April 2019 Revised Support Document for Updating CA Forest Practice Rules Stocking Standards from the William Main Seminar Research Group

Prepared for the April 2019 Board of Forestry Management Committee Meeting
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Introduction

The 1973 Z'Berg-Nejedly Forest Practice Act required restocking of California commercial forests after harvest such that minimum average point count or basal area levels were met in order to ensure a "cover of trees of commercial species" that properly utilize the growing space remaining after harvest. This requirement complemented the stated intent of the legislation: that "the productivity of timberlands is restored, enhanced, and maintained", and that the goal of high forest productivity for timber was achieved while also protecting the co-benefits forests provide. At the time this Act was passed, there was significant concern that low minimum restocking levels following harvest could lead to understocked forests with sub-par long term growth rates. In the time since its passage, changes in planting practices, genetic stock, fire frequency, insects and disease, and climate have led to the minimum point count requirements becoming out of alignment with optimal forest productivity across a wide range of attributes. Research from multiple agencies as well as empirical evidence from California's private landowners has shown that these requirements are in need of updating.

In 2014, Assembly Bill 2082 (Dahle) was approved by the Governor. AB-2082 authorized the State Board of Forestry to "adopt alternative stocking standards if those alternative standards reasonably address variables in forest characteristics and achieve suitable resource conservation, as provided." The passing of AB2082 created a new section in the California Forest Practice Rules, Section 4561.2, which specifically sates that the board may adopt alternative stocking standards "…if those alternative standards reasonably address the variables in forest characteristics, achieve suitable resource conservation, and contribute to specific forest health and ecological goals as defined by the board."

In response to AB-2082 and the creation of the FPR Section 4561.2, representatives from the University of California's William Main Seminar Research Group (WMSRG), the California Licensed Foresters Association (CLFA), and the California Forestry Association (CFA) began collaborating in 2017 to review evidence on how (and if) California's current stocking standards address the variables in forest characteristics, achieve suitable resource conservation and contribute to specific forest health and ecological goals. Initially, the WMSRG considered four different lines of evidence to guide our proposal for revising the point count stocking standards:

1. How long-term timberland owners reforest after severe wildfires when the FPR stocking standards do not apply to their large-scale voluntary reinvestment in reestablishing high productive forests and they are therefore allowed to apply new and innovative approaches.
2. Whether the FIA remeasurement data used in the AB-1504 reports presented to the Board of Forestry provide any support for the hypothesis that higher initial stocking standards are consistently related to desired higher net growth rates.
3. Feedback from Registered Professional Foresters (RPFs) regarding changes in the survival rates of seedlings, management techniques up to the time of the first commercial thinning, changes in the cost of conducting pre-commercial thinning (PCT), the future demand and price for PCT products as a bioenergy feedstock, and the increasing need to implement significant reductions in ladder fuels to at least slow the rapid increase in the prevalence of severe wildfires in timberlands.
4. A comparison of current and proposed California stocking standards compared to other more mesic Western States (OR, WA, ID) with similar forests, wildfire risks, and other mortality drivers.

1. Post fire reforestation practices in California

One of the best empirical tests of what are more appropriate stocking standards is what private landowners do when they reforest after a large wildfire, and thus do not have to meet the same standards as with post-harvest reforestation. Most private landowners engaged in post wildfire reforestation are responding by planting far fewer seedlings per acre than would be required under the FPRs after a planned harvest. Ordering fewer seedlings per acre reduces wastage of seeds from the seed zones where the fires are occurring, reduces the seedling costs per acre, and can reduce follow-up costs of vegetation management within the newly growing stands. Different foresters apply different stocking levels based on their professional assessments of what is appropriate given available resources and future potential. Below is a small sample of reforestation efforts following fires from the last 12 years, across a variety of site classifications:

2007 Moonlight Fire, Plumas County
Site II and III lands with some site IV
Seedlings planted at 220 TPA with some areas planted at 260 TPA across 12,000 acres
PCT currently underway

2009 Corral Fire, Lassen County
Site III and some site IV lands
Seedlings planted at 150 TPA across 1,850 acres
PCT required on approximately 10% of the reforested land

2014 Day Fire, Modoc County
Site II, III and IV lands
Seedlings planted at 170 TPA on 1/3 of the burn area and 220 TPA on the other 2/3 across 5,870 acres
PCT planned in the next 5 to 7 years

2016 Willard Fire, Lassen County
Site III land
Seedlings planted at 170 TPA in eastern portion and 220 TPA in western portion across 1,342 acres
PCT Planned in the next 5-7 years

None of the areas were planted at the current required minimum stocking standard, and many were planted at levels much closer to those proposed by the WMSRG. Land managers noted that in areas where PCT was necessary, considerably more slash would have been left behind and costs would have been $20-30 more per acre if they would have had to plant at the current post-harvest restocking rate of 300 TPA. In two of the above replanting efforts, the land managers noted that should they have been required to plant at 300 TPA there would not have been enough seed available to plant the entire area.

Not being constrained by the minimum stocking standard allows RPFs to employ innovative reforestation plans that are customized to specific sites – taking into account not just site class but factors such as neighboring ownership and desired stand structure post disturbance. For example, in areas where private timber lands abut National Forest lands, which have much higher fire probabilities, some strategic units are replanted to levels designed to maximize potential survival of at least some sawlog sized trees in the event of a highly probable future fire, rather than to maximize fire risk-free growth. The recent experiences of RPFs responsible for large-scale post fire reforestation efforts was a major source of empirical evidence on what modified minimum stocking standards should be in different situations around the state.

2. FIA remeasurement data analysis for even aged stands in California owned by corporate owners, non-corporate owners, and the National Forests

Since all private forests (except those that have been reforested after severe wildfires) were replanted to the 300/150 TPA standard, the remeasured FIA plots cannot provide us with data that compare different stocking standards in California. However, further analysis of the data presented in the AB-1504 reports delivered to the BOF compiled by Olaf Kuegler at the Pacific Northwest Research Station provides some insights into what determined historic growth rates. The net (growth & yield) growth rates for remeasured FIA plots are compared against the initial basal area per acre levels in Figure 2 (at the end of this proposal). The figures show net growth rates on the Y axis by increasing basal area per acre on the X axis by owner and grouped FIA site class. (Please note, the 6 FIA site classes do not exactly match or align with the site class designations in the California FPR but are similar.) Initial growth rates for basal area levels below the 60 (average of the 30-90 BA/acre subgroup) are roughly similar across ownerships, but larger differences show up at higher basal area levels where corporate lands always outperform the other ownerships. The basic pattern is that stands with higher basal area (and more leaf area) have higher net growth rates – but there are very large deviations from the median/mean trendline. Three key takeaway messages are:

1) that proscribed 'best practices' based on textbook patterns or mean empirical values WILL NOT be representative of all situations, as many sites are far below the mean and there are clearly some best practices shared by less than a quarter of sites;
2) on-going forest management actions designed and implemented by licensed professionals are going to be more important determinants of stand level growth rates than complex regulations concerning initial stocking standards or commercial thinning standards.
3) TPA or basal area per acre are not great predictors of net growth rates, as the upper quartile of stands after controlling for site class, initial basal area per acre, and ownership can be 3x as high as the lowest quartile. This suggests that the single line 'Langsaeter curve' referred to in the FPR definition of 'Adequate Site Occupancy' may not be very accurate for California.

3. Registered Professional Forester feedback

Through a survey of its members conducted in 2017, followed by a series of meetings and field trips in the fall of 2018, the California Licensed Foresters Association (CLFA) has gathered and provided the WMSRG with considerable feedback from foresters from around the state. As a part of the 2017 survey, members were specifically asked about the 300/150 stocking standard – whether they thought it was too low, too high, or just right. 68% of respondents reported that they thought the stocking standard was "too high". This number increases to 78% in the northern and southern districts (discounting the coast district). The field tours provided further insight from CLFA's membership, where foresters from across the state engaged in discussion about current stocking standards while observing various planting, thinning, and nursery operations at UC Berkeley's Blodgett Research Forest, Sierra Pacific Industries, and Green

Diamond Resource Company properties. Attendees noted the significant improvement in seedling quality and survival rates, pointing out that often they are planting trees only to thin a short time after, unnecessarily adding fuels to the landscape. Data collected at U.C. Berkeley's Blodgett Research Forest supports this feedback, showing planted seedling survival rates of between 87-96% across half a dozen species. Foresters across the state commented that they consider what site-specific stocking is appropriate for location, available resources (seeds, labor, contractors, etc.), landscape level risks (who are their neighbors and what are the probabilities of future fire sweeping onto newly planted site), and what future threats need to be considered over many decades as they make decisions in the first decade of stand initiation.

Additional discussion was had around the benefits of a lower stocking standard for small landowners. Attendees noted that current stocking standards require PCT to maintain forest health, which is often not financially viable for small land owners or is conducted outside of the optimal PCT window. Missing the optimal PCT window reduces initial investment but can also reduce net growth over the next 40 years and the overall return on investment.

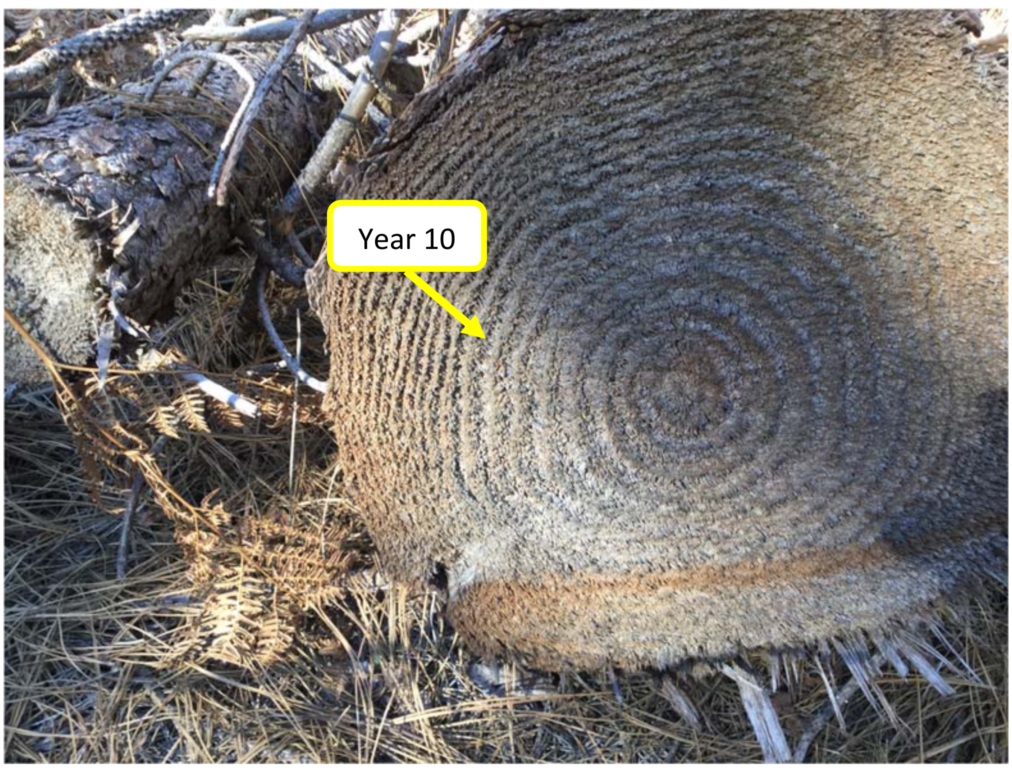


Figure 1: Cross section of tree that did not receive PCT within the optimal window. Note reduced growth rings following the 10-year mark.

This can be of particular importance to capital-limited family forest owners who often miss the optimal PCT window. PCT is labor intensive, and labor costs are increasing much faster than commodity prices for small diameter wood that must often be shipped to far off energy plants if the wood can even be sold (often at a loss). In addition, if the PCT trimmings are simply left on site, they add considerable dry fuel to stands (albeit for a short time period). Leaving trimmings is not uncommon if the low value wood cannot be economically removed.

4. Comparison of West Coast Stocking Standards and recommendation for new stocking standards

Ensuring that sufficient stocking is implemented is a consistent component of state forest practice regulations across western states. As pointed out by many on the CFLA Field Tours, Washington, Oregon, and Idaho all use lower stocking standards and a simpler breakdown of sites based on geographic location, dividing each state into two initial regional stocking standards. The following table compares the four western states, with a proposed revised stocking standard for California, with a basic comparison between coastal and interior sites.

Table 1: Comparison of TPA Stocking Standards for Western States

<table>
<tr><td>State</td><td colspan="3">Coastal</td><td colspan="3">Interior</td></tr>
<tr><td>WA</td><td colspan="3">190 avg, 150 min</td><td colspan="3">150 avg, 120 min</td></tr>
<tr><td>OR</td><td colspan="3">Site Productivity = 120+ cu ft/ac/yr</td><td colspan="2">Site Productivity = 50-119 cu ft/ac/yr</td><td>Site Prod = 20-49 cu ft/ac/yr</td></tr>
<tr><td>OR</td><td colspan="3">200</td><td colspan="2">125</td><td>100</td></tr>
<tr><td>ID</td><td>NA</td><td colspan="2">NA</td><td>North</td><td>South</td><td>South</td></tr>
<tr><td>ID</td><td>NA</td><td colspan="2">NA</td><td>170</td><td>125</td><td>125</td></tr>
<tr><td>CA</td><td>Site I, II</td><td>Site III</td><td>Site IV, V</td><td>Site I, II, III</td><td>Site IV</td><td>Site V</td></tr>
<tr><td>CA</td><td>300</td><td>300</td><td>150</td><td>300</td><td>150</td><td>150</td></tr>
<tr><td colspan="7">William Main Research Group Stocking Standards March 2019 Proposal</td></tr>
<tr><td>CA</td><td>200</td><td>125</td><td>100</td><td>125</td><td>100</td><td>100</td></tr>
</table>

More xeric conditions in California (vs the other western states) support a lower number of TPA proposed as the new stocking standards for California. Soil moisture is the limiting factor for seedling establishment in these conditions, and managing inter-tree competition through spacing is critical to forest health in our Mediterranean Climate. The proposed standards would move away from the 12’ spacing needed to meet the 300 TPA minimum, to spacing closer to 15’ to 20’ before PCT. The table below outlines the spacing (in feet) at different stocking levels.

Table 2: Comparison of TPA and average tree spacing

	Spacing (in feet) at Different Stocking Levels								
TPA	303	258	222	194	170	151	134	120	109
Avg. Spacing	12’*12’	13’*13’	14’*14’	15’*15’	16’*16’	17’*17’	18’*18’	19’*19’	20’*20’

Consulting foresters have pointed out that many owners with smaller properties will not perform the costly PCTs at the correct time and will end up carrying far too many trees that will compete with each other for limited resources. Larger landowners may also struggle to preform timely PCTs, as the 2018 California Forest Carbon Plan has already tasked them with a staggering amount of work – setting forth a goal of increasing the rate of forest restoration and fuels treatments on nonfederal forest lands from the recent average of 17,500 acres per year to 35,000 acres per year by 2020, and from 250,000 acres per year to 500,000 acres per year by 2020 on Federal forest lands.

<u>Forest Health and Ecological Goals</u>

Following the WMSRG’s presentation to the Management Committee in March 2019, additional research was conducted at the Committee’s request to better understand how a revised point-count stocking standard would contribute to forest health, and how it may help achieve specific resource goals. The WMSRG has examined how a lower stocking standard would help achieve four specific ecological goals:

1. Increased carbon sequestration
2. Improved fire resilience

3. Improved forest pest and disease resistance
4. Increased drought tolerance

1. Increased carbon sequestration

The 2018 California Carbon Plan lays out lofty goals for carbon sequestration in California in the coming years. It specifically calls on forest management to create "healthy and resilient net sinks of carbon that provide a range of ecosystem and societal benefits…" Lowering the minimum stocking standard and empowering RPFs who have local expertise to plant at the best rates for a given site is one step in improving forest management to enhance forest health and resilience.

Forest management plays an important role in carbon sequestration. Trees sequester carbon as they grow, making growth rates a critical aspect in carbon sequestration (Van Kooten et al., 1995). Although planting at higher rates may provide an initial increase in carbon sequestration, competition between trees, especially if a PCT is not conducted, will eventually slow growth rates and sequestration. There is considerable evidence that even delayed PCT leads to large reductions in annual growth increments (Gray, 2018).

Figure 2: On the right, a stand that experienced PCT within the ideal time frame (5-10 years after planting), at left a stand that was thinned "late" (not within 5-10 years of planting).

As recognized in the 2018 California Carbon Plan, some actions necessary to achieve the long-term goals for resilience and sequestration may result in short-term emissions or reduced carbon stocks. So is the case for a lower minimum stocking standard. A healthy, faster-growing forest with fewer trees will sequester more carbon in the long-term than an overstocked stand that stagnates early on (Forest Climate Action Team, 2018; Stephenson et al., 2014). A lower minimum stocking standard also helps prevent overly dense stand conditions, which can lead to increased carbon emissions via wildfire and tree mortality. Overstocked stands are more susceptible to wildfire, mortality from pests and disease and drought. These issues are addressed in the remaining three ecological goals.

2. Improved fire resilience

It is well documented that the probability of wildfires in California's conifer forests and other vegetation types has increased considerably since the 1970s when the current stocking standards were codified. All evidence also points to an unfortunate situation where losses from forest fires will only increase unless there are substantial changes in vegetation management or fire suppression practices. CAL FIRE's 2018 Strategic Fire Plan notes that the average annual acres of forestland burned in the 1970s was 50,000 in contrast to the average between 2010 and 2017, which was 250,000 acres – quintuple the land area burned when the Z'berg-Nejedly Forest Practice Act was authored. Trends identified in the Strategic Fire Plan also indicate that wildfire is only increasing, not just in area burned, but also in number of ignitions, fire severity and impacts to ecosystems.

The following figure summarizes recent research on the trends in wildfire probabilities for different land types in California.

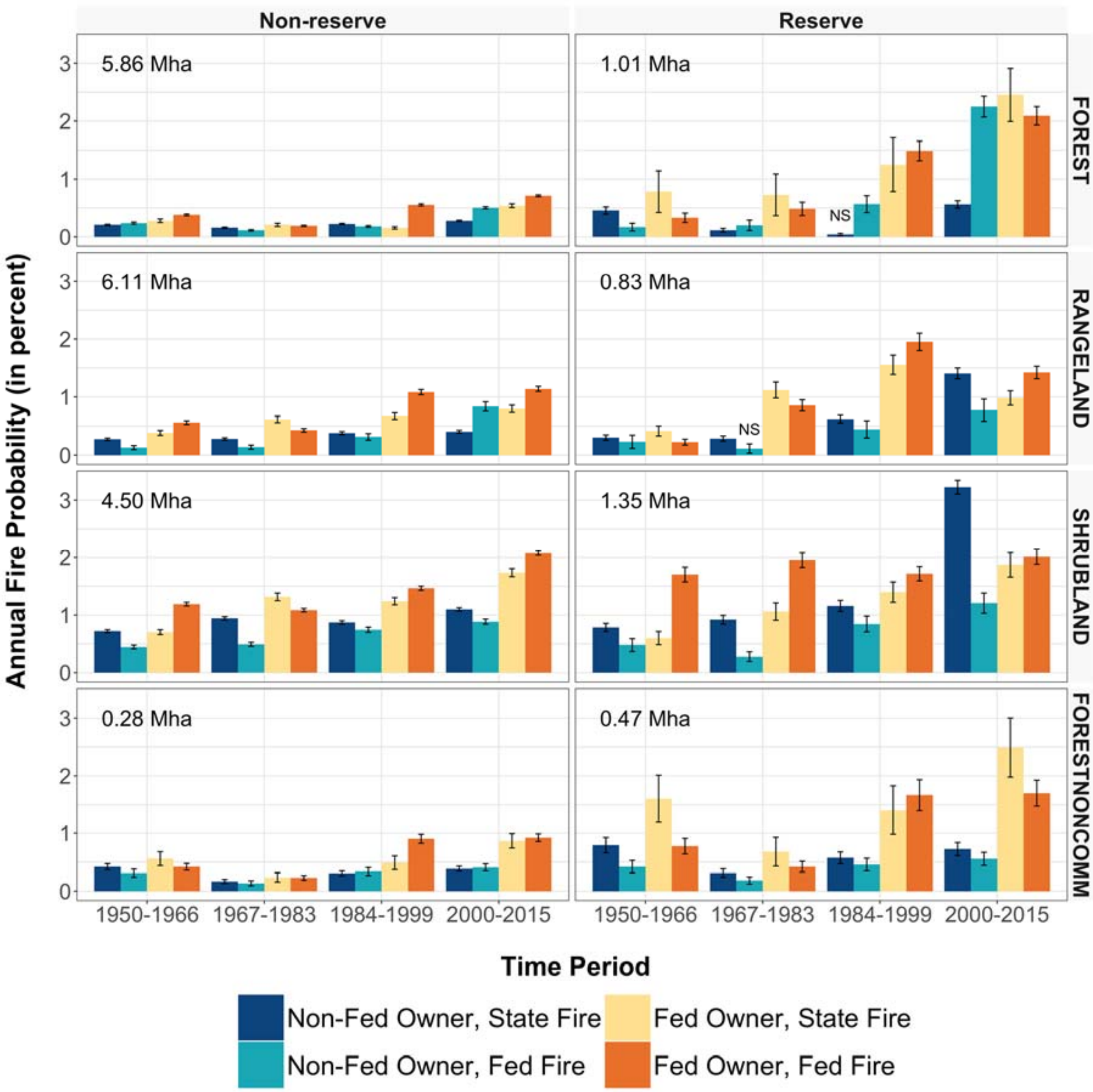


Figure 3: Annual fire probabilities for California landscapes. (Source Starrs et al. 2018)
http://iopscience.iop.org/10.1088/1748-9326/aaaad1 - open access web link

After separating wildfire rates by major vegetation types and ensuring that ecologically similar plots on private and federal land are compared, the trends are very clear – wildfire probabilities have doubled on private timberlands and quadrupled on National Forest timberlands since the 1970s.

As recognized by the California State Senate (SB-462), “surface and ladder fuels, when at unnaturally high densities, constitute 80 to 90 percent of the driving force for dangerous potential wildland fire behavior." California forests are experiencing increased tree densities, smaller average tree diameters and increasing surface fuel loads – all of which increase the likelihood of high severity, large-scale fires from which the forests cannot naturally recover (Stephens et al. 2016). The current stocking standard encourages overplanting in many areas, exacerbating the conditions identified above and potentially leading to extensive and severe wildfires. Loss of life, structures, critical habitat and productive forest land are all issues associated with high-severity fires (State Board of Forestry, 2018). Additionally, wildfires are the largest source of carbon storage loss and greenhouse gas emissions from forested lands (Forest Climate Action Team, 2018). Per the 2018 California Carbon Plan, "of the estimated 150 million metric tons of carbon lost from forests from 2001-2010, approximately 120 million metric tons of carbon was lost through wildland fire. Wildfire also is the single biggest source of black carbon emissions."

Both the 2018 Strategic Fire Plan and the 2018 California Carbon Plan call for better management of wildland fire through fuels reduction, sustainable timber management practices, and long-term management changes. Lowering the stocking standard is just one of many tools that can be employed to achieve the goals of these plans. Empowering RPFs to determine site-specific appropriate stocking rates directly addresses one of the stated goals of the goals of the 2018 Strategic Fire Plan, which calls for the integrated implementation of "vegetative fuels management practices consistent with the priorities of landowners or managers." The current stocking rates, which require foresters to overplant seedlings that are expensive to remove via PCT and grow into ladder fuels if left unthinned, is not at all consistent with the current priorities of landowners and managers – especially as the climate changes and increasingly nuanced approaches to replanting California's forests are required.

3. Improved forest pest and disease resistance

Overstocked forests are more susceptible to forest pest and disease outbreaks at levels far beyond those associated with normal, cyclical outbreaks (Menzie et al., 2015). When planted too densely, trees are unable to access the resources (especially water) required for basic metabolic processes that allow them to resist pests and disease. Already stressed trees are further weakened by attacks, eventually leading to full tree mortality. As these highly competitive growing conditions occur throughout the state, attacks are now able to spread across areas far more massive than historical outbreaks.

Planting stands at levels closer to those desired when the trees reach maturity will allow trees the resources required to successfully fight attacks from pests and disease, without the need for repeated, costly human intervention. Given that seedling survival rates are often upwards of 85%, there is no need to plant at rates 3 to 10 times the desired final density.

4. Increased drought tolerance

Unprecedented drought in California is the underlying issue in both increases in high-severity fires and unprecedented pest and disease outbreaks. Tree ring data indicates that the levels of drought seen most recently (2012-2014), had only been seen a handful of times in the past several hundred years – less than one occurrence per century (Williams et al., 2015). In California's Mediterranean climate, water has always been a limiting resource. As anthropogenic causes will continue to contribute to warming throughout the state, it is likely that we will continue to see extreme droughts throughout the state.

Stands with fewer, larger trees are less likely to be water-stressed as the spacing will be at levels that reduce inter-tree competition for water (Sapsis et al., 2016). As noted above, reducing the stocking standard allows foresters to plant stands at levels closer to those desired when the trees reach maturity, creating a forest condition relies less on multiple, costly human interventions for their continued health.

Conclusion

As they currently exist, the stocking standards do not achieve suitable resource conservation, especially in light of the changing climate in California, nor do they reasonably address variables in forest characteristics. The purpose of the proposed change to the stocking standards is not to simply reduce levels of stocking across the state, but to allow RPFs the freedom to make site specific, innovative decisions when it comes to replanting post-harvest. We believe this management change will help empower landowners to improve management for carbon sequestration and other public benefits, as is called for in the 2018 California Carbon Plan. The standards proposed by the WMSRG provide only a revised minimum density, which must be met or exceeded. Many foresters will still prefer to initially plant at higher densities higher than the proposed new stocking standards to ensure that they have the desired number of seedlings by the desired species mix and/or young trees that exhibit better than average growth characteristics.

RPFs have the local expertise and experience necessary to best determine proper stocking within any one site. The process of becoming a RPF in California is challenging – one of the most difficult licensing processes in the United States. A burden of responsibility is placed upon RPFs, not only by the Office of Professional Foresters Registration, but by the Z'berg-Nejedly Forest Practices Act (which contains nearly 40 instances in which it specifies that a RPF may make an alternative determination than what is recommended in the Act), to do what is best for the forest at the local level.

Proposed language changes

Included with this support document is the WMSRG's official rule-change plead. The plead document includes proposed language changes throughout the relevant sections of the Forest Practices Rules. Foresters have suggested different TPA for different site indexes and districts, as summarized below:

Main Points

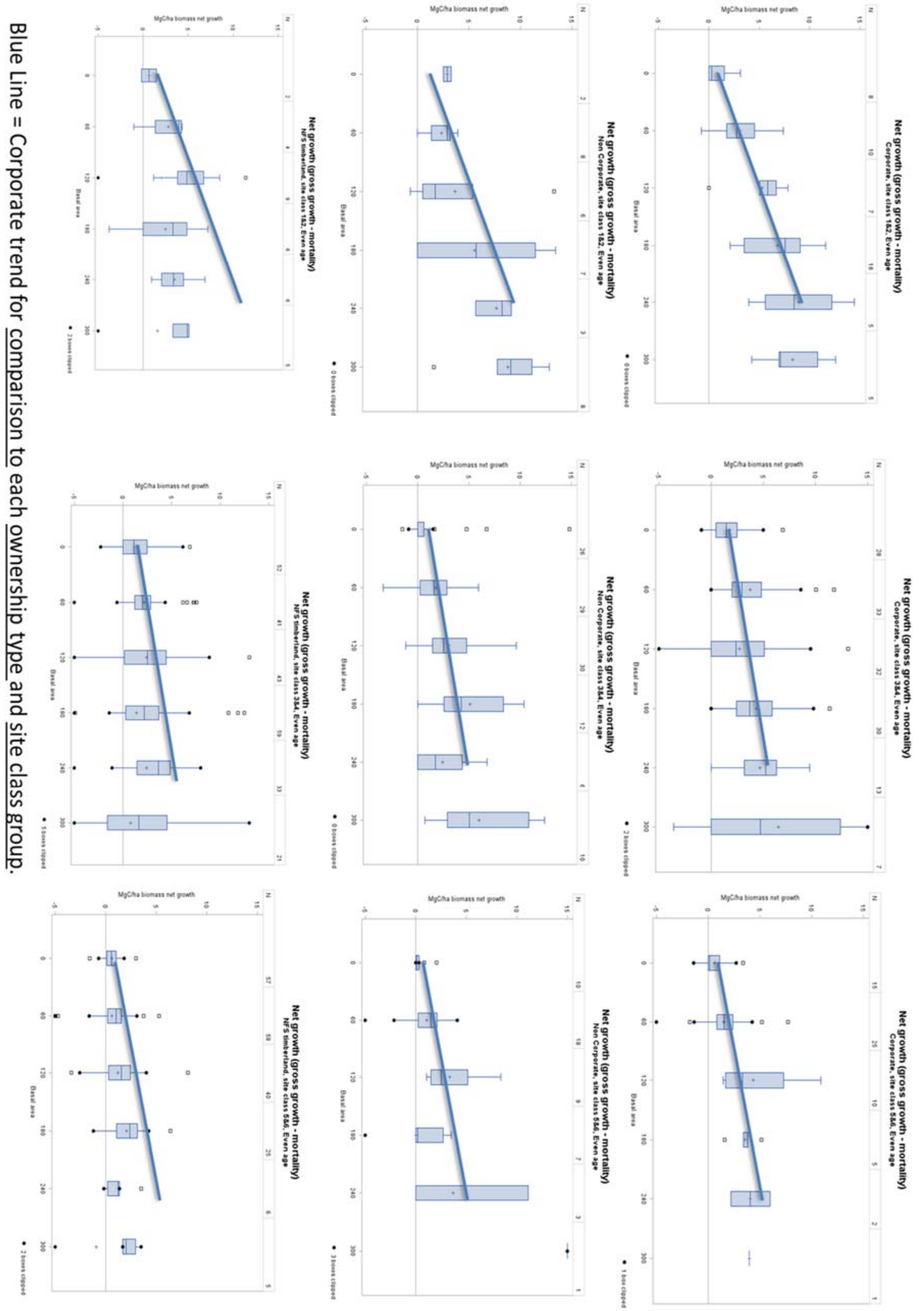
1. Separate sets of minimum TPA stocking standards for the higher fire risk soil water limitations in the Northern and Southern Districts, compared to the Coast District.
2. Southern Subdistrict TPA stocking standards are revised to reflect what appears to simply be a higher ratio from the baseline Coast standards.
3. No proposed changes in how stocking sampling is measured and evaluated

4. No proposed changes in the basal area-based stocking standards

Table 3: Summary of Proposed Point Count Stocking Standard changes

			FPR Site		
Districts	I	II	III	IV	V
Northern, Southern	125	125	125	100	100
Coast	200	200	125	100	100
Coast, Southern Subdistrict	300	300	200	200	200

Figure 4: The net (growth & yield) growth rates for remeasured FIA plots are compared against the initial basal area per acre levels



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