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Correction

Correction: Hanson, C.T. Cumulative Severity of Thinned and Unthinned Forests in a Large California Wildfire. *Land* 2022, *11*, 373

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Text Correction

There was an error in the original publication [1]. Scientists affiliated with the U.S. Forest Service brought to my attention the fact that several of my point locations, which I had classified as unthinned, had been wholly or partially thinned. This included several that had been thinned shortly before the occurrence of the 2021 Antelope fire and a subset of my unthinned point locations that were partially within the buffers surrounding each thinning unit. In this context, it was suggested that my sample size was insufficient, especially if the erroneous locations were removed. I thank them for bringing this error to my attention. Separately, I realized recently that the tree basal area mortality figures from thinning in each unit, reported by Ritchie (2005) [2], represented only a portion of the tree removal that had occurred, and additionally, unquantified basal area mortality had occurred in the thinning units. I corrected these errors.

Corrections have been made to the following: (a) the Abstract; (b) the last two paragraphs of the Introduction; (c) all paragraphs of the Methods and Results, including Figure 1 and its caption and Table 1 and its caption; and (d) the first paragraph of the Discussion. The corrected paragraphs, and corrected figure and table, are inserted below:

Corrected Abstract:

Abstract: Studies pertaining to fire severity in commercially thinned versus unthinned forests are based on a comparison of tree mortality between the two categories. Commercial thinning is widely conducted on public and private forestlands as a fire management approach designed to reduce fire severity and associated tree mortality. However, tree mortality from thinning itself, prior to the occurrence of the wildfire, is generally not taken into account, which leaves a potentially important source of tree loss, with its associated forest carbon loss and carbon emissions, unreported. This study investigated the "cumulative severity" of commercially thinned and unthinned forests in a large 2021 wildfire, the Antelope fire, occurring within mixed-conifer forests on public lands in northern California, USA. Using satellite imagery to estimate pre-fire percent basal area mortality from thinning at each thinned location, combined with percent basal area mortality due to the fire itself from post-fire satellite imagery, it was found that commercial thinning was associated with significantly higher overall tree mortality levels (cumulative severity). More research is needed, on other large forest fires, to determine whether the finding that commercial thinning killed more trees than it prevented from being killed is common elsewhere.

Corrected Paragraphs from the Introduction:

Yet commercial thinning and other logging practices play a large role in removing live trees and thus reducing forest carbon storage, which influences climate change [9,10]. Moreover, there are many native wildlife species that depend upon dense, mature, and

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old conifer forests, both before and after mixed-severity wildfires. Commercial thinning can adversely affect such species by degrading dense older forests that many imperiled species need for nesting or denning, while also reducing the quality of "complex early seral forest" habitats [11] by removing so many trees from forests that they may be deficient for many snag-dependent species when such areas later experience high-severity fire [12,13]. Therefore, there is an important need to understand the degree to which commercial thinning itself affects overall tree mortality in forests. If, for example, a given stand that was commercially thinned experienced 10% lower basal area mortality in a fire compared to an adjacent unthinned stand, but the thinning operation resulted in 30% basal area mortality before the fire occurred, observers focusing solely on fire severity would miss the overall cumulative impact on live trees and imperiled wildlife species that depend on denser stands of live trees. Cumulative severity, which captures the combined basal area mortality from thinning and wildfire, presents a more complete picture of the effects.

This study investigated whether cumulative fire severity, based on percent basal area mortality from commercial thinning plus percent basal area mortality from subsequent wildfire, would be different in thinned versus unthinned forests.

Corrected Paragraphs, Figure, and Figure Caption, from the Methods:

I analyzed 13 commercial thinning units and adjacent unthinned forests in a portion of the Goosenest Adaptive Management Area in the Klamath National Forest in northern California (Figure 1). The study area comprises mixed-conifer forests, dominated by white fir (*Abies concolor*), ponderosa pine (*Pinus ponderosa*), sugar pine (*Pinus lambertiana*), and incense cedar (*Calocedrus decurrens*), with smaller amounts of red fir (*Abies magnifica*) and lodgepole pine (*Pinus contorta*) in some areas [14,15]. Elevation in the study area ranges from 1460 m to 1515 m.

The study area was heavily logged (mostly selective logging focusing on pine removal) in the 1920s and 1930s. Commercial thinning in the 13 units occurred circa 1998–2000, with prescribed fire occurring in 5 of the 13 units in 2001 (no post-thin burning occurred in the other 8 units). Each thinning unit was 40.49 ha in size, with buffers of varying widths (generally ~100–150 m) surrounding each thinning unit (Figure 1). At the time of thinning, 5 control (no thinning) units of the same size were also established (Figure 1). Forests outside of the units had a mix of thinning and other logging activities in some areas and no contemporary-era thinning or other logging (i.e., no logging since the 1920s and 1930s) in other areas. There were two additional thinning units that were not included in this study due to a lack of unthinned areas outside of the units (Figure 1). The locations and shapes of each unit are from Ritchie (2005, 2020) [14,15]. GIS data for the thinning units and buffers were obtained from the U.S. Forest Service.

In August of 2021, the 58,935 ha Antelope lightning fire burned through the Goosenest Adaptive Management Area, including the thinning units in the study area. For each of the 13 commercial thinning units, I analyzed "cumulative severity" at pairs of locations 100 m inside and 100 m outside (100 m pairs), and 200 m inside and 200 m outside (200 m pairs), of the buffer boundary around each of the thinning units, with six 100 m pairs and six 200 m pairs on each side of each thinning unit (Figure 1). Using the Generate Transects Along Lines tool in ArcGIS Pro (version 3.3), 400-m lines perpendicular to the thinning unit boundaries, and 105.166 m apart on each side of the thinning units, were created along each side of each thinning unit and then moved in a direction perpendicular to the side of the thinning unit to center on the thinning buffer boundary. Paired locations (thinning versus no thinning) were established along each of the 400-m lines at 100 m and 200 m inside and outside of the thinning buffer boundaries (Figure 1), using the Extend Polylines Tool in ArcGIS Pro (version 3.3).

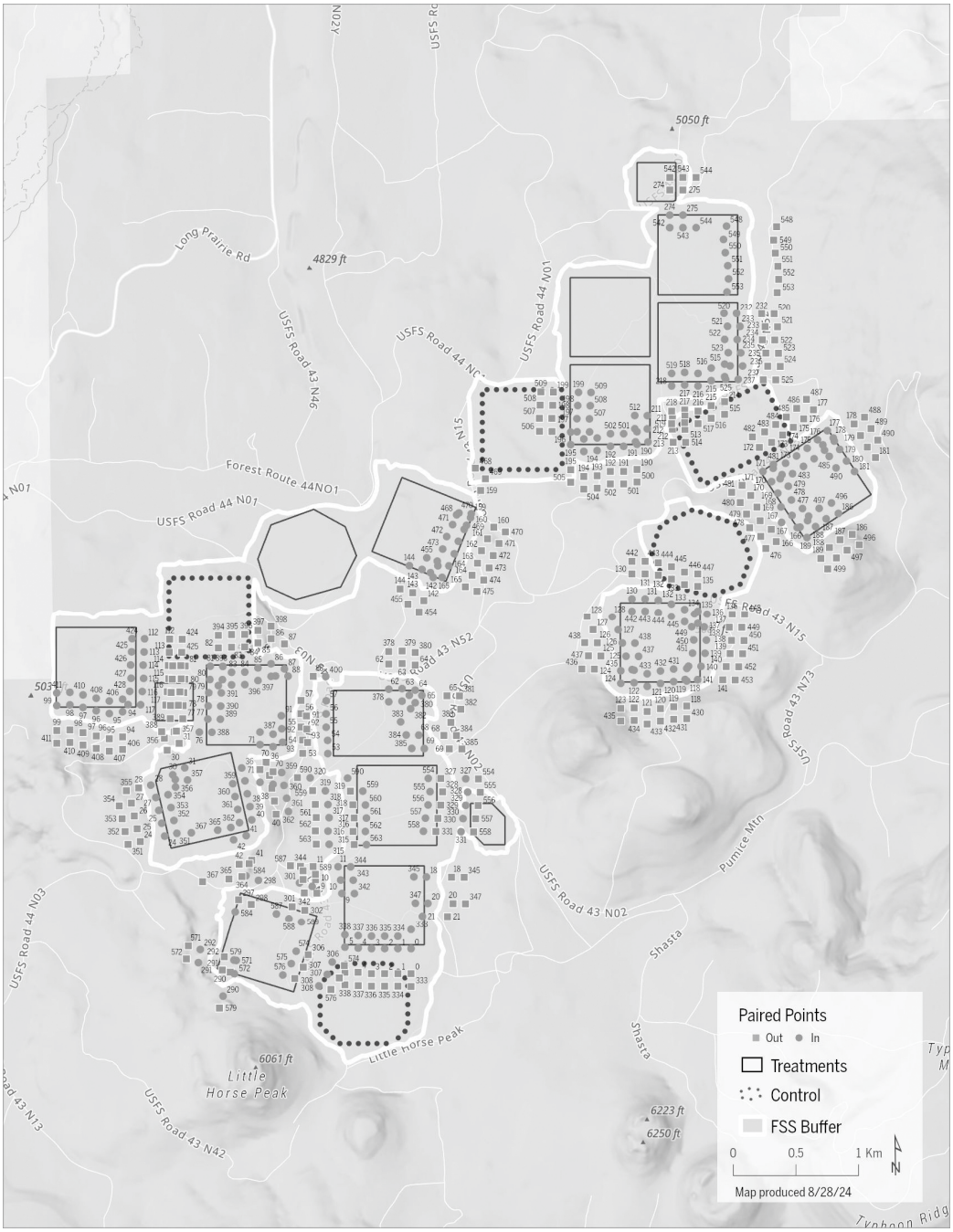


Figure 1. The Goosenest study area located within the Antelope fire of 2021, with plots and paired locations shown. The location of the study area within the larger landscape, and at the local scale, is shown in Figure 1 and Figure A.1, respectively, of Ritchie (2005) [14].

At each point location in each thinned/unthinned pair, I determined percent basal area mortality from the 2021 Antelope fire using Rapid Assessment of Vegetation Condition after Wildfire (RAVG) satellite imagery data (https://fsapps.nwcg.gov/ravg/, accessed on 2 July 2024), which assigns each 30 m × 30 m pixel to a percent basal area mortality category: 0%; 1–9.9%; 10–24.9%; 25–49.9%; 50–74.9%; 75–89.9%; and 90–100%. I used the midpoints of each basal area mortality category. To determine percent basal area mortality at each location (pixel) from thinning, prior to the 2021 Antelope fire, I used the midpoints of the same percent basal area mortality categories used in RAVG, visually assigning each location to a mortality category using images from 2002 to 2020 from the National

Agriculture Imagery Program (NAIP; https://naip-usdaonline.hub.arcgis.com, accessed on 2 July 2024) and 1990s high-resolution aerial photos from the U.S. Geological Survey (https://mil.library.ucsb.edu/ap_indexes/FrameFinder/, accessed on 2 July 2024).

I defined cumulative severity as the percent basal area mortality from thinning (if any) for a particular location, plus the percent basal area mortality of the remaining (after thinning) live tree basal area due to the Antelope fire. For example, if the basal area mortality from commercial thinning was 38%, and the basal area mortality of the remaining 62% of live tree basal area was 18%, then the cumulative severity for such a location would be 38% + 11% = 49%. Thus, cumulative severity presents a more comprehensive assessment of live tree mortality. I classified each pair in terms of whether or not cumulative severity was lower in the thinned location.

I excluded pairs of locations if the "outside" location had any evidence of pre-fire logging in the contemporary era. For this determination, I again used NAIP imagery from 2002 to 2020 and 1990s U.S. Geological Survey imagery. The imagery was of sufficient quality to clearly see canopy cover reduction from tree removal due to logging, along with skid trails, logging roads, and landings.

I used a Chi-square test for differences in proportion [16] to evaluate whether it would be warranted to analyze locations with commercial thinning and no prescribed fire ("thin/no-burn") separately from locations with commercial thinning and prescribed fire ("thin/burn"). There was no significant difference between these two categories in terms of the proportion of paired locations with cumulative severity that was lower versus higher than unthinned forests, excluding the small number of paired locations with equivalent values, since there was by definition no difference between thinned and unthinned locations in these pairs ($\chi^2 = 2.54$, $df = 1$, $p = 0.111$). Therefore, I combined the two thinning categories into one category for statistical analysis purposes. This was warranted given that the Antelope fire did not burn significantly differently in the commercial thin/no-burn units than it did in the commercial thin/burn units. I assessed whether there was a difference in cumulative severity between commercial thinning and no thinning using a Chi-square goodness of fit test, again excluding the small number of paired locations with equivalent values [17].

Corrected Paragraphs, Table, and Table Caption, from the Results:

Commercial thinning locations had cumulative severity levels that were higher than adjacent unthinned locations significantly more often than the opposite effect ($\chi^2 = 11.93$, $df = 1$, $p < 0.001$; Table 1, Spreadsheet S1). An interactive map with thinning plots, buffers, paired locations, aerial satellite imagery, and RAVG fire severity data is available at https://ginfo.maps.arcgis.com/apps/mapviewer/index.html?webmap=7a610e1f59b840dba9d1309d66e4d50e, accessed on 2 July 2024.

Table 1. Summary of paired thinned/unthinned locations and whether cumulative severity was lower, equal, or higher in commercially thinned forests compared to unthinned forests in the Goosenest study area within the Antelope fire of 2021.

Category	Thinning = Lower Cumulative Severity (# Pairs)	Thinning = Equal Cumulative Severity (# Pairs)	Thinning = Higher Cumulative Severity (# Pairs)
Thin/No-Burn	77	9	95
Thin/Burn	51	7	91
All Thinning	128	16	186

Corrected Paragraph from the Discussion:

Commercial thinning resulted in overall higher levels of tree mortality, as compared to unthinned forests, when tree mortality from both thinning and the Antelope fire was combined. Accounting for the tree mortality from commercial thinning, prior to the occurrence of the 2021 Antelope fire, provided a more contextualized and complete assessment of the cumulative effects of this type of forest management on tree mortality.

Insert Supplementary Materials paragraph:

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/land11030373/s1, Table S1: Land correction Spreadsheet S1.

The author states that the scientific conclusions are unaffected. This correction was approved by the Academic Editor. The original publication has also been updated. All authors have read and agreed to the published version of the manuscript.

References

1. Hanson, C.T. Cumulative Severity of Thinned and Unthinned Forests in a Large California Wildfire. *Land* **2022**, *11*, 373. [CrossRef]
2. Ritchie, M.W. *Ecological Research at the Goosenest Adaptive Management Area in Northeastern California*; Gen. Tech. Rep. PSW-192; U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: Albany, CA, USA, 2005; 120p.

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