**Wind Disturbance Update**

LANDFIRE supports three blowdown severity classes including low, moderate and high wind storm events. Wind disturbances only affect fuelbeds that have a tree canopy layer. For our disturbance update rules, we reviewed the Gulf Coast Hurricane Photo Series (Vihnanek et al. 2009) and older Hurricane residue series (Wade et al. 1993) to inform updates of eastern US fuelbeds and a range of published literature on western windstorm events (ADD REFS). These decision rules are to be implemented based on the EVT\_Fuels crosswalk to FCCS fuelbeds that was in place prior to the disturbance.

Although LANDFIRE often changes EVT for recently disturbed pixels, we have decided not to change species and relative cover assignments for fuelbeds. This would require specific assignments for each individual fuelbed and would make it very difficult to auto-generate fuelbeds.

LANDFIRE definitions (forest and savanna fuelbeds only)

* Low severity: < 25% of area affected
* Moderate severity: >25 to < 75% area affected
* High severity: >75% affected.

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 recovery rates due to high productivity and rapid vegetation growth:

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

|  |  |  |
| --- | --- | --- |
| **Severity** | **Time** | **Code** |
| Low Severity | 1 | 411 |
|  | 2 | 412 |
|  | 3 | 413 |
| Moderate Severity | 1 | 421 |
|  | 2 | 422 |
|  | 3 | 423 |
| High Severity | 1 | 431 |
|  | 2 | 432 |
|  | 3 | 433 |

**Vihnanek, R.E., Balog, C.S., Wright, C.S., Ottmar, R.D., Kelly, J.W. 2009.**Stereo photo series for quantifying natural fuels. Volume XII: Post-hurricane fuels in forests of the Southeast United States. Gen. Tech. Rep. PNW-GTR-803. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 53 p.

Wade et.al. 1993. **Photo Series for Estimating Post-Hurricane Residues and Fire Behavior in Southern Pine**. USDA Forest Service GTR SE-82.

**Canopy updates (for forested fuelbeds)**

411: Low Severity Time Step 1 (immediately post wind event):

* 15% of overstory and midstory trees fall. Changes include a 15% reduction in total canopy cover and 15% reduction in overstory and midstory tree cover and density.
* Height, HLC, and DBH are stand averages and are assumed to not change.
* 15% reduction in snag density for all snag classes.

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

* No additional change.

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

* No additional change.

421: Moderate Severity Time Step 1 (immediately post wind event):

* 45% of overstory and midstory trees fall. Changes include a 45% reduction in total canopy cover and 45% reduction in overstory and midstory tree cover and density.
* Height, HLC and DBH are stand averages and are assumed to not change.
* 45% reduction in snag density for all snag classes.

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

* No additional change

423: Moderate Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* No additional change

431: High Severity Time Step 1 (immediate post wind)

* 75% of overstory and midstory trees fall. Changes include a 75% reduction in total canopy cover and 75% reduction in overstory and midstory tree cover and density.
* Height, HLC and DBH are stand averages and are assumed to not change.
* 75% reduction in snag density for all snag classes.

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

* No additional change

433: High Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* No additional change

**Shrub updates (for forested fuelbeds)**

Immediately following a wind/hurricane event, we expect that damage from tree and branch fall will result in a modest decrease in live shrub biomass. More open canopy conditions would increase shrub cover in Time Step 2.

411: Low Severity Time Step 1 (immediately post wind event):

* 10% reduction in percent live and percent cover (due to tree fall)

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

* 10% increase shrub cover and percent live.
* If an optional shrub loading is specified, increase loading by 10%.

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

* No subsequent change.

421: Moderate Severity Time Step 1 (immediately post wind event):

* 30% reduction in percent live and percent cover (due to tree fall)

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

* 30% increase shrub cover and percent live.
* If an optional shrub loading is specified, increase loading by 20%.

423: Moderate Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* 30% increase in shrub cover. No subsequent change in percent live.

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

* 50% reduction in percent live and percent cover (due to tree fall)

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

* 50% increase shrub cover and percent live.
* If an optional shrub loading is specified, increase loading by 50%.

433: High Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* 50% increase in shrub cover. No subsequent change in percent live.

**Herb updates (for forested fuelbeds)**

411: Low Severity Time Step 1 (immediately post wind event):

* No initial change.

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

* 10% increase herb cover and loading. No change in height or percent live.

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

* No change from time step 2.

421: Moderate Severity Time Step 1 (immediately post wind event):

* No initial change.

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

* 20% increase herb cover and loading. No change in height or percent live.

423: Moderate Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* No change from time step 2.

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

* No initial change.

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

* 50% increase herb cover and loading. No change in height or percent live.

433: High Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* No change from time step 2.

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

Pre-disturbance, forested fuelbeds may not have much (if any) downed wood. In these cases, recommended minimums are used to estimate the surface fuels created by tree fall associated with low, moderate and high severity wind events. Percent increases in FWD and CWD are based on Woodall and Nagal (2007) from a large-scale blowdown in the Boundary Waters Canoe Area Wilderness (northern Minnesota) and Guan (2014) from multiple hurricane events in the SE US.

For forested fuelbeds with at least 40% cover, the following minimum values are recommended for moderate and high severity wind events. Minimum values loosely from Wade et al. (1993) and Vihnanek et al. (2009).

|  |  |  |  |
| --- | --- | --- | --- |
| Downed wood category | Minimum values\*  (tons/acre) | Vihnanek – Gulf Coast PS  Minimum load (tons/acre) | Wade et al. (1993)  Min load (tons/acre) |
| 1hr | 0.2 | 0.2 | 0.05 |
| 10hr | 1 | 0.7 | 1.24 |
| 100hr | 2 | 1.7 | 2.8 |
| S1000hr (3-9 inch) | 3 | 2.9 | - |
| S10,000hr (9-20 inch) | 6.5 | 6.6 | - |
| S>10,000hr (>20 inch) | 7.5 |  |  |

411: Low Severity Time Step 1 (immediately post wind event):

* 50% increase in FWD (1hr, 10hr, and 100hr)
* 25% increase in fine wood percent cover and depth
* 100% increase in 1000hr, 10k, and >10k sound wood or minimum values specified in the above table for fuelbeds with low pre-disturbance surface fuels. If fuelbeds only have small diameter trees, then some coarse wood categories may not apply (e.g., > 20 inch trees are required to create loadings in the S >10,000hr downed wood category).

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

* 25% of sound wood transitions to rotten wood.

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

* 50% of sound wood transitions to rotten wood.

421: Moderate Severity Time Step 1 (immediately post wind event):

* 100% increase in FWD (1hr, 10hr, and 100hr). 50% increase in fine wood percent cover and depth. Min depth = 1 inch, percent cover = 50% Cap percent cover to 100%
* 150% increase in 1000hr, 10k, and >10k sound wood or minimum values specified in the above table for fuelbeds with low pre-disturbance surface fuels. If fuelbeds only have small diameter trees, then some coarse wood categories may not apply (e.g., > 20 inch trees are required to create loadings in the S >10,000hr downed wood category).

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

* 25% of sound wood transitions to rotten wood.

423: Moderate Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* 50% of sound wood transitions to rotten wood.

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

* 200% increase in FWD (1hr, 10hr, and 100hr). Min woody depth = 1 inch, percent cover = 75%. Cap percent cover to 100%.
* 300% increase in 1000hr, 10k, and >10k sound wood or minimum values specified in the above table for fuelbeds with low pre-disturbance surface fuels. If fuelbeds only have small diameter trees, then some coarse wood categories may not apply (e.g., > 20 inch trees are required to create loadings in the S >10,000hr downed wood category).

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

* 25% of sound wood transitions to rotten wood.

433: High Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* 50% of sound wood transitions to rotten wood.

**Stump updates (for forested fuelbeds)**

*No changes expected for stumps.*

**Pile updates (for forested fuelbeds)**

*No changes expected for piles.*

**Litter-Lichen-Moss updates**

411: Low Severity Time Step 1 (immediately post wind event):

* 25% increase in litter depth and cover.
* If an optional LLM loading is specified, increase loading by 25%

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

* No subsequent change.

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

* Restore LLM inputs to pre-wind damage.

421: Moderate Severity Time Step 1 (immediately post wind event):

* 50% increase in litter depth and cover.
* If an optional LLM loading is specified, increase loading by 50%

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

* No subsequent change.

423: Moderate Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* 25% reduction in litter depth and cover.

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

* 100% increase in litter depth and cover.
* If an optional LLM loading is specified, increase loading by 100%

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

* No subsequent change.

433: High Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* 25% reduction in litter depth and cover.

**Ground Fuel updates**

411: Low Severity Time Step 1 (immediately post wind event):

* No immediate change.

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

* 25% increase in duff depth and cover.

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

* No subsequent change.

421: Moderate Severity Time Step 1 (immediately post wind event):

* No immediate change.

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

* 50% increase in duff depth and cover.

423: Moderate Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* No subsequent change.

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

* No immediate change.

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

* 100% increase in duff depth and cover.

433: High Severity Time Step 3 (5-10 years post wind event or 3-10 years for Hawaii and SE US)

* No subsequent change.