

JFSP Project Highlights

Research Supporting Sound Decisions

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The JFSP, a partnership of six federal wildland fire and research organizations, provides scientific information and support for fuel and fire management programs.

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FireStem – New Software for Predicting Fire-Induced Tree Mortality

FireStem is a stand-alone computer program designed to aid fire managers with predicting fire-induced tree mortality based on fire duration and intensity. The eventual goal is to link *FireStem* and *BehavePlus* to produce mortality predictions based on fuel loading, moisture, and fire behavior characteristics for a given area and range of tree species.

FireStem is based on fundamental thermodynamics and heat transfer principles that are used to predict temperature at the living tissue or cambium. It consists of accurate, physics-based models of fire-induced stem heating and cambial mortality that include the following features:

- More complete accounting of all of the energy production and absorption processes occurring when a plant stem is heated than other models to date
- Incorporates a spatially varying moisture profile in the stem
- Includes a heat flux boundary condition at the exterior surface so the model can be readily linked to fire behavior models
- The model is linked with a sophisticated tissue necrosis model to account for specific tissue response to heating and the impact of temperature and duration on tissue viability.

The combination of these elements has provided *FireStem* the ability to accurately predict mortality 75% of the time when compared against measurements. *FireStem* has been tested against experimental data collected from four tree species: Douglas-fir, Ponderosa Pine, Red Maple, and Chestnut Oak. Other species will be added as their thermo-physical properties are identified and validated.

In its current version, *FireStem* allows the user to specify the tree species of interest, diameter ranges, percent moisture at the inner bark, bark thickness, energy at the bark surface either by reading a data file or by specifying intensity (using a slider bar to indicate a unit-less quantity of low, medium or high) and duration of burning. See image.

Results are compiled for each tree species selected and can be viewed individually in tables or in graphical format. Outputs include the maximum cambial temperature reached, depth of kill and mortality by species and diameter. See image.

In the future, the user will be able to input a range of species for a given ecosystem, run *FireStem* and review the mortality prediction for a range of diameters for each species. The fire intensity used by *FireStem* will also be linked with Fireline Intensity, a measure often used with other current fire behavior models.

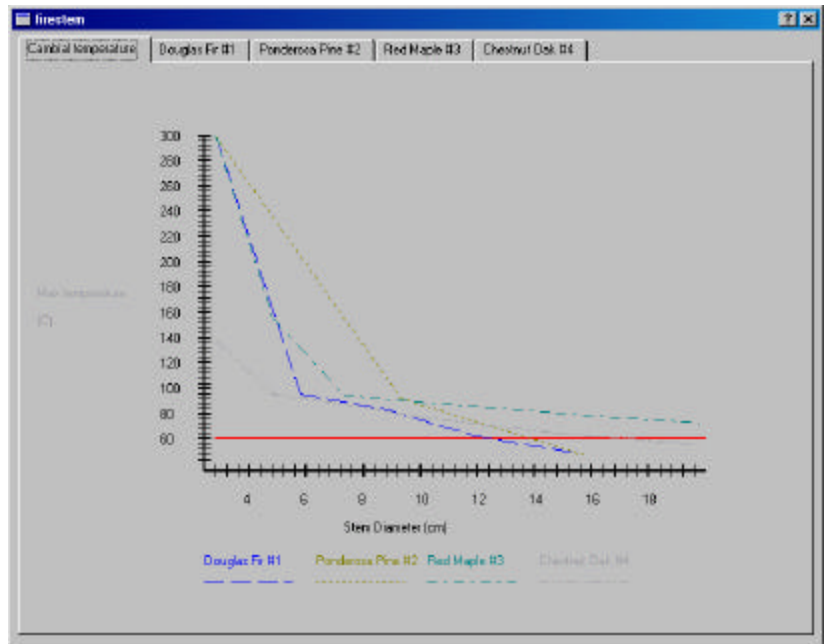
The screenshot shows the 'firestem' application window with the following parameters:

Species	Min dia (cm)	Max dia (cm)	Moisture (%)	Bark thickness:
Douglas Fir	3	25	200 (Ave.)	100% (ave.)
Ponderosa Pine	3	50	200 (Ave.)	100% (ave.)
Red Maple	3	20	200 (Ave.)	100% (ave.)
Chestnut Oak	3	20	200 (Ave.)	100% (ave.)

Additional parameters shown below the table:

- # of steps to run: 8
- Fire intensity: 15 (with a slider bar)
- Duration: (minutes) 10 (with a slider bar)
- Run model button

At this time *FireStem* only considers fire-induced heating of the tree stem; however, *FireStem* forms the foundation for a comprehensive tool that will predict tree mortality based on the combined effects of fire on the roots, stem and crowns of trees.



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You can obtain further information at: <http://www.firelab.org/fbp/fbresearch/stemheating/Homepage.htm>

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