Forest histories
&
Forest futures

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Last 400,000 yrs

Temperature and CO₂ concentration in the atmosphere over the past 400,000 years (from the Vostok ice core)

>380 ppm in 2005

Unprecedented climate change

Last 2000 yrs

Last 150 yrs

Temperature and CO₂ concentration in the atmosphere over the past 2000 years

Temperature change from present, °C

Temperature and CO₂ concentration in the atmosphere over the past 150 years

Carbon Dioxide in atmosphere at Mauna Loa (approx 372 in 2003)

“History is more or less bunk.”

~Henry Ford, 1916
Lakes are the place!
Sediment records with annual precision

Crevice Lake, YNP
MSU Paleoecology Lab
Douglas-fir pollen (80 microns)

Ragweed pollen (30 microns)

Charcoal particles

Fossil beetle remains
GYE: 20,000 years ago

Smith & Siegel, 2000
Climate
(climate variability, mean state)

Fire
(frequency, size, intensity)

Vegetation
(composition, structure)

Humans
(ignition, suppression)
40,000 years of vegetation dynamics at Little Lake, OR

Worona & Whitlock, 1995
Long et al., 1998
Grigg et al., 2003
Little Lake, Oregon Coast Range

Worona & Whitlock, 1995
20,000 years ago:
Full-glacial cold dry period

15,000 years ago
Late-glacial warming

present
Regional vegetation-climate patterns

Updated from Mock and Brunelle, 1999
Location matters

- rhyolite
- andesite
- glacial
Geology influences the vegetation

Glacial deposits: grassland

Yellowstone eruptions
rhyolite: lodgepole pine forest

Older volcanic eruptions
andesite: spruce/fir forest

Photo: Tom Murphy
Cygnet Lakes, Yellowstone NP
Cygnet Lake on rhyolite

Millspaugh et al., 2000
Cygnet Lake on rhyolite

Millspaugh et al., 2000
Cygnet Lake on rhyolite

Millspaugh et al., 2000
Geology has affected the vegetation history

- Glacial deposits: grassland
- Yellowstone eruptions
  - Rhyolite: lodgepole pine forest
- Older volcanic eruptions
  - Andesite: spruce/fir forest

Photo: Tom Murphy
~Lessons learned~

- Lakes are excellent sources of environmental information;
- Large-scale patterns in vegetation change are a response to large-scale changes in climate;
- At single sites, vegetation changes can be large and rapid;
- Challenge is to separate climate from local drivers of environmental change.
Climate (climate variability, mean state)

Fire (frequency, size, intensity)

Vegetation (composition, structure)

Humans (ignition, suppression)
**High Country News**

**Burning issues**

Australia's cities impinge upon an ancient landscape shaped by fire. Carina Dennis talks to the researchers who are striving to protect lives and property, while retaining natural fire regimes that nurture the land.

**ECOLOGY**

**Salvage Harvesting Policies After Natural Disturbance**

D. B. Lindenmayer,1 D. R. Foster,2 J. F. Franklin,3 M. L. Hunter,4 R. F. Noss,5 P. A. Schmigolow,6 D. Perry7

Salvage harvesting policies are a key component of natural resource management after natural disturbances. Policy makers need to understand the biological legacies produced by natural disturbances. Recent large-scale natural disturbances include wildfires burned nearly 1.5 million ha in Indonesia in 1997–98, 1.0 million ha in Russia, 1.1 million ha in Brazil (1–2), 0.9 million ha in Canada and 4 million ha in the US. The policy implications of these large-scale disturbances are often poorly understood by policy makers.

**News Focus**

**Land management**

**Forests, fires and climate**

Cathy Whitlock

A new analysis of the effect of climatic variation on forest fires goes back several thousand years. One take-home message is that global climate change, which has only a few decades, may have a profound effect on fire regimes, and that successional sequences are likely to change as the climate changes.

Seemingly unprecedented events in human lifetimes can be business-as-usual when viewed on longer time-frames. But that's not always recognized. For example, management strategies in the United States that seek to restore landscapes must be reevaluated.

In the past 15 years, the western United States has experienced some extreme fires that are notable for their size and severity. The annual costs of fire suppression now exceed $1.6 billion, and the burning seems nowhere in sight. In the absence of large fires during most of this period, fire risk has increased.

**Fire in the Earth System**


Fire is a worldwide phenomenon that appears in the fossil record soon after the appearance of terrestrial plants. Fire influences global ecosystem patterns and processes, including vegetation diversity, land use, and fire frequency. Fire has been both a positive and negative force in the evolution of terrestrial ecosystems.

**Implementation of National Fire Plan treatments near the wildland–urban interface in the western United States**

Tanja Schoennagel1,2, Cara R. Nelson3, David M. Theobald4, Gunnar C. Cannwitz3, and Teresa B. Chapman4

The National Fire Plan is a set of treatments designed to reduce the risk of catastrophic fire in the western United States. The plan includes a variety of strategies, including prescribed burning, thinning, and the creation of firebreaks. The treatments are intended to reduce the risk of large, uncontrolled fires and to enhance the resilience of ecosystems to future fires.
Fires are nothing new!

35-55-my-old *Sequoia* have fire scars
Different explanations at different spatial and temporal scales.
Fires in the Western U.S.

Lightning-Started Fires 1986-1996

Human-Started Fires 1986-1996

National Fire Occurrence Data Base  http://www.fs.fed.us/fire/fuelman/

P.J. Bartlein, unpub.
1986-1996 Daily Fire Starts

Bartlein et al. (2003)
Years with Large Area Burned are associated with:
- Well-developed upper-level ridge
- Sinking air
- Persistent high pressure system

Bartlein, unpublished
How frequent are large severe fires?
Fire history:
Fire-scars on tree rings

- Extend back 300-500 years
- Spatially & temporally precise
- Describe fires that don’t kill trees
Fire history:

Charcoal records

- 1000s years old
- Describe severe fires
- Register local & regional fires
Fire-climate linkages on millennial time scales

Cygnet Lake, central YNP

Fire frequency changed, even when vegetation did not.

Millspaugh et al., 2000
Different parts of YNP have different fire histories
Lessons learned

Fire and climate are closely linked on many time scales:

• Information from historical, tree-ring, and charcoal records;

• Large-area burns associated with predictable circulation patterns;

• We’ve had lots of fires, and regional differences in fire history. Knowing time of last fire is not enough.
Climate (climate variability, mean state)

Fire (frequency, size, intensity)

Vegetation (composition, structure)

Humans (ignition, suppression)
Fire-human linkages

Patagonia?

American West?
Willamette Valley Fire History

Walsh, 2008
Willamette Valley, western Oregon

- Prehistoric human influence is localized;
- Decrease in fires in last 600 years;
  - Cooler climate during Little Ice Age?
  - Decrease in human populations?
- Euroamericans burned a lot initially.
Can we separate human-set fires from natural ones?
Before the Māori arrived

- Fires were generally rare.
- Fire return intervals typically > 500 yrs
- Native species not adapted to fire and highly vulnerable

Ogden et al., 1998
After Māori arrived

- Fire frequency increased dramatically;
- Fire return intervals < 20 yrs;
- Dramatic shift in vegetation from forest to grasses and shrubs.
NZ loss of forest in the last 700 years
Initial Burning Period

(AD 1250-1400)

McWethy et al., 2009
Response of watersheds to Initial Burning Period

Lake Diamond
- IBP
- Erosion

Lake Kirkpatrick
- IBP
- Erosion

Lake Thomas
- IBP
- Erosion

Lake Te Aroha
- IBP
- Erosion

Years before fire

Years after fire
Unresolved Questions

- What motivated Māori burning?
- What is the spatial pattern of burning?
- Why did burned forests NOT recover?
- What role did climate play?
Global patterns in fire history
(Global Palaeofire Working Group, IGBP activity)

Changes in fire regimes since the Last Glacial Maximum:
an assessment based on a global synthesis and analysis
of charcoal data

M. J. Power · J. Marlon · N. Ortiz · P. J. Bartlein · S. P. Harrison · F. E. Mayle · A. Ballouche ·
R. H. W. Bradshaw · C. Carcaillét · C. Cordova · S. Mooney · P. I. Moreno · I. C. Prentice ·
K. Thonicke · W. Tinner · C. Whitlock · Y. Zhang · Y. Zhao · A. A. Ali · R. S. Anderson · R. Beer ·
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M. Walsh · X. Wang · N. Williams · J. Wilmshurst · J. H. Zhang

Climate Dynamics, 2008
Wildfires have been a natural part of the Earth system for millions of years. A new charcoal database for the past two millennia shows that human activity increased biomass burning after AD 1750 and suppressed it after AD 1870.

Climate and human influences on global biomass burning over the past two millennia


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Global patterns in biomass burning in the last 2000 years: another hockey stick?

Marlon et al., 2008
Global biomass burning trends

- Declined between AD 0-1750 (climate)
- Rose between AD 1750-1870 (forest clearance)
- Declined after AD 1870 (land-use changes)
The impact of contemporary human activity has been to reduce biomass burning.

Marlon et al., 2008
~Lessons learned~

Fire-human linkages are understandable on multiple spatial and temporal scales:

- Prehistoric burning was localized in western US;
- Anthropogenic burning in the absence of natural fires is profound and long-lived;
- Charcoal levels have declined in last century (fire elimination and land-cover change).
“As a rule, we get as much information out of what [history] does not say as we get out of what it does say...history consists of two equal parts: one of these halves is statements of fact, the other half is inference, drawn from fact.”

~Mark Twain, 1901
Understanding forest resilience requires historical perspectives.

Ecosystems change on all time scales, but which is the most relevant for managing forests in the face of climate change?

Scale and impact of recent anthropogenic burning has been large.

Why history?

Suppression costs (Forest Service):
2002: $1.2 billion
2006: $1.5 billion
2007: $1.4 billion

Westerling et al., 2006