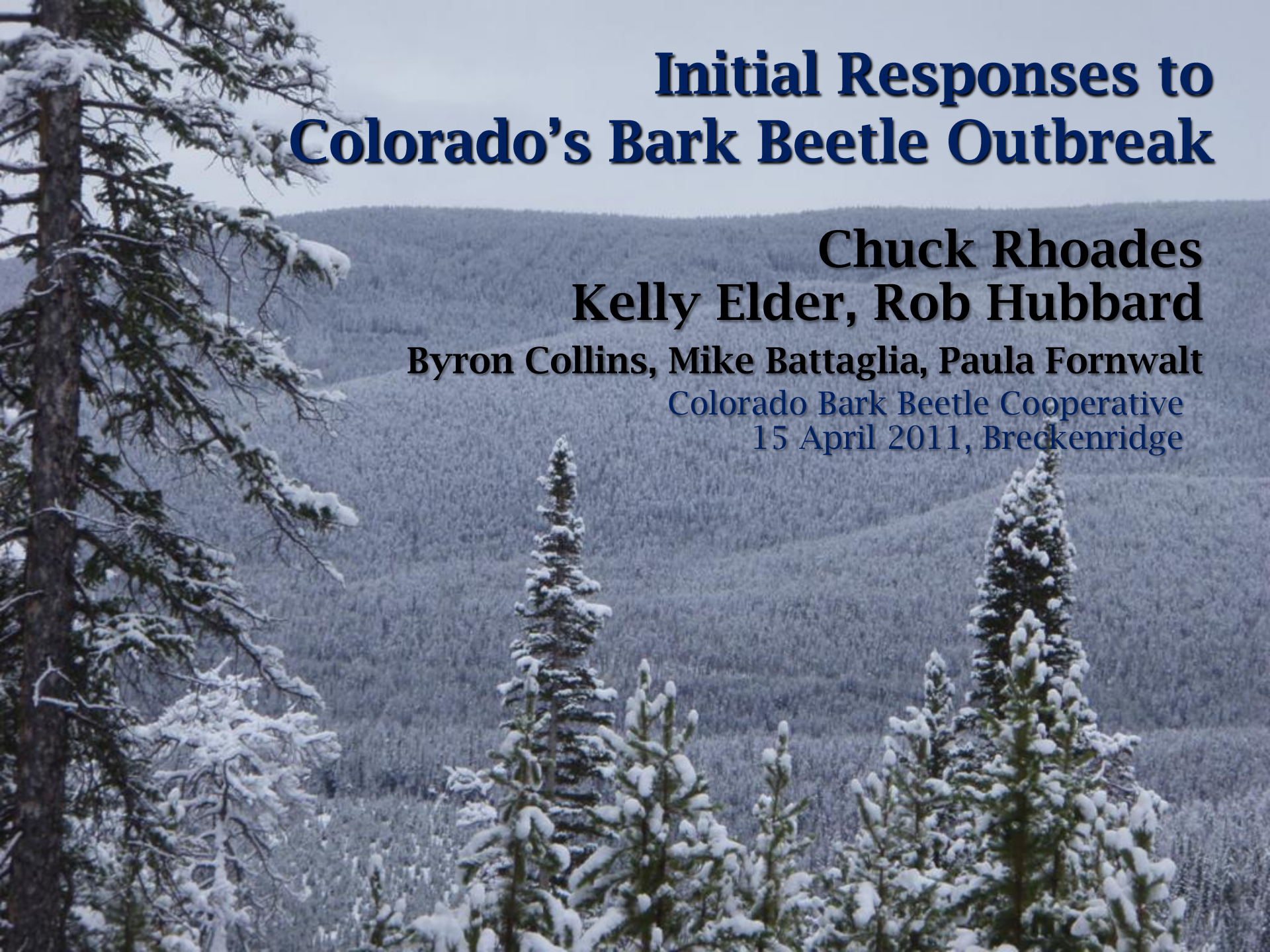
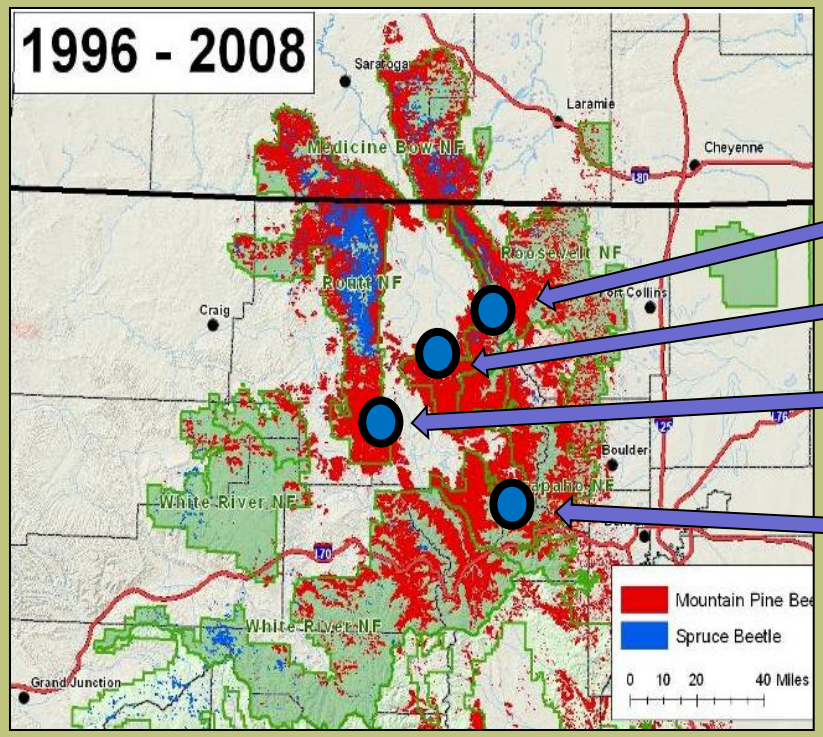


# Initial Responses to Colorado's Bark Beetle Outbreak


Chuck Rhoades
Kelly Elder, Rob Hubbard
Byron Collins, Mike Battaglia, Paula Fornwalt
Colorado Bark Beetle Cooperative

15 April 2011, Breckenridge

# Colorado's Bark Beetle Outbreak




CO State Forest

Willow Ck, Parks RD

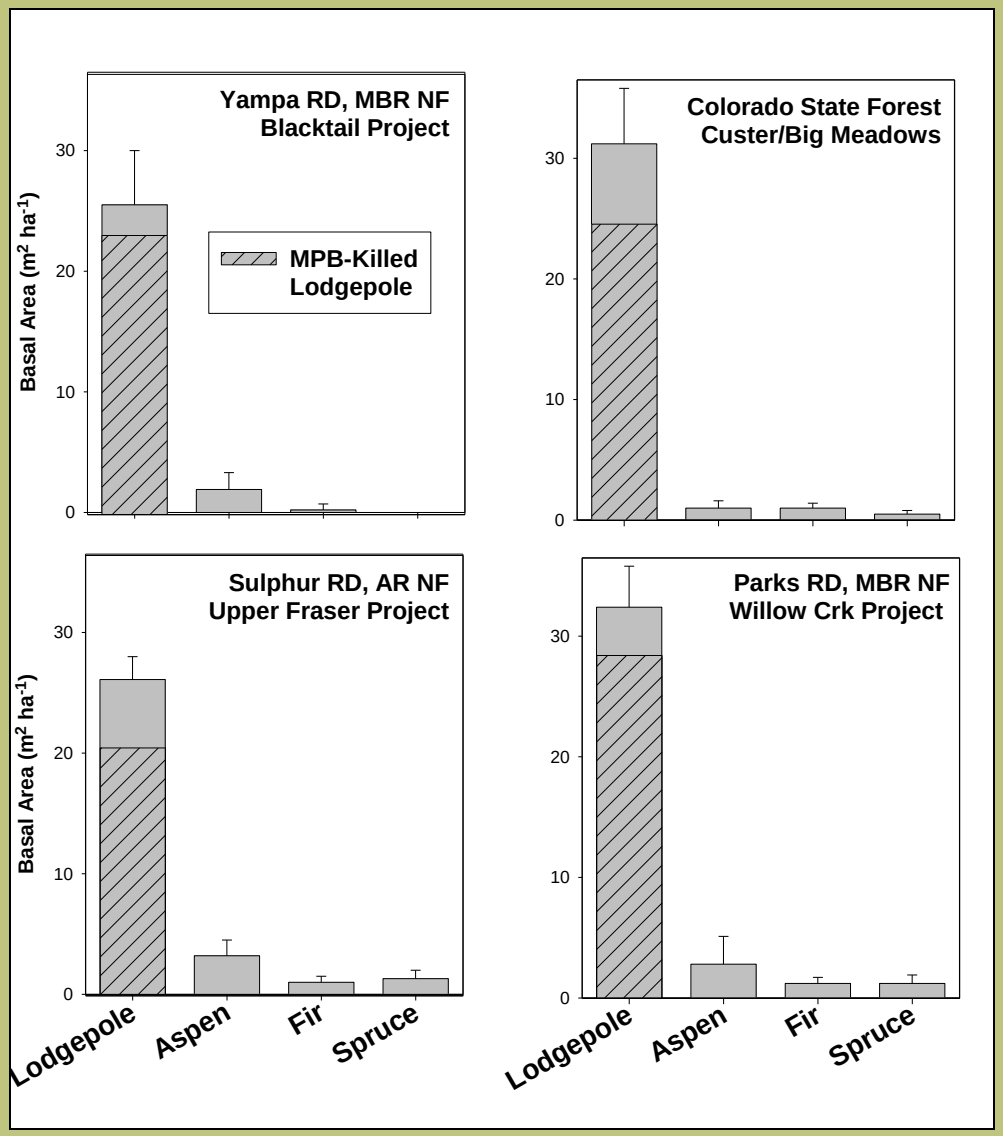
Gore Pass, Yampa RD

Fraser Expt Forest

## Today's Topics

- Forest & Watershed Change
- Signs of Forest Recovery
- Implications of Current Management

# Overstory Change




**Loss of lodgepole**

pine basal area = 80-90%

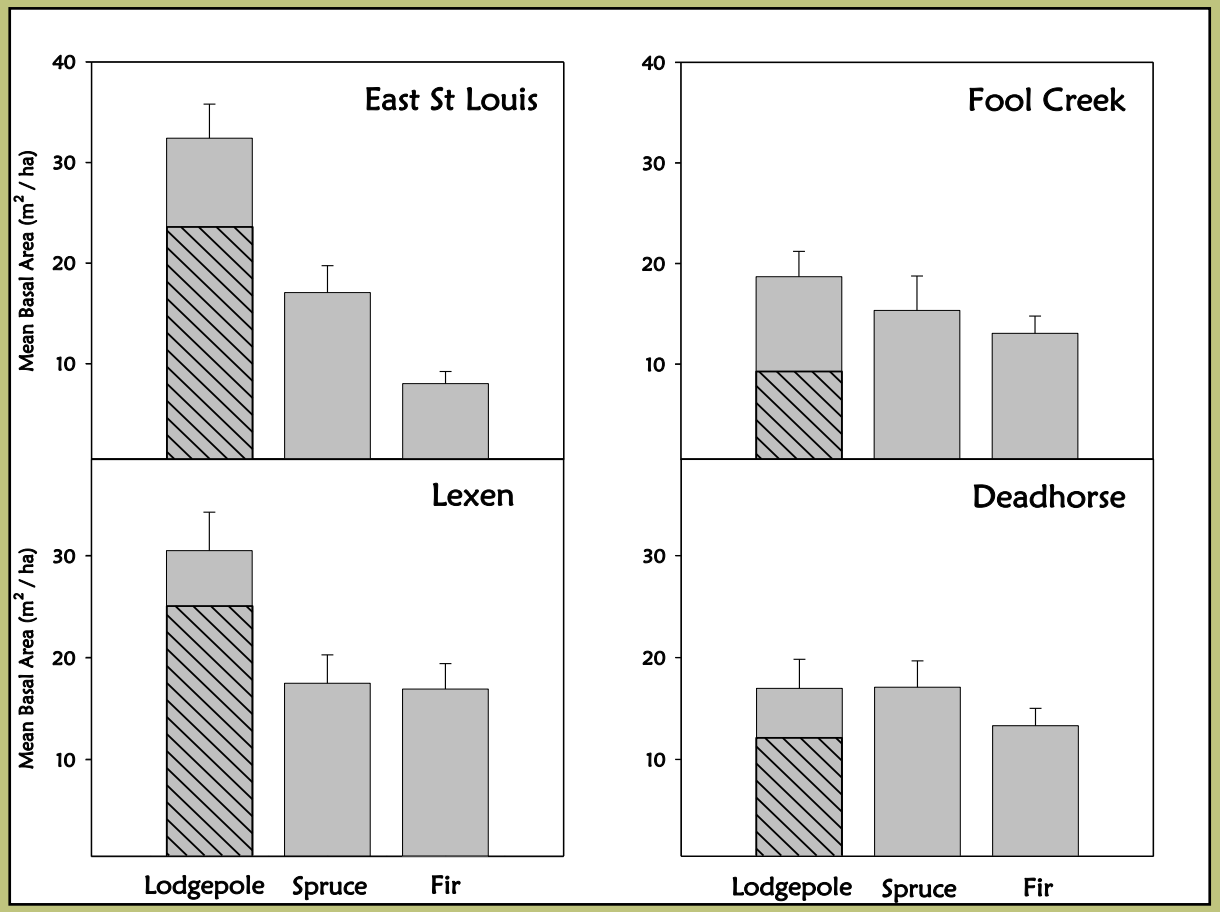
**Residual live**

15-35% of total stand BA.

*24 pine-dominated stands at 4 MPB projects

* Trees >10 cm (4”) DBH

# Amount of Mortality – Depends on Forest Composition & Structure




## Basal Area Loss

### Old Growth

73– 83% LPP loss

39 – 41% total loss

### Mixed Age/Managed

50–70% of LPP

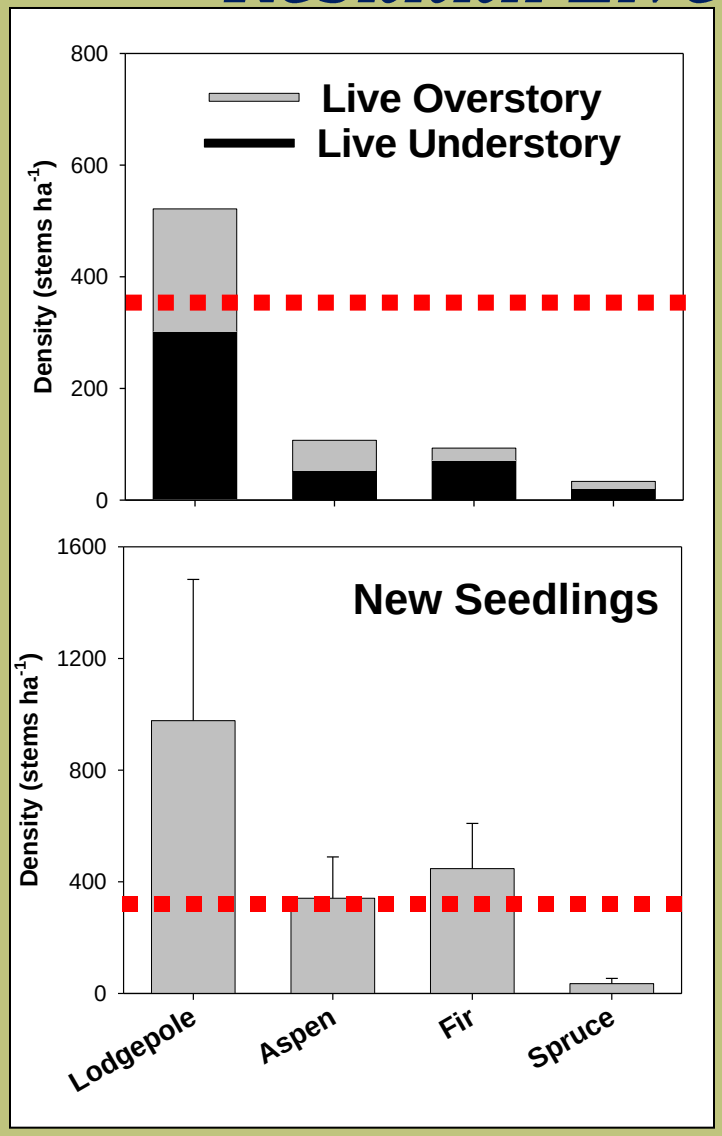
20–25% of total

Old Growth

Mixed Young/Old

# Growing Stock in MPB Forests

## *Residual Live & New Trees*




**Overstory**

310 t/ha (126 t/acre)
71% LPP; 17% AS; 7% SF

**Understory Trees**

445 t/ha (180 t/Ac)
68% LPP; 12% AS; 15% SF

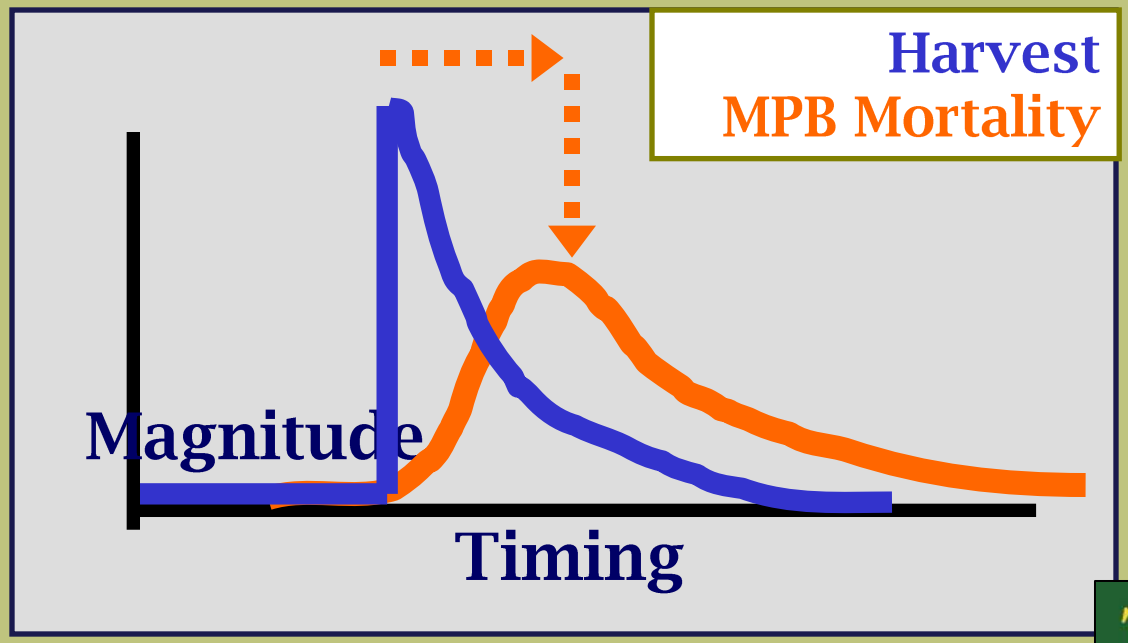
**New Recruits**

1820 t/ha (736 t/Ac)
54% LPP; 19% AS; 25% SF

*Stocking Levels**

370 t/ha (150 t/Ac)

# Watershed Change




**Trees are the answer**

**Responses Regulated by Change in**

Canopy interception & Snowpack accumulation

Water uptake & Soil nutrient use

**Complicating Factors**

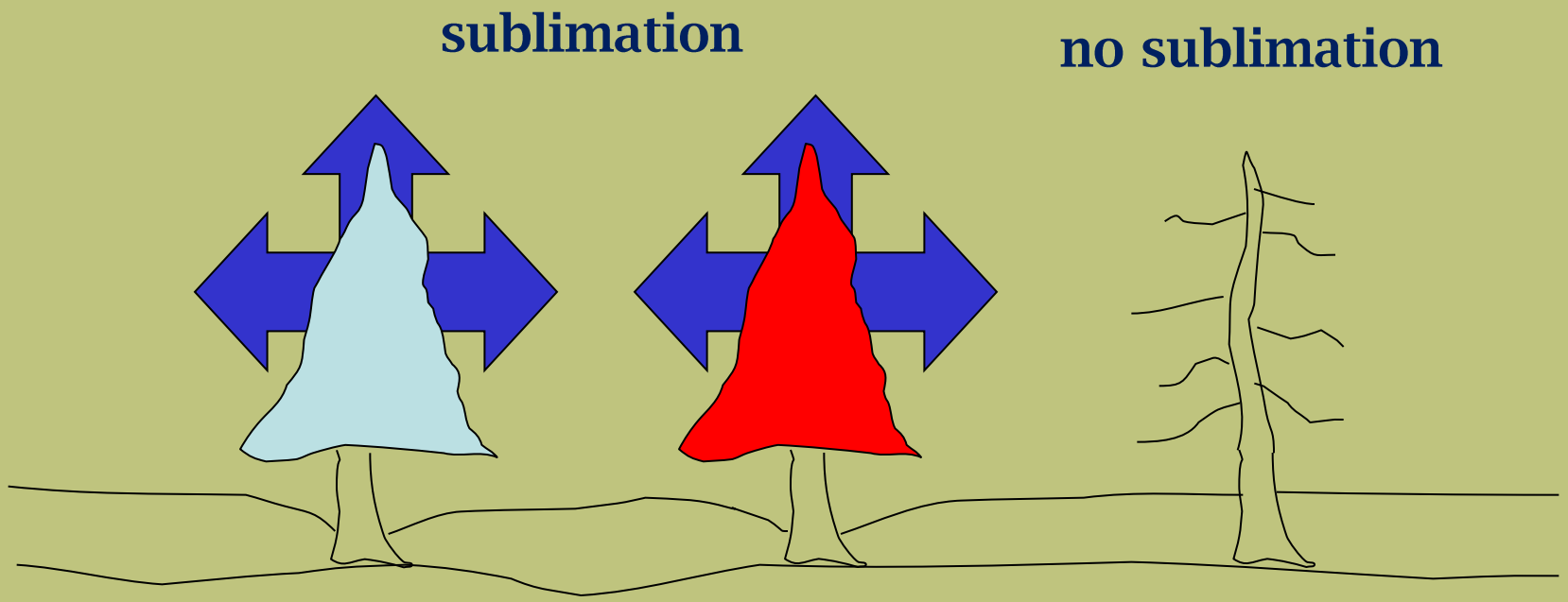
Responses may lag, difficult to detect, prolonged

Complex spatial & temporal patterns

# Watershed Change

## Interception

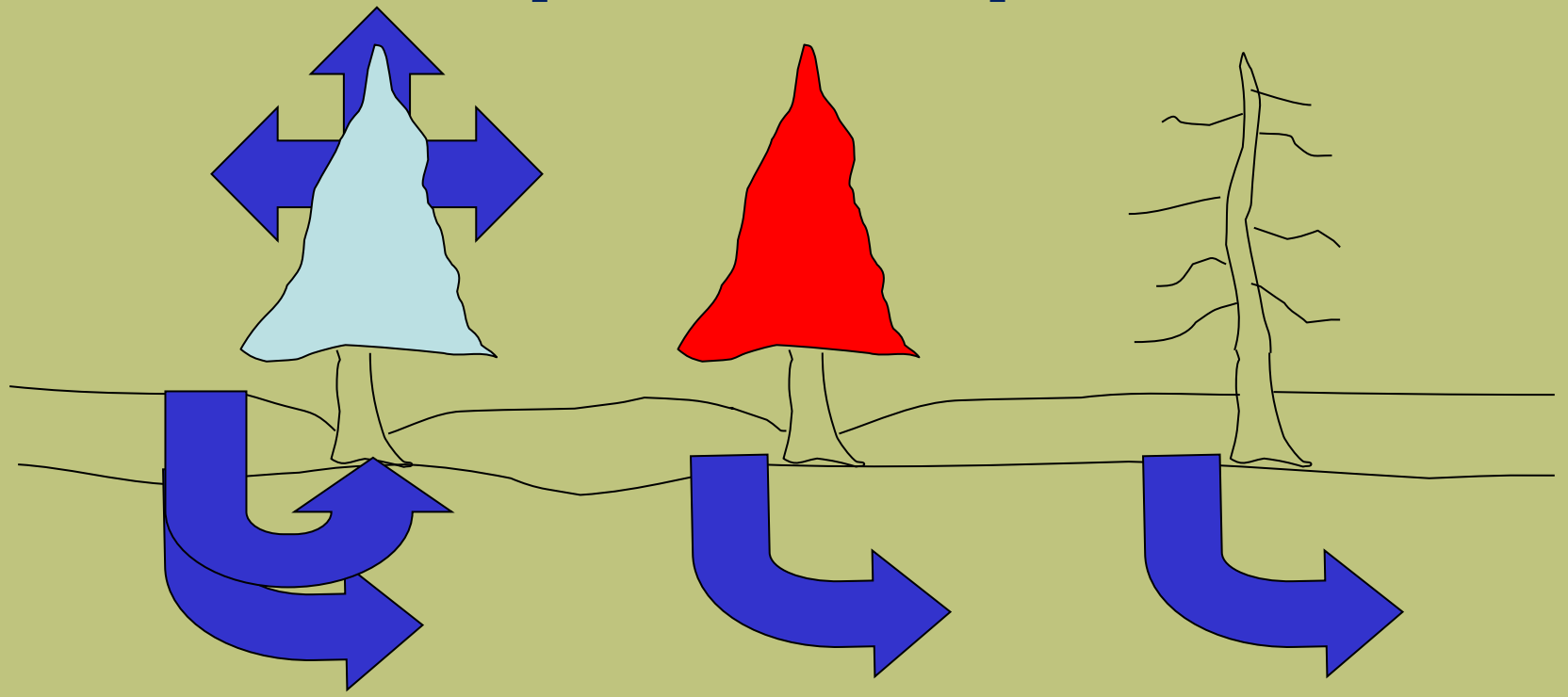
Interception losses from canopy are significant with green or red needles



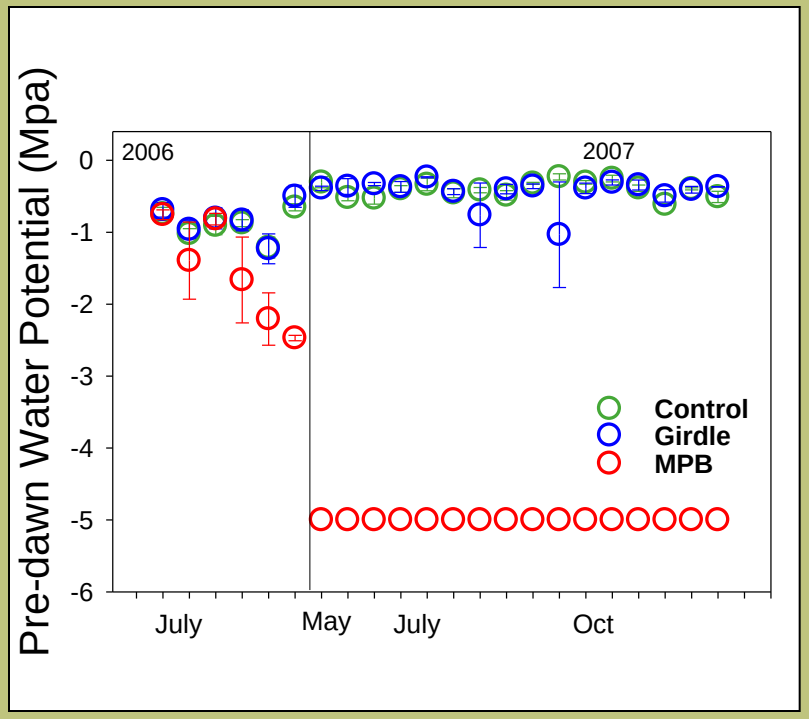
# Watershed Change

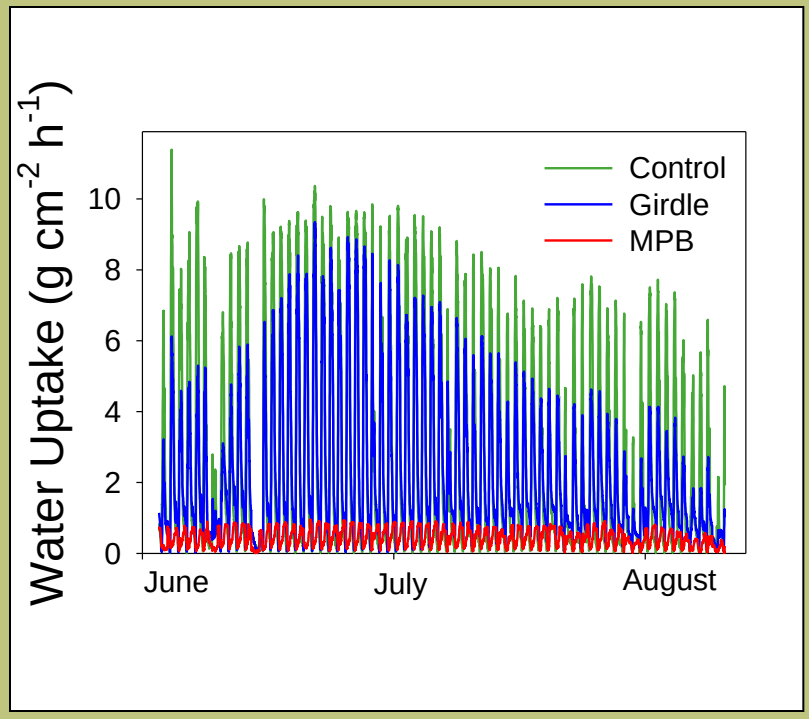
## Water & Nutrient Use

Trees use a significant portion of meltwater and soil nutrients. These are available for export (runoff, leaching) following canopy death.



# Change in Tree Water Use



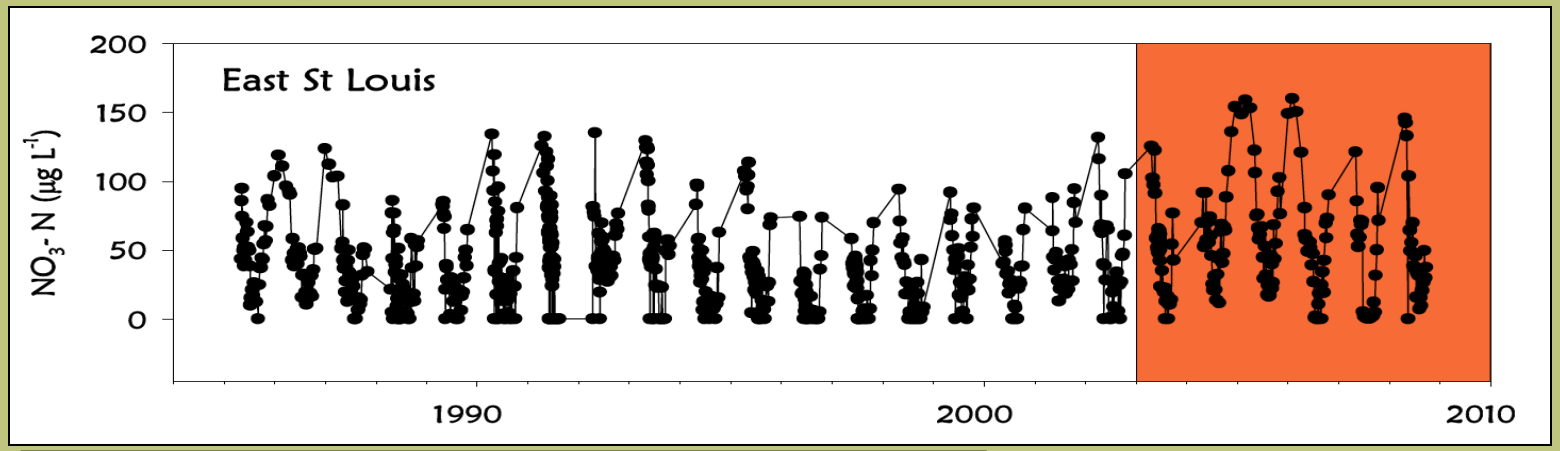

**Transpiration drops ~50% within 3 weeks of MPB**

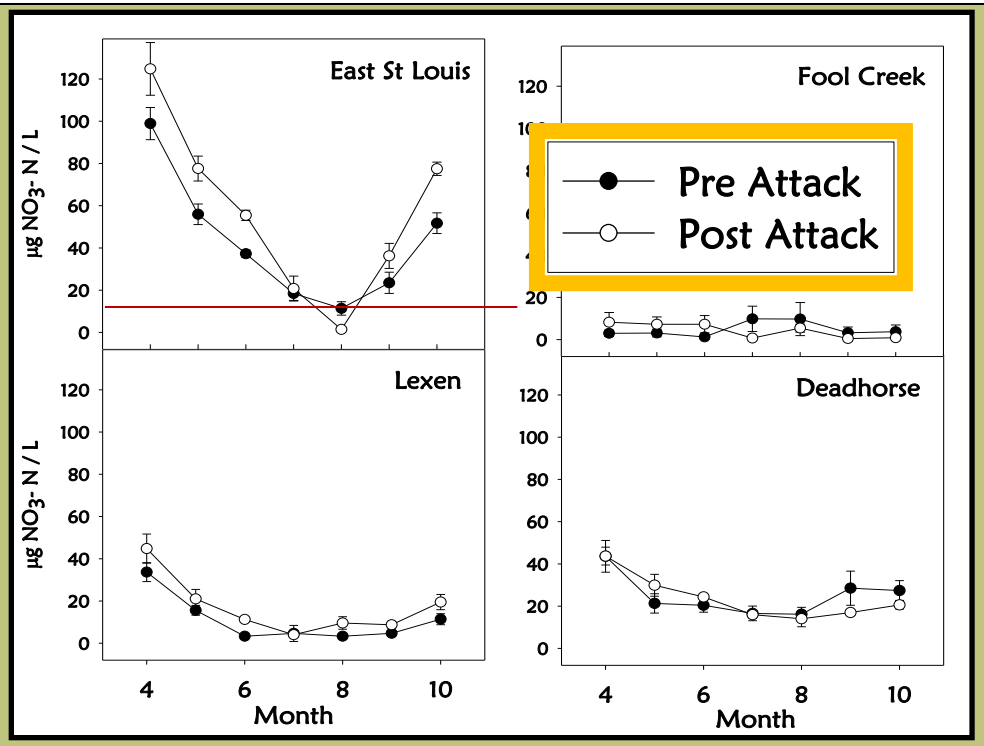
**Water status of girdled trees unchanged – continued growing for 1 year after attack**

**Blue-stain fungus: primary mortality agent**

**(Hubbard unpublished data)**

# Change in Stream Nitrate




**MPB Effects:**

Small relative to seasonal change

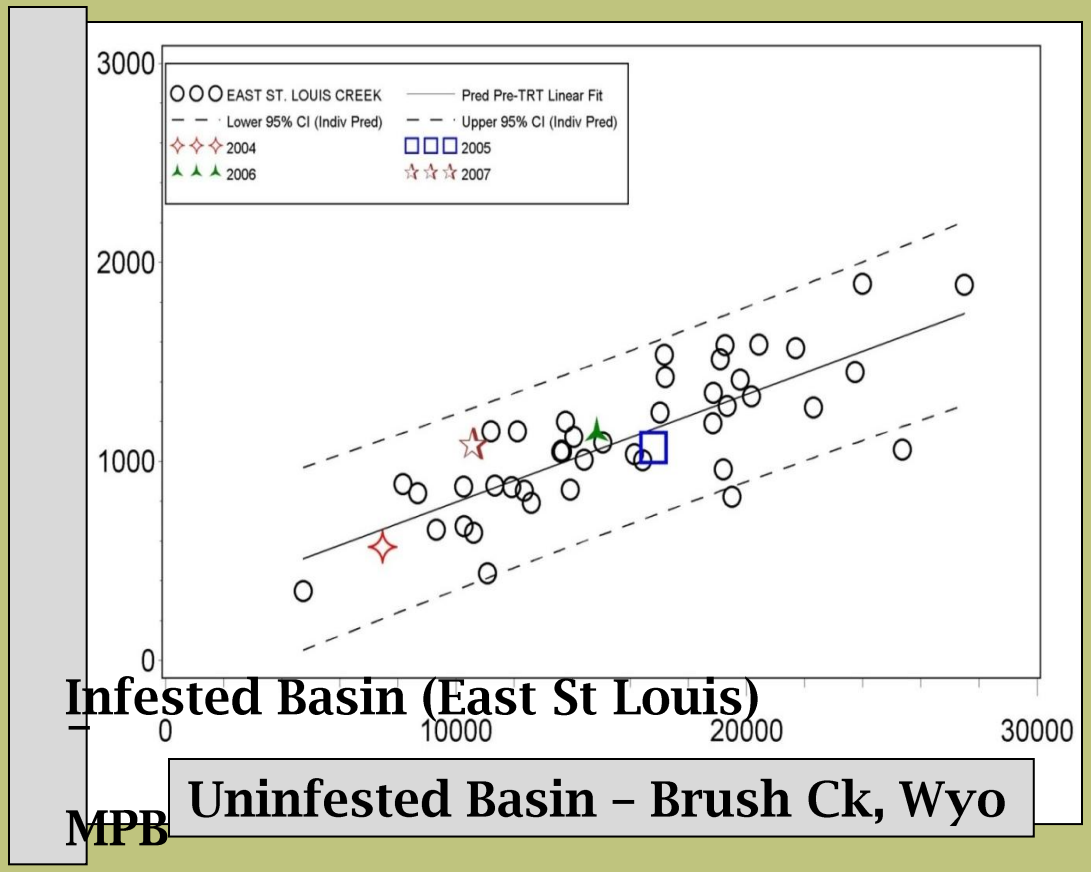
Minor relative to atmospheric inputs (~1% of N deposition)

Vary among basins

Old Growth  Mixed Young/Old

(Rhoades et al. 2008; AGU)

# Change in Streamflow




Infested Basin (East St Louis)

MPB

Uninfested Basin – Brush Ck, Wyo

No indication of initial change in discharge compared to un-infested basin

30 yrs pre-MPB comparison (through 2003)

4 post-MPB yrs (2004 – 2007)

A previous Colorado beetle outbreak suggests that these initial finding are unlikely to be the whole story!

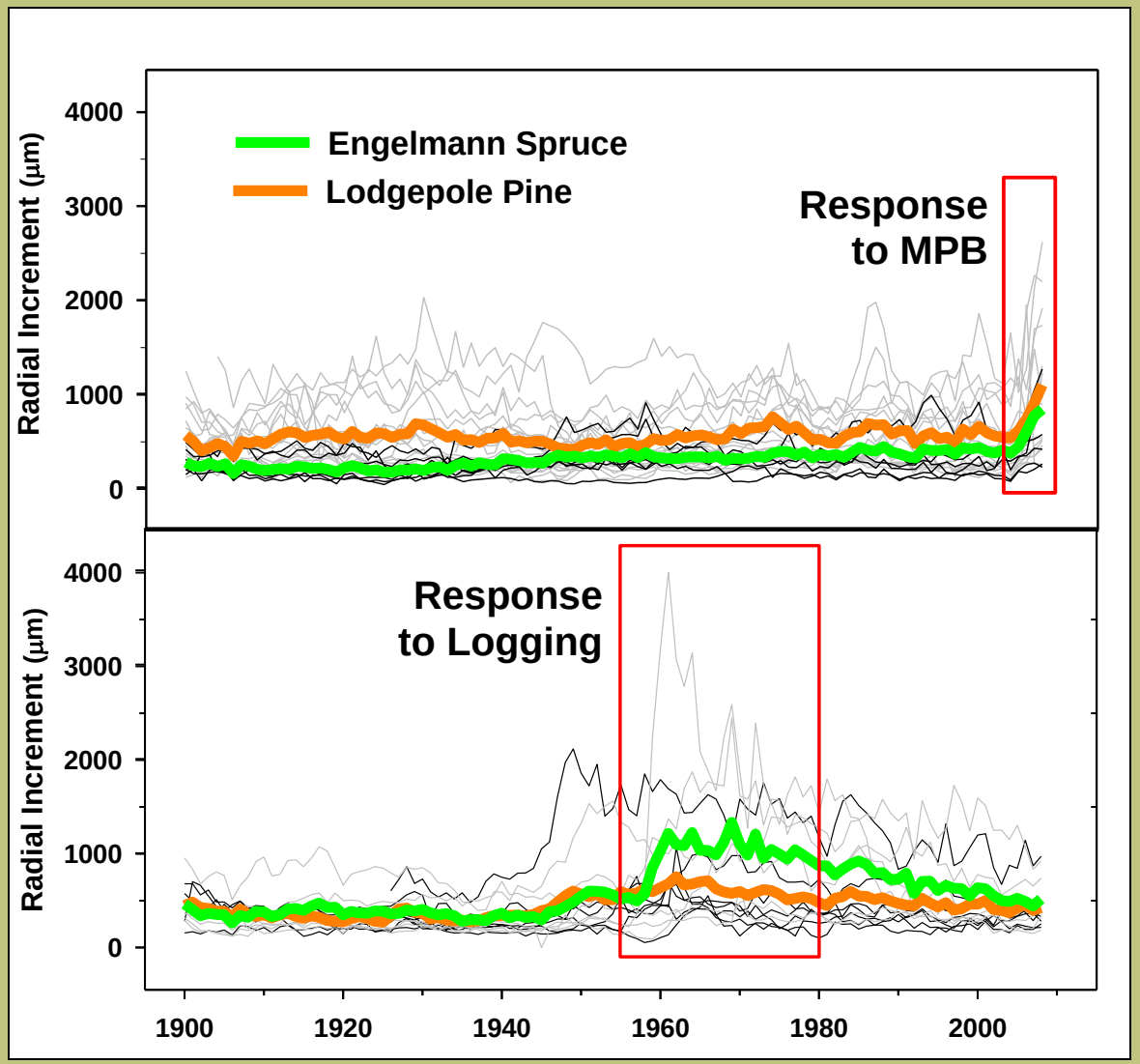
15 yrs delay to see peak increase in streamflow

>25 year recovery period

Annual variability related to snowpack

(Love 1955; Bethlahmy 1973 & 1975)

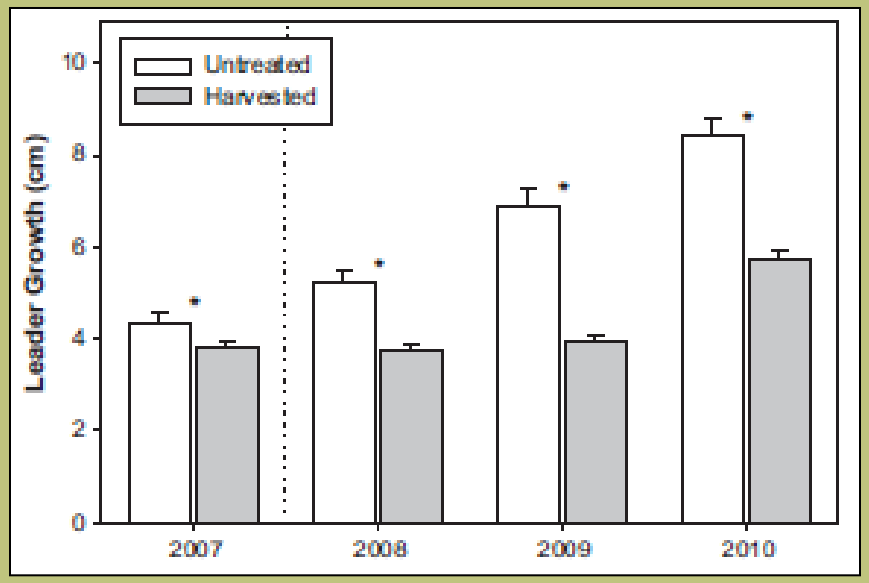
# Radial Growth Response




Some overstory trees (~35%) have grown faster since the infestation started than during the previous decade

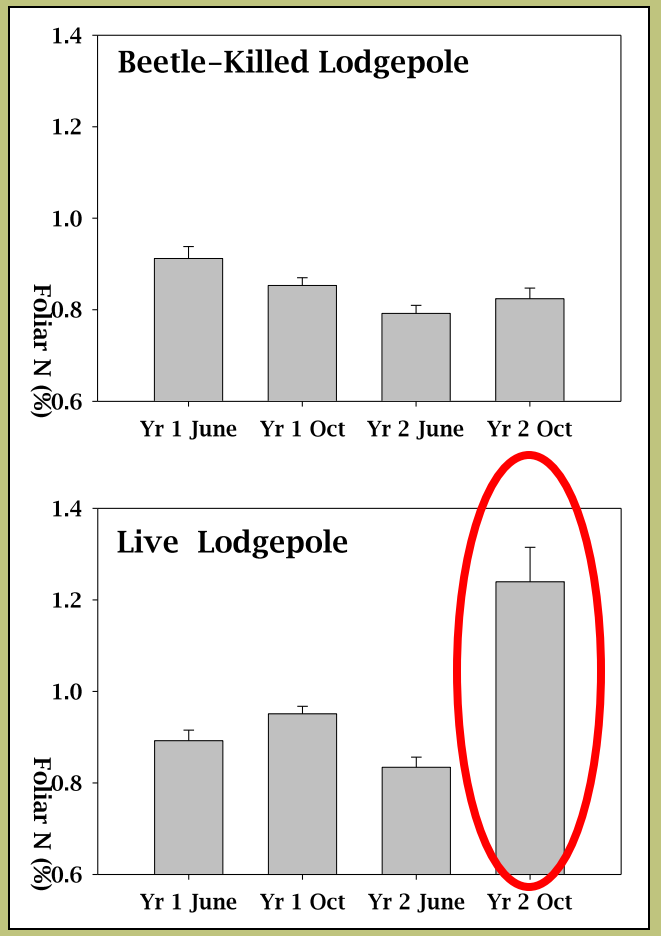
16% of all trees grew faster than ever before!

# Height Growth & Foliar Responses




Advanced regeneration has begun to respond to the increased light and soil resources beneath the dead canopy.

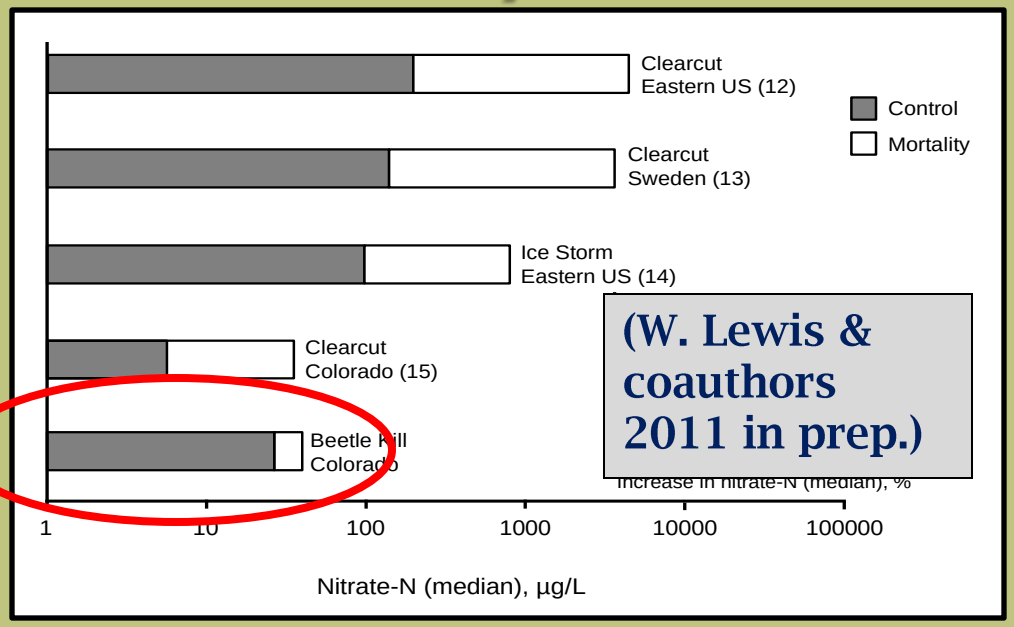
Nearly 40% of understory trees added > 2X as much height in 2010 as in 2007.

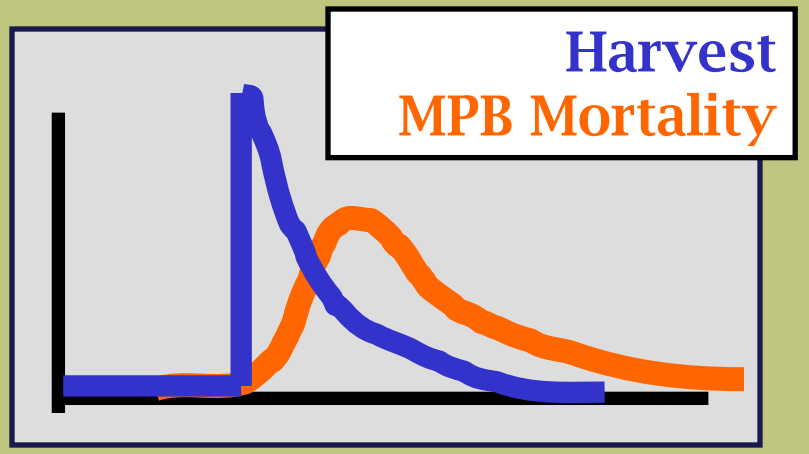



Foliar N more than doubled following loss of neighboring trees.

# Initial Watershed Responses are Relatively Minor

Western Water Assessment
MPB – Water Science Workshop
(Lukas & Gordon 2010)



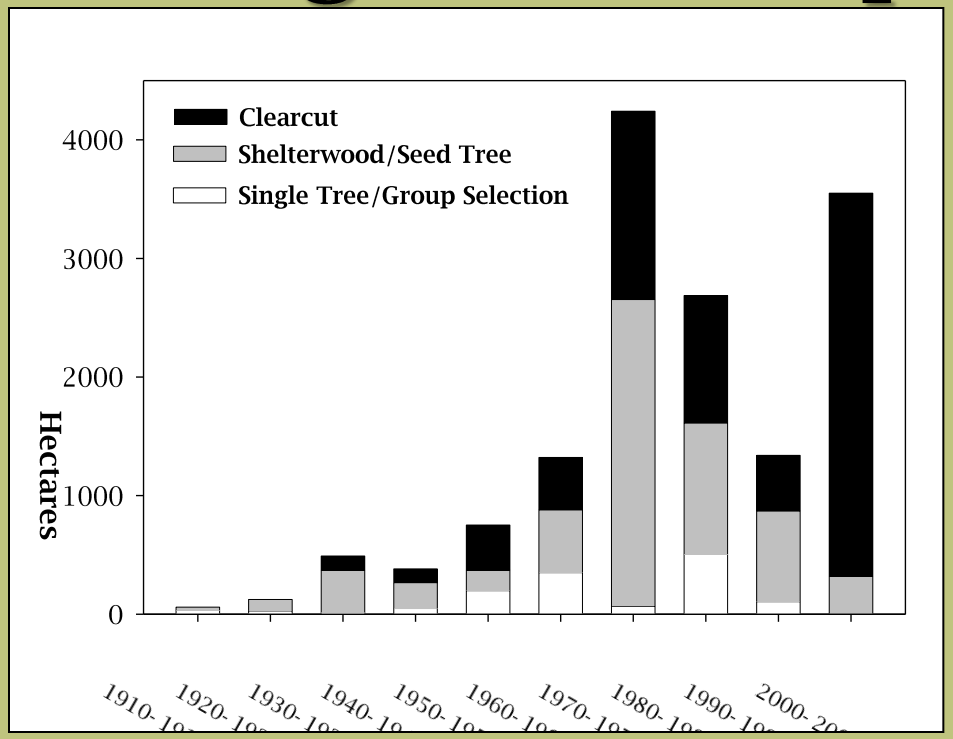




Decline in stand transpiration and nutrient use depends on extent of mortality, species composition, understory response

Magnitude and timing of changes in water differ from harvest response

In general, studies do not indicate nutrient loading or other water chemistry changes of the magnitude that would present problems for either human water use or aquatic ecosystems.

# Management Response to MPB




## Sulphur Ranger District Arapaho–Roosevelt NF

More harvesting than at any time since the 1970s

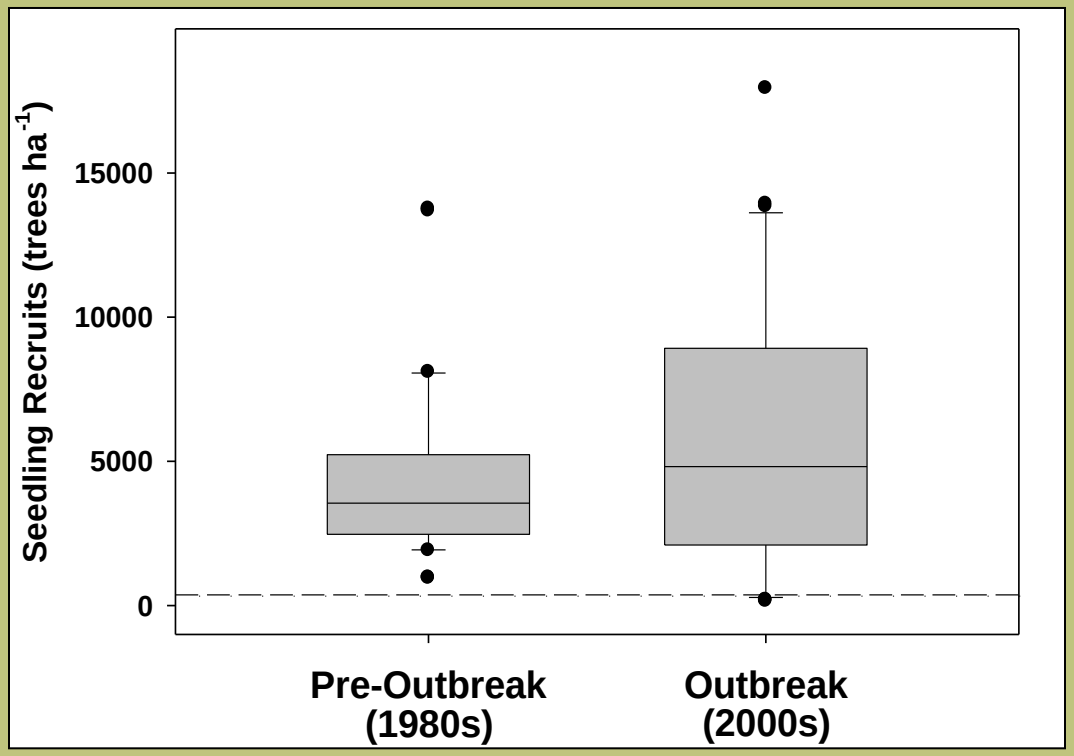
Greater amount of overstory removal, clear cut, salvage

~10 – 15% of treatable area

*AR NF unpublished data

# Response to Management

## *Post–Harvest Recruitment*




**Pine recruitment is at least as good now as it was in the past**

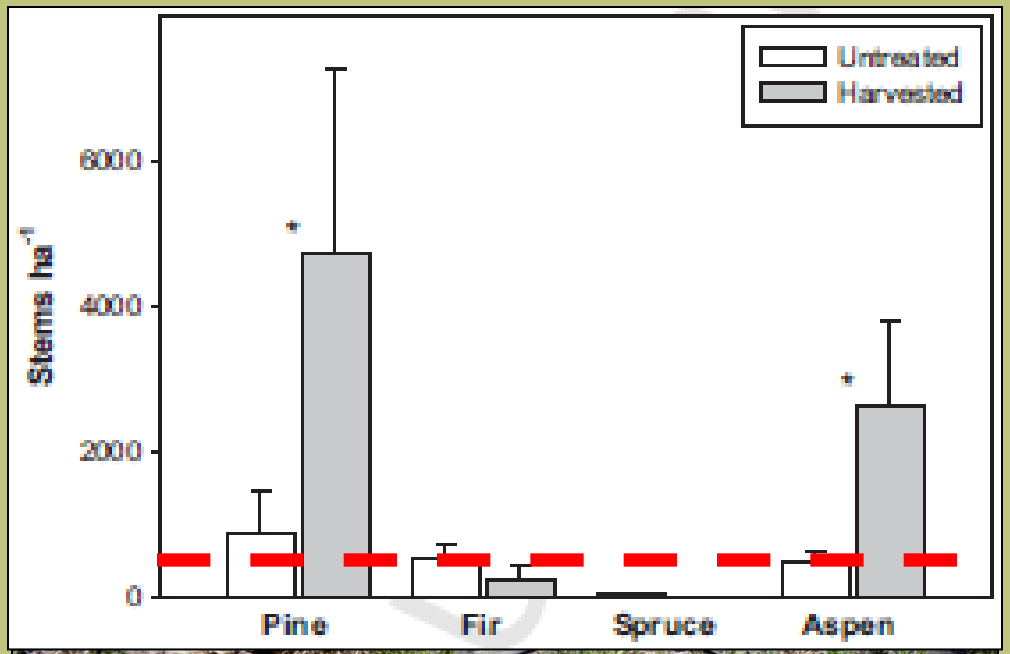
**> 90% of stands meet minimum stocking requirements**

Pre-outbreak stands cut in the ’80s vs. stands cut in the first phase of MPB-related harvesting on the SRD (Crimson VMA)

(Collins et al. 2010a)

# Response to Management

## *Tree Recruitment*




**Harvesting stimulates new pine seedlings and aspen sprouts.**

5 times more pine, aspen compared to uncut stands

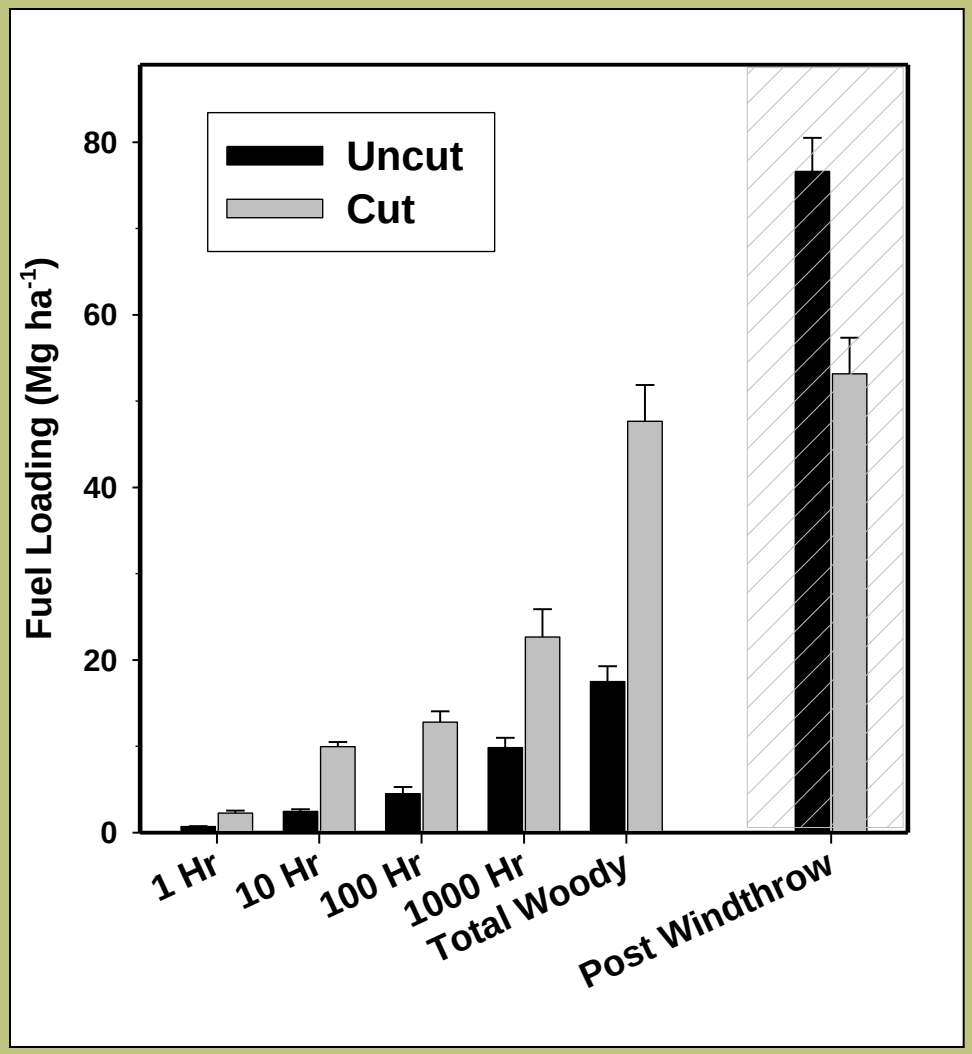
Fir recruitment is promoted in uncut stands

*Cut stands meet minimum stocking requirements
(i.e., > 150 t/acre)

*8 paired sites at Fraser

(Collins et al. 2010b)

# Post-Treatment Surface Fuels




**Harvesting adds**

~4X fine fuels (1 + 10 hr)

~3X total surface fuels

**The increase in surface fuels may result in greater flame lengths (i.e., under extreme weather conditions: 2.3 vs 1.7 m compared to 5m).**

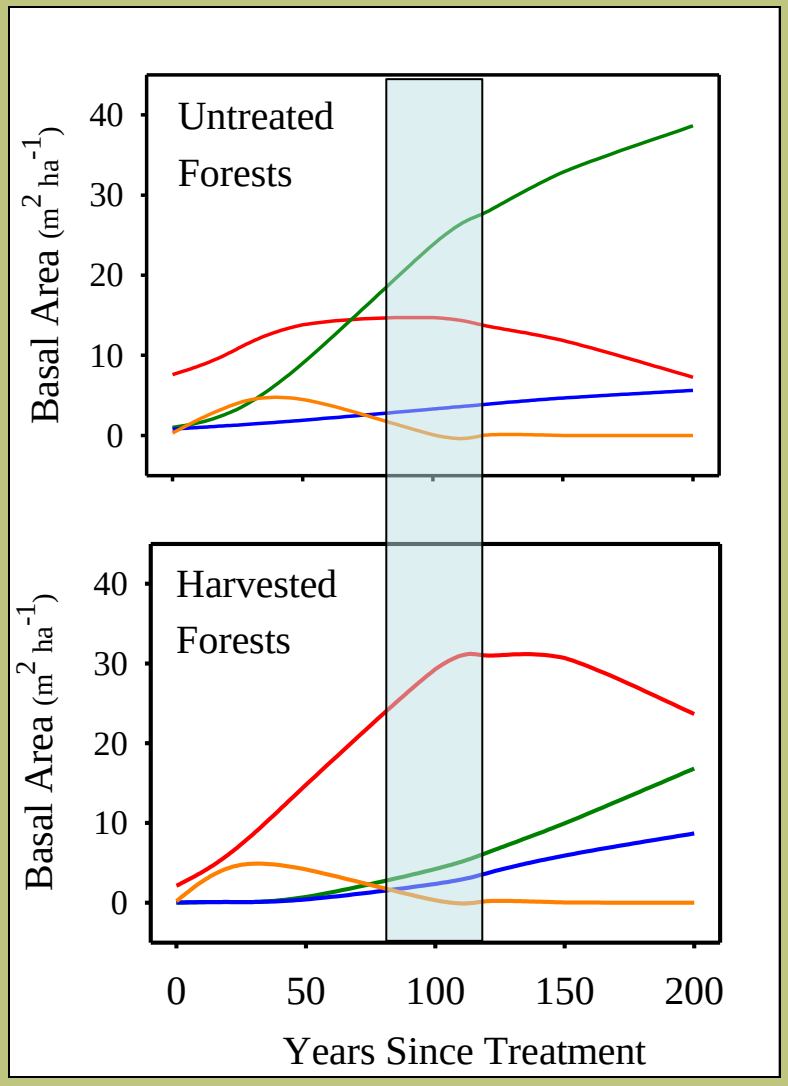
1.2 m - halt direct-attack

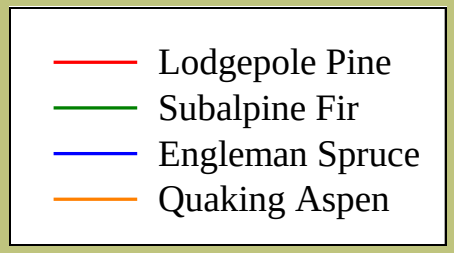
2.5 m - halt dozers

**Windthrow will increase the surface load in uncut areas**

~1.4x higher than cut areas

# *Stand Species Composition*
# Varies with Management




**Forest Recovery**
Projections based on stand-level measurements

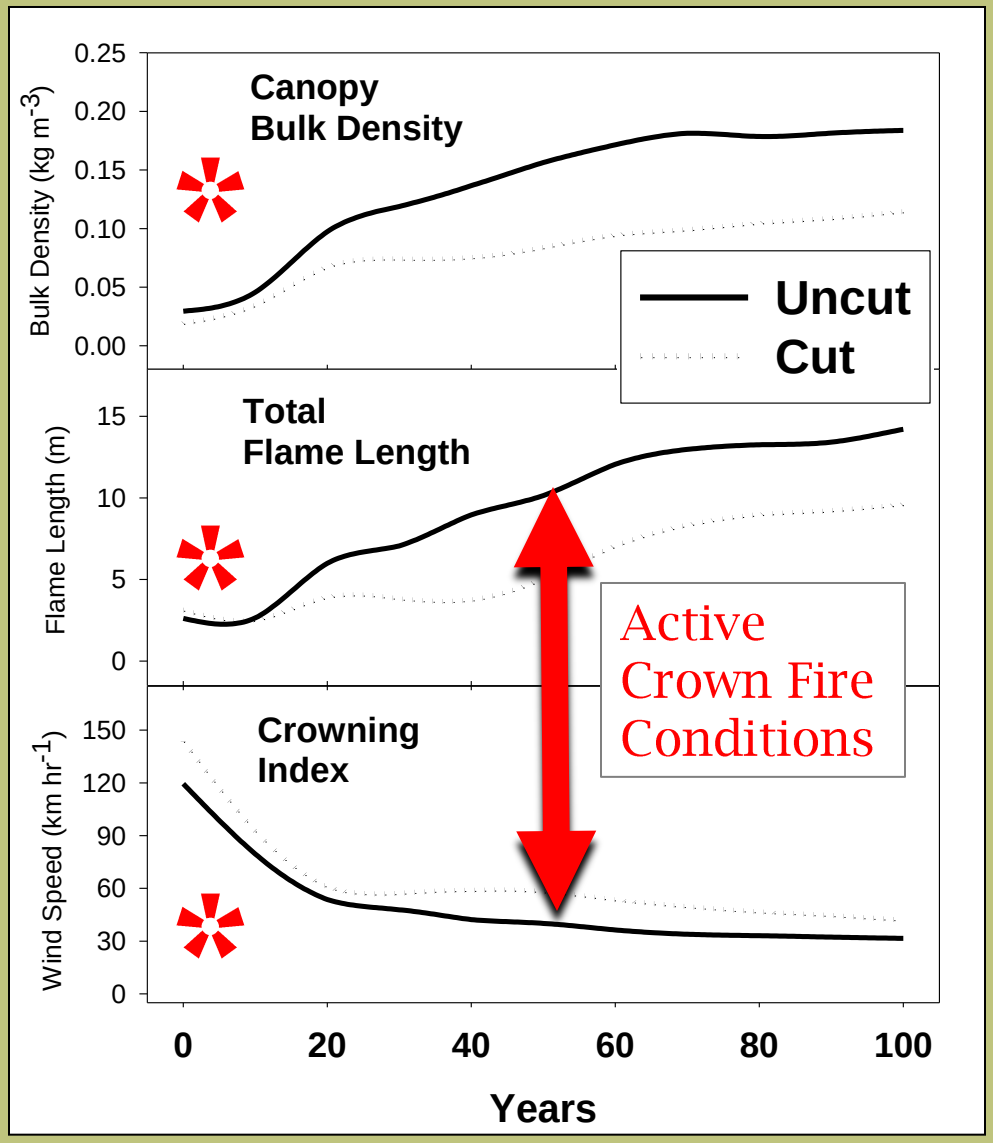
MPB-killed stands recover to pre-MPB basal area in 80 - 105 yr

**Uncut & Partial Cut Stands**
Dominated by fir

**Clear Cut Stands**
Similar to pre-MPB stands
Dominated by pine

(Collins et al. 2010b)

# Post Treatment Fire Behavior




Recovery of the forest canopy determines fire behavior in future stands

Risk of crown fire is low and will differ little between treated & uncut stands until new stands develop (~20 yrs).

More fir in uncut stands increases canopy BD, crown base height and flame length.

**Green Stands** - Risk, intensity of crown fire is greater:

* 6m total flame length
* Crowing Index 55 km/hr (34 mph – moderate risk)

# MPB Management Alternatives

## Varying Environmental Conditions

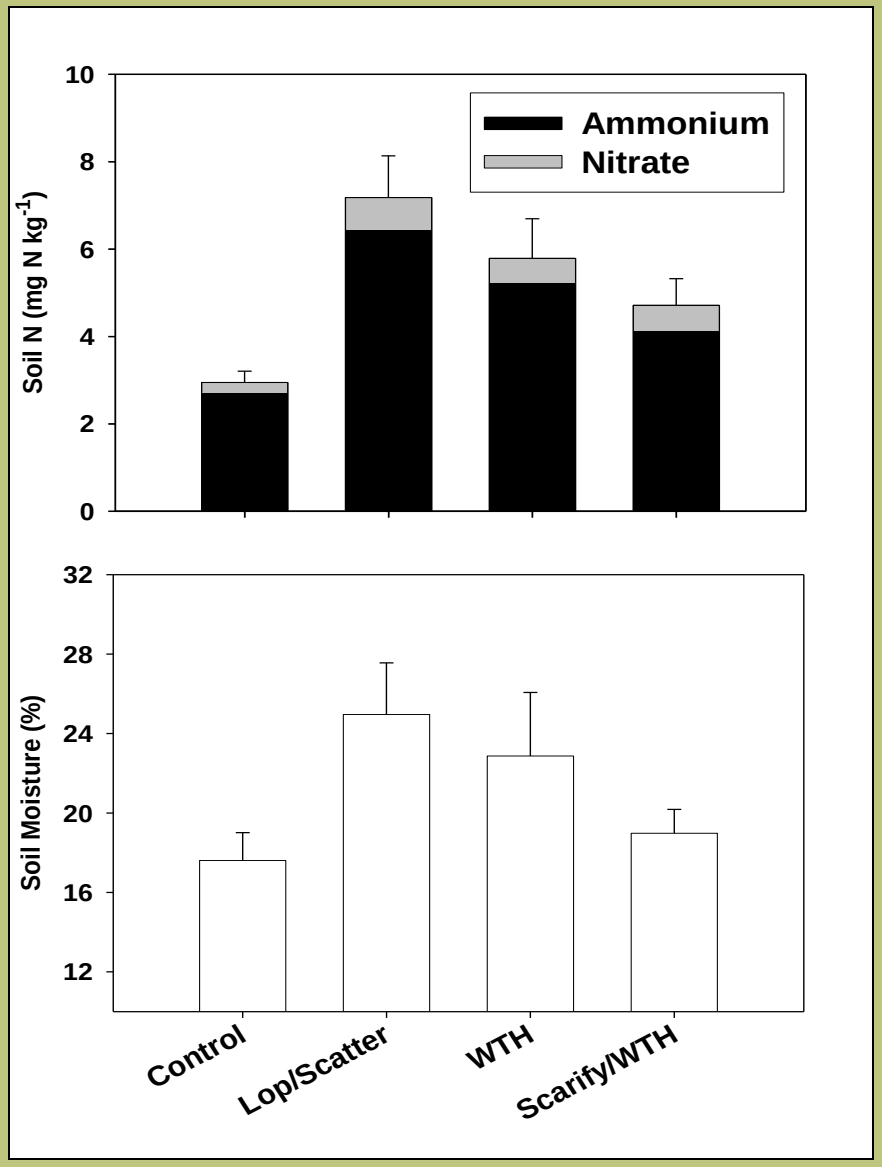
**No Action**
Untreated Stands

**Fuel Reduction**
Whole Tree Harvest (WTH)

**Water Delivery**
Harvest, retain slash

**Forest Regeneration**
WTH + Mechanical Site Prep

# MPB Management Alternatives



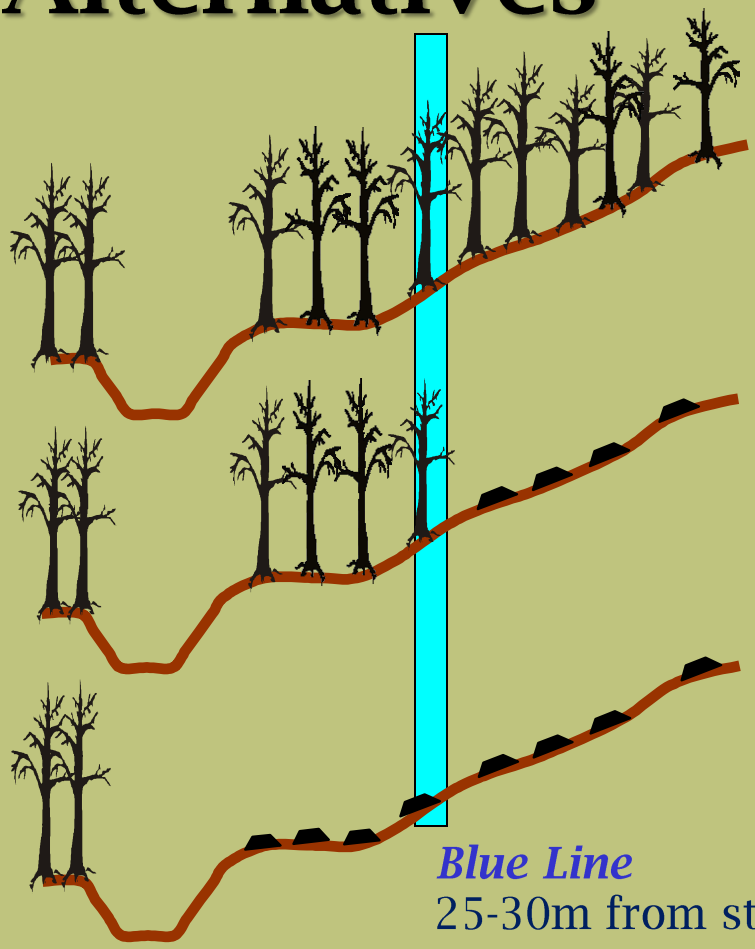

**Soil nutrients & moisture**

Plant-available soil N doubles in harvest areas.

- Increased inputs, lack of uptake, change in turnover
- Mobile nitrate form is minor

Slash retention has positive effect on N and moisture

# MPB Management Alternatives




**Do dead riparian buffers protect water quality?**

**Riparian Fuel Management** – Fuels reduction underway in riparian zones on > ½ of western USFS districts.
(Stone et al. 2010 )

# MPB Management Alternatives

## Understory Plant Community

MPB outbreak has the potential to reinvigorate the understory plants as light, nutrients, and water become more available.

In areas where salvage logging exposes the soil seedbed, the establishment of opportunistic understory species – both native and exotic – may be promoted

**Preliminary Findings**

Noxious Weed - Canada thistle (*Cirsium arvense*)

30% of cut units / Absent from uncut areas

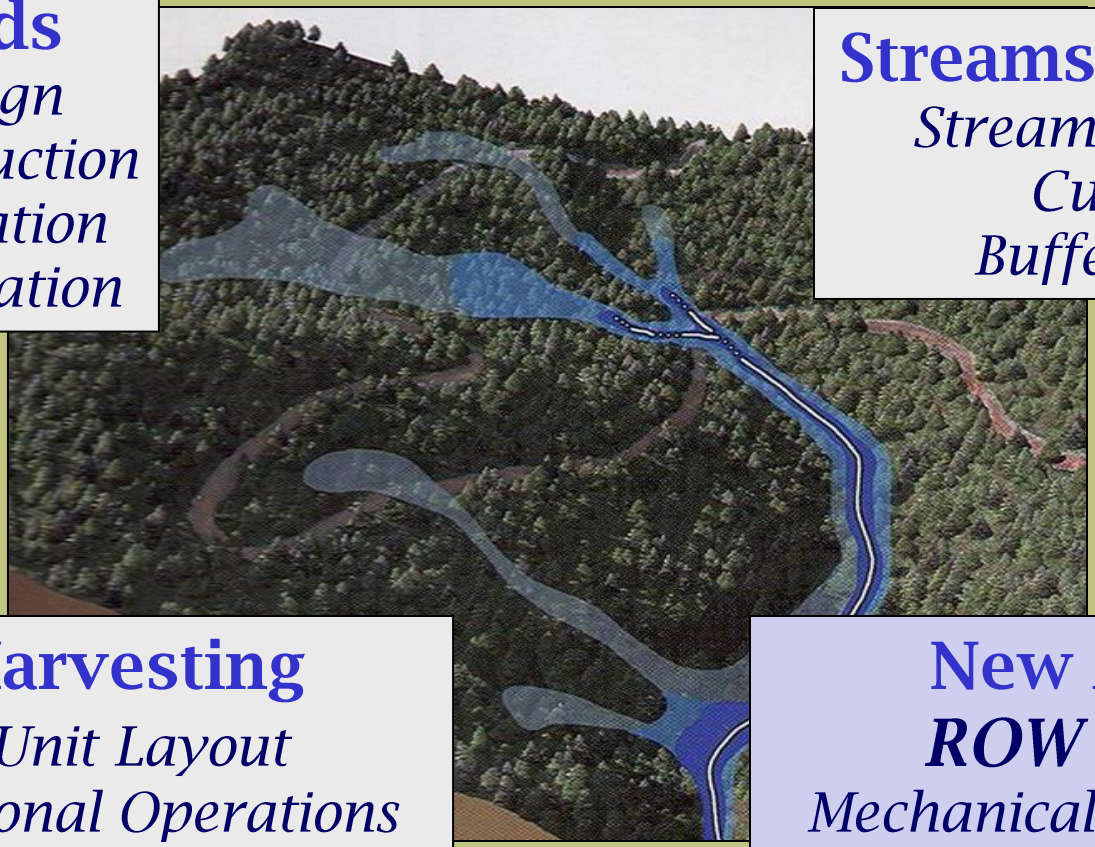
Non-Native - Dandelion (*Taraxacum officinale*)
Most common exotic species
73% of cut units vs. 44% of uncut areas
Lop & Scatter units have ½ the cover of WTH plots

(P. Fornwalt unpublished; R. Harris, unpublished)

# Protecting Clean Water Delivery

## Best Management Practices

**Roads**
*Design*
*Construction*
*Utilization*
*Obliteration*



**Streams, Wetlands**
*Stream Crossings*
*Culverts*
*Buffer Zones*

**Harvesting**
*Unit Layout*
*Seasonal Operations*
*Slash Management*
*Pile Burn Rehabilitation*

**New Activities**
***ROW Corridors***
*Mechanical Fuel Treatments*
*Biomass Utilization*
*C Accounting*
*Soil Productivity*

# Many Thanks!

## PROJECT SUPPORT


USFS Chief's Emergency Funds

USFS R2 – Bark Beetle Initiative

USFS AR, MBR, WR National Forests

USFS Sulphur Ranger District – Upper Fraser Project ID team

Colorado State Forest Service

Colorado Water Conservation Board

Joint Fire Science Program

Colorado Forest Restoration Institute

Denver Water


## On-the-Ground

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