Projecting Regenerated Stand Growth for Timber Supply & Silviculture Decision Making

Eleanor McWilliams, MSc, RPF

J&E McWilliams & Associates Ltd.

Associated Strategic Consulting Experts Inc.

February 21, 2017

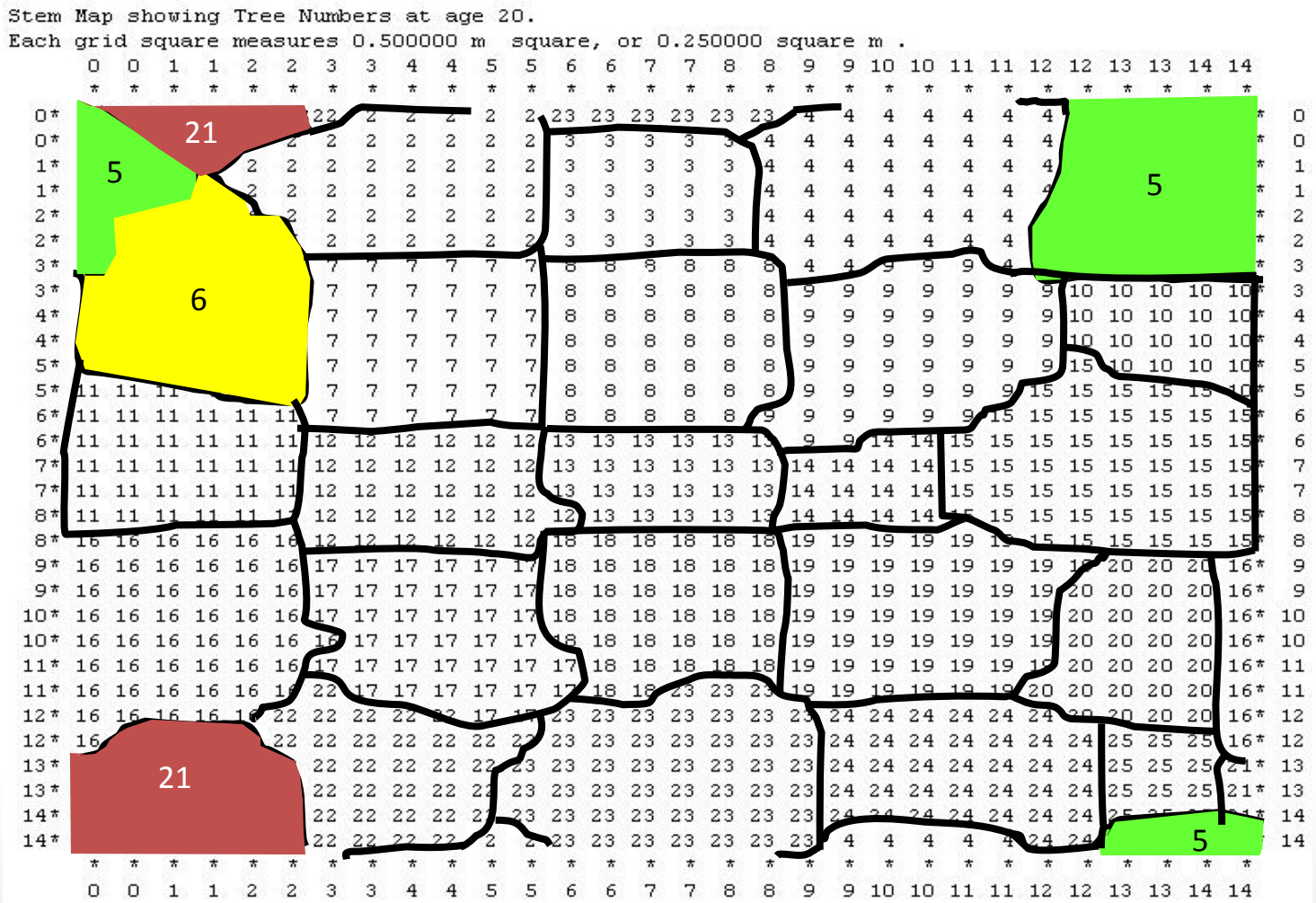
Overview

- Reliability of growth projections are based on both the model used and the data used to describe the stands and initiate the model.
- Brief overview of the models most commonly used in BC
  - TASS and TIPSY
  - *Thanks to Catherine Bealle-Statland and Jim Goudie for slides*
- What are the key input variables - what are the projections most sensitive to?
- Where do the input variables currently come from?
- How can we improve the process?

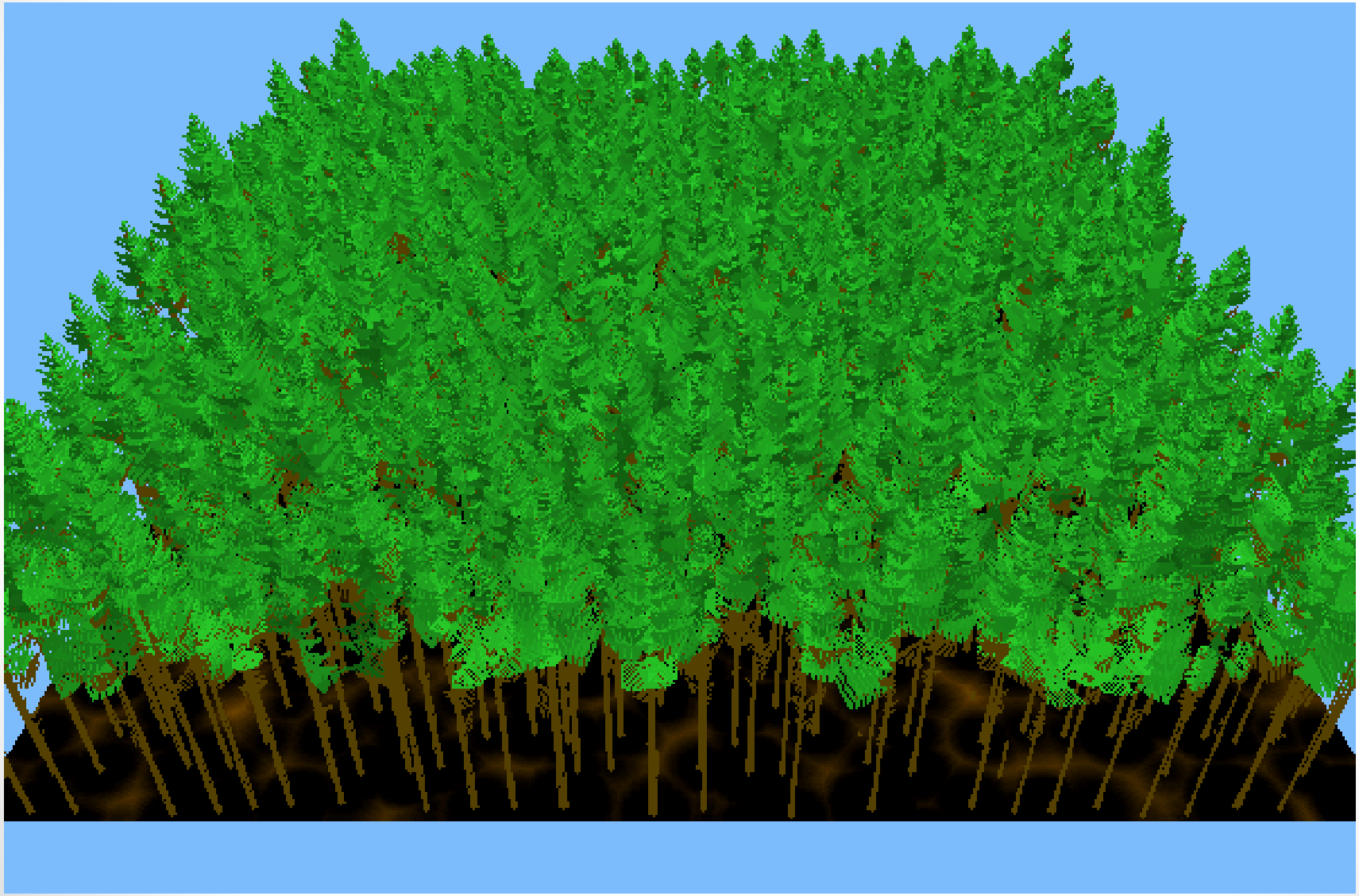
Tree And Stand Simulator - TASS

- TASS is an individual tree spatial model with a focus on the tree crowns as the engines of growth.
- Long history - Ken Mitchell started working on TASS in 1963.
- TASS I was completed for his PhD work at Yale in 1968.
  - Crowns were modelled in 2 dimensions
- TASS II (initial version) was completed in 1975
  - Crowns were modelled in 3 dimensions
- TASS III is under development
  - Light model now incorporated

TASS I


Stem Map showing Tree Numbers at age 20.
Each grid square measures 0.500000 m square, or 0.250000 square m .
21
5
6
5
21
5

TASS II



TASS III

Table Interpolation Program for Stand Yield - TIPSY

- TASS is a great tool but is not (yet) in general distribution.
- TIPSY developed to provide access to TASS II output
- TIPSY is a “meta-model” that gives access to a vast database of yield tables produced by TASS.
- TIPSY does not simulate stand growth, but retrieves, customizes and displays information from the database.

TIPSY Limitations

- TIPSY database only has a subset of the potential TASS simulations.
- TIPSY database does not have information on mixed species stands.
- TIPSY database does not have scenarios for stands that have both planted and natural ingress.

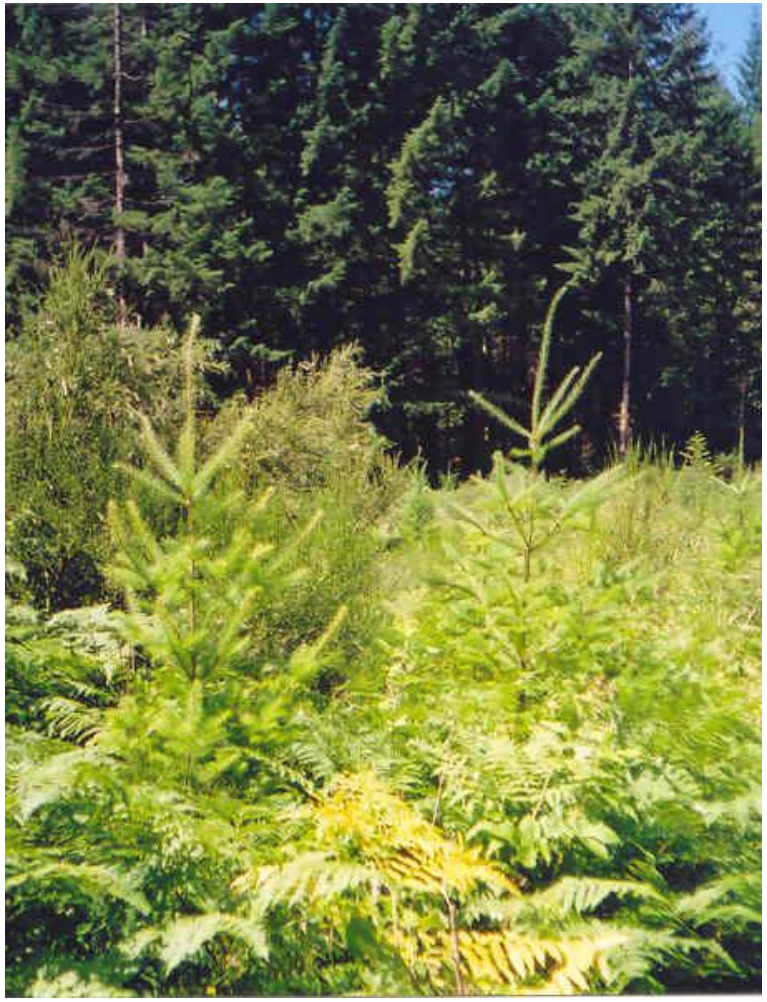
TASS II Limitations

- All over-topped trees die.
- Limited ability to simulate multi-layered canopies.
- Severely limits fidelity in simulating complex stands.

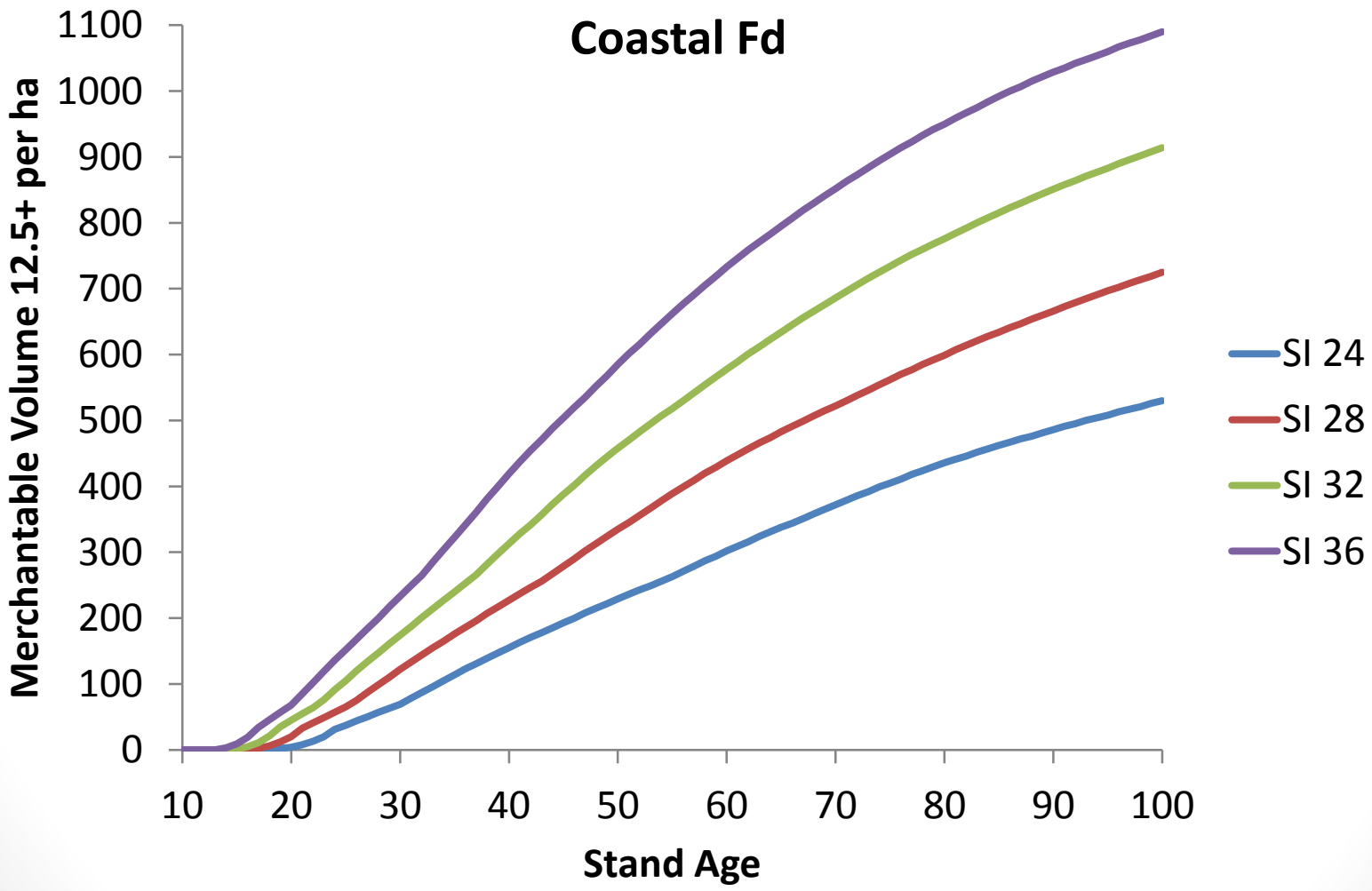
- TASS II does a fair job of modelling ingress for monocultures and species with similar height growth trajectories, but over-estimates mortality of shade tolerant species.
- This is why TASS III incorporates a light model and has new functions that are responsive to relative light levels.

What Factors Influence Future Yields?

- Site productivity
- Species composition
- Genetic worth
- Spatial distribution
- Temporal distribution
- Density
- Forest health



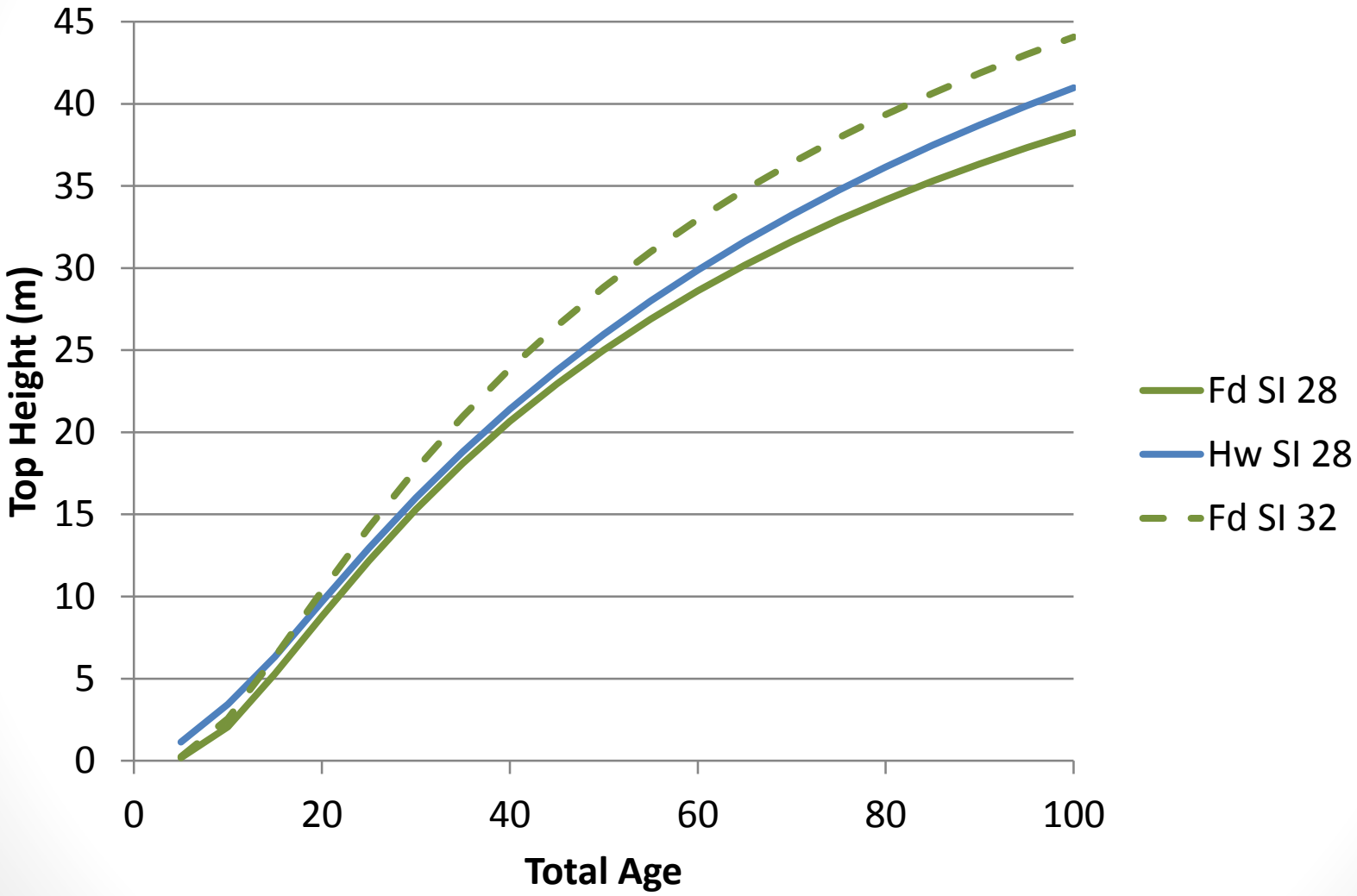
Site Index


Coastal Fd
Merchantable Volume 12.5+ per ha
1100
1000
900
800
700
600
500
400
300
200
100
0
10
20
30
40
50
60
70
80
90
100
Stand Age
SI 24
SI 28
SI 32
SI 36

Species Composition

- Mixed species stands have much more variation between individuals than single species stands which in turn leads to more types of competitive interactions.
- The proportions of different species and their spatial arrangement will influence how the stand develops.
- Different height growth patterns and levels of shade tolerance also play significant roles.

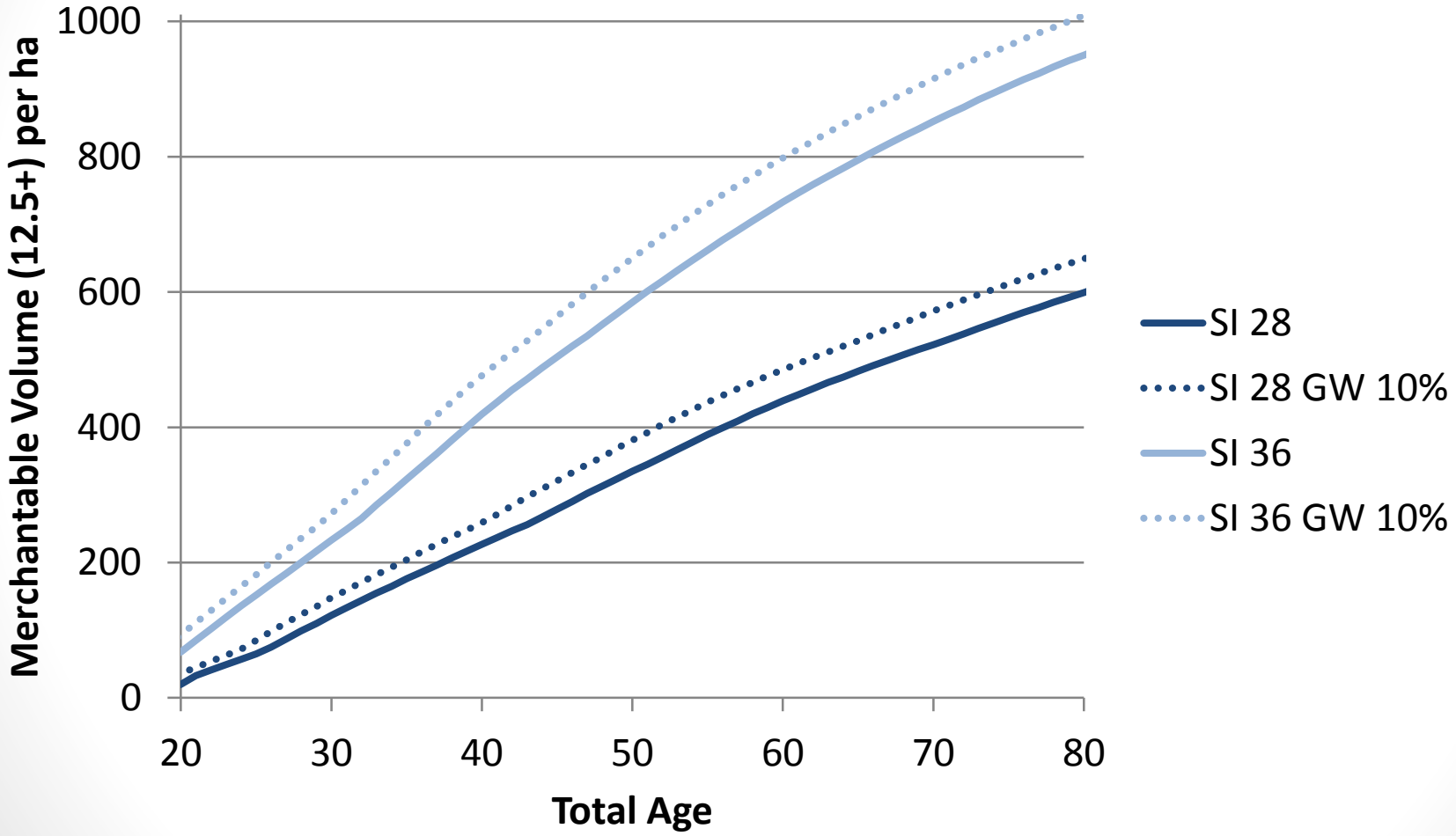
Site Index & Stratification in Mixtures



Genetic Gain

- Projected volume increases resulting from increased genetic worth can be significant.
- As genetic gain is modelled as a percentage increase it results in higher absolute volume gains on higher sites.

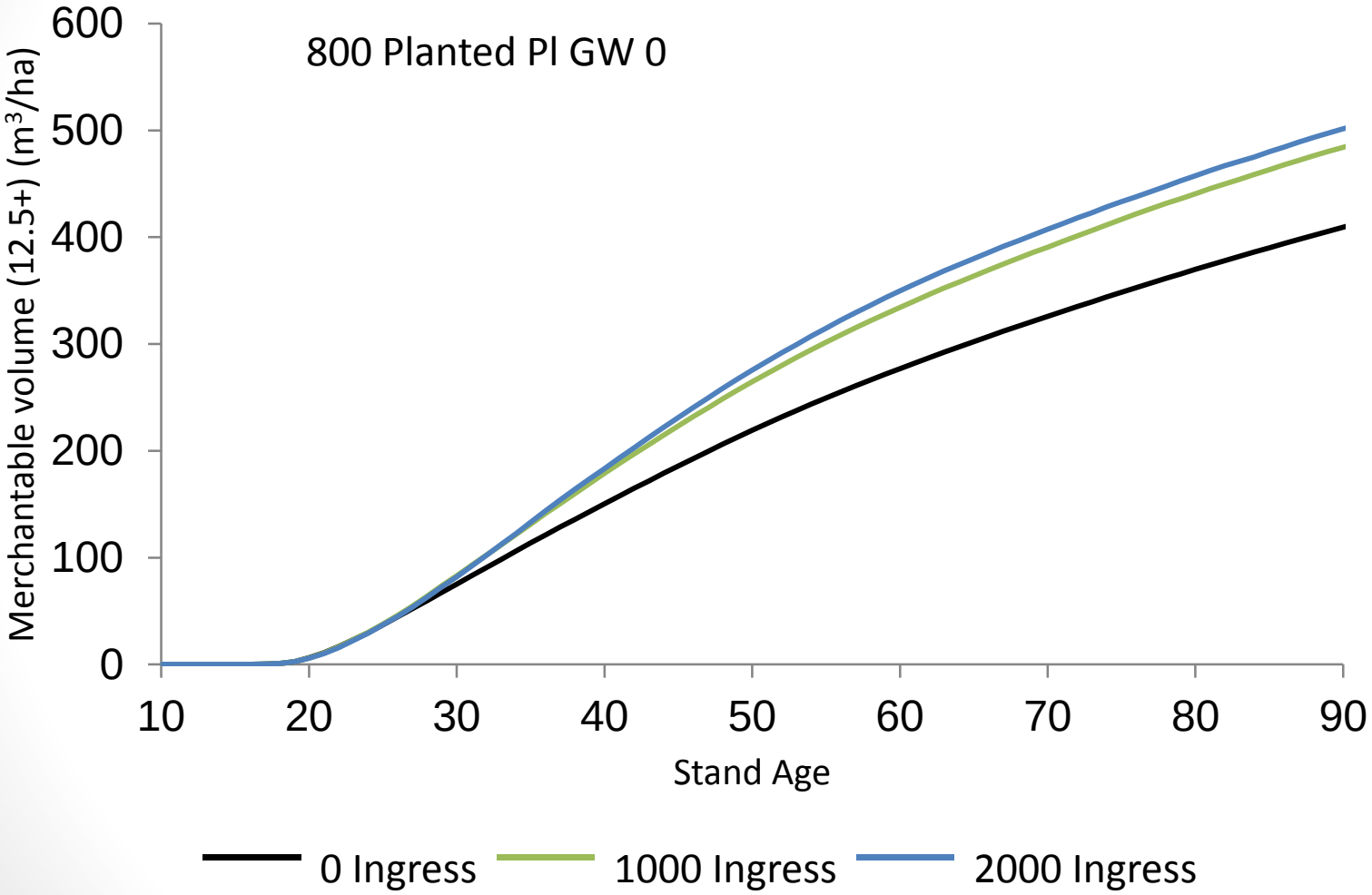
Fd Genetic Gain 10% SI 28 and 36 m



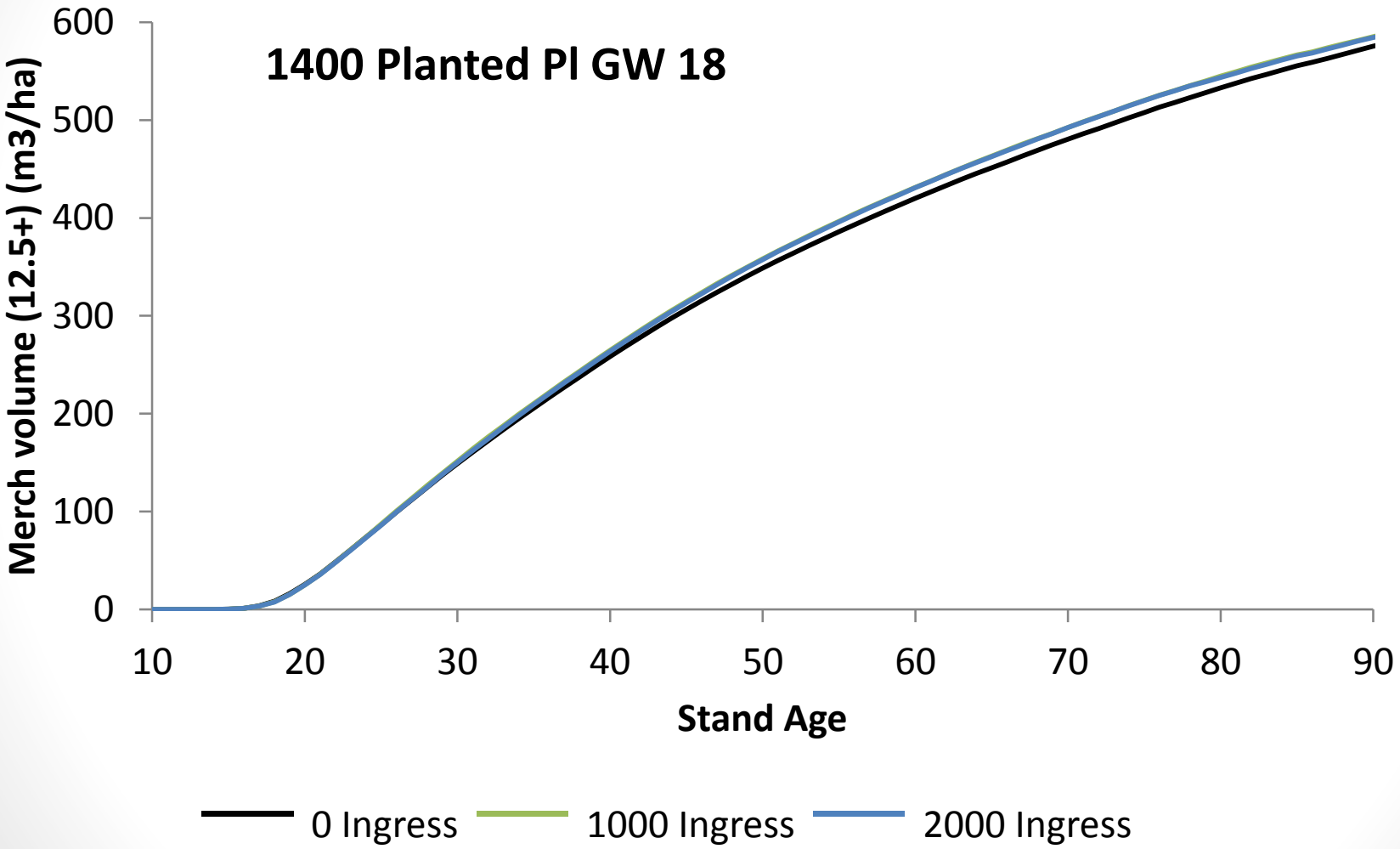
Spatial Distribution

- The key factor is the size and distribution of unoccupied areas (holes) in the stand.
- Knowing whether a stand was planted is critical as we assume the planting will cover the site and leave few to no holes.
- In terms of merchantable volume production, the importance of knowing the amount, temporal and spatial distribution of the ingress decreases as the planting density and genetic worth of the planting stock increase.

Spatial Distribution



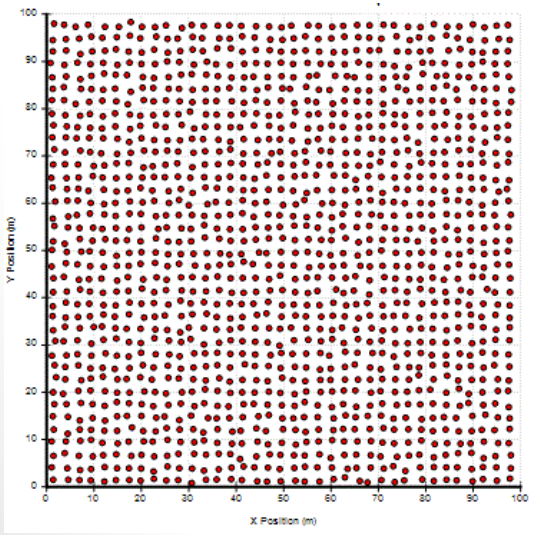
Spatial Distribution

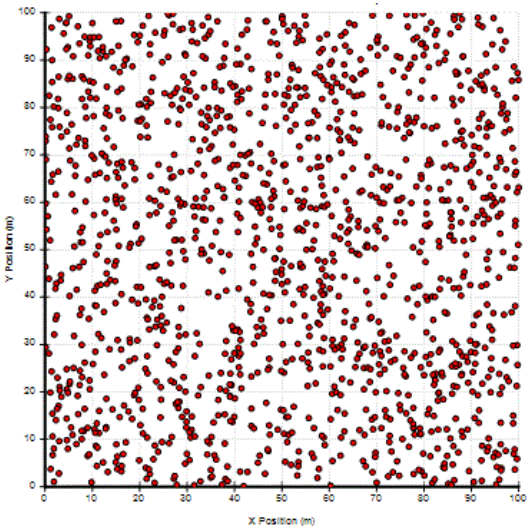


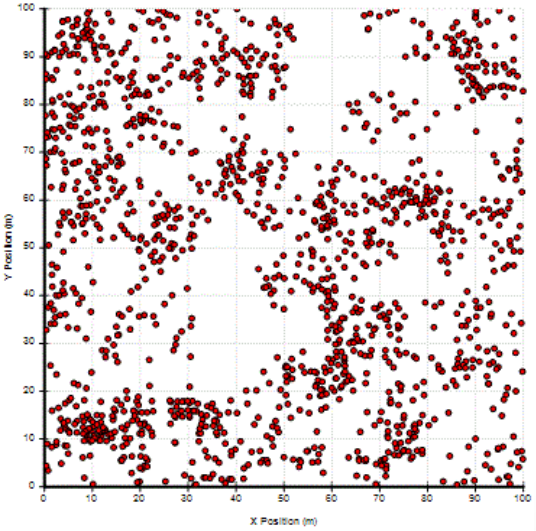
Spatial Distribution

- TIPSY is limited to 3 spatial distributions

Planted	Random	Clumped

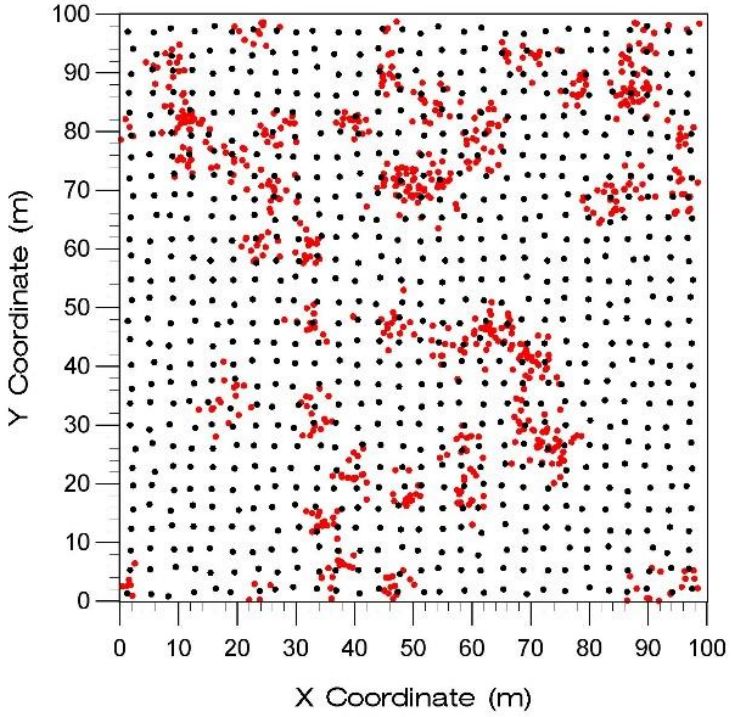




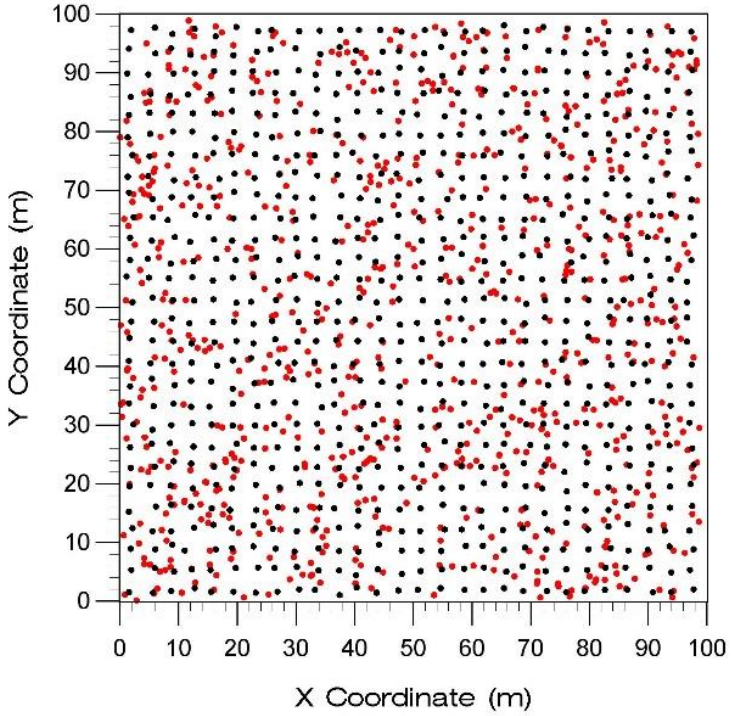


Spatial Distribution

- TASS has UNLIMITED spatial distributions

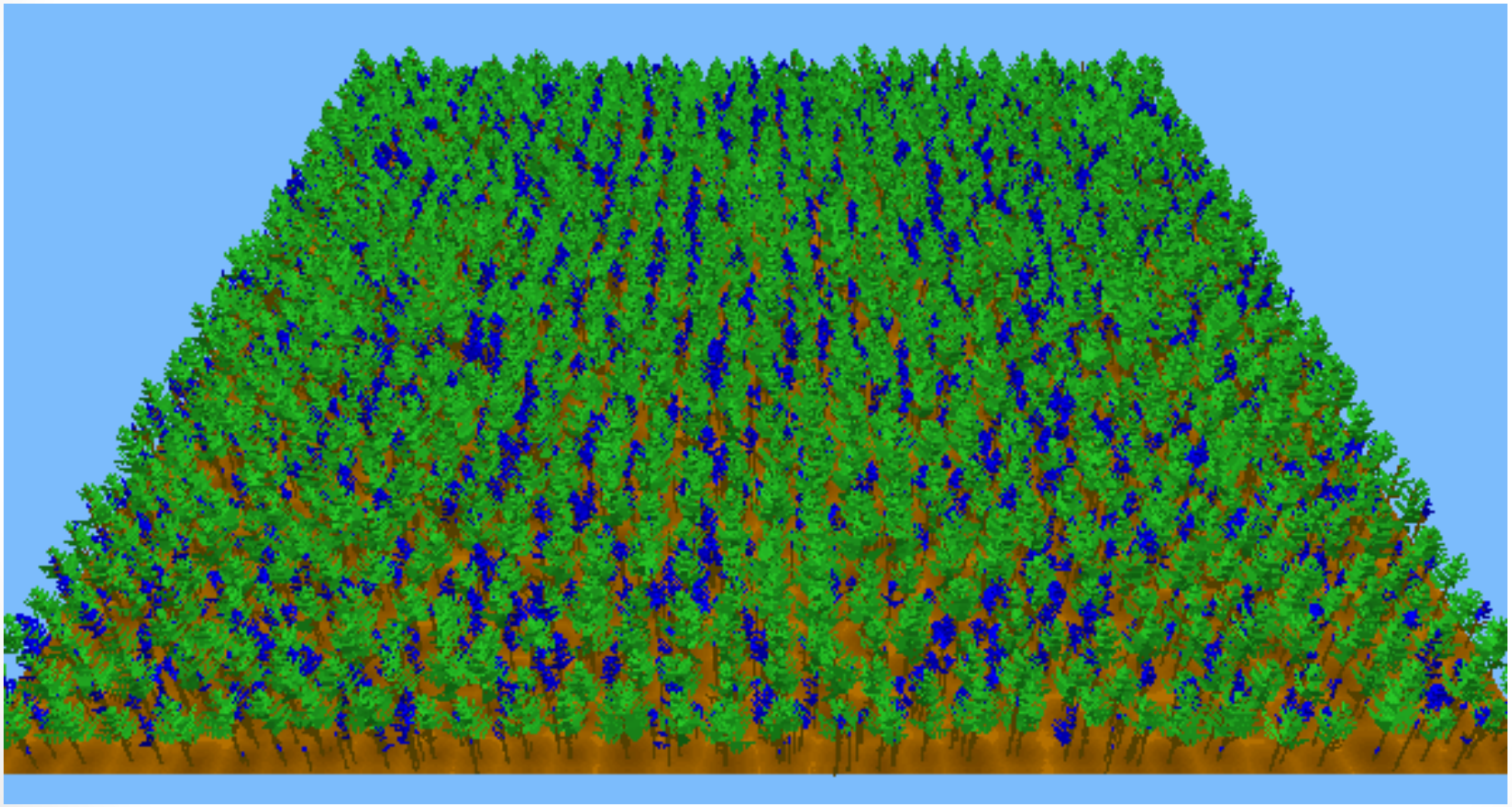


Planted with strongly clumped ingress



Planted with random ingress

Spatial Distribution - TASS



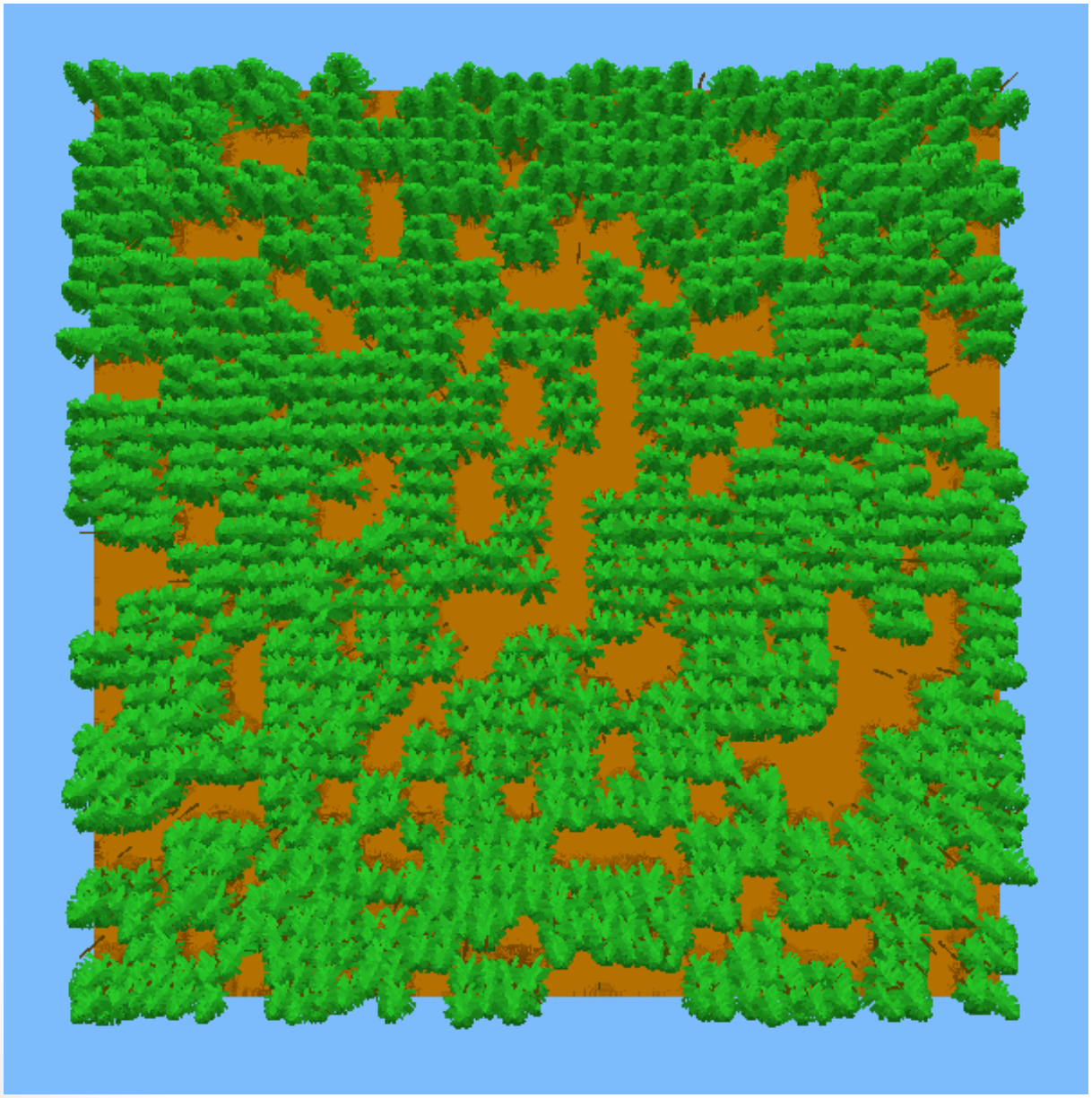
Temporal Distribution

- The assumed temporal distribution of the ingress can have a significant impact **if** the planting density is below current operational densities.
- TIPSY has default temporal distributions for natural ingress.
- In TASS you can specify any temporal distribution you want for the natural ingress.
- Temporal distribution can be important, but is generally not as important as the spatial distribution (the holes!)

Forest Health

- Forest health can have a significant impact on the growth and development of stands.
- The impact on future yield is a function of the timing (stage of stand development), number and sizes of trees infected and killed.

Forest Health



So what is take home message?

- Knowing what (if any) trees were planted is very important to obtaining a reliable projection of the stand.
  - This tells us that there were likely few holes in the stand at the time it was planted.
  - We know the genetic worth to apply.
  - We know the species.
  - We know the trees per ha planted.
- Site productivity (site index) estimates are critical.
- Species composition is important
  - Relative growth rates between species is important
- Ingress species, numbers, spatial and temporal patterns are important for projecting size distributions (value implications) and forest health impacts.

So what is take home message?

- If we want to project existing stands, then we need data on the numbers, species, health (agents, severity, tree sizes) and sizes (heights and diameters) of trees in the stand.
  - In this case the planting information is used to obtain genetic worth, and upper limits of the number of trees by species to apply the genetic worth to.
- TASS will have an existing stand start up routine.

Currently Available Data

- Information on regenerated stands comes primarily from silviculture surveys and planting records.
- This information is captured initially in RESULTS and then a portion of it is transferred to the VRI.

- Can we get all the information we need from RESULTS?
- Unfortunately no.

Silviculture Surveys

- The current generation of silviculture surveys were not designed to provide inputs to growth models.
- They were designed to collect information to assess regulatory benchmarks.
- The emphasis on counts (total or well-spaced trees) severely limits the utility of silviculture surveys for initiating more sophisticated GY models or contributing to GY analysis in general.
- Well-spaced trees have little to no use for GY purposes.

What can we do?

- Overall – consider revisions to the silviculture surveys and the regenerated stand inventory.
- This will require input from a wide range of disciplines
  - Silviculture
  - Inventory
  - Growth and yield
  - Sampling
  - Forest health
  - Legislation / Policy
  - Remote sensing
  - Database design
  - GIS
  - ??

Other thoughts to consider…

Planting Information

- For areas where the prescription is to plant, could we replace the regeneration survey with a requirement to submit spatial planting records?
- Create a “planting” layer for the inventory?

Free-Growing Declaration

- One option is to reduce the survey requirements for free-growing.
- Switch to more professional sign-offs and audits.
- Take the money saved and use it for an inventory survey.

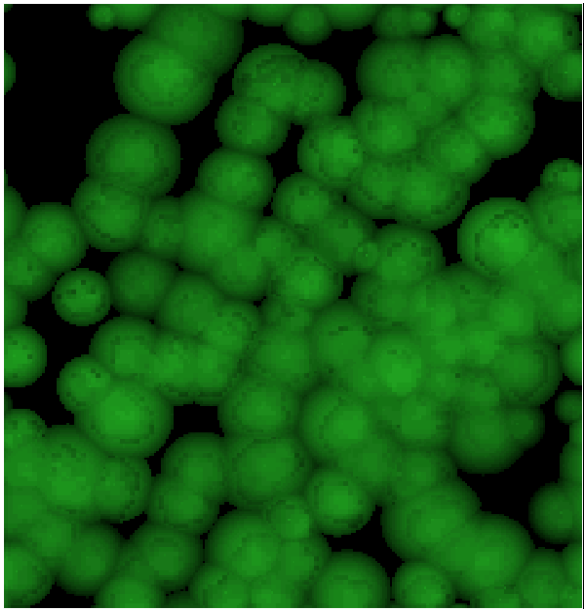
- OR Design a survey with a primary objective of providing inventory information (this includes necessary GY model inputs) that ALSO provides information to assess free-growing.

Landscape Level Regeneration Standards

- If landscape-level standards are developed, then by definition, information is needed to project individual stands and assess the collective achievement of future volume targets.
- It is possible that the information collected to project stands to assess a landscape-level stocking standard is the same information used to generate yield curves for timber supply.

TASS and Lidar / DAP

- TASS is a individual tree crown model
- Lidar and DAP provide information on individual trees and their crowns.
- Preliminary work has been done on linking the two.
- This could be explored further.



Lots of questions…

Lots to discuss…