

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

3 Prepared for the April 2019 Board of Forestry Management Committee Meeting
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5

6 Introduction

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

20

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

29

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

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

53

54 *1. Post fire reforestation practices in California*

55 One of the best empirical tests of what are more appropriate stocking standards is what private
56 landowners do when they reforest after a large wildfire, and thus do not have to meet the
57 same standards as with post-harvest reforestation. Most private landowners engaged in post
58 wildfire reforestation are responding by planting far fewer seedlings per acre than would be

59 required under the FPRs after a planned harvest. Ordering fewer seedlings per acre reduces
60 wastage of seeds from the seed zones where the fires are occurring, reduces the seedling costs
61 per acre, and can reduce follow-up costs of vegetation management within the newly growing
62 stands. Different foresters apply different stocking levels based on their professional
63 assessments of what is appropriate given available resources and future potential. Below is a
64 small sample of reforestation efforts following fires from the last 12 years, across a variety of
65 site classifications:

66

67 2007 Moonlight Fire, Plumas County

68 Site II and III lands with some site IV

69 Seedlings planted at 220 TPA with some areas planted at 260 TPA across 12,000 acres

70 PCT currently underway

71

72 2009 Corral Fire, Lassen County

73 Site III and some site IV lands

74 Seedlings planted at 150 TPA across 1,850 acres

75 PCT required on approximately 10% of the reforested land

76

77 2014 Day Fire, Modoc County

78 Site II, III and IV lands

79 Seedlings planted at 170 TPA on 1/3 of the burn area and 220 TPA on the other 2/3

80 across 5,870 acres

81 PCT planned in the next 5 to 7 years

82

83 2016 Willard Fire, Lassen County

84 Site III land

85 Seedlings planted at 170 TPA in eastern portion and 220 TPA in western portion across

86 1,342 acres

87 PCT Planned in the next 5-7 years

88

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

96

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

106

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

109 Since all private forests (except those that have been reforested after severe wildfires) were
110 replanted to the 300/150 TPA standard, the remeasured FIA plots cannot provide us with data
111 that compare different stocking standards in California. However, further analysis of the data
112 presented in the AB-1504 reports delivered to the BOF compiled by Olaf Kuegler at the Pacific
113 Northwest Research Station provides some insights into what determined historic growth rates.
114 The net (growth & yield) growth rates for remeasured FIA plots are compared against the initial
115 basal area per acre levels in Figure 2 (at the end of this proposal). The figures show net growth
116 rates on the Y axis by increasing basal area per acre on the X axis by owner and grouped FIA site

117 class. (Please note, the 6 FIA site classes do not exactly match or align with the site class
118 designations in the California FPR but are similar.) Initial growth rates for basal area levels
119 below the 60 (average of the 30-90 BA/acre subgroup) are roughly similar across ownerships,
120 but larger differences show up at higher basal area levels where corporate lands always
121 outperform the other ownerships. The basic pattern is that stands with higher basal area (and
122 more leaf area) have higher net growth rates – but there are very large deviations from the
123 median/mean trendline. Three key takeaway messages are:

124 1) that proscribed ‘best practices’ based on textbook patterns or mean empirical values WILL
125 NOT be representative of all situations, as many sites are far below the mean and there are
126 clearly some best practices shared by less than a quarter of sites;

127 2) on-going forest management actions designed and implemented by licensed professionals
128 are going to be more important determinants of stand level growth rates than complex
129 regulations concerning initial stocking standards or commercial thinning standards.

130 3) TPA or basal area per acre are not great predictors of net growth rates, as the upper quartile
131 of stands after controlling for site class, initial basal area per acre, and ownership can be 3x as
132 high as the lowest quartile. This suggests that the single line ‘Langsaeter curve’ referred to in
133 the FPR definition of ‘Adequate Site Occupancy’ may not be very accurate for California.

134

135 *3. Registered Professional Forester feedback*

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

146 Diamond Resource Company properties. Attendees noted the significant improvement in
147 seedling quality and survival rates, pointing out that often they are planting trees only to thin a
148 short time after, unnecessarily adding fuels to the landscape. Data collected at U.C. Berkeley's
149 Blodgett Research Forest supports this feedback, showing planted seedling survival rates of
150 between 87-96% across half a dozen species. Foresters across the state commented that they
151 consider what site-specific stocking is appropriate for location, available resources (seeds,
152 labor, contractors, etc.), landscape level risks (who are their neighbors and what are the
153 probabilities of future fire sweeping onto newly planted site), and what future threats need to
154 be considered over many decades as they make decisions in the first decade of stand initiation.
155 Additional discussion was had around the benefits of a lower stocking standard for small
156 landowners. Attendees noted that current stocking standards require PCT to maintain forest
157 health, which is often not financially viable for small land owners or is conducted outside of the
158 optimal PCT window. Missing the optimal PCT window reduces initial investment but can also
159 reduce net growth over the next 40 years and the overall return on investment.



160
161 Figure 1: Cross section of tree that did not receive PCT within the optimal window. Note
162 reduced growth rings following the 10-year mark.
163

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

170

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

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

179

180 Table 1: Comparison of TPA Stocking Standards for Western States

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

181 More xeric conditions in California (vs the other western states) support a lower number of TPA
 182 proposed as the new stocking standards for California. Soil moisture is the limiting factor for
 183 seedling establishment in these conditions, and managing inter-tree competition through
 184 spacing is critical to forest health in our Mediterranean Climate. The proposed standards would
 185 move away from the 12’ spacing needed to meet the 300 TPA minimum, to spacing closer to
 186 15’ to 20’ before PCT. The table below outlines the spacing (in feet) at different stocking levels.
 187

188 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’ |

189
 190 Consulting foresters have pointed out that many owners with smaller properties will not
 191 perform the costly PCTs at the correct time and will end up carrying far too many trees that will
 192 compete with each other for limited resources. Larger landowners may also struggle to perform
 193 timely PCTs, as the 2018 California Forest Carbon Plan has already tasked them with a
 194 staggering amount of work – setting forth a goal of increasing the rate of forest restoration and
 195 fuels treatments on nonfederal forest lands from the recent average of 17,500 acres per year to
 196 35,000 acres per year by 2020, and from 250,000 acres per year to 500,000 acres per year by
 197 2020 on Federal forest lands.

198
 199 Forest Health and Ecological Goals

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

- 205 1. Increased carbon sequestration
- 206 2. Improved fire resilience

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

209

210 *1. Increased carbon sequestration*

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

217

218 Forest management plays an important role in carbon sequestration. Trees sequester carbon
219 as they grow, making growth rates a critical aspect in carbon sequestration (Van Kooten et al.,
220 1995). Although planting at higher rates may provide an initial increase in carbon
221 sequestration, competition between trees, especially if a PCT is not conducted, will eventually
222 slow growth rates and sequestration. There is considerable evidence that even delayed PCT
223 leads to large reductions in annual growth increments (Gray, 2018).



224

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

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

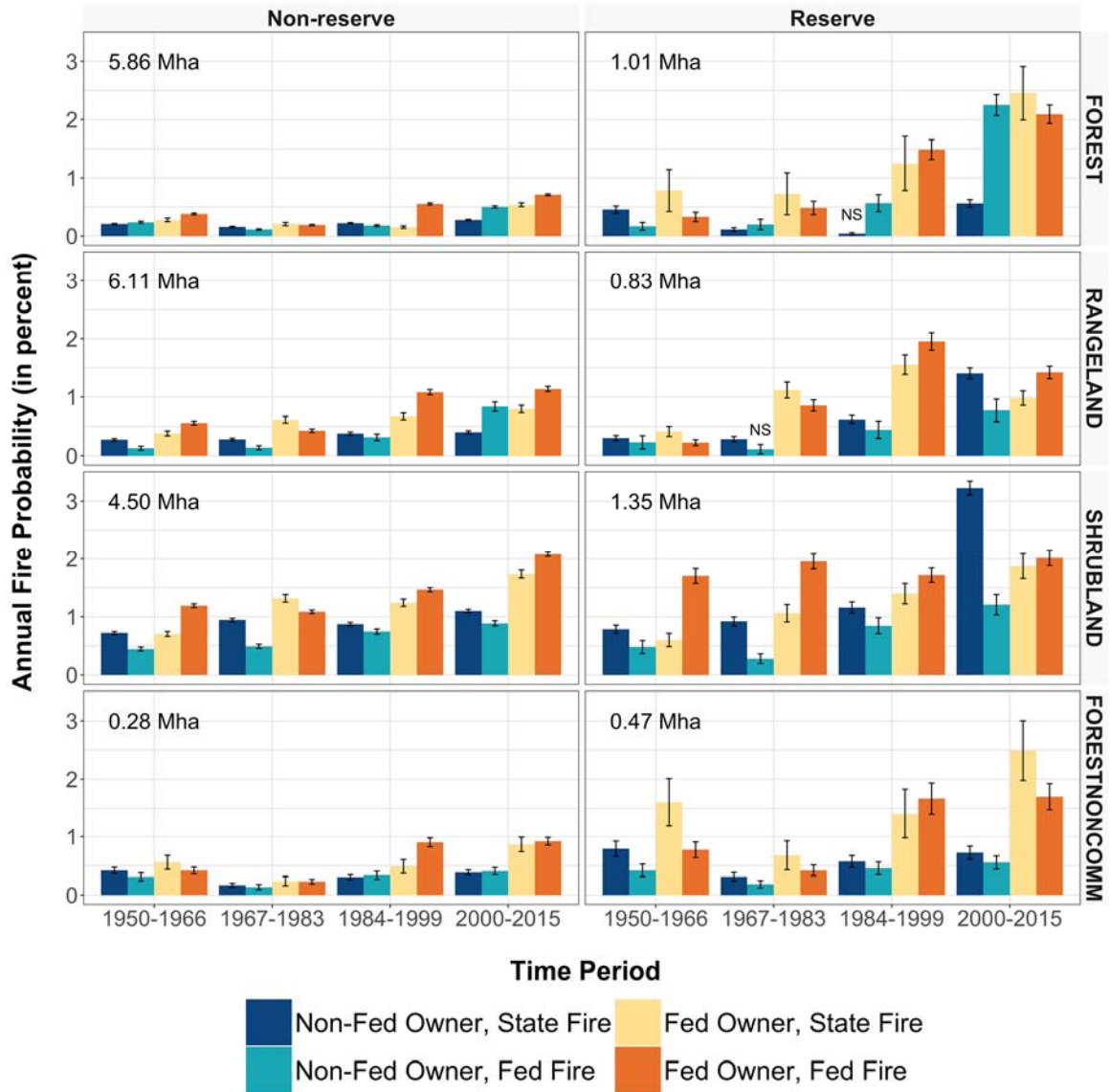
236

237 *2. Improved fire resilience*

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

248

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



251
 252 Figure 3: Annual fire probabilities for California landscapes. (Source Starrs et al. 2018)
 253 <http://iopscience.iop.org/10.1088/1748-9326/aaaad1> - open access web link
 254

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

259
 260 As recognized by the California State Senate (SB-462), “surface and ladder fuels, when at
 261 unnaturally high densities, constitute 80 to 90 percent of the driving force for dangerous

262 potential wildland fire behavior.” California forests are experiencing increased tree
263 densities, smaller average tree diameters and increasing surface fuel loads – all of which
264 increase the likelihood of high severity, large-scale fires from which the forests cannot
265 naturally recover (Stephens et al. 2016). The current stocking standard encourages
266 overplanting in many areas, exacerbating the conditions identified above and potentially
267 leading to extensive and severe wildfires. Loss of life, structures, critical habitat and
268 productive forest land are all issues associated with high-severity fires (State Board of
269 Forestry, 2018). Additionally, wildfires are the largest source of carbon storage loss and
270 greenhouse gas emissions from forested lands (Forest Climate Action Team, 2018). Per the
271 2018 California Carbon Plan, “of the estimated 150 million metric tons of carbon lost from
272 forests from 2001-2010, approximately 120 million metric tons of carbon was lost through
273 wildland fire. Wildfire also is the single biggest source of black carbon emissions.”

274
275 Both the 2018 Strategic Fire Plan and the 2018 California Carbon Plan call for better
276 management of wildland fire through fuels reduction, sustainable timber management
277 practices, and long-term management changes. Lowering the stocking standard is just one of
278 many tools that can be employed to achieve the goals of these plans. Empowering RPFs to
279 determine site-specific appropriate stocking rates directly addresses one of the stated goals
280 of the goals of the 2018 Strategic Fire Plan, which calls for the integrated implementation of
281 “vegetative fuels management practices consistent with the priorities of landowners or
282 managers.” The current stocking rates, which require foresters to overplant seedlings that
283 are expensive to remove via PCT and grow into ladder fuels if left unthinned, is not at all
284 consistent with the current priorities of landowners and managers – especially as the climate
285 changes and increasingly nuanced approaches to replanting California’s forests are required.

286
287 *3. Improved forest pest and disease resistance*

288 Overstocked forests are more susceptible to forest pest and disease outbreaks at levels far
289 beyond those associated with normal, cyclical outbreaks (Menzie et al., 2015). When planted
290 too densely, trees are unable to access the resources (especially water) required for basic

291 metabolic processes that allow them to resist pests and disease. Already stressed trees are
292 further weakened by attacks, eventually leading to full tree mortality. As these highly
293 competitive growing conditions occur throughout the state, attacks are now able to spread
294 across areas far more massive than historical outbreaks.

295
296 Planting stands at levels closer to those desired when the trees reach maturity will allow trees
297 the resources required to successfully fight attacks from pests and disease, without the need
298 for repeated, costly human intervention. Given that seedling survival rates are often upwards
299 of 85%, there is no need to plant at rates 3 to 10 times the desired final density.

300

301 *4. Increased drought tolerance*

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

309

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

315

316 Conclusion

317 As they currently exist, the stocking standards do not achieve suitable resource conservation,
318 especially in light of the changing climate in California, nor do they reasonably address variables
319 in forest characteristics. The purpose of the proposed change to the stocking standards is not to

320 simply reduce levels of stocking across the state, but to allow RPFs the freedom to make site
321 specific, innovative decisions when it comes to replanting post-harvest. We believe this
322 management change will help empower landowners to improve management for carbon
323 sequestration and other public benefits, as is called for in the 2018 California Carbon Plan. The
324 standards proposed by the WMSRG provide only a revised minimum density, which must be
325 met or exceeded. Many foresters will still prefer to initially plant at higher densities higher than
326 the proposed new stocking standards to ensure that they have the desired number of seedlings
327 by the desired species mix and/or young trees that exhibit better than average growth
328 characteristics.

329

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

337

338 Proposed language changes

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

343 Main Points

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

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

350

351 Table 3: Summary of Proposed Point Count Stocking Standard changes

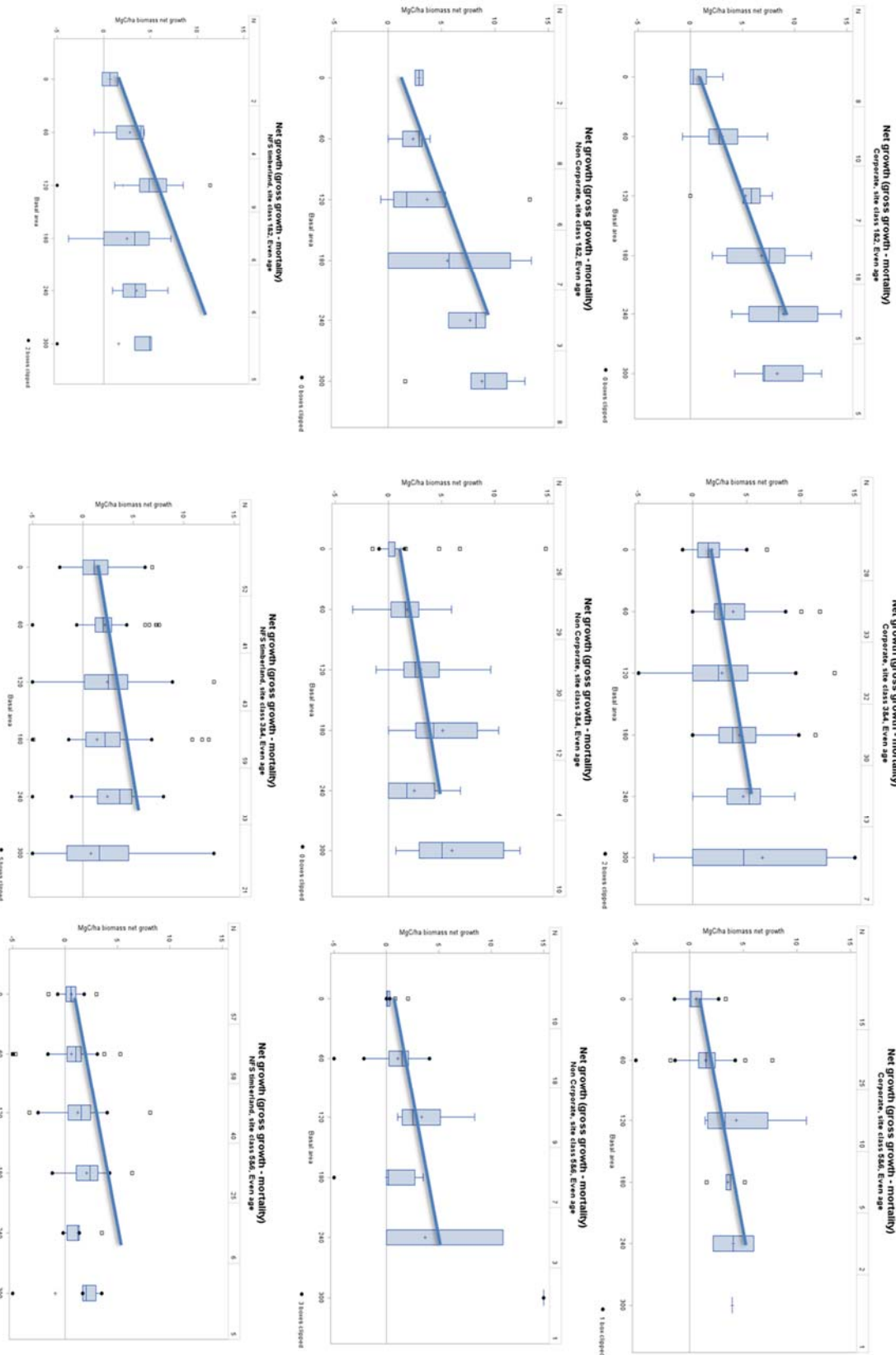
| | | | FPR Site | | |
|-----------------------------------|-----|-----|----------|-----|-----|
| Districts | I | II | III | IV | V |
| Northern, Southern | 125 | 125 | 125 | 100 | 100 |
| Coast | 200 | 200 | 125 | 100 | 100 |
| Coast, Southern Subdistrict | 300 | 300 | 200 | 200 | 200 |

352

353

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

Blue Line = Corporate trend for comparison to each ownership type and site class group.



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