Carbon Calculator Default Historical Fire Regime Parameterization

Introduction

A wildfire regime is defined by the frequency, severity, and spatial pattern of fires characteristic of a given area or region. In the Forest Sector Carbon Calculator the frequency, severity, and size of simulated wildfires is determined by the wildfire scheduler. These simulated wildfire regime attributes are then used by the wildfire module of LANDCARB 3.0 to determine the effect of wildfire on various carbon pools. Within a given area or region, all three of the above mentioned wildfire regime attributes are quantified as probability distributions (rather than mean or median values) to portray the variability in fire regimes inherent in any given landscape.

Fire Frequency

In the Forest Sector Carbon Calculator, fire frequency is quantified by the mean fire return interval (mFRI), which quantifies the average number of years between fires under the presumed historical fire regime. We used gridded (30m cell size) simulated mFRI data from LANDFIRE (http://www.landfire.gov/). LANDFIRE is an interagency vegetation, fire, and fuel characteristics mapping program, sponsored by the United States Department of the Interior and the United States Department of Agriculture. Gridded mFRI was extracted from LANDFIRE for the state of Oregon, and a non-forest masked was applied to remove areas without forest cover from further analysis. The probability distribution of mFRI was then calculated for each modeled ecoregion, and for each of three elevation bands (Table 1) within each modeled ecoregion (Figure 1). We did not calculate mFRI probability distributions within ownership allocations (Federal, State, Private Industrial, etc.), because small spatial extents of some ecoregion/elevation band/ownership combinations (for example Private Industrial land at high elevations in the West Cascades Ecoregion) would have resulted in unusual and unrepresentative mFRI probability distributions.

Table 1. Elevation bands for the East and West Cascades Ecoregions

Ecoregion	Elevation Bands (ft asl)		
	Low	Medium	High
East Cascades	71-2851	2851-5632	5632-8412
West Cascades	0-2954	2954-5908	5908-8862

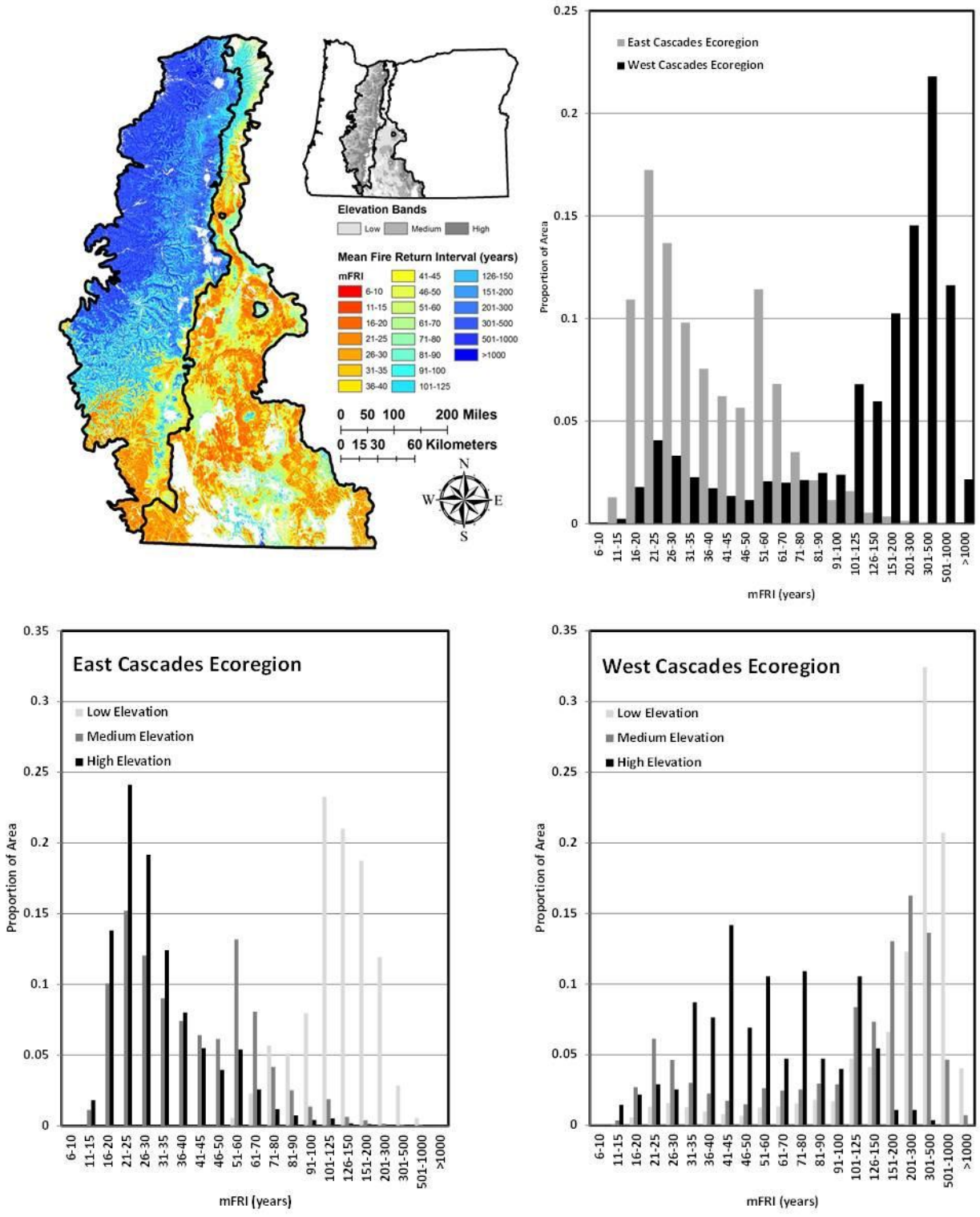

Figure 1. Map of mean fire return interval (mFRI) for Oregon's East and West Cascades Ecoregions, along with mFRI probability distributions at the ecoregion and elevation band within ecoregion levels. See Table 1 for elevation band values by ecoregion.

Fire Severity

Fire severity was defined has the percentage of overstory mortality within a typical fire perimeter given a vegetation type. Severity in LANDFIRE is grouped into three classes, low (0-25 percent mortality, moderate (25-75 percent), and high (75-100 percent). Fire severity data from LANDFIRE comes in the form of three gridded datasets representing the probability grid cells would burn in a given fire severity class, relative to the other two severity classes. The three fire severity probability grids were extracted from LANDFIRE for forested land of a given modeling ecoregion and elevation bands within ecoregion, and the mean probability of each severity class calculated (Figure 2).

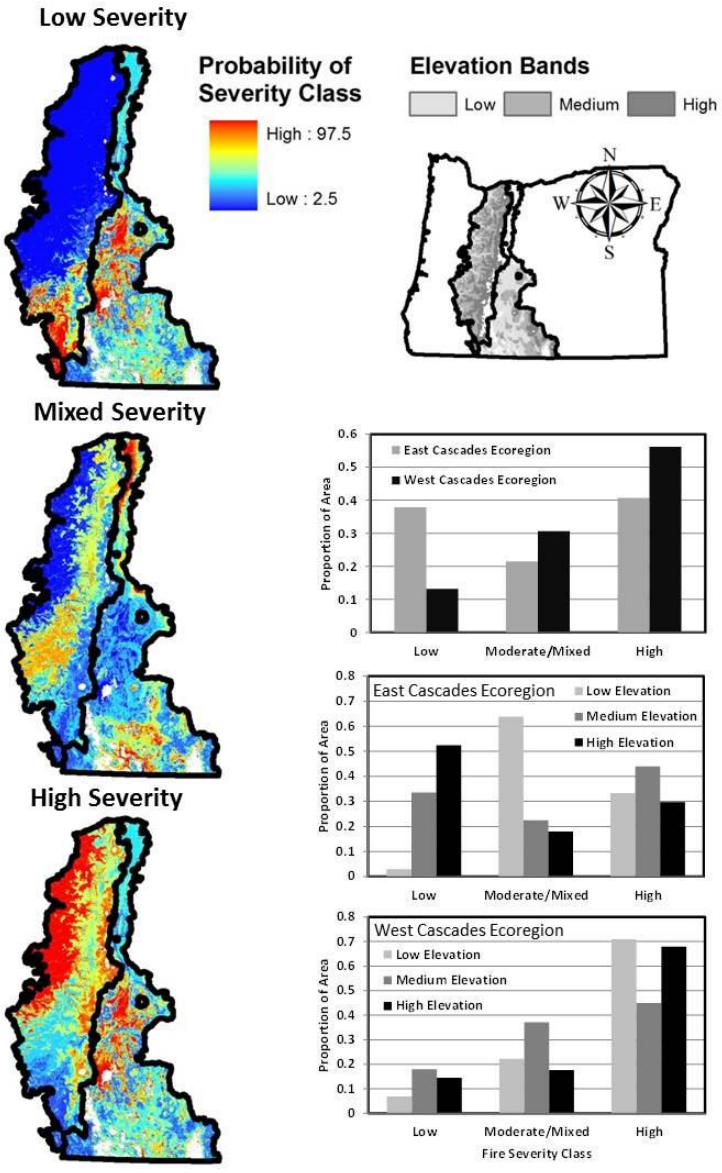

Figure 2. Fire severity probability maps for Oregon's East and West Cascades Ecoregions, and severity probability distributions at the ecoregion and elevation band within ecoregion levels. See Table 1 for elevation band values by ecoregion.

In the Forest Sector Carbon Calculator, finer gradations of fire severity (5 severity classes) were desired compared to the 3 severity classes used in LANDFIRE. The 5 severity classes used in the Forest Sector Carbon Calculator are nested with the existing 3 severity classes from LANDFIRE (Table 2). To calculate the new severity classes, we assumed uniform probability of overstory mortality throughout the range of mortality values within a LANDFIRE severity class (i.e. the probability of 1% mortality is the same as 2% mortality, 3% mortality, etc.). For example the proportion of a given area of interest in the Very Low severity class (less than 5% mortality) was calculated as 20% of the proportion of the area in the Low Severity class from LANDFIRE for that same area (Figure 3).

Table 2. Relationship between 5 fire severity classes used in the Forest Sector Carbon Calculator to the 3 fire severity classes from LANDFIRE

Forest Sector Carbon Calculator		LANDFIRE	
Severity Class	Overstory Mortality	Severity Class	Overstory Mortality
Very Low	less than 5%		
Low	5-25%	Low	0-25%
Moderate	25-75%	Moderate/Mixed	25-75%
High	75-95%	High	75-100%
Very High	greater than 95%		

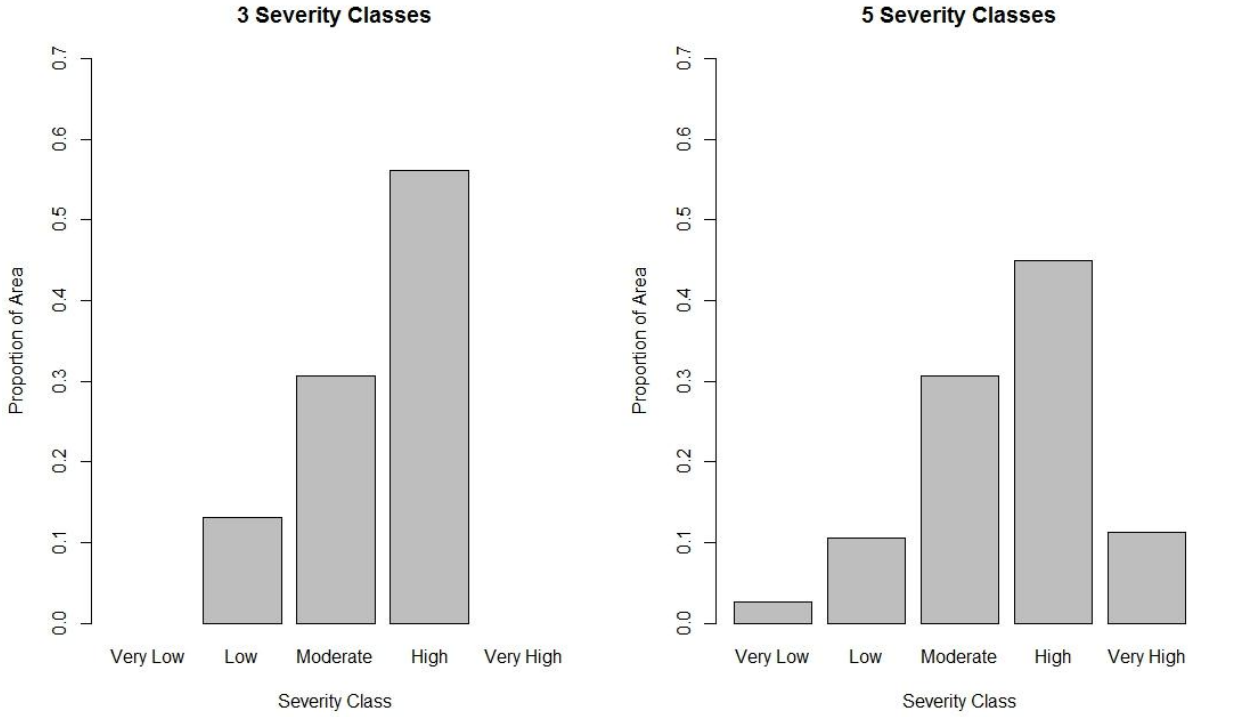

Figure 3. Comparison of overall probability distribution of the 3 severity classes from LANDFIRE to the 5 severity classes used in the Forest Sector Carbon Calculator. Example is from forested land in Oregon's West Cascade Ecoregion.

Fire Area

The third attribute of fire regime we parameterized was the distribution of fire sizes (area). We used fire area records from the 1970 – 2010 time period for three National Forests (Mount Hood NF, Willamette NF, and Umpqua NF) to represent Oregon's West Cascades Ecoregion, and three National Forests (Deschutes NF, Fremont NF, and Winema NF) to represent Oregon's East Cascades Ecoregion. Fire records were extracted from the National Interagency Fire Management Integrated Database (NIFMID) using KCFast (http://fam.nwcg.gov/fam-web/kcfast/mnmenu.htm) and FireFamilyPlus (http://www.firemodels.org/index.php/national-systems/firefamilyplus) software. From these fire records the distribution of fire sizes was calculated (Figure 4). Note that fire size distributions were calculated at only the ecoregion level. Fire size distributions were not calculated by elevation band or ownership types within ecoregions, because large fires often crossed elevation bands, while fire size information was not consistently available for all non-federal forestland ownership groups. The cumulative probability distribution of fire frequency in relation to fire area was then modeled as a reverse Weibull function for each ecoregion (Figure 5).

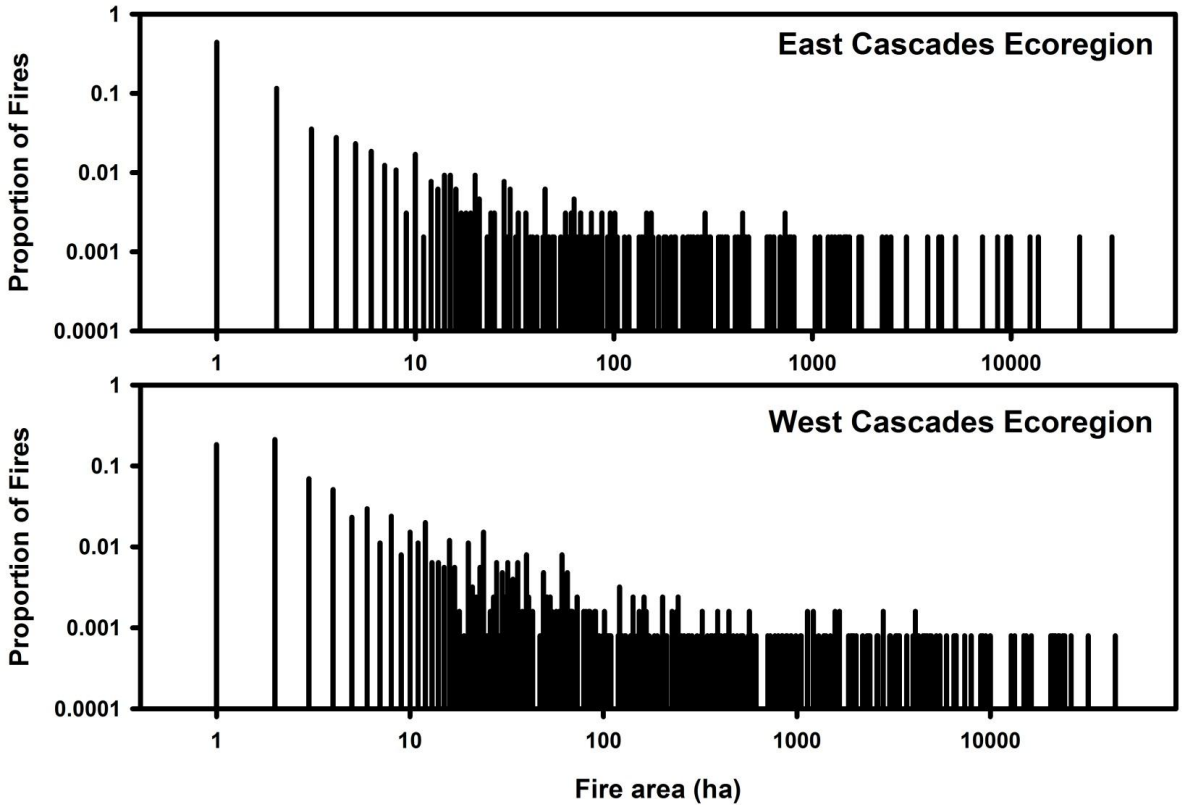

Figure 4. Probability distribution of fires in relation to fire size over the 1970 – 2010 time period for Oregon's East and West Cascades Ecoregions. Note that both fire area and proportion of fires are plotted in log scale.

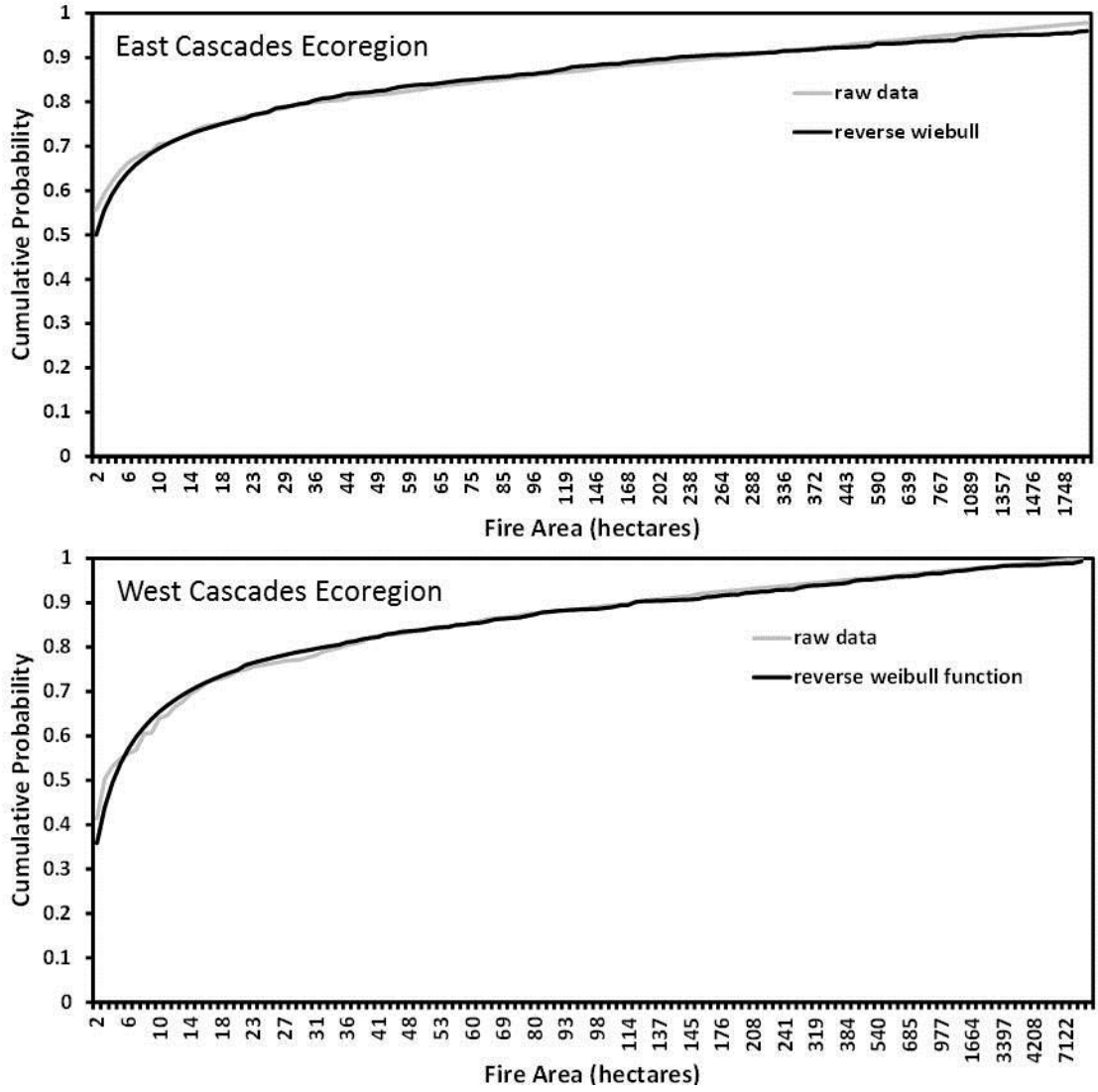

Figure 5. Cumulative probability distributions for raw fire data and reverse weibull function for recorded fires at least 1 hectare in size in Oregon's East and West Cascades Ecoregion from 1970 – 2010.

The wildfire scheduler generates wildfires consistent with the historical fire regime for an area of interest by applying a random number generator to the probability distributions of fire frequency, severity, and size (as represented by the reverse Weibull distribution) as presented above. This creates simulated fires of the desired frequency, severity and size distributions that are used by the wildfire module of LANDCARB 3.0 to determine the effect of wildfire on various carbon pools.