# 5.6 Prescribed fire and fuel reduction treatments


# Restoring fire as a landscape process


# The three fundamental elements of restoration:

1. A defined reference condition.
2. A disrupted ecosystem.
3. A defined desire future condition.

**Do we have these three elements for restoring fire as a biophysical and ecological process?**

# Two basic reasons to reintroduce fire to the landscape:

1. Reduce fuels, and thus fire hazard
2. Restore fire as an ecological process

# Prescribed fire

- Intentional reintroduction of fire
- Usually done at relatively small scales (10's to 100's of acres)
- Burn under limited fuel and weather conditions ("prescription")

# “Prescribed fire”

- Intentionally set to reduce fuels
- The “prescription” is the set of conditions under which the fire will be started, including:
  - Wind speed and direction
  - RH
  - Temperature
  - Live and dead fuel moistures
  - Potential containment features

United States Department of Agriculture

Forest Service

**Rocky Mountain Research Station**

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# Science Basis for Changing Forest Structure to Modify Wildfire Behavior and Severity

**U.S. Department of Agriculture Forest Service**

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# Main objectives of prescribed fire:

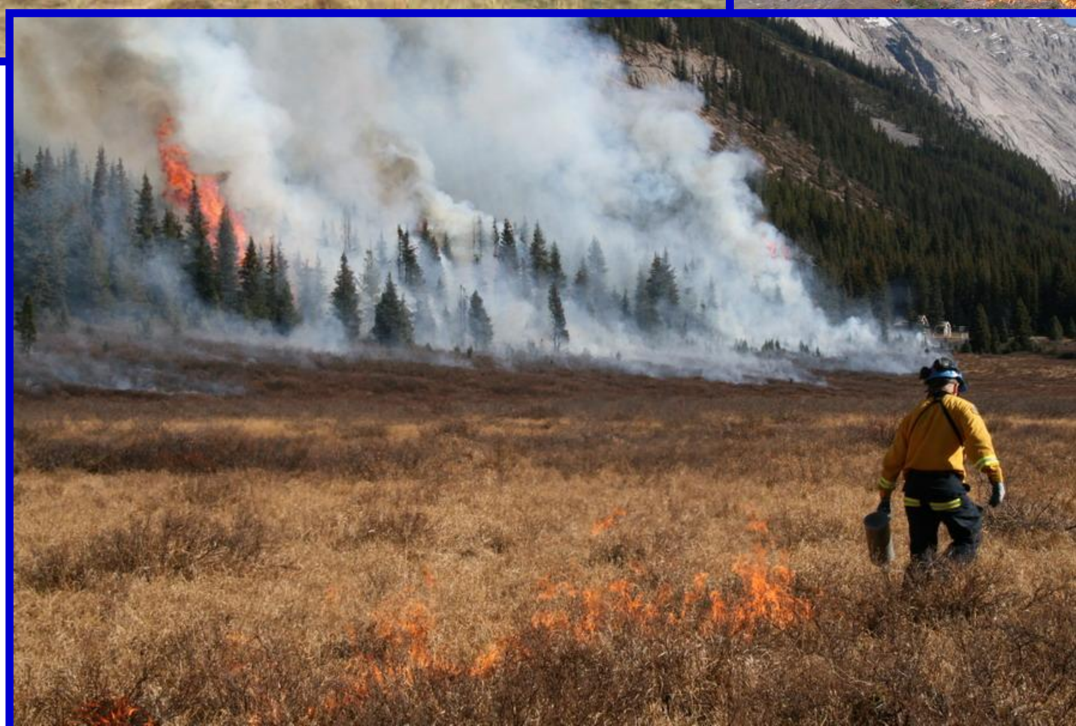
From Graham et al. 2004

1. **Reducing loading** of fine fuels, duff, large woody fuels, rotten material, shrubs, and other live surface fuels, to reduce the fuel energy stored on the site and potential spread rate and intensity.
2. **Reducing horizontal fuel continuity** (low vegetation, woody fuel strata), to disrupt growth of surface fires, limit buildup of intensity, and reduce spot fire ignition probability.
3. **Reduce vertical fuel continuity**, by consuming some of the lowest ladder fuels and scorching the lower branches of the overstory trees, effectively raising the crown fuels above the ground surface.

# How does prescribed fire work?

- Reduces fuel loads, especially fine fuels and 1-10 hr woody fuels
- So “fuel consumption” is a vital objective
- Typically done under moderate weather conditions to avoid extreme fire behavior
- Best when used at regular intervals to prevent fuel accumulation





Prescribed burning in Banff NP, Alberta

Images courtesy Ian Pengelly

# Environmental Prescription:

| Prescription Element | Preferred Range | Acceptable Range | Prescription Element | Preferred Range | Acceptable Range |
|---|---|---|---|---|---|
| 1-hr Fuel Moisture % (< 1/4" in diameter) | 6 - 7 % | 5 -15 %* | Wind Direction<br>**Any restrictions will be documented in site specific supplemental prescribed fire plan** | Any | Any |
| % Cloud Cover | 0 - 25 % | 0 - 100 % | Maximum eye level Wind Speed ~ **on site reading** | 5 -8 mph | 2 - 14 mph* |
| | | | Transport Wind Speed | 9 – 28 mph | > 9 mph |
| Temperature º F | 40 - 75 º F | 35 – 95 º F | Dispersion Conditions<br>**Obtained from the Mesonet** | Good to Excellent | Moderately Good to Excellent |
| Rel. Humidity % | 30 - 45 % | 25 - 65 %* | Probability of Ignition | 20 - 60% | 10 - 60 % |
| Dew-Point Temp º F | 10 - 52 º F | 3 - 81 º F | KBDI | ≤650 | 0 - 700 |

# Fire behavior Prescription:

| Prescription Element | Preferred Range | Acceptable Range | Prescription Element | Preferred Range | Acceptable Range |
|---|---|---|---|---|---|
| Head Fire Flame Length Fuel Model 3 | 6 - 8 ft | 1 - 25 ft | Head Fire Fireline Intensity Fuel Model 8 | 7 – 13 btu/ft/s | 3 - 20 btu/ft/s |
| Head Fire Rate of Spread Fuel Model 3 | 80-320 ch/hr | 26-480 ch/hr | Head Fire Flame Length Fuel Model 9 | 2 - 4 ft | 1 - 6 ft |
| Head Fire Fireline Intensity Fuel Model 3 | 1620 - 3000 btu/ft/s | 300 - 4490 btu/ft/s | Head Fire Rate of Spread Fuel Model 9 | 7 – 19 ch/hr | 1.5 – 45 ch/hr |
| Head Fire Flame Length Fuel Model 8 | 1 - 2 ft Surface fuels only | 0.7 – 2 ft For surface fuels <80 ft For torching cedar trees | Head Fire Fireline Intensity Fuel Model 9 | 50 - 126 btu/ft/s | 9 - 266 btu/ft/s |
| Head Fire Rate of Spread Fuel Model 8 | 3 - 6 ch/hr | 1- 20 ch/hr | Spotting Distance from fire | 0 | 0 – 600 ft<br>0 - .125 mi |

From: Wewoka Agency, Burean of Indian Affairs, Tallgrass & Cross Timbers Programmatic Prescribed Fire Plan, Seminole County, Oklahoma, 2010

# Conditions are reviewed each day at the morning briefing


From Bidwell et al.

# Is prescribed fire effective for modifying fire behavior?

- Example: Cone Fire (2002)
- Blacks Mountain Experimental Forest, northern CA
- Adjacent thinned and unthinned stands, also prescribed burn areas
- Wildfire ignited in hot, dry, windy late September weather
- What happened?

# Stands that were thinned and Rx burned (left) and untreated (right) following the Cone Fire

# *Key Findings from the 2002 Cone Fire:*

- Fire dropped from the crown to the surface within a few feet of entering the treatment units.
- Trees near (but outside) the treatment unit boundary were less likely to survive than those within the unit.
- Survival rates of trees more than 80 feet inside the boundary were much higher
- Fire burned with much greater severity outside the Blacks Mountain Ecological Research Project treatment areas.

# Agee and Skinner (2005), “Basic principles of forest fuel reduction treatments”

- Low thinning more effective than crown or selection thinning
- Management of surface fuels increases the likelihood that a stand will survive wildfire
- Focused on forest resilience

# Selective Thinning and Clearing

Images courtesy Ian Pengelly, Banff NP

# Mechanical Pile and Burn

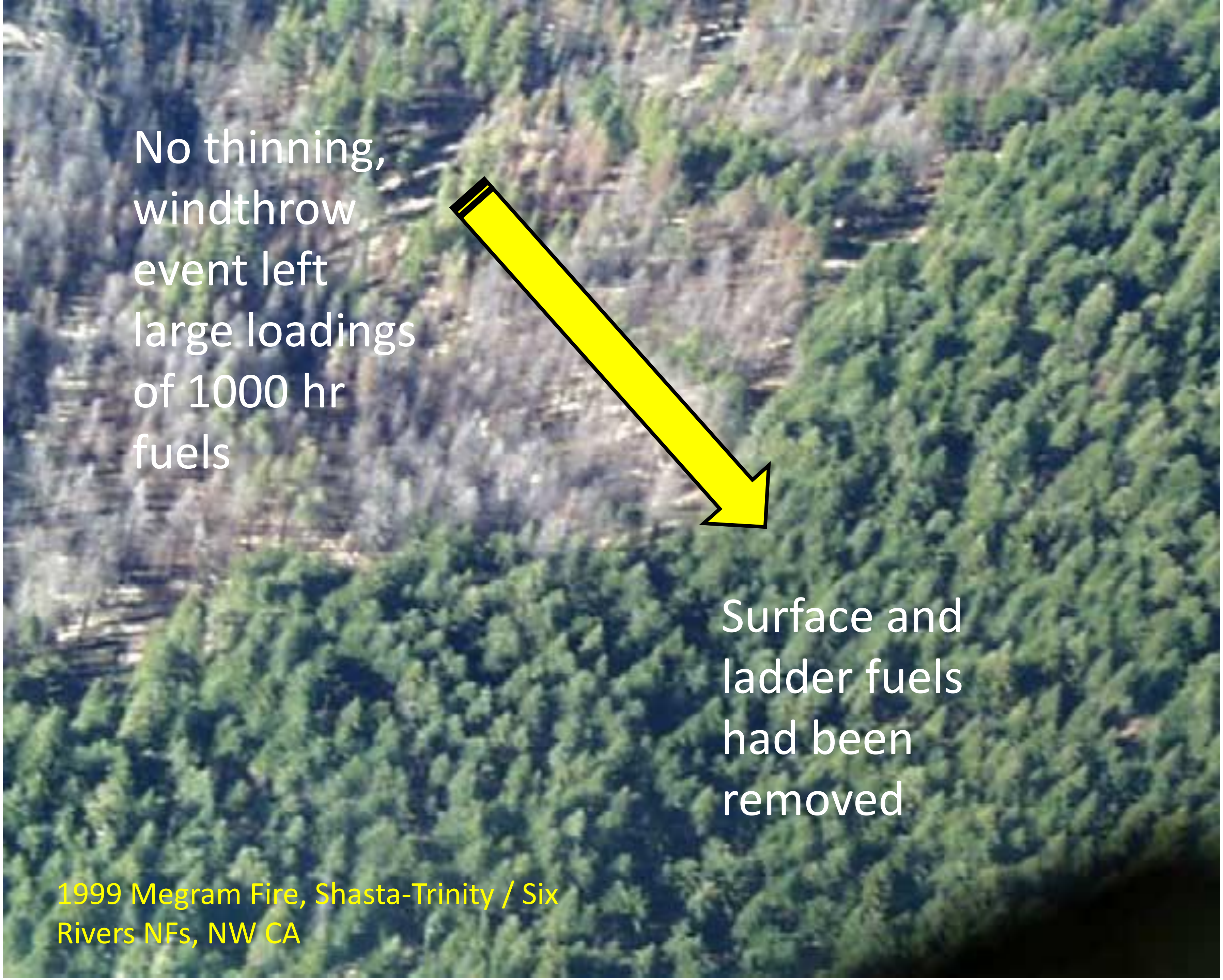
Images courtesy Ian Pengelly, Banff NP

# Chipping and mastication

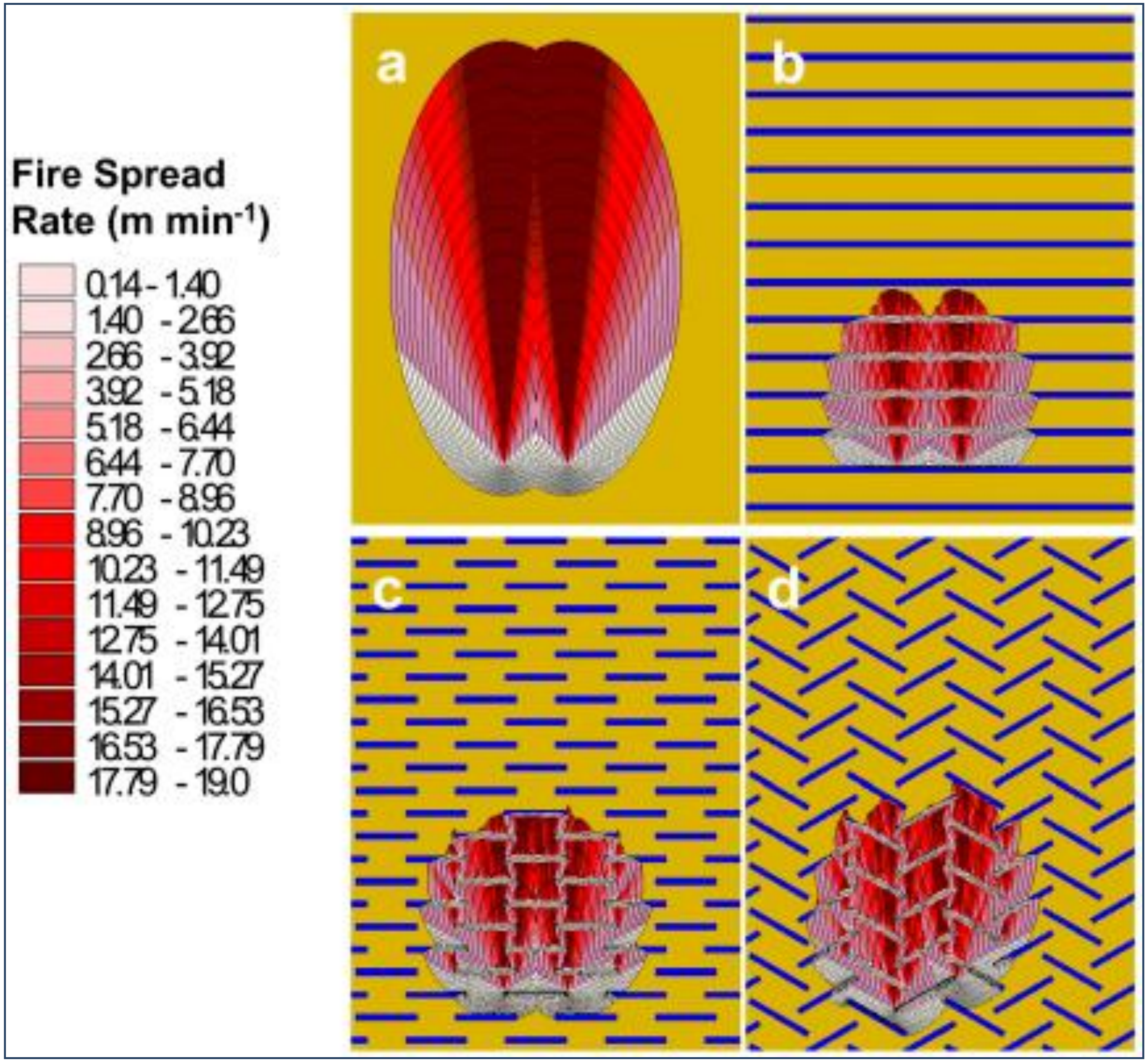

# Four primary objectives of mechanical thinning treatments:

1. Reduce surface fuels
    1. Reduces flame length, fire intensity and ROS at ground level
2. Increase height to live crown
    1. Decreases likelihood of ladder fuels carrying fire into canopy
    2. Increases torching index (km/hr)
3. Decrease crown density
    1. Decreases likelihood of fire propagating actively through canopy
4. Retain large trees of fire-resistant species
    1. Highest probability of surviving; seed source for post-fire recruitment

Agee and Skinner 2005


No thinning, windthrow event left large loadings of 1000 hr fuels
Surface and ladder fuels had been removed
1999 Megram Fire, Shasta-Trinity / Six Rivers NFs, NW CA

# Some more theoretical approaches: Strategically Placed Landscape Treatments (SPLATS)




Fire growth and spread rate patterns simulated using FARSITE with various treatment patterns. The relative spread rate in the treated areas (blue) is 1/10th of that in the matrix (yellow). All treatments occupy about 19% of the area.

Finney 2001, Forest Science

# Pros and cons of mechanical thinning

**Advantages**

- Mechanical thinning can more precisely create targeted stand structure than does prescribed fire.
- Specific trees can be selected for both removal and retention.
- Mechanical thinning emphasizing smaller trees and shrubs can be effective in reducing vertical fuel continuity that fosters initiation of crown fires.
- Thinning of small material and pruning branches are more precise methods then prescribed fire for targeting ladder fuels.
- Relatively easy and safe in WUIs.

**Disadvantages**

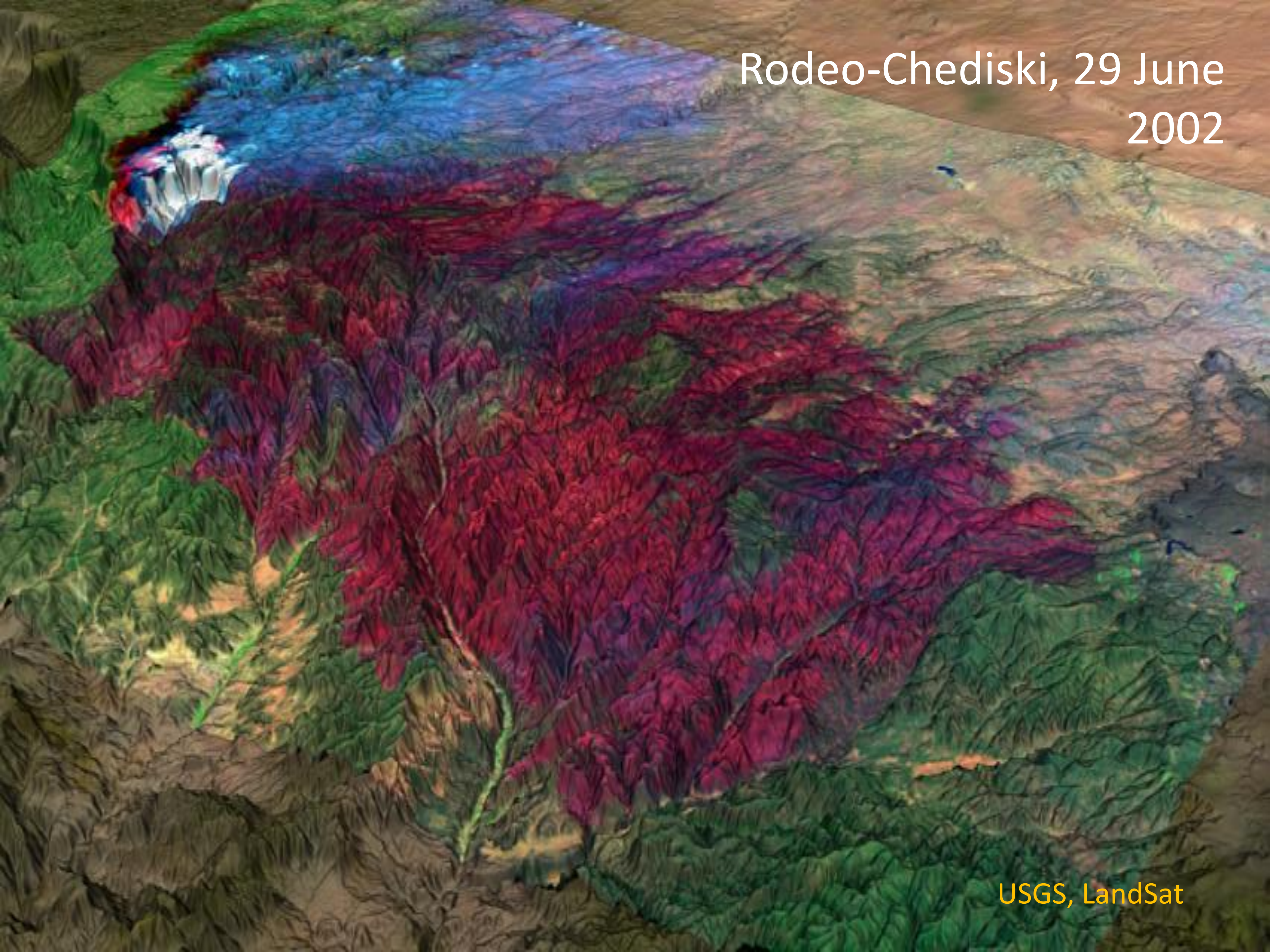
- Mechanical thinning is not an inherently ecological process and doesn't have the other benefits of fire.
- Thinning residue can be substantial and has to be burned or removed.
- Some areas are not suitable for bringing in heavy machinery.
- Thinning can often actually <u>increase</u> fuel loads of fine and 1-10 hr fuels on the surface, thus <u>increasing</u> fire intensity.
- Difficult and expensive to treat large landscape areas.

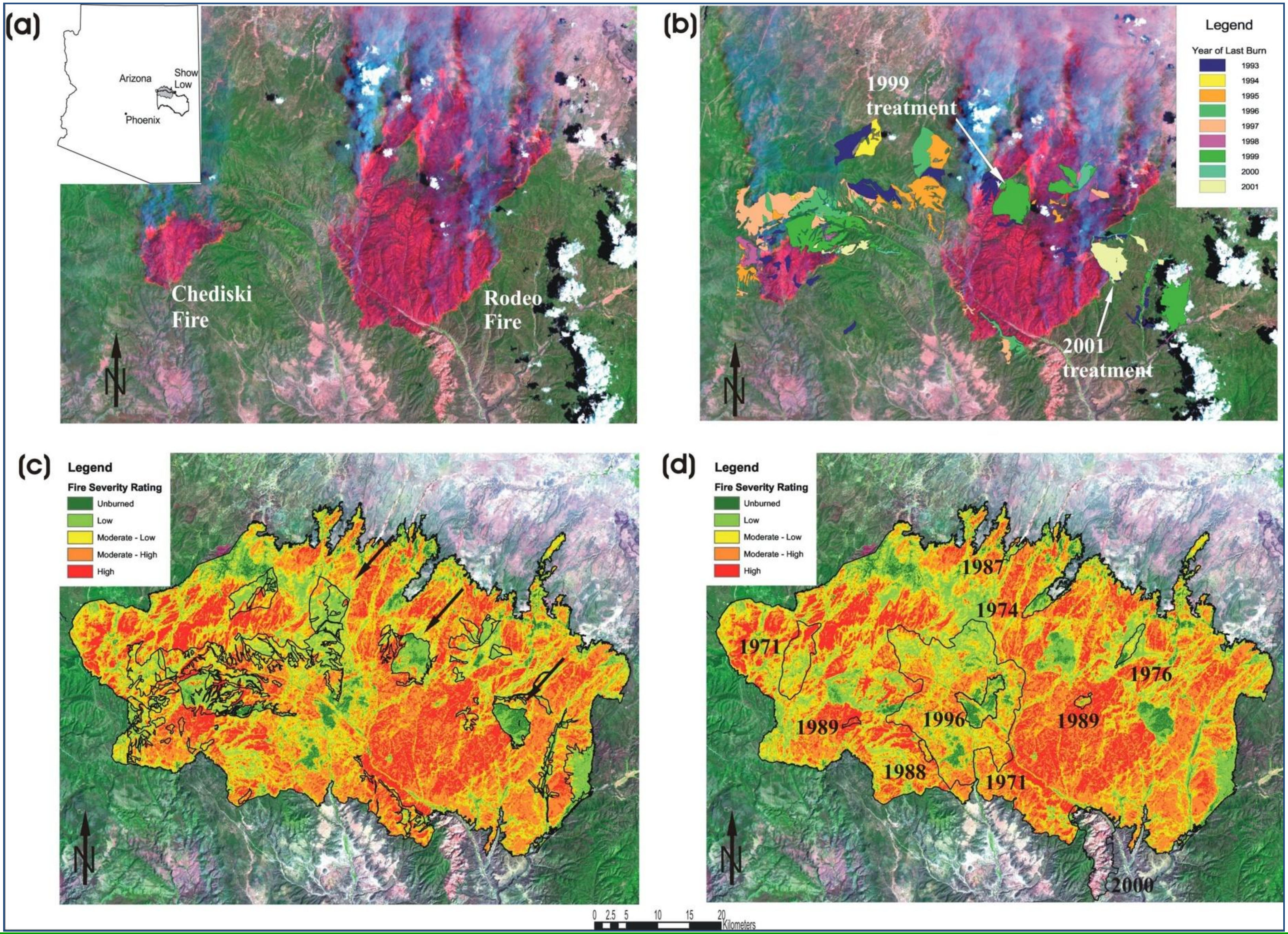
# Wildland fire for resource benefit

- One of the most important fire policies
- Utilizes natural ignitions in areas where fire can be allowed to spread
- Where feasible, allows fire to regain its natural ecological role

# How long do treatment effects last?

- Most studies and experience indicate that fuel loads and continuity are largely recovered after 10-15 years
- Larger treatments (e.g. burn units) last longer
- Thus the best combination is large, recent treatment


Rodeo-Chediski, 29 June 2002
USGS, LandSat




**Previously burned patches can influence landscape-scale fire behavior even under extreme conditions**

**Finney *et al.* 2005**



# 2002 Hayman Fire, CO

- Prescribed burns in some areas removed surface fuel and pruned lower live branches from trees in a ponderosa pine forest but did not significantly reduce overstory density.
- These changes were sufficient to stop the Hayman Fire when it burned into the area in June 2002 even though intense fire behavior was present, facilitated by high winds (30 mph and greater) and low relative humidities (near or below 10 percent).
- Other areas with mechanical thinning still burned severely due to slash piles that had not been cleared.

# Main lessons linking fuel treatments to fire behavior

- For a given set of weather conditions, fire behavior is strongly influenced by stand and fuel structure.
- Fuel treatments can produce forest structures and fuel characteristics that reduce the likelihood of severe wildfires.
- Fuel treatments can also modify fire behavior sufficiently so that some wildfires can be suppressed more easily, or allowed to burn for resource benefit.
- Fuel treatments cannot guarantee benign fire behavior, but can reduce the probability that extreme fire behavior will occur.

(Graham et al. 2004)

un-thinned

thinned

un-thinned

thinned