

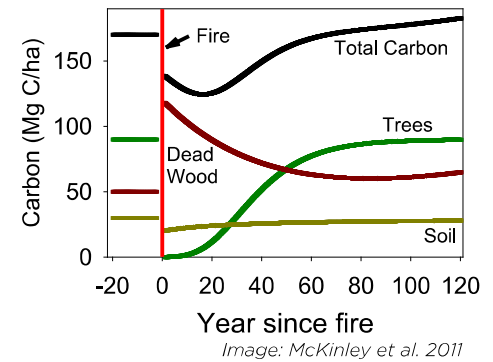
Science Background: Disturbances and their Carbon Impact

Disturbance and Forest Carbon Balance

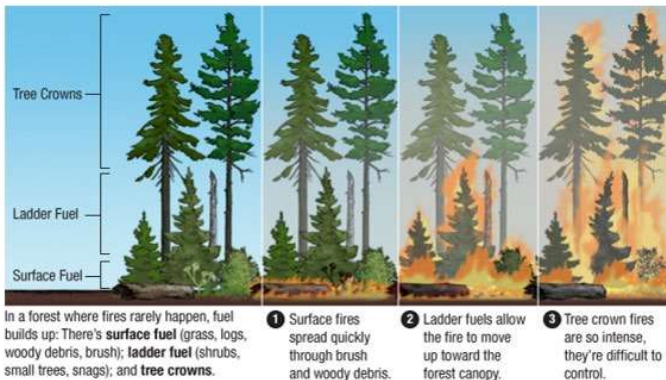
- Disturbance kills trees
- 2 carbon cycling implications:
 1. Dead trees are no longer contributing to NPP -reduces uptake of carbon by ecosystem
 2. Dead trees add biomass carbon to the decomposition pathway -increases release of CO₂ from the ecosystem through heterotrophic respiration
- Disturbance results in a net loss of ecosystem carbon or a net reduction in carbon sequestration - at least in the short term

Fire Disturbance

- Following a long recovery, forest regeneration post-fire will recover carbon lost
- Severity of a fire greatly impacts losses and recovery times
- Stand-replacing (high intensity) vs. Understory (low intensity):



Stand Replacing: HIGH INTENSITY



Understory: LOW INTENSITY

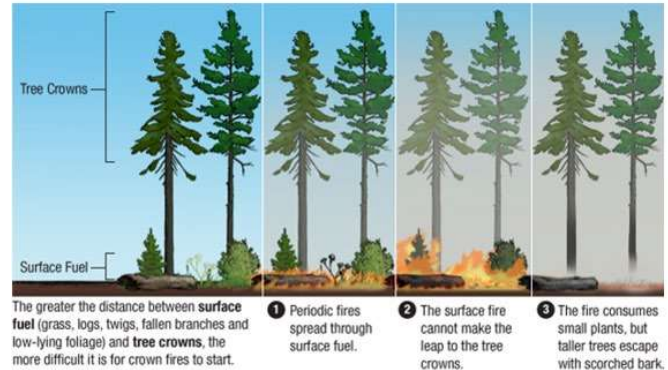


Image: USFS

- Stand-replacing Fires: Carbon Dynamics
 - Relatively minor impact on immediate carbon loss if part of forests' natural fire regime - significant partial combustion of forest floor and herbaceous vegetation
 - Long-term, repeated fire maintains open conditions that hold carbon storage below the potential for that site
 - Exclusion of fire from these systems allows greater biomass accumulation
 - Example: Hurteau et al. 2011 reconstructed aboveground live C stocks in Ponderosa Pine forests and compared to modern conditions:
 - 1876: 28 - 37 Mg C ha⁻¹
 - 1998: 70 - 75 Mg C ha⁻¹

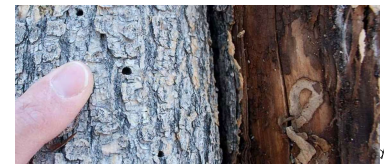


Wind Disturbance

- Knocks over trees or snaps stems – does not consume biomass
- Death of trees reduces NPP, adds C to dead wood and forest floor pools
- Wind disturbance can also reduce leaf area (NPP) and transfer C to the forest floor without killing trees
- Biggest difference between wind and fire has to do with litter pools
 - Fire burns off litter pool
 - Wind increases litter pool

Biotic Disturbance Agents – Pests and Pathogens

- Severity of disturbance ranges: individual tree death > varying defoliation > complete stand mortality
- Carbon impact similar to wind (reduce leaf area and/or kill trees without combustion losses and chemical transformations associated with fire)
- Unlike wind and fire, pests and pathogens are often taxon specific.
 - E.g. Emerald ash borer has killed virtually all overstory trees in the genus *Fraxinus* (Ash) in Michigan



related tree damage, Colorado State Forest Service

Immediate Effects of Disturbance Summary

- Depending on disturbance severity, carbon sequestration rate is reduced or net loss of carbon
- Disturbance reduces the carbon storage of a landscape below its potential
 - Greater frequency and severity = greater reduction
- Disturbance also opens up growing space for young, rapidly growing trees
 - Disturbance effects on carbon dynamics have a strong temporal component
 - Immediate impacts and impacts over time

Stand Age and Carbon Storage

- How do carbon storage and carbon fluxes change over time following a major disturbance?
- Growth of individual trees and even-aged forest stands follow a sigmoidal growth pattern

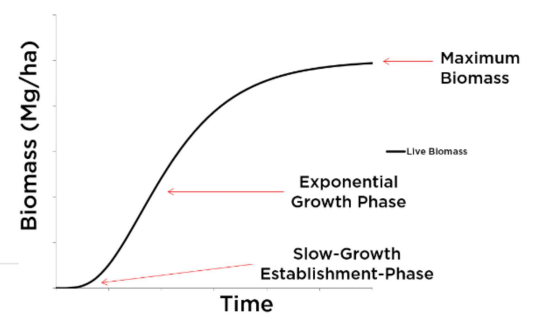


Image: MSU FCCP

Are Old-Growth Forests Carbon Neutral?

- Preservation of old-growth forests prevents loss of their large carbon stocks - but do they provide carbon sink benefits?
- Several recent studies conclude old-growth forests are stronger sinks for carbon than previously thought
 - Maintain positive carbon balance much longer than expected based on growth patterns of the living biomass
- However, productivity does decline in older stands

