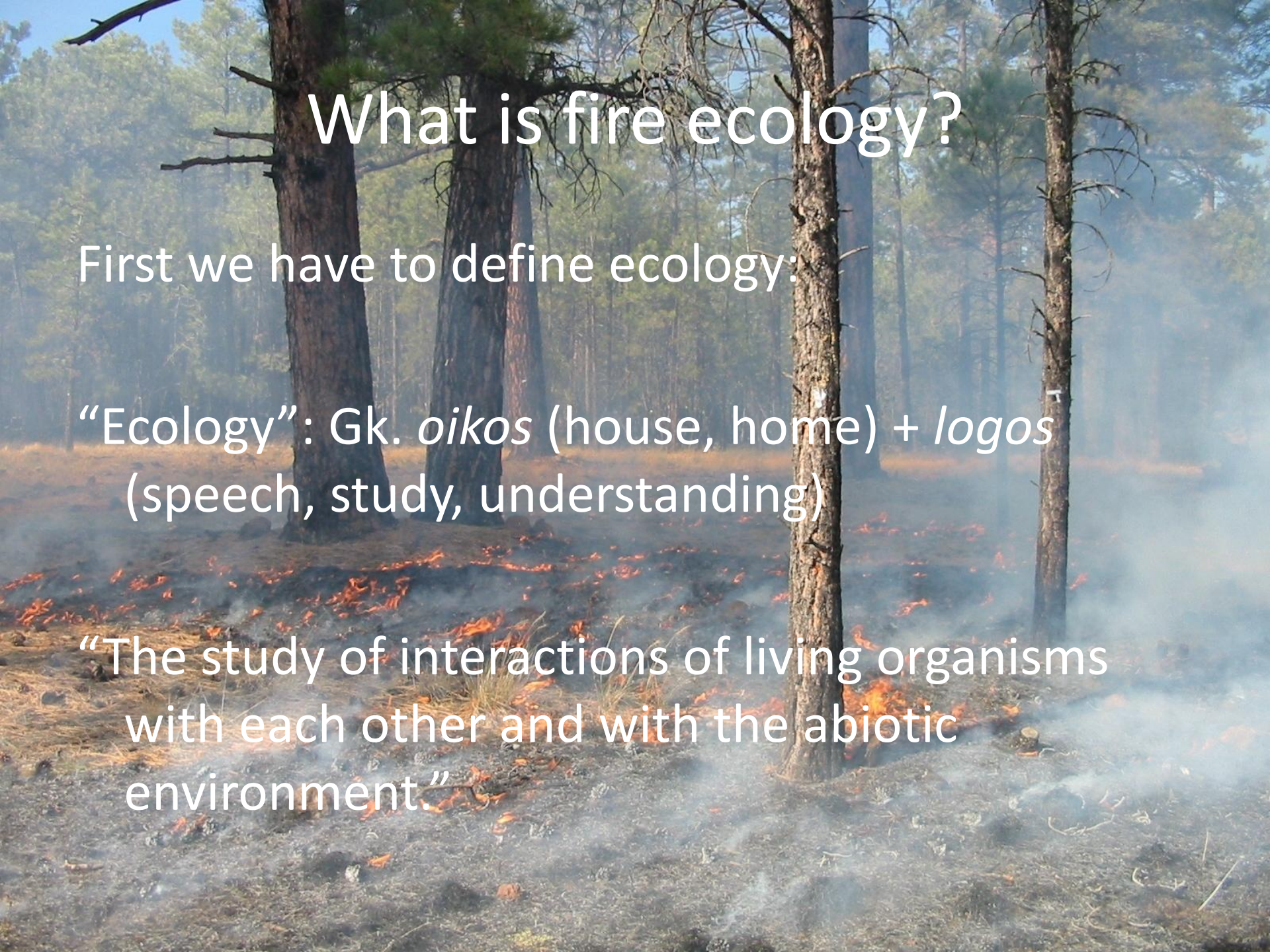
Unit 3: Fire ecology

3.1 Fire effects

Our story thus far:

- ✓ Fire fundamentals: fire as a physical process
- ✓ Fire behavior
- ❖ **Fire ecology**
  - Fire regimes
  - Fire management
  - Fire in a changing world



What is fire ecology?

First we have to define ecology:

"Ecology": Gk. *oikos* (house, home) + *logos* (speech, study, understanding)

"The study of interactions of living organisms with each other and with the abiotic environment."

Is fire itself on the "living organism" side or the "abiotic" side?

- Fire burns biomass, which (by definition) is the composed of living organisms
- Fire is central to many interactions among organisms (this will be a central topic of this section)
- On the other hand, fire is a (presumably) inanimate physical process, the oxidative combustion of gases
- What do you think?

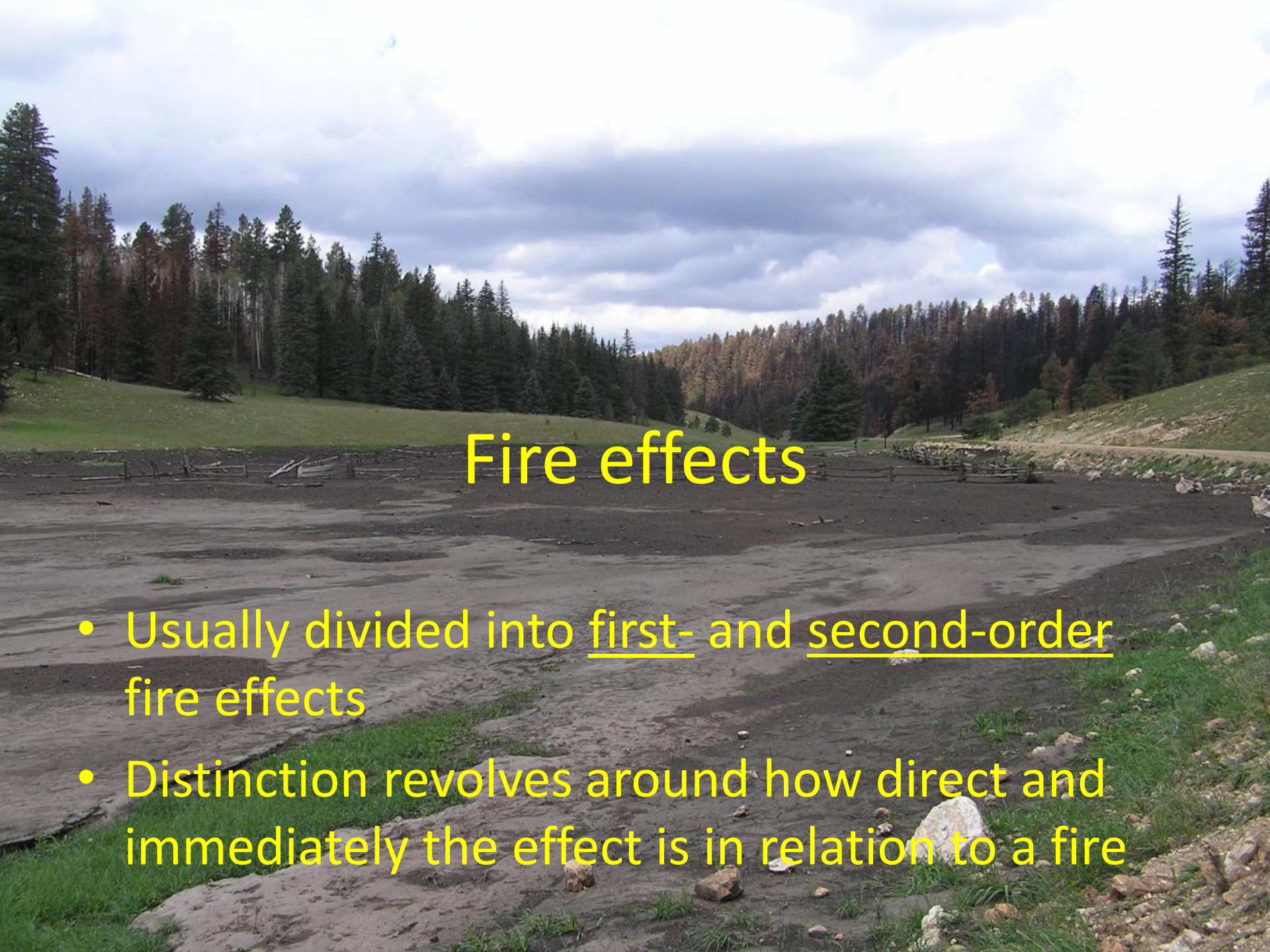
Some central themes in fire ecology

Fire has effects on:

- Soil
- Water
- Air
- Plants
- Animals
- Aquatic ecosystems
- Fungi

Fire has effects across levels of biological organization

- Species and populations
- Plant communities
- Watersheds
- Ecosystem processes
  - Carbon
  - Hydrologic cycles
  - Biogeochemical cycles



Fire effects

- Usually divided into first- and second-order fire effects
- Distinction revolves around how direct and immediately the effect is in relation to a fire

First-order fire effects

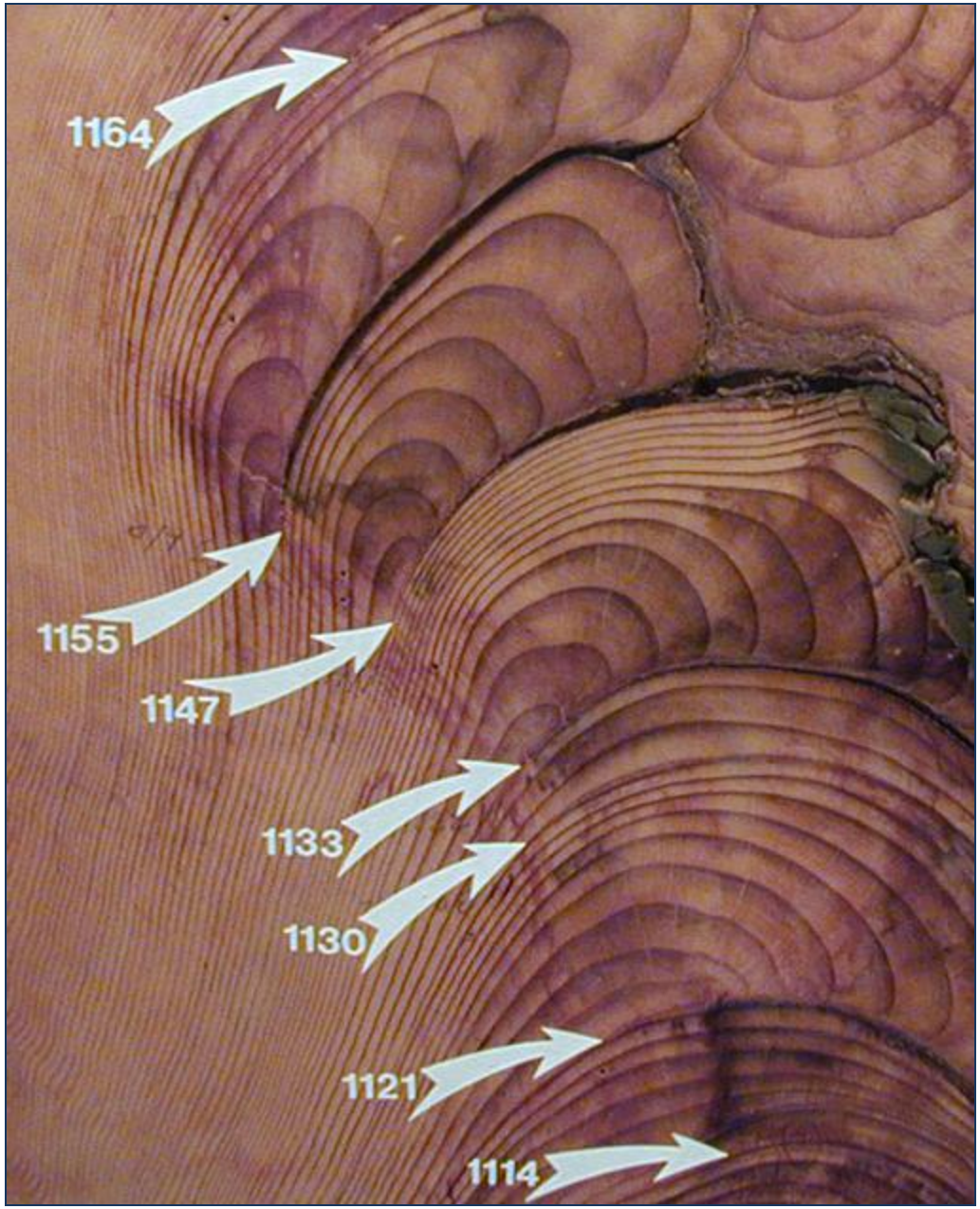
- Occur during or immediately after a fire
- Localized to the burned area
- TPS: some examples?

Some examples of 1st order fire effects:

- Burned or scorched foliage
- Tree cambium or meristems killed by heat > 65 ^{o}C
- Terrestrial animal mortality from heat exposure
- Mortality of aquatic organisms from heating of streams
- Litter or duff layers consumed (fine fuels)
- Germination of seeds that use smoke as a “cue”
- Structure and chemistry of soil profile altered by heating
- Smoke effects on air chemistry
- Release of sequestered carbon into the atmosphere
- Volatilization of soil nitrogen

Tree-scale first order effects

- Damaged, killed or consumed:
  - **foliage**
  - **terminal buds** (vertical and lateral growth)
  - **roots** (esp. fine roots near surface)
- Heat flux through bark kills **cambium** (radial growth of stem)



Tree scale

Fire scars form on living trees when portions of the cambium (growing surface of the stem) are killed by heat flux through the bark

Multiple fire scars in *Sequoiadendron giganteum*, Giant Sequoia. T. Swetnam and C. Baisan, UA-LTRR


UGA0808093

Calvin Farris, University of Arizona

Fire effects give us an index of fire severity

Fire severity: The magnitude of effects of fire on biotic or abiotic elements of an ecosystem

Fire intensity: Heat output from combustion

Do NOT confuse these two!!!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Smoke is a first-order effect on air quality

Second-order fire effects

- Second-order effects arise as a consequence of first-order effects
- May involve:
  - delayed effects in time
  - displaced effects in space
  - effects on higher levels of biological organization (communities, ecosystems)

Some examples of 2nd order fire effects:

- erosion resulting from rain on damaged soils
- altered competition between species (e.g. fire tolerant *vs.* fire sensitive, trees *vs.* shrubs)
- increased tree growth resulting from available (mineralized) nitrogen
- mass attack of weakened trees by bark beetles
- changes in the abundance and distribution of disease organisms and parasites
- altered age and size structure in species populations resulting from differential mortality
- post-fire openings and in forests and or woodlands

Severe post-fire erosion in the Chiricahua Mountains following the 1994 Rattlesnake Fire

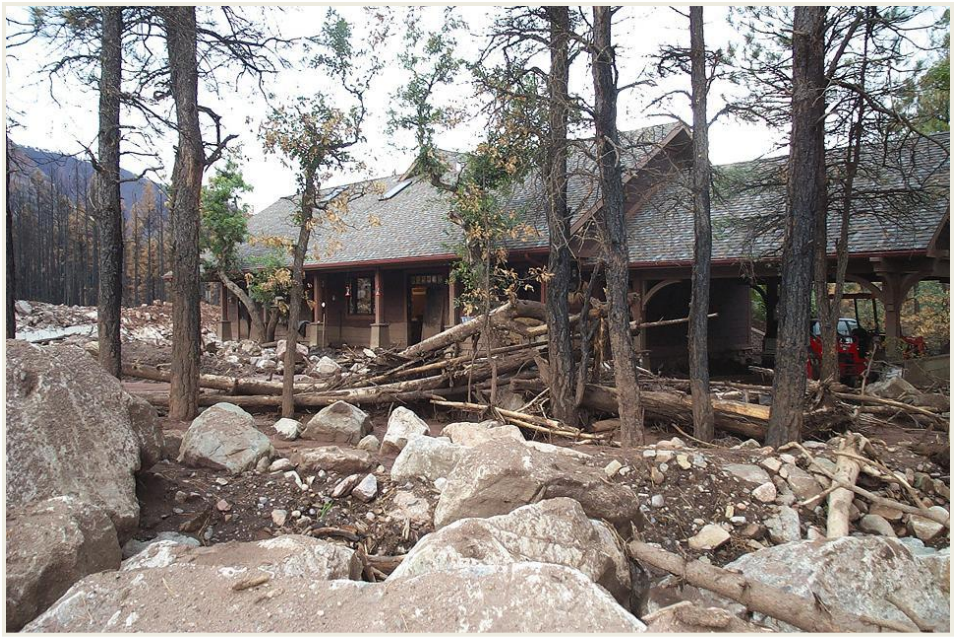
More than 15 meters of sediment eroded in Turkey Creek – about 100,000 years of accumulation

Photos: Tom Swetnam and Chris Baisan, UA-LTRR

Removal of channel and fan material is a dominant feature of the geomorphic response to the Missionary Ridge Fire event:

Increased runoff initiated debris flows and sediment-laden floods throughout the burned area:

- Debris flow producing basins burned at > 70% moderate and high severity
- < 2 year return interval rain events



From Bigio (2007)

Post-fire regeneration

- Fires frequently reset inter- and intra-specific competition
- Seeds of some species require fire for dispersal and/or germination
- Some species (*e.g. Populus tremuloides*) can colonize clonally post-fire
- Result: commonly observed post-fire pulses of regeneration occur in some (but clearly not all!) fire regimes
- *But*: “post-fire” regeneration of many species may be years or decades later!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Rocky Mountain Lodgepole Pine/Spruce-fir

U.S. Forest Service, Idaho Panhandle National Forest

- Notice that 1st order fire effects are often at the level of individual organisms or populations, or fine-scale biophysical elements (soil, water)
- 2nd order fire effects are often at higher levels of organization (communities, ecosystems)

Mapping burn severity

- Can be done on the ground, from planes or satellites, or combinations thereof
- On the ground: surveys esp. of soil and vegetation condition, remaining fuels
- Aerial satellite: based on reflectance in bands that detect soil, moisture, and chlorophyll (Yool lecture, 10 October)

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mtbs.gov
scb smith fellowship

Monitoring Trends in Burn Severity (MTBS) is a multi-year project designed to consistently map the burn severity and perimeters of fires across all lands of the United States for the period spanning 1984 through 2010. The data generated by MTBS will be used to identify national trends in burn severity, providing information necessary to monitor the effectiveness and effects of the National Fire Plan and Healthy Forests Restoration Act. MTBS is sponsored by the Wildland Fire Leadership Council (WFLC), a multi-agency oversight group responsible for implementing and coordinating the National Fire Plan and Federal Wildland Fire Management Policies. The project will be conducted through a partnership between the U.S. Geological Survey National Center for Earth Resources Observation and Science (EROS) and the USDA Forest Service Remote Sensing Applications Center (RSAC).

The MTBS project objective is to provide consistent, 30 meter resolution burn severity data and fire perimeters that will serve four primary user groups:

1. National policies and policy makers such as the National Fire Plan and WFLC which require information about long-term trends in burn severity and recent burn severity impacts within vegetation types, fuel models, condition classes, and land management activities.
2. Field management units that benefit from mid to broad scale GIS-ready maps and data for pre- and post-fire assessment and monitoring. Field units that require finer scale burn severity data will also benefit from increased efficiency, reduced costs, and data consistency by starting with MTBS data.
3. Existing databases from other comparably scaled programs, such as Fire Regime and Condition Class (FRCC) within LANDFIRE, that will benefit from MTBS data for validation and updating of geospatial data sets.
4. Academic and agency research entities interested in fire severity data over significant geographic and temporal extents.

MTBS is divided into zonal and temporal analysis phases and includes a technical transfer component. See the schedule map to view analysis schedules by mapping zone. Current fires, beginning with 2004, will be mapped for the entire United States on an annual basis. Historical fires (1984-2003) will be mapped according to the schedule.

MTBS is based on image processing and analysis methods currently utilized by the USGS and USFS for existing post-fire burn severity mapping efforts. The USGS Landsat Thematic Mapper image archive will provide a consistent and continuous source of 30 meter resolution data going back to 1984 for mapping burn severity of all fires greater than 1000 acres in the west and 500 acres in the east.

Please check for the latest news and updates on the What's NEW page.

USGS

RSAC

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Post-Fire Vegetation Conditions

(enter query) Search

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U.S. Forest Service
Attn: Forest Management
1400 Independence Ave., SW,
Mailstop: 1103
Washington DC 20250-0003

Please contact us with questions or comments regarding this website.

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Post-Fire Vegetation Conditions on the National Forests

This website offers an initial description of post-fire vegetative conditions using the ***Rapid Assessment of Vegetation Condition after Wildfire (RAVG)*** process. RAVG analysis looks at fires that burn more than 1,000 acres of forested National Forest System (NFS) lands, beginning with fires that occurred in 2007. These fires result in direct losses of vegetative cover and many of the benefits associated with forested ecosystems.

NFS lands experience thousands of wildfires every year, most of which are relatively small. The largest fires typically account for 90% of the total acreage burned. RAVG analysis provides a first approximation of areas that due to severity of the fire may require reforestation treatments. These reforestation treatments would re-establish forest cover and restore associated ecosystem services. This initial approximation could be followed by a site-specific diagnosis and development of a silvicultural prescription identifying reforestation needs.

NOTE: RAVG data is not available for Region 5 (California) prior to 2008. Visit the U.S. Forest Service Pacific Southwest Region: *The Threat of Deforested Conditions in California's National Forests* website for information prior to 2008.

RAVG Data Access & Summaries

Step 1. Introduction

This interface allows you to access and download RAVG data as well as create graphical and tabular summaries of the data. The interface is designed to provide a quick and customizable way for you to access and summarize results from RAVG. After choosing either the Fire Name Query or Advanced Query option below, simply provide the information requested on the Query Builder page, and corresponding graphical and tabular summaries will be created based on the selection criteria you provide.

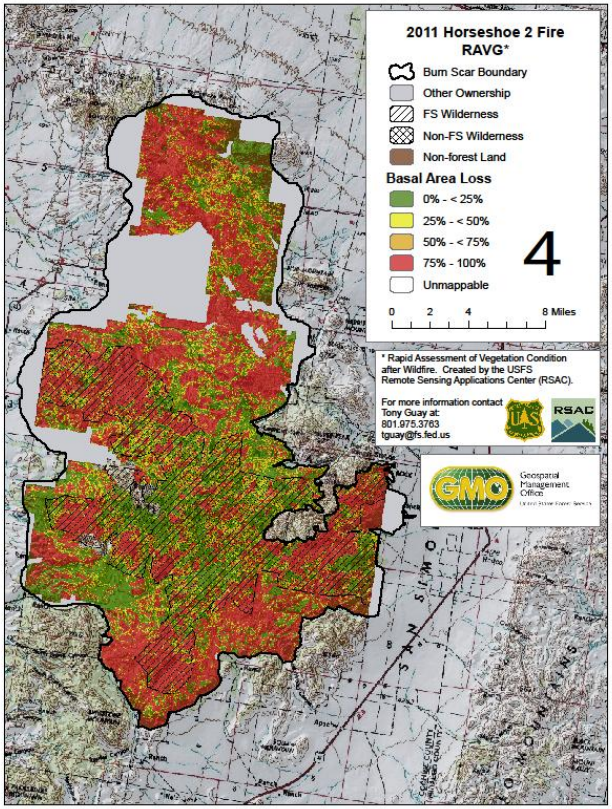
This interface is not meant to provide answers to all of the questions you might have, but it is designed to allow you to explore, summarize, and view trends from fires that are contained in the RAVG database. RAVG data packages (i.e., the full RAVG product suite for a fire) are available for download when using the Fire Name Query option. This enables you to perform customized analysis of your own for any fire that is in the RAVG database.

Please select one of the two query options shown below to begin.

Horseshoe II fire (Chiricahua Mts, 2011), Soil burn severity

- 12% high severity
- 30% moderate
- 38% low
- 20% unburned

Burn Severity	Acres
Unburned/Very Low	44,146
Low	84,852
Moderate	66,226
High	27,730



Sources of information about fire effects

The Fire Effects Information System (FEIS)

http://www.fs.fed.us/database/feis/

FEIS Home - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://www.fs.fed.us/database/feis/
Most Visited Getting Started
FEIS Home
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Fire Effects Information System

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FEIS Reviews:

- Animal species
- Lichen species
- Plant species
- - Invasive plants
- Fire Studies
- Kuchler types

Fire Citation Database

- Citation Retrieval System

System Information:

- About FEIS
- Format of FEIS reviews
- Fire Regimes of the US
- Glossary
- Pesticide precautionary statement
- Tutorial

Contact:
Jane Kapler Smith
406 329-4805,
jsmith09@fs.fed.us

FEIS Home Page

Search FEIS:

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FEIS summarizes and synthesizes research about living organisms in the United States—their biology, ecology, and relationship to fire.

To cite information from a FEIS review, copy and paste the Authorship and Citation section from the INTRODUCTORY page.

Example:

Tollefson, Jennifer E. 2008. Calocedrus decurrens. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis [2008, September 22].

Other fire effects reports available online:

RMRS-GTR-42-vol. 1. Wildland fire in ecosystems: effects of fire on fauna
RMRS-GTR-42-vol. 2. Wildland fire in ecosystems: effects of fire on flora
RMRS-GTR-42-vol. 4. Wildland fire in ecosystems: effects of fire on soils and water
RMRS-GTR-42-vol. 5. Wildland fire in ecosystems: effects of fire on air
RMRS-GTR-42-vol. 6. Wildland fire in ecosystems: fire and nonnative invasive plants

More information on fire research and management: FRAMES

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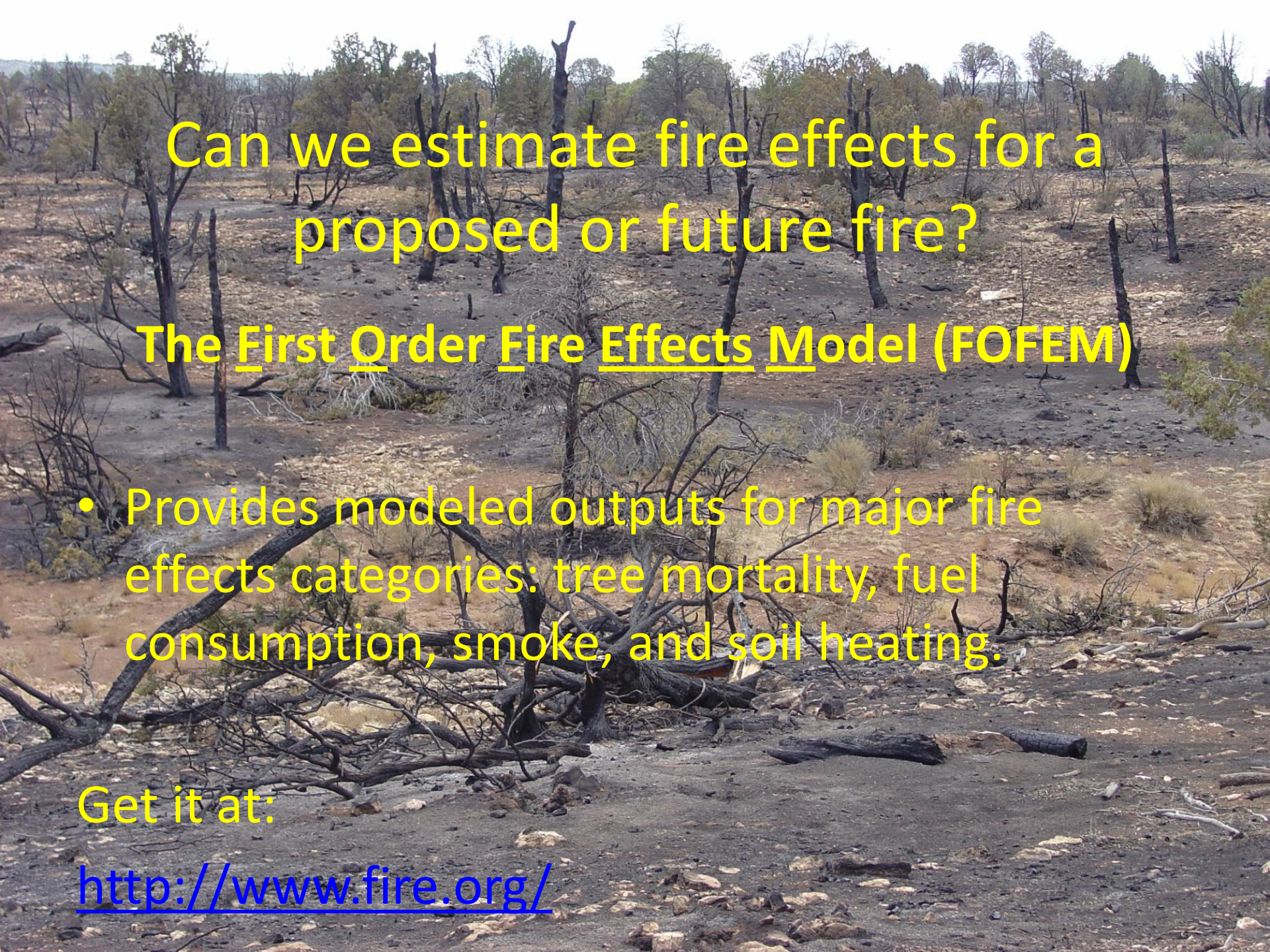
How does FEIS work?

- Collects and catalogues information on 1st and 2nd order fire effects by organisms
- Accessible database with references
- Your taxes at work (*i.e.*, it's a public resource)
- Similar data sources in Canada, Australia, Europe

Try it!



Can we estimate fire effects for a proposed or future fire?

The First Order Fire Effects Model (FOFEM)

- Provides modeled outputs for major fire effects categories: tree mortality, fuel consumption, smoke, and soil heating.

Get it at:

http://www.fire.org/