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The long-term effects of pre-commercial thinning on carbon storage and distribution in western larch (Larix occidentalis) stands of the Northern Rockies: Insights from a long-term silvicultural experiment.

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Using forests to sequester and store carbon in order to mitigate climate change has gained interest in public policy discussions and is increasingly becoming a land management objective. Research indicates that forests currently sequester approximately 10% of annual US fossil fuel emissions and it is suggested that through intentional carbon management that this rate could be increased. Forests store atmospheric carbon in biomass through photosynthetic uptake. Many studies show that high tree densities may store the greatest amount of on-sight carbon. However, there are trade-offs to managing forests solely for carbon sequestration, namely a decrease in forest resilience that may lead to a higher frequency and severity of fires, insect outbreaks, and disease. These large scale disturbances cause the release of much of the stored carbon in the forest ecosystem. Tree density management, often accomplished through thinning, is one of the major tools foresters employ in order to improve forest health and resilience. While thinning is a common practice in restoring resilience to forest ecosystems and managing forests for the production of wood products little is known about the long-term effects of thinning on the ability of forest to act as carbon sinks. This study examines how the common practice of forest thinning affects carbon storage in western larch dominated mixed-conifer forests in the Northern Rockies.

Past studies of the effects of thinning and partial harvest on carbon storage have contradictory findings; some studies show that thinning causes increased carbon storage, attributable to increased growth rates of residual trees, while other studies find a decrease in carbon storage due to the removal of tree biomass from the forest stand. These conflicting results are potentially caused by several differences in study designs: 1) thinning objectives, 2) carbon storage pools measured, 3) length of the study and, 4) age of the stand when thinned. The five major pools of carbon storage are live-tree biomass, live-understory biomass, dead woody detritus, forest floor litter and duff, and mineral soil.

This study is superimposed on a long-term western larch spacing study established in northern Montana in 1961. The larch spacing study used a 3x3 factorial design made up of three thinning intensities (residual tree densities of 494 TPH, 890 TPH, and 1640 TPH) and three thinning intervals (entries every 10 years (4 entries), every 20 years (2 entries), and every 40 years (1 entry)). Data was collected at a five year intervals from 1961 to 2001 on a suite of attributes of tree growth and vigor. For this study, carbon will be measure in five major pools: live tree, understory vegetation, woody detritus and snags, forest floor, and mineral soil. To capture live-tree biomass a re-measurement of the larch spacing study will be completed to capture tree attributes on all of the 0.04 ha treatment plots. Allometric equations will be used to convert tree volume to carbon biomass. Understory vegetation will be sampled in 0.25 m^2

subplots by clipping the vegetation and taking it back to a lab to analyze carbon content. Dead woody detritus will be measured by doing a census of woody debris in the 0.04 ha plot and converting the volume to carbon using established equations that take into account changes in wood density due to the stages of woody decay. The forest floor will be sampled in 0.05 m^2 circular plots where all organic material is taken to a lab and burned to analyze carbon content. Mineral soil will be sampled using soil cores taken to a depth of 30cm and analyzed by burning the soil to measure the carbon content. Measurements will be taken in the summer of 2015. Live tree and understory carbon will be tracked through time using the new data in conjunction with the data from the long-term western larch spacing study.

An oral presentation of this study will include an analysis of live tree and understory carbon storage trends through time utilizing existing data from the larch spacing study. By measuring 5 major carbon pools and using a long- term data set this study will be able to provide more conclusive information on the effects of thinning on carbon storage. This data will help land managers identify effective ways of managing mixed-conifer forests as carbon sinks and asses any carbon storage trade-offs made while managing for other objectives, such as forest resilience and wood production.