

Repression Density Treatment Decision Key

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Definition of Repression

- Mitchell and Goudie (1980) first characterized repression in Pl as:

*“...curtailed height growth which begins before the dominant trees attain a height of 2 or 3 meters if **50,000** or more seedlings are established per hectare. The severity of repression is related to the level of initial stocking.”*

- Their work and subsequent work has shown that repressed stands differentiate into crown classes, express dominance, and self-thin, although at a rate slower than expected from the inherent quality of the site.

So where did 10,000 maximum density come from?

Repression and Site Index

- Repression of height growth has an obvious effect on the estimation of site index.
- Measurements of the height-growth trends of the dominant trees in repressed stands through stem analysis techniques and through repeated measures of fixed-area plots indicate that repressed stands tend to grow as if the site quality had been reduced.
- Interpreting repression as a loss of site index is a realistic analogy and leads to realistic expectations of the growth and future yield of repressed stands.

Repression can be modelled as a loss in site index

Research Summary

- Repression has been commonly observed in high density fire-origin PI stands, and much more infrequently in very high density fire-origin Lw stands.
- Repression has not been observed in high density fire-origin Fd.
- Repression has not been observed in high density PHR stands of any species.
- Lw, if established early, has rapid early height growth and will generally overtop and dominate other species.

Research Summary

- Repressed PI stands grow and develop in a similar manner to unrepressed stands but at a slower rate.
- The magnitude of repression varies with initial stand density and site quality.
- Evidence suggests that the earlier the treatment of repression the greater the mitigation of the site index loss.

Predicting Repression

- Unfortunately very difficult to do.
- For a given initial stand density and site quality (e.g., 100,000 stems/ha and site index 18) there is **not** a single expected level of repression (e.g. 3 m SI loss).
- There is some unknown *probability* of different levels of repression (e.g., could be a 10%, 10%, 20%, 20%, 20%, 10%, 10% chance of 0, 1, 2, 3, 4, 5 and 6 m loss respectively).
- We know that the *probability* of repression occurring increases with:
 - Increasing initial stand density
 - Decreases site quality

Unfortunately, the probabilistic nature of the occurrence and magnitude of repression does not fit well within regulatory rule-based stocking standards.

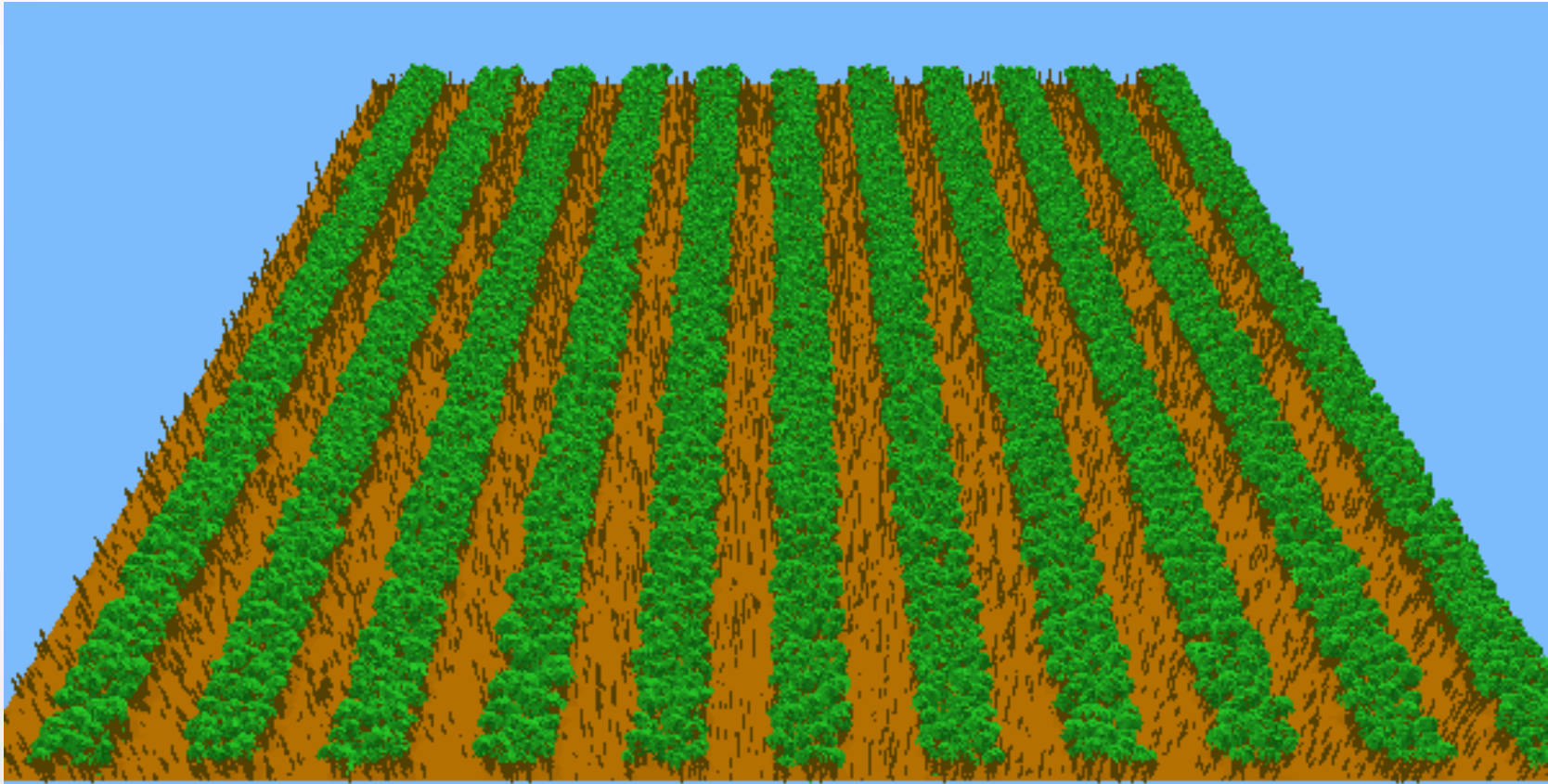
RISK

- Simply being risk adverse to repression in setting stocking standards (i.e., setting a low maximum density above which spacing is required) is not acceptable.
- The reason for this is if you space a stand that would not have gone into repression you will have LOWERED its product value and WASTED the MONEY spent on spacing.
- So there is a risk to spacing that must be considered.

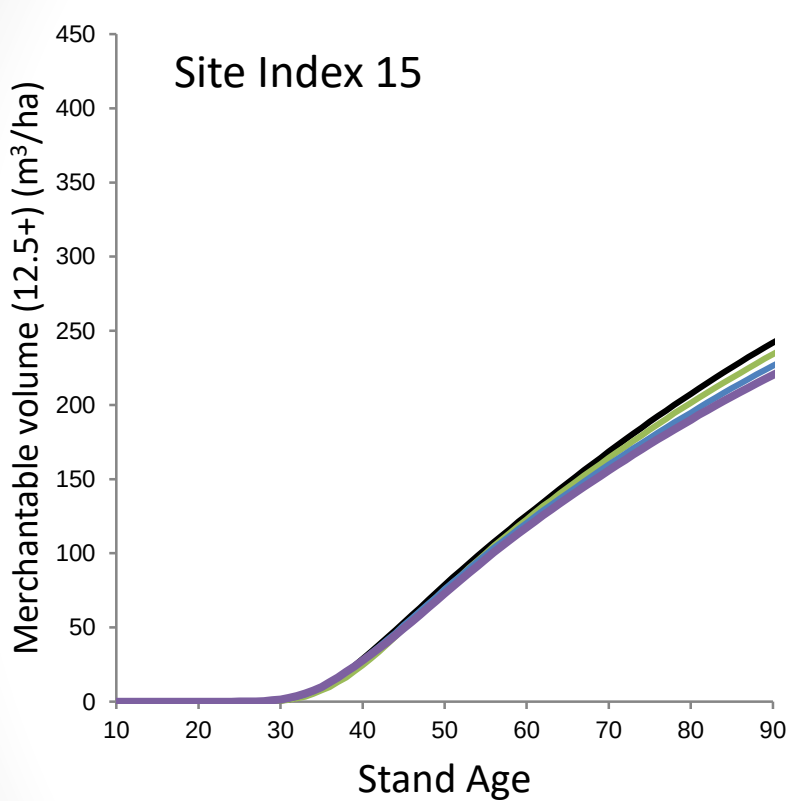
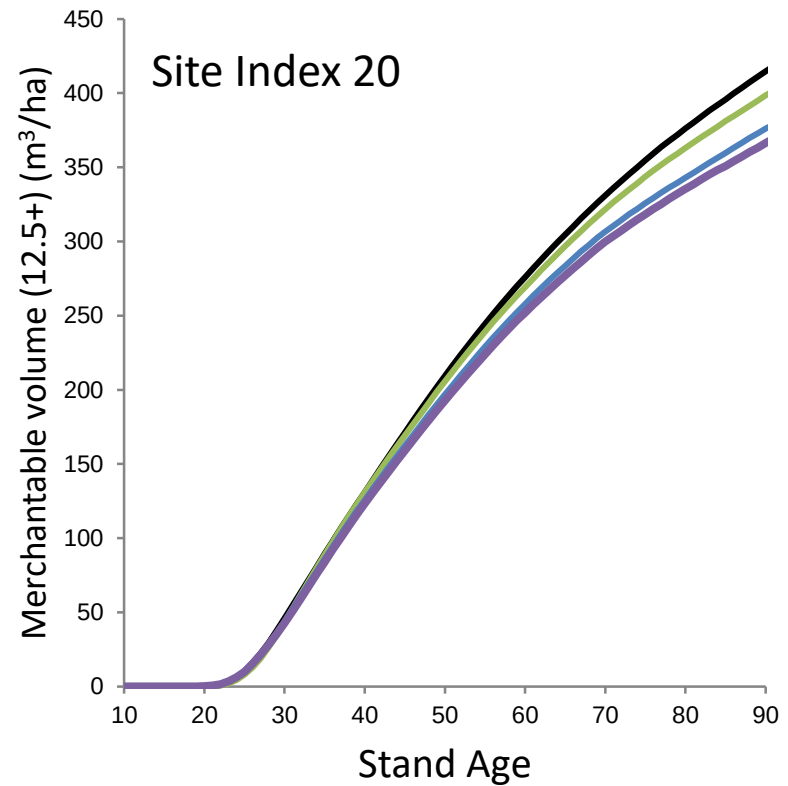
Financial Analysis

- A financial analysis was done to support the development of the FFT repression density decision key.
- Over 700 TASS runs for pure PI across a wide range of site indices and spacing scenarios including strip and cross-hatched leave patterns.
- Custom bucking routine was run to merchandize trees into industrial log sorts.
- Site Value analysis was used as it accounts for future stands. This is critical as a key difference between spaced and unspaced repressed stands is a difference in rotation length.

TASS – Strip Spacing

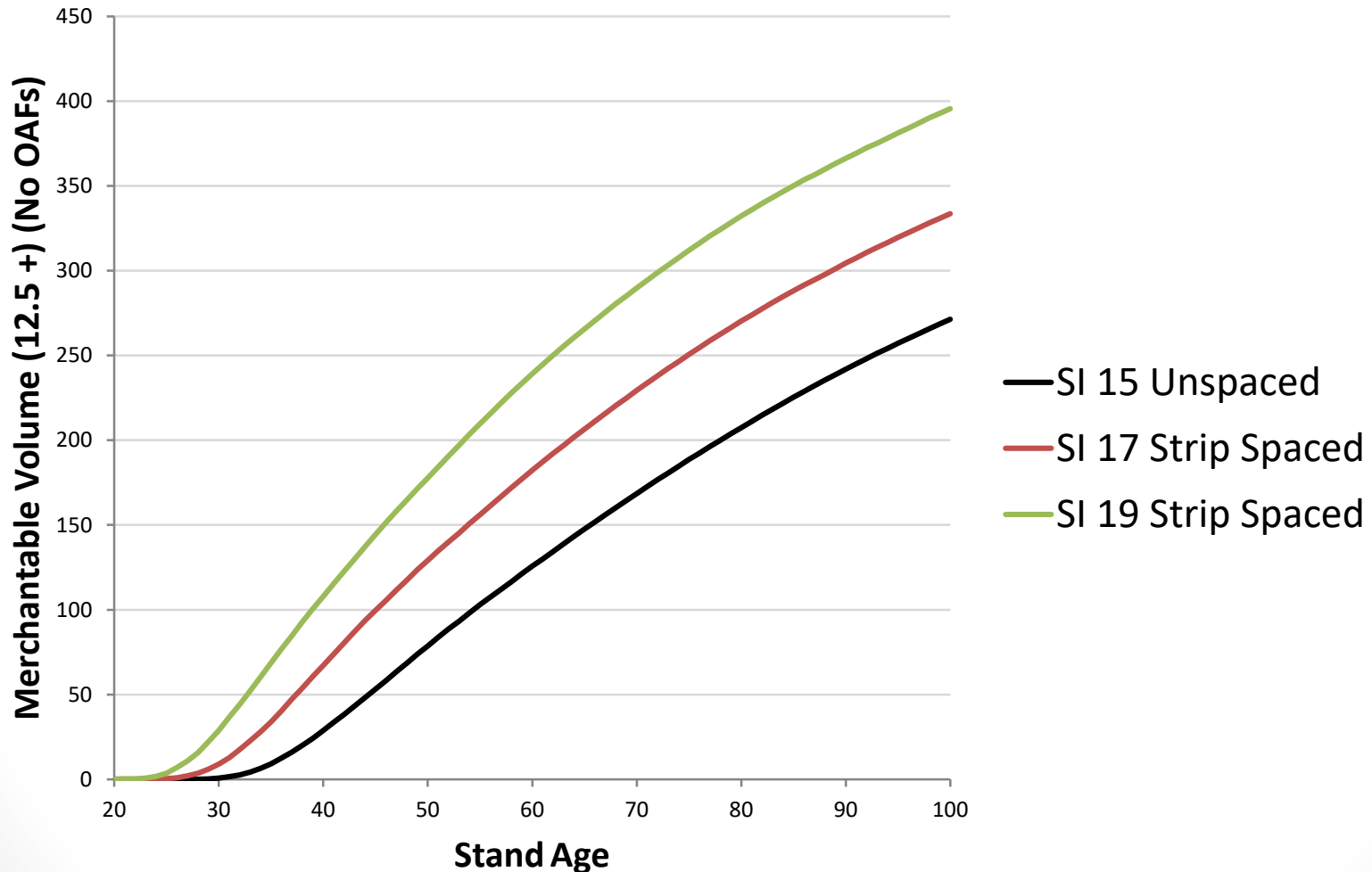


Merch Volume vs Age



— Unspaced — Strip — Patch — Patch + Brushsaw

Merch Volume vs Age



Break Even Spacing Costs

- The break even spacing cost was defined as the cost that resulted in the site value of the spaced stand being equal to the site value of the unspaced stand.
- All financial analyses were done using the FFT prescribed discount rate of 2%.

Break Even Spacing Costs

Traditional Spacing to 4000 trees/ha

Site Index After Trtmt	Site Index Before Treatment			
	8	12	16	20
15	\$1,500	\$600		
16	\$2,000	\$1,000	-\$600	
17	\$2,500	\$1,400	-\$200	
18	\$3,100	\$2,000	\$300	
19	\$3,700	\$2,600	\$800	
20	\$4,400	\$3,200	\$1,400	-\$700
21	\$5,200	\$3,900	\$2,000	-\$100
22	\$6,100	\$4,600	\$2,600	\$500
23	\$7,000	\$5,400	\$3,300	\$1,100
24	\$7,800	\$6,000	\$3,900	\$1,700

FFT Decision Key – Guiding Concepts

- Repression can be quantified by a loss of site index.
- Repressed stands grow and develop (differentiate into crown classes) in a similar manner to unrepressed stands but at a much slower rate.
- Repression has been commonly observed in high density fire-origin PI stands and much less commonly in high density fire-origin Lw stands.
- Repression has not been observed in PHR stands of any species.
- The temporal ingress pattern of fire-origin stands is significantly different (shorter) than PHR stands.

FFT Decision Key – Guiding Concepts

- Financial analyses suggest that a minimum of 2-3 m site index loss is required to warrant treatment of stands (the lower the potential site index, the higher the loss required to warrant treatment).
- For the two case studies with data that allows us to predict site index loss as a function of initial density (Farnden and Herring 2002, Carlson and Johnstone 1983) the initial total stems/ha that resulted in a 2 m loss were 87,500 and 110,000 stems/ha. Minor amounts of repression start at lower densities.

FFT Decision Key – Guiding Concepts

- The value of treating repressed stands comes from releasing them from repression to grow at a faster rate (higher site index).
- Spacing stands that are not in repression decreases stand value.
- All recent financial analyses that include wood quality indicate that spacing PI stands will decrease stand value.
- This means there is a significant risk associated with simply assuming all stands above a certain density will go into repression and therefore need spacing.

FFT Decision Key – Guiding Concepts

- On any given site, the exact density at which fire-origin PI stands enter repression is not known. We do know that the probability of repression occurring increases with:
 - Increasing initial stand density
 - Decreasing site quality
- For example, it is possible (though unlikely) to have fire-origin PI stands that regenerated with less than 50,000 stems/ha go into repression, but it is also possible for stands that regenerate with more than 150,000 stems/ha not to go into repression (e.g., TFL 59 study – Thrower 2013).

FFT Decision Key: PHR Stands

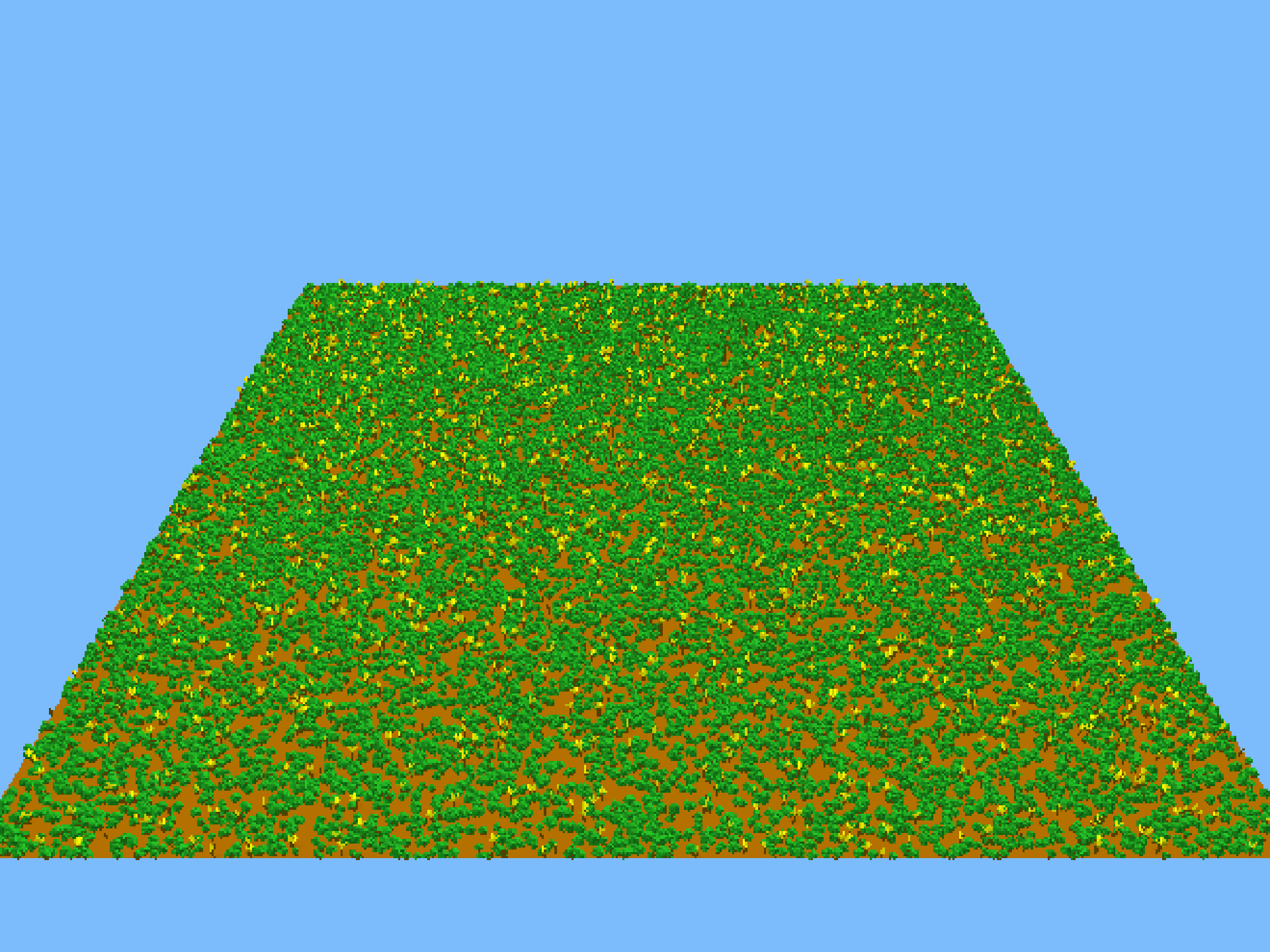
- Repression has not been observed in PHR stands of any species.
- The 150,000 stems/ha of dominant and co-dominants decision point was based on the best data currently available combined with the financial analyses.
- Note that this is not a “treat / do not treat” decision point, but rather a density above which one should assess the stand for possible repression.
- If you need a “treat / do not treat” decision point for stocking standards *it should be no lower* than 150,000 dominant / co-dominant stems.

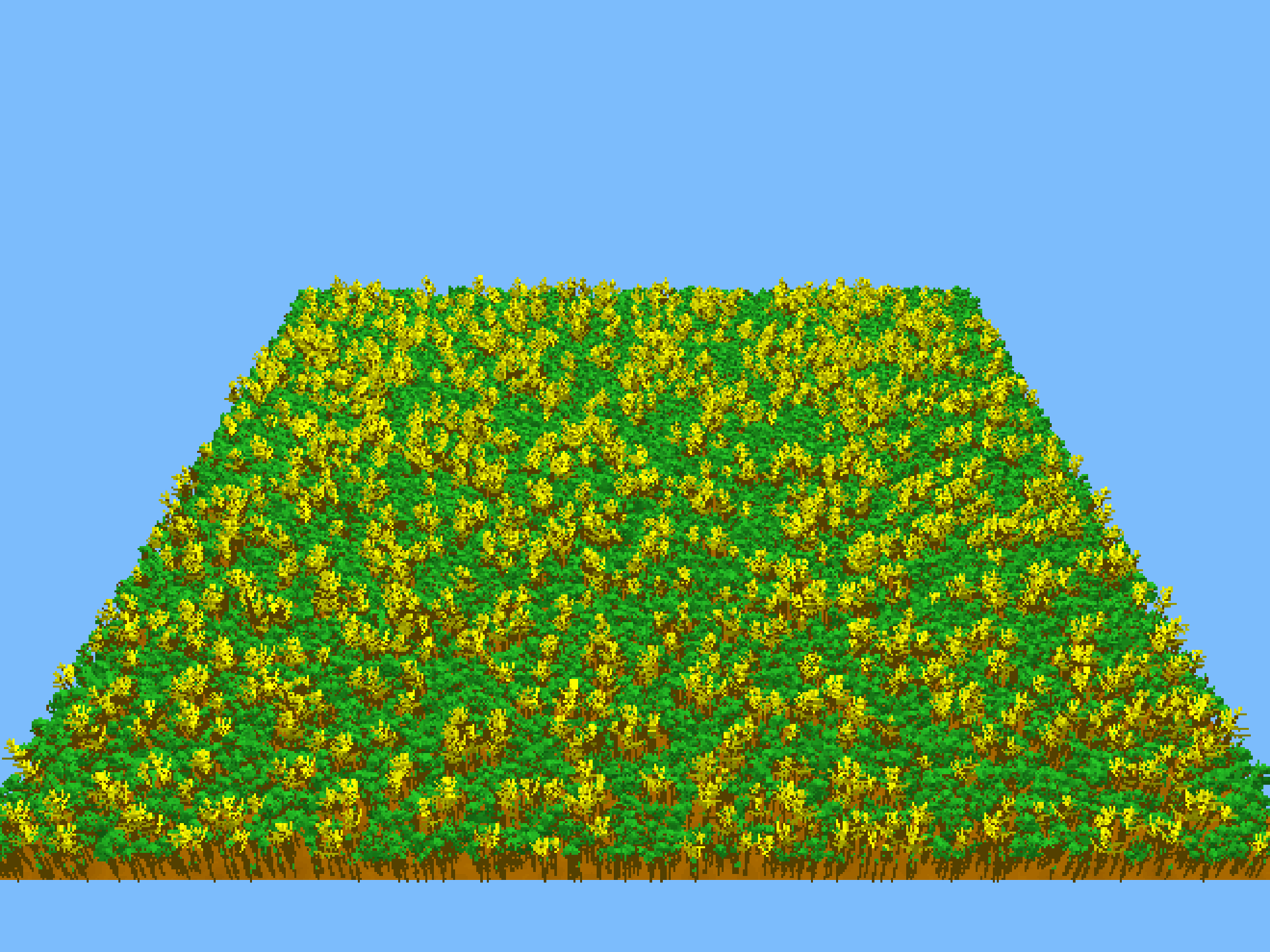
FFT Decision Key: Fire Origin Pl Stands

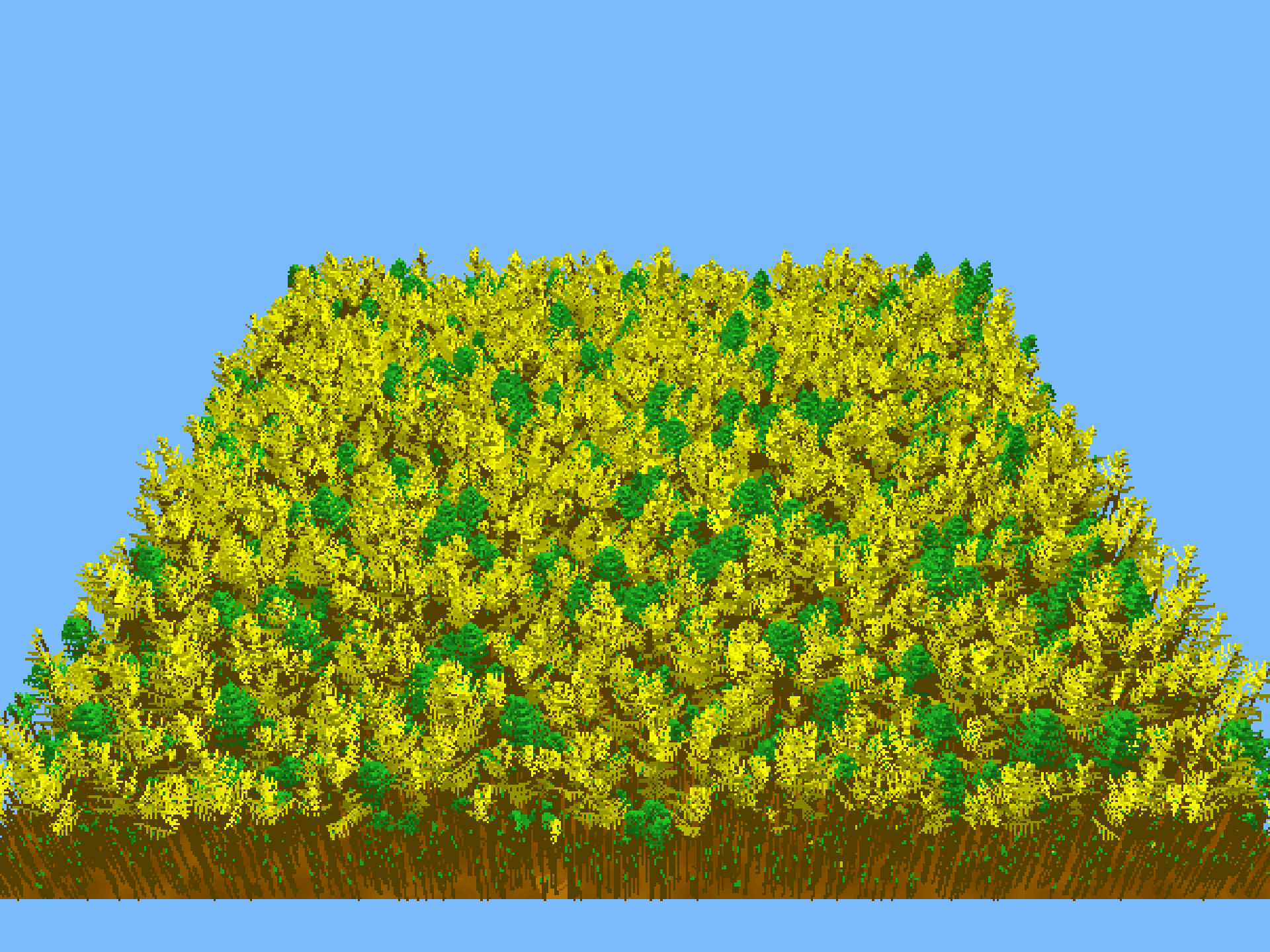
- Need to assess the number and distribution of Lw
- There is sufficient evidence to suggest that if Lw establishes immediately after a fire on non-dry sites it will often outcompete Pl and take over the site.
- On dry sites, there is a higher likelihood that the Pl will outcompete the Lw.
- Additionally, Lw regenerating a few years after Pl may not be able to catch up and outcompete the Pl.

Here is what the stand development looks like if Lw establishes immediately and is well distributed.

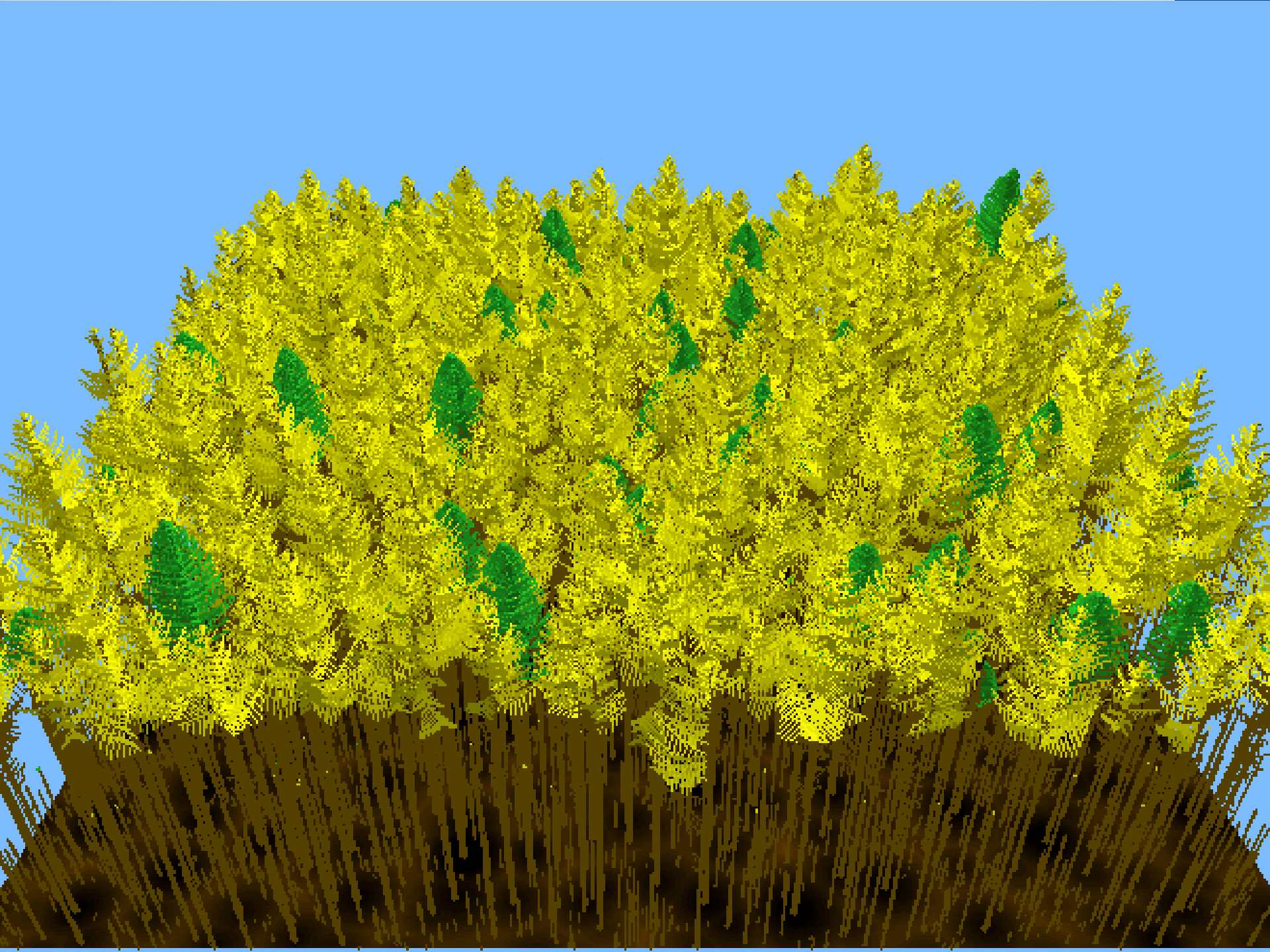
The following is a TASS simulation for 50,000 Pl and 4,000 Lw.

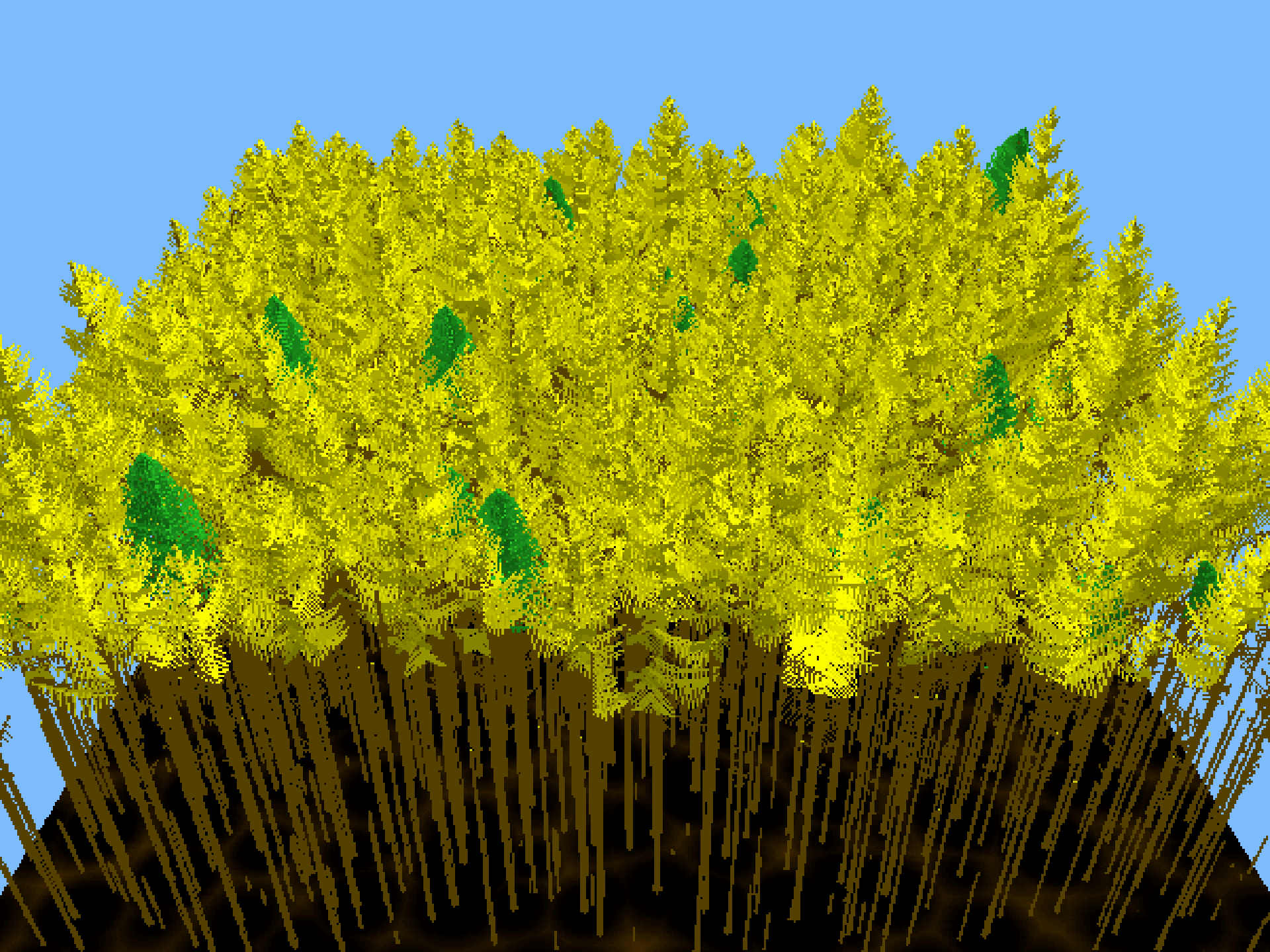












FFT Decision Key: Fire Origin Pl Stands

- The 50,000 stems/ha of dominant and co-dominants decision point was based on the best data currently available combined with the financial analyses.
- Note that this is not a “treat / do not treat” decision point, but rather a density above which one should assess the stand for possible repression.
- If you need a “treat / do not treat” decision point for stocking standards *it should be no lower* than 50,000 dominant / co-dominant stems.
- Recall – the 2 studies with data that allow us to predict SI loss as a function of initial density indicate 87,500 and 110,000 stems/ha needed for 2 m SI loss.

FFT Decision Key: Fire Origin Non Pl Stands

- The 150,000 stems/ha of dominant and co-dominants decision point was based on the best data currently available combined with the financial analyses.
- Note that this is not a “treat / do not treat” decision point, but rather a density above which one should assess the stand for possible repression.
- If you need a “treat / do not treat” decision point for stocking standards *it should be no lower* than 150,000 dominant / co-dominant stems.

Max Density Recommendations

- The following recommended densities are the lowest that should be used.

Stand Type	Dom/Co-Dom Trees/ha
PHR All Species	150,000
Fire Origin Pl with well distributed Lw on non-dry sites	Do Not Treat
Fire Origin Pl – no Lw	50,000
Fire Origin – all other species	150,000

Dominants

- Trees with crowns that extend above the general level of the trees immediately around the measured trees.
- They are somewhat taller than the codominant trees
- They have well-developed crowns, which may be somewhat crowded on the sides, receiving full light from above and partly from the side.

Co-dominants

- Trees with crowns forming the general level of the trees immediately around the measured trees.
- The crown is generally smaller than those of the dominant trees and is usually more crowded on the sides, receiving full light from above and little from the sides.

Intermediate

- Trees with crowns below, but extending into, the general level of the trees immediately around the measured trees.
- The crowns are usually small and quite crowded on the sides, receiving little direct light from above but none from the sides.

Suppressed

- Trees with crowns entirely below the general level of the trees around the measured trees, receiving no direct light either from above or from the sides.