**Supplementary**

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| (1) | (2) |
| Chart, waterfall chart  Description automatically generated | |
| (3) | |
| **Figure S1. AGBC change by fire disturbances varied across different forest types and ecological conditions in the Western United States.** | |

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| **Chart  Description automatically generated** |
| **Figure S2. Differences between using the exact FIA locations, and 0.8 km buffer and 1.6 km buffer of perturbed FIA locations to harmonize Monitoring Trends in Burn Severity (MTBS) to adjust each FIA plot's fire frequency and fire severity for forests in the Western United States.** |

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| **Figure S3. Tree mortality ration caused by fire across forest group at different mean tree diameter in the Western US.** Bars present mortality ratio and dots present mean diameter. |

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| **Table S1: The keys to merge other data sources to FIA.** | | |
| **Data source** | **Key link to FIA** | **Variables’ contributions** |
| FIA | -- | Land use and change, disturbance, biomass, mortality, ecological region, tree status, topography, environmental conditions and etc. |
| MTBS | Latitude, longitude, &year | Fire severity and frequency |
| PRISM | Latitude & longitude | Temperature and precipitation |
| WorldClim | County | Temperature and precipitation |
| US Drought Monitor | County | Drought severity, drought season length, drought start month |

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| **Table S2: Use the burn severity images to set fire severity classes.** | | |
| **Fire severity classes** | **Burn severity code at MTBS**  **(=Actual FIA plot locations)** | **Threshold of fire severity classes**  **(=Perturbed FIA plot locations)** |
| Low | 1,2 | <2.5 |
| Moderate | 3 | 2.5~3.5 |
| High | 4 | >3.5 |

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| **Table S3. Extreme carbon loss events (<-150 Mg/ha). There were three in five plots that lost carbon due to fire disturbances.** | | | | | | | | | |
| **Carbon loss**  **(Mg/ha)** | **Mortality reason** | **Stand age** | **Initial condition** | | | **Forest group** | **Fire** | | |
| Diameter  (cm) | Height  (m) | Biomass  (Mg/ha) | Mortality | Severity | Freq. |
| **Ecological region: Sierran Steppe - Mixed Forest - Coniferous Forest - Alpine Meadow Province** | | | | | | | | | |
| -222.956 | death at t1 | 0 | 68.48 | 27.36 | 247.21 | Nonstocked | 6.12 | 3.67 | 1 |
| **Ecological region: California Coastal Chaparral Forest and Shrub Province** | | | | | | | | | |
| -153.592 | fire | 515 | 93.60 | 38.32 | 153.59 | Redwood group | 30.77 | 1.56 | 2 |
| **Ecological region: Middle Rocky Mountain Steppe – Coniferous Forest - Alpine Meadow Province** | | | | | | | | | |
| -255.219 | fire | 0 | 29.85 | 23.68 | 311.66 | Nonstocked | 95.24 | 4.00 | 1 |
| **Ecological region: Cascade Mixed Forest - Coniferous Forest - Alpine Meadow Province** | | | | | | | | | |
| -165.532 | weather | NA | 33.73 | 24.56 | 165.53 | NA | 0.00 | 0.00 | 0 |
| **Ecological region: Cascade Mixed Forest - Coniferous Forest - Alpine Meadow Province** | | | | | | | | | |
| -243.449 | NA | 8 | 36.02 | 31.61 | 244.60 | Hemlock / Sitka spruce group | 0.00 | 0.00 | 0 |
| **Ecological region: Pacific Lowland Mixed Forest Province** | | | | | | | | | |
| -162.744 | NA | 10 | 31.50 | 23.71 | 162.74 | Douglas-fir group | 0.00 | 0.00 | 0 |

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| **Table S4. Pairwise t-test of total AGBC at actual FIA locations. P-value was adjusted by Benjamini Hochberg method. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
|  | HS-LF | LS-HF | LS-LF | No fire |
| LS-HF | 2.96E-02 |  |  |  |
| LS-LF | 2.08E-65 | 1.62E-02 |  |  |
| No fire | 3.63E-158 | 3.51E-06 | 4.50E-99 |  |
| rest | 8.05E-32 | 2.79E-01 | 1.19E-18 | 5.83E-191 |

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| **Table S5. Pairwise t-test of total AGBC at 800 m buffer perturbed FIA locations. P-value was adjusted by Benjamini Hochberg method. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
|  | HS-LF | LS-HF | LS-LF | No fire |
| LS-HF | 4.64E-01 |  |  |  |
| LS-LF | 8.30E-01 | 4.51E-01 |  |  |
| No fire | 2.88E-29 | 1.78E-04 | 7.97E-256 |  |
| rest | 8.30E-01 | 4.51E-01 | 9.56E-01 | 1.47E-101 |

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| **Table S6. Pairwise t-test of total AGBC at 1600 m buffer perturbed FIA locations. P-value was adjusted by Benjamini Hochberg method. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
|  | HS-LF | LS-HF | LS-LF | No fire |
| LS-HF | 2.09E-03 |  |  |  |
| LS-LF | 4.77E-01 | 1.11E-03 |  |  |
| No fire | 6.54E-49 | 1.56E-09 | 3.95E-322 |  |
| rest | 3.96E-01 | 1.11E-03 | 6.44E-01 | 1.75E-133 |

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| **Table S7. Pairwise t-test of live AGBC at actual FIA locations. P-value was adjusted by Benjamini Hochberg method. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
|  | HS-LF | LS-HF | LS-LF | No fire |
| LS-HF | 1.05E-03 | NA | NA | NA |
| LS-LF | 1.02E-194 | 1.24E-06 | NA | NA |
| No fire | 0.00E+00 | 1.86E-13 | 7.16E-125 | NA |
| rest | 4.82E-85 | 2.93E-02 | 7.72E-66 | 0.00E+00 |

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| **Table S8. Pairwise t-test of live AGBC at 800m buffer perturbed FIA locations. P-value was adjusted by Benjamini Hochberg method. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
|  | HS-LF | LS-HF | LS-LF | No fire |
| LS-HF | 7.10E-01 |  |  |  |
| LS-LF | 9.04E-05 | 1.70E-01 |  |  |
| No fire | 3.19E-77 | 3.77E-07 | 0.00E+00 |  |
| rest | 2.84E-02 | 3.24E-01 | 8.91E-03 | 8.51E-216 |

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| **Table S9. Pairwise t-test of live AGBC at 1600m buffer perturbed FIA locations. P-value was adjusted by Benjamini Hochberg method. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
|  | HS-LF | LS-HF | LS-LF | No fire |
| LS-HF | 1.09E-03 |  |  |  |
| LS-LF | 4.07E-10 | 3.96E-06 |  |  |
| No fire | 6.77E-132 | 4.60E-16 | 0.00E+00 |  |
| rest | 3.53E-03 | 8.03E-05 | 2.91E-07 | 3.08E-319 |

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| **Table S10. Pairwise t-test of standing dead AGBC at actual FIA locations. P-value was adjusted by Benjamini Hochberg method. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
|  | HS-LF | LS-HF | LS-LF | No fire |
| LS-HF | 1.96E-02 |  |  |  |
| LS-LF | 6.67E-150 | 1.74E-06 |  |  |
| No fire | 4.27E-215 | 1.42E-08 | 5.80E-17 |  |
| rest | 4.72E-59 | 2.85E-02 | 4.24E-62 | 1.73E-181 |

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| **Table S11. Pairwise t-test of standing dead AGBC at 800m buffer perturbed FIA locations. P-value was adjusted by Benjamini Hochberg method. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
|  | HS-LF | LS-HF | LS-LF | No fire |
| LS-HF | 4.21E-01 |  |  |  |
| LS-LF | 2.07E-11 | 4.21E-01 |  |  |
| No fire | 9.29E-53 | 3.54E-03 | 5.11E-145 |  |
| rest | 3.27E-04 | 9.16E-01 | 1.14E-06 | 1.07E-105 |

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| **Table S12. Pairwise t-test of standing dead AGBC at 1600m buffer perturbed FIA locations. P-value was adjusted by Benjamini Hochberg method. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
|  | HS-LF | LS-HF | LS-LF | No fire |
| LS-HF | 4.68E-01 |  |  |  |
| LS-LF | 4.16E-23 | 5.78E-03 |  |  |
| No fire | 4.35E-85 | 5.76E-06 | 3.59E-137 |  |
| rest | 5.46E-04 | 1.39E-01 | 4.16E-23 | 3.82E-173 |

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| **Table S13. Tukey Honest Significant Differences of total AGBC at actual FIA locations. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
| Contrast | Estimate | conf.low | conf.high | adj.p.value |
| LS-HF-HS-LF | 1.414804 | -0.32637 | 3.155973 | 0.173482 |
| LS-LF-HS-LF | 2.957921 | 2.487146 | 3.428695 | 0 |
| no fire-HS-LF | 4.326306 | 3.887208 | 4.765404 | 0 |
| rest-HS-LF | 2.088775 | 1.605886 | 2.571665 | 0 |
| LS-LF-LS-HF | 1.543117 | -0.15096 | 3.23719 | 0.09405 |
| no fire-LS-HF | 2.911502 | 1.225957 | 4.597047 | 2.42E-05 |
| rest-LS-HF | 0.673971 | -1.02351 | 2.371451 | 0.815389 |
| no fire-LS-LF | 1.368385 | 1.192265 | 1.544506 | 0 |
| rest-LS-LF | -0.86915 | -1.13634 | -0.60195 | 3.60E-14 |
| rest-no fire | -2.23753 | -2.44386 | -2.0312 | 0 |

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| **Table S14. Tukey Honest Significant Differences of total AGBC at 800m buffer perturbed FIA locations. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
| Contrast | Estimate | conf.low | conf.high | adj.p.value |
| LS-HF-HS-LF | -0.74049 | -2.79247 | 1.311485 | 0.862468 |
| LS-LF-HS-LF | 0.074874 | -0.46657 | 0.616318 | 0.995706 |
| no fire-HS-LF | 2.151873 | 1.634165 | 2.669582 | 0 |
| rest-HS-LF | 0.068584 | -0.51092 | 0.648089 | 0.997655 |
| LS-LF-LS-HF | 0.815366 | -1.1771 | 2.807829 | 0.798043 |
| no fire-LS-HF | 2.892365 | 0.90622 | 4.87851 | 0.000679 |
| rest-LS-HF | 0.809077 | -1.19406 | 2.812218 | 0.805706 |
| no fire-LS-LF | 2.076999 | 1.9117 | 2.242299 | 0 |
| rest-LS-LF | -0.00629 | -0.31472 | 0.302137 | 0.999998 |
| rest-no fire | -2.08329 | -2.34784 | -1.81874 | 0 |

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| **Table S15. Tukey Honest Significant Differences of total AGBC at 1600m buffer perturbed FIA locations. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
| Contrast | Estimate | conf.low | conf.high | adj.p.value |
| LS-HF-HS-LF | -2.38199 | -4.42356 | -0.34041 | 0.012699 |
| LS-LF-HS-LF | 0.122231 | -0.29934 | 0.543805 | 0.933352 |
| no fire-HS-LF | 2.158842 | 1.760495 | 2.55719 | 0 |
| rest-HS-LF | 0.166324 | -0.28693 | 0.619574 | 0.85503 |
| LS-LF-LS-HF | 2.504218 | 0.496685 | 4.51175 | 0.006013 |
| no fire-LS-HF | 4.540829 | 2.538045 | 6.543613 | 6.22E-09 |
| rest-LS-HF | 2.548311 | 0.533888 | 4.562733 | 0.00507 |
| no fire-LS-LF | 2.036611 | 1.89223 | 2.180992 | 0 |
| rest-LS-LF | 0.044093 | -0.21591 | 0.304094 | 0.990604 |
| rest-no fire | -1.99252 | -2.21287 | -1.77216 | 0 |

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| **Table S16. Tukey Honest Significant Differences of live AGBC at actual FIA locations. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
| Contrast | Estimate | conf.low | conf.high | adj.p.value |
| LS-HF-HS-LF | 1.414804 | -0.32637 | 3.155973 | 0.173482 |
| LS-LF-HS-LF | 2.957921 | 2.487146 | 3.428695 | 0 |
| no fire-HS-LF | 4.326306 | 3.887208 | 4.765404 | 0 |
| rest-HS-LF | 2.088775 | 1.605886 | 2.571665 | 0 |
| LS-LF-LS-HF | 1.543117 | -0.15096 | 3.23719 | 0.09405 |
| no fire-LS-HF | 2.911502 | 1.225957 | 4.597047 | 2.42E-05 |
| rest-LS-HF | 0.673971 | -1.02351 | 2.371451 | 0.815389 |
| no fire-LS-LF | 1.368385 | 1.192265 | 1.544506 | 0 |
| rest-LS-LF | -0.86915 | -1.13634 | -0.60195 | 3.60E-14 |
| rest-no fire | -2.23753 | -2.44386 | -2.0312 | 0 |

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| **Table S17. Tukey Honest Significant Differences of live AGBC at 800m buffer perturbed FIA locations. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
| Contrast | Estimate | conf.low | conf.high | adj.p.value |
| LS-HF-HS-LF | -0.74049 | -2.79247 | 1.311485 | 0.862468 |
| LS-LF-HS-LF | 0.074874 | -0.46657 | 0.616318 | 0.995706 |
| no fire-HS-LF | 2.151873 | 1.634165 | 2.669582 | 0 |
| rest-HS-LF | 0.068584 | -0.51092 | 0.648089 | 0.997655 |
| LS-LF-LS-HF | 0.815366 | -1.1771 | 2.807829 | 0.798043 |
| no fire-LS-HF | 2.892365 | 0.90622 | 4.87851 | 0.000679 |
| rest-LS-HF | 0.809077 | -1.19406 | 2.812218 | 0.805706 |
| no fire-LS-LF | 2.076999 | 1.9117 | 2.242299 | 0 |
| rest-LS-LF | -0.00629 | -0.31472 | 0.302137 | 0.999998 |
| rest-no fire | -2.08329 | -2.34784 | -1.81874 | 0 |

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| **Table S18. Tukey Honest Significant Differences of live AGBC at 1600m buffer perturbed FIA locations. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
| Contrast | Estimate | conf.low | conf.high | adj.p.value |
| LS-HF-HS-LF | -2.38199 | -4.42356 | -0.34041 | 0.012699 |
| LS-LF-HS-LF | 0.122231 | -0.29934 | 0.543805 | 0.933352 |
| no fire-HS-LF | 2.158842 | 1.760495 | 2.55719 | 0 |
| rest-HS-LF | 0.166324 | -0.28693 | 0.619574 | 0.85503 |
| LS-LF-LS-HF | 2.504218 | 0.496685 | 4.51175 | 0.006013 |
| no fire-LS-HF | 4.540829 | 2.538045 | 6.543613 | 6.22E-09 |
| rest-LS-HF | 2.548311 | 0.533888 | 4.562733 | 0.00507 |
| no fire-LS-LF | 2.036611 | 1.89223 | 2.180992 | 0 |
| rest-LS-LF | 0.044093 | -0.21591 | 0.304094 | 0.990604 |
| rest-no fire | -1.99252 | -2.21287 | -1.77216 | 0 |

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| **Table S19. Tukey Honest Significant Differences of standing dead AGBC at actual FIA locations. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
| Contrast | Estimate | conf.low | conf.high | adj.p.value |
| LS-HF-HS-LF | 1.414804 | -0.32637 | 3.155973 | 0.173482 |
| LS-LF-HS-LF | 2.957921 | 2.487146 | 3.428695 | 0 |
| no fire-HS-LF | 4.326306 | 3.887208 | 4.765404 | 0 |
| rest-HS-LF | 2.088775 | 1.605886 | 2.571665 | 0 |
| LS-LF-LS-HF | 1.543117 | -0.15096 | 3.23719 | 0.09405 |
| no fire-LS-HF | 2.911502 | 1.225957 | 4.597047 | 2.42E-05 |
| rest-LS-HF | 0.673971 | -1.02351 | 2.371451 | 0.815389 |
| no fire-LS-LF | 1.368385 | 1.192265 | 1.544506 | 0 |
| rest-LS-LF | -0.86915 | -1.13634 | -0.60195 | 3.60E-14 |
| rest-no fire | -2.23753 | -2.44386 | -2.0312 | 0 |

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| **Table S20. Tukey Honest Significant Differences of standing dead AGBC at 800m buffer perturbed FIA locations. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
| Contrast | Estimate | conf.low | conf.high | adj.p.value |
| LS-HF-HS-LF | -0.74049 | -2.79247 | 1.311485 | 0.862468 |
| LS-LF-HS-LF | 0.074874 | -0.46657 | 0.616318 | 0.995706 |
| no fire-HS-LF | 2.151873 | 1.634165 | 2.669582 | 0 |
| rest-HS-LF | 0.068584 | -0.51092 | 0.648089 | 0.997655 |
| LS-LF-LS-HF | 0.815366 | -1.1771 | 2.807829 | 0.798043 |
| no fire-LS-HF | 2.892365 | 0.90622 | 4.87851 | 0.000679 |
| rest-LS-HF | 0.809077 | -1.19406 | 2.812218 | 0.805706 |
| no fire-LS-LF | 2.076999 | 1.9117 | 2.242299 | 0 |
| rest-LS-LF | -0.00629 | -0.31472 | 0.302137 | 0.999998 |
| rest-no fire | -2.08329 | -2.34784 | -1.81874 | 0 |

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| **Table S21. Tukey Honest Significant Differences of standing dead AGBC at 1600m buffer perturbed FIA locations. H meant high; L meant low; S meant fire severity; F meant fire frequency.** | | | | |
| Contrast | Estimate | conf.low | conf.high | adj.p.value |
| LS-HF-HS-LF | -2.38199 | -4.42356 | -0.34041 | 0.012699 |
| LS-LF-HS-LF | 0.122231 | -0.29934 | 0.543805 | 0.933352 |
| no fire-HS-LF | 2.158842 | 1.760495 | 2.55719 | 0 |
| rest-HS-LF | 0.166324 | -0.28693 | 0.619574 | 0.85503 |
| LS-LF-LS-HF | 2.504218 | 0.496685 | 4.51175 | 0.006013 |
| no fire-LS-HF | 4.540829 | 2.538045 | 6.543613 | 6.22E-09 |
| rest-LS-HF | 2.548311 | 0.533888 | 4.562733 | 0.00507 |
| no fire-LS-LF | 2.036611 | 1.89223 | 2.180992 | 0 |
| rest-LS-LF | 0.044093 | -0.21591 | 0.304094 | 0.990604 |
| rest-no fire | -1.99252 | -2.21287 | -1.77216 | 0 |

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| **Table S22. Relationships between AGBC change and numeric biotic and abiotic factors at total C stocks.** | | | | |
| **Term** | **Estimate** | **std.error** | **Statistic** | **p.value** |
| (Intercept) | -1.6114 | 1.437128 | -1.12126 | 0.262267 |
| LAT.x | -0.0044 | 0.008053 | -0.54683 | 0.584538 |
| LON.x | -0.01356 | 0.00981 | -1.38211 | 0.167042 |
| ELEV.x | 1.50E-05 | 1.76E-05 | 0.852015 | 0.394274 |
| SLOPE\_M | -0.00244 | 0.001234 | -1.97435 | 0.048434 |
| ASPECT\_M | 0.000752 | 0.000465 | 1.616956 | 0.105994 |
| TOTAGE\_M | -0.0031 | 0.000627 | -4.93727 | 8.36E-07 |
| BHAGE\_M | -0.00173 | 0.000733 | -2.36555 | 0.018067 |
| AG\_T1 | 0.119278 | 0.003558 | 33.52681 | ######## |
| DIA\_Growth\_M | 0.405748 | 0.030971 | 13.10072 | 3.66E-38 |
| HT\_Change\_M | 0.644157 | 0.044381 | 14.51419 | 3.63E-46 |
| CCLCD\_change2 | -0.2755 | 1.036308 | -0.26584 | 0.790378 |
| CCLCD\_change3 | 0.156297 | 0.954526 | 0.163743 | 0.869945 |
| CCLCD\_change4 | -0.45062 | 0.955147 | -0.47178 | 0.637117 |
| CCLCD\_change5 | -0.4085 | 0.961213 | -0.42498 | 0.670879 |
| CCLCD\_changedecrease | -0.58383 | 0.955926 | -0.61075 | 0.541412 |
| CCLCD\_changeincrease | -0.4046 | 0.955662 | -0.42337 | 0.672054 |
| condition\_tree\_density\_M | 0.00024 | 3.69E-05 | 6.495138 | 9.69E-11 |
| fire\_occuredYes | 0.01086 | 0.112374 | 0.096643 | 0.923016 |