**Mechanical Thinning - add fuels**

**Mechanical Thinning Scenarios**

LANDFIRE supports three scenarios of mechanical thinning that adds downed wood to surface fuels. Mechanical thinning effectively reduces crown fuels and raises canopy base height or in shrublands, reduces overall shrub cover. Surface slash is left on site and results in low, moderate and high continuity of dispersed logging residues.

LANDFIRE definitions:

* Low severity: < 25% area includes low concentrations of lop and scattered or masticated logging slash.
* Moderate severity: 25 to 75% of the area includes low to moderate concentrations of lop and scattered or masticated logging slash.
* High severity: >75% area includes understory thinning to increase CBH and light to moderate concentrations of masticated fuels.

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 Add Loading | Low Severity | 1 | 211 |
|  |  | 2 | 212 |
|  |  | 3 | 213 |
| Mechanical Add Loading | Moderate Severity | 1 | 221 |
|  |  | 2 | 222 |
|  |  | 3 | 223 |
| Mechanical Add Loading | High Severity | 1 | 231 |
|  |  | 2 | 232 |
|  |  | 3 | 233 |

**FORESTED FUELBEDS**

*Note – percentages loosely based on Reinhardt et al. (2006).*

**Canopy updates**

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

* 15% reduction in canopy cover
* 25% reduction in density, percent cover of overstory and midstory trees
* 25% increase in overstory and midstory HLC
* 10% increase in overstory and midstory tree diameter
* 75% reduction in understory canopy cover and tree density (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 (ASK ROGER AND JIM)

212: 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.

213: 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.

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

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

222: 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.

223: 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.

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

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

232: 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.

233: 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 chipped or masticated and contribute to surface fuel accumulations. Because of more open canopy conditions in the high severity thin and add scenario, we expect shrub cover will initially decline due to equipment damage but increase by 10% in time steps 2 and 3.

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

* 25% reduction in shrub cover.
* 50% reduction in percent live (due to equipment damage)

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

* 10% increase in shrub cover
* Restore percent live to pre-mastication settings

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

* 10% increase in shrub cover

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

* 50% reduction in shrub cover.
* 75% reduction in percent live (due to equipment damage)

222: Moderate 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-mastication settings

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

* 25% increase in shrub cover.

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

* 75% reduction in shrub cover and percent live (due to equipment damage)

232: 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-mastication settings.

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

* 50% increase in shrub cover.

**Herb updates**

If herb layers are present in forested fuelbeds, we expect an initial reduction in herbaceous fuels associated with equipment damage followed by a modest increase in herbaceous cover in response to more open canopy conditions.

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

* 25% reduction in herb cover, percent live and loading due to equipment damage

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

* 25% increase in herb cover and loading
* Restore percent live to pre-mastication settings

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

* 25% increase in herb cover and loading

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

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

222: 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 loading
* Restore percent live to pre-mastication settings

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

* 50% increase in herb cover and loading

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

* 75% reduction in herb cover, percent live and loading (due to equipment damage)

232: 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 loading
* Restore percent live to pre-mastication settings

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

* 50% increase in herb cover and loading

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

To discuss with Kjell – we should consider a minimum loading % cover and depth at Time step 1 under each of these severity classes, based on the amount of trees removed by logging activity. Need to carefully discuss this. Would only be applied to FBs with >40% forest cover to start out with… or some threshold around there.

Recommended minimum values for masticated fuelbeds, loosely based on literature (Kreye et al. 2014) for Time Step 1 masticated fuelbeds.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Low  tpa | Mod  tpa | High  Tpa |
| 1h | 0.5 | 1 | 1.5 |
| 10hr | 1 | 2 | 3 |
| 100hr | 0.5 | 1 | 1.5 |

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

* Increase in 1-hr, 10-hr and 100-hr wood by 25%. Increase fine wood cover and depth also by 25%. Use minimum values above in cases of low pre-disturbance FWD.
* No change in CWD (including 1000-hr, 10,000-hr and >10,000hr sound and rotten categories)

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

* Decrease fine wood cover, depth and load in Time Step 1 by 25%.
* Move 25% sound wood to rotten wood by category (S1000hr to R1000hr, etc.)

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

* Decrease fine wood cover, depth and load in Time Step 2 by 50%.

Move 50% sound wood to rotten wood by category (S1000hr to R1000hr, etc.)

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

* Increase in 1-hr, 10-hr and 100-hr wood by 50%. Increase fine wood cover and depth also by 50%. Use minimum values above in cases of low pre-disturbance FWD.
* No change in CWD

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

* Decrease fine wood cover, depth and load in Time Step 1 by 25%.
* Move 25% sound wood to rotten wood by category (S1000hr to R1000hr, etc.)

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

* Decrease fine wood cover, depth and load in Time Step 2 by 50%.
* Move 50% sound wood to rotten wood by category (S1000hr to R1000hr, etc.)

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

* Increase in 1-hr, 10-hr and 100-hr wood by 100%. Increase fine wood cover and depth also by 100%. Use minimum values above in cases of low pre-disturbance FWD.
* No change in CWD

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

* Decrease fine wood cover, depth and load in Time Step 1 by 25%.
* Move 25% sound wood to rotten wood by category (S1000hr to R1000hr, etc.)

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

* Decrease fine wood cover, depth and load in Time Step 2 by 50%.
* Move 50% sound wood to rotten wood by category (S1000hr to R1000hr, etc.)

**Stump updates (for forested fuelbeds)**

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

211: 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).

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

* No change

213: 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)

221: 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).

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

* No change

223: 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)

231: 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).

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

* No change

233: 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)**

*No change in piles.*

**Litter-Lichen-Moss updates**

An increase in the litter layer is expected in the event of a moderate or high severity events. No changes are expected for lichen or moss layers.

*Note: I need to come up with minimum cover and depth to reach 3 and 5 tons/acre.*

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

* Increase in litter cover, depth and optional loading by 25%

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

* No change.

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

* No change.

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

* Increase in litter cover, depth and optional loading by 50%.

Minimum litter loading = 3 tons/acre. (litter loading is calculated; not sure how to implement)

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

* No change.

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

* No change.

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

* Increase in litter cover, depth and optional loading by 75%.

Minimum litter loading = 5 tons/acre. (litter loading is calculated; not sure how to implement)

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

* No change.

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

* No change.

**Ground Fuel updates**

Modest increases in duff accumulations are expected at time step 3 following moderate or high severity events, associated with increased fine wood and litter accumulations in time step 2.

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

* No change.

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

* No change.

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

* No change.

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

* No change.

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

* No change.

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

* 20% increase in upper duff cover, depth, and optional loading (if specified).

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

* No change.

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

* No change.

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

* 40% increase in upper duff cover, depth, and optional loading (if specified).

**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 as follows: low severity (no change), moderate severity (45% reduction) and high severity (75% reduction).

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

* 15% reduction in shrub cover, percent live and optional shrub loading (if specified).

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

* 20% increase in shrub cover, percent live and optional shrub loading (if specified).

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

* Restore pre-disturbance inputs.

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

* 45% reduction in shrub cover, percent live and optional shrub loading (if specified).

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

* 20% increase in shrub cover, percent live and optional shrub loading (if specified).

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

* Restore pre-disturbance inputs.

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

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

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

* 20% increase in shrub cover, percent live and optional shrub loading (if specified).

233: 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 increase in herbaceous fuels after the reduction in shrub cover as follows: low severity (no change), moderate severity (50% increase) and high severity (75% increase).

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

* 15% reduction in herb cover, percent live and loading.

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

* 20% increase in herb cover, percent live and loading.

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

* Restore pre-disturbance inputs.

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

* 45% reduction in herb cover, percent live and loading.

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

* 20% increase in herb cover, percent live and loading.

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

* Restore pre-disturbance inputs.

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

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

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

* 20% increase in herb cover, percent live and loading.

233: 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 minimal increase in fine downed wood is expected in the event of a moderate and high severity events.

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

* No change

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

* No change

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

* No change

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

* No change

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

* 20% increase in fine wood cover, depth and loadings (1, 10-hr). No change in 100-hr loadings or coarse wood. Minimums 1hr and 10hr wood (each) are 0.5 ton/acre.

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

* Return to pre-disturbance values.

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

* No change

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

* 40% increase in fine wood cover, depth and loadings (1, 10). Mininmum values for 1hr and 10hr wood (each) are 1 ton/acre.

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

* Return to pre-disturbance values. No change in 100-hr loadings or coarse wood.

**Stump updates**

No change

**Pile updates**

No change

**Litter-Lichen-Moss updates**

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

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

* No change.

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

* No change.

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

* No change.

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

* No change.

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

* 30% increase in litter cover, depth, and optional loading (if specified).

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

* No change after time step 2.

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

* No change.

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

* 50% increase in litter cover, depth, and optional loading (if specified).

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

* No change after time step 2.

**Ground Fuel updates**

Modest increases in duff accumulations are expected at time step 3 following moderate or high severity events, associated with increased litter accumulations in time step 2.

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

* No change.

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

* No change.

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

* No change.

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

* No change.

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

* No change.

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

* 20% increase in upper duff cover, depth, and optional loading (if specified).

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

* No change.

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

* No change.

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

* 40% increase in upper duff cover, depth, and optional loading (if specified).

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