

STRATEGY: We are interested in writing that demonstrates your ability to synthesize the course concepts, use citations concisely, elucidate both major and minor factors, and differentiate between strong and weak inferences.

READ THIS: Top exams will show a broad understanding of a wide selection of the course content. While we will evaluate each paper independently, we will give additional consideration to those who rely on a variety of papers *in toto* to make their points. Citing a variety of papers to develop your idea shows good synthesis of the course material. Citing too many papers leaves insufficient space for your own ideas and inferences. When you use a complete phrase or sentence from a source, it **must be set off in quotation marks**. You may want to limit your use of quotations and citations since they take up space and you earn credit primarily for your own synthesis. To save space, you may cite class readings in abbreviated form (e.g. “Harrod et al. 1999” may be cited as “Harrod”).

These questions involve different ecosystems or general phenomena; develop and support your reasoning with citations from course material rather than unsupported assertions.

Write a “rich” answer to the questions. Style and tone should be similar to the peer reviewed literature we have read. Provide evidence that supports your statements. Restrict sources of information to CFR501 materials and carefully cite all sources: readings, lectures (papers used in lectures may be cited), discussions, handouts, and fieldtrips. Use correct spelling and adhere to species naming conventions. Address the entire question.

Page Limit: Two pages each for questions one, two and three, not including figures or references. As usual, margins are to be 1” all around; 12 point font.

Format: Your entire final exam must be submitted as a single Microsoft Word document. Please put your name in the header of the document, so it appears on every page. Mac users please also provide a single PDF file. Send your final exam to us in a single email message.

Due: Noon, Thursday December 13, 2006 by email to cfr501@u.washington.edu

Questions or Clarifications

If you have any questions or need some clarifications about any aspect of the questions, please email us at cfr501@u.washington.edu. We will send a reply to your question to the class mailing list so everyone receives the same information (people posing questions will remain anonymous).

Section 1: Ecological inferences from indirect evidence

Structure, composition, climatological influences and disturbances of western forests can be well quantified by field observations and recent records. Stand reconstructions have often been used to infer past structure, composition, climate and disturbance where there are no direct observational records of past conditions.

In unpublished research, Taylor and Scholl (Fire Lecture 11/19/2007) found (using stand reconstruction) that present fire regimes and stand structure in Yosemite National Park differ from historical conditions (Appendix I). The reconstruction was well implemented in terms of sampling design and numbers of trees sampled (A. H. Taylor is a top expert on reconstructions of western forests).

Discuss the limitations of stand reconstructions and 1900 forest reference conditions for managers seeking to reintroduce natural processes and characteristic vegetation to Yosemite National Park.

Include quantitative and qualitative bounds to the accuracy of the analysis to the extent possible. Your audience is the Park Science Team and A. H. Taylor. You have heard that they like it short, like it specific, and like it fully cited. Draw inferences based on citations from a variety of course material.

Section 2: Controls of Forest Plant Community Composition

Ecological processes affecting the structure, composition and emergent patterns of forest plant communities can be divided into two categories: endogenous processes and exogenous processes. Endogenous processes are biotic interactions *within* the producer trophic level (i.e., trees, shrubs, herbs, grasses, etc.) such as competition and facilitation. Exogenous processes are external forces acting on a vegetation community.

In what circumstances do endogenous and exogenous processes, respectively, exert more control on forest plant community composition and structure at a spatial scale of one hectare? How do endogenous processes and exogenous processes influence each other at this scale?

Section 3: Stand Development Models

In forest communities, are changes in species composition synchronized with changes in structural development? What explains any differences or similarities?

Appendix I: Information from Taylor and Scholl 2006

These are the “key findings” from Taylor and Scholl’s report to Yosemite National Park, edited to include references to only one of the forest areas they studied, and including some of the figures from that report. Some, none or all of the findings may be useful in addressing the question. However, these findings may leave some issues unaddressed. Do not critique these findings point by point. Rather, use this information, as appropriate, to develop your response.

Assume that climate in the Sierra Nevada was “cool and dry” from 1650 to 1850 and “warm and wet” from 1850 to the present.

The ecosystem composition and structure of the study site can be approximated by a combination of Franklin and Dyrness Zones: the *Pinus ponderosa* Zone and two zones from southwestern Oregon: the mixed-conifer Zone and *Abies concolor* Zone.

Key Findings

Fire History

- Mixed conifer forests in Yosemite National Park experienced frequent fire before the onset of fire suppression. Mean return intervals for fires scarring 10% or more of the grid points and 25% or more of the grid points were 2.5 years (range 1-12) and 7-10 years (range 1-48), respectively. The mean point fire return interval was 12.4 years (range 2-84) in Big Oak Flat.
- The position of fire scars within tree rings was mainly in latewood (46.5%) and at the ring boundary indicating that fires burned most frequently in late summer and fall.
- Mixed conifer forests experienced a dramatic decrease in fire occurrence and extent in the early 1900s and the frequency of fire was similar in the pre-Euro American and settlement period in both forests.
- Fire extent varied among years, and mean and median fire extent were similar (202 ha). Three fires burned >1000 ha.
- There were more small than large (>350 ha) fires and larger burns (19%) accounted for nearly 50% of the area burned since AD 1575.
- Fire rotations for the pre-Euro American and settlement period ranged from 10-13 years and increased to 211-378 years during the fire suppression period depending on study area.
- Fire severity was inferred from forest age structure and there was no evidence of high severity fire in either study area. Burns were either low or moderate in severity.
- The location and extent of burns in one year affected burn patterns in subsequent years and this was evident in both the pre Euro American and settlement period.

Stand Structure

- Contemporary forest structure was different than the reconstructed reference forest (AD 1899) due mainly to fire suppression.

- Average density of trees >10 cm dbh in the contemporary forest (576.8 ha^{-1} , range 90-2060 ha^{-1}) was higher than in the reference forest (133.3 ha^{-1} , range 10-520 ha^{-1}).
- Average basal area of trees >10 cm dbh in the contemporary forest ($66.2 \text{ m}^2 \text{ ha}^{-1}$, range 20.7-150.8 $\text{m}^2 \text{ ha}^{-1}$) was higher than in the reference forest ($42.7 \text{ m}^2 \text{ ha}^{-1}$, range 4.9-103.7 $\text{m}^2 \text{ ha}^{-1}$).
- Average quadratic mean diameter of trees >10 cm dbh in the contemporary forest (42.1 cm, range 19.2-84 cm) was smaller than in the reference forest (67.6 cm, range 28.3-131.2 cm).
- Average structural diversity (mean Shannon's Diversity Index) was similar between reference and contemporary forests (1.9 vs. 1.9)
- Much of the forest change was caused by a dramatic increase in establishment of white fir and incense cedar that began with the onset of fire suppression.
- Forest changes since 1899 did not alter the shape of tree diameter distributions. Diameter class distributions were the same in the reference and contemporary forest.
- There was a high incidence of spatial autocorrelation in the ages of trees in the reference forest. Small and intermediate sized patches of similar aged trees were a conspicuous structural feature of pre fire suppression forests.

Implications for Management

- Quantitative data on reference conditions for forest structure and fire regimes are essential for developing restoration plans, management treatments, and evaluation metrics to judge success of fire and resource management programs.
- Reference forest structure data indicate that restoration objectives should emphasize: 1) density and basal area reduction, mainly of small diameter trees; 2) increasing structural heterogeneity across the forest landscape.
- There was considerable spatial variability in reference forest structure within each study area. Consequently, management plans and treatments should emphasize variability in outcomes across a landscape rather than achieving an average condition.
- Reference fire regime data indicate that re-introducing frequent fire is essential for restoring the functional relationships between fire and forest structure that regulated pre fire suppression forests.
- Prescriptions should emphasize a mixture of small and large later season burns over several decades to be consistent with historical burn patterns. 2

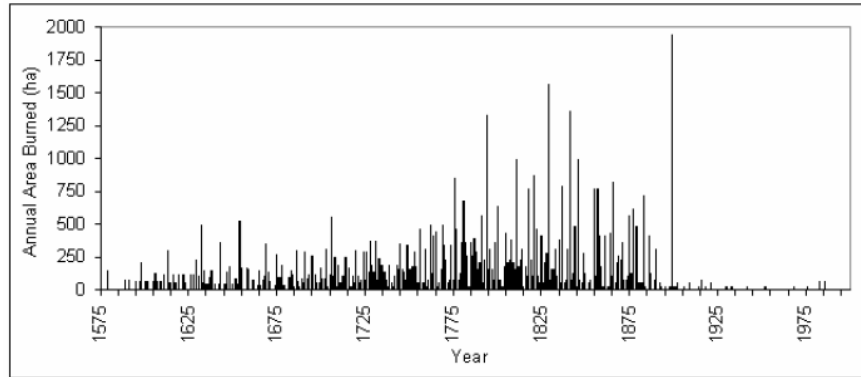


Figure 7. Annual fire extent between 1575 and 2000 in the Bog Oak Flat mixed conifer forest, Yosemite National Park, California. Minimum fire extent is 25 ha.

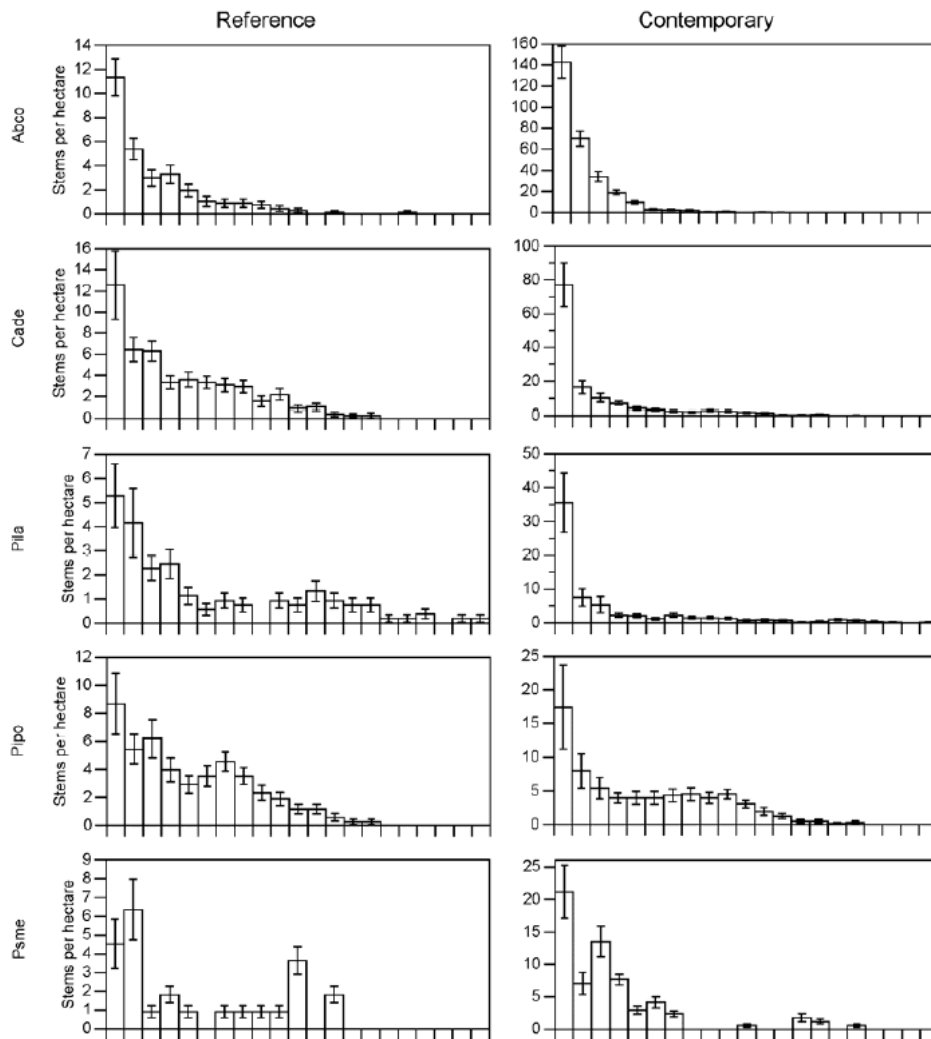


Figure 4a. Mean (\pm SE) density of trees (>10 cm dbh) in 10 cm diameter classes in the reference (AD 1899) and contemporary Big Oak Flat mixed conifer forest, Yosemite National Park, California. Note that the y-axis scale is different on each graph. Species (from top to bottom: *Abies concolor*, *Calocedrus decurrens*, *Pinus lambertiana*, *Pinus ponderosa*, *Pseudotsuga menziesii*).

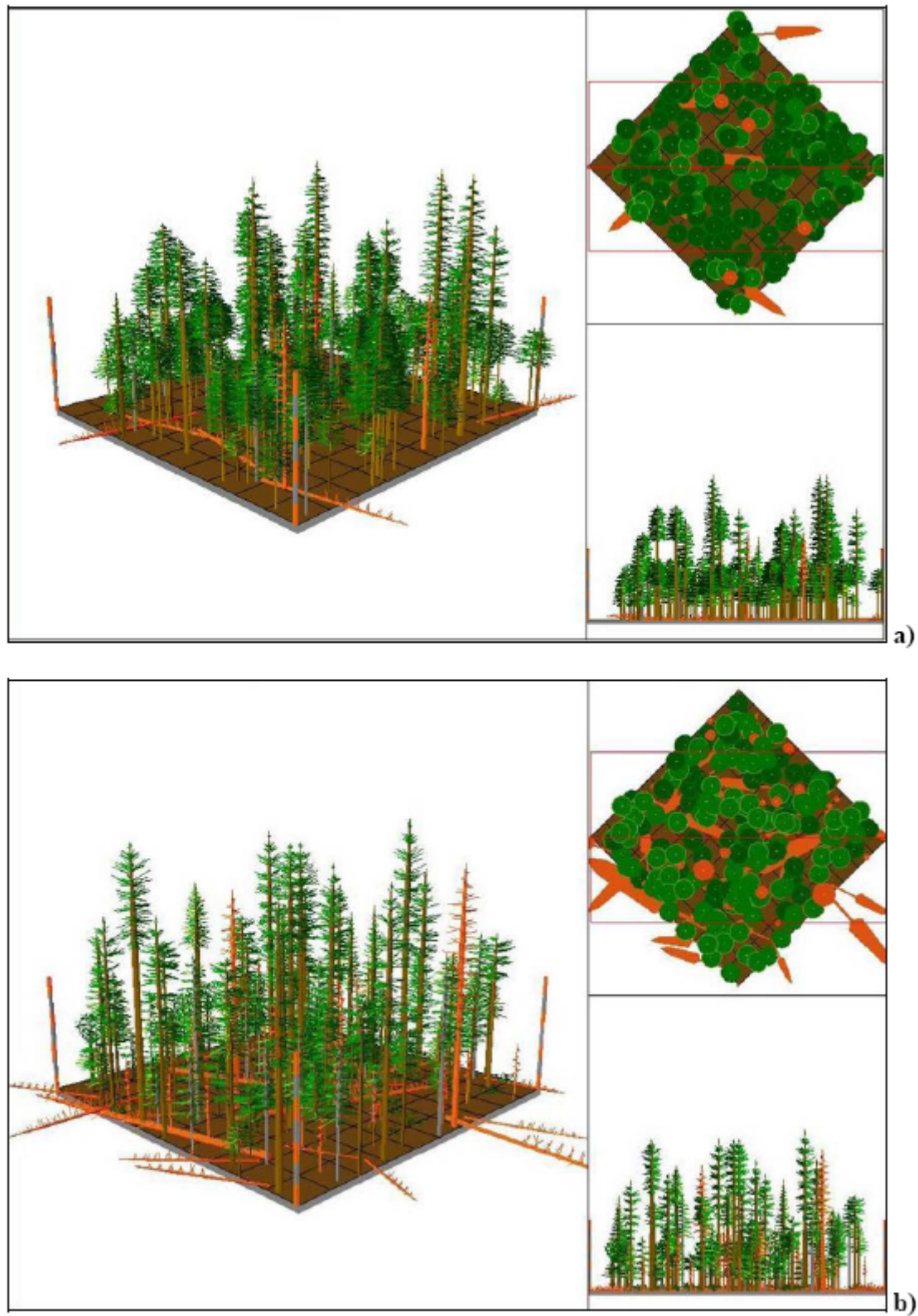


Figure 5a. Visual representations of reference (AD1899) (a) and contemporary (b) forest structure in selected plots representative of a low degree of structural change in the Big Oak Flat mixed conifer forest. Visualizations were developed using FVS software.

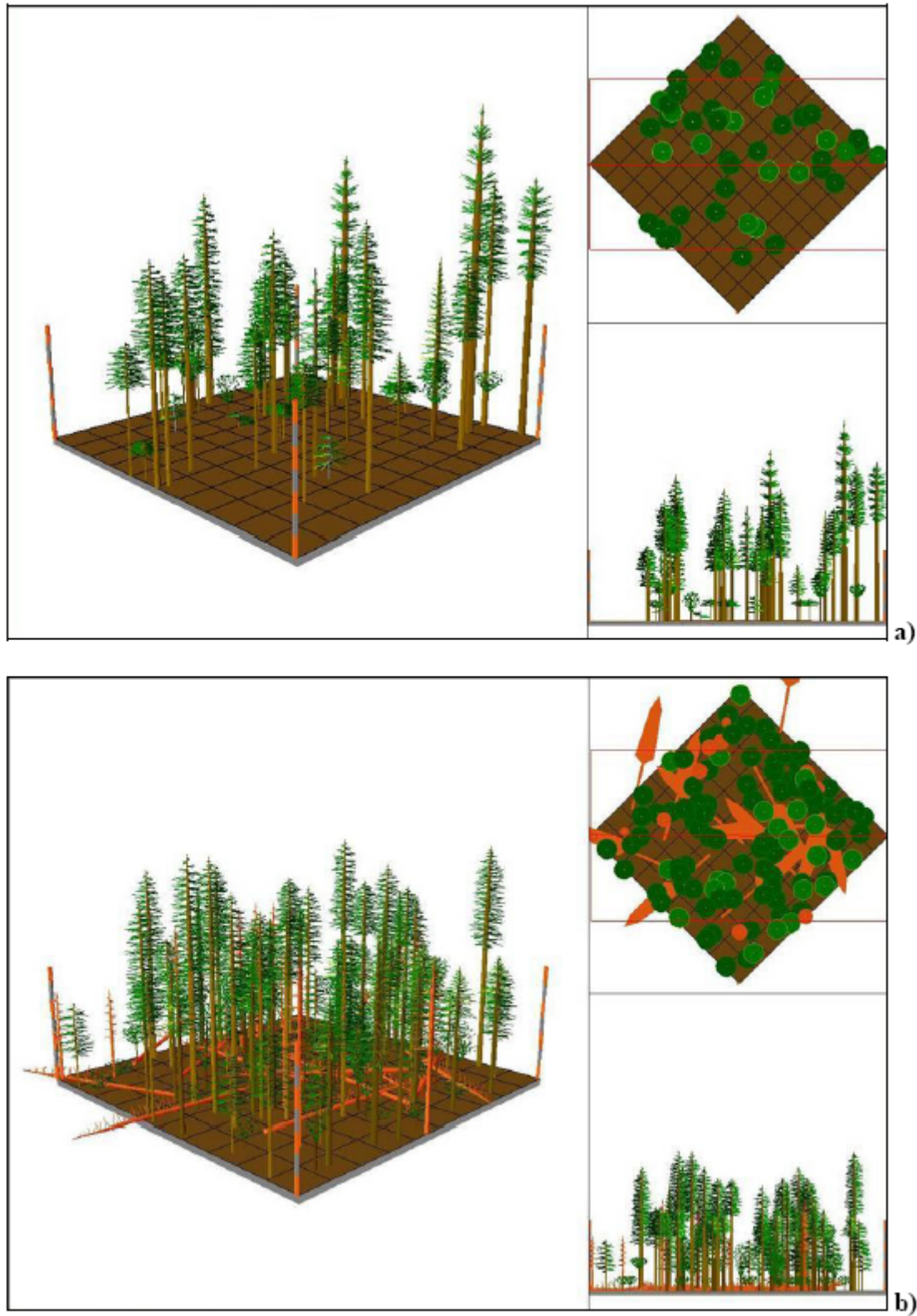


Figure 5b. Visual representations of reference (AD1899) (a) and contemporary (b) forest structure in selected plots representative of a medium degree of structural change in the Big Oak Flat mixed conifer forest. Visualizations were developed using FVS software.

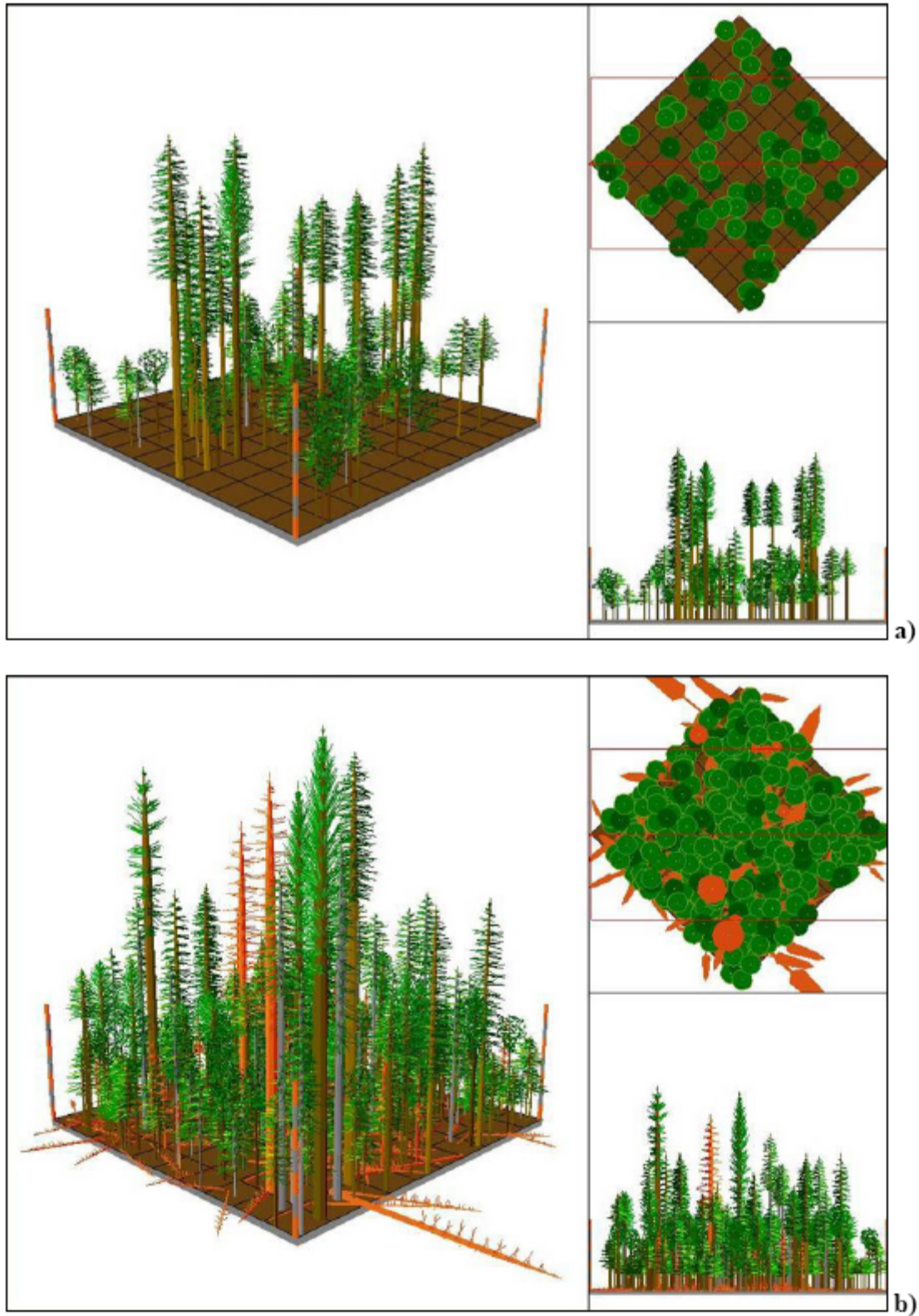


Figure 5c. Visual representations of reference (AD1899) (a) and contemporary (b) forest structure in selected plots representative of a high degree of structural change in the Big Oak Flat mixed conifer forest. Visualizations were developed using FVS software.