



# **The Potential Effect of Climate Change on Quaking Aspen in the West**

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# THE ASPEN TIMES

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**Colorado's aspens dying off**  
Researchers to burn trees to aid regeneration of rapidly dying aspen groves  
By Bob Berwyn  
Summit County correspondent  
Aspen, CO Colorado

Email Print Comment Record



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## SCIENCE & NATURE

### What's Killing the Aspen?

The signature tree of the Rockies is in trouble  
By Michelle Nijhuis  
Smithsonian magazine, December 2008



Angel Watkins and co-workers in Colorado blame many culprits in the decline of the Aspen.

JT Thomas

## REUTERS

NEWS OBAMA IN CHINA

Home > News > Lifestyle > Article



## NEWS & FINANCE

### Fall colors fade in U.S. west as aspen trees die

Fri Sep 4, 2009 9:09am EDT  
Email Print Share Reprints Single Page

By Laura Zuckerman

U.S. NEWS | OCTOBER 15, 2009

## Aspen Trees Die Across the West

*Mysterious Ailment, in Wake of Pine-Beetle Invasion, Diminishes Fall Foliage*

Article

Slideshow

Comments

< More progress

## Feeling kind of SAD (Sudden Aspen Decline)

Back in September the AZ Daily Sun's Bonnie Stevens posted an article titled Aspen Fading Fast on Sudden Aspen



# Quaking Aspen

*Populus tremuloides*

- Most widespread tree in NA
- Require high resource environment
  - Shade intolerant
- Seral or stable
  - 1/3 of western aspen stable?



C. Millar

# Aspen's Value

- Keystone species
- Biodiversity hotspot
- Structural diversity
- Soil quality
- Forage



# Aspen's Value

- Water conservation
  - Greater snow accumulation
  - Understory
  - Low water use efficiency
- ↓ Wildfire risk
  - 200x less likely
- Aesthetic value



# Aspen Reproduction

- Primarily clonal
- Rarely from seeds in the west
  - High temperature and precipitation requirements
  - Unknown in CA
  - Important in marginal stands or areas with suitable habitat but no roots



C. Miller

→ Important in changing climates?

# Is Disturbance Necessary?

**No:** Disturbance is not necessary to trigger sprouting but eliminates competition

- Stands w/o conifers regenerate w/o disturbance
- In some cases, frequent fire historically has depleted the conifer seed bank, preventing succession even in the absence of fire



# Is Disturbance Necessary?

**Yes:** Without disturbance, aspen stands decline

- As aspens age, soil degrades
  - loses its organic layer
  - leaches nutrients
  - becomes more acidic, thinner, and colder

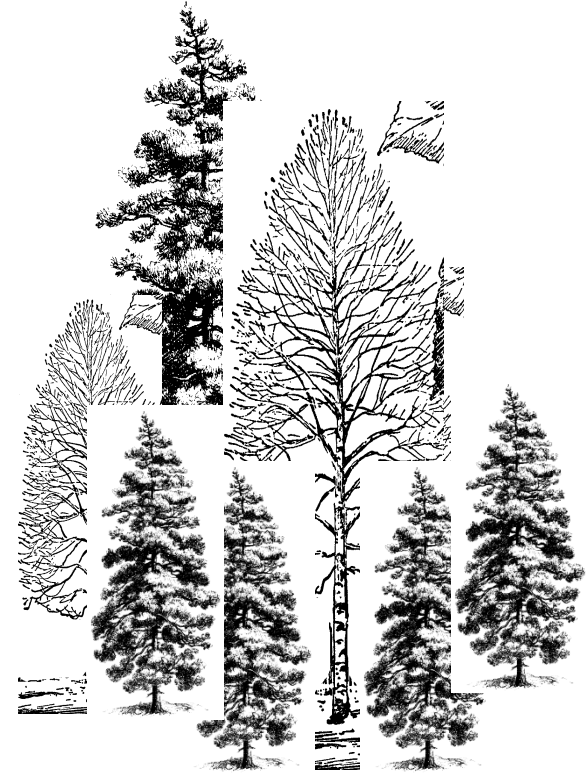
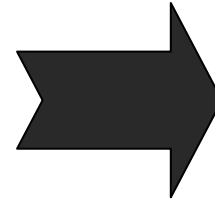
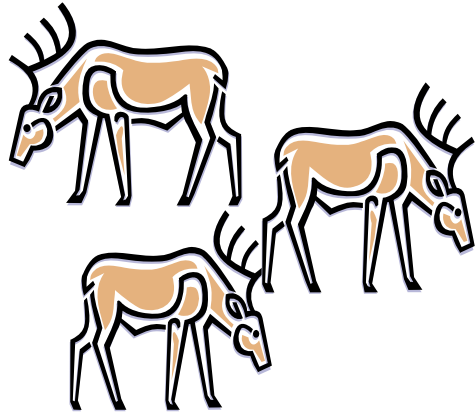
## Conifers establish

- Once conifers establish, shaded aspen decline further
- In CA, conifers are replacing some aspen stands due to less frequent fire and grazing pressures
- Rare fire events (1/50 yr) can replace a stand
  - Even if just a few aspen left!

# General Aspen Decline



+



# Sudden Aspen Decline



David Burton

# Sudden Aspen Decline

(Shepperd 2008, Worrall et al. 2008)

= the death of mature aspen with little or no regeneration

- UT and AZ >2002
- Rapid and simultaneous
- 1-3 years
- White defoliated trees standing w/ bark

# SAD Numbers

- CO, N Arizona, parts of UT and Canada,  
+ ID, NV, MT, S WY
- Average mortality of aspen in the IM region in 2006-2007 was 31%, 2/3 within 2 years
- 56,091 ha affected in CO (aerial survey)
  - ~ 13% of CO aspen cover showed effects by 2007
  - 140,000 acres lost in San Juan area alone by 2009
- Outside of the inner West, effects are unclear:
  - Recent survey in E WA showed no sign of SAD in 2 NFs

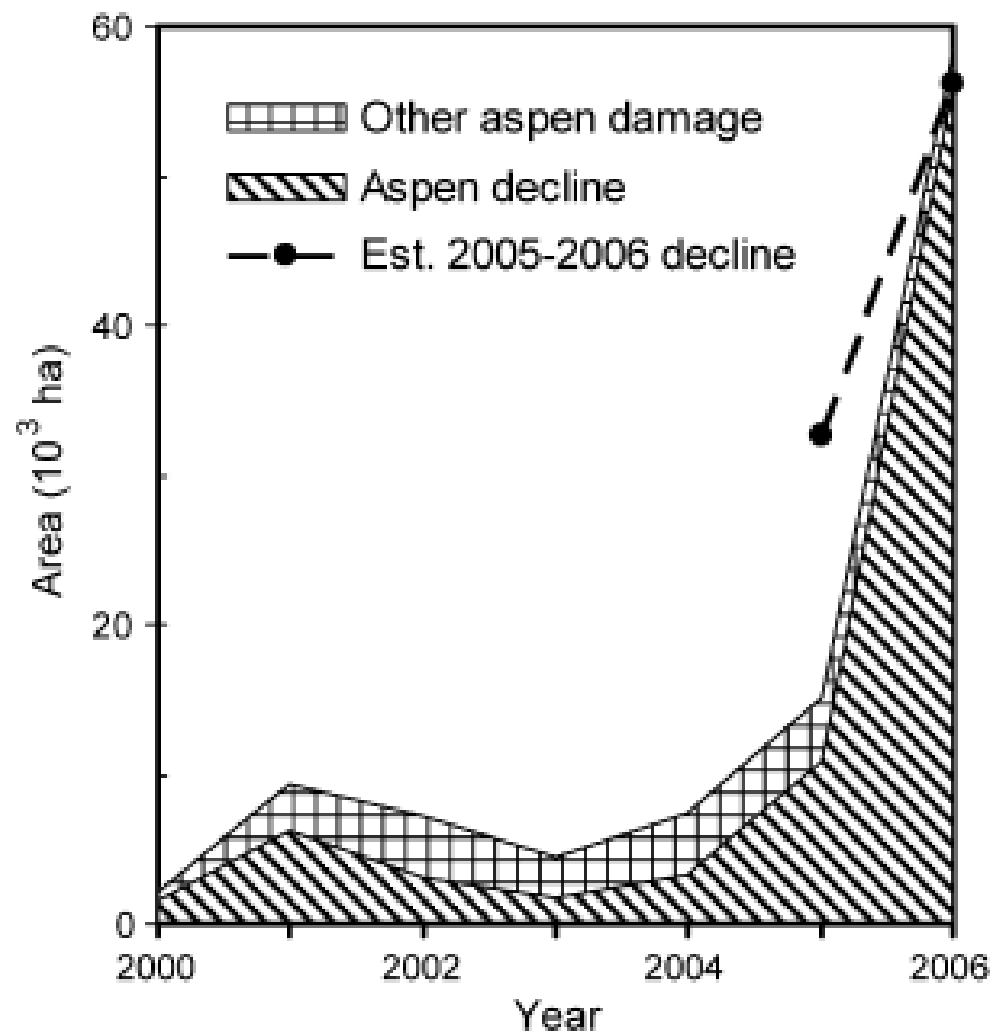


Fig. 1. Area of aspen damage recorded on lands of all ownerships by aerial survey in Colorado, 2000–2006. Aspen was not a priority in most surveys before 2006 and may be under represented. An estimate of 2005 Colorado “aspen decline” was made by applying the 58% increase from 2005 to 2006 documented on the Mancos-Dolores Ranger District to the statewide 2006 value (dashed line).

# SAD Characteristics

- Large trees die first? -> does not affect young
- Starts at edge of stand
- Complete defoliation + branch dieback
- Roots are dying first? → no regeneration?!  
(may see delay of effect for a season)
- Most affected:
  - Low elevation
    - but more conifers at lower elevations
  - S & SW aspects
  - Lower slope areas?

# SAD Causes

- Drought and high temperatures  
(Worrall et al. 2008)
  - Early 2000s in IM West and W Canada
  - Similar effects from a 1961 drought in W Canada
- Fine root damage caused by extreme winter freeze followed by drought could reduce water and nutrient uptake

Climate changes seem to be causing SAD

# SAD Causes

## Decline Disease Hypothesis

(Frey et al. 2004, Worrall et al. 2008)

- Stand/site factors predispose  
(Low elevation, S/SW aspect, low slope)
- Defoliation/severe drought + high temp during the growing season incite
- Certain insects/pathogens contribute

# SAD Contributors

- Cytospora canker:
  - The most common aspen fungus, normally not serious
- Poplar borer (and Bronze poplar borer):
  - Infest all age-classes esp stressed trees signs of ejected frass and dried sap
- Aspen bark beetles:
  - Affect dead bark or stressed trees fairly commonly, mining the bark on the trunk and large branches



(These are species that do not normally kill aspen.)

# Climate Change & Aspen

## Preferred Climate

- Aspen growth is limited by
  - Temperature
  - Precipitation, including snow
  - Radiation

Bright, warm (especially soil), and wet
- Better at southern aspects at high elevations (and vice versa)
- Otherwise stress-tolerant
  - Leaves
  - Clonality

# Climate Change & Aspen

## Preferred Climate

- Aspen are water-limited, drought-intolerant
- moisture deficits in w. Canadian interior have a more negative effect on boreal aspen than insects, even severe forest tent caterpillar outbreaks  
(Hogg and colleagues)
  - Pathogens and herbivores interact with environmental stress
  - e.g., SAD

# Climate Change & Aspen ?

## Response to future climate

- Drier = Bad
- Hotter = Good and Bad
- More fire/extreme weather = Good
- More CO<sub>2</sub> = Mixed:
- A modeling example

Aspen in the Canadian boreal will increase productivity for the next 200 years, acting as a large carbon sink, as long as prolonged droughts do not occur

(Grant et al. 2006)

# Managing Aspen

- Healthy aspen groves should have multiple age classes mostly younger than 100 years, adequate sprouting, and an ample herbaceous layer underneath the canopy
- 5 main risk factors for aspen:
  - conifer cover (understory and overstory) > 25%
  - aspen canopy cover < 40%
  - dominant aspen trees > 100 yrs old
  - aspen regeneration < 500 stems per acre (5-15 ft tall)
  - sagebrush cover > 10%

# The Status of Quaking Aspen (*Populus tremuloides*) in the Sierra Nevada

July 2009

Toni Lyn Morelli  
Pacific Southwest Research Station  
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## BACKGROUND

In this review, I summarize the existing general knowledge of aspen in the western United States, focusing specifically on the Sierra Nevada whenever possible (although see Shepperd et al. 2006 for an extensive report on this topic), and addressing the recent knowledge of climate effects on aspen, including sudden aspen decline (SAD).

Quaking Aspen (*Populus tremuloides*) is the most widespread tree species in North America (Little 1971, Mueggler 1988) and makes up some of the most biodiverse forests. In western North America, aspen are primarily clonal, reproducing by sprouting from roots (Schier et al. 1985). They are adapted to high resource environments, specifically high light

forage, and aesthetic value, aspen can be managed for multiple uses (DeByle & Winokur 1985, Bartos & Campell 1998).

Aspen is considered a “keystone species” (Bartos 2001) and a “hotspot” of diversity (Stohlgren et al. 1999). Aspen stands have the highest vascular plant species richness in the southern boreal forest (Reich et al. 2001), second only to the western juniper/sagebrush association in the upper montane zone of the Sierra Nevada (Potter 1998). Aspen stands incorporate some of the highest bird diversity in the U.S. (Griffis-Kyle & Beier 2003), and the greatest number of bird species in the Sierra Nevada specifically (Richardson & Heath 2004), including nesting habitat for goshawk. Over 100 bird species are known to nest in aspen

## Pacific Southwest Research Station

[www.fs.fed.us/psw/topics/climate\\_change/ecosystem/quaking\\_aspen.shtml](http://www.fs.fed.us/psw/topics/climate_change/ecosystem/quaking_aspen.shtml)

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### The Status of Quaking Aspen (*Populus tremuloides*) in the Sierra Nevada



Quaking aspen (*Populus tremuloides*) is the most widespread tree species in North America. It provides great benefits where it occurs as forage and habitat for wildlife. It also acts as a fuel break and retains much more water in the environment than do most conifer species.

#### Objectives

- ▶ To review the literature on quaking aspen in the western U.S.
- ▶ To elucidate the potential effects of climate change on aspen
- ▶ To provide land managers the tools with which they can monitor, understand, and potentially restore aspen populations on the landscape.

#### Application of Research Results

This report also summarizes the latest research on sudden aspen decline, or SAD, a climate-related phenomenon that is affecting the inner west of the United States but has not yet been seen in California. In consultation with aspen experts, we developed a survey in order to establish baseline health of trees and potentially detect the early arrival of SAD in California. The links below provide information for land managers to begin to understand the potential effects of climate change on quaking aspen.



#### Lead Scientists/Collaborators

Morelli, T. L., [Millar, C.I.](#), [Delany, D.D.](#), and [Westfall, R.D.](#)

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#### Publications and Reports

- [Poster from the Northern Rockies Aspen Conference, April 3, 2009](#)
- [Presentation to Inyo National Forest staff, June 9, 2009](#)
- [Sudden Aspen Decline survey, July 2009](#)
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## Sudden Aspen Decline (SAD) Survey

\*\*\*CONDUCT THIS SURVEY IN THE CENTER OF THE STAND DURING SPRING OR SUMMER\*\*\*

Surveyor's Name: \_\_\_\_\_ Surveyor's Phone #: \_\_\_\_\_ DATE: \_\_\_\_\_

Stand Center GPS Coordinates: \_\_\_\_\_ N \_\_\_\_\_ W units: \_\_\_\_\_

Stand ID: \_\_\_\_\_ Stand size: \_\_\_\_\_ ha

Environmental context: elevation: \_\_\_\_\_ m aspect: \_\_\_\_\_ ° slope: \_\_\_\_\_ %

Primary stand type: Slope  Lithic  Meadow Fringe  Riparian

Primary aspen form: Upright tree  Shrub

1. How much recent crown loss (thinning of the foliage and/or branch dieback) across the canopy?

<34%  34-66%  >66%

2. What percentage of the stand is down and dead aspen?

<34%  34-66%  >66%

3. What percentage of the stand is standing and dead aspen?

0-25%  26-50%  51-75%  76-100%

Do they appear recently dead (bark still intact)?

<34%  34-66%  >67%

4. The majority (>50%) of live aspen is in which size class?

<1 inch dbh  1-8 inch dbh  >8 inch dbh

5. The majority of current aspen mortality is located in which size classes?

<1 inch dbh  1-8 inch dbh  >8 inch dbh

6. How many more young established aspen (1-5 inch dbh) are present than mature aspen (>8 inches)?

<1x  2x  5x  >10x

7. How many more aspen sprouts (<1 inch dbh) are present than mature aspen (>8 inches)?

<1x  10x  100x  1000x

8. What percentage of sprouts (<1 inch dbh) show any evidence of ungulate (e.g., elk, deer, cattle, sheep) herbivory?

0-25%  26-50%  51-75%  76-100%

Is the sprout herbivory

light

moderate

heavy

9. Is there evidence of pathogens or insect damage? Is there evidence of beaver damage? Describe.

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

10. Is there any evidence of past fire in the stand?

## Pacific Southwest Research Station

[http://www.fs.fed.us/psw/topics/climate\\_change/ecosystem/quaking\\_aspen.shtml](http://www.fs.fed.us/psw/topics/climate_change/ecosystem/quaking_aspen.shtml)

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