Sierra Watershed Ecosystem Enhancement Project

Welcome to **SWEEP**! In our newsletters, we will explain the SWEEP project and highlight recent progress. In this edition, we will focus on UC Berkeley graduate student Andrea Hardlund's thesis paper based on her work with SWEEP. For more information and past newsletters, please visit the project website at: http://ucanr.edu/sweep/.

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SWEEP Goals

SWEEP is a 4 year project with the goal of quantifying the physical and financial relationships in Sierra mixed conifer forests in terms of fire resiliency, carbon storage in trees, and water in streams. Much of the Sierra Nevada is covered with forests that are dramatically denser in trees per acre than before fire suppression policies led to extinguishing most wildfires. Today's denser forests are more prone to experiencing high severity fire in which most trees are killed and forest litter is consumed. This can lead to soil erosion, reduced ability of forests to absorb precipitation, and increased risk of flooding. The forest and shrubs also use large amounts of water that could have gone to streams, rivers, canals and the delta.

SWEEP's goal is to design and implement field level projects to quantify the interaction of forest biomass growth, fire risk, and water yield. Field measurements of leaf area, biomass, soil moisture, snowpack and evapotranspiration will be combined with intensive water measurements to better understand how the forests function now and the tradeoffs between different outputs. In collaboration with beneficiaries and stakeholders, we will then estimate the values different beneficiaries place on increases or decreases in fire resiliency, carbon storage, and water yield.

Testing key SWEEP questions

Hardlund's research asks the following questions: What are some examples of realistically possible management regimes for actual forest stands in the Sierra Nevada that might result in increased water yield to reservoirs below, decreased fire risk, and provide a sustainable yield of wood products? How does a real forest stand respond to these treatments over time? How are the three key SWEEP metrics (large trees, fire risk, water use) affected over time by these treatments? What are the financial implications of different treatments? How should management be scheduled to maximize these values?

For modeling purposes, Andrea identified 141 forest plots measured by the USFS Forest Inventory and Analysis (FIA) program located in upper reaches of the Feather, Yuba, Bear, and American River watersheds. The plots are spaced about 3 miles apart on sites forest management is allowed. 69% of these sites were in federal and 31% were in private forests. Based on the volume of trees on each plot, up to four treatment scenarios and a no treatment control were applied and forest growth was modeled over the next 40 years using the Forest Vegetation Simulator (FVS) forest growth model. Effects on each resource (large trees, fire, water) were assessed by tracking different parameters in the model such as basal area, timber volume growth and yield, and the probability of torching under severe fire weather conditions.

Featured Researcher

Andrea Hardlund, completed her Masters of Forestry at UC Berkeley in 2014 where her professional paper tested several silvicultural treatments designed to achieve SWEEP's multiple objectives of recruiting and maintaining large trees on the landscape, reducing fire risk, and increasing forest water yields. Her final paper, "Silvicultural Prescriptions and Opportunities for Forest Management of Western Sierra Nevada Mixed Conifer for Timber, Water, and Fire Objectives" can be found on the SWEEP website: http://ucanr.edu/sweep/. She is now the Lead Forestry Technician at a consulting forestry and GIS firm in Grass Valley, CA, Forester's Co-Op, and she is pursuing her Registered Professional Forester license this fall.

Modeled treatment types continued

Scenario 1 included the "full restoration" treatment wherever possible. It was designed to convert dense stands to more open stands dominated by a relatively small number of larger trees that many researchers consider to have been common in the Sierra Nevada before the Gold Rush. This treatment left only 30% of the initial inventory to meet the stocking standards of the California Forest Practice rules after a selection operation. Forest area with less inventory was treated with the partial restoration treatment that left 60% of the initial inventory, or an initial fuels reduction treatment if there was not sufficient inventory to have a profitable harvest.

Scenario 2 used the partial restoration treatment where there was sufficient volume for a profitable harvest even if there was enough volume to use the full restoration treatment, and an initial fuels reduction treatment on the rest of the area. 42% of the total area could be retreated to produce revenue, reduce fire risk, and increased estimated stream flows in year 20. In both scenario 1 and 2, the fire risk reduction treatments produced no net revenue in the first entry and 30% of the stands could produce net revenue after 20 years.

Table 1: Area of forested upper watersheds with types of treatments at year 0 and year 20 in the 40 year forest growth simulation

TREATMENT TYPE	Full Restoration	Partial Restoration	Fuels Reduction	No Treatment
SCENARIO	*Year 0/20*	*Year 0/20*	*Year 0/20*	*Year 0/20*
Control	0%/ 0%	0%/ 0%	0%/ 0%	100%/ 100%
Scenario 1	16%/ 0%	36%/ 27%	48%/ 0%	0%/ 0%
Scenario 2	0%/ 0%	52%/ 42%	48%/ 0%	0%/ 0%

Above: Partial restoration treatment example. Below: Full restoration treatment example

Modeling results

Scenario 1 produced slightly more timber volume than Scenario 2 and presumably the greatest increase in enhanced stream yields. Canopy cover was significantly reduced initially but regrew to 40% to 60% coverage within a decade. However, the area treated with full restoration did not have sufficient timber volume for a harvest 20 years later as half of regrowth occurred in trees smaller than 10" in diameter. These smaller trees increased water use and fire risk but were not large enough to justify another revenue generating harvest twenty years after the initial entry.

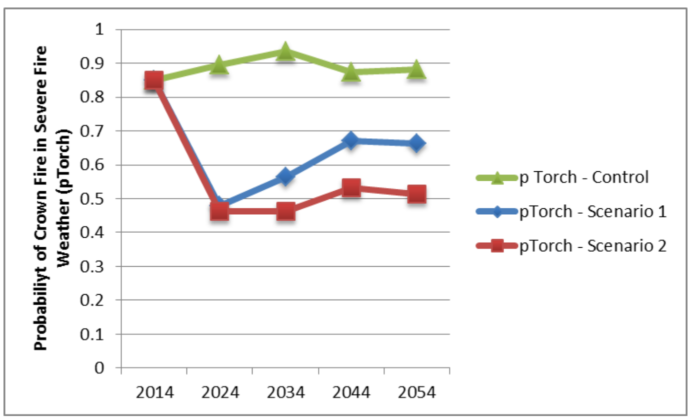
Scenario 2 produced slightly less total timber volume. However, these stands had sufficient volume to allow for a revenue-generating treatment twenty years after the initial treatment.

Modeling results continued

Total revenue production and estimated enhanced stream flows was similar over the forty year period to the Scenario 1 without the significant increase in fire risk that occurred in the last twenty years of the full restoration scenario. Given the current high fire risk and the serious damage that occurs to water storage systems from crown fires, Scenario 2 was preferred over both scenario1 and the 'do nothing' control scenario.

The following figures compare the average fire risk as measured by the probability of a forest stand initiating a crown fire under severe weather conditions over time as well as the average inventories across the whole area.

Figure 1: Probability of initiation of Crown Fires over 40 years with Scenario 1, 2 and control



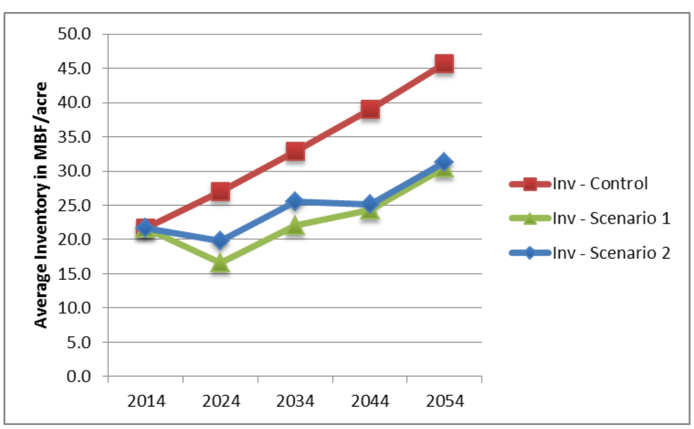
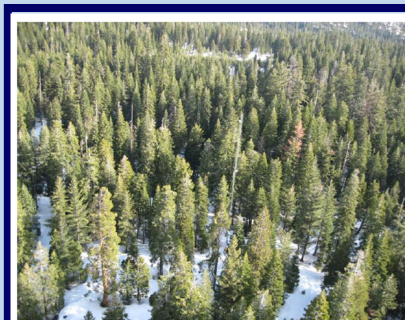


Figure 2: Average timber inventories over time with Scenario 1, 2 and Control

Modeling conclusion

To achieve landscape level fire risk reduction and stream flow enhancement outcomes, forest treatments would need to be coordinated across the upper watersheds, of which approximately 70% is in federal ownership and the 30% in private ownership within the study area. While Scenario 1 included the full restoration treatments that would produce larger early increases in revenues and enhanced stream flows, only a limited number of sites had sufficient timber inventories to apply such treatments. More importantly, Scenario 1 did not have the revenue flow in later years that could finance a reentry to reduce fire risk and increase stream flows. Scenario 2 applied partial restoration treatments and so produced slightly lower initial revenue but offered the opportunity to better manage fire risks over the whole 40 year period.



For more information:
http://ucanr.edu/sweep/