**Mechanical Thinning - remove fuels**

**Mechanical Thinning and Burning Scenarios**

LANDFIRE supports three scenarios of mechanical thinning followed by prescribed burning that temporarily removes surface fuels. Mechanical thinning effectively reduces crown fuels and raises canopy base height or in shrublands, reduces overall shrub cover. Surface slash is then either pile burned or underburned and results in low surface fuel accumulations.

LANDFIRE definitions:

* Low severity: < 25% area includes some under thinning with pile and burn or concentration burning
* Moderate severity: 25 to 75% of the area includes some overstory thinning with burning or aggressive understory thinning with burning
* High severity: >75% area includes clear cut with slash treatment—shelterwoods with slash burning treatments

Time since disturbance:

* Step 1: Immediately post disturbance
* Step 2: 2-5 years post disturbance – second growing season
* Step 3: 5-10 years post disturbance.

Because the SE and Hawaii have much faster decomposition rates:

* 2: 0-3 years post disturbance
* 3: 3-10 years post disturbance

|  |  |  |  |
| --- | --- | --- | --- |
| **Type** | **Severity class** | **Time step** | **Code** |
| Mechanical Remove Loading | Low Severity | 1 | 311 |
|  |  | 2 | 312 |
|  |  | 3 | 313 |
| Mechanical Remove Loading | Moderate Severity | 1 | 321 |
|  |  | 2 | 322 |
|  |  | 3 | 323 |
| Mechanical Remove Loading | High Severity | 1 | 331 |
|  |  | 2 | 332 |
|  |  | 3 | 333 |

**FORESTED FUELBEDS**

*Note – percentages loosely based on Reinhardt et al. (2006) and are identical to the thin and add disturbance scenario.*

**Canopy updates**

311: Low Severity Time Step 1 (immediately post disturbance):

* 15% reduction in canopy cover
* 25% reduction in density of overstory and midstory trees
* 25% increase in overstory and midstory HLC
* 10% increase in overstory and midstory tree diameter
* 75% reduction in understory tree density and cover (no concomitant change in understory HLC and tree diameter expected because we assume a uniform size distribution)
* Average tree height is assumed to not change
* No anticipated change in snag classes

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No additional change anticipated in canopy layers.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No additional change anticipated in canopy layers.

321: Moderate Severity Time Step 1 (immediately post disturbance):

* 33% reduction in canopy cover
* 50% reduction in density of overstory and midstory trees.
* 50% increase in overstory and midstory HLC
* 25% increase in tree diameter
* 100% reduction in understory canopy cover and density
* Average tree height is assumed to not change.
* No anticipated change in snag classes.

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No additional change anticipated in canopy layers.

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No additional change anticipated in canopy layers.

331: High Severity Time Step 1 (immediate post disturbance)

* 67% reduction in canopy cover
* 75% reduction in density of overstory and midstory trees.
* 50% increase in overstory and midstory HLC.
* 25% increase in tree diameter
* 100% reduction in understory canopy cover and density
* Average tree height is assumed to not change.
* No anticipated change in snag classes.

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No additional change anticipated in canopy layers.

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No additional change anticipated in canopy layers.

**Shrub updates**

If shrub layers are present in forested fuelbeds, we expect that they will be temporarily reduced due to understory broadcast and pile burning.

311: Low Severity Time Step 1 (immediately post disturbance):

* 25% reduction in shrub cover
* 50% reduction in percent live.

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 25% increase in shrub cover
* Restore percent live to pre-disturbance value.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore shrub cover to pre-disturbance inputs.

321: Moderate Severity Time Step 1 (immediately post disturbance):

* 50% reduction in shrub cover
* 75% reduction in percent live.

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 50% increase in shrub cover.
* Restore percent live to pre-disturbance value.

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore shrub cover to pre-disturbance inputs.

331: High Severity Time Step 1 (immediate post disturbance)

* 75% reduction in shrub cover
* 90% reduction in percent live.

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 50% increase in shrub cover.
* Restore percent live to pre-disturbance value.

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore shrub cover to pre-disturbance inputs.

**Herb updates**

If herb layers are present in forested fuelbeds, we expect an immediate decrease in herbaceous fuels following fire followed by a modest increase in herbaceous vegetation with more open canopy conditions.

311: Low Severity Time Step 1 (immediately post disturbance):

* 25% reduction in herb cover, percent live and load from prescribed fire

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 50% increase in herb cover and load
* Restore percent live to pre-treatment value.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore herb cover and load to pre-treatment inputs

321: Moderate Severity Time Step 1 (immediately post disturbance):

* 50% reduction in herb cover, percent live and load from prescribed fire

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 50% increase in herb cover and load
* Restore percent live to pre-treatment value.

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore herb cover and load to pre-treatment inputs

331: High Severity Time Step 1 (immediate post disturbance)

* 75% reduction in herb cover, percent live and load from prescribed fire
* 75% reduction in percent live (due to equipment damage)

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 50% increase in herb cover and load
* Restore percent live to pre-treatment value.

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore herb cover and load to pre-treatment inputs

**Downed Wood updates (for forested fuelbeds)**

Fuel reductions are based on Consume’s activity equations, which represent broadcast burn scenarios with 75-100% burn unit coverage in recent logging slash. I used a 1000-hr FM of 40%. The southern and western consumption results at the same 1000-hrFM are also shown for reference purposes.

|  |  |  |  |
| --- | --- | --- | --- |
| Timelag class | Southern | Western | Activity |
| 1hr | 83% | 85% | 100% |
| 10hr | 37% | 85% | 100% |
| 100hr | 57% | 71% | 100% |
| 1000hr+ Sound | 45% | 45% | 45% |
| 1000hr+ Rotten | 55% | 55% | 45% |

311: Low Severity Time Step 1 (immediately post disturbance):

* Decrease in 1hr, 10hr and 100hr wood by 25%. Decrease fine wood cover and depth also by 25%.
* Reduce 1000hr, 10,000hr and >10,000hr sound and rotten wood by 10%

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 25% of sound coarse wood (>1000-hr) becomes rotten wood.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore fine downed wood inputs to pre-fire settings.
* 50% of sound coarse wood (>1000-hr) becomes rotten wood.

321: Moderate Severity Time Step 1 (immediately post disturbance):

* Decrease in 1hr, 10hr and 100hr wood by 50%.
* Decrease fine wood cover and depth also by 50%.
* Reduce 1000hr, 10,000hr and >10,000hr sound and rotten wood by 20%

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

25% of sound coarse wood (>1000-hr) becomes rotten wood.

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore fine downed wood inputs to pre-fire settings.
* 50% of sound coarse wood (>1000-hr) becomes rotten wood.

331: High Severity Time Step 1 (immediate post disturbance)

* Decrease in 1hr, 10hr and 100hr wood by 75%.
* Decrease fine wood cover and depth also by 75%.
* Reduce 1000hr, 10,000hr and >10,000hr sound and rotten wood by 45%

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 25% of sound coarse wood (>1000-hr) becomes rotten wood.

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore fine downed wood inputs to pre-fire settings.
* 50% of sound coarse wood (>1000-hr) becomes rotten wood.

**Stump updates (for forested fuelbeds)**

* *Discuss options with Kjell in adjusting height and dbh of rotten stump category if sound stumps are numerous?*

311: Low Severity Time Step 1 (immediately post disturbance):

* Increase sound stump density by the reduction in overstory and midstory stump density (25% of original overstory and midstory tree density).

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Move all sound stumps to rotten stump category (needs clarification)

321: Moderate Severity Time Step 1 (immediately post disturbance):

* Increase sound stump density by the reduction in overstory and midstory stump density (50% of original overstory and midstory tree density).

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Move all sound stumps to rotten stumps (needs clarification)

331: High Severity Time Step 1 (immediate post disturbance)

* Increase sound stump density by the reduction in overstory and midstory stump density (75% of original overstory and midstory tree density).

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Move all sound stumps to rotten stumps (needs clarification)

**Pile updates (for forested fuelbeds)**

311: Low Severity Time Step 1 (immediately post fire):

* 25% reduction in pile density.

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No change. *Assume revert to original fuelbed > 10 years.*

321: Moderate Severity Time Step 1 (immediately post fire):

* 50% reduction in pile density.

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

323: Moderate Severity Time Step 3 (5-10 years post fire or 3-10 years for Hawaii and SE US)

* No change.

331: High Severity Time Step 1 (immediate post disturbance)

* 75% reduction in pile density

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

333: High Severity Time Step 3 (5-10 years post fire or 3-10 years for Hawaii and SE US)

* No change.

**Litter-Lichen-Moss updates**

311: Low Severity Time Step 1 (immediately post disturbance):

* 25% reduction in litter, lichen or moss cover and depth.
* If an optional LLM loading is specified, decrease loading by 25%

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* Restore Litter inputs to pre-fire settings.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore Lichen and Moss inputs to pre-fire settings.

321: Moderate Severity Time Step 1 (immediately post disturbance):

* 50% reduction in litter, lichen or moss cover and depth.
* If an optional LLM loading is specified, decrease loading by 75%

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* Restore Litter inputs to pre-fire settings.

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore Lichen and Moss inputs to pre-fire settings.

331: High Severity Time Step 1 (immediate post disturbance)

* 75% reduction in litter, lichen or moss cover and depth.
* If an optional LLM loading is specified, decrease loading by 75%

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* Restore Litter inputs to pre-fire settings.

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore Lichen and Moss inputs to pre-fire settings.

**Ground Fuel updates**

311: Low Severity Time Step 1 (immediately post disturbance):

* 25% reduction in upper and lower duff cover and depth.
* 25% reduction in depth and density of basal accumulations and squirrel middens.
* If an optional loading is specified, decrease loading by 25%

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No change.

321: Moderate Severity Time Step 1 (immediately post disturbance):

* 50% reduction in upper and lower duff cover and depth.
* 50% reduction in depth and density of basal accumulations and squirrel middens.
* If an optional duff loading is specified, decrease loading by 50%

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No change.

331: High Severity Time Step 1 (immediate post disturbance)

* 75% reduction in upper and lower duff cover and depth.
* 75% reduction in depth and density of basal accumulations and squirrel middens.
* If an optional duff loading is specified, decrease loading by 75%

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No change.

**SHRUBLAND FUELBEDS**

**Canopy updates**

None – should be not present or very sparse.

**Shrub updates**

For shrub fuelbeds (sagebrush EVGroups only), we would expect a reduction in shrub cover from prescribed burning.

311: Low Severity Time Step 1 (immediately post disturbance):

* 25% reduction in shrub cover, percent live and optional shrub loading (if specified).

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 25% increase in shrub cover, percent live and optional shrub loading (if specified).

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore pre-disturbance inputs.

321: Moderate Severity Time Step 1 (immediately post disturbance):

* 50% reduction in shrub cover, percent live and optional shrub loading (if specified).

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 50% increase in shrub cover, percent live and optional shrub loading (if specified).

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore pre-disturbance inputs.

331: High Severity Time Step 1 (immediate post disturbance)

* 75% reduction in shrub cover, percent live, and optional shrub loading (if specified).

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 50% increase in shrub cover, percent live and optional shrub loading (if specified).

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore pre-disturbance inputs.

**Herb updates**

For herb fuelbeds (sagebrush only), we would expect an initial decrease in herbaceous fuels following prescribed burning and then an increase in time step 2 due to more open growing conditions.

311: Low Severity Time Step 1 (immediately post disturbance):

* 25% reduction in herb cover, percent live and loading.

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 25% increase in herb cover, percent live and loading.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore pre-disturbance inputs.

321: Moderate Severity Time Step 1 (immediately post disturbance):

* 50% reduction in herb cover, percent live and loading.

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 75% increase in herb cover, percent live and loading.

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore pre-disturbance inputs.

331: High Severity Time Step 1 (immediate post disturbance)

* 75% decrease in herb cover, percent live, and loading.

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* 100% increase in herb cover, percent live and loading.

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore pre-disturbance inputs.

**Downed Wood updates**

For shrubland fuelbeds, a decrease in fine downed wood is expected in the event of a moderate and high severity events. We assume there is very little CWD in shrubland fuelbed sites and recommend no change (*discuss with Kjell – review reference fuelbeds to confirm).*

311: Low Severity Time Step 1 (immediately post disturbance):

* Decrease in 1hr, 10hr and 100hr wood by 25%. Decrease fine wood cover and depth also by 25%.

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore fine downed wood inputs to pre-fire settings.

321: Moderate Severity Time Step 1 (immediately post disturbance):

* Decrease in 1hr, 10hr and 100hr wood by 50%. Decrease fine wood cover and depth also by 50%.

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* Increase in 1hr, 10hr and 100hr wood by 50%. Increase in fine wood cover and depth also by 50%.

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore fine downed wood inputs to pre-fire settings.

331: High Severity Time Step 1 (immediate post disturbance)

* Decrease in 1hr, 10hr and 100hr wood by 75%. Decrease fine wood cover and depth also by 75%.

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* Restore fine downed wood inputs to pre-fire settings.

**Stump updates**

No change

**Pile updates**

311: Low Severity Time Step 1 (immediately post fire):

* 15% reduction in pile density.

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No change. *Assume revert to original fuelbed > 10 years.*

321: Moderate Severity Time Step 1 (immediately post fire):

* 40% reduction in pile density.

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

323: Moderate Severity Time Step 3 (5-10 years post fire or 3-10 years for Hawaii and SE US)

* No change.

331: High Severity Time Step 1 (immediate post disturbance)

* 60% reduction in pile density

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

333: High Severity Time Step 3 (5-10 years post fire or 3-10 years for Hawaii and SE US)

* No change.

**Litter-Lichen-Moss updates**

In shrubland fuelbeds, decreases in the litter layer are expected in the event of a moderate or high severity events.

311: Low Severity Time Step 1 (immediately post disturbance):

* 25% reduction in litter, lichen or moss cover and depth.
* If an optional LLM loading is specified, decrease loading by 25%

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* Restore LLM inputs to pre-fire settings.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No change.

321: Moderate Severity Time Step 1 (immediately post disturbance):

* 50% reduction in litter, lichen or moss cover and depth.
* If an optional LLM loading is specified, decrease loading by 75%

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

Restore LLM inputs to pre-fire settings.

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No change.

331: High Severity Time Step 1 (immediate post disturbance)

* 75% reduction in litter, lichen or moss cover and depth.
* If an optional LLM loading is specified, decrease loading by 75%

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No change.

**Ground Fuel updates**

311: Low Severity Time Step 1 (immediately post disturbance):

* 25% reduction in upper and lower duff cover and depth.
* 25% reduction in depth and density of basal accumulations and squirrel middens.
* If an optional loading is specified, decrease loading by 25%

312: Low severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

313: Low severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No change.

321: Moderate Severity Time Step 1 (immediately post disturbance):

* 50% reduction in upper and lower duff cover and depth.
* 50% reduction in depth and density of basal accumulations and squirrel middens.
* If an optional duff loading is specified, decrease loading by 50%

322: Moderate Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

323: Moderate Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No change.

331: High Severity Time Step 1 (immediate post disturbance)

* 75% reduction in upper and lower duff cover and depth.
* 75% reduction in depth and density of basal accumulations and squirrel middens.
* If an optional duff loading is specified, decrease loading by 75%

332: High Severity Time Step 2 (2-5 years post disturbance or 0-3 years for Hawaii and SE US)

* No change.

333: High Severity Time Step 3 (5-10 years post disturbance or 3-10 years for Hawaii and SE US)

* No change.

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