Long-Term Dead Wood Changes in a Sierra Nevada Mixed Conifer Forest: Habitat and Fire Hazard Implications

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Snag habitat

- Nesting, roosting and resting structures for many bird and mammal species
- Source of food: bark beetles and other wood boring insects
- Bigger is generally better

D. Backlund

Coarse woody debris (CWD)

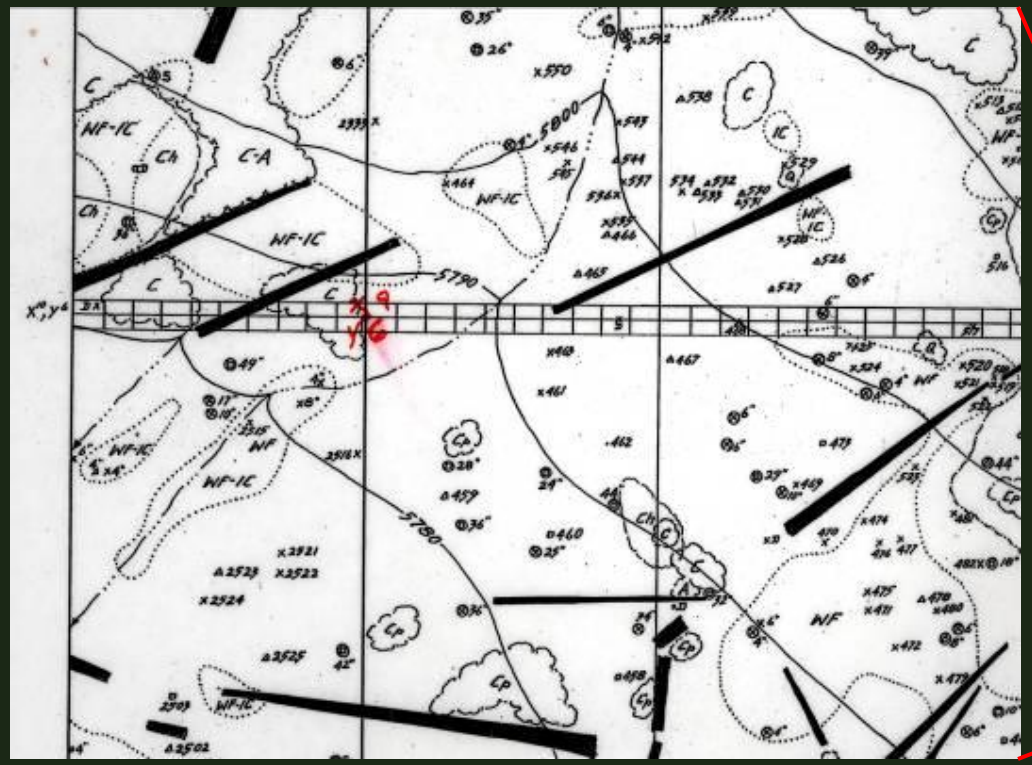
- Dead and down wood also has ecological value
  - Shelter/ cover
  - Fungi, insects = Food
  - Nutrient cycling

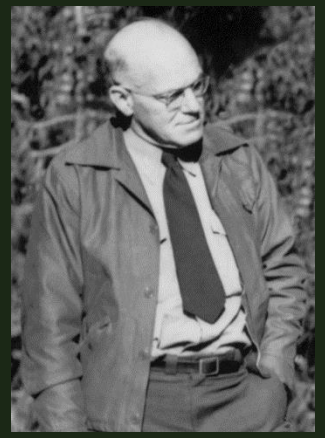
J. Sullivan

Dead wood is flammable and can contribute to extreme fire behavior

How much dead wood is sufficient to meet ecological/wildlife needs, yet not so much that it becomes a fire hazard?

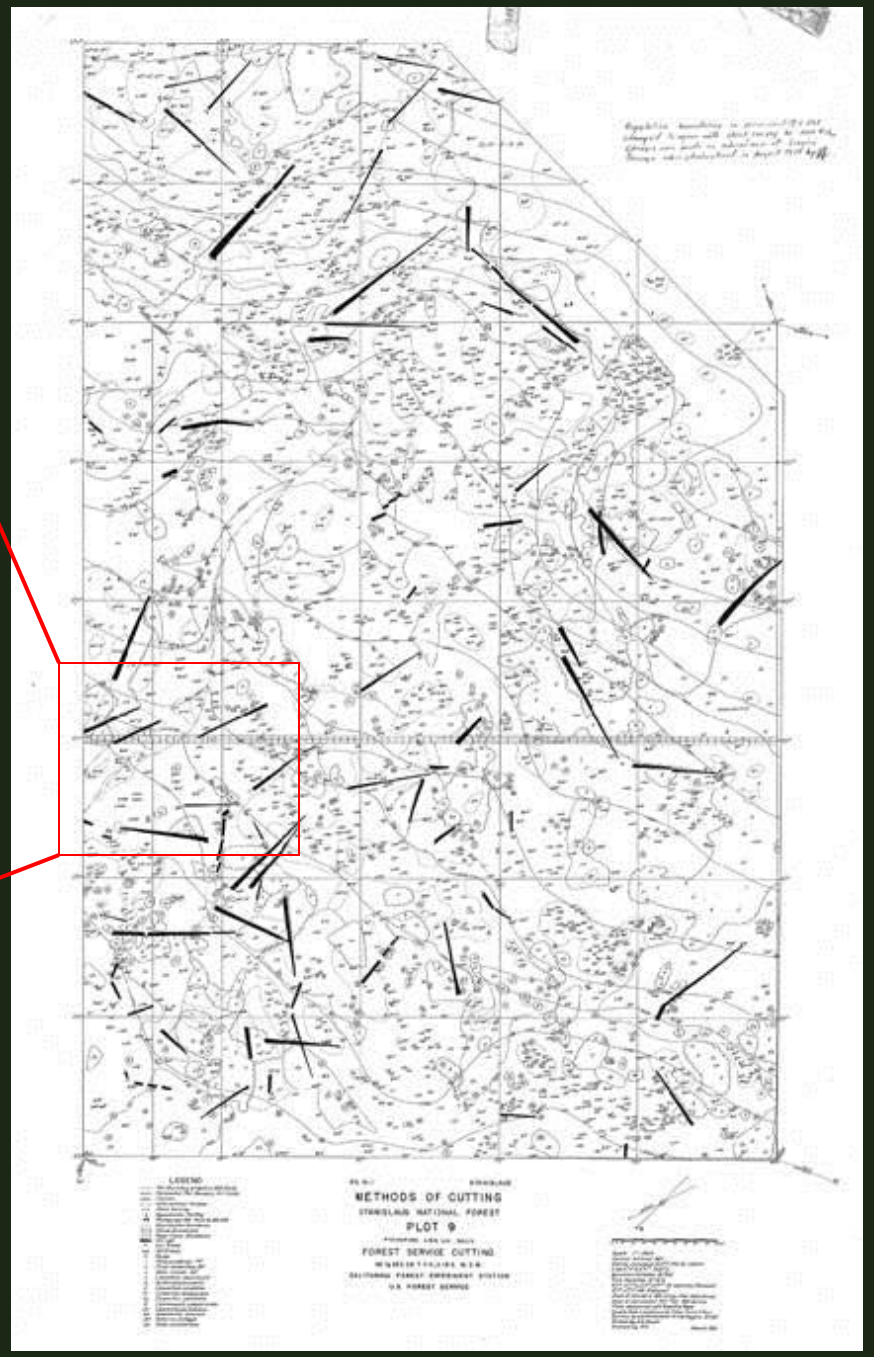
Historical Methods of Cutting plots



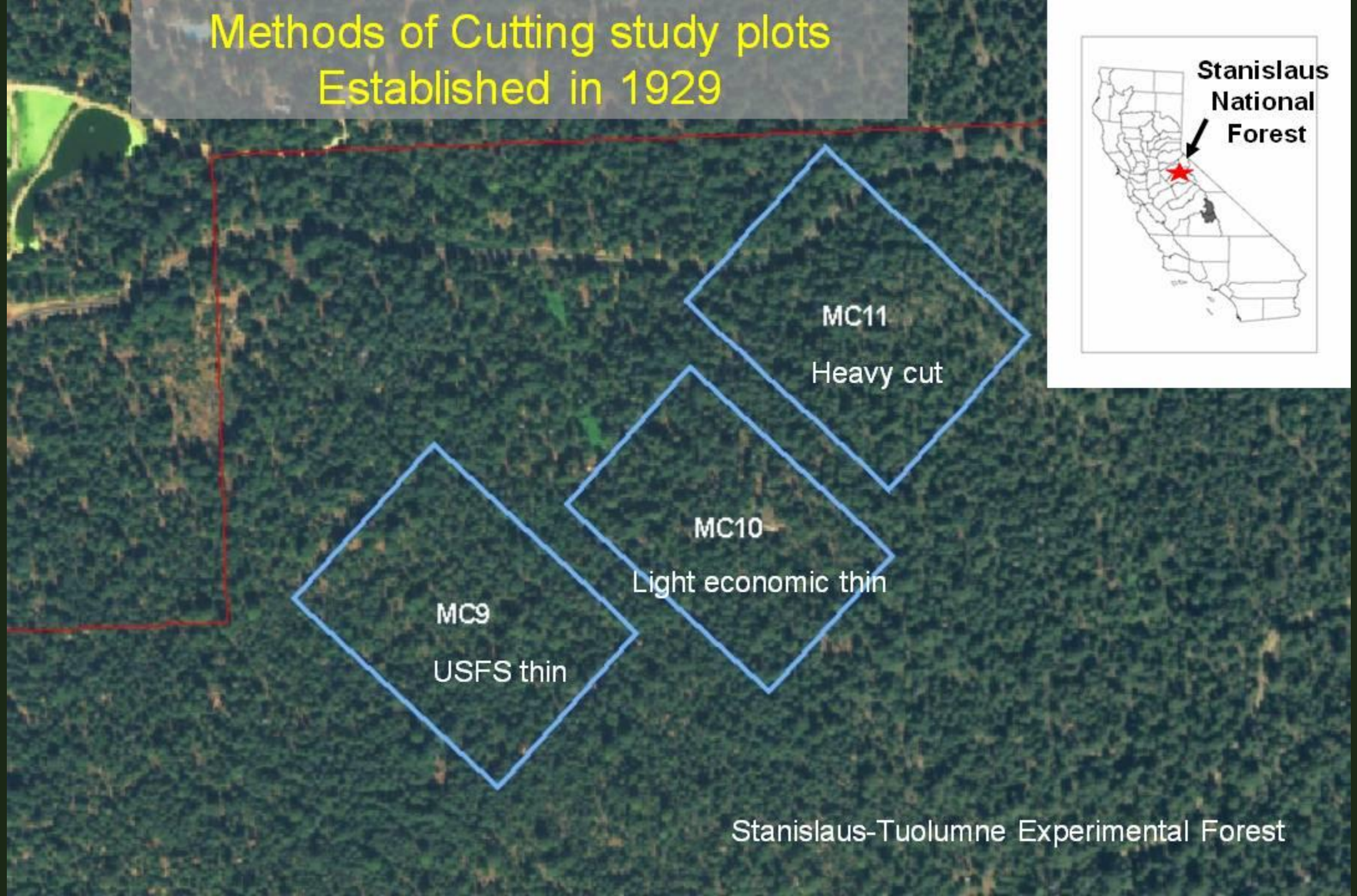


1929 stand maps

Duncan Dunning
USFS Forester (1915-1950)



Methods of Cutting study plots Established in 1929



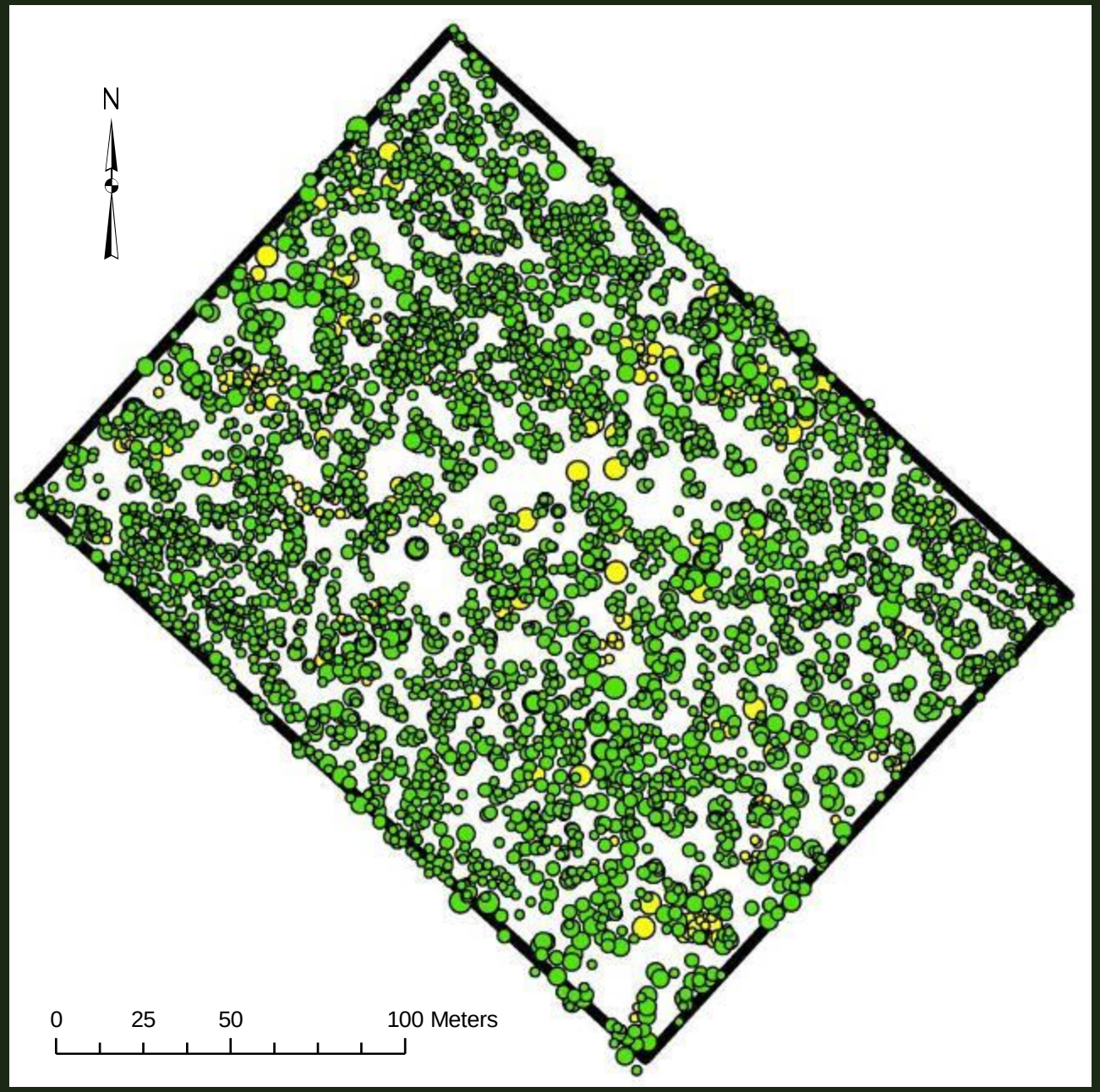
79 years of forest change: live trees

Productive mixed conifer forest
Elevation: 5800 ft
NW-facing aspect

	1929	2008
Trees ac^{-1} *(≥ 4 in)*	127	299
Basal area ft^2 ac^{-1}	235	302
% Pine	37	21

Live trees in 1929 post-logging

Plot 9 – USFS thin

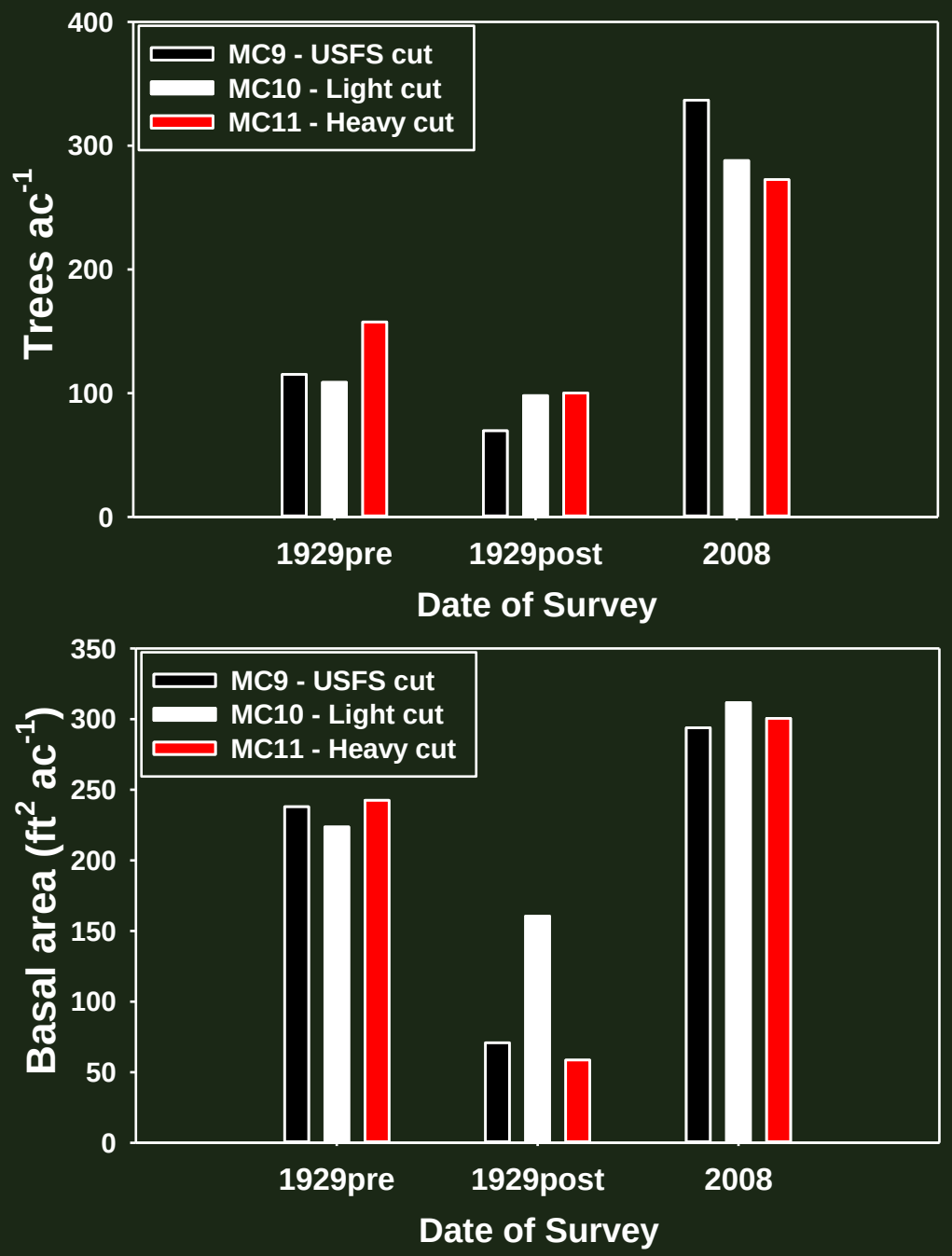


DBH 1929 (in)

- 0- 10
- 10 - 20
- 20 - 40
- 40 - 76

DBH 2008 (in)

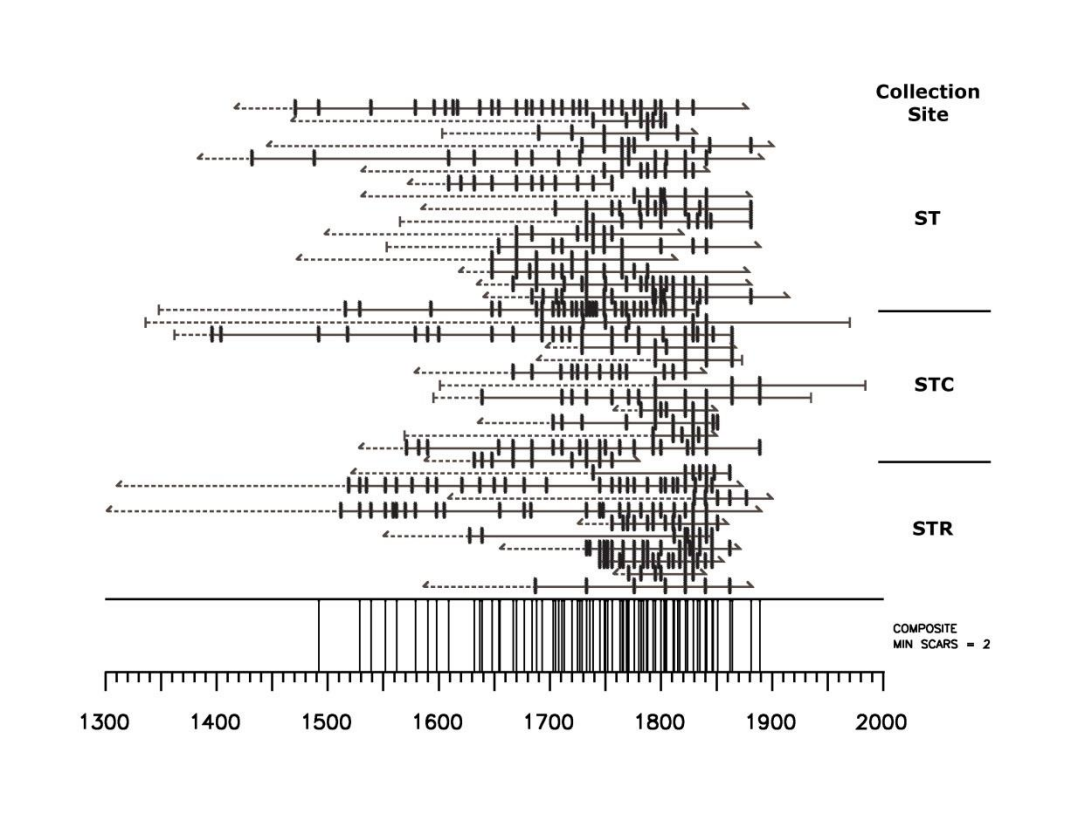
- 0 - 10
- 10 - 20
- 20- 40
- 40 - 76



Potential causes of forest change: effect of logging treatment

Historical role of fire in the Sierra Nevada

Fire history from the Pinecrest/Strawberry area



Median fire return interval: 6 years
Last major fire: 1889

“So continuous and widespread are these fires, that except where some natural barrier or chance has prevented, they keep a very large percentage of the seedling growth down.”

“Dense stands of yellow pine 25 to 50 years old suffer a thinning every time surface fires run through them, and not infrequently the younger stands succumb entirely.”

- Sudworth (1900)

Forest change in absence of fire

Clark Fork, Stanislaus NF
Photo: A.E. Wieslander, 1931

Snag density change 1929 – 2008

(≥ 4 inches in diameter)

	# Snags ac^{-1}		
	1929 - pre	**1929 - post**	**2008**
Plot 9 – USFS cut	3.7	3.7	65.1
Plot 10 – Light Economic cut	4.8	3.6	66.0
Plot 11 – Heavy cut	10.0	4.5	40.3
Average	**6.2**	**3.9**	**56.7**

Snag size change

Management standard for wildlife:
4 or more snags/ acre (>15 in.)

	No. ac^{-1}	
	1929	**2008**
Snags 4 -15 in	1.8	44.2
Snags > 15 in	4.4	12.5
% > 15 in	72%	22%

Snag basal area 2008

	Basal area (ft^2 ac^{-1})		
	Small (4 – 15 in)	**Medium** (15 – 30 in)	**Large** (>30 in)
Plot 9 – USFS cut	19.2	20.9	9.1
Plot 10 – Light Economic cut	22.2	22.2	44.0
Plot 11 – Heavy cut	10.9	23.5	3.9

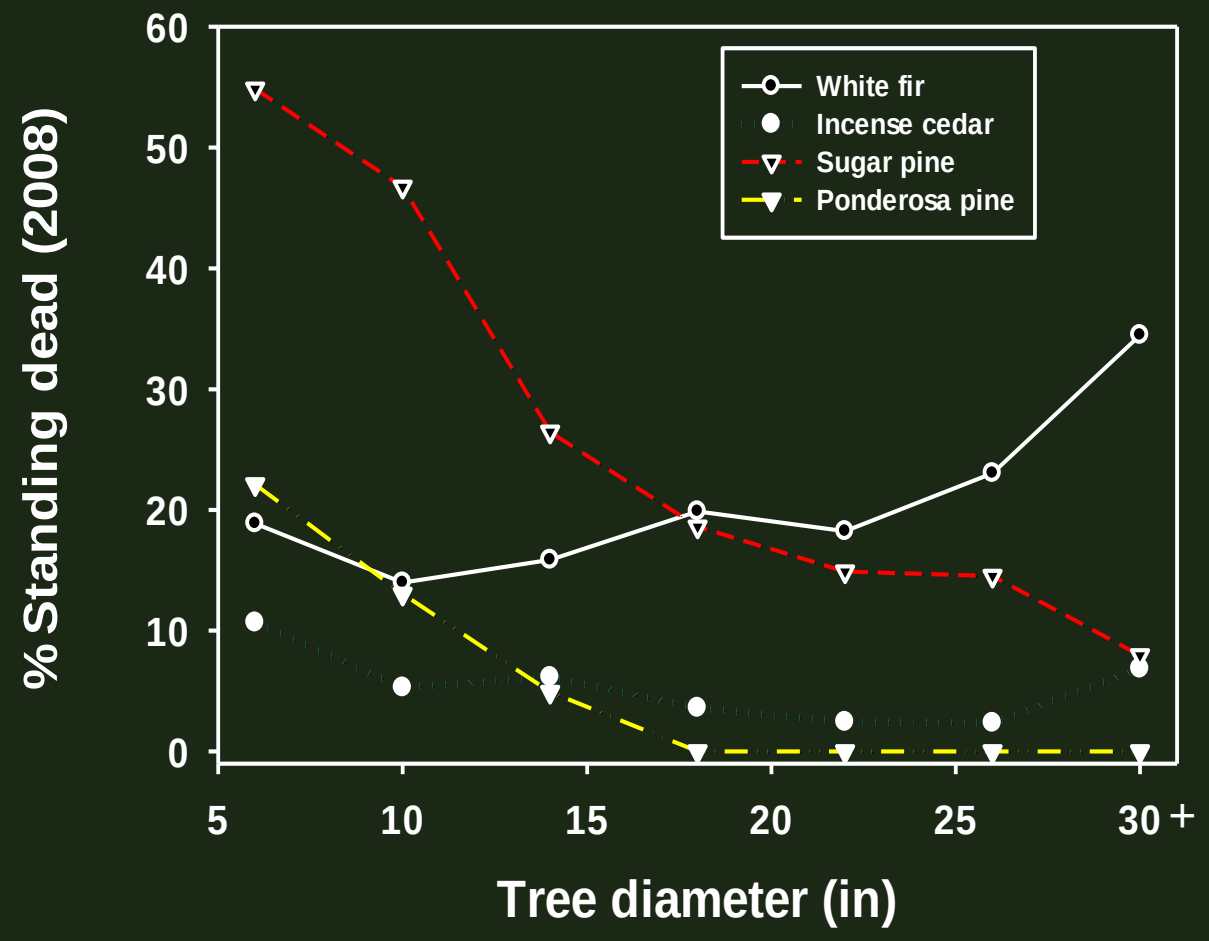
Methods of Cutting plots 9-11, Stanislaus NF

Percentage of standing trees that were dead

	% Dead 1929	% Dead 2008
White fir	4.1	18.2
Incense cedar	3.7	8.0
Sugar pine	3.8	37.5
Ponderosa pine	6.0	9.3
AVERAGE	**4.0**	**15.9**

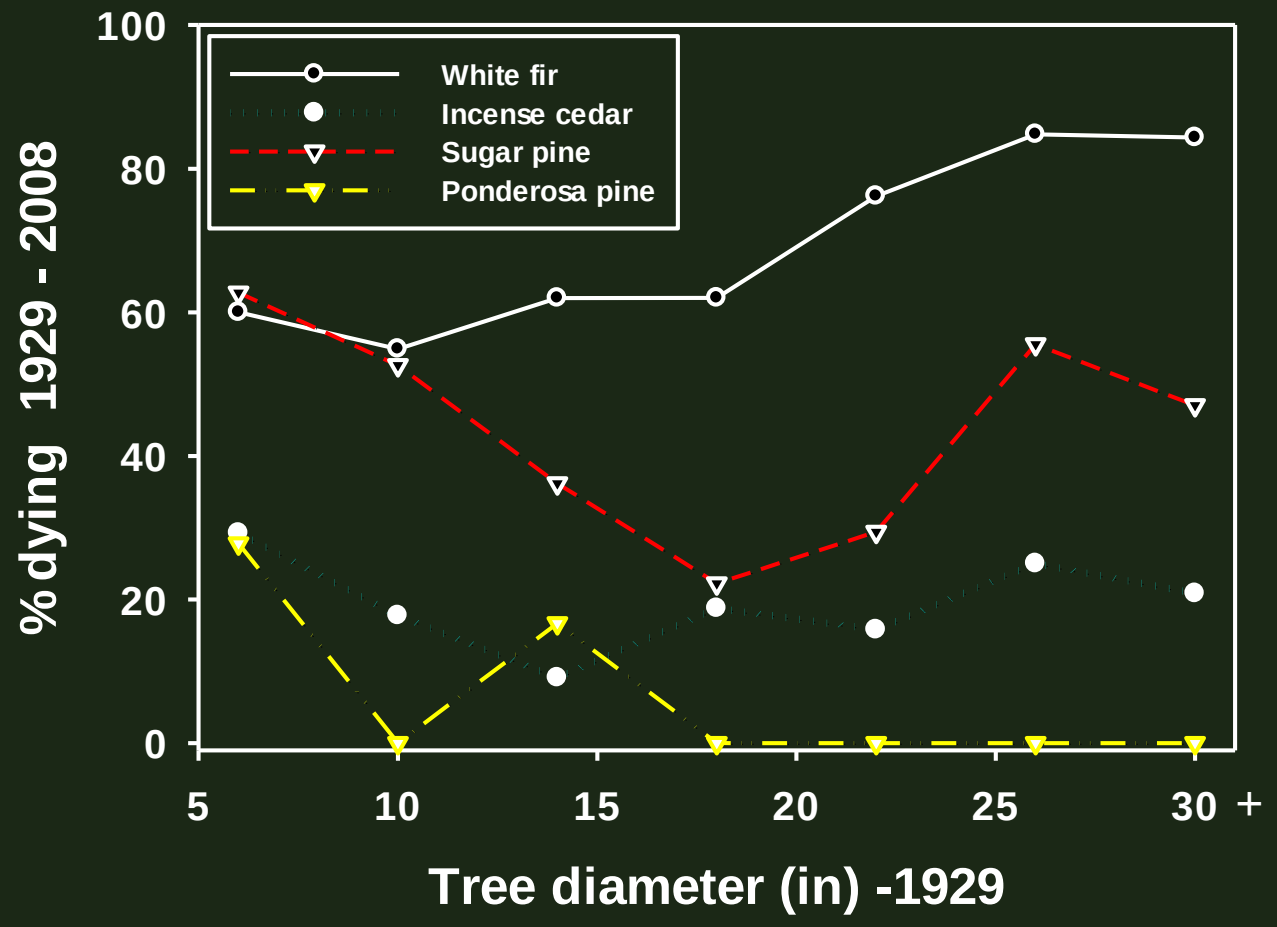
Methods of Cutting plots 9-11, Stanislaus NF

Percentage of standing trees dead by size - 2008



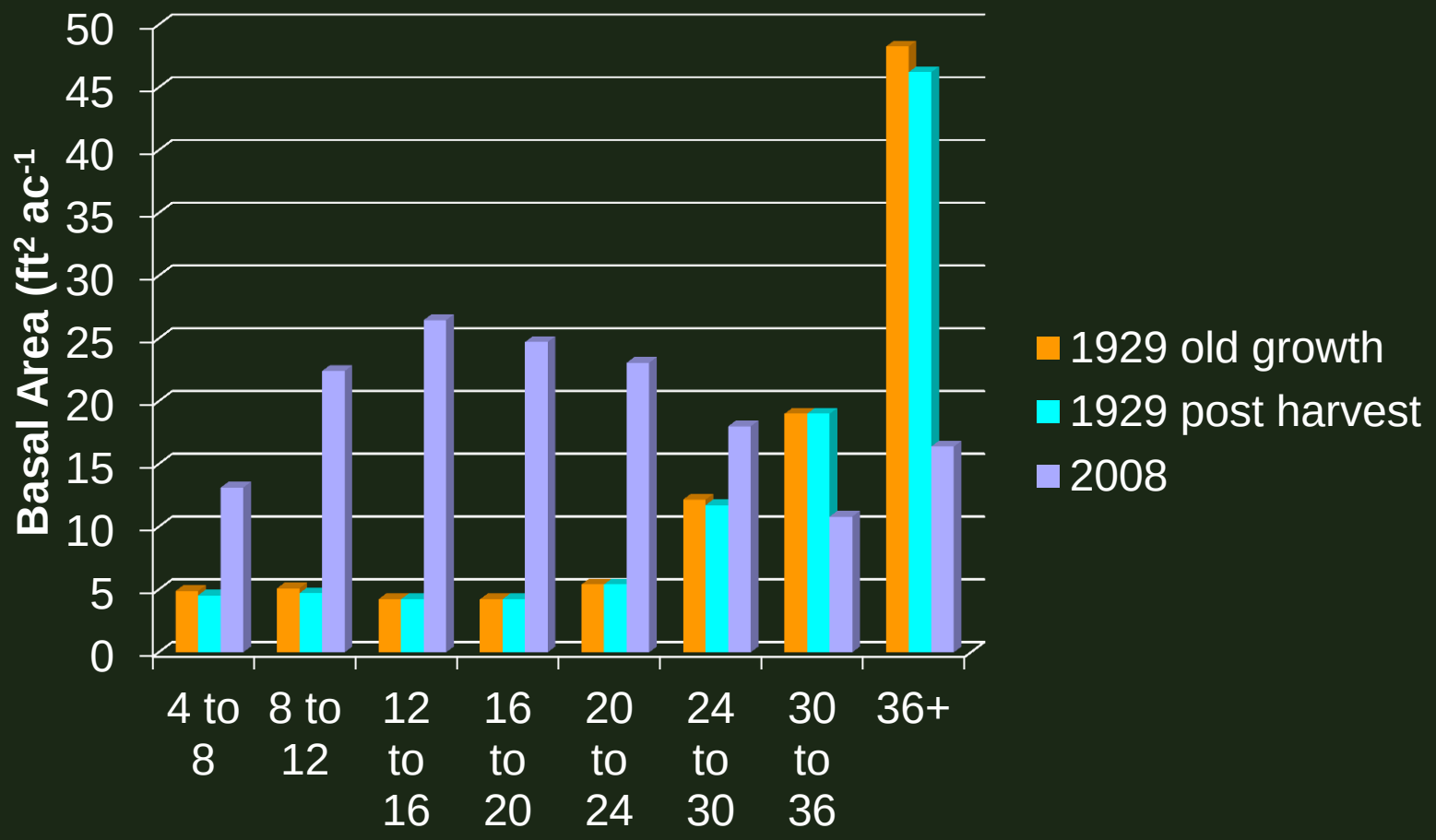
Methods of Cutting plots 9-11, Stanislaus NF

% death between 1929 and 2008

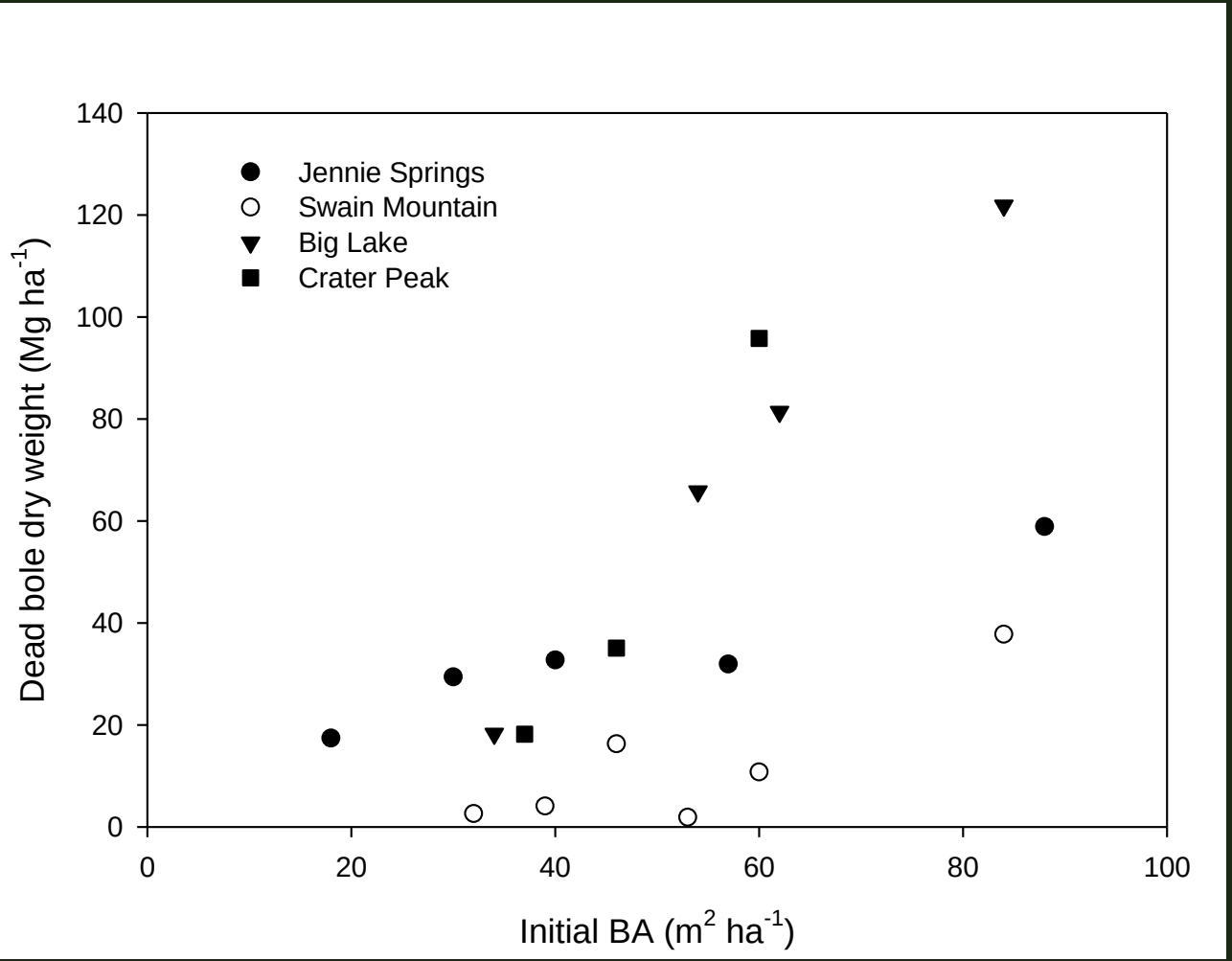


Methods of Cutting plot 10

Live white fir by size class 1929 to 2008



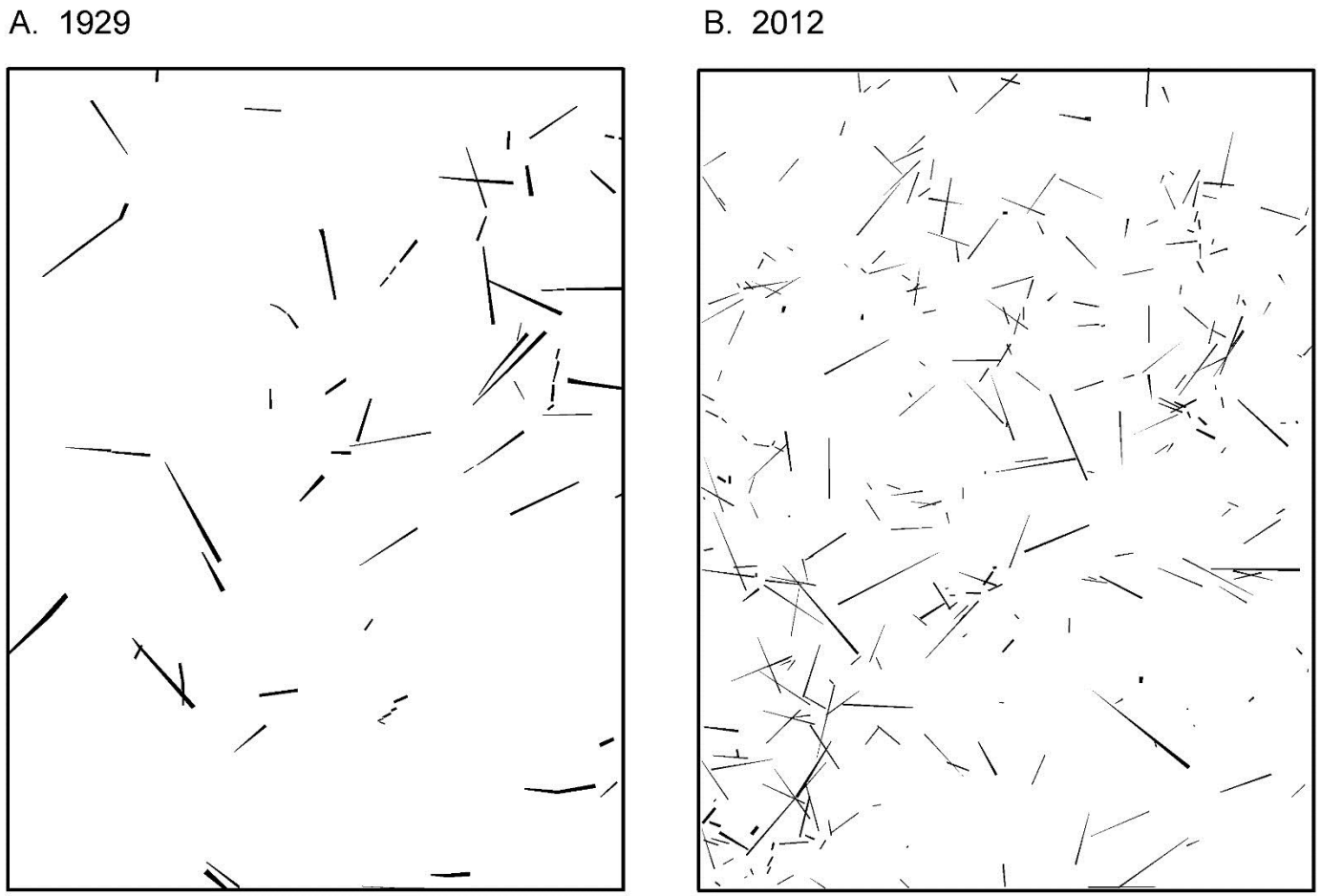
Basal area and tree mortality



From: Zhang J, Oliver WW, and Ritchie MW. 2007. Effect of stand densities on stand dynamics in white fir (*Abies concolor*) forests in northeast California, USA. Forest Ecology and Management 244: 50-59.

Coarse woody debris change 1929-2012

MC9 – 1929 prior to logging **MC9 – 2012**



Coarse woody debris change 1929 - 2012

	# Logs ac^{-1}		Log diam. inches		Log mass tons ac^{-1}	
	1929	**2008**	**1929**	**2008**	**1929**	**2008**
Plot 9 – USFS cut	6	28	38.6	17.5	16.9	8.8
Plot 10 – Light Economic cut	8	40	34.1	20.4	21.1	19.2
Plot 11 – Heavy cut	20	25	26.5	18.5	25.0	9.2
Average	**11**	**31**	**33.7**	**18.8**	**21.1**	**12.4**
	$P = 0.042$		$P = 0.019$		$P = 0.105$	

Snags, CWD and fire behavior

- Snags loft embers
- Consumption
  - Small diameter > large diameter
  - Decayed > sound
- Decayed wood – receptive to embers
- More logs = more jackpots
- Torching and extreme fire behavior

How fires once burned

"…the only food for these fires is the scanty fall of pine and fir needles, irregular patches of low conifer seedlings, and chaparral. In general, these materials limit the fires to surface burning." - Sudworth (1900)

Versus now

Rim Fire – 2013

Re-thinking the role of CWD in seasonally dry western forests

- Slow decomposition, but less CWD can accumulate with frequent fire
- Unstable resource: wildlife may not be as dependent on CWD in frequent fire forests
  - *(Sollman et al. 2015. Mammalian Biology 80:247-254)*

A.E. Wieslander
Near Butte Lake, Lassen County (1941)

Conclusions

- With forest densification in absence of fire:
  - Many more snags and more downed logs today than in 1929
  - Mortality shifted from large size/old age to smaller size/ younger age
    - Density dependent mortality
    - White pine blister rust
- Current situation with smaller snags and logs – lower habitat value: potential fire hazard ratio
- To restore dead wood condition:
  - Reduce stand density/ basal area
    - Reduced mortality
    - Larger tree size = larger snag size = larger CWD
  - Re-introduce periodic fire to consume dead wood

Acknowledgements

- Stanislaus National Forest
- PSW field crews 2007-2012

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