Individual Trees Under Global Climate Change

Tom Hinckley
University of Washington
College of Forest Resources
hinckley@u.washington.edu

Content

- Historical Record: Lessons to be applied to present conditions
- What does climate change mean?
- Current Proposed Outcomes
  - “Greening of planet earth”
    - Increased productivity
    - Increased distribution
  - Complex changes that are likely species & location dependent
- Some examples of potential outcomes -- groups of trees

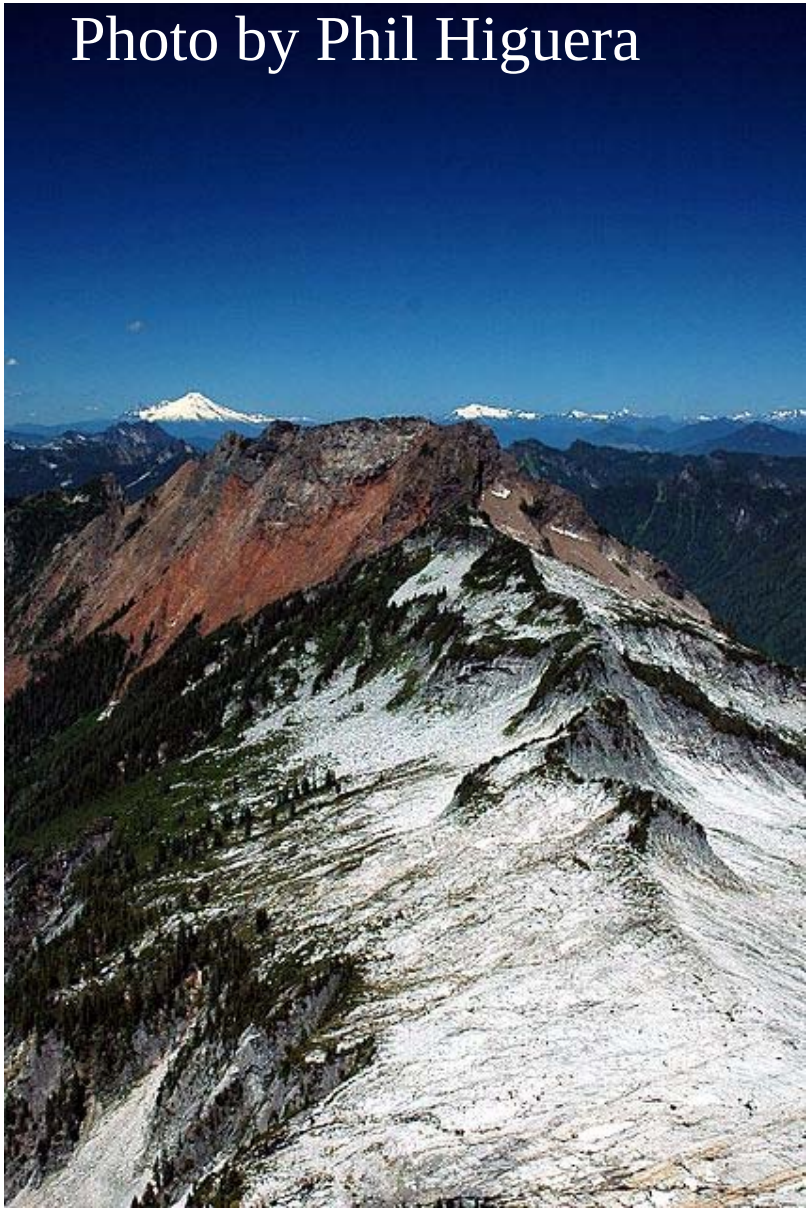
Historical Record: Lessons

- Climate changes uniquely.
- **Species respond individualistically**
- **The established organism, has been resistant to change**.
- Disturbances are likely drivers of change.

Therefore, a focus on the individual has value.

Climate Change for Washington

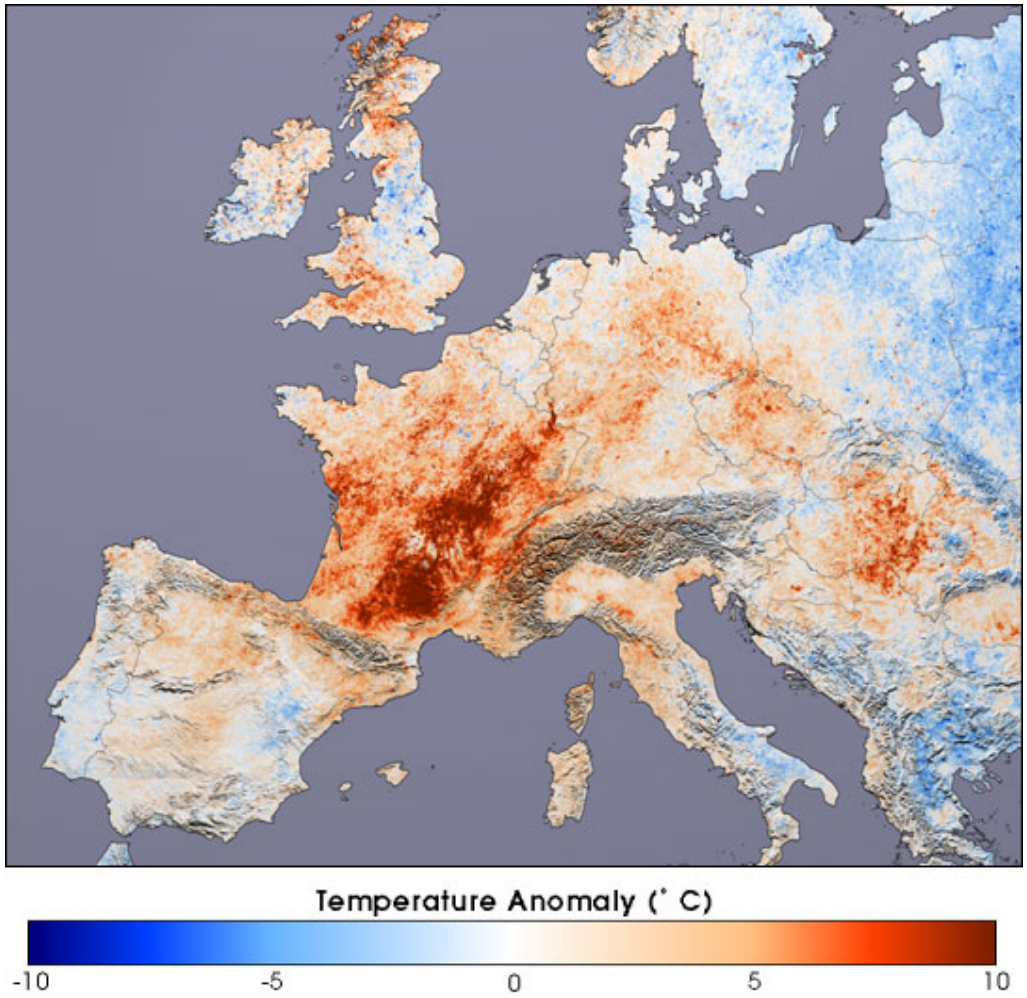
- Levels of carbon dioxide have increased from ~280 to 378 ppm (35% increase)
- Carbon dioxide will continue to increase (~500±50 ppm)
- Temperature has increased/will continue.
- Snowpack & water equivalents have decreased.



What Does This Mean for the Individual Tree

- It depends!
- The increase in CO_2 should act as a fertilizer. Tree growth should increase.
- **Therefore**, where it is wet or the soil is deep, productivity **might** increase.
- **However**, where it is dry, the stand is dense, or the soil is thin:
  - Trees close stomata, save water, & survive or
  - Mortality is likely to occur because of a complex of other factors. Leaf, branch, tree, stand!
  - 2003 Heat Wave in Europe

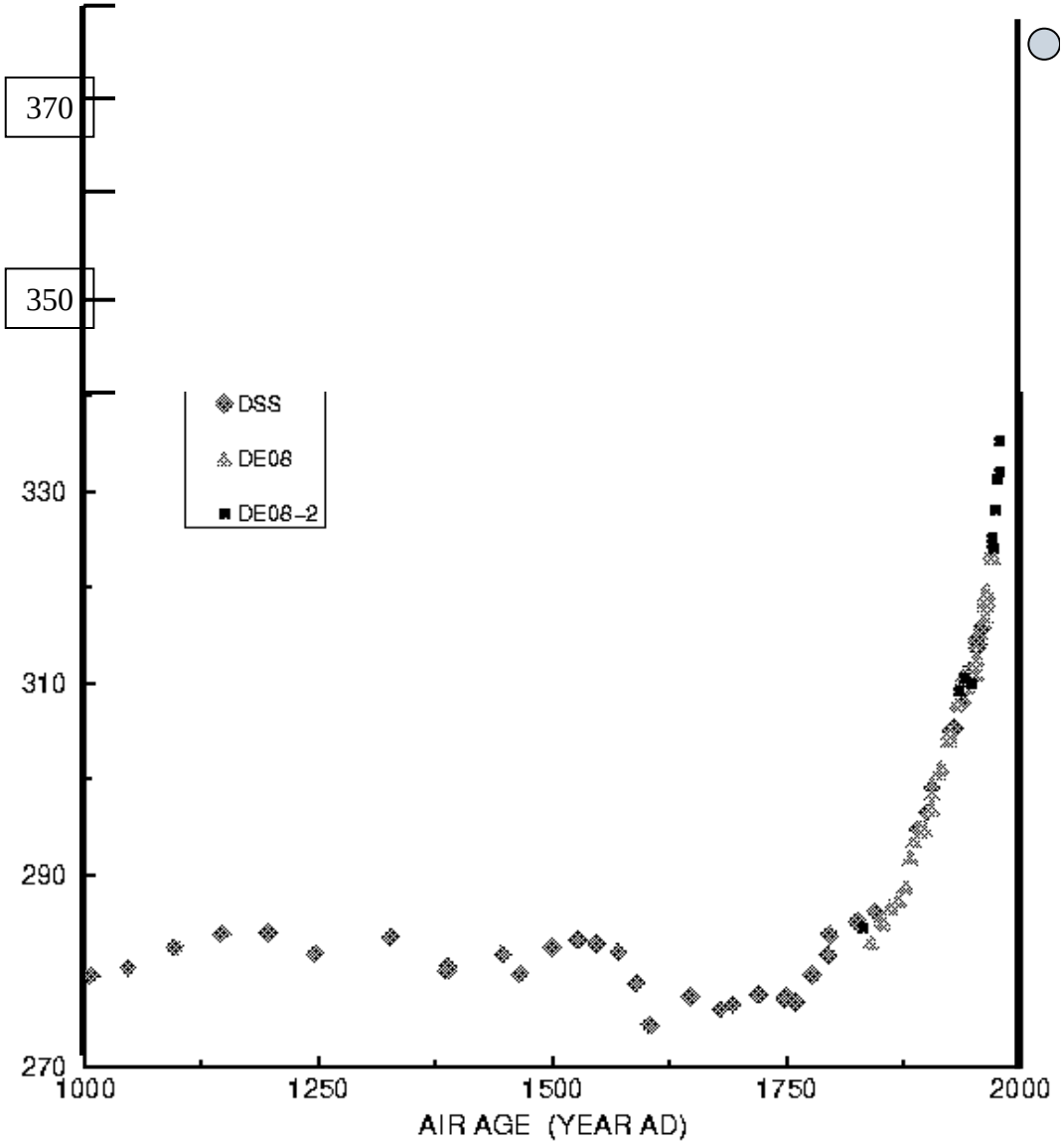
European Heat Wave



- For 2004, there was a 1.5 billion ton decrease in CO_2 uptake!

What do we know about CO_2?

- Increased 35%
- Will increase by 35 to 40%.
- Carbon is a limiting nutrient or resource just like nitrogen and water




Center of
CO_2-spring
Trees in
600-800 ppm CO_2

How do trees (and plants) respond to increases in CO_2?

- Simple systems: Uniform increase in productivity (≤ 50%).
- Complex systems (≤30%; average ~ 12%)
- Variability increases.
- Four troubling pieces of information:
  - Invasive species response > native species.
  - Maximum ability to respond already reached
  - Insect & disease behavior largely unknown
  - Decomposition & nutrient cycling difficult

Will elevated CO_2 compensate?

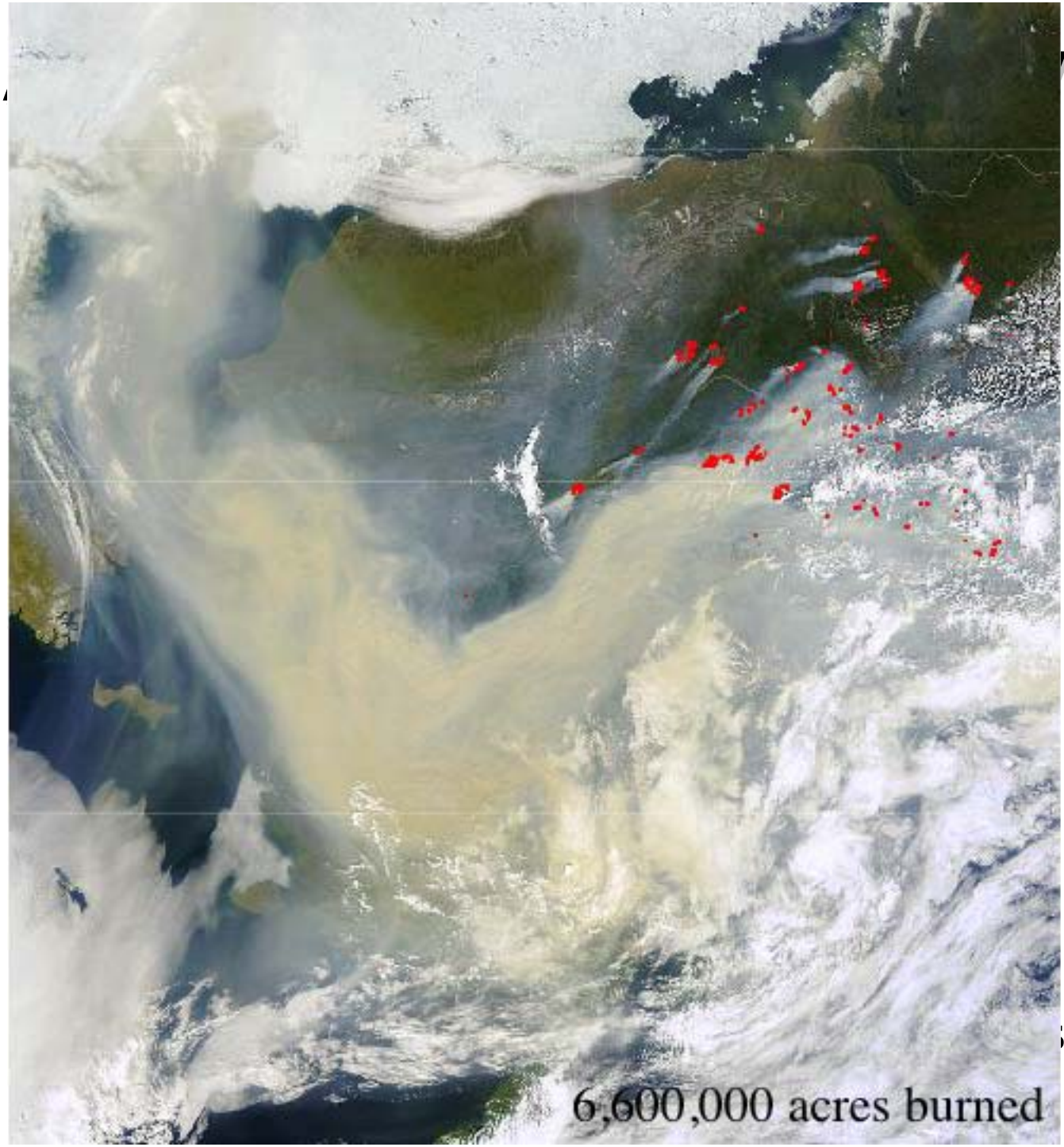
- It depends.
- Much more complex.
- Climate change is more than elevated CO_2.
- Let's examine.

Examples of Drought and Insect Induced Mortality in Forest Types

- Three examples
  - Spruce bark beetle in Alaska and the Yukon
  - Drought and bark beetles in pinyon pine of the basin and desert SW (3rd largest forest type).
  - Mountain pine beetle and lodgepole pine in British Columbia

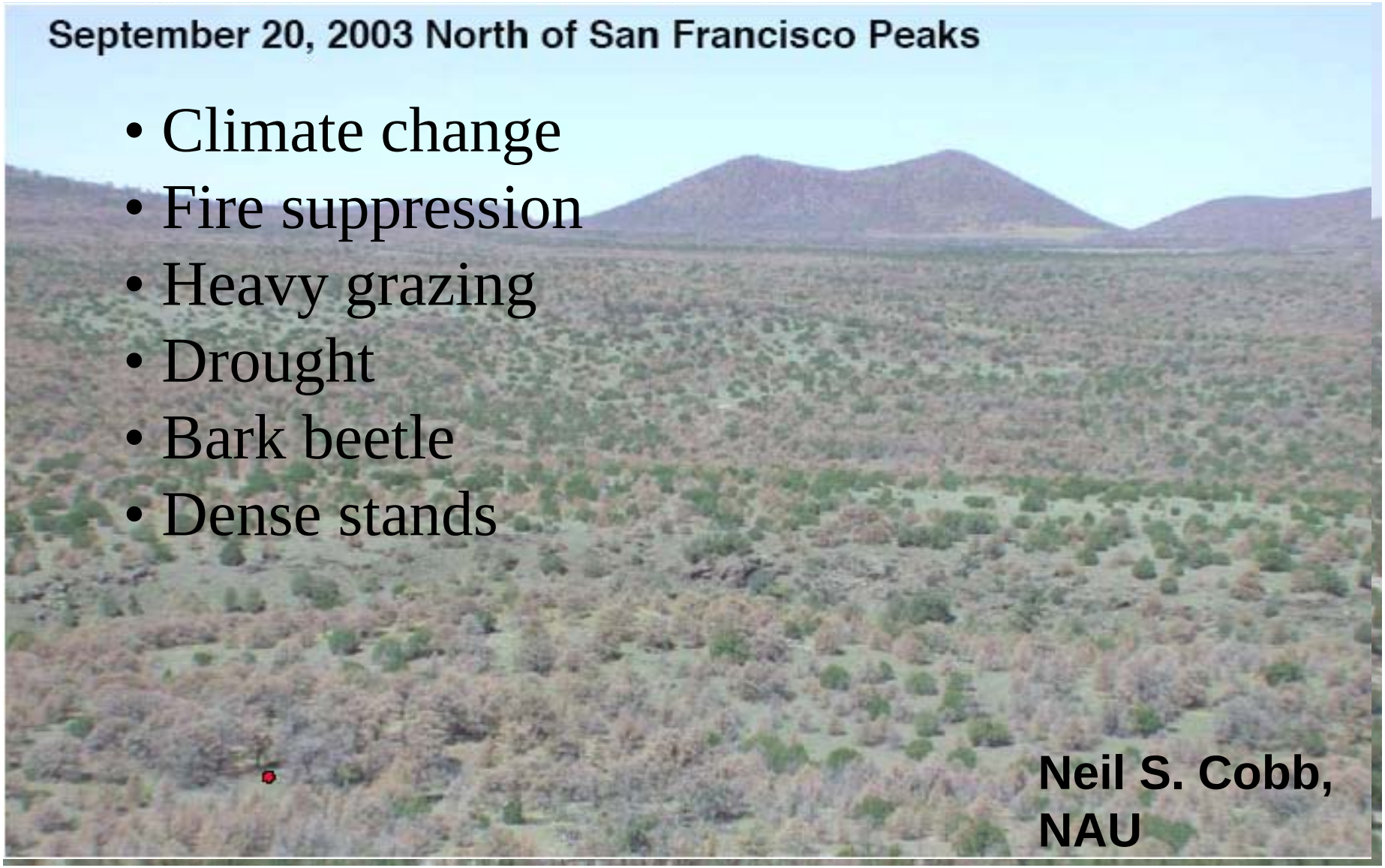
Spruce Bark Beetle - Alaska

- 3.2 million acres
- Kenai Peninsula
- **Low rainfall, summer temperatures 3ºF higher**
- **Tree health or vigor**
- **Insect life cycle**



equences?

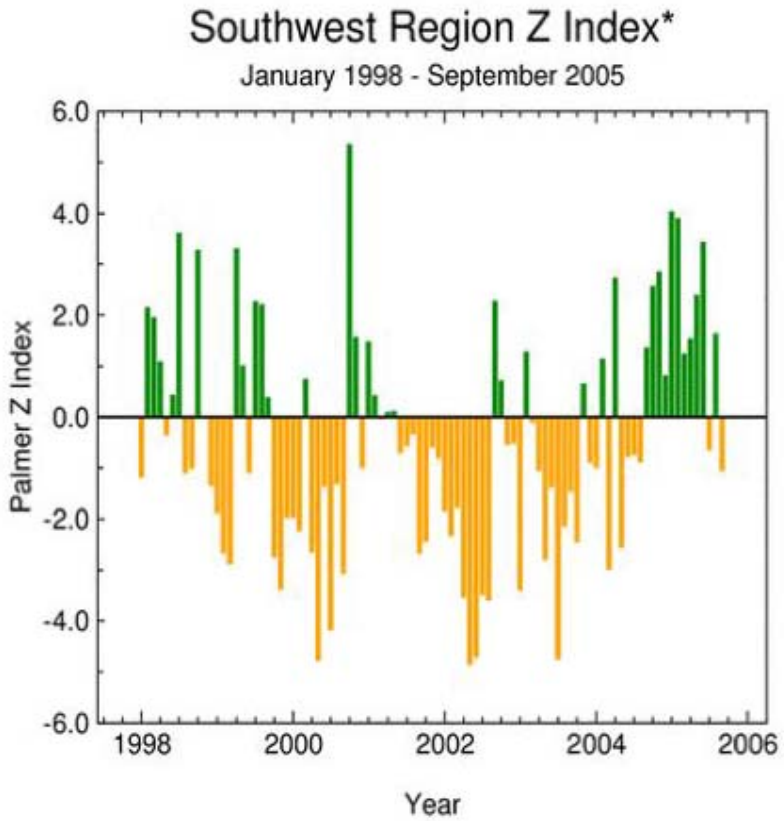
Pinyon pine


September 20, 2003 North of San Francisco Peaks
• Climate change
• Fire suppression
• Heavy grazing
• Drought
• Bark beetle
• Dense stands
Neil S. Cobb, NAU

Pinyon Pine - 110 years of

Pinyon Mortality - is it really due to …

- Climate change?
- Drought?
- Density?
- Insect life cycle?
- Heavy grazing?
- Fire suppression?

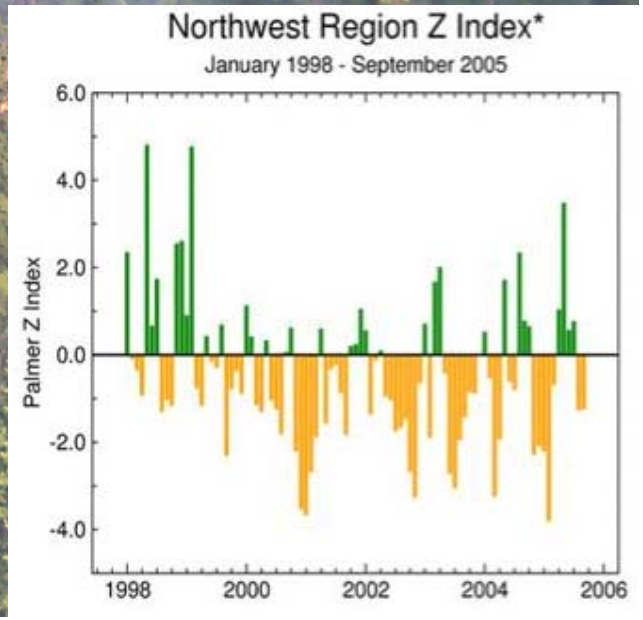


Mountain pine beetle: BC

- 1999 - 410,000 acres affected
- 2004 - 17,350,000 acres (> West Virginia)

What about the Pacific Northwest?

- Prolonged drought
- Low snow pack
- Very low SWE
- Water shortages
- Fire
- Response of trees
- It depends!



Summary

- There will be good news: CO_2 can increase growth. May have already seen maximum response except for invasives
- There will be bad news.
- These are likely spatial and temporally separated.
- There will be change and with change comes increased risk and uncertainty.


Thank you.
Tom Hinckley