LANDIS-II
Forest Carbon Succession Extension
Version 3.1

User's Guide

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1. Introduction

This document describes the Forest Carbon Succession v3.1 (ForCS) extension for the LANDIS-II model. For information about the LANDIS-II model and its core concepts including succession, see the LANDIS-II Conceptual Model Description. It is compatible with v7 of the core.

The growth and reproduction generally follow the Biomass Succession (v5.7) extension and the methods outlined in Scheller and Mladenoff (2004). The ForCS calculates how cohorts reproduce, age, and die. In addition, changes in cohort biomass, dead organic matter (DOM) and soil carbon are tracked over time. The modelling of decay generally follows the methods outlined in Kurz et al. (2009).

1.1. Carbon Pools

ForCS tracks biomass in two live biomass pools and several dead organic matter (DOM) and soil pools (Table 1). Other pools are calculated each time step as needed.

The live aboveground carbon pools are divided into a woody pool, which is 90% of the aboveground biomass, and a foliage pool which is the remaining 10% of the aboveground biomass (Niklas and Enquist 2002). When material is transferred into the DOM pools (e.g., through cohort death or turnover), the Woody pool is further divided into Merchantable wood and Other woody material. The merchantable portion is calculated as:

$$\text{PropStem} = a\,(1 - b^{Age}) \qquad \text{Eq 1.}$$

The parameters A and B are specified by the user in the input file.

The carbon in roots is also calculated, as needed, from the aboveground biomass. First, the total root biomass is calculated using a user-defined root:shoot ratio that can vary depending on the total aboveground biomass. Note that “biomass” in LANDIS-II is defined as all aboveground living biomass, and is consistent with the definition of “shoot” in Moknay et al (2006). The fine roots are calculated as another user-defined proportion of the total root biomass. Coarse roots are simply calculated as the difference between the total root biomass and the fine root biomass.

Each of the DOM and soil pools (shown in Table 1) is tracked for each site, and for each species that is present, or has ever been present, on each site.

Transfers between these pools occur through decay, litterfall, death, and disturbances. Each process is described in the appropriate sections below.

Table 1. The carbon pools tracked in ForCS and available as outputs. The pool number is for reference for use in the input file

Pools and sub-pools	Pool #	Stored in memory	Description
1. Aboveground Biomass[1]		Yes	Living, aboveground biomass for each species and age-cohort on a site.
1.1. Woody[2]		Generated	90% of aboveground biomass.
1.1.1. Merchantable[3]	1	Generated	Live stemwood of merchantable size.
1.1.2. Other woody[3]	2	Generated	Live branches, stumps and small trees.
1.2. Leaves[2]	3	Generated	10% of aboveground biomass.
1.3. Fine roots[4]	5	Generated	User defined root: shoot ratio.
1.4. Coarse roots[2]	6	Generated	User defined root: shoot ratio.
2. Dead organic matter		Generated	Dead wood, litter and forest floor organic matter
2.1. Snag stem[3]	8	Yes	Dead standing stemwood of merchantable size.
2.2. Snag other wood[3]	9	Yes	Dead branches, stumps and small trees.
2.3. Medium[3]	5	Yes	Coarse woody debris on the ground. It may be on the surface or buried within the forest floor.
2.4. Aboveground very fast[3]	1	Yes	The L horizon comprised of foliar litter plus dead fine roots, approximately <5mm diameter.[5]
2.5. Aboveground fast[3]	3	Yes	Fine and small woody debris plus dead coarse roots in the forest floor, approximately ≥5 and <75mm. diameter.
2.6. Aboveground slow[3]	6	Yes	F, H and O horizons.[5]
2.7. Belowground fast[3]	4	Yes	Dead coarse roots in the mineral soil, approximately ≥5 diameter.
3. Soil		Generated	Mineral soil.
3.1. Belowground very fast[3]	2	Yes	Dead fine roots in the mineral soil, approximately <5mm diameter.
3.2. Belowground slow[3]	7	Yes	Humified organic matter in the mineral soil.
4. Undefined			
4.1. Extra pool	10	Yes	A decaying pool written into the code but with no inputs at this time.

1.2. Initializing Carbon Pools

At the beginning of a scenario, the initial communities begin with appropriate living and dead biomass values estimated for each site. However, the user does not supply the initial biomass estimates. Rather, the ForCS extension iterates the number of time steps equal to the maximum cohort age for each site. Beginning at time (t - oldest cohort age), cohorts are added at each time step corresponding to the time when the existing cohorts were established. Thus, each cohort undergoes growth and mortality for the number of years equal to its current age, and its initial biomass value reflects competition among cohorts.

[1] Scheller and Mladenoff (2004)

[2] Based on Scheller and Mladenoff (2004) and Niklas and Enquist (2002)

[3] Based on Kurz et al. (2009)

[4] Based on Moknay et al. (2006) and Yuan and Chen 2010

[5] Soil Classification Working Group (1998).

There are three methods to determine the carbon stocks for the dead organic matter and soil pools at the start of a simulation. The simplest approach is to set the spin-up soils flag in the input file to "true" which will initialize the soil pools and then seamlessly start the simulation. The second approach is to run the soil pool initialization process and transfer the values to the ForCS input file. The third approach is to provide initial values in the ForCS input file as determined by field work or another means.

During soil pool initialization, , i.e. the process that is run when the spin-up soils flag in the input file is set to "true", the model operates by growing the biomass pools to the largest age present on the site as defined in the initial communities file. At this age, the model will then assume that **all cohorts present have been killed by a high severity (severity = 4) fire, and then will regrow exactly as before. This process will repeat until the slow soil pools have stabilized, which is defined as the size of the slow soil pool at the end of one cycle is the same (to a user-specified tolerance) as the slow soil pool at the end of the next cycle.** The last cycle of the initialization procedure starts with a stand replacing fire and then simulates growth and decay dynamics until all cohorts reach the age in the initial communities file.

Note: this is a computationally intensive process that may require significant time for complex landscapes.

Note: If the initial communities file contains young stands, the initial DOM and soil pools may be underestimated by using the seamless spin-up. Thus, for young landscapes it is recommended to use one of the approaches below.

If users provide initial estimates of DOM and soil carbon (g C /m^2) for the start of the last cycle of the initialization procedure in the ForCS input file, these values should correspond to stocks when the cohort age is zero. Default values are 0 g C /m^2 which will likely result in an underestimate of initial carbon stocks. During the initialization of the biomass values, material will be added to, and decayed from the soil pools. Thus, the soil C values at year 0 will likely be different from those entered by the user. For a soil-initialization only run, set the spin-up soils flag in the input file to "true", set the scenario to 1 time step, and use an initial communities file that has the maximum age, or the usual rotation age of each species in each ecoregion. The model will then run the soil spin-up initialization that is described above. The model will output the size of the soil pools by species and ecoregion at the end of the initialization: timestep 0 in the output file. These soil pools can then be used to initialize a model run by adding them to column 5 of the EcoSppDOMParameters table.

The advantage of using a separate soil initialization run is that the initialization can take some time, depending on the number of species and ecoregions in the landscape, so only having to do it once and then using the values as input to many simulations reduce the total amount of time needed. Furthermore, since the purpose of this run is to get reasonable initial values by species and ecoregion, one can use a smaller, simpler landscape for determining the initial values than is needed to do a full simulation. However, the initial pool values will differ between using the input approach or the seamless approach for sites with more than one cohort.

This overall initialization process (both biomass and soils) does not account for disturbances that would likely happen prior to initialization and therefore overestimates initial live biomass and underestimates initial dead biomass quantities.

Note: *An initial (time zero) ANPP, maximum biomass, and climate stream are required for initialization (see below). Negative values time steps can also be used for the ANPP and maximum biomass to allow users to simulate changes in these during the initialization period, prior to the start of the model run.*

1.2.1.Snag Initialization

Many landscapes have snags that are present in the landscape that were created by disturbances. The initial communities map and file historically contains just the live cohorts. However, snags can now be included in the initial communities. The snag cohorts are identified as being dead in a separate input file. During biomass initialization, the model will grow these cohorts as live cohorts, with the other live biomass on site. At the age at which these cohorts die, however, the model will kill the cohort and transfer the carbon stocks to the DOM pools according to the rules defined by the cause of death. Sites can be initialized with both live and dead cohorts.

During biomass initialization, the model will grow all cohorts as live cohorts. However, the ForCS model (not a disturbance extension) kills the identified snag cohort at the appropriate age and time-since death. It relies on the user-defined disturbance impacts (harvest, wind, drought, bda, and other, but not fire) in the DisturbOtherTransferBiomass table and DisturbOtherTransferDOM table in the Disturbance Matrix file to determine the relevant carbon transfers. Because of this, the related disturbance extension does not need to be installed or active in the run. If there are no defined transfers, the biomass will be killed, but will not be transferred to the DOM pools. Recall that stand replacing fire is available to users as the most recent disturbance through the use of live cohorts. By identifying the time-since-death, the model initialization will apply decay processes to those snags that occurred prior to the model run.

Note: Prior to their death, these cohorts will be growing with the other live cohorts. Thus, the live biomass on the site will be less (due to competition) with these snags present than if the snags were not present.

For example, perhaps a landscape experienced a beetle outbreak 12 years ago that killed the pine, and regeneration has started. Also, there was a blow down 5 years ago that killed the oak.

The initial communities text file could look like this:

```
>>new jackpine cohort with beetle-killed cohort
MapCode  0     pinubank 1 98

>> dead oak from blow-down
MapCode  1    querelli  53
```

And the snag text file like this:

>>Species	AgeAtDeath	TimeSinceDeath	Cause
querrelli	53	5	wind
pinubank	98	12	bda

In this example, there are two pine cohorts associated with MapCode 0 sites. The one age 98 is defined in the snag file as having been dead for 12 years and being killed by a biological disturbance agent ("bda"). The age 1 pine cohort is a live cohort, since it is not defined in the snag file. The 53-year-old oak is also dead, this time killed by wind 5 years prior to the start of the model run.

Note that all pinubank 98 and querrelli 53 cohorts will be treated as dead, so use unique ages for dead vs live cohorts.

1.3. Cohort Reproduction - Shade Calculation

In order for a species to seed a site or to resprout on a site, there must be sufficient light. Sufficient light is determined by comparing the species' shade tolerance with the shade on the site.

There are six possible site shade classes ranging from zero (no shade) to 5 (highest shade). Site shade is calculated based on the ratio between the biomass present on a site and the maximum possible biomass on a site. A site will remain shade class 0 until the minimum biomass for shade class 1 is reached. The maximum possible biomass varies by ecoregion.

1.4. Cohort Reproduction – Seeding

In this form of reproduction, a species reproduces from seeds. Each species has an effective and maximum seeding distance. LANDIS-II calculates the probability of a seed landing at a site using "WardSeedDispersal", "NoDispersal" or "UniversalDispersal" algorithms. These algorithms are described in section 4.5.1 Seeding of the LANDIS-II Conceptual Model Description and the Technical Report: LANDIS-II double exponential seed dispersal algorithm.

To determine if a species that has reproduced on a site establishes itself, the species' probability of establishment (P_{EST}) is compared with a uniform random number between 0 and 1.

1.5. Cohort Reproduction – Disturbance Interactions

Every disturbance will trigger succession at each site at the time step that the disturbance(s) occur. In succession, there is a hierarchy of reproduction options following a disturbance that gives reproductive precedence to species with propagules available on site.

If planting (currently possible only through a Harvest extension) is triggered for one or more species, then no other reproduction will occur. Planting is given highest precedence as we assume that a viable cohort is generated. However, the probability of establishment must be greater than zero.

If serotiny (only possible immediately following a fire) is triggered for one or more species, then neither resprouting nor seeding will occur. Serotiny is given precedence over resprouting as it typically has a higher threshold for success than resprouting. This slightly favours serotinous species when mixed with species able to resprout following a fire.

If resprouting (which can be induced by many disturbance types) is triggered, then seeding will not occur. Finally, if neither planting, serotiny, nor resprouting occurred, seeding dispersal into a site will occur.

1.6. Cohort Growth and Ageing

Growth and ageing follow the algorithms in the Biomass Succession Extension v5.7 with the exception that input units are g /m^2/yr or g /m^2 and output units are gC /m^2/yr or gC /m^2. Cohort reproduction is the establishment of a cohort, aged 1 year and the calculation of its initial biomass.

$$B_{AGE=1\_SPP} = \text{maxANPP} \times B_{MAX\_S\_E} \times e\ (-1.6 \times B_{ACT}/B_{MAX\_ECO}) \qquad \text{Eq 2.}$$

where $B_{MAX\_S\_E}$ is the maximum aboveground biomass possible for the species in the ecoregion; $B_{MAX-ECO}$ is the maximum aboveground biomass possible for the ecoregion; B_{ACT} is the current total aboveground biomass for the site (not including other new cohorts), and maxANPP is the maximum ANPP value (by species and ecoregion) entered in the input file. Initial biomass must be ≥ 2 (g / m^2); if < 1, initial biomass is set equal to 2. The initial biomass also cannot be greater than the ANPP value used in the equation. Note: this initial cohort will be grouped ('binned') appropriately into a larger cohort (e.g., 1 – 10) at the next successional time step.

Cohort aboveground net growth is based on the principles outlined in Scheller and Mladenoff (2004). Cohort net growth takes into consideration the maximum ANPP, the age of the cohort, species, ecoregion, competition and maximum biomass possible. Cohort aboveground net growth is gross growth minus development-related mortality.

Cohort ageing is simply the addition of the time step to each existing cohort.

As a cohort nears its longevity age, there will be an increase in the loss of biomass. This is called age-related mortality, and the age at which this mortality begins to be a factor is species-specific and controlled by the user. The biomass will decline to near zero at the maximum life span. Cohorts are not randomly killed as in Age-Only Succession. If a cohort exceeds the longevity for that species, then the cohort dies.

Special Note:
While the equations for growth that are used in ForC v2.1 match those used in the Biomass Succession model v5.7, the results from the two models will not be identical even if the same input values are used. This occurs for two reasons. First, the maximum ANPP value that is entered by the user is used directly as entered in the Biomass Succession model, but in the ForCS model, the value is assumed to be the mean of a normal distribution. Even if a standard deviation of 0.01 is entered in the input file, the model may use an ANPP value that is slightly different from the mean. Second, the probability of establishment also is based in part on the use of a random number generator. The numbers generated by this can differ between the two models, leading to differences in when and where species are established.

1.7. Litterfall

ForCS captures biomass from turnover (e.g., leaf litter) and age-related mortality and adds these to the appropriate DOM pool. With the exceptions noted in the table below, the user has no control over rates of input or which DOM pool receives the biomass input.

Table 2. Paths of carbon transferred from biomass pools to DOM and soil pools.

From Biomass Pool	To DOM and Soil pools	Proportion of biomass into each DOM or soil pool
Leaves	Aboveground very fast	1.0
Fine roots	Aboveground & Belowground very fast	User input
Coarse roots	Belowground fast & Aboveground fast	User input
Merchantable	Snag stems	1.0
Other woody	Aboveground fast & Snag other	User input

Litterfall and turnover are calculated from the predicted mortality for the year and the predicted ANPP. First, the leaf turnover is calculated as:

$$LeafTurnover = actualANPP * leafFraction \qquad \text{Eq 4.}$$

Leaf fraction is a constant 35%. In young stands, the amount of biomass mortality predicted by this leaf turnover is greater than the total amount of biomass mortality predicted for the cohort, so it becomes the only input to the DOM pools. In older stands, the remaining mortality is divided between the woody and non-woody pools:

$$Mort_{nonwood} = Mort_{pred} * ((LeafTurnover * LeafLongevity) - LeafTurnover) / Bio_{cohort}) \qquad \text{Eq 5.}$$

Root turnover and mortality are calculated two different ways. Root turnover is the determined based on a user-defined proportion that is applied to the root stocks. This proportion can be different for coarse and fine roots, and can also vary based on the amount of aboveground biomass. Root turnover is calculated every year. Other root mortality is calculated only when the amount of aboveground biomass in the cohort is decreasing. The model calculates the amount by which the total roots decreased and apportions this amount between the coarse and fine roots according to the proportion of each that were present prior to the biomass decline. These amounts are then transferred to the DOM and soil pools. Note that the actual *amount* of roots is still being calculated based on the aboveground biomass.

Note that because the methods of calculating the amount of total, coarse or fine roots can vary based on the aboveground biomass, discontinuities can occur. For example, even though total biomass is decreasing, and total root biomass is decreasing, either fine roots or coarse roots may increase. If this occurs, a warning message will be written to the log file. The methods used to calculate root mortality ensure that the appropriate amount of biomass is transferred to the biomass pools.

1.8. Dead Organic Matter and Soil C Decay

When a cohort dies and is not consumed by a mortality agent (e.g., fire or harvest), its biomass carbon is added to the dead organic matter and soil pools. The proportion of biomass carbon transferred to different dead pools is partially under user control.

Decomposition for each DOM and soil pool is modelled using a temperature-dependent decay rate. The user defines base decay rates, Q_{10} parameters and mean annual temperatures (derived from monthly minimum and maximum temperatures). Once the amount of carbon to be decayed is determined, a user-defined proportion of it is released as gas and the remainder is transferred to the more stable slow pools. The belowground slow pools release all of their decayed material to the atmosphere. Decay dynamics are simulated in each year. These algorithms are described in Kurz et al. (2009).

In addition, physical transfers are simulated between DOM and soil pools. Dead trees drop branches and fall over time; carbon is moved from the forest floor into the mineral soil. These are also simulated on an annual basis. The transfer rates are under user control, but not the transfer paths.

Table 3. Paths of carbon transferred from between DOM and soil pools. All other carbon is released to the atmosphere as a gas.

From DOM Pool	To DOM and Soil pools
1 Very fast, aboveground	Slow, aboveground
2 Very fast, belowground	Slow, belowground
3 Fast, aboveground	Slow, aboveground
4 Fast, belowground	Slow, belowground
5 Medium	Slow, aboveground
6 Slow, aboveground	Slow, aboveground
7 Slow, belowground	Slow, belowground
8 Snag stem	Meduim
9 Snag other	Fast, aboveground
10 Extra	

1.9. Interactions with Disturbance Extensions

Disturbances can alter the biomass, DOM, and soil pools. They can transfer carbon (e.g., wind) and/or remove carbon from the ecosystem (e.g., combustion, harvesting).

ForCS was written to allow disturbances to affect carbon pools. Currently, a user can run ForCS with the extensions: Base Fire, Base Wind, Base Harvest, Biomass Harvest, Biological Disturbance Agents, and Dynamic Fuels and Fire.

The user must setup the disturbance extension as described in the applicable disturbance User Guide. The disturbance extension does all the work to determine when and which cohorts are killed. ForCS can capture information about the disturbances and translate this into impacts on the carbon pools. Tables in the ForCS input files allow a user to indicate: a) whether and how much non-woody or woody live biomass is transferred to their respective dead pools by a disturbance type when mortality occurs, b) whether and how much DOM is transferred to other DOM pools, and c) whether and how much of the live or dead carbon pools leave the ecosystem to the air (as a gas) or to the forest products sector.

For example, if a fire kills a cohort, we would expect that all of its leaves and some of the woody biomass to be volatilized immediately and this biomass would not enter a dead organic matter or soil pool. In addition, we would expect all of the snag branches and some of the existing Snag stem pool to be volatilized during a fire and the rest to fall down. Thus, in this case, tables in the ForCS input file would define that 100% of the foliage pool and 80% of the woody biomass would go to air. A separate table would define that 100% of snag branches and 50% of the snag stems would go to air, and the other 50% of snag branches would go to the DOM pools.

1.9.1. Special notes about specific disturbance extensions:

Base Fire and Dynamic Fire Extensions

ForCS calculates the impacts of fire based upon the Fire Severity Index set by the Fire Extensions. Note that ForCS does not recognize fire severity variables of 0. This means if you simulate low intensity surface fires or grass fires with a Fire Extension, ForCS will not capture the impacts of that fire on dead organic matter or soil C.

Note that a Fire Severity Index of 0 in the extension means different things when you are dealing with Base Fire or Dynamic Fire. In Base Fire, sites that are checked but do not have enough fuel to burn are logged with severity of 0 (R. Scheller, pers. comm.). In Dynamic Fire, if a fire burned a cell, but no cohorts died, then the severity class would be listed as 0 and the cell would be recorded as burned (used in area burned estimates, etc.) (B. Miranda, pers. comm.).

Base Harvest and Biomass Harvest

If you wish to track the carbon that is harvested, you must request in the input file (table DisturbOtherTransferBiomass) that some portion of at least one pool goes to the Forest Product Sector after harvest. This does not actually move the carbon to another part of the ForCS model; it is simply for mass-balance accounting purposes. The biomass harvested is removed from the ecosystem either way.

Base Wind

The Base Wind extension creates wind events which may or may not cause mortality. For all wind events, the ForCS extension will transfer carbon in the DOM pools according to the user-defined rules in the DisturbOtherTransferDOM table. For example, the user can define that if a wind event occurs, snags will become downed wood. If mortality occurs due to the wind event, ForCS will transfer the carbon from the live pools to the DOM according to the DisturbOtherTransferBiomass table.

Note that wind severity, unlike fire severity, is not recognized by the ForCS extension. Thus, all wind events will have the same impact on live biomass (if wind caused mortality) and DOM pools.

1.10. References

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terrestrial biomes. Global Change Biology 12:84-96.
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1.11. Changes from Version 1.0

Input Files:

1. The AgeOnlyDisturbances file is no longer required, and reference to it must be removed from the input file.
2. A new optional file containing information about snags in the inventory can be present.
3. The climate file must be updated to match the new climate model.

Operations:

1. The model now contains the option to include snags as cohorts in the initial communities.
2. The soil spin-up has been slightly modified so that the last cycle of the spin-up will always occur. Thus, slight differences in the initial soil values will be found between this version and earlier versions of the extension.
3. The soil spin-up can now be done seamlessly at the start of a simulation.
4. Memory requirements have been greatly reduced.

Output Files:

1. The flux output file has been split into three different output files to reduce file sizes.
2. The initial conditions are printed to the biomass and pools output files.
3. The site column has been removed from all output files.
4. There are minor changes to the columns printed to the summary output file.

1.12. Changes from Version 2.0

Input Files:

1. This version uses a new climate input file that is specific to ForCS. It contains only mean annual temperature by ecoregion and year (see Section 2.3)

Operations:

1. There are no new operations in this version.

1.13. Changes from Version 2.1

Version 2.2 of the code has been updated to run with v7 of the core.

A number of unplanned changes to the growth code were found had crept into the release version. These have been reversed. Therefore carbon stock and sequestration rate values will be lower than 2.0 and very similar to version 1.0 (Schelley and Mladenoff 2004 equations).

1.14. Changes from Version 2.2

Input Files:

1. There is one extra column at the end of the SpeciesParameter table: the GrowthShapeParameter, with a value between 0 and 1.

Operations:

2. The biomass growth operations have been changed so that they match the Biomass Succession.version 5.7 model.

1.15. Changes from Version 3.0

Input Files:

1. The definitions for disturbance transfers have been moved to a new file.
2. The transfer definitions can now recognize different harvest prescriptions.

Operations:

3. This version now works with the Biomass Harvest extension.

1.16. Acknowledgments

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2. Succession Input File

Nearly all the input parameters for this extension are specified in one main 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.

2.1. Header

LandisData	This parameter's value must be "ForC Succession".
Timestep	This parameter is the timestep of the extension. Value: 1. Units: years.

2.2. SeedingAlgorithm

This parameter is the seeding algorithm to be used. Valid values are "WardSeedDispersal", "NoDispersal" or "UniversalDispersal". The algorithms are described in Section 4.5.1 Seeding of the LANDIS-II Conceptual Model Description and the Technical Report: LANDIS-II double exponential seed dispersal algorithm.

2.3. ClimateFile

The next row must contain the words "ForCSClimateFile" and then the name of a file with climate information. Note that ForCS only uses this information to calculate mean annual temperature (MAT) and uses its own format .

The climate input file contains the MAT for each ecoregion for one or more years.

A sample climate input file is provided below.

2.4. Initialization Communities Files

The next two rows contain the information about the initial communities. The first row is the information about what is in the communities, while the second row is the map of the initial communities.

Row 1 must start with the words "InitialCommunities", followed by the name of the text file with the community information.
Row 2 must start with the words "InitialCommunitiesMap", followed by the name of the initial communities map (e.g., .gis) file.

2.5. Disturbance Matrix Files

This is a new row in version 3.1. The row must contain the words "DisturbanceMatrixFile", followed by the name of the text file that contains the four disturbance matrices.

The disturbance matrix file, and a sample, are both provided below.

2.6. Snag Initialization File

This is a new row, and is **optional**. The model will run whether or not it is present. The information is on one row that must start with the words "SnagFile" and then have the name of the file with the initial snag information.

A sample snag initialization file is provided below.

2.7. Output Tables

The output tables contain the information about how frequently the four different output files should be printed. All files give results by cell, and three also give the results by species and/or cohort. If a complex landscape is used, these files can become quite large. All output is printed at the end of the timestep (annual). Thus, pools at t1 + fluxes at t2 = pools at t2.

First Row – ForCSOutput

Col 1: Interval for the biomass output table (years)

Col 2: Interval for the DOM pools table (years)

Col 3: Interval for the Flux tables (years)

Col 4: Interval for the Summary output table (years)

2.8. Soil Spin-up Controls

This table contains the information about whether to do the initial soil spin-up phase. It also sets the stopping rules.

First Row – SoilSpinUp

Col 1: On/Off Flag. 0 (or a negative number) = off (do not do the spin up), 1 (or a positive number) = on

Col 2: Tolerance. (Percentage > 0 and <=100).
This is the amount by which the slow soil pools can vary from one year to another. Smaller values mean that there is little change between the pool sizes.

Col 3: Maximum number of iterations. (Integer > 0)
This value tells the model the maximum number of rotations to use for calculating the soil values. It will only be used if, for some reason, the change in soil values from one rotation to the next continues to be larger than the percentage set in Col 2. This is a necessary value so that the model can stop, even without convergence.

2.9. AvailableLightBiomass Table

This table contains the minimum relative biomass for shade classes 1 - 5.

The first row in the table is a list of all the active ecoregions defined in the ecoregions input file (see Chapter 6 in the LANDIS-II Model User's Guide). The ecoregions can appear in any order; they do not need to appear in the same order as in the ecoregions input file.

First Row – Ecoregions

The remaining rows give the shade class and the minimum biomass percentage for each ecoregion.

Col 1: Shade Class
This column contains shade class values: 1 ≤ integer ≤ 5. The shade classes must be in increasing order: class 1 first and ending with class 5. Shade class 5 represents the most shade. A site will be shade class 0 (no shade) until the minimum relative biomass for shade class 1 is reached.

Col 2: Minimum Biomass Percentage per Ecoregion

Each ecoregion listed in the table's first row must have a separate column of minimum biomass by shade class. The percentages represent the lower threshold of biomass on a site relative to the ecoregion's maximum possible biomass (for any species) for the site to enter the shade class indicated in column 1. Sites with less than the lowest threshold value will be assigned to shade class 0 (full sunlight).
Value: 0.0 ≤ decimal number ≤ 100.0. Units: percent.

2.10. LightEstablishmentTable

This table allows a more nuanced site-scale P_{EST} dependent upon species light requirements (i.e., shade class) and available light. For example, if a species is mid-tolerant of low light (light requirement = 3) and the available light class is 5 (very low light), the probability may be low but not zero. If the user indicates a low probability, then there would still some small chance that a mid-tolerant can become established as may be the case in small gaps.

Col 1: Species Shade Tolerance Class
This column contains shade class values. The shade classes must be in increasing order: class 1 first and ending with class 5. Shade class 5 represents the most shade tolerant.
Valid values: integers from 1-5.

Cols 2-7: Probability of Establishment, given light conditions
The probability of establishment for each possible site-level light condition (0 – 5) and degree of shade tolerance.
Value: 0.0 ≤ decimal number ≤ 1.0.

2.11. SpeciesParameters

This table contains species' biomass parameters. Each row in the table has the parameters for one species. Every active species must have an entry.

Col 1: Species: The species must be defined in the species input file (see Chapter 5 in the LANDIS-II Model User Guide). Species may appear in any order.

Col 2: Leaf Longevity This parameter is the average longevity of a leaf or needle.
Value: 1.0 ≤ decimal number ≤ 10.0. Units: years.

Col 3: Mortality Curve Shape Parameter
This parameter determines how quickly age-related mortality begins. Value: 0.0 ≤ decimal number ≤ 50.0. If the parameter = 5, then age-related mortality will begin at 10% of life span. If the parameter = 15, then age-related mortality will begin at 70% of life span. Note that if the value is 0, mortality will be 100% for all ages.

Col 4: Minimum age for merchantable stems
When the age of the cohort is greater than the minimum age, an equation (see below) is used to determine the proportion of the biomass "woody" pool that is merchantable and therefore should go to the snag stem pool when killed or to the forest products sector if harvested. The remainder goes to the snag other pool or the above ground fast pool (see col. 8).

Cols 5-6: Merchantability curve shape parameters a and b
These columns define the parameters used to determine proportion of the biomass Woody pool that is merchantable, where x is the age and PropStem is the

proportion which varies between 0 and 1.
PropStem = a * $(1 - b^x)$

Col 7: Non-merchantable biomass to soil
This column gives the proportion of the non-merchantable biomass (as determined from the parameters in cols 5-7) that when it is killed that goes into the Aboveground fast pool rather than the Snag other pool.
Valid values: $0.0 \leq$ decimal number ≤ 1.0

2.12. AgeOnlyDisturbances table

This table is no longer present and must be removed from any previously existing input files.

2.13. DOMPools table

This is the first of three sets of parameters controlling decay rates and spin-up of DOM and soil. Note that all DOM and soil processing is handled in units of carbon: g C/m^2/yr.

Col 1: ID row headings. These are the pool IDs used internally by ForCS. They must be numbered 1-10 and cannot be altered by users. They are in this table for reference for other tables.

Col 2: Name of each of the DOM and soil pool. These too are fixed and are there for reference purposes.

Col 3: Proportion of the decayed material that goes to the atmosphere. Valid values: $0.0 \leq$ decimal number ≤ 1.0.

2.14. EcoSppDOMParameters

The base decay rate (before using the Q_{10}), initial stocks, and Q_{10} for all combinations of ecoregion, species and DOM and soil pool. Typically, decay rates are not known to vary among local ecoregions or species so the same values can be used.

Col 1: Ecoregions. This must be an ecoregion name as defined in the ecoregions input file.

Col 2: Species. This must be a species name as defined in the species input file.

Col 3: DOM or soil Pool. This must be a value from 1 to 10, and refers to the pools given above.

Col 4: Decay Rate for the given ecoregion, species, and pool. Valid values: $0.0 \leq$ decimal number ≤ 1.0. Note that a value of 0 will issue a warning message as no decay will occur.

Col 5: Initial DOM & soil pool values to start the spin-up procedure. They should correspond to a cohort age 0. Units: g C/m^2/yr. Default value 0 (not recommended unless using ForCS for initialization).

Col 6: Q_{10} A temperature coefficient measuring the rate of change of decay as a consequence of increasing the temperature by 10 °C. Valid values: $1.0 \leq$ decimal number ≤ 5.0

2.15. ForCS Proportions

This table gives the proportion of physical turnover transferred from a biomass pool to a specific DOM or soil pool, or between certain DOM or soil pools. Users can change the proportions, but not where material is transferred from or to. Numbers in brackets are the DOM or soil pool numbers. Unless otherwise specified, the proportion of the material that is not specified here will remain in its pool. Valid values: 0.0 ≤ decimal number ≤ 1.0.

Col 1:	Fine Roots to Very Fast Aboveground (1): The proportion of fine roots going to the above ground very fast pool. The remainder goes to the below ground very fast pool (2).
Col 2:	Coarse Roots to Fast Aboveground (3): The proportion of coarse roots going to the above ground fast pool. The remainder goes to the below ground fast pool (4).
Col 3:	Slow Aboveground (6) to Slow Belowground (7): Annual proportion of carbon transferred between these two pools.
Col 4:	Snag Stem (8) to Medium (5): Annual proportion of carbon stock transferred between the snag stem pool and the medium pool. This could represent a process such as snag stems falling or breaking.
Col 5:	Snag Other (9) to Fast Aboveground (3): Annual proportion of carbon stock transferred between these two pools. This represents a process such as the dead branches falling from snags.

2.16. ANPPTimeSeries

The ANPP data is provided by species and ecoregion for year 0 and any other years. For each period, ANPP also has a standard deviation, allowing for variation within that time period. The model will use the standard deviation to pick a random number produced by a random number generator that assumes a normal distribution. ANPP can also be provided for years prior to year 0 using negative values for the year. These values will be used for the initialization phase.

The ANPP and standard deviation in the file will be used from the given year until a new set of values are provided. If no other years are provided, year 0 ANPP values are used. For example, if ANPP is provided in year 0, 5 and 10, then the year 0 ANPP values are used for the spin-up and for years 1-4; year 5 ANPP and standard deviation are applied for years 5-9. This model behaviour includes negative years, so it is important to ensure that if using a different ANPP value for the initialization phase, the negative value is set to account for all initialization years. For example, if the oldest cohort in the landscape is 150, then setting the first year in the ANPP file at -150 will ensure that the appropriate ANPP values are used. If instead, the first year is -20, then the model will use year 0 values for the first 110 years of initialization, and the year -20 ANPP values only for the last 20 years.

Col 1: Year	This is the first year for the period of time during which the model will apply the ANPP values. Year 0 must always be present. All other years, positive or negative, are optional. Valid values: integer numbers.
Col 2: Ecoregion	This must correspond to an ecoregion name in the ecoregions file.
Col 3: Species	This must correspond to a species name defined in the species input file.
Col 4: ANPP	This parameter is the maximum possible aboveground net primary productivity (ANPP) for the species in the ecoregion during the time period. This parameter is independent of age and competition. Units: g/m2/yr. Valid values: decimal numbers.

Col 5: ANPP standard deviation. Valid values: decimal numbers.

2.17. MaxBiomassTimeSeries

This table is almost identical in formation to the ANPP table, except that it is does not have a standard deviation column. Like the ANPP table, maximum biomass data is provided by species and ecoregion for year 0 and any other years. The maximum biomass in the file will be used from the given year until a new set of values are provided.
Maximum biomass can also be provided for years prior to year 0 using negative values for the year. These values will be used for the initialization phase.
See the note above for ANPP for how the different year values are used.

Col 1: Year	This is the first year for the period of time during which the model will apply the maximum biomass values. Year 0 must always be present. All other years are optional. Valid values: integer numbers.
Col 2: Ecoregion	This must correspond to an ecoregion name in the ecoregions file.
Col 3: Species	This must correspond to a species name defined in the species input file.
Col 4: Max Biomass	This parameter is the maximum possible maximum biomass for the species in the ecoregion during the time period. Units: g/m^2. Valid values: decimal numbers.

2.18. EstablishmentProbabilities Table

The establishment probability parameter controls regeneration likelihood for different species and regions in different years. Values must be present and greater than 0 for a species to occur on a site (other than the cohorts defined initially). Like the ANPP and maximum biomass tables, establishment probabilities must be provided by species and ecoregion for year 0 and any other years. The establishment probability in the file will be used from the given year until a new set of values are provided.

Establishment probabilities can also be provided for years prior to year 0 using negative values for the year. These values will be used for the initialization phase.
See the note above for ANPP for how the different year values are used.

Col 1: Year	This is the first year for the period of time during which the model will apply the establishment probabilities. Year 0 must always be present. All other years are optional.
Col 2: Ecoregion	This must correspond to an ecoregion name in the ecoregions file.
Col 3: Species	This must correspond to a species name defined in the species input file.
Col 4: Probability	The probability that a species establishes in the ecoregion in one year. Value: $0.0 < \text{decimal number} \leq 1.0$.

2.19. RootDynamics Table

The root dynamics table contains the parameters that are used to define the amount of roots and their annual turnover for different species and region combinations. Note that fine roots are defined as less than or equal to 5 mm diameter. All other roots are coarse roots.
Values may be entered that apply to different ranges of aboveground minimum biomass. The model requires that at least one set of parameters that applies to a minimum aboveground biomass of 0 is entered for each ecoregion-species combination. Also, it assumes that the values are entered in ascending order of minimum biomass. For example, values that apply to a minimum biomass of 0 must be entered before those that apply starting at minimum biomass of 3000, which must be entered before those that apply to a minimum biomass of 6000. The model

does not check that this order occurred.

Col 1: Ecoregion This must correspond to an ecoregion in the ecoregions file.
Col 2: Species This must correspond to a species in the species input file.
Col 3: MinABio: The minimum amount of aboveground biomass for which the defined parameters apply. Units: g/m^2 Value: ≥ 0.0
Col 4: Ratio The proportion of aboveground biomass that is used to estimate total root biomass. Value: $0 <$ decimal number ≤ 1.0
Col 5: Prop Fine Roots: The proportion of root biomass that are fine roots. All other roots will be coarse roots. Value: $0 <$ decimal number ≤ 1.0
Col 6: Fine Root turnover The proportion of fine root biomass which dies annually and will be added to the DOM
Col 7: Coarse Root turnover The proportion of coarse root biomass which dies annually and will be added to the DOM

3. Sample Main Input File

```
LandisData  "ForC Succession"

Timestep  1

SeedingAlgorithm  WardSeedDispersal

ForCSClimateFile        "ForCSClimateInput.txt"
InitialCommunities      "./initial-communities.txt"
InitialCommunitiesMap   "./initial-communities.gis"
DisturbanceMatrixFile   "ForCS_DM.txt"

SnagFile      "Snags_Initial.txt"


ForCSOutput
>> Output interval
>>  Biomass    DOM_Pools   Fluxes         Summary
>>  ---------------------------------------------------------------
     1          1                   1           1

SoilSpinUp
>> On/Off  Tolerance    Max
>>  Flag         %          Iterations
>>  ---------------------------------------------------------------
     1          1.0          20

AvailableLightBiomass
>>Shade
>>Class       Ecoregions
>> ---------------------------------------------
              eco1       eco2
   1          30%        30%
   2          35%        35%
   3          55%        55%
   4          80%        80%
   5          100%       100%

LightEstablishmentTable
```

```
>> Spp Shade          Probability
>> Class              by Actual Shade
>> ----------------------------------------------------------------------------------
>>          0        1        2        3        4        5
   1        1        0.5      0.0      0.0      0.0      0.0
   2        0.5      1        0.5      0.0      0.0      0.0
   3        0.2      0.2      1        0.5      0.0      0.0
   4        0.1      0.1      0.2      1        0.5      0.5
   5        0.1      0.5      0.2      0.2      1        1


SpeciesParameters
>> Species  Leaf   Mortal   Merchantable   Merch.       Merch.           Prop.          Growth
>>          Long   Shape    Stems          Curve Shape  Curve Shape      Non-merch.     Shape
>>                 Param    Min Age        Param a      Param b          to FastAG      Parm
>> -------------------------------------------------------------------------------- --------------------------------------------
  pinubank  3.0    10       10             0.7546       0.983            0.25           0.25
  querelli  1.0    10       30             0.7546       0.983            0.25           0.25


DOMPools
>>  ID     Name                        Proportion to
>>                                     Atmosphere
>>  -----------------------------------------------------------
   1     "Very Fast Aboveground"         0.815
   2     "Very Fast Belowground"         0.83
   3     "Fast Aboveground"              0.83
   4     "Fast Belowground"              0.83
   5     "Medium"                        0.83
   6     "Slow Aboveground"              1
   7     "Slow Belowground"              1
   8     "Stem Snag"                     0.83
   9     "Other Snag"                    0.83
   10     "Extra pool"                   0.83

EcoSppDOMParameters
>> Decay parameters. Example values can be seen in Table 4 in Kurz et al 2009 Ecol. Mod.
>> Max applied decay rate = 1    Min applied decay rate = 0
>> Warning if calculated applied decay rate is neg and set to 0 or >1 and set to 1.
>>
>> Ecoregion  Spp      DOM      Decay    Amount     Q10 Ref
>>                     Pool     Rate     at T0      Temp 10C
>>  ----------------------------------------------------------------------------
   eco1     pinubank 1        0.355      53.04     2.65
   eco1     pinubank 2        0.5        295.4     2
   eco1     pinubank 3        0.1435     1395.49   2
   eco1     pinubank 4        0.0374     1360.62   2
   eco1     pinubank 5        0.015      863.88    2
   eco1     pinubank 6        0.0033     1656.13   2.65
   eco1     pinubank 7        0.0187     8451.22   2
   eco1     pinubank 8        0.07175    7466.54   2
   eco1     pinubank 9        0.07       2036.14   2
   eco1     pinubank 10       0          0         2
   eco2     pinubank 1        0.355      53.04     2.65
   eco2     pinubank 2        0.5        295.4     2
   eco2     pinubank 3        0.1435     1395.49   2
   eco2     pinubank 4        0.0374     1360.62   2
   eco2     pinubank 5        0.015      863.88    2
   eco2     pinubank 6        0.0033     1656.13   2.65
   eco2     pinubank 7        0.0187     8451.22   2
```

eco2	pinubank	8	0.07175	7466.54	2
eco2	pinubank	9	0.07	2036.14	2
eco2	pinubank	10	0	0	2
eco1	querelli	1	0.355	53.04	2.65
eco1	querelli	2	0.5	295.4	2
eco1	querelli	3	0.1435	1395.49	2
eco1	querelli	4	0.0374	1360.62	2
eco1	querelli	5	0.015	863.88	2
eco1	querelli	6	0.0033	1656.13	2.65
eco1	querelli	7	0.0187	8451.22	2
eco1	querelli	8	0.07175	7466.54	2
eco1	querelli	9	0.07	2036.14	2
eco1	querelli	10	0	0	2
eco2	querelli	1	0.355	53.04	2.65
eco2	querelli	2	0.5	295.4	2
eco2	querelli	3	0.1435	1395.49	2
eco2	querelli	4	0.0374	1360.62	2
eco2	querelli	5	0.015	863.88	2
eco2	querelli	6	0.0033	1656.13	2.65
eco2	querelli	7	0.0187	8451.22	2
eco2	querelli	8	0.07175	7466.54	2
eco2	querelli	9	0.07	2036.14	2
eco2	querelli	10	0	0	2

ForCSProportions
>> Proportion of physical turnover transferred from a biomass pool to a specific DOM pool.
>> Proportions are to be specified as a value between [0, 1].
>>
>> Biomass Fine Roots: The proportion of fine roots going to the above ground very fast pool (i.e. DOMPoolID = 1, "Very Fast Aboveground") where the remainder going to the below ground very fast pool (i.e. DOMPoolID = 2, "Very Fast Belowground").
>>
>> Biomass Coarse Roots: The proportion of coarse roots going to the above ground fast pool (i.e. DOMPoolID = 3, "Fast Aboveground") where the remainder going to the below ground fast pool (i.e. DOMPoolID = 4, "Fast Belowground").
>>
>> Biomass default values correspond to Table 3 in Kurz et al 2009 Ecol. Mod., where 100% of the foliage goes to the very fast above ground pool.
>>
>> Annual SlowAG (6) to SlowBG (7): Annual Proportion of C transferred between these two pools.
>>
>> Annual StemSnag (8) to Medium (5): Annual Proportion of C transferred between these two pools.
>>
>> Annual BranchSnag (9) to FastAG (3): Annual Proportion of C transferred between these two pools.
>>
>> Example values correspond to Table 4 in Kurz et al 2009 Ecol. Mod.
>>
>> Biomass Biomass Annual Annual Annual
>> Fine Coarse SlowAG to StemSnag to BranchSnag
>> SlowBG Medium to FastAG
>> --

0.5	0.5	0.006	0.032	0.1

ANPPTimeSeries
>> Aboveground, annual net primary production
>> Yr Ecoregion Spp ANPP ANPP-Std
>> (g/m2/yr)
>> ---

0	eco1	pinubank	648	0

0	eco1	querelli	1415	0
0	eco2	pinubank	648	0
0	eco2	querelli	1415	0

MaxBiomassTimeSeries

>> Yr	Ecoregion	Spp	Max Biomass (g/m2)
0	eco1	pinubank	15000
0	eco1	querelli	25000
0	eco2	pinubank	15000
0	eco2	querelli	25000

EstablishProbabilities

>> Yr	Ecoregion	Spp	Probability
0	eco1	pinubank	0.1
0	eco1	querelli	0.1
0	eco2	pinubank	0.1
0	eco2	querelli	0.1

RootDynamics

>> MinABio value must be in acending order

>> Ecoregion	Species	MinABio (g/m2)	Root: Abio	PropFineRt	Frturnover	Crturnover
eco1	pinubank	0	0.403	0.18	0.6	0.02
eco1	pinubank	5000	0.292	0.1	0.6	0.02
eco1	querelli	0	0.403	0.18	1	0.02
eco2	pinubank	0	0.433	0.18	0.6	0.02
eco2	querelli	0	0.403	0.18	1	0.02
eco2	querelli	5000	0.292	0.1	0.6	0.02

4. Disturbance Matrix File

The Disturbance Matrix file contains all the information that ForCS needs to know to move C between pools after a disturbance. There are separate tables for the transfer of C from DOM pools and the transfer of C from biomass pools. As well, transfers related to Fire are in different tables from those related to other disturbances, because fire transfers are related to the severity of the fire.

New to version 3.1 is the ability to have transfers after harvest be specific to the harvest regime name defined in the harvest module input file, in either the Base Harvest or Biomass Harvest disturbance modules.

4.1. DisturbFireTransferDOM

This is the first of two tables that define how material is transferred out of different DOM or soil pools after a disturbance. This table is only for the transfers after fire. We allow only certain transfers at this point. Users may affect the amount that is transferred, but cannot create a new path. The allowable transfers are from any pool to the air (i.e., as a gas), from snags to the ground (to DOM), and from snags and merchantable wood to the Forest Product Sector.

Note that the table must be present (even if it contains no values) even if the fire extension is not being used.

Col 1: Intensity or fire severity (1-5) from the Fire Extension.
Col 2: From DOM or soil pool, Valid values: $1 \leq$ integer number ≤ 9.
Col 3: To Air. This is the proportion of the DOM or soil pool C stocks that is consumed by the fire and released to the air. Valid values: $0.0 \leq$ decimal number ≤ 1.0.
Col 4: To DOM. This is the proportion of the DOM pool C stocks that should be transferred to other DOM and soil pools. The only pathways that are operational are to go from the snag pools (8 and 9) to the ground. Thus, values in this column for any other DOM pool will have no impact. Valid values: $0.0 \leq$ decimal number ≤ 1.0.
Col 5: To FPS: This the proportion of the DOM pool C stocks that should be transferred to the forest product sector. Since this table is for fire, this value should be 0 in most cases. Non-zero values will result in a warning in the Landis log file. A potentially valid use of this column, however, is if there is a salvage harvest following a fire, and that this salvage would include the harvest of pre-existing snags. Salvage harvesting of trees by the simulated fire is handled in the DisturbFireTransferBiomass table.

Note that if the proportions in cols 3-5 do not add to one, then some of the DOM pool will not be moved to another pool and will remain in the existing pool. This is not a problem from a complete account perspective.

4.2. DisturbOtherTransferDOM

This is the second of two tables that define how material is transferred out of different DOM or soil pools after a disturbance. This table is only for disturbances other than fire. We allow only certain transfers at this point. Users may affect the amount that is transferred, but cannot create a new path. The allowable transfers are from any pool to the air (i.e., as a gas), from snags to the ground (to DOM), and from snags and large wood to the Forest Product Sector (e.g., salvage logging).

Note that the table must be present (even if it contains no values) even if no disturbance extensions are being used. Also note that the disturbance transfers listed in this table also apply to the transfers that occur during the creation of snags during initialization. Thus, three extra valid disturbance types ("drought", "defol" and "other") can be used even though there's no link to a disturbance extension.

When using partial harvesting, the Biomass Harvest extension only affects the live trees and not the snags. If a proportion of snags should also be harvested or knocked to the ground be sure to add the effect in this table.

Col 1: Disturbance type. This must be lowercase disturbance names. Valid entries are: "wind", "bda", "drought", "defol" , "other" or the harvest regime name defined in the harvest module input file.
Col 2: From DOM or soil pool, numbered 1-10.

Col 3: To Air. This is the proportion of the DOM and soil pool C stocks that is consumed by the disturbance and released to the air. Valid values: 1 ≤ integer number ≤ 9.

Col 4: To DOM. This is the proportion of the DOM pool C stocks that should be transferred to other DOM pools. The only pathways that are operational are to go from the snag pools (8 and 9) to the ground. Thus, values in this column for any other DOM pool will have no impact. Valid values: 0.0 ≤ decimal number ≤ 1.0.

Col 5: To FPS: This the proportion of the DOM pool C stocks that should be transferred to the forest product sector. A warning will be issued if the user tries to send a belowground DOM or soil pool to the forest product sector. Valid values: 0.0 ≤ decimal number ≤ 1.0.

Note that if the proportions in cols 3-5 do not add to one, then some of the DOM pool will not be moved to another pool and will remain in the existing pool. This is not a problem from a complete account perspective.

4.3. DisturbFireTransferBiomass

This is the first table from a set of two tables that define how material is transferred out of different biomass pools after a disturbance. This table is only for the transfers after a fire. The allowable transfers are from any pool to the air (i.e., as a gas after combusting in the fire), to the dead carbon pools, and to the Forest Product Sector (unlikely from fire).

Note that the table must be present even if it contains no values and even if the fire extension is not being used. *Note that these transfers are also used during soil initialization, so even if the fire extension is not being used, if the model is being run to initialize the soils, the values for transfers from a severe fire must be present.*

Values should be entered for every combination of fire intensity and biomass pool, and these values should add up to 1. If a row is missing, or if the values on a row sum to less than 1, then the carbon that was in the biomass that was killed will not be accounted for.

Col 1: Fire Intensity Valid values: 1 ≤ integer number ≤5, from the Fire Extension

Col 2: Biomass Pools. Indices to be used when referring to biomass pools are (note that 4 is not a valid value):

1. Merchantable part of the woody pool
2. Foliage
3. Non-merchantable part of the woody pool
5. Coarse Root
6. Fine Root

Col 3: To Air. This is the proportion of the given biomass pool C stocks that is consumed by the fire and released to the air. Valid values: 0.0 ≤ decimal number ≤ 1.0.

Col 4: To FPS: This the proportion of the given biomass pool C stocks that should be transferred to the forest product sector. Since this table is for fire, this value will be 0 in most cases. To simulate salvage logging of the fire killed tree boles then set the value greater than zero for Biomass Pool 1. Valid values: 0.0 ≤ decimal number ≤ 1.0.

Col 5: To DOM. This is the proportion of the given biomass pool C stocks that should be transferred to DOM pools. Valid values: 0.0 ≤ decimal number ≤ 1.0.

Note that if the proportions in cols 3-5 do not add to one, then some of the C from the biomass will not appear in the output file. It will will have been removed from the biomass pool, but it will not go to the DOM pools, and there will no report of whether it went to air or to the FPS. Reporting all flows is important when doing complete C accounting.

4.4. DisturbOtherTransferBiomass

This table is the second of a set of two tables that define how material is transferred out of different biomass pools after a disturbance. This table is only for the transfers from disturbances other than fire. The allowable transfers are from any pool to the air, to the dead carbon pools, and to the forest product sector.

Note that the table must be present even if it contains no values and even if no disturbance extensions are being used. Also note that the disturbance transfers listed in this table also apply to the transfers that occur during the creation of snags during initialization.
Values should be entered for every combination of disturbance type and biomass pool, and these values should add up to 1.

Col 1: Disturbance type: Valid entries are: “wind”, “bda”, “drought”, “defol” , “other” or the harvest regime name defined in the harvest module input file.

Col 2: Biomass Pools. Indices to be used when referring to biomass pools are (note that 4 is not a valid value):

1. Merchantable part of the woody pool
2. Foliage
3. Non-merchantable part of the woody pool
5. Coarse Root
6. Fine Root

Col 3: To Air. This is the proportion of the given biomass pool C stocks that is consumed by the disturbance and released to the air. Valid values: 0.0 ≤ decimal number ≤ 1.0.

Col 4: To FPS: This the proportion of the given biomass pool C stocks that should be transferred to the forest product sector. *Note that the model does not check whether this transfer is realistic (e.g., fine roots to FPS is possible). Any carbon that is defined as going to the FPS will not appear in the DOM pools.*

Col 5: To DOM. This is the proportion of the given biomass pool C stocks that should be transferred to DOM pools. Valid values: 0.0 ≤ decimal number ≤ 1.0.

Note that if the proportions in cols 3-5 do not add to one, then some of the C from the biomass will not appear in the output file. It will have been removed from the biomass pool, but it will not go to the DOM pools, and there will no report of whether it went to air or to the FPS. Reporting all C flows is important when doing complete C accounting.

4.5. Sample Disturbance Matrix Input File

LandisData "ForC Succession"

DisturbFireTransferDOM
>> If a fire occurs through the Base Fire Extension or Dynamic Fire Extension, this table defines how carbon should be transferred from the DOM and soil pools to the DOM, soil, Forest Products Sector, or air.
>> We allow only certain transfers at this point.
>> From any pool to air, from aboveground pools and snags to FPS, and from snags to the ground (stem snag to medium or other snag to fast aboveground)
>> No other transfers are allowed. Default is no transfer

>> Intensity	From DOM	To Air	To DOM	To FPS
1	1	0.5	0.0	0.0
1	3	0.2	0.0	0.0
2	1	0.5	0.0	0.0
2	2	0.25	0.0	0.0
2	3	0.35	0.0	0.0
2	8	0.0	0.5	0.0
2	9	0.0	1.0	0.0
3	1	0.65	0.0	0.0
3	2	0.35	0.0	0.0
3	3	0.4	0.0	0.0
3	8	0.0	0.75	0.0
3	9	0.5	0.5	0.0
4	1	1.0	0.0	0.0
4	2	0.5	0.0	0.0
4	3	0.4	0.0	0.0
4	5	0.1	0.0	0.0
4	8	0.0	1.0	0.0
4	9	0.7	0.3	0.0
5	1	1.0	0.0	0.0
5	2	0.65	0.0	0.0
5	3	0.45	0.0	0.0
5	5	0.1	0.0	0.0
5	8	0.1	0.9	0.0
5	9	0.7	0.3	0.0

DisturbOtherTransferDOM
>> If a disturbance occurs, this table defines how carbon should be transferred from the DOM and soil pools to other DOM and soil pools, to the Forest Products Sector, or air.
>> We allow only certain transfers at this point.
>> From any pool to air, from aboveground pools and snags to FPS, and from snags to the ground (stem snag to medium or other snag to fast aboveground)
>> No other transfers are allowed.

>> Disturbance Type	From DOM	To Air	To DOM	To FPS
Clearcut	1	0.0	0.0	0.0
Clearcut	8	0.0	0.4	0.6
wind	8	0.0	0.8	0.0
wind	9	0.0	1.0	0.0

>> Biomass Pools
>> Indices to be used when referring to biomass pools. ** Note there is no #4.

>> 1. Merchantable part of woody biomass
>> 2. Foliage
>> 3. Other woody biomass
>> 5. Coarse Root
>> 6. Fine Root

DisturbFireTransferBiomass
>> If a fire occurs through the Base Fire Extension, this table defines how carbon should be transferred from the biomass pools to the DOM, Forest Products Sector, or air.
>> We allow only certain transfers at this point.
>> From any biomass pool to air, from aboveground pools to FPS, and from biomass pool to the DOM pools
>> No other transfers are allowed.
>> If mortality is caused by a fire and the biomass pools are not in this table the carbon will disappear.

>> Intensity	From Biomass	To Air	To FPS	To DOM
1	1	0	0	1
1	2	0.5	0	0.5
1	3	0	0	1
1	5	0	0	1
1	6	0	0	1
2	1	0	0	1
2	2	0.7	0	0.3
2	3	0.1	0	0.9
2	5	0	0	1
2	6	0	0	1
3	1	0	0	1
3	2	0.75	0	0.25
3	3	0.1	0	0.9
3	5	0	0	1
3	6	0	0	1
4	1	0	0	1
4	2	1	0	0
4	3	0.2	0	0.8
4	5	0	0	1
4	6	0	0	1
5	1	0	0	1
5	2	1	0	0
5	3	0.3	0	0.7
5	5	0	0	1
5	6	0	0	1

DisturbOtherTransferBiomass
>> If a disturbance occurs, this table defines how carbon should be transferred from the biomass pools to the DOM, Forest Products Sector, or air.
>> If mortality is caused by disturbance extension other than fire, and the biomass pools are not in this table the carbon will disappear.

>> Disturbance Type	From Biomass	To Air	To FPS	To DOM
Clearcut	1	0	1	0
Clearcut	2	0	0	1
Clearcut	3	0	0	1
Clearcut	5	0	0	1
Clearcut	6	0	0	1
wind	1	0	0	1
wind	2	0	0	1
wind	3	0	0	1
wind	5	0	0	1

wind	6	0	0	1
bda	1	0	0	1
bda	2	0.3	0	0.7
bda	3	0.2	0	0.8
bda	5	0	0	1
bda	6	0	0	1

5. Sample Climate File

The climate file is a simple one compared to other Landis modules. This file contains only the annual average temperature by ecoregion and year. Only the first year of data are required. The model will use the values defined for that year until another year is defined. For example, in the sample file below, the year 0 value will be used for years 1-4, year 5 data for years 5-9, year 20 for the years 20 to the end of the simulation time.

```
LandisData "ForC Succession"

ClimateTable
>>Time  Eco     AvgT
>>Step          (C)
>>-------------------------
0       eco1    5
0       eco2    2
5       eco1    5.5
5       eco2    2.5
10      eco1    6
10      eco2    3
20      eco1    7
20      eco2    5
```

6. Sample Snag Initialization File

The snag input file must start with a line that identifies it as being part of the ForCS Succession Extension. The next line identifies that the data following are snag data. The remaining lines list information about the snags. There can be at most 20 different rows, and they must be listed in ascending order of age at death.

Line 1: LandisData “ForCS Succession”
Line 2: SnagData
Lines 3-22:
Col 1: Species
Col 2: Age at death *(Note that these must be in ascending order)*
Col 3: Number of years that the snag has been dead
Col 4: Cause of death. Valid responses: harvest, wind, bda, drought, other

```
LandisData "ForC Succession"

SnagData
>>Species  AgeAtDeath  TimeSinceDeath Cause
querelli     53           5           other
pinubank     88           12          bda
```

NOTES:

1. All cohorts in the initial conditions file with the defined species and age combination will

become snags. Thus, ensure that values in this table are different from all live cohorts.

2. The cause of death that is used MUST have valid transfers defined in the DisturbOtherBiomassTransfer table. If transfers are not defined in this table, the cohort will be killed, but no snag will be created. The disturbance extension is NOT used in this process and does not need to be installed. Transfers should also be defined in the DisturbOtherDOMTransfer table.
3. If you wish to create snags from fire, you must use the "other" option and define transfers in the DisturbOtherBiomassTransfer table, not the DisturbFireBiomassTransfer table. Thus, only one severity of fire will be used.
4. The transfers that are defined for a disturbance type in these transfer tables are used both when creating snags and when doing an actual disturbance.

7. Output

ForCS automatically produces output at the intervals specified in the ForCSOutput table. Comma-separated-value files are used rather than raster files due to the former 8-bit constraint in LANDIS-II.

7.1. ForCs-ANPP-Establishment-log.csv

This table reports internal values for error checking.

Col 1: Timestep
Col 2: Ecoregion
Col 3: Species
Col 4: MaxANPP. The ANPP drawn from the distribution prior to taking into account age, competition, etc.
Col 5: MaxBiomass. The calculated MaxBiomass see equation 2 above.
Col 6: ProbEst. The probability of establishment. Should be the same as provided in the input file.

7.2. log_Summary.csv

This file contains a summary of output most likely to be required by users. Units of (gC/m^2) for stocks and (gC/m^2 y) for fluxes.

Col 1: Timestep
Col 2: Row. Together with the column these values can be used to create a raster map of the output.
Col 3: Column.
Col 4: Ecoregion. ID number for ecoregion based on order in ecoregions text file.
Col 5: ABio. Aboveground biomass stocks
Col 6: BBio. Belowground (root) biomass stocks
Col 7: TotalDOM. Total dead organic matter and soil stocks
Col 8: DelBio. Annual change in biomass stocks
Col 9: Turnover. Annual transfer of biomass (above-and belowground) to dead organic matter and soil pools before disturbances occur

Col 10: NetGrowth.	Change in biomass from growth alone: the difference between the biomass at the beginning and the end of the growth routine in the timestep. This value could be negative as the stand ages and mortality outpaces growth. DelBio and NetGrowth will be the same when there are no losses caused by disturbances.
Col 11: NPP.	Net Primary Production (includes above and belowground. This includes growth and replacement of litterfall and annual turnover, i.e., the sum of NetGrow and turnover.
Col 12: Rh.	Heterotrophic respiration. This is the sum of the "To Air" fluxes through decomposition, not disturbance.
Col 13: NEP.	Net Ecosystem Productivity. NPP minus Rh.
Col 14: NBP.	Net Biome Productivity. NEP minus losses from the ecosystem due to disturbances (both emissions to air from combustion and losses to the forest products sector).

7.3. log_BiomassC.csv

This file gives information about the biomass C of each site (gC/m^2), by cohort.

Col 1: Time:	Timestep 0 is the starting biomass after initialization.
Col 2: Row	Together with the column these values can be used to create a raster map of the output.
Col 3: Column	
Col 4: Ecoregion	ID number for ecoregion based on order in ecoregions text file.
Col 5: Species	Species name from the species text file.
Col 6: Age	Age of the cohort in years.
Col 7: Wood	Woody biomass
Col 8: Leaf	Leaf biomass
Col 9: CrsRoot	Coarse root biomass
Col 10: FineRoot	Fine root biomass

7.4. log_Flux.csv

This file contains the fluxes that occur in the absence of any disturbance: i.e, those from mortality, turnover, and decay (gC/m^2 y).

Col 1: Time	Timestep (year)
Col 2: row	Together with the column these values can be used to create a raster map of the output.
Col 3: column	
Col 4: ecoregion	ID number for ecoregion based on order in ecoregions text file.
Col 5: species	Species name from the species text file.
Col 6: Dist	This will always be 0 (no disturbance)
Col 7: VF_A_toAir	Release from the very fast aboveground pool to air
Col 8: VF_A_toSlow	Transfer from the very fast aboveground to slow aboveground pool.
Col 9: VF_B_toAir	Release from the very fast belowground pool to air.

Col 10: VF_B_ toSlow	Transfer from the very fast belowground to slow belowground pool.
Col 11: Fast_A_toAir	Release from the fast aboveground pool to air.
Col 12: Fast_A_ toSlow	Transfer from the fast aboveground to slow aboveground pool.
Col 13: Fast_B_toAir	Release from the fast belowground pool to air.
Col 14: Fast_B_ toSlow	Transfer from the fast belowground to slow aboveground pool.
Col 15: MED_toAir	Release from the medium pool to air.
Col 16: MED_ toSlow	Transfer from the medium to slow aboveground pool.
Col 17: Slow_A_toAir	Release from the slow aboveground pool to air.
Col 18: Slow_A_ toSlow	Transfer from the slow aboveground to slow belowground pool.
Col 19: Slow_B_toAir	Release from the slow belowground pool to air.
Col 20: Slow_B_ toSlow	Transfer from the slow belowground to slow aboveground pool. (Should always be 0).
Col 21: Sng_Stem_toAir	Release from the snag stems pool to air.
Col 22: Sng_Stem_ toSlow	Transfer from the snag stems to slow aboveground pool.
Col 23: SngStemtoMed	Transfer from the snag stems to medium pool.
Col 24 Sng_Oth_toAir	Release from the snag other pool to air.
Col 25 Sng_Oth_ toSlow	Transfer from the snag other to slow aboveground pool.
Col 26 SngOth_toFast	Transfer from the snag other to aboveground fast pool.
Col 27: Extra_toAir	Release from extra pool to air. (Should always be 0).
Col 28: Extra_toSlow	Transfer from extra to slow pool. (Should always be 0).
Col 29: MERCH_ToDOM	Transfer of C from merchantable to DOM pools (including to snags).
Col 30: FOL_ToDOM	Transfer of C from the foliage to DOM pools.
Col 31: OtherWoody_ToDOM Transfer from other live woody to DOM pools.
Col 32: CrsRt_ToDOM	Transfer from coarse root to DOM pools .
Col 33: FRt_ToDOM	Transfer from fine root to DOM pools.

7.5. log_FluxBio.csv

This file gives information about the transfer of C from the live biomass on each site (gC/m^2 y) after a disturbance in that timestep.

Col 1: Time	Timestep (year)
Col 2: row	Together with the column these values can be used to create a raster map of the output.
Col 3: column
Col 4: ecoregion	ID number for ecoregion based on order in ecoregions text file.
Col 5: species	Species name from the species text file.
Col 6: Dist	Disturbance type ID: 1=fire, 2=harvest, 3=wind, 4=bda
Col 7: MERCH_ToDOM	Transfer of C from merchantable to snags or other DOM pools
Col 8: MERCH_ToAir	Release from merchantable live biomass to the air
Col 9: FOL_ToDOM	Transfer from the foliage to DOM pools
Col 10: FOL_ToAir	Release from foliage to the air
Col 11: OtherWoody_ToDOM Transfer other live woody to DOM pools
Col 12: OtherWoody_ToAir	Release from other live woody to air
Col 13: CrsRt_ToDOM	Transfer from coarse root to DOM pools

Col 14: CrsRt_ToAir	Release from coarse root to air
Col 15: FRt_ToDOM	Transfer from fine root to DOM pools
Col 16: FRt_ToAir	Release from fine root to air
Col 17: BioToFPS	Loss to the forest product sector (e.g., from harvest). This is for accounting purposes only as there is no FPS is part of this model.

7.6. log_FluxDOM.csv

This file gives information about the transfer of C from the DOM on each site (gC/m^2 y) after a disturbance in that timestep.

Col 1: Time	Timestep (year)
Col 2: row	Together with the column these values can be used to create a raster map of the output.
Col 3: column	
Col 4: ecoregion	ID number for ecoregion based on order in ecoregions text file.
Col 5: species	Species name from the species text file
Col 6: Dist	Disturbance type ID: 1=fire, 2=harvest, 3=wind, 4=bda
Col 7: VF_A_toAir	Release from the very fast aboveground pool to air
Col 8: VF_B_toAir	Release from the very fast belowground pool to air
Col 9: Fast_A_toAir	Release from the fast aboveground pool to air
Col 10: Fast_B_toAir	Release from the fast belowground pool to air
Col 11: MED_toAir	Release from the medium pool to air
Col 12: Slow_A_toAir	Release from the slow aboveground pool to air
Col 13: Slow_B_toAir	Release from the slow belowground pool to air
Col 14: Sng_Stem_toAir	Release from the snag stems pool to air
Col 15 SngStemToMed	Transfer from the snag stems pool to the medium pool
Col 16 Sng_Oth_toAir	Release from the snag other pool to air
Col 17 SngOthToFast	Transfer from the snag other pool to the fast aboveground pool
Col 18: Extra_toAir	Release of from the extra pool to air
Col 19: SnagsToFPS	Loss from snag stem to the forest product sector
Col 20: DOMtoFPS	Loss of any other dead C to the forest product sector

7.7. log_Pools.csv

This file gives information about the DOM and soil carbon stocks of each site (gC/m^2), by species. Year 0 gives the size of the pools after initialization. They will be different than the pools in the input file due to additions and decay during the spin-up process.

Col 1: Time	Timestep (year)
Col 2: row	Together with the column these values can be used to create a raster map of the output.
Col 3: column	
Col 4: ecoregion	ID number for ecoregion based on order in ecoregions text file.
Col 5: species	Species name from the species text file
Col 6: VF_A	Very fast aboveground pool C
Col 7: VF_B	Very fast belowground pool C

Col 10: Fast_A	Fast aboveground pool C
Col 11: Fast_B	Fast belowground pool C
Col 12: MED	Medium pool C
Col 13: Slow_A	Slow aboveground pool C
Col 14: Slow_B	Slow belowground pool C
Col 15: Sng_Stem	Snag stem pool C
Col 16: Sng_Oth	Snag other pool C
Col 17: Extra	“Extra” pool C. This should be 0 unless you have explicitly initialized it.

8. Sample Output Files

8.1. ForCs-ANPP-Establishment-log.csv

This table shows a few lines of an output file with two ecoregions and two species only.

Time	Ecoregion	Species	MaxANPP	MaxBiomass	ProbEst
1	eco1	pinubank	648	15053	0.1
1	eco1	querelli	1415	25161	0.1
1	eco2	pinubank	648	15053	0.1
1	eco2	querelli	1415	25161	0.1
2	eco1	pinubank	648	15053	0.1
2	eco1	querelli	1415	25161	0.1
2	eco2	pinubank	648	15053	0.1
2	eco2	querelli	1415	25161	0.1
3	eco1	pinubank	648	15053	0.1
3	eco1	querelli	1415	25161	0.1
3	eco2	pinubank	648	15053	0.1
3	eco2	querelli	1415	25161	0.1

8.2. log_Summary.csv

This table shows a few lines of an output file with two ecoregions and two species only. Values are reported in gC/m^2 or gC/m^2y. Note that the sites 1,4 and 1,5 were harvested and planted in year 1.

Time	row	column	ecoregion	ABio	BBio	TotalDOM	DelBio	Turnover	NetGrowth	NPP	Rh	NEP	NBP
1	1	4	1	279.5	112.6	18401.7	-8171.9	32.7	41.4	74.1	743.7	-669.6	-5261.2
1	1	5	1	279.5	112.6	18401.7	-8171.9	32.7	41.4	74.1	743.7	-669.6	-5261.2
1	1	6	1	2034	880.7	5526	180.6	154	180.6	334.6	147.3	187.3	187.3
1	1	7	1	2034	880.7	5526	180.6	154	180.6	334.6	147.3	187.3	187.3

8.3. log_BiomassC.csv

This table shows a few lines of an output file with two ecoregions and two species only. Wood, Leaf, CrsRoot, and FineRoot are reported in gC/m^2. Note that the sites 1,4 and 1,5 were harvested and planted in year 1.

Time	row	column	ecoregion	species	Age	Wood	Leaf	CrsRoot	FineRoot
0	1	4	1	querelli	130	5966	662.5	1742	193.6
0	1	5	1	querelli	130	5966	662.5	1742	193.6
0	1	6	1	pinubank	30	1717.5	190.5	677.5	148.7
0	1	7	1	pinubank	30	1717.5	190.5	677.5	148.7
1	1	4	1	querelli	2	252	27.5	92.4	20.3
1	1	5	1	querelli	2	252	27.5	92.4	20.3
1	1	6	1	pinubank	31	1831	203	722.2	158.5
1	1	7	1	pinubank	31	1831	203	722.2	158.5

8.4. log_Pools.csv

This table shows the first few lines of an output file with two ecoregions and two species only. Values are reported in gC/m^2. Note that the sites 1,4 and 1,5 were harvested and planted in year 1.

Time	row	column	ecoregion	species	VF_A	VF_B	Fast_A	Fast_B	MED	Slow_A	Slow_B	Sng_Stem	Sng_Oth	Extra
0	1	4	1	querelli	432.12	88.14	588.16	533.76	2840.15	5921.02	2723.74	1646.61	366.58	0
0	1	5	1	querelli	432.12	88.14	588.16	533.76	2840.15	5921.02	2723.74	1646.61	366.58	0
0	1	6	1	pinubank	214.54	61.28	33.37	141.29	865.91	2517.02	1683.68	2.19	0.01	0
0	1	7	1	pinubank	214.54	61.28	33.37	141.29	865.91	2517.02	1683.68	2.19	0.01	0
1	1	4	1	querelli	901.00	117.62	1963.86	1363.93	3457.13	5996.79	2739.46	757.70	1104.20	0
1	1	5	1	querelli	901.00	117.62	1963.86	1363.93	3457.13	5996.79	2739.46	757.70	1104.20	0
1	1	6	1	pinubank	227.89	65.63	35.97	144.10	855.67	2512.92	1681.82	2.00	0.01	0
1	1	7	1	pinubank	227.89	65.63	35.97	144.10	855.67	2512.92	1681.82	2.00	0.01	0

8.5. log_Flux.csv

This table shows the first part of the log_Flux table. It is too wide to fit on a single page. No disturbances occur. A Dist value of 0 means decay. Values are reported in gC/m^2y.

Time	row	column	ecoregion	species	Dist	VF_A_toAir	VF_A_toSlow	VF_B_toAir	VF_B_toSlow	Fast_A_toAir	Fast_A_toSlow	Fast_B_toAir	Fast_B_toSlow	MED_toAir	MED_toSlow
1	1	4	1	querelli	0	253.531	57.55	64.27	13.164	209.589	42.928	34.644	7.096	34.585	7.084
1	1	5	1	querelli	0	253.531	57.55	64.27	13.164	209.589	42.928	34.644	7.096	34.585	7.084
1	1	6	1	pinubank	0	64.126	14.556	35.86	7.345	3.838	0.786	3.66	0.75	8.56	1.753
1	1	7	1	pinubank	0	64.126	14.556	35.86	7.345	3.838	0.786	3.66	0.75	8.56	1.753

This table shows the second part of the log_Flux table.

Slow_A_ toAir	Slow_A_ toSlow	Slow_B_ toAir	Slow_B_ toSlow	Sng_Stem _ toAir	Sng_Stem _ toSlow	SngStem ToMed	Sng_Oth_ toAir	Sng_Oth_ toSlow	SngOth ToFast	Extra_ toAir	Extra_ toSlow	MERCH_ ToDOM	FOL_ ToDOM	OtherWo ody_ ToDOM	CrsRt_ ToDOM	FRt_ToDO M
14.428	36.198	40.74	0	37.99	7.781	0	53.933	11.046	0	0	0	803.475	673.049	1558.902	1743.817	213.827
14.428	36.198	40.74	0	37.99	7.781	0	53.933	11.046	0	0	0	803.475	673.049	1558.902	1743.817	213.827
6.046	15.169	25.118	0	0.1	0.02	0.07	0	0	0.001	0	0	0	44.477	0	14.444	95.118
6.046	15.169	25.118	0	0.1	0.02	0.07	0	0	0.001	0	0	0	44.477	0	14.444	95.118

8.6. log_FluxBio.csv

This table shows a portion of a larger output table. Sites 1,4 and 1,5 were harvested and planted in year 1 (Dist type 2).

Time	row	column	ecoregion	species	Dist	MERCH_ToDOM	MERCH_ToAir	FOL_ToDOM	FOL_ToAir	OtherWoody_ToDOM	OtherWoody_ToAir	CrsRt_ToDOM	CrsRt_ToAir	FRt_ToDOM	FRt_ToAir	BioToFPS
1	1	4	1	querelli	2	803.475	0	662.5	0	1558.902	0	1741.97	0	193.552	0	3603.624
1	1	5	1	querelli	2	803.475	0	662.5	0	1558.902	0	1741.97	0	193.552	0	3603.624

8.7. log_FluxDOM.csv

This table shows a portion of a larger output table. Sites 1,4 and 1,5 were harvested and planted in year 1 (Dist type 2).

Time	row	column	ecoregion	species	Dist	VF_A_ toAir	VF_B_ toAir	Fast_A_ toAir	Fast_B_ toAir	MED_ toAir	Slow_A_ toAir	Slow_B_ toAir	Sng_Stem_ toAir	SngStem ToMed	Sng_Oth_ toAir	SngOth ToFast	Extra_ toAir	Snags ToFPS	DOM toFPS
1	1	4	1	querelli	2	0	0	0	0	0	0	0	0	658.644	0	366.579	0	987.967	0
1	1	5	1	querelli	2	0	0	0	0	0	0	0	0	658.644	0	366.579	0	987.967	0