LANDIS-II Stress Mortality v

Extension User Guide

Doug Shinneman, US Geological Survey

Robert Scheller, Portland State University

Jian Yang, University of Nevada - Reno

Last Revised: July 25, 2011

# Table of Contents

[1 Introduction 2](#_Toc298396938)

[1.1 Version 1.0 2](#_Toc298396939)

[1.2 Extension Description 2](#_Toc298396940)

[1.2.1 Overview 2](#_Toc298396941)

[1.2.2 Drought Years 2](#_Toc298396942)

[1.2.3 Biomass Removal 2](#_Toc298396943)

[1.2.4 Establishment Modification 3](#_Toc298396944)

[1.3 References 3](#_Toc298396945)

[1.4 Acknowledgments 3](#_Toc298396946)

[2 Parameter Input File 4](#_Toc298396947)

[2.1 LandisData 4](#_Toc298396948)

[2.2 Timestep 4](#_Toc298396949)

[2.3 MinDroughtYears 4](#_Toc298396950)

[2.4 SpeciesParameters 4](#_Toc298396951)

[2.5 MapName 4](#_Toc298396952)

[2.6 LogFile 4](#_Toc298396953)

[3 Output Files 5](#_Toc298396954)

[3.1 Drought Years per Decade Maps 5](#_Toc298396955)

[3.2 Drought Generator Log 5](#_Toc298396956)

[4 Example File 6](#_Toc298396957)

# Introduction

This document describes the for use with the LANDIS-II model. This extension must be run with a Biomass Succession. For information about the model and its core concepts, see the *LANDIS‑II Conceptual Model Description.*

## Version 1.0

Version 1.0 is compatible with LANDIS-II v6.0.

## Extension Description

### Overview

This extension simulates temporally and spatially variable biomass removal and mortality due to stress. Stress conditions can be caused by many different exogenous factors (e.g., climate extremes, pervasive disease). The extension was initially developed to simulate stress due to drought, although the logic is general enough to be used for multiple purposes.

Stress years can be determined external to the LANDIS-II model by using a variety of data sources (e.g., historical climate data for drought occurrence), and stress impacts on species-age cohorts should be derived from relevant empirical studies.

The stress extension does not include any spatial processes. It determines whether stress is occurring in each ecoregion, determines the effect on individual cohorts, and modifies or kills the cohorts. Thus, stress can occur at different times and for different species in each ecoregion.

There is no stress intensity. A stress is either occurring or not occurring. If a stress occurs for an ecoregion and species, a biomass reduction is applied dependent upon age. If the cumulative stress exceeds a designated threshold within the current year plus a user defined window of time (in years), the cohort is killed.

### Time Step

The extension has a fixed annual time step. Therefore, the user does not need to indicate the time step.

### Onset of Stress

Stress can begin at any year and for any species and ecoregion. These years do not need to be consecutive nor do they need to follow the time step of any other extension, including succession. The duration of stress is similarly flexible with a minimum duration of one year.

### Partial Biomass Removal

The removal of biomass from cohorts depends on the species and age of each cohort. The fraction of biomass to be removed (e.g., a portion of the total cohort) for a species and age is determined by an input table. Dead biomass will be added to the appropriate dead biomass pools tracked by the Biomass Succession extension.

### Cumulative Stress Mortality

Complete cohort mortality can be triggered by the cumulative effects of stress over time (e.g., carbon starvation or hydraulic failure in trees during multi-year drought). To simulate this effect, a cohort may be killed if the cumulative fraction of biomass removed (above) exceeds a threshold determined by the user. The current year and a user-designated number of years (up to but not exceeding ten years) are taken into consideration when calculating cumulative stress. Stress need not be consecutive within this window of time to be cumulative, i.e., one good year will not necessarily ‘rescue’ a cohort.

## References

## Acknowledgments

This research was funded the US Geological Survey through the National Climate Change and Wildlife Science Center and the Forest and Rangeland Ecosystem Science Center.

# Parameter Input File

The input parameters for this extension are specified in one input file. This text file must comply with the general format requirements described in section 3.1 *Text Input Files* in the *LANDIS-II Model User Guide*.

## LandisData

This parameter’s value must be "Stress Mortality".

## StressOnsetTable

This table contains the year, ecoregion, and species during which stress occurs. The first column is year beginning from simulation year 1. The second column is the ecoregion name and must match one of the ecoregion names defined for the scenario. The third column is species and must match one of the species defined for the scenario.

Example:

StressOnsetTable

>>year landtype species

>> -------- -------------

2 eco1 abiebals

2 eco1 poputrem

20 eco1 abiebals

20 eco1 poputrem

## PartialMortalityTable

The partial mortality table contains a list of the species for which stress will apply. The species name is followed by a **fraction cohort removal** and the corresponding cohort ages. The fraction cohort removal must be between 0.0 and 1.0. The cohort ages are in parentheses and can be given as a range (50-75) or given a less than or greater than comparative (>150) (<25). They need not be mutually exclusive. Only the greater than (>) and less than (<) inequality comparatives are allowed within the input file (e.g., greater than or equal to, >=, will cause errors). Greater than (>) is implemented as greater than or equal to, whereas less than (<) is always less than. Ranges are treated as greater than or equal to the lower value of the range, and less than the upper value of the range.

Example:

PartialMortalityTable

>> species MortalityRate(Agegroup)

abiebals 0.37(1-50) 0.2(>50)

poputrem 0.37(1-40) 0.5(40-80) 0.63(>80)

**Note: There CANNOT be any spaces between the fraction cohort removal and the open parentheses.**

## CompleteMortalityTable

The Complete Mortality Table defines the threshold for cumulative mortality fraction and the cumulative time during which mortality accumulates that will cause mortality. If the sum of mortality fractions x 100 exceeds the threshold over the defined period of time, the cohort will die.

Example:

CompleteMortalityTable

>> species CummulativeBiomassReduction(%) to

>> trigger complete mortality and cumulative

>> time in years.

abiebals 90 3

poputrem 90 4

## MapName

**Note: This is not currently functioning.**

This file parameter is the template for the names of the stress induced biomass removal output map. The parameter value must include the variable “**timestep**” to ensure that the maps have unique names (see section 3.1.8.1 *Variables* in the *LANDIS-II Model User Guide*). The user must indicate the file extension. The user must also include sub-directory name(s) as needed.

## LogFile

The file parameter is the name of the extension’s log file. The log file contains biomass removed by species and total and the number of cohorts killed by species and total. These data are arranged by time step.

# Example File

LandisData "Stress Mortality"

StressOnsetTable

>>year landtype species

>> -------- -------------

2 eco1 abiebals

2 eco1 poputrem

20 eco1 abiebals

20 eco1 poputrem

21 eco1 poputrem

22 eco1 poputrem

23 eco1 abiebals

23 eco1 poputrem

2 eco2 poputrem

3 eco2 poputrem

4 eco2 poputrem

5 eco2 poputrem

20 eco2 poputrem

23 eco2 poputrem

PartialMortalityTable

>> species MortalityRate(Agegroup)

abiebals 0.37(1-50) 0.2(>50)

poputrem 0.37(1-40) 0.5(40-80) 0.63(>80)

CompleteMortalityTable

>> species CummulativeBiomassReduction(%) to trigger complete mortality

abiebals 90

poputrem 90

MapName stress/stress-map-{timestep}.img << Currently no maps are being produced; a placeholder

LogFile "stress-mortality-log.csv"