Fire Ecology and Conservation
Mary Jane Epps

84% of important global conservation areas are considered at risk because of human-caused changes to the natural fire regime. (TNC)

Fire History Pre-1900
Active use of fire by Native Americans
- hunting
- crop management
- improved grazing for animals
- pest management

Frequent fires up to 1900 (tree rings!)
- Low-intensity surface fires
- Patchy burning pattern diversified landscape
- Stand-replacing or catastrophic fires rare

Fire Suppression in 20th Century America
- 1905 US Forest Service Created – fire management
- 1910 Big Blow Up – 3 million acres burned in Montana & Idaho; 85 dead
- 1933 Tillamook fire (Oregon) – "10 am policy" adopted in response
  - Formation of CCC
- 1950 Smoky the Bear
- 1961 Burned acreage ~ 3% of 1910 acreage

The Ecological Role of Fire
The Ecological Role of Fire: Key Terms

- **Fire Regime**
  - Describes various fire characteristics for an ecosystem (e.g., fire intensity, severity, frequency, and vegetative community)

- **Fire Dependence**
  - Many plant species depend on fire to make their environment more suitable for growth and/or regeneration

Not all fires are created equal….

- **Surface Fire**
  - Frequently low intensity
  - Frequently patchy
  - Slow-moving
  - Soil heating
  - Clears out understory

- **Crown Fire**
  - High intensity
  - Fast-moving (uncontrollable)
  - Stand-replacing
  - Little soil heating

Variation in Fire Intensity

- **Fire intensity** closely tied to fuel load

- **Factors affecting fuel load (today unusually high)**
  - Insect damage (e.g., gypsy moth, woolly adelgid, pine bark beetle)
  - Disease
  - Storm damage (esp. from wind & ice)
  - Logging

Ecosystem Effects of Fire

- **Biodiversity Effects**
  - Evidence for increased plant and insect diversity after low intensity, patchy fires

- **Soil Effects**

- **Watershed Effects**

- **Effects on Invasive Species**

Ecosystem Effects: Fire and Soils

- **Low intensity fire**
  - Usually (not always!) low soil temperatures
  - Releases N and minerals into soil (mineral-rich ash)
  - Organic layer usually not wholly consumed

- **High intensity fire**
  - High soil temperatures
  - May burn away or volatilize nutrients, severely degrading soil
  - Can destroy organic layer
  - Soil can become hydrophobic and impervious to water (severe cases)

- **Crown fires**
  - May have little direct impact on soil (if pass over quickly and concentrated in tree-tops)
Watershed Effects

Pre-fire organic layer
- Sponge effect; releases water slowly
- Stabilizes soil

High intensity surface fires can destroy organic layer
- Increased water run-off leads to post-fire flooding
- Soil stabilization lost; vulnerable to erosion – leads to silting of streams, post-fire mudslides

Fire and Invasive Species

Higher disturbance opens the door to biological invasion
Especially abundant after stand-replacing fires (early-stage succession)

Fire as a management tool to fight invasives
Used to control invasives & promote native species in some ecosystems
Usually requires follow-up treatments (often herbicide)

2002 Burn at Ivy Creek Natural Area to fight exotic grasses, encourage natives

Response of Invasive Species to Burning

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Buffelgrass and a Changing Desert Fire Regime

Fire-adapted Ecosystems

- Tallgrass prairie
- Ponderosa pine forest
- Chaparral
- Longleaf pine forest
- Boreal forest and tundra
- Oak-hickory forest
- Lodgepole pine forest (Rockies)
- Sequoia
- Many others…

Tallgrass Prairie

- **Five-ten year fire cycle**
  - Low intensity fires
  - Keeps woody plants from encroaching
  - Releases nutrients for plant growth
  - Stimulates growth of prairie plants
  - Prepares seedbed
    - (seeds that are dormant in soil until conditions right)
  - Triggers seeds to leave dormancy

Chaparral

- **15-20 year fire cycle**
  - Mediterranean climate (hot, dry summers; mild, wet winters)
  - Natural decomposition slow – fire needed to cycle nutrients
  - Plants adapted to promote fire

Ponderosa Pine Forest

- **5-25 year fire cycle**
  - Forest adapted to low-intensity ground fires
  - Fire creates open, park-like stands; removes shrub layer
  - Releases nutrients from litter and preps seedbed

Plant adaptations to fire

- **Adaptations to avoid injury by fire**
  - Thick bark (e.g. ponderosa pine, oaks)
  - Rapid juvenile growth
  - Quick foliage decomposition
  - Deep vertical roots (e.g. longleaf pine)
  - Ready ability to re-sprout from roots or trunk

- **Adaptations to encourage fire** (e.g. Mediterranean climate)
  - Flammable resins in leaves (Eucalyptus, Ceanothus)
  - Fuel ladder growth form

- **Traits for post-fire colonization**
  - Fire-induced germination
  - Serotinous cones (table mountain pine)
  - Abundant, air-borne seeds
Fire and Endangered Species Conservation

Peter’s Mountain Mallow
- Known only from Peter’s Mountain, Virginia
- Population declined steadily over the 20th Century
- Only three individuals by 1991

Major threats
- Changing canopy structure due to long-term fire suppression (over-shading)
- Seeds germinate only after scarification by fire

Conservation by fire
- 1992 burn raised population count from three to 12
- 1993 burn produced >500 seedlings

Kirtland’s Warbler
- Endemic to Midwestern jack pine forests – fire adapted, serotinous cones
- Specific habitat requirements – suitable nesting habitat only within a window of 6-15 years after a fire
- Dramatic population decline following the advent of fire suppression
- Remaining habitat now actively managed through controlled burning

Longleaf Pine Forest: A Vanishing Ecosystem
- Longleaf pine (Pinus palustris) – monotypic stands
- Once vast, covering 90 million acres
- Heavy logging decimated historical populations
**Longleaf Pine Forest: A Vanishing Ecosystem**

**Major current threat – fire suppression**
- Uniquely adapted to fire
- Less frequent fire causes longleaf forests to become replaced by other, less fire-dependent pines and hardwoods
- Dramatic decline in native range since 1900
- 97% of historical range gone; isolated populations

**Associated Species at Risk**
- Longleaf pine forest supports 187 rare plant species
- 27 plants federally listed as threatened or endangered
- Greatest diversity of carnivorous plants worldwide
- Federally endangered red-cockaded woodpecker
  - depends on fire to maintain nesting habitat (only nests in old trees of longleaf savanna—no encroaching shrub layer)

**Ecological Effects of Fire Suppression**
1. Increased stand density (e.g. longleaf pine, ponderosa pine)
2. Altered habitat for resident species
3. Fuel buildup increases risk of catastrophic wildfire
4. Exacerbation of fire’s negative effects when burning occurs (whole stand die-off, soil degradation, destruction of seedbank, etc.)
5. Changing forest composition (fire-sensitive spp replacing fire-tolerant spp)

...Ultimate loss of biodiversity (endangerment of fire-dependent ecosystems and associated species)

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**The Legacy of Longleaf Pine**

- Photographs by William P. Dinsmore, taken in the 1940s as a member of the Black Hills of South Dakota Club.
- Major Garden George Armstrong Custer. Looking down Cravens Creek, notice how the trees in the understorey, indicating younger growth, have joined the canopy.
- Photograph of Cravens Creek Valley taken by Richard 271 Mayfield in 1974 from near the same location. This photograph was taken in the early 1700s, a century after the Vanishing Ecosystem.
Eastern Oak-Hickory Forests
Fire Suppression and Changing Forest Composition

Economic Costs of Fire Suppression

Facing the Predicament: Conservation Options
• ‘Let alone’ (i.e. continued suppression)
• Prescribed burning
• Selective thinning and fuel removal

Conservation Options: Continued Suppression?
• The default practice after a century of suppression
• Becoming increasingly difficult with worsening fuel load
• Danger of catastrophic fires
• Many unfavorable ecological effects
• Growing economic costs

Conservation Options: Prescribed Burning?
• Goal: gradual reintroduction of a more natural fire regime
  – Also used in management of endangered species, control of invasive plants and insect pests
• Has been applied with success in many areas
• Relatively inexpensive (ca. $125/ha.)
• Can be disastrous in dense stands or areas of heavy fuel buildup
  – Can get out of control
  – Negative ecological effects of extra-hot, intense fires as occur after a century of fuel accumulation. Can kill even large trees (whole forests), severely degrade soil.
• Ecological effects comparable to that of natural fire?
  Uncertain.
Conservation Options: Prescribed Burning?

...Not a new Concept!

“Why not by practical forestry keep the supply of inflammable matter on the forest cover or carpet so limited by timely burning as to deprive even the lighting fires of sufficient fuel to in any manner put them in the position of master!... Fires to the forests are as necessary as are crematories and cemeteries to our cities and towns; this is Nature’s process for removing the dead of the forest family and for bettering conditions for the living.”

G.L. Hoxie, 1910

Conservation Options: Prescribed Burning?

• Labor-intensive, costly (ca. $2,500/ha.) - impractical over large areas
• Sometimes involves use of heavy equipment (negative impact on soil and landscape)
• More roads built into our wildlands?
• Ecological effects of this treatment are not understood
• May be the safest conservation option for areas with extreme fuel buildup (e.g. thin first, then prescribe burn)

Conservation Options: Selective Thinning and Fuel Removal?

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After a Century of Suppression: Modern Fire Politics

• 2000 – National Fire Plan (NFP)
• 2003 – Healthy Forest Restoration Act (HFRA)
  – Both NFP & HFRA focus on fuel reduction
• 2009 – Forest Landscape Restoration Act
  – To counteract suppression costs, $40 million per year for 10 yrs added to a national pool of funds to be spent on landscape-scale forest restoration projects (fuel reduction, etc.)
• Aggressive fire suppression is still the primary recourse

“...keep firmly in mind that fires have always been in the forests, centuries and centuries before we began to meddle with them. The only question that remains is whether, after accumulating kindling by twenty years or so of ‘protection’, we can now get rid of it safely... In other words, if we try to burn it out now, will we not get a destructive fire? We have caught the beast by the tail - can we let it go?...In this one matter of fire in the forests, the Forest Service has unconsciously veered to the attitude of defense of its theory at all costs. There is no conscious dishonesty, but there is plenty of human nature.”

S.E. White, 1920