
  - Other human-created networks (fuels)
- **Distribution of timber harvest in time & space**
  - Dispersed
  - Aggregated





Landscapes as “black and  
white”?  
(habitat or non-habitat, etc.)

...or as “shades of gray”?



(a range of value  
for habitat or other functions)



...or even “shades of green”!





# Natural Forest Development Following Moderate Severity Wildfire

