



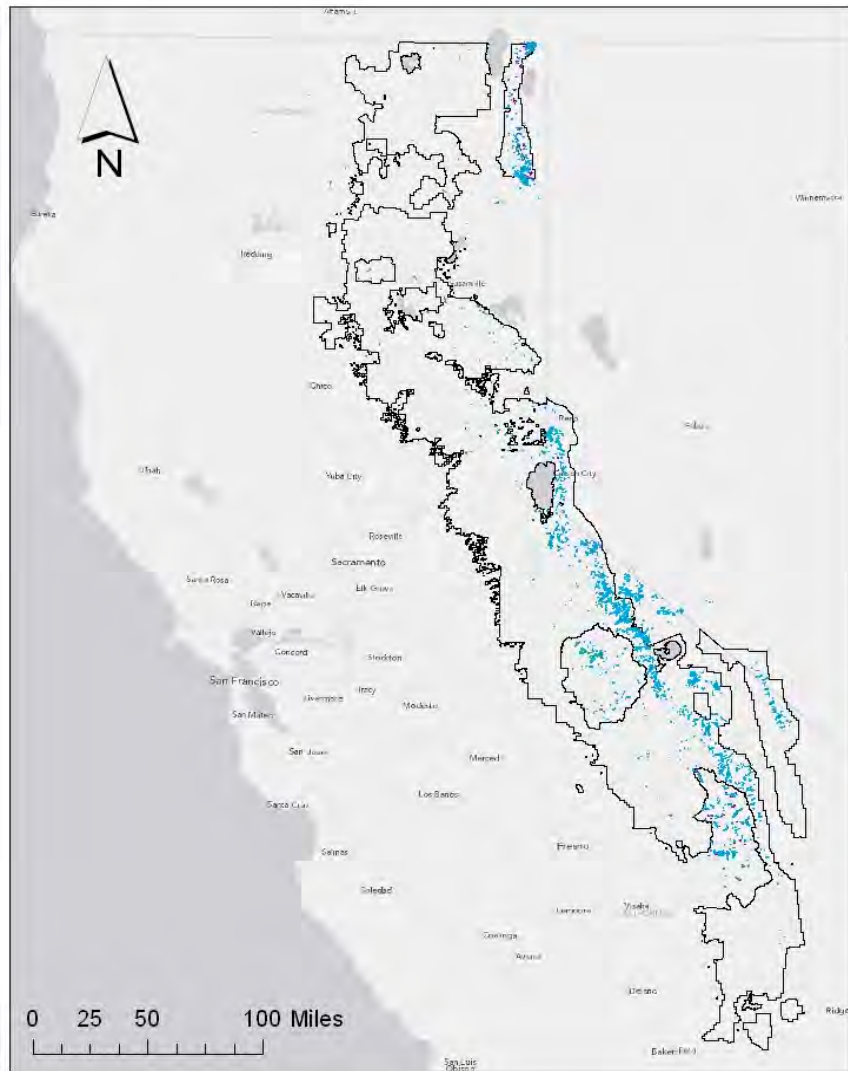
# Natural Range of Variability of Aspen in the Sierra Nevada and Southern Cascades

Aspen Ecology and Restoration  
Management in California Workshop  
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# Extent of Aspen



- Aspen is found throughout the three ecoregions
  - Sierra Nevada
  - Southern Cascades
  - Modoc Plateau
- Occurs both east and west of the crest

# Climate/Geology

Ecoregion	Elevation of Aspen (ft)	Average Annual Rainfall (in)	Percent Snow	Average Annual Temperature (°F)	Geomorphology	Dominant Parent Material
Sierra Nevada	5,310 – 8,800	30-60	>60	62	Westward tilted block	Granite
Southern Cascades	5,500 – 8,000	20-70	>60	60	Volcanic andesite	Basalt
Modoc Plateau	3,700 – 9,892	8-30	30	48	Block faults	Basalt



Crystal Basin, ENF



## Common aspen stand types, location and seral stage

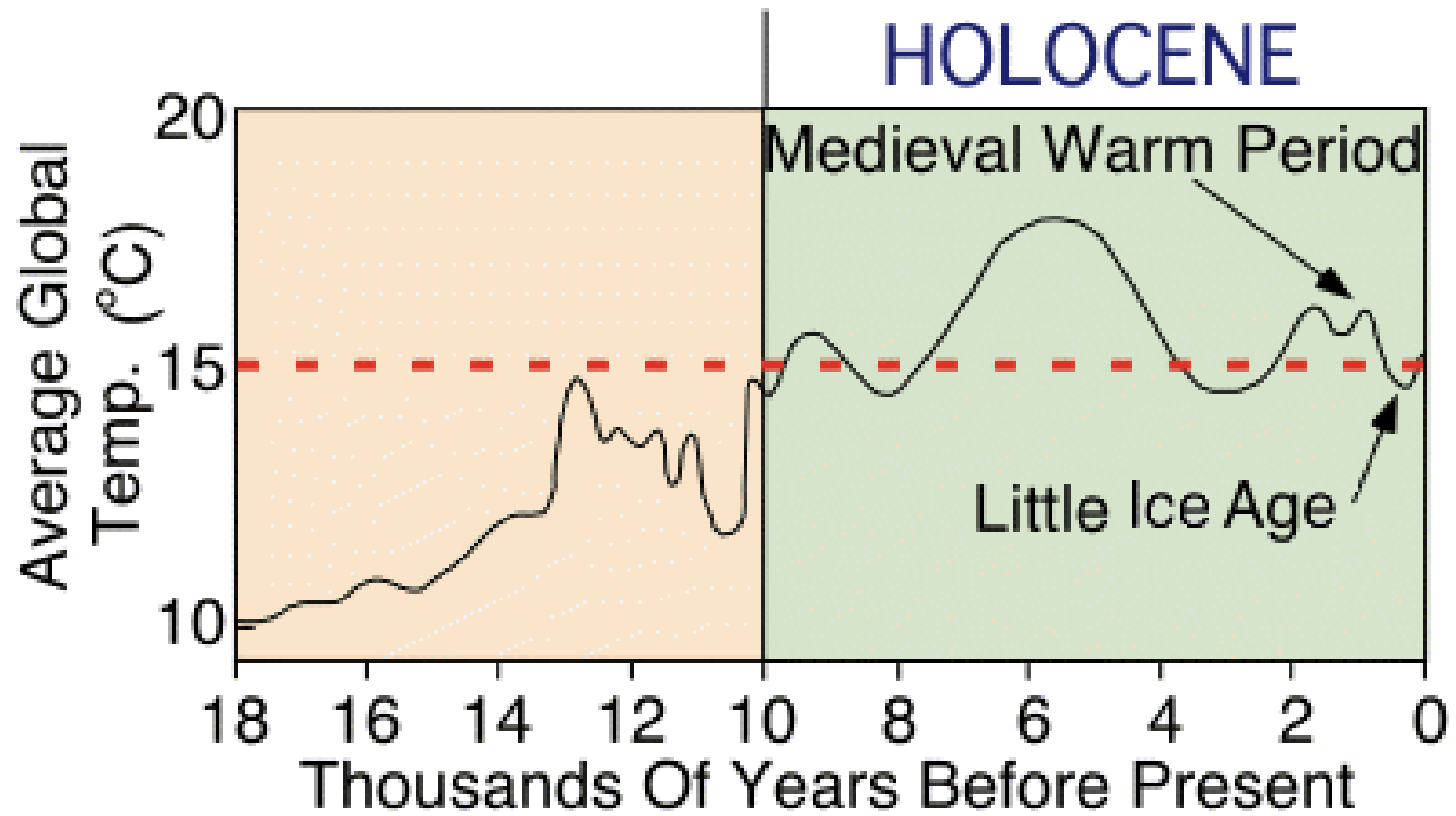
Stand type	Location	Fire dependence	Seral stage
Riparian	Permanent/seasonal water course	Dependent	Early
Meadow fringe	Dry meadow fringes	Dependent	Early
Upland aspen/conifer	Located away from any surface moisture regimes	Dependent	Early
Lithic	Lateral/terminal moraines, talus, rock	Independent	Stable
Upland pure	Variable site locations	Independent	Stable
Snow pocket	Topographic positions where snow accumulates	Influenced	Stable
Krummholtz	Ridgelines	Independent	Stable

(Shepperd et al. 2006, Shinneman et al. 2013)

# Climate, fire frequency, and vegetation extent throughout the early Holocene (12,000 -650 YBP)

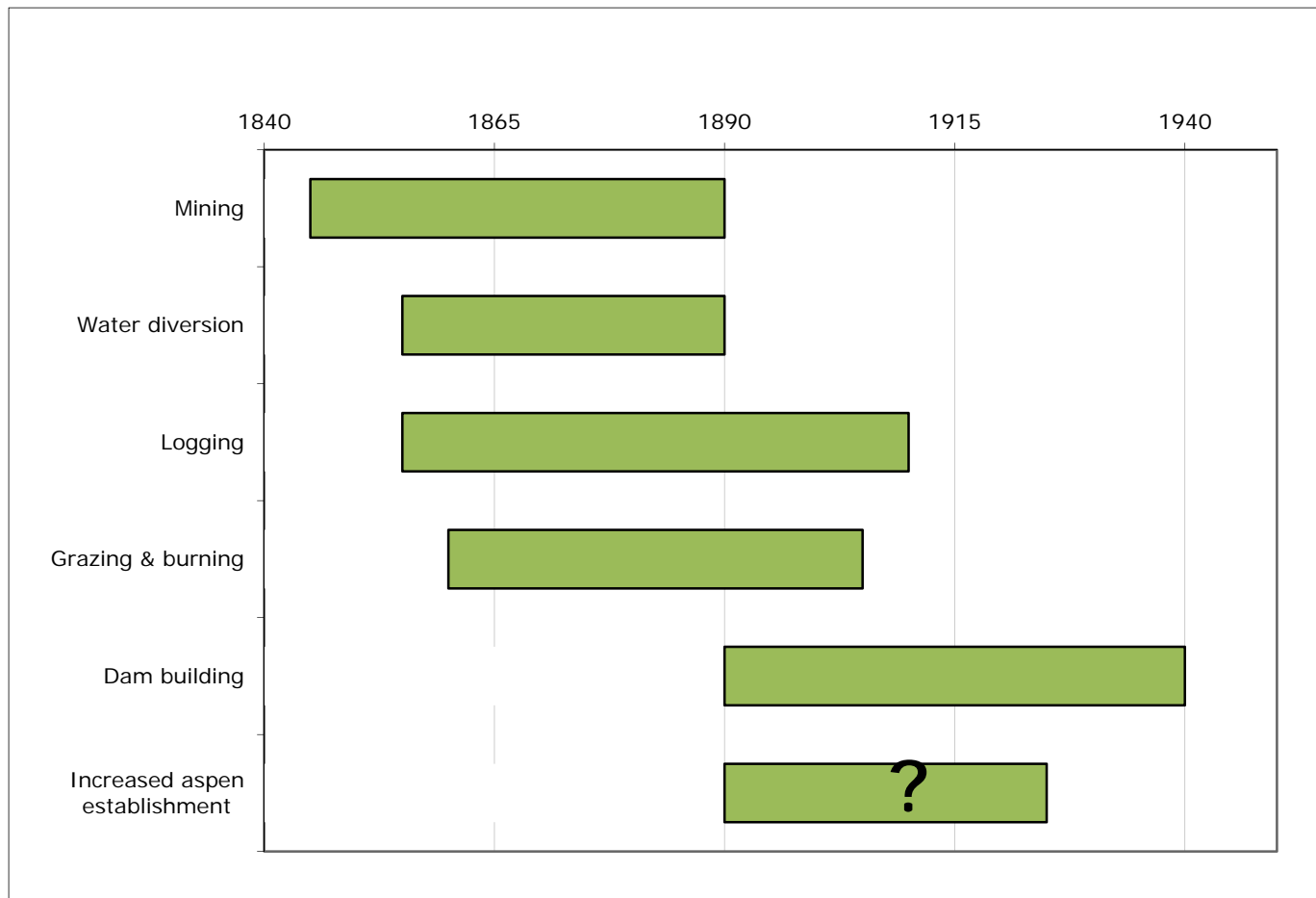
Temporal Scales (YBP)	Temperature (difference from current)	Precipitation (difference from current)	Charcoal Concentrations /Fire Frequency	Aspen Extent	Lodgepole Pine Extent
650-present	Low <sup>4</sup>	Moist <sup>4</sup>	Low <sup>3,4,7,11,12</sup>	Increase	Increase <sup>14</sup>
1,100-650	Moderate <sup>1, 7, 8</sup>	Dry <sup>7, 8</sup>	Low <sup>3,4,7,11,12</sup>	Decrease <sup>13</sup>	Unknown
4,000 – 1,100	Moderate <sup>1, 2</sup>	Moist <sup>4</sup>	Moderate <sup>3,4, 5,7,11,12</sup>	Increase <sup>13</sup>	Increase <sup>14</sup>
8,000 – 4,000	High <sup>1, 4</sup>	Dry <sup>10</sup>	High <sup>2,3,4, 5, 7,9,11,12</sup>	Unknown	Decrease <sup>14</sup>
12,000 – 8,000	Low <sup>4, 5</sup>	Moist <sup>5</sup>	Low <sup>3,7,11,12</sup>	Unknown	Increase <sup>14</sup>

<sup>1</sup>(Potito et al. 2006), <sup>2</sup>(Anderson 1990), <sup>3</sup>(Beaty and Taylor 2009), <sup>4</sup>(Anderson 1996), <sup>5</sup>(Smith and Anderson 1992), <sup>6</sup>(Woolfenden 2003), <sup>7</sup>(Anderson et al. 2008), <sup>8</sup>(Millar et al. 2006), <sup>10</sup>(Anderson and Smith 1994), <sup>11</sup>(Brunelle and Anderson 2003), <sup>12</sup> (Daniels et al. 2005), <sup>13</sup> (Anderson 1991), <sup>14</sup>(Anderson 1996)





# Human caused disturbances that occurred from 100 YBP - present (approx. 1850 - 1940)



# Definition of the Natural Range of Variability

Natural Range of Variation (NRV) [is the] spatial and temporal variation in ecosystem characteristics under historic disturbance regimes during a reference period.

“Natural range of variation” (NRV) is a term used synonymously with historic range of variation or range of natural variation. The NRV is a tool for assessing ecological integrity, and does not necessarily constitute a management target or desired condition. The NRV can help identify key structural, functional, compositional, and connectivity characteristics, for which plan components may be important for either maintenance or restoration of such ecological conditions.

- FSH 1909.12.10.5



# Assessing NRV

- Describe the ecological conditions that would sustain ecosystem integrity relevant to the key characteristics, which will be evaluated using the natural range of variation (NRV) or a related approach;
- Describe the current ecological conditions relevant to the key ecosystem characteristics;
- Compare the present condition of the selected key ecosystem characteristics to those that would sustain ecosystem integrity to determine the status of each key ecosystem characteristic; and
- When possible, describe projected future trends or vulnerabilities relevant to the key ecosystem characteristics.

## Function - NRV

Ecosystem Attribute	Indicator Group	Indicator	Variable	Within NRV	Confidence
Function	Disturbance	Fire	Fire return interval	no	moderate
Function	Disturbance	Fire	Fire severity	no	low
Function	Disturbance	Insects/Disease	Insect/Disease Occurrence	yes	low
Function	Disturbance	Grazing	Utilization	no	high
Function	Disturbance	Hydrologic regime	Water balance	no	low
Function	Succession	Successional patterns	Conifer density	no	moderate





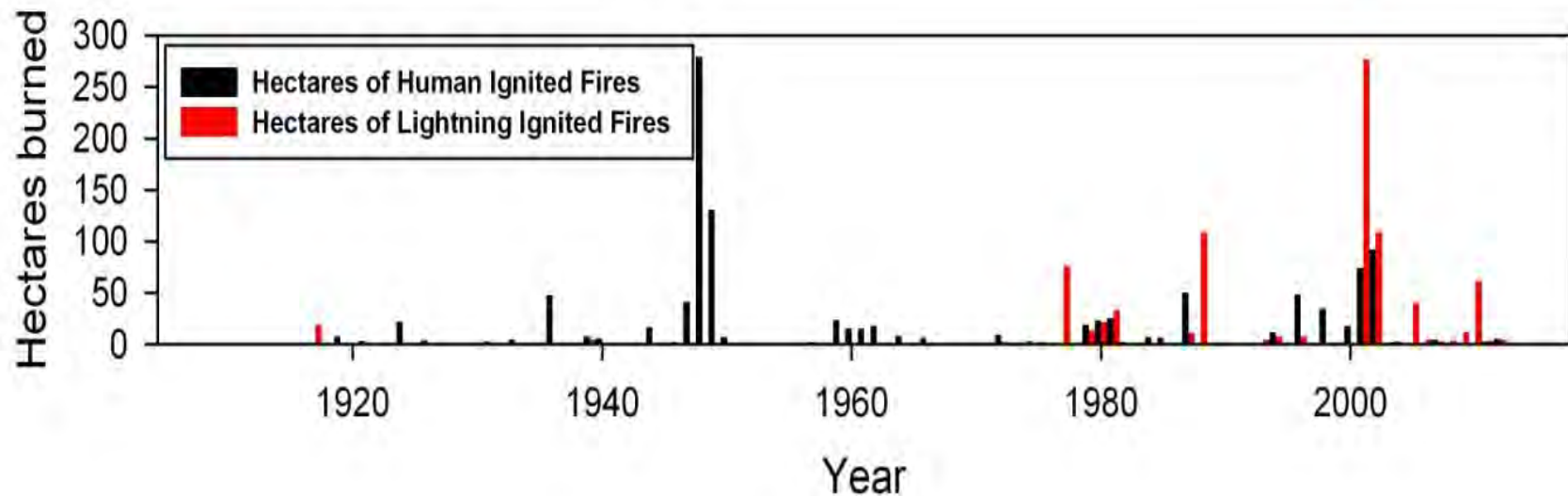
## Fire return interval

### Pre-European Fire Return Intervals

Low elevation mixed conifer zones: 30 – 90 years

High elevation red fir zones: 50 -150 years

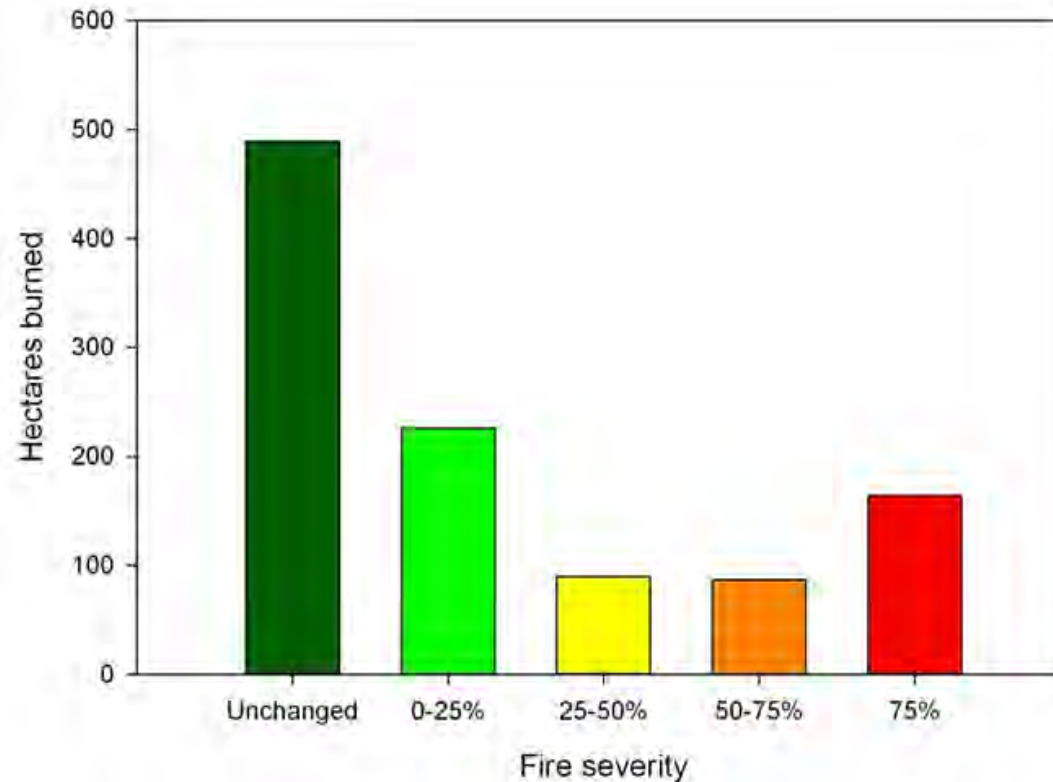
All vegetation types: 10 – 90 years



Hectares burned in the aspen vegetation type (identified using the CalVeg Regional Dominance) by human or lightning ignited fires derived from the FRAP database from 1904-2012.

## Fire severity

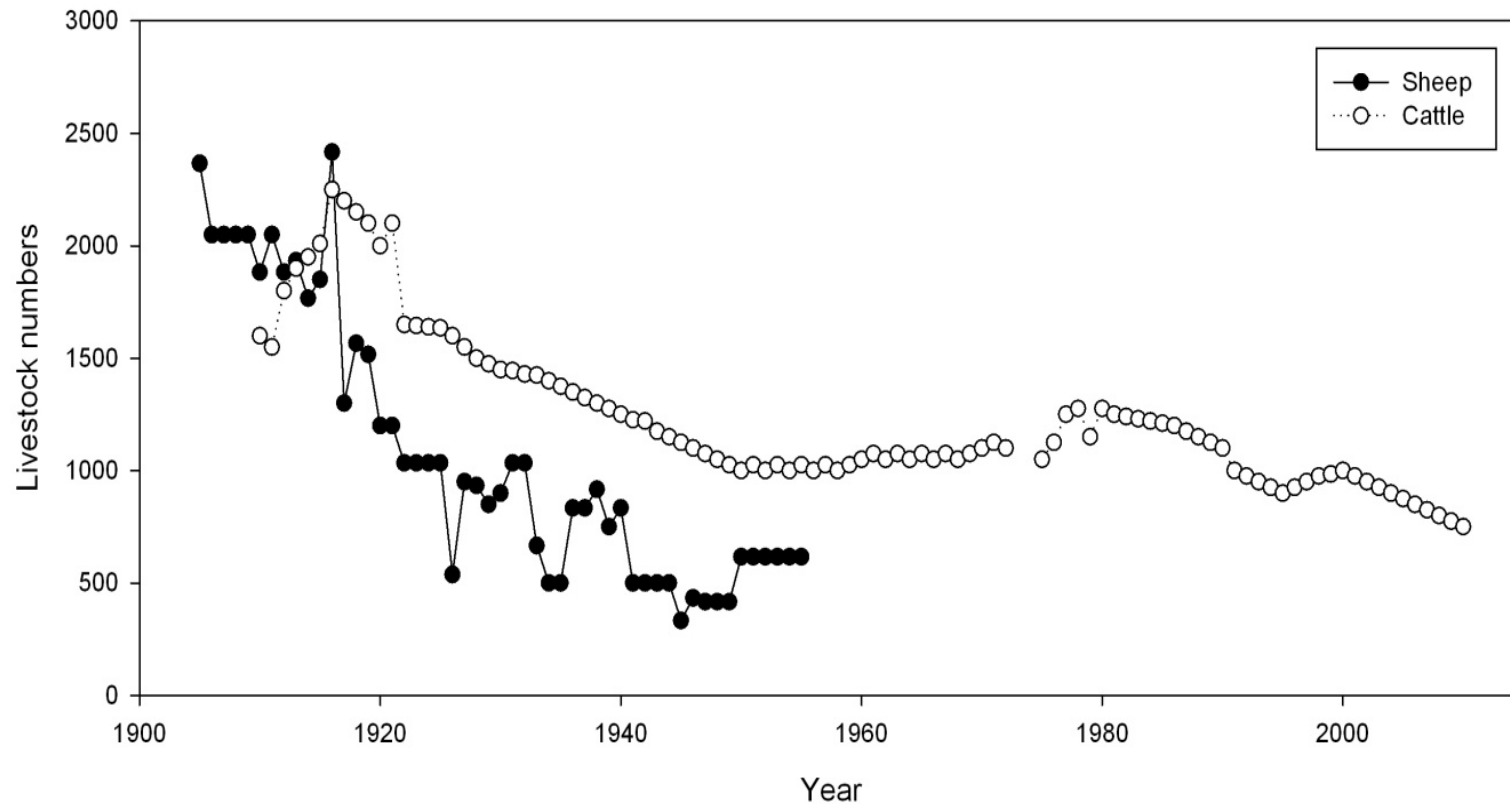
Fire severity (derived from the MTBS dataset) from fires that occurred from 1984-2012 within the aspen vegetation type (identified using the CalVeg Regional Dominance). Fire severity is defined as the percent change in canopy cover.





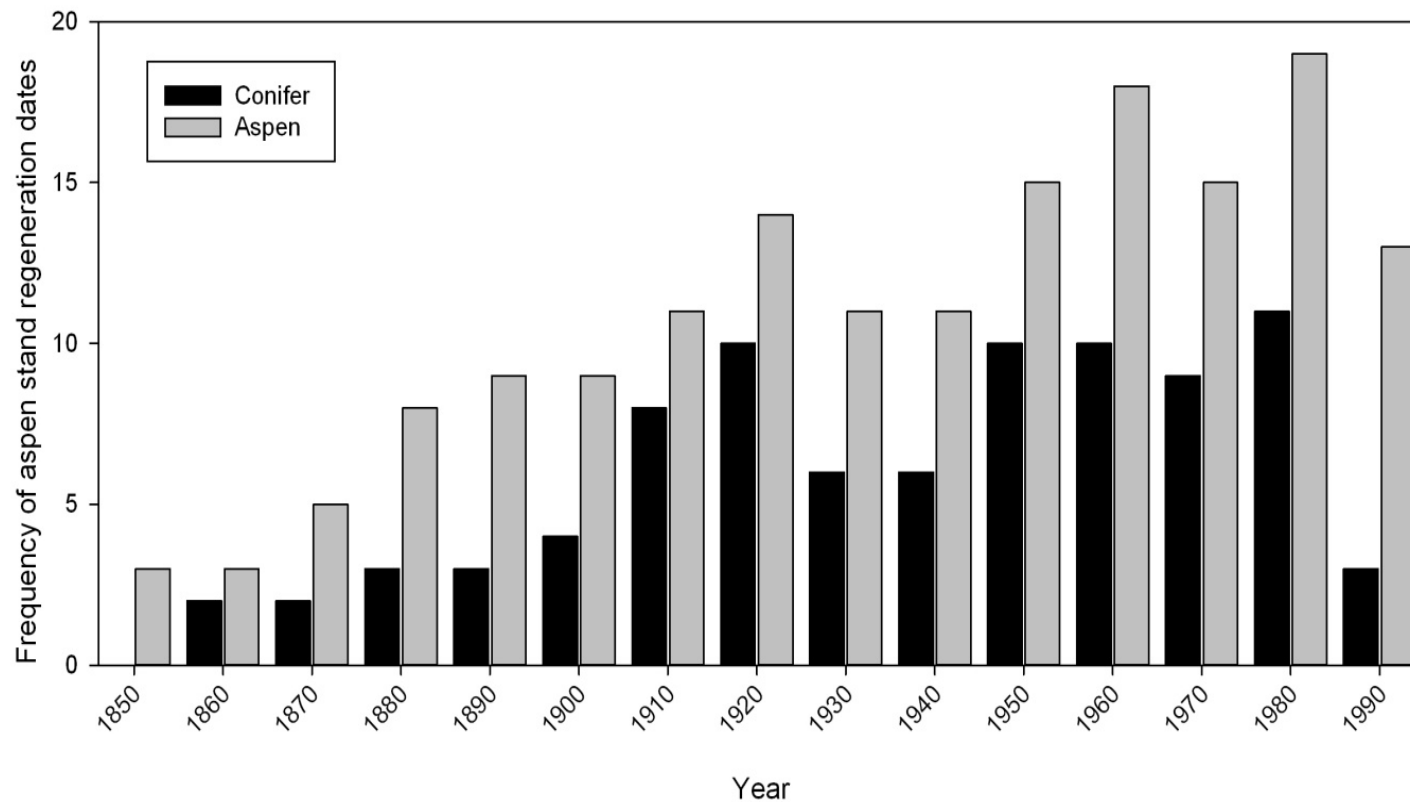
# Grazing

Grazing records from 1905 to 1955 in the North subregion (Lassen National Forest, reproduced from Taylor 2008).



# Succession

## Frequency of aspen regeneration in 51 stands in the North subregion





## Hydrological Pathways

- Relevant in seral state aspen stands where conifer encroachment is occurring
- Replacement of aspen with conifers could be decreasing water yields as evidenced in studies throughout the Western US
- Aspen's net water consumption is considerably less than conifers due to low water use efficiency and greater snow accumulation





# Structure - NRV

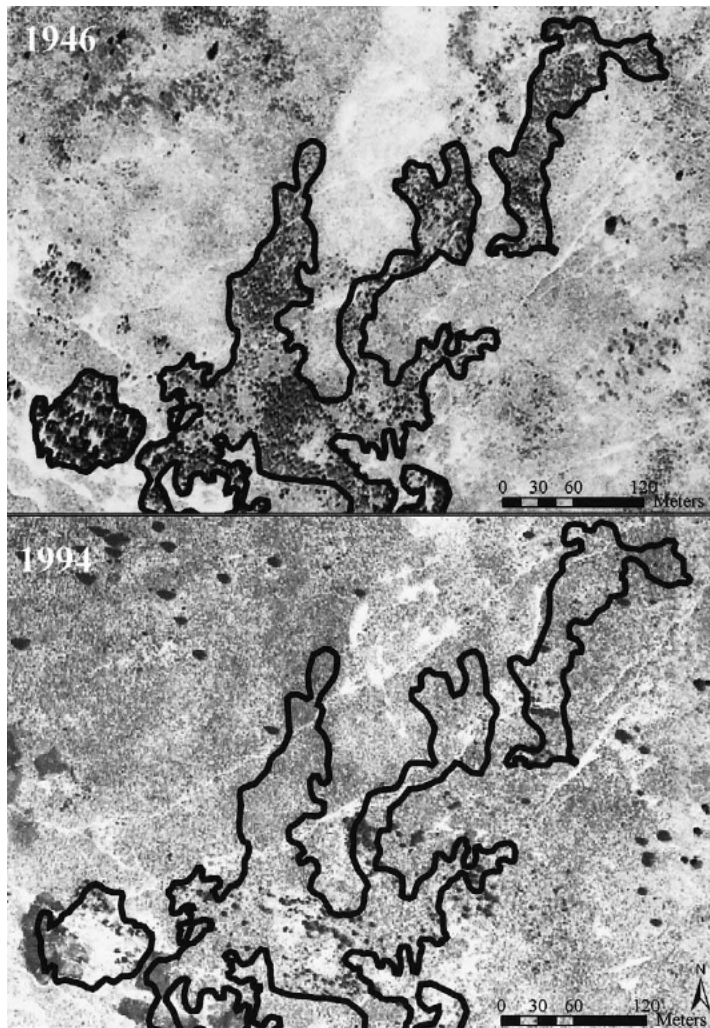
Ecosystem Attribute	Indicator Group	Indicator	Variable	Within NRV	Confidence
Structure	Understory cover	Percent of cover	Percent cover	yes	low
Structure	Patchiness	Size and connectivity	Size of aspen stands	no	low
Structure	Patchiness	Size and connectivity	Clone size	maybe	low
Structure	Productivity	Biomass	Herbage	maybe	low



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## Patchiness and Connectivity



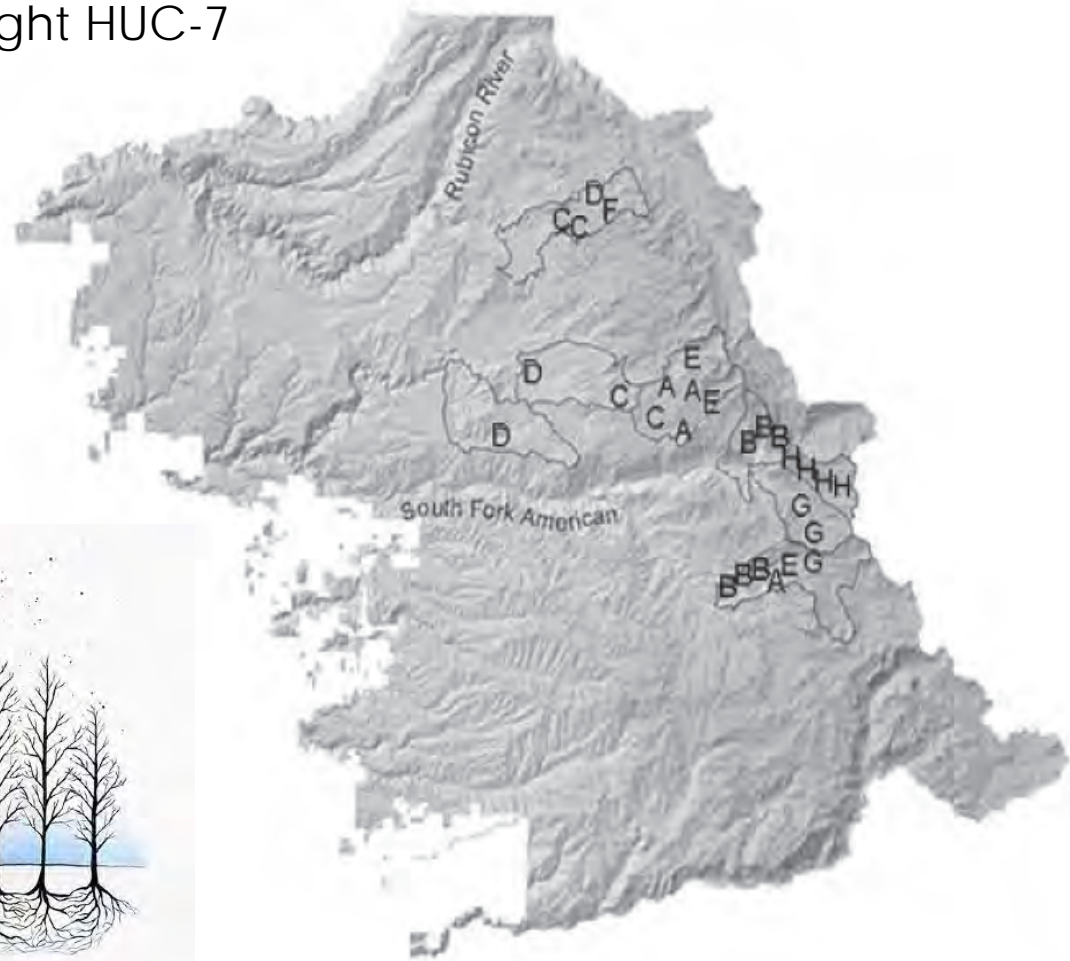
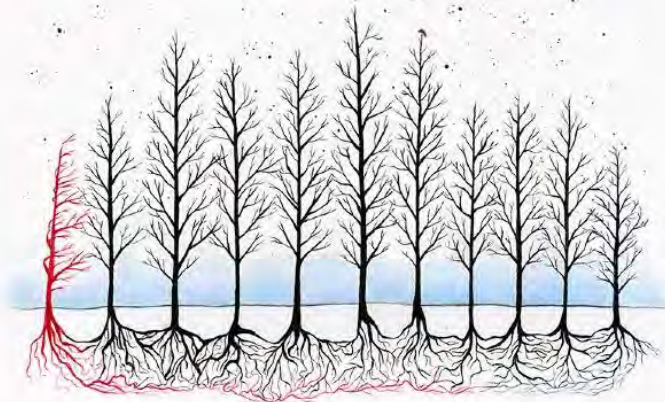
Di Orio et al. 2005

- Decreased patch sizes across assessment area
- Increased fragmentation as patches become disjunct
- Attributed to a change in disturbance regimes



## Patchiness and Connectivity

Genetic-Geographic classes of aspen stands on the Eldorado National Forest within eight HUC-7 watershed boundaries.



Hipkins and Kitzmiller 2004

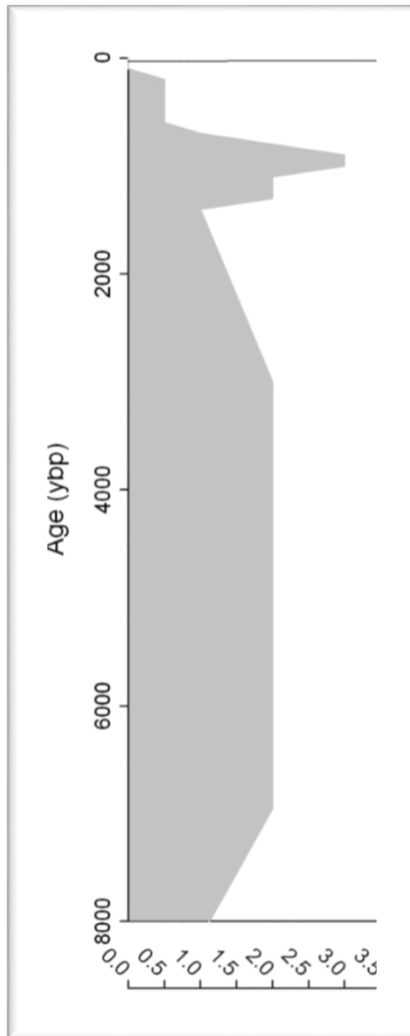


# Composition - NRV

Ecosystem Attribute	Indicator Group	Indicator	Variable	Within NRV	Confidence
Composition	geographic distribution of ecosystems	land cover	land cover	yes	low
Composition	geographic distribution of major species	Species composition	Distribution of major species	yes	low
Composition	Proportion of growth forms	Clonal/genetic diversity	Polymorphic loci	yes	low
Composition	Species diversity	Total number of species	Total number of species	maybe	low
Composition	Species assemblage	Species assemblage	Number of non-native species	no	moderate
Composition	Proportion of growth forms	Sexual distribution of aspen clones	Male:female clone ratio	maybe	low



## Geographic Distribution



- 11,000 – 8,000 YBP - In the Central/Southern bioregion indicated high rates of pollen after the glacial period
- 8,000 – 1,100 YBP - Aspen pollen remained constant in the record
- 1,100-650 YBP - Temperatures were warmer which most likely encouraged the growth of tree species that were resistant to drought and recurring low intensity fire
- In the early Holocene during the transition from the Medieval Warm Period (MWP) to the Little Ice Age (LIA) (650 YBP) a peak in *Populus* pollen grains at several lake basins was observed

(Anderson 1991, Morris et al. 2012)



# Projected Future Conditions and Trends

