Beyond Zone 1: Monitoring of Fire Hazard Reduction Within 300 Feet of Residences Through Timber Harvest with the §1038(c)(6) Exemption

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A note for reading this report: The nature of monitoring complex regulatory frameworks and ecological variables in a rapid manner involves detailed, sometimes complicated analysis. To help readers, this report includes:

- A detailed Executive Summary of the full report and key findings
- Gray text boxes and **bolded text** within the main body of the report to highlight and summarize each section or important findings, followed by detailed analysis results for readers that wish to know more about the outcomes of the monitoring.

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EXECUTIVE SUMMARY

Beyond Zone 1: Monitoring of Fire Hazard Reduction Within 300 Feet of Residences Through Timber Harvest with the §1038(c)(6) Exemption

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As part of ongoing monitoring of timber harvests that are exempt from the Timber Harvesting Plan ("THP") process, this report focuses on the §1038(c)(6) Exemption (hereafter "(c)(6) Notice"), which allows for exempt commercial harvesting of timber within 300 feet of legally permitted and habitable structures. It is the third of such reports, following the report on Emergency Notice Use (Olsen et al., 2019) and 1038(c) 0-150 Foot Fire Hazard Reduction report (Olsen and Coe, 2021). The core intent of the (c)(6) Notice reads "**Trees that are located from one-hundred-fifty (150) feet up to three-hundred (300) feet from any point of an Approved and Legally Permitted Habitable Structure that complies with the California Building Standards Code may also be cut and removed for the purpose of reducing flammable materials and maintaining a fuelbreak…**"

The (c)(6) Notice compliments the §1038(c) Notice, which allows for more intensive tree harvesting within 150 feet of permitted structures. The (c)(6) Notice was first introduced in 2015 and nearly 250 Notices have been accepted by the California Department of Forestry and Fire Protection (CAL FIRE), with an average of 41 per year between 2016 and 2020, with an increase in usage in recent years. The most prevalent usage of the (c)(6) Exemption has been in the Cascade and Coast Forest Practice Areas (FPA), with extensive usage in Humboldt, Siskiyou, Mendocino, Nevada, and Shasta counties. From 2015 through April 2021, a total of seven (c)(6) Notices have had Forest Practice Rule (FPR) violations, or approximately 3% of all accepted Notices. The most frequently given violation related to a failure to adequately treat fuels created through timber harvesting.

To assess the efficacy of the (c)(6) Notice, we randomly sampled 35 (c)(6) Notices statewide, to achieve results with a 95% confidence level and margin of error of 8%. Generally, most (c)(6) Notices were relatively small in their spatial footprint and intensity, averaging 4.9 acres in reported harvest size for sampled Notices. Unlike the 1038(c) Notice, however, most (c)(6) Notices harvested a larger volume of timber. Most landowners treated one or two habitable structures on their property, while a very small minority treated the forest around a larger number of homes. Of the landowners who

reported financial estimates from operations, a majority reported either breaking even or a financial gain, with a minority reporting that operations and the treatment of their property resulted in a financial loss.

Watercourse protection was adequate on all (c)(6) Notices where watercourses were present, which occurred on 40% of the sampled Notices. Where sediment discharges occurred, they were largely related to crossings of watercourses by heavy equipment during operations, or from operations in close proximity to watercourses.

All sampled (c)(6) Notices had an average post-harvest slash depth below 18 inches per the FPRs, however there were often isolated individual instances of deeper slash depths. As the spatial extent of slash coverage increased, and maximum observed slash depth increased, overall mean slash depth generally increased as well as the size of residual slash pieces. Residual surface fuels were generally reduced by operations, or already minimal, with ladder fuels lacking vertical continuity into the crown, on average, on all sampled (c)(6) Notices. Mastication and chipping of surface fuels was observed on less than half of the Notices, and did not appear to have a relationship with landowner profit or cost from operations. Generally, areas with high unit area biomass, such as the north Coast, had more substantial post-harvest slash amounts and surface fuels. Sixty-percent of the (c)(6) Notices that underwent mastication had reduced taller ladder fuel height classes present, contrary to those that did not treat surface fuels with mastication where all ladder fuel heights were present on 55% of all Notices. However, mastication and chipping led to isolated instances of continuous fuelbeds that represented a potential short-term fire hazard.

Tree spacing, and the disruption of horizontal crown continuity, was varied throughout the sample, with an average of 74% of residual trees in crown contact on (c)(6) Notices following operations. Tree spacing generally decreased as slope within the operation area increased. Tree density and residual basal area did not have a clear relationship, even as basal area retention increased.

A minority of the sampled (c)(6) Notices did not meet basal area retention requirements per the FPRs. Similarly, a minority likely did not meet the FPR requirement to increase the quadratic mean diameter (QMD) on residual trees (11%). Of these two metrics, only 6% of the entire sample both failed to meet basal area and QMD requirements. This indicates that 6% of the statewide population does not focus harvesting on the smaller, more fire-prone trees, thereby failing to meet the intent of the Exemption. Where these instances occurred, multiple metrics including the size and number of harvested trees, size and number of residual trees, and disruption of surface fuels indicated the Exemption intent was not followed. There was overwhelming agreement between basal area retention standards and diameter size class of residual trees, such that frequently Notices retained the necessary basal area, retained the same diameter class (if not increasing it), and achieved various instances of surface and ladder fuel treatment. Where potential inconsistencies occurred relative to the FPRs, it was important to note individual project settings and pre-existing forest stand structure.

Intent is inherently difficult to assess, in particular quantitively, outside of relying on professional judgement and/or intensive sampling and assessment. We present multiple metrics to assess whether intent is achieved. These multiple lines of evidence indicate that a minority of the (c)(6) Notices failed to meet the desired intent of the Exemption.

The (c)(6) Notice, with the intent of reducing potential for crown fire proximal to structures, is not meant to stop wildfires, but rather to reduce or eliminate extreme fire behavior. Additional science-based guidance to licensed professionals, and integration into the FPRs, will benefit the public and hopefully reduce wildfire-related threats to homes. That said, this Exemption does not negate the need for additional steps, including home hardening and community-based fire hazard reduction. As such, we recommend several options for increasing the efficacy of the (c)(6) Notice for the public, and for simplifying regulatory options on the 1038(c)(6) Exemption:

Operational Recommendations

1) LTOs utilize whole-tree yarding as possible and appropriate in order to minimize residual slash within project areas that could negatively influence fire behavior. This is particularly important in areas with high unit area biomass.
2) Ensure that mastication and chipping treatments do not result in continuous fuel beds of small diameter, 1- and 10-hour fuels that may be receptive fuelbeds during hot and dry conditions.
3) Actively focus on removal of the smallest diameter trees, and in stands where only larger diameter trees are present, ensure horizontal continuity of tree crowns has been disrupted, in addition to eliminating vertical fuel continuity through surface fuel treatments and/or pruning the lower limbs of residual trees.

Policy Recommendations

1) CAL FIRE and the Board of Forestry and Fire Protection (BOF) revisit Technical Rule Addendum #4, and integrate explicit, science-based guidance for both the 1038(c) and 1038(c)(6) Notices relative to surface and ladder fuel treatments, with discrete performance-based outcome expectations.
2) Develop a regulatory framework outside of increasing QMD that is flexible, enforceable, and ensures modification of fire behavior.
    a. Basal area retention requirements in conjunction with expectations that post-harvest stands do not depart from a pre-harvest average diameter class (e.g., the wildlife habitat relationship size classes) may ensure both environmental protection and fire behavior modification, while being readily enforceable.
3) CAL FIRE and the BOF determine acceptable slash depth requirements and the acceptable methodology by which target metrics for slash treatment can be regulated.
    a. The best available science should be used to determine if 18 inches is in fact an acceptable depth of slash following timber harvesting, and determine if small concentrations of slash exceeding this depth are allowable.

Acknowledgments: Special thanks to CAL FIRE Exemption and Emergency Notice Monitoring Specialists' Dorus Van Goidsenhoven, Ross Mathewson, Michael Novak, Peter Smith, and Senior Environmental Scientist Roberta Lim for their efforts to complete field monitoring of the 1038(c)(6) Exemption Notice.

Will Olsen devised the monitoring protocol with revisions from Drew Coe and Pete Cafferata, in addition to feedback and changes from the aforementioned field crew. Will Olsen undertook the primary analysis and writing of this report in conjunction with Drew Coe. We'd like to thank numerous CAL FIRE Forest Practice Inspectors for their input, and Review Team agencies for their revisions. Thanks are owed to numerous timberland owners and licensed professionals for allowing access to their properties for this effort, and input from the perspective of the regulated public.

Beyond Zone 1: Monitoring of Fire Hazard Reduction Within 300 Feet of Residences Through Timber Harvest with the §1038(c)(6) Exemption

Introduction

Background

- **14 CCR §1038(c)(6), which exempts commercial timber harvesting from the Timber Harvesting Plan ("THP") process for the purpose of reducing fire hazard and creating fuel breaks within 150-300 feet of legally habitable structures, was first introduced in 2015.**
- **The 1038(c)(6) Exemption compliments the 1038(c) Exemption, which allows for more intensive commercial tree removal for fire hazard reduction within 150 feet of permitted structures, to help meet California Public Resource Code relative to defensible space goals.**

As part of the 2018 Senate Bill 901 and other legislation, monitoring is required of Exempt and Emergency timber harvesting on non-federal timberland in California. Previous monitoring included pilot work in 2018 (Olsen et al., 2019a), and monitoring of Emergency Notice timber harvests (Olsen et al., 2019b). These THP-exempt operations are done under Exemption and Emergency Notices ("EX-EM Notices"), which are non-discretionary timber harvest permits. This monitoring report focuses on the §1038(c)(6) Exemption, which allows for the thinning of commercial tree species within the area between 150 and 300 feet of residences. The §1038(c)(6) Exemption (hereafter "(c)(6)" or "300 Foot Exemption") was first adopted by the State Board of Forestry in 2015, and the regulatory language begins stating:

"Trees that are located from one-hundred-fifty (150) feet up to three-hundred (300) feet from any point of an Approved and Legally Permitted Habitable Structure that complies with the California Building Standards Code may also be cut and removed for the purpose of reducing flammable materials and maintaining a fuelbreak…"

The (c)(6) Exemption compliments the §1038(c) Exemption (**Figure 1**), which allows for more intensive commercial removal of trees within 150 feet of permitted structures to reduce fire hazard and meet Public Resource Code requirements for defensible space, and is one of the most widely used Exemption documents in the state of California (Olsen and Coe, 2021).

The (c)(6) rule language also outlines requirements to be achieved post-harvest, and sets certain numeric regulatory limits for basal area retention and quadratic mean diameter (QMD) following the harvesting of timber under the (c)(6). Following the previous report on the §1038(c) Exemption (Olsen and Coe, 2021), this document reports on the usage of the (c)(6) Exemption Notice, and findings of objective and rapid monitoring of randomly selected (c)(6) Notices statewide, with a focus on outcomes and intent with respect to the applicable Forest Practice Rules (FPRs).

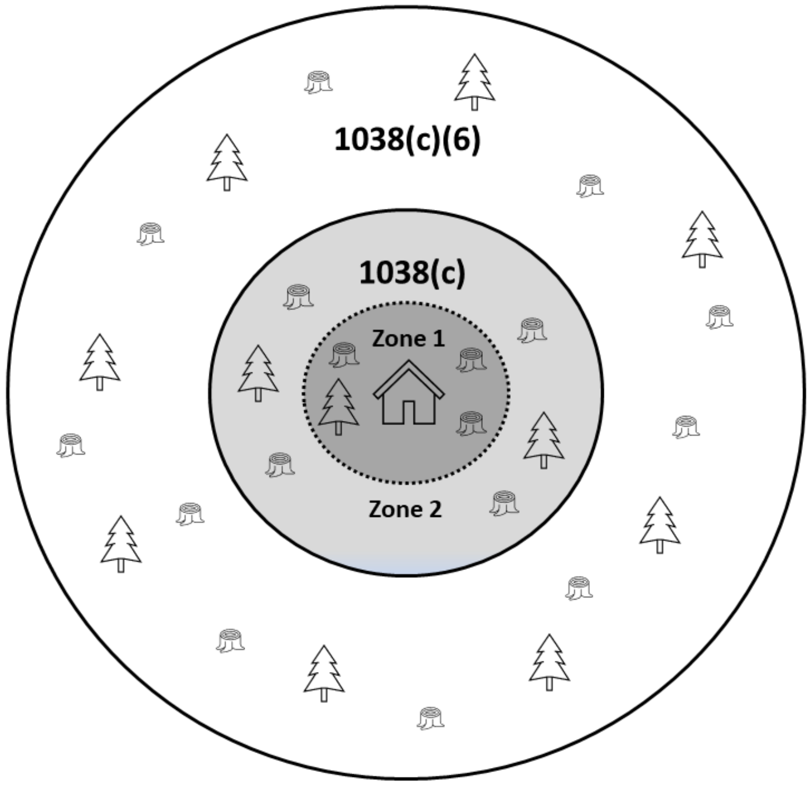

Figure 1: Schematic showing an idealized representation of how the 1038(c)(6) 150-300 foot Exemption complements the 1038(c) 0-150 foot Exemption. Darker shading represents more intensive harvesting, with a larger potential for fire behavior modification. Schematic not to scale.

§1038(c)(6) Exemption Usage and Forest Practice Rule Compliance

- **The use of the §1038(c)(6) Exemption has increased since it was introduced in 2015, with the most notable usage in the Coast and Cascade Forest Practice Areas.**
- **Humboldt, Siskiyou, Mendocino, Nevada, and Shasta counties were the top five counties to see usage of this Exemption in terms of percent of total accepted (c)(6)s from 2015 through 2020, with Humboldt County having over 25% of all accepted Notices in that time period.**
- **Just over 3%, or seven, of the (c)(6)s accepted between 2015 and 2020 had a violation of a Forest Practice Rule; these violations involved insufficient treatment of surface fuels from harvesting, i.e., slash, LTO/RPF failure to comply with the FPRs, unpermitted timberland conversions, and the use of prohibited silviculture such as clearcutting.**

Statewide §1038(c)(6) Usage

Since the introduction of the 300 Foot Exemption in 2015, nearly 250 of the Notices have been accepted by CAL FIRE, as of June 30, 2021. Yearly, as few as 10 and as many as 53 (c)(6)s have been accepted in that timeframe, averaging 41 Notices per year between 2016 and 2020.

Overall, the general trend has been a significant increase in submittal and acceptance of (c)(6) Notices, statewide, since 2015 (**Figure 3**). Of all accepted 300 Foot Exemptions since 2015, 48% were within the Coast Forest Practice Area (hereafter “FPA”), 44% in the Cascade FPA, and 8% were in the Sierra FPA.

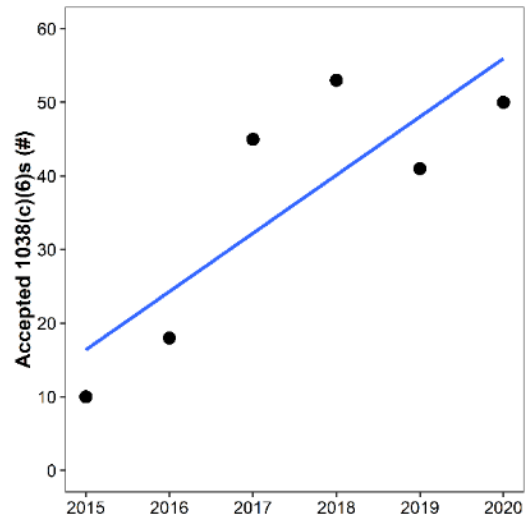

Figure 3: Total accepted 1038(c)(6)s, statewide, by year, from 2015 through 2020.

On a yearly basis, the Coast and Cascade FPAs contain the majority of (c)(6) Notices, with a minority accepted in the Sierra FPA (**Figure 2A**). At the county scale, Humboldt had over one quarter of all accepted 300 Foot Exemptions from 2015 through June 30, 2021. Siskiyou, Mendocino, Nevada, and Shasta counties also account for the remaining top five counties where timberland owners have used this Exemption (**Figure 2B**).

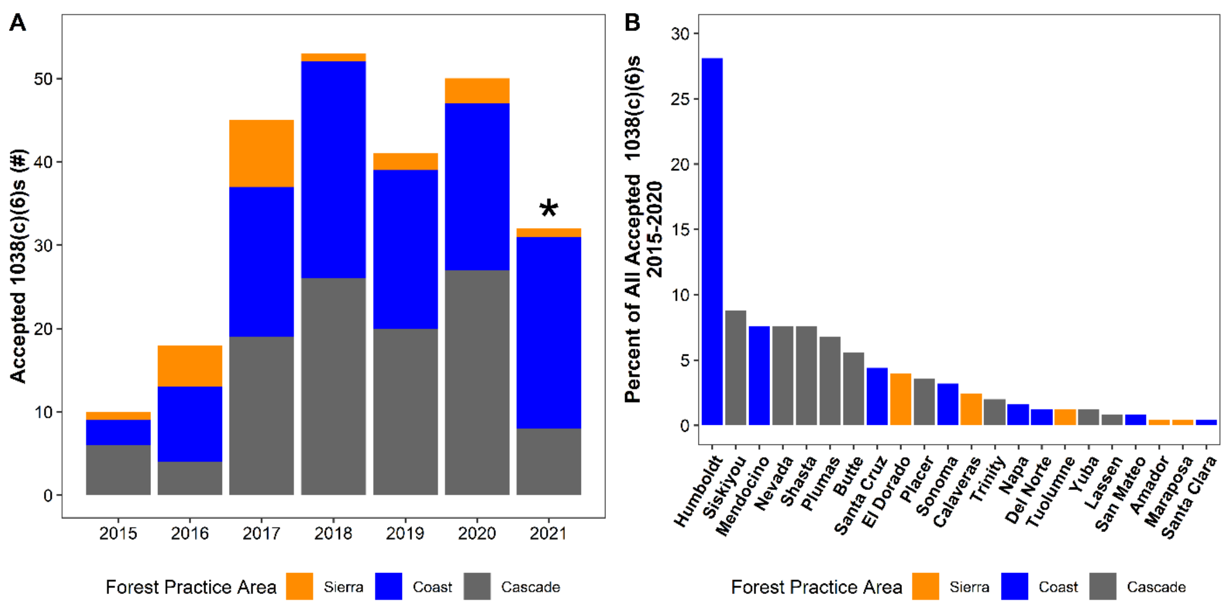

Figure 2: Accepted (c)(6) Notices by Forest Practice Area and year, A, and the percent of total accepted (c)(6)s from 2015 through 2020 by county, B. The ‘*’ above 2021 in A indicates data are through June 30, 2021 only.

§1038(c)(6) Forest Practice Rule Compliance

Based on a CalTREES record search through April of 2021 for (c)(6)s accepted between 2015 and 2020 (n = 217), seven individual 300 Foot Exemptions had at least one violation of the FPRs, for a total of 13 separate Rule violations.

These violations involved three (c)(6)s accepted in 2020, one (c)(6) from 2018, and three (c)(6)s from 2017. Of all (c)(6) Notices accepted by CAL FIRE from 2015 through 2020, these seven Notices represented 3.2% of that population. Therefore, out of 217 (c)(6) Notices, 3.2% involved a violation of the FPRs. In plain language summary, these violations are shown in **Table 1**, with the most numerous violations related to treatment of slash from timber harvest activity.

Table 1: Description and number of violations found on 1038(c)(6) Notices accepted from 2015 through 2020.

Plain Language Summary of Rule	Instances
Failure to treat or remove surface fuels created by timber harvest activity	5
LTO/RPF failure to comply with Forest Practice Rules including Notice of Commencement	3
Conversion of timberland without a permit	3
Use of prohibited Clearcutting, Seed Tree Removal, Shelterwood Removal silviculture	2

Monitoring Outline and Critical Questions

- **Monitoring was objective and random, with a focus on outcome and intent under the 1038(c)(6) Exemption.**
- **Monitoring was not enforcement oriented with a goal of issuing violations**
- **Monitoring was rapid, with a general focus on residual trees, harvested trees, surface fuels, and ladder fuels, in addition to watercourse assessments and qualitative data collection on each (c)(6).**

Our monitoring goal was ***not*** enforcement oriented with a goal of issuing violations or acting as an audit of regulatory efforts. Rather, our monitoring focused on the implementation and effectiveness of the Exemption, its value to the public, and as feedback to regulatory agencies and information to the regulated public.

Monitoring of the 300 Foot Exemption was objective and random. We sampled 35 randomly selected (c)(6)s (**Figure 4**), based on a two year average of 45 (c)(6) Notices accepted by CAL FIRE, with 40 and 50 accepted Notices in 2019 and 2020, respectively. The sample was stratified proportionately by FPA; that is, the sample was reflective of where the most Notices were accepted, statewide, by FPA. From 2019-2020, the Coast FPA averaged 44% of accepted Notices, the Cascade FPA 51%, and the Sierra FPA 5%. However, the dynamics of the COVID-

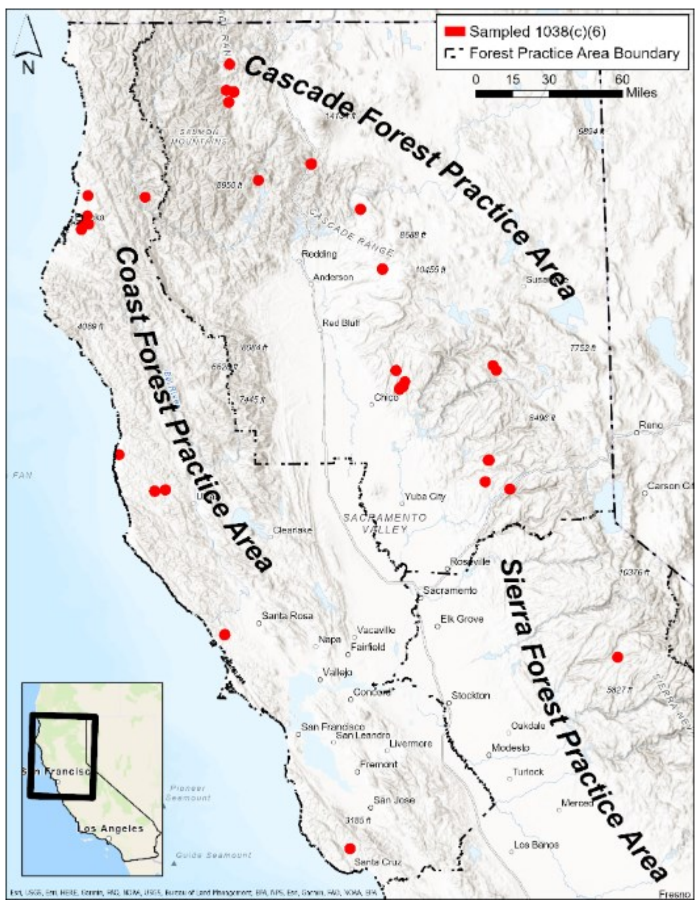

Figure 4: Map of sampled 1038(c)(6) Notices, with Forest Practice Areas shown.

19 pandemic, LTO and Registered Professional Forester (RPF) demand, timber markets, and landowner choices were such that not all accepted 300 Foot Exemptions underwent harvest or had completed harvesting during the span of monitoring work. As such, approximately 31% of the randomly selected (c)(6)s were in the Coast FPA, 66% in the Cascade FPA, and 3% in the Sierra FPA (**Figure 4**). Based on the two-year average of 45 Notices, our sample achieves a margin of error of 8% with a 95% confidence level.

Specific Methods

Field monitoring used an area-dependent number of fixed, 1/10th acre plots (37 feet, 2 inches in radius), based on the reported acreage on each (c)(6) and the accepted Exemption map (**Figure 5**). Plots were based off of an initial control point, and evenly spaced in areas representative of the timber harvest, as a semi-objective and rapid approach to sampling each Notice. This allowed flexibility to avoid sampling non-timber portions within the harvest map, due to the nature of being in close proximity to developed areas, and the sometimes irregular harvest areas associated with this Exemption (**Figure 5A**).

Measurements focused on the residual trees and stumps of trees harvested under the Notice, residual ladder fuel height classes and ladder fuel density, slash coverage, depth, and size (**Table 2**), in addition to data on additional plot treatments and qualities (e.g., mastication or dead standing tree presence).

Table 2: Assorted measurements made within each fixed plot on a (c)(6) Notice.

Tree Metrics		**Stump Metrics**		**Other Metrics**
Species	**General species**	Species	**General species**	Pile presence: **Yes/No**
Health	**Live/Dead**	Diameter (stump)	**Inches**	Mastication/Chipping: **Yes/No**
Diameter	**Inches**	Distance to nearest tree	**Feet**	Dead standing non-commercial tree >6" DBH: **Yes/No**
Height	**Feet**			Dead standing commercial tree >6" DBH: **Yes/No**
Tree crown base	**Feet**			Other pertinent notes
Crown-to-crown contact	**Yes/No**			4 Photos in cardinal directions
Distance to nearest tree	**Feet**			
Nearest tree type	**Conifer/HW**			
Distance to nearest stump	**Feet**			
Ladder Fuel Metrics:	Height classes: **0 Feet (None), < 2 Feet, 2 to 5 Feet, > 5 Feet** Dominant height class: **Most prevalent height class (ocular estimation)** Ladder Fuel Density: **< 33%, 33 to 66%, > 66% (Viewed from above, ocular estimation)**			
Slash Metrics:	Diameter, as Yes/No Presence :**(1hr [< 1/4"], 10hr [<1"], 100hr [< 3"], 1000hr [< 8"], 10,000hr [> 8"])** 4 Slash Depths in each Cardinal Direction, 15' from plot center: **Inches** Max Plot Slash Depth: **Inches – Deepest slash measurement at any point within the fixed plot** Slash Density: **(< 33%, 33 to 66%, > 66% (Viewed from above, ocular estimation))**			

Assumptions Included in Monitoring and Analysis

As part of monitoring, field crews did not explicitly evaluate the habitability and legality of structures used for the 150-300 foot timber harvest area on the (c)(6)s. For analysis, Ready For Wildfire guidelines and published literature were used to help inform analysis related to treatment-induced changes in potential fire behavior, particularly in regards to ladder fuel heights and potential flame lengths and tree spacing relative to slope. As a worst case scenario, we assumed that ladder fuels five feet or taller would have flame lengths three times the median assumed height of five feet, or 15 feet. Thus, any measured tree with a crown base less than or equal to 15 feet with ladder fuels of five feet or taller would be at risk for vertical fuel connectivity. Similarly, for ladder fuels of zero, under two, and two to five feet median fuel heights of 0.5, 1, and 4 feet, corresponding to maximum potential flame lengths of 1.5, 3, and 12 feet, were used. Further assumptions, calculations, and equations used are presented in Appendix 1. Results are presented as individual plot values, as means across all plots to give a Notice-wide value representative of the post-harvest outcomes as a whole, and as values across the entire Statewide sample.

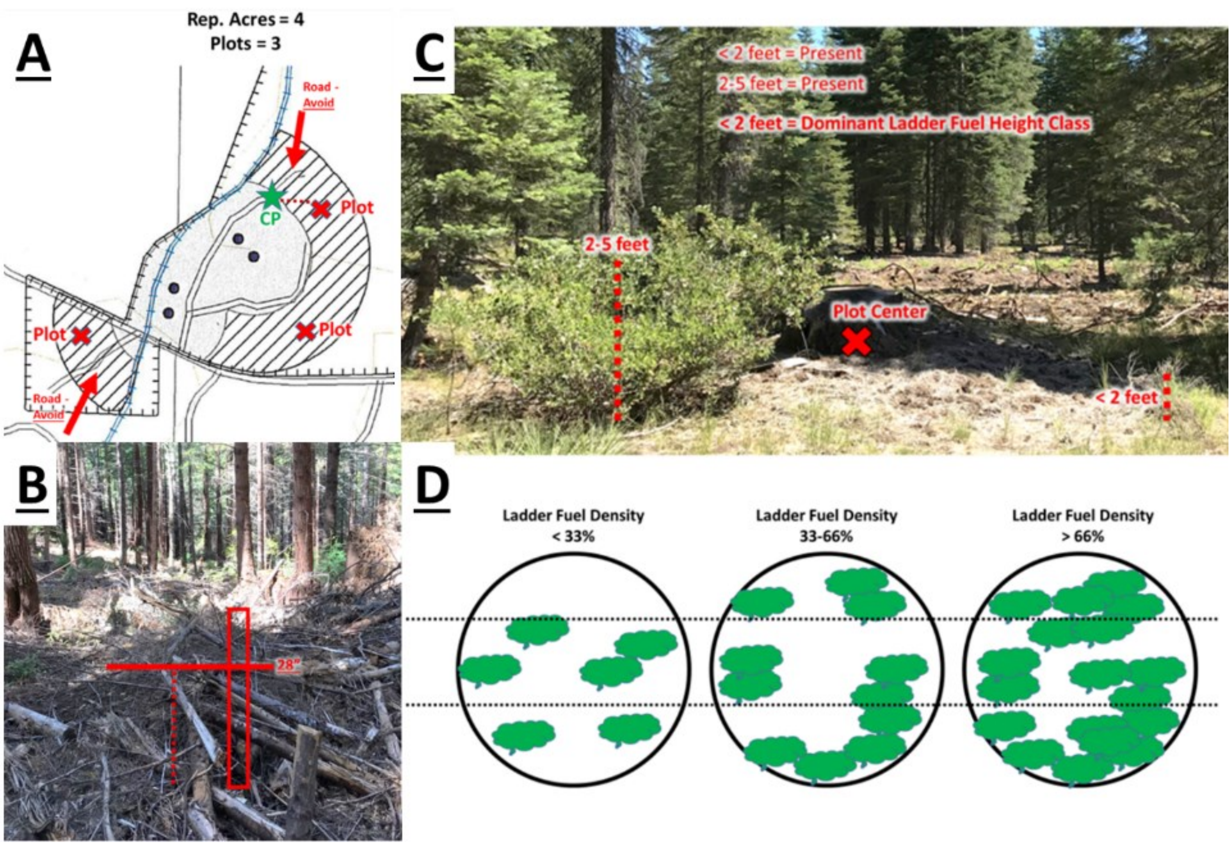

Figure 5: Plot measurements, with an example of plot placement on a 4 acre (c)(6), A, slash depth measurement, B, ladder fuel height class and dominant class determination, C, and ladder fuel density as viewed from overhead, D.

Results

Summary Overview of Sampled §1038(c)(6) Exemptions

- **Sampled (c)(6)s ranged from 0.25 to 15 acres in reported harvest size, with an average reported harvest size of 4.9 acres. Field crews found that some (c)(6) Notices reported a much larger acreage than what was treated under the Notice**
- **In contrast to §1038(c) [0-150 foot] Exemptions, very few (c)(6)s reported less than 8 thousand board feet (MBF) of timber removed; 29% reported over 25 MBF of timber removed, and 52% reported 8 to 15 or 16 to 25 MBF of volume harvested.**
- **Most (c)(6) Notices involved treatment around one to two habitable residences or permitted structures.**
- **60% (n=21) of landowners reported profit or loss estimates from operations, with four landowners indicating a financial *loss* from operations (19% of those self-reporting), nine reporting a financial *gain* from harvested timber (43% of those self-reporting), and eight reporting that they broke *even* (38% of those self-reporting).**

The sampled (c)(6) Notices averaged 4.9 acres in reported size, ranging from 0.25 to 15 acres. Some (c)(6)s harvested far less of an area than what was reported on the Exemption form. Very few of the Notices reported harvesting less than 8 MBF of timber, contrary to the findings for the 1038(c) Exemption.

A single residential structure, after removing the 0-150 foot area and assuming no parcel boundaries to curtail operations, could have approximately 5 acres of eligible timberland to be treated. As reported on the harvest documents, (c)(6) acreage on the sampled Notices averaged 4.9 acres, ranging from 0.25 to 15 acres (**Table 3**). Field crews discovered that some (c)(6) Notices reported much larger acreages for harvest than what were actually treated during operations.

Figure 6: A treated portion of the 150-300 foot zone, with a residence visible in the background. Note the absence of surface and ladder fuels and lower tree limbs.

Twenty-nine percent of the 300 Foot Exemptions reported removing 25 MBF of timber or more, while 52% reported either 8 to 15 MBF or 16 to 25 MBF of timber removed (**Table 3**). Only 19% of the sample reported the lowest volume removal of less than 8 MBF. This contrasts with 1038(c) 0-150 foot Notices, where the majority of Exemptions reported less than 8 MBF of timber removed (Olsen and Coe, 2021). A total of 43% of the sample had reported Site Class III timberland, where a minimum of 75 ft^2 ac^{-1} must be retained (**Table 3**). Site Class I and II were reported on 20% and 28% of the (c)(6)s, respectively. Only 3% of the sampled (c)(6)s reported a Site Class IV timberland. Mixed site classes were reported on only 6% of the sample (**Table 3**).

Reported QMD increases averaged 3 inches, and were highest on the most productive site classes.

The quadratic mean diameter (QMD) post-harvest increase, as reported on the harvest document by the RPF, ranged from 0 inches to 10 inches, with an average of 3 inches (**Table 3**). QMD changes had the largest mean reported increase on (c)(6)s with Site Class I timberland.

All sampled 300 Foot Exemptions had a habitable residence on the treated parcel itself, and did not rely solely on residential homes on neighboring parcels.

All sampled 300 Foot Exemptions had structures present on the parcel being treated itself, and monitoring did not include cases where a parcel had an absence of permitted structures, but used *only* structures on adjacent parcels for the 300-foot zone. However, there were instances where harvesting was performed in the 300-foot zone of structures on both the parcel being treated and adjacent parcels. A single residence was the focus of treatment on 31% of the (c)(6)s, while 20% had two habitable or permitted structures. In the case of one (c)(6) in the Cascade FPA, 22 cabins on a single ownership were related to the timber harvesting in multiple, aggregated 300-foot zones.

Table 3: Reported acreage, timber volume removal, and QMD change as per the sampled (c)(6) Notice documents.

Reported Acreage	Minimum 0.25 ac		Maximum 15 ac		Mean (Standard Deviation) 4.9 ac (3.8 ac)	
Reported Site Class	**I**: 20% (Basal Area Retention: 125 ft^2 ac^{-1} [Coast]; 100 ft^2 ac^{-1}) **II**: 28% (Basal Area Retention: 75 ft^2 ac^{-1}) **III**: 43% (Basal Area Retention: 75 ft^2 ac^{-1}) **IV**: 3% (Basal Area Retention 50 ft^2 ac^{-1}) **I/II**: 3% (Coast FPA; Basal Area Retention 125/75 ft^2 ac^{-1}) **II/III**: 3% (Cascade FPA; Basal Area Retention 75/50 ft^2 ac^{-1})					
Reported Timber Volume Removed	**< 8 MBF**: 19% **8 to 15 MBF**: 26% **16 to 25 MBF**: 26% **> 25 MBF**: 29%					
Reported QMD Change	Minimum 0 inches		Maximum 10 inches		Mean (Standard Deviation) 3 inches (2.3 inches)	
Reported QMD Changes	0-0.5" 6%	0.51-1" 11%	1.1-2" 34%	2.1-3" 17%	3.1-5" 9%	>5" 23%

Just under 1/3rd of the sampled Notices also had a previous or currently active Exemption or Emergency Notice, and generally landowners self-reported either breaking even economically or a financial gain from timber operations, while a minority reported a financial loss.

Thirty-one percent of the sampled (c)(6)s had an additional Exemption or Emergency Notice present on the treated parcel, either from past operations or concurrent with the (c)(6). These included Fuel Hazard Reduction Emergencies, Less Than 3 Acre Conversion Exemptions, Forest Fire Prevention Exemptions, <10% Dead, Dying, or Diseased Exemptions, and 0-150 foot 1038(c) Exemptions. One (c)(6) also had an active Non-Industrial Timber Management Plan (NTMP) on the parcel. In the case of another 300 Foot Exemption, the landowner indicated they planned to use the profits from harvesting for a larger scale Timber Harvesting Plan on their ownership.

Sixty percent of the landowners offered estimates of the cost or profit of operations on their parcel with the (c)(6) Notice. While these are self-reported and simplified estimates of financial gain or loss to the landowner only, the data do help illuminate the economics of the Exemption. Four landowners indicated a financial cost from operations, and one of the four indicated that cost was approximately $7,000. Eight landowners indicated they broke even between operation costs of the logging and the profit from the harvested timber. Nine landowners reported profits from operations; while not all disclosed an amount, those that did reported $2,000 to $9,000 in profit. One landowner reported a very substantial profit, however that included profits from concurrently active additional EX-EM Notices on the parcel as well. Additionally, one landowner reported going through the process of becoming a LTO, in order to allow them to perform their own harvesting on their parcel under the (c)(6) Notice.

Watercourse Prevalence and Protection

- **Watercourses were found on only 40% of the (c)(6) Notices, and were largely Class III or Class IV types.**
- **Watercourses were adequately protected, with minimal occurrences of harvesting within the watercourse's Equipment Limitation Zone (ELZ) and few observed sediment discharges. Where discharges to watercourses were observed, they were "Trace" amounts only.**
- **Generally, sediment discharges were associated with temporary skid trail crossings of watercourses and harvesting near watercourses.**

The majority of sampled (c)(6) Notices did not have a watercourse present within the harvest area or where it would be directly affected by harvest operations. Where watercourses were present, they were adequately protected per the FPRs, and sediment discharges were kept to minimal "Trace" amounts (i.e., volume too small to estimate visually). Where sediment discharges did occur, they were associated with harvesting near watercourses or from temporary tractor crossings of Class III watercourses.

Of the sampled (c)(6) Notices, 60% did not have a watercourse present within the harvest area or areas associated with harvest activity (i.e. logging roads). Of the 40% of Notices with watercourses present, half had observed harvesting within the watercourse ELZ, and in each case the watercourse associated with the Exemption was either a Class III or Class IV.

Thirty-six percent (n=5) of the 300 Foot Exemptions with watercourses had observed sediment discharges to watercourses, and in each case the discharge was a "Trace" amount. Further, all five incidences of trace sediment discharges were associated with harvesting within the ELZ or where temporary skid trail crossings of the watercourses were used (**Figure 7**).

Figure 7: Skid trail crossings of Class III watercourses, with "Trace" sediment discharges. The left photo shows what was an unmapped Class III that was flowing during a rainfall event, while the right photo shows a Class III that had a temporary crossing, with waterbarred and slash packed skid trail approaches (not shown).

Anecdotally, in one case of a trace discharge, there were visual observations of operations on saturated soils (i.e., rutting). In another incident, the documented Class III watercourse was observed during a rainfall event; it was likely not apparent pre-harvest, and only exposed following tree harvesting and surface fuel treatments (**Figure 7**, left). In one other case, the Class III temporary skid trail crossing was properly waterbarred and slash packed, helping to limit the discharge to a "Trace" amount (**Figure 7**, right).

Surface Fuel and Harvest-Related Slash Treatments

- **Only 29% of (c)(6) Notices had piled logging slash or harvest-related fuel remaining to be treated, although large accumulations of slash and woody fuel were encountered on some (c)(6)s.**
- **Slightly less than half of the 300 Foot Exemptions also undertook the mastication or chipping of surface fuels and other ladder fuels in order to reduce fire hazard.**
- **All Notices and plots had a mean slash depth below the 18 inch FPR requirement, however there were individual instances of slash depths in excess of 18 inches on over half of the (c)(6) Notices.**
- **Spatial coverage of slash was generally less than 33% on most plots and Notices, and increasing spatial coverage of slash appeared to be related to both increasing slash depths and prevalence of larger slash fuel size classes.**
- **Additionally, average slash depth increased with maximum observed slash depth.**
- **Ladder fuels were generally reduced by mastication and chipping work; most plots and Notices were dominated by ladder fuels less than two feet in height, but had individual instances of taller ladder fuels (e.g., saplings or large manzanita shrubs).**

Surface Fuel Treatments

The majority of (c)(6) Notices did not have piled harvest-related slash and fuel waiting to be treated, and very flew plots had remaining slash to be treated. Field crews did encounter "jackpot" piles of slash on some 300 Foot Exemptions that should have been treated to reduce fire hazard. Mastication and chipping of surface fuels were found on less than half of the (c)(6) Notices. There did not seem to be a relationship between surface fuels being treated through mastication/chipping and whether landowners self-reported a financial loss or gain.

Figure 8: Piled slash from harvesting operations awaiting treatment, left photo, and a "jackpot" of slash from harvest operations that should have been treated, right photo.

Residual piles of slash and forest biomass waiting to be chipped, burned, or hauled away were absent on 71% of the parcels that underwent treatment under the (c)(6) Notices. Within the harvested areas specifically, only 7% of all random plots had piled slash awaiting treatment (**Figure 8**, left). Outside of the random plots, field crews did encounter "jackpots" of logging slash on a small number of (c)(6) Notices (**Figure 8**, right).

Figure 9: An example of a plot with mastication and chipping of surface fuels performed, where the average depth of slash and fuel was 2 inches.

Mastication and chipping were found on 43% of the (c)(6) Notices (n=15), and 43% of our random plots were treated with mastication and/or chipping in addition to timber harvest (**Figure 9**). At the Forest Practice Area level, 45% and 39% of the Coast and Cascade (c)(6) Notices, respectively, had mastication and chipping of surface fuels done, while the lone Sierra (c)(6) Notice also had surface fuels treated.

Interestingly, only one of the four landowners who reported a financial loss from undertaking the (c)(6) Notice also had mastication work done on surface fuels on their parcel. Half of the landowners who reported breaking even, financially, also had surface fuel mastication and chipping done, while just under half of the landowners who reported a profit from operations had mastication work done as part of the fuel treatments associated with the 300 Foot Exemption.

Post-Harvest Slash Spatial Coverage and Depth

Slash had a spatial coverage of less than 33% on the majority of plots and Notices. Only 11% of all sampled Notices had in excess of 66% slash coverage. As slash spatial coverage increased, slash depth increased on plots and Notices, particularly as slash coverage exceeded 66% of the plot area. Less than half of the plots in the Coast FPA had under 33% coverage of slash, while the overwhelming majority of the plots in the Cascade and Coast FPAs had 33% or less slash coverage.

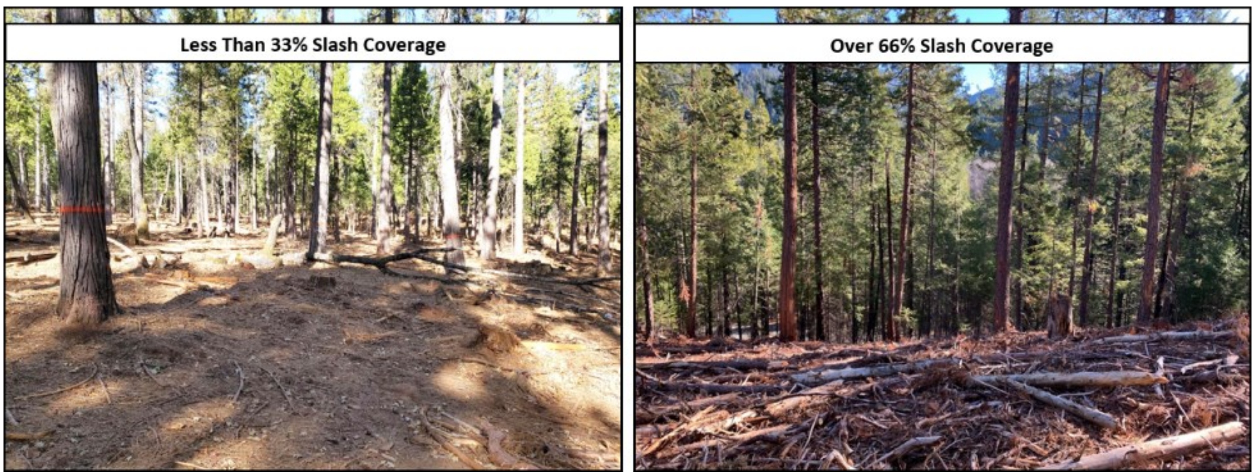

Figure 10: Examples of slash coverage within plots, with the minimal end of slash coverage at less than 33%, left, and extensive slash coverage, over 66%, right.

Table 4: Spatial coverage of harvest-related slash by plot, Notice, and Forest Practice Area. Note, the percentages of Notices where each slash coverage category was recorded does not add up to 100% across columns, as Notices with multiple plots may have multiple slash coverage categories present across plots.

	< 33% Slash Coverage	33-66% Slash Coverage	> 66% Slash Coverage
% of Plots with Slash Coverage Category	76%	20%	4%
% of Notices with Slash Coverage Present	91%	40%	11%
Coast FPA % of Plots	48%	42%	10%
Cascade FPA % of Plots	86%	12%	2%
Sierra FPA % of Plots	100%	NA	NA

The spatial coverage of post-harvest slash was less than 33% on most plots, and these plots were found on 91% of the Notices (**Table 4**). The increasing slash coverage categories decreased in prevalence on both plots and (c)(6) Notices, with only 4% of all plots having over 66% spatial slash coverage, and these plots were found on 11% of all sampled Notices (**Table 4**). A total of 21 or 60% of all sampled 300 Foot Exemptions had *only* 33% or less spatial slash coverage on all plots.

When assessing slash coverage across all plots by FPA, 52% of all sampled plots in the Coast FPA had 33-66% or over 66% spatial coverage of slash; comparatively, only 14% of all sampled plots in the Cascade FPA had 33-66% or over 66% slash coverage, while all plots from the Sierra FPA (c)(6) had less than 33% spatial coverage of slash.

All plots and (c)(6) Notices achieved a mean slash depth below 18 inches, per the FPRs. Thirty percent of all plots did have maximum slash depths in excess of 18 inches, which were found on 54% of the sampled (c)(6)s. Slash depth averaged 2 inches across all Notices, averaging 0 to 6 inches on Notices, while individual plots averaged 0 to 15 inches. Average slash depth also was highest in the Coast FPA, particularly as the spatial coverage of slash increased. When plots had maximum observed slash depths in excess of 18 inches, average slash depth was observed to increase as well.

At the plot level, all 98 plots from the (c)(6) Notices averaged less than 18 inches of slash depth, based on the four objective slash measurements made 15 feet from plot center (**Figure 11**). Extrapolating from this finding, 100% of the sampled (c)(6) Notices achieved an Exemption-wide average of less than 18 inches of slash depth, per 14 CCR § 1038(c)(6)(C).

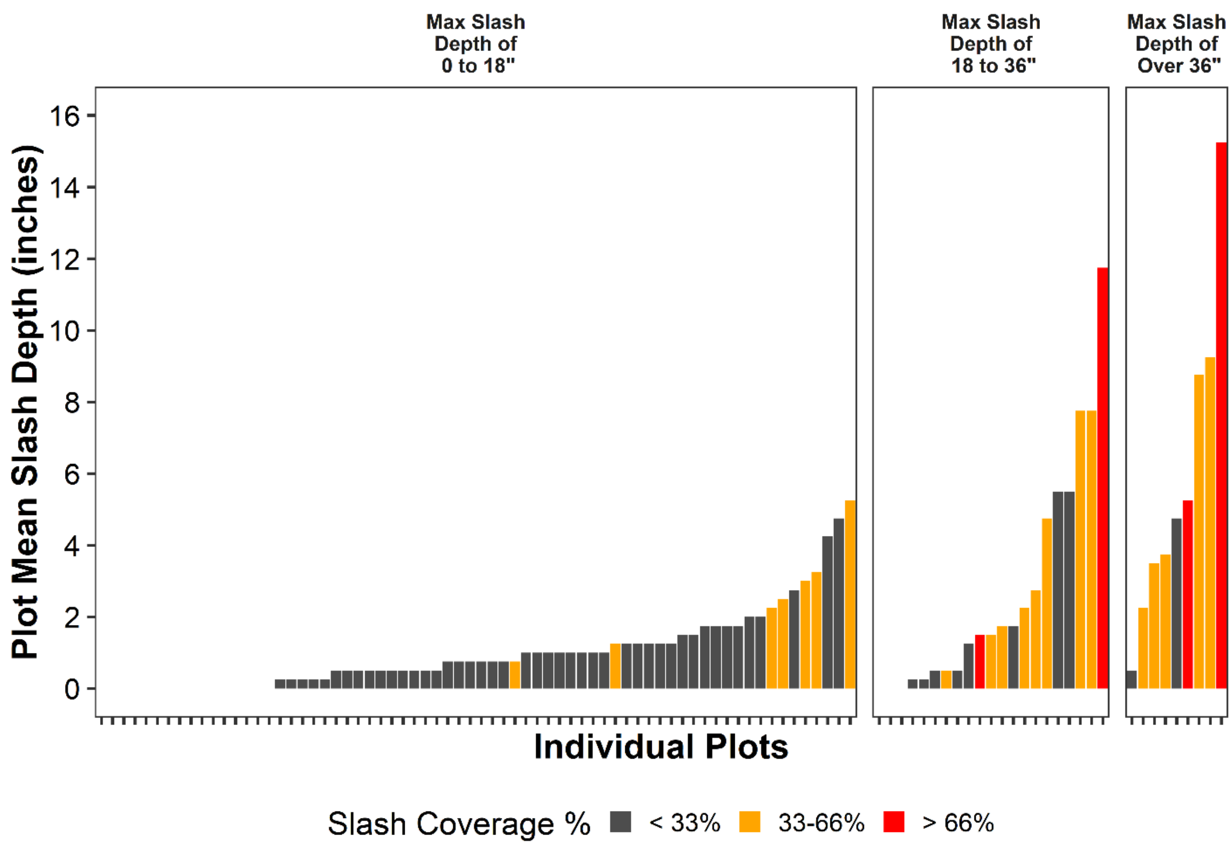

Figure 11: Mean plot slash depth, based on the four-point measurements made from plot center, colored by the plot spatial slash coverage, and binned by the maximum observed slash depth within the plot, regardless of location. Note: Ticks without a bar above them indicate a mean slash depth of 0 inches.

When acknowledging the maximum observed slash depth within each plot, including outside the four objective measurements, 69% of all plots had a maximum slash depth of less than 18 inches, 21% had a maximum slash depth of 18 to 36 inches, and 9% had a maximum slash depth in excess of 36 inches or three feet (**Figure 11**). Plots that had individual instances of slash depth in excess of 18 inches represented 19 (c)(6) Notices, or 54% of the entire sample.

Figure 12: Two examples of post-harvest slash coverage within plots. Left is a Cascade FPA (c)(6) plot with a 1.5 inch mean slash depth and plot maximum slash depth of 22 inches, while right is a Coast FPA (c)(6) plot with a 0.8 inches mean slash depth and plot maximum slash depth of 10 inches, where mastication/chipping of surface fuels was also done.

Slash depth, measured by the Notice-wide average of all plots, averaged 2 inches (standard deviation = 1.8 inches), with a minimum mean of 0 inches and maximum mean of 6 inches. The median value sample wide was 1 inches of harvest related slash. Individual plot average slash depths ranged from 0 to 15.3 inches, with a mean and median depth of 2 and 1 inches, respectively (standard deviation = 2.6 inches). Slash depths averaged 0.8 inches on plots with a reported Site Class of I, 1.2 inches on Site Class II, and 3.2 inches on Site Class III; one Notice with mixed Site Classes of I and II averaged 3.3 inches of slash, while one with Site Classes of II and III averaged 0.8 inches of slash. Observationally, some of the Site Class III Notices were also in the Coast FPA and areas with inherently higher unit-area biomass, resulting in deeper post-harvest slash depths despite a less productive timberland Site Class.

Relative to the spatial percent slash cover, those plots with less than 33% slash had a mean slash depth of 1 inch, those plots with 33 to 66% slash coverage averaged a slash depth of 3.7 inches, and those plots with over 66% slash coverage averaged 8.4 inches of slash depth. When further assessed at the FPA level, the average plot slash depth increased both as the spatial coverage of slash increased, and from minimal depths in the Sierra and Cascade FPAs, to maximum observed mean depths in the Coast FPA (**Table 5**). Generally, the lowest average slash depths were found when the spatial slash coverage was less than 66%, and when harvest areas had an absence of any slash depths over 18” (**Figure 11**). When slash spatial coverage exceeded 66%, or maximum slash depths within plots, exceeded 18”, average slash depths increased as well.

Table 5: Mean plot slash depth by FPA and spatial coverage of slash within the plot, and across all FPAs and slash coverages.

	< 33% Slash Coverage	33-66% Slash Coverage	> 66% Slash Coverage	All Plots
Coast FPA	1.8”	4.4”	9.5”	3.7”
Cascade FPA	0.8”	2.7”	5.3”	1.1”
Sierra FPA	0.6”	NA	NA	0.6”
All Plots	1.0”	3.7”	8.4”	

Harvest-Related Slash Fuel Size

Unsurprisingly, the smallest slash fuel size classes of 1, 10, and 100-hour fuels were prevalent on almost all (c)(6) Notices and plots. The larger 1000 and 10,000-hour harvest-related fuels were found to be less prevalent sample wide; however, these slash size classes were found more often when mean slash depths increased on a Notice, and when slash coverage increased beyond 1/3rd of a plot area.

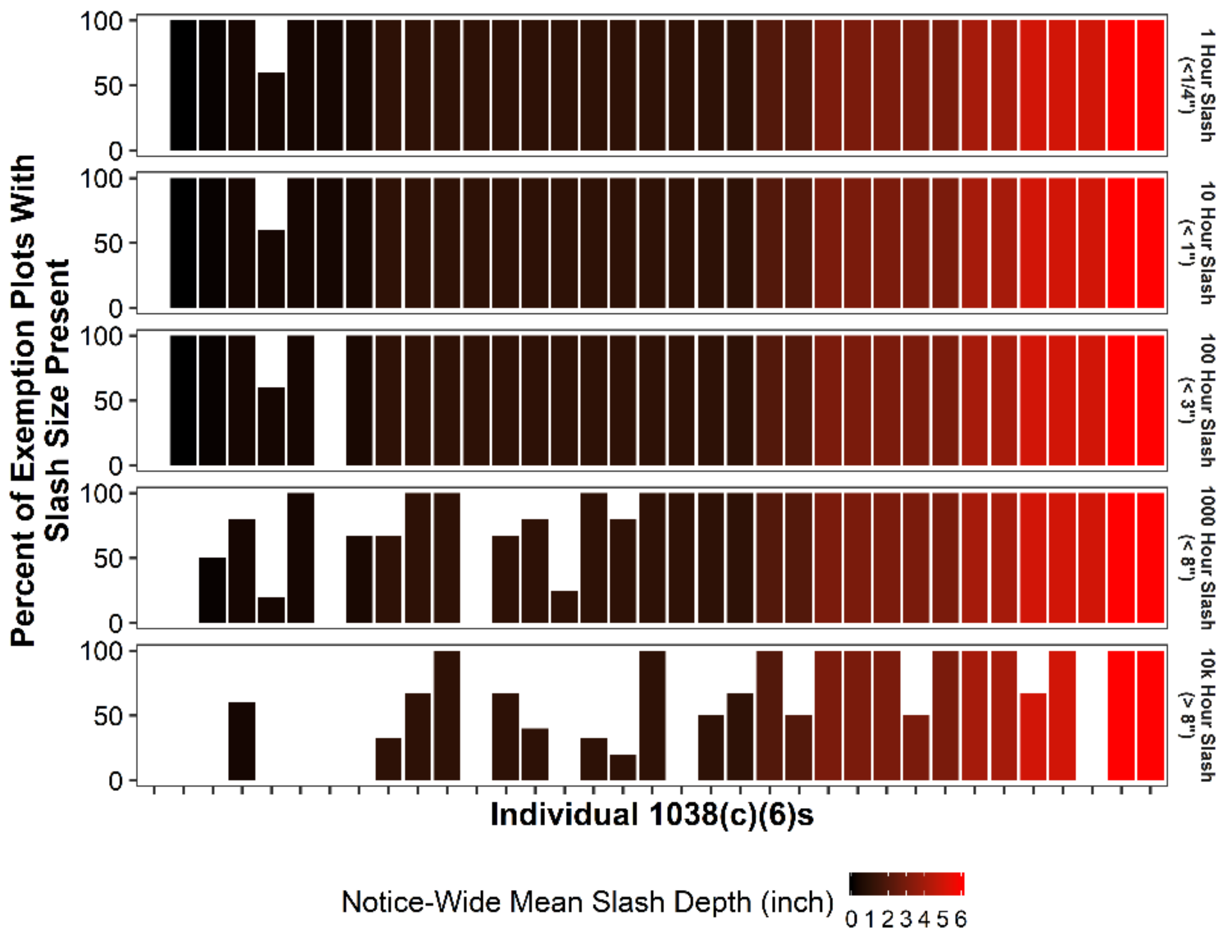

Figure 13: The percentage of plots with each slash fuel size class present, by individual 1038(c)(6) Notice and fuel size class, colored by the Notice-wide mean slash depth, and ordered from left to right by Notice-wide mean slash depth.

Slash fuel sizes, using standard classifications based on fire behavior of < ¼ inch, ¼ to 1" inch, 1 to 3 inches, 3 to 8 inches, and > 8 inches in diameter, were evaluated on all plots on sampled (c)(6) Notices. The 1 hour (< ¼") slash fuel was present on nearly all 300 Foot Exemptions, and within each (c)(6) was found on nearly every plot (**Figure 13**). The 10- hour, ¼ to 1 inch sized slash was also found on almost every (c)(6) Notice, and similar to the 1-hour slash size, was also found on nearly every plot. It was also a very similar finding for the 100-hour, 1-3 inch slash (**Figure 13**). The 1000-hour, 3-8 inch slash is where results diverged, with this larger size slash class either absent or only found on 50% or less of the plots on 20% of the (c)(6) Notices. The 10,000-hour slash over 8" in diameter was entirely absent on 31% of the 300 Foot Exemptions, and another 20% of Notices had this size of slash present on less than 50% of the plots (**Figure 13**).

Observationally, **Figure 13** indicates that as Notice-wide average slash depth increases, the largest slash sizes also become more prevalent in addition to smaller sized slash. Likewise, at the plot level across our entire sample, the 1, 10, and 100-hour slash sizes were overwhelmingly present regardless of the spatial slash coverage (**Table 6**). The larger 1000-hour slash sizes were less prevalent on plots with less than 33% slash coverage, and present on only 69% of the plots. The largest pieces of slash found within plots, the 10,000-hour pieces larger than 8 inches, were absent on 62% of plots with less than 33% slash coverage, and also absent on 15% of plots with 33-66% slash coverage. However, 100% of all plots with over 66% slash coverage also had the largest harvest-related slash present (**Table 6**).

Table 6: The percentage of plots with slash fuel size classes present, by spatial slash coverage and fuel size class.

Percent of Plots with Slash Fuel Class Sizes By Spatial Slash Coverage			
	< 33% Slash Coverage	**33 to 66% Slash Coverage**	**> 66% Slash Coverage**
1 Hour (< ¼")			
Present	95%	100%	100%
Absent	5%	0%	0%
10 Hour (¼"-1")			
Present	95%	100%	100%
Absent	5%	0%	0%
100 Hour (1"-3")			
Present	93%	100%	100%
Absent	7%	0%	0%
1000 Hour (3"-8")			
Present	69%	100%	100%
Absent	31%	0%	0%
10,000 Hour (> 8")			
Present	38%	85%	100%
Absent	62%	15%	0%

Ladder Fuels

When evaluating the most prevalent dominant ladder fuel class present, the majority of plots and Notices had either an absence of ladder fuels or ladder fuels less than two feet in height. Only one (i.e., 3%) of the (c)(6)s was dominated by ladder fuels five feet or taller, however there were frequent individual instances of this ladder fuel height class present on plots (e.g., individual saplings or shrubs

below residual trees). Ladder fuels were reduced when mastication or chipping work were also used as a treatment, and all ladder fuel height classes were less prevalent when ladder fuels covered a lower spatial footprint of a Notice area.

Figure 14: Examples of (c)(6) Notice plots with all ladder fuel height classes present, left two photos, and plots without all ladder fuel height classes present, right two photos.

Sample wide, 59% of all plots had a dominant ladder fuel class of less than 2 feet in height. Twenty percent of the plots had an absence of any ladder fuels, while 17% had ladder fuels between 2 to 5 feet in height, and 3% of all plots had ladder fuels over 5 feet in height as the dominant ladder fuel type (**Table 7**). At the Notice-wide level, 74% of (c)(6)s had ladder fuels two feet or less in height as the most prevalent dominant ladder fuel height class, followed by fuels two to five feet in height and an absence of ladder fuels (**Table 7**). When (c)(6) Notices also underwent mastication and chipping of surface fuels, 40% had an absence of ladder fuels as a dominant condition, and 47% had ladder fuels under two feet as the dominant ladder fuel height class (i.e., 87% less than 2 feet). Interestingly, only 5% of Notices *without* mastication/chipping had an absence of ladder fuels as the dominant ladder fuel height class, and only 5% of Notices without mastication/chipping had ladder fuels over five feet in height as the dominant height class (**Table 7**).

Table 7: Most prevalent dominant ladder fuel heights by plot and Notice-wide, and Notice-wide with and without mastication/chipping work. Notice wide determinations were made as the ladder fuel class that had the highest percentage of presence on plots, the median value, or in the case of a tie, the higher ladder fuel class, in order to reflect greatest potential fire behavior. Note, percentages may not add up to 100% due to rounding.

	Notice-wide Most Prevalent Dominant Ladder Fuel Height Class			
	Ladder Fuels Absent	Ladder Fuels < 2 Feet	Ladder Fuels 2 to 5 Feet	Ladder Fuels Over 5 Feet
% of **Plots** With Dominant Ladder Fuel Class	20%	59%	17%	3%
% of **Notices** With Most Prevalent Dominant Ladder Fuel Class	20%	54%	23%	3%
% of **Notices** With Most Prevalent Dominant Ladder Fuel Class, ***with*** Chipping/Mastication	40%	47%	13%	0%
% of **Notices** With Most Prevalent Dominant Ladder Fuel Class, ***without*** Chipping/Mastication	5%	60%	30%	5%

Across all sampled plots, 90% had a spatial density of ladder fuels less than 33% of the plot area, followed by 9% with 33-66% of the plot area full of ladder fuels, and 1% with an excess of 66% ladder fuel coverage. This translated to 97% of all (c)(6) Notices having at least one plot with 33% or less spatial coverage of ladder fuels; 89% of the Notices had the most prevalent spatial coverage of ladder fuels of less than 33%. In fact, only one Notice had a plot showing an excess of 66% coverage of ladder fuels; similarly, only one Notice had every plot with 33 to 66% coverage of ladder fuels.

Table 8: The number of (c)(6) Notices with either all ladder fuel height classes present on all plots, or those Notices with a mix of presence/absence of ladder fuel heights, analogous to the homogeneity of ladder fuels and effect on surface-to-crown fire effects. Results shown by FPA, by the most prevalent spatial coverage of ladder fuels on each (c)(6) Notice, and the most prevalent dominant ladder fuel height class found on each Notice.

	(c)(6) Notice ***with*** all ladder fuel heights present	(c)(6) Notice ***without*** all ladder fuel heights present
Coast FPA	6	5
Cascade FPA	11	12
Sierra FPA	0	1
< 33% Spatial Coverage of Ladder Fuels	13	18
33-66% Spatial Coverage of Ladder Fuels	4	0
Notice Dominant Ladder Fuels – Absent	0	7
Notice Dominant Ladder Fuels – < 2 Feet	11	8
Notice Dominant Ladder Fuels – 2-5 Feet	5	3
Notice Dominant Ladder Fuels – > 5 Feet	1	0

Generally, there was an even split between (c)(6) Notices with all ladder fuel height classes present and those with an absence of some ladder fuel height classes, by FPA (**Table 8**). All the Notices where ladder fuels were predominantly found to be 33-66% in spatial coverage also had every ladder fuel height class present, while only 42% of the Notices with less than 33% spatial coverage of ladder fuels had all ladder fuel classes present (**Table 8**). Of the (c)(6) Notices where the most prevalent dominant ladder fuel class was either less than two feet, or was two to five feet, the majority of 300 Foot Exemptions also had every ladder fuel height class present (**Table 8**). That is, while ladder fuels were dominated by those less than two feet or between two to five feet, many (c)(6) Notices also had larger ladder fuel height classes present within the harvest area, although typically as individual stand-alone instances.

Interestingly, the reported site class did seem to have an influence on the height of residual ladder fuels. Eighty-eight percent of plots on Site Class I (c)(6)s had ladder fuels under two feet in height or absent as the main ladder fuel class; On Site Class III (c)(6)s, 89% of plots also had an absence of ladder fuels, or fuels less than two feet high.

Lastly, of those Notices that had mastication and chipping work done, in addition to timber harvesting, 60% did ***not*** have all ladder fuel height classes present, while 55% of those Notices that did not have the same additional work done to surface fuels had all instances of ladder fuel height classes present.

Post-Harvest Forest Structure

- **Sampled trees had an absence of crown contact when tree spacing averaged 14 feet between tree boles, while (c)(6) Notices had an average of 74% of trees in crown contact following operations.**
- **Generally, tree spacing decreased as hillslope gradient increased**
- **All sampled (c)(6) Notices had, on average, a lack of continuous vertical fuel continuity between surface fuels and the residual forest canopy, although many had isolated pockets of vertical fuel continuity. This result was achieved through purposeful treatment of ladder fuels and pruning tree limbs, passive treatment of surface fuels and a naturally high crown base (height of the lowest limbs), or a combination of both factors.**
- **A minority of (c)(6) Notices likely did not meet basal area retention standards, and there was no clear relationship between basal area retention and tree density. Post-harvest forest stands were mostly dominated by conifer species in excess of 8" diameter at breast height (DBH).**
- **Dead standing trees, following harvest, were found on over half of the monitored Notices, from singular trees with a small diameter, to more substantive incidences of dead trees across diameter sizes. Causal factors likely included yarding-related tree damage, pre-existing tree health issues, and post-harvest insect damage.**

Tree Spacing

Following harvest operations, average geometric mean tree spacing on Notices ranged from 2 to 18 feet, with an average tree spacing of 7 feet. Trees that were not in crown contact averaged 14 feet apart. Sample-wide the average percentage of trees in crown contact on (c)(6)s was 74%. Tree spacing generally decreased as slope increased, with 95% of all sampled trees on slopes over 40% in crown contact.

The average post-harvest geometric mean tree spacing across all (c)(6) Notices was seven feet with a minimum and maximum value of two and 18 feet, respectively, as measured from tree bole to tree bole (**Figure 15**). Trees that were not in crown to crown contact averaged fourteen feet apart across all plots (standard deviation = 9.4 feet), while those in crown contact averaged six feet apart (standard deviation = 5.8 feet) (**Figure 15**). At the FPA level, trees not in crown contact averaged nine, 15, and 20 feet apart in the Coast, Cascade, and Sierra FPAs, respectively. Sampled (c)(6) Notices had an average of 74% of trees in crown contact, ranging from 18 to 100%.

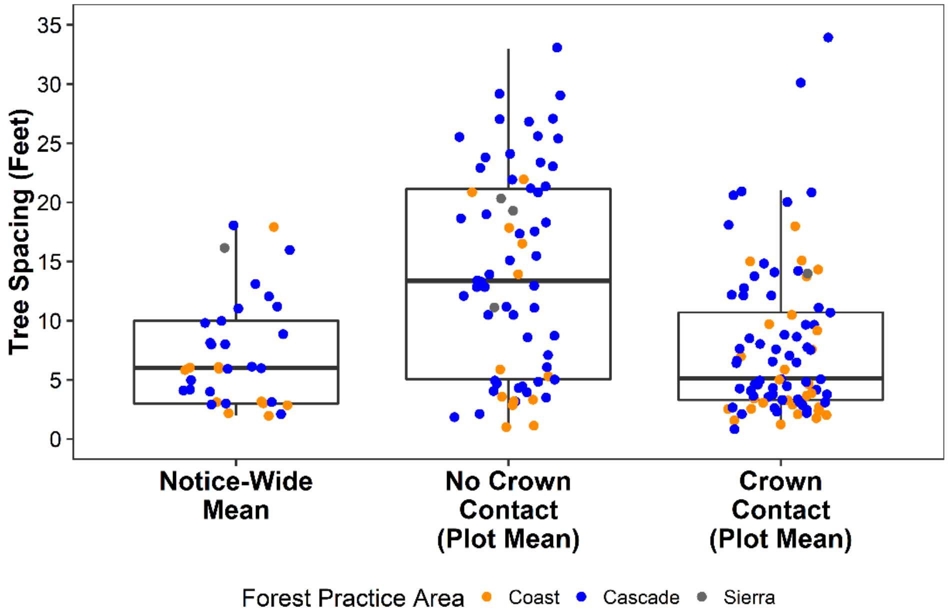

Figure 15: Tree spacing on sampled (c)(6) Notices and plots, shown by the Notice-wide geometric mean, plot geometric mean, plot geometric mean where trees were not in crown contact, and plot geometric mean where tree were in crown contact. Colors indicate the FPA of the sample. Individual points are either sampled Notices or plots; the thick black line is the median for each box; the upper and lower bounds of each box represent the 25th and 75th percentiles of the data, while the top and bottom "whisker" represents 1.5 times that area within the box. Values above or below the whiskers are "outliers".

At the individual species level, fir, cedar, and pine species were in crown contact when spaced less than ten feet apart (**Table 9**). However, for redwood and hardwood species, the less substantive differences in tree spacing and if crown contact was observed indicates site- and tree-specific influence (**Table 9**). There was no discernable difference in distance between trees that had an absence of crown contact when the nearest tree was either a conifer or hardwood species.

Table 9: Tree to tree bole spacing by species, for determining whether crown contact was observed or not.

	Fir	Cedar	Pine	Redwood	Hardwood
Crown Contact	7 feet	9 feet	8 feet	5 feet	5 feet
Absence of Crown Contact	15 feet	17 feet	17 feet	6 feet	9 feet

Table 10: Tree spacing with and without crown contact by general plot hillslope gradient, and the percentage of trees with and without crown contact by slope category.

	0-20% Slope	20-40% Slope	> 40% Slope
Crown Contact	7 feet (82%)	6 feet (81%)	5 feet (95%)
Absence of Crown Contact	16 feet (18%)	8 feet (19%)	10 feet (5%)

Trees without crown contact found on slopes 0-20% in gradient averaged seven feet from tree to the next nearest tree (n = 125), six feet for trees on slopes 20-40% (n = 43), and five feet apart on slopes over 40% (n = 8). As slope category increased, tree spacing for both crown contact and an absence of crown contact decreased. Only five percent of sampled trees on slopes over 40% had an absence of crown contact.

Surface-to-Tree Crown Fire Susceptibility

Generally, a lack of vertical fuel continuity was observed for the majority of residual trees and plots on sampled (c)(6) Notices. Similarly, on average, all 300 Foot Exemptions had a lack of surface-to-canopy fuel continuity, although many had isolated pockets of vertical fuel continuity to some degree,

Of the 1,162 trees sampled during monitoring, 83% had either lower limbs removed, ladder fuels treated, or a combination of both treatments such that based on the dominant ladder fuels within a plot, they likely had an *absence* of vertical fuel continuity. Redwood and fir conifer species had the largest sample-wide percentages of trees with potential vertical fuel continuity, at 19 and 20% of sampled trees, respectively; these occurrences were the most prevalent in the Coast FPA.

At the plot level, 95% of all sampled plots had vertical fuel continuity *absent,* based on the plot mean crown base and dominant ladder fuel class (**Figure 16**). The 5% of plots with potential vertical fuel continuity present were found on five (c)(6)s, or 14% of the sample.

Figure 16: Plots with an absence of ladder fuels that could promote surface-to-crown continuity.

The sampled 300 Foot Exemptions had an average of 86% of trees without vertical fuel continuity, ranging from 44% to 100%. Just over half of the sampled (c)(6)s had 90% or more of their residual trees lacking vertical fuel continuity. Considering the most prevalent dominant ladder fuel class found on each (c)(6) (**Table 7**), and the Notice-wide mean crown base, 100% of the sampled 300 Foot Exemptions had, on average, vertical fuel continuity ***absent***.

This indicates that where either ***surface or ladder fuels have been treated***, residual trees had a ***crown base significantly above these fuels.*** As such, treatments appeared to mitigate against the transition from surface to crown fire. However, it is critical to note presence of isolated instances of surface-to-canopy fuel continuity, as indicated in the previous paragraphs.

Tree Retention

The 300 Foot Exemptions had between 10 to 267 trees per acre, with the highest density of trees found in the Coast FPA. The majority of sampled (c)(6) Notices met FPR basal area retention requirements, with slight differences when considering all species and only conifer species. Most Notices that did not meet this requirement were on Site Class II or III timberlands, but largely not the most productive Site Class I timberlands.

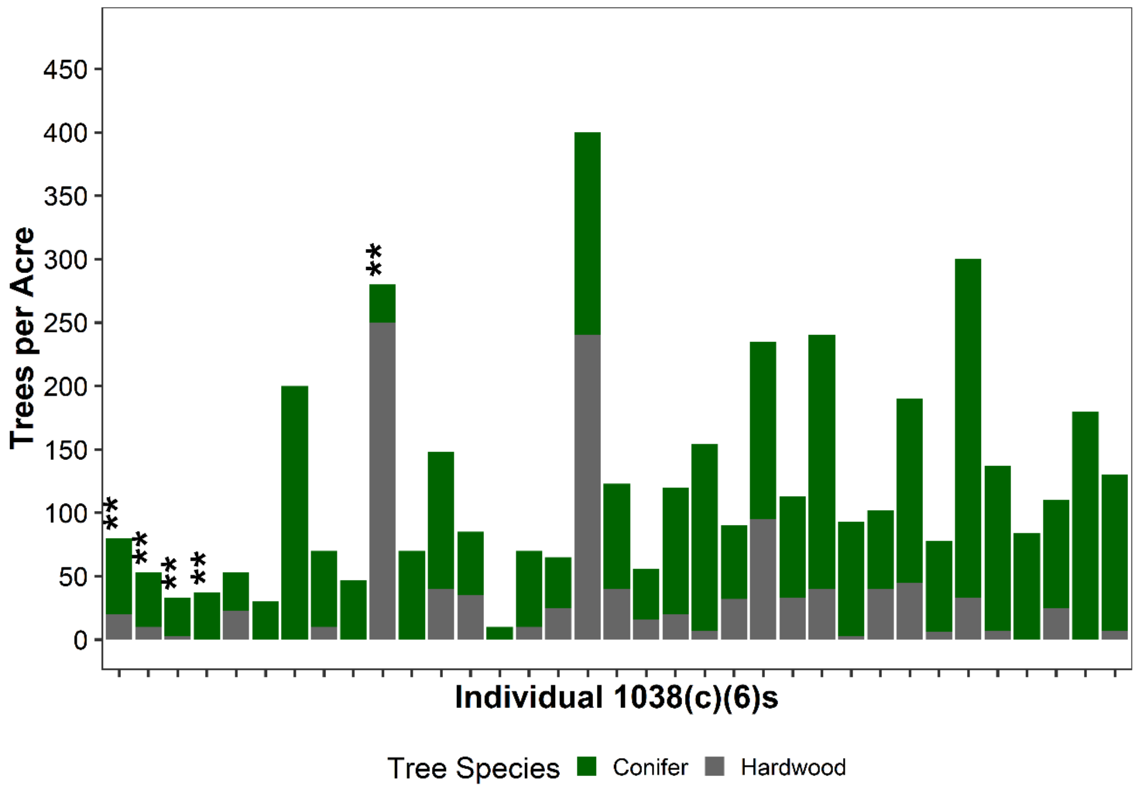

Figure 17: Trees per acre, by individual (c)(6) Notice, order from left to right by increasing total basal area (**Figure 18**), with each bar colored by the proportion of the trees per acre by conifer or hardwood species. A "**" above a bar indicates basal area retention, based on conifer species, was likely not met.

Conifer species represented 11 to 100% of the residual trees per acre on the (c)(6) Notices, averaging 80% of all residual trees. The Coast FPA had the highest mean value for trees per acre, at 139, while the Cascade and Sierra FPAs averaged 117 and 37 trees per acre. There were between 10 to 267 trees per acre of conifer species, while hardwoods, found on 77% of sampled (c)(6) Notices, ranged between 3 to 250 trees per acre. Overall, there did not seem to be a relationship between retained basal area and the number of trees per acre, either across the entire sample, nor at the FPA level, and regardless of the number of conifer or hardwood trees per acre.

Dead standing trees, regardless of diameter and species, were found on 54% of the sampled (c)(6) Notices, and ranged from 1 to 17 total trees across all plots on the (c)(6) Notices. Fifty-five percent of these dead standing trees were WHR2 or 1-6" DBH, while 23% were WHR3 or 6-11" DBH. Dead standing trees 11-24" DBH (WHR4) made up 18% of all residual dead trees, while only 3% were WHR5 or greater than 24" DBH.

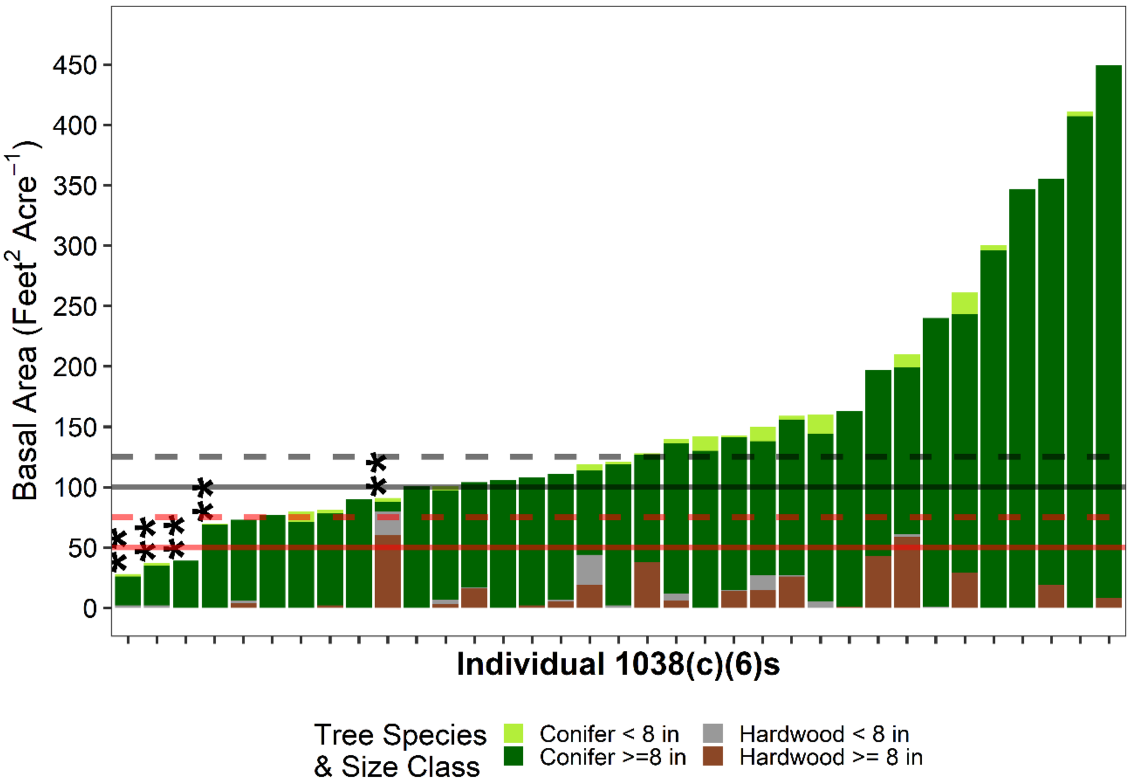

Figure 18: Post-harvest basal area retention on individual (c)(6) Notices for all trees and species, with each bar colored by the tree species type and size class. The horizontal lines represent FPR retention requirements for conifers; the red line is Site Class IV (50 ft^2 ac^{-1}), the red dashed line is Site Class II and III (75 ft^2 ac^{-1}), the black line Site Class I (100 ft^2 ac^{-1}), and the dashed black line Site Class I on the Coast FPA (125 ft^2 ac^{-1}). A "**" above a bar indicates basal area retention, based on conifer species, was likely not met.

The 300 Foot Exemptions had basal areas that ranged from 28 to 449 ft^2 ac^{-1}, inclusive of both hardwood and conifers species of all diameters, with a sample-wide average of 157 ft^2 ac^{-1} (**Figure 18**). Hardwood species of all sizes ranged from 1 to 80 ft^2 ac^{-1} where present (**Figure 18**). Conifer species, also of all diameters, ranged from 11 to 441 ft^2 ac^{-1}, and averaged 145 ft^2 ac^{-1} across the sample (**Figure 18**). Dead standing trees, where present, ranged from 1 to 34 ft^2 ac^{-1}, with a mean of 11 ft^2 ac^{-1}.

When considering all species and diameters, 89% (n = 31) of the sample met basal area retention requirements per the reported site class. For only conifers of all diameters, 86% of the sample (n = 30) met the basal area retention per the reported site class. Where basal area retention was likely not met when considering conifer species only, four (c)(6)s were Site Class III, and one was Site Class I. These particular (c)(6)s had between 11 to 70 ft^2 ac^{-1}, with an average of 36 ft^2 ac^{-1}. In two cases, the reported and treated harvest area on the sample Notices were minimal in spatial size (one acre or less), and the lack of basal area retention may reflect not sampling 100% of all residual trees, pre-harvest stand conditions, or a combination of these two factors.

Stand Structure Change

- **Seventy-two percent of (c)(6) Notices increased the QMD of trees following harvest (25 out of 35 Notices). The largest decreases in QMD were found on 11% of the sample; another 17% of the sample potentially had a decrease in QMD, however this finding was nuanced.**
- **Most (c)(6) Notices increased or kept average diameter classes of residual trees static, with respect to wildlife habitat relationship (WHR) categories, with a very small minority reducing average tree size relative to habitat requirements.**
- **The size of harvested trees was generally varied across Notices, with no clear trend towards a bias in size and removal on most projects relative to basal area retention or QMD change requirements.**
- **Intent of this Exemption is inherently difficult to show and enforce outside of professional judgement and/or intensive inventory. Certain quantitative requirements in the FPRs may not necessarily result in the reduction of fire behavior and hazard, as there is an absence of explicit linkages between numeric targets and the potential for fire behavior modification.**

Quadratic Mean Diameter Changes

Generally, the majority of (c)(6) Notices saw an increase in quadratic mean diameter of the residual trees, following harvest. Due to varying spatial harvest intensities, some Notices had QMD changes that were reflective of varying levels of harvest, pre-existing stand conditions, or a combination of both factors. For example, one (c)(6) had a portion of the Notice that was intensively harvested, while another portion had large trees retained, such that most plots had a QMD decrease, but overall the Notice had a QMD increase. There was also nuance when considering all tree species, and only conifer species. The largest QMD decreases were found on 11% of (c)(6) Notices, and 6% of Notices had both a substantial QMD decrease and failed to meet basal area retention requirements.

When addressing the pre- to post-harvest change in quadratic mean diameter (QMD), nuance is involved in regard to individual plot mean and (c)(6) Notice-wide changes. The nature of these treatments is sometimes not spatially equal, and §1038(c)(6)(B) does not explicitly specify how the QMD requirement is to be met.

When considering QMD change across all measured trees and stumps 8 inches DBH or larger on each (c)(6), 23% of the Notices likely did not increase QMD (**Figure 19A**), while when considering only conifer species 8 inches DBH or larger, 20% of the (c)(6) Notices likely did not increase QMD (**Figure 19A**). If the QMD changes on individual plots are averaged for each (c)(6) Notice, 26% of the 300 Foot Exemptions likely did not increase QMD across all species that were 8 inches DBH or larger (**Figure 19B**). For only conifers 8 inches DBH or larger, 23% of the (c)(6) Notices likely did not increase QMD when averaging plot-level QMD changes (**Figure 19B**). QMD changes for individual (c)(6) Notices with decreases are shown in **Table 11**.

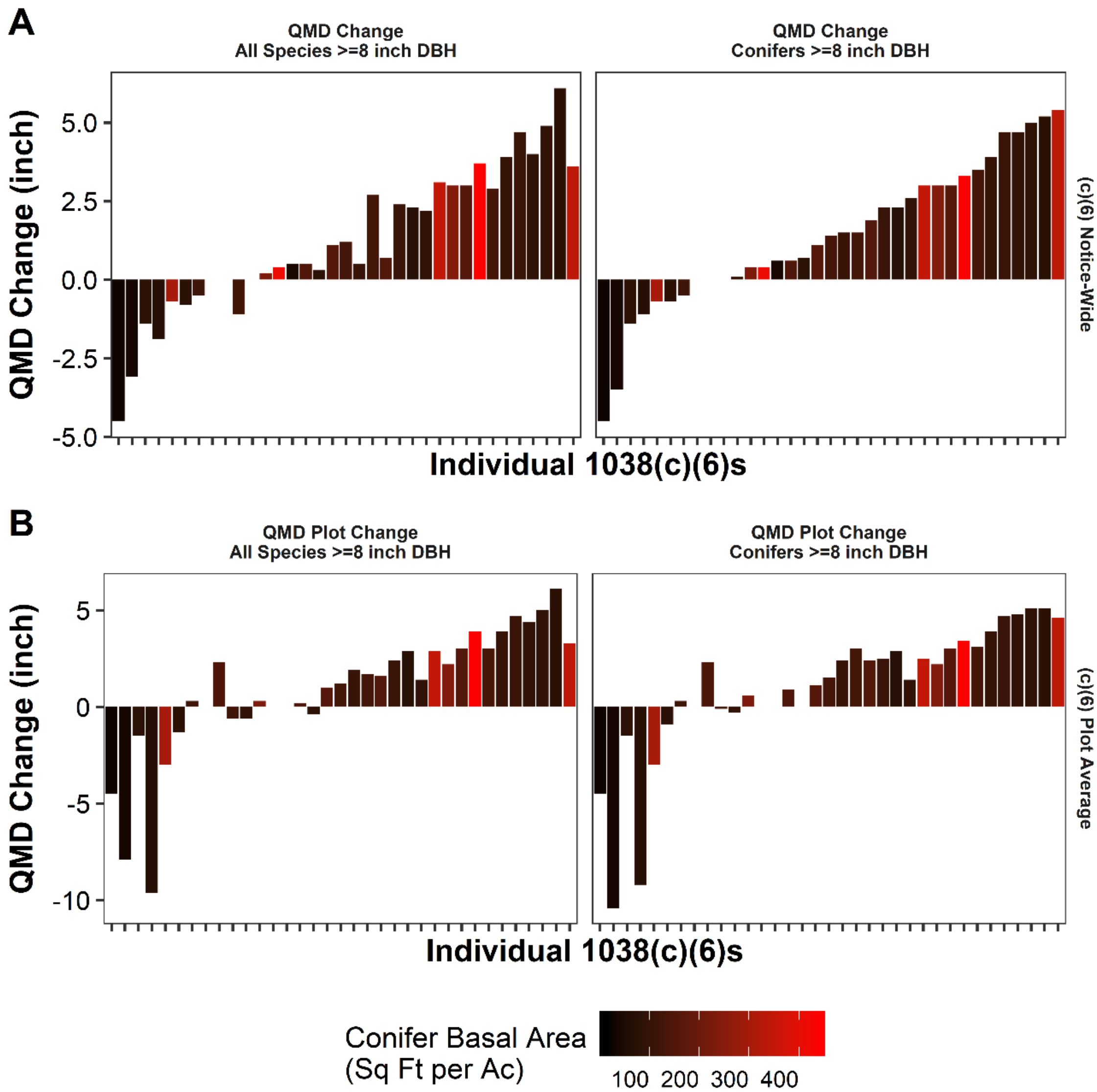

Figure 19: QMD change at the Notice-wide level, A, and plot-average for each (c)(6), B, shown by QMD change considering trees only 8 inches or larger in DBH, and only conifers 8 inches or larger. Bars indicate individual (c)(6) Notices, are ordered from left to right by increasing Notice-wide QMD change for conifers 8 inches or larger, and the bar color indicates the basal area in feet^2 acre^{-1}, post-harvest, for all conifer species.

Overall, when considering potential sampling limitations due to the rapid nature of our monitoring, and both plot-average and Notice-wide calculations of QMD, 11% (n = 4) of the sample showed more substantial 1 inch or larger *decreases* in QMD, regardless of how QMD change was assessed (**Table 11**). Of these four 300 Foot Exemptions, two also failed to meet basal area retention standards, indicating that sample-wide, 6% of (c)(6) Notices are likely being over-harvested or potentially "high-graded" of the largest and most abundant trees. The remaining eight Notices with potential QMD decreases had mixed outcomes, dependent on how they were assessed.

We've presented this thorough approach in **Table 11**, in order to fully convey results, and to capture those Notices that had spatial acreage limitations or spatially varying levels of harvest intensity. For example, in **Table 11**, Cascade FPA Notice #4 showed neutral or positive QMD increases at the Notice-wide level, while showing a QMD decrease across all species 8 inches or larger and a neutral result for conifer species 8 inches or larger at the plot-average level. Cascade FPA Notice #8 shows a 0.5 inch decrease at the Notice-wide level, while the plot-average level showed a 0.3 inch increase in QMD.

Table 11: QMD change following harvest on sampled (c)(6) Notices, where QMD decreased. Columns show QMD changes by Notice-wide calculations, and by averaging the fixed plots on each Notice, for both all tree species 8" DBH or larger, and for only conifer species 8" DBH and larger. Red shading indicates a decrease of 1" or more, orange shading indicates a decrease between 0.5 and 1", gray shading indicates a decrease of 0.5" or less, and green indicates a particular metric that showed a QMD increase.

	QMD Change, All Species >=8", Notice-Wide	QMD Change, Conifer Species >=8", Notice-Wide	QMD Change, All Species >=8", Plot-Average	QMD Change, Conifer Species >=8", Plot-Average
(c)(6) #1, Coast	-3.1	-3.5	-7.9	-10.4
(c)(6) #2, Coast	-0.7	-0.7	-3.0	-3.0
(c)(6) #1, Cascade	-1.4	-1.4	-1.5	-1.5
(c)(6) #2, Cascade	0.3	0.7	-0.4	0.0
(c)(6) #3, Cascade	-4.5	-4.5	-4.5	-4.5
(c)(6) #4, Cascade	0.0	0.1	-0.6	-0.3
(c)(6) #5, Cascade	-1.9	-1.1	-9.6	-9.2
(c)(6) #6, Cascade	-0.8	-0.7	-1.3	-0.9
(c)(6) #7, Cascade	-1.1	0.0	-0.6	-0.1
(c)(6) #8, Cascade	-0.5	-0.5	0.3	0.3

These examples illustrate our capturing of what was likely more intensive harvesting or lower stand densities (Cascade Notice #4), or plots with more abundant large trees relative to the rest of the Notice (Cascade Notice #8). Other examples, such as Coast FPA Notice #1 and Cascade FPA Notice #3, show much more substantial decreases in QMD, with plot-average QMD change estimates of -10.4" and -4.5" for conifer species 8" DBH or larger (**Table 11**).

The two Notices with substantial QMD decreases also had plots with complete absences of residual trees, but stumps of a commercial size present. The 11% of Notices with substantial QMD decreases (**Table 11**) all had, on average, either an equal number of stumps as residual trees within plots, or more harvested trees than residual trees. In the case of the Notice with a plot-average 10.4" QMD decrease, the QMD of all residual conifer trees 8" DBH and larger was 16.2", while the QMD estimate of harvested conifers 8" DBH and larger was 20.7", indicating that the largest trees were harvested. Examples of Notices with both QMD increases and decreases are shown in **Figure 20**.

Figure 20: Examples of Notices where QMD was decreased across the entire harvest area, either through harvesting of the largest trees, pre-existing stand conditions, or a combination of both, left, and examples of Notices with QMD increases across the entire harvest area, right.

Post-Harvest Ecological Metrics

Overall, most (c)(6) Notices either maintained or increased the Wildlife Habitat Relationship-based diameter class, although some of these Notices did not increase QMD or failed to meet basal area retention requirements. In general, nearly 2/3rd of all 300 Foot Exemptions were WHR4 with tree sizes of 11-24" in diameter on average, both before and after harvest.

Of the sampled 300 Foot Exemptions, 94% of the Notices either maintained or increased the WHR class, based on the QMD of all sizes of residual and harvested tree species (**Table 12**). Within the sample, the majority, 63%, of all (c)(6) Notices were WHR4 pre- and post-harvest (**Table 12**). Only 6% of the sample had an overall WHR classification decrease, while negative QMD changes were only found on those Notices where WHR either did not change, or decreased (**Table 12**). In each case where QMD *decreased* for either all species 8 inches DBH or larger, or for only conifers 8 inches DBH or larger, WHR either remained static or also decreased. Where basal area retention was likely not met, only one Notice also had a WHR size class decrease (WHR4 to WHR3).

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Table 12: WHR Class and change post-harvest, based on the QMD of all species of trees and all diameters, and re-created stump diameters of all species, with min, mean, and max values for QMD change and basal area retention across all species and only conifer species. Percentages may not add up to 100%. Red QMD numbers indicate a QMD decrease.

Pre-harvest WHR Estimate	Post-Harvest WHR Estimate	% of Sample/#	QMD Change, All Species >8" (Min-**Mean**-Max)	QMD Change, Conifers >8" (Min-**Mean**-Max)	[All Species] Basal Area (Min-**Mean**-Max)	[Conifers] Basal Area (Min-**Mean**-Max)
WHR 5 (> 24" DBH)	**WHR 5** (> 24" DBH)	6% / n=2	3.1" - **3.9"** - 4.7"	3.0" - **3.8"** - 4.7"	106 - **226** - 347	106 – **226** - 347
WHR 4 (11-24" DBH)	**WHR 5** (> 24" DBH)	6% / n=2	3.6" - **3.6"** – 3.7"	3.3" - **4.3"** - 5.4"	355 - **402** - 449	336 - **389** - 441
WHR 4 (11-24" DBH)	**WHR 4** (11-24" DBH)	63% / n=22	-3.1" - **1.1"** – 4.9"	-3.5" - **1.3"** – 5.0"	37 - **154** - 412	35 - **141** - 412
WHR 3 (6-11" DBH)	**WHR 4** (11-24" DBH)	11% / n=4	0.0" - **3.1"** - 6.1"	0.1 - **2.9"** - 5.2"	77 - **97** - 108	77 - **95** - 106
WHR 3 (6-11" DBH)	**WHR 3** (6-11" DBH)	6% / n=2	-1.4" - **-1.1"** - -0.8"	-1.4" - **-1.1"** - -0.7"	80 - **100** - 119	75 - **78** - 80
WHR 2 (1-6" DBH)	**WHR 3** (6-11" DBH)	3% / n=1	NA - **0.0** - NA	NA - **0.0** - NA	NA - **91** - NA	NA - **11** - NA
WHR 4 (11-24" DBH)	**WHR 3** (6-11" DBH)	6% / n=2	-4.5" - **-2.8"** - -1.1"	-4.5" - **-2.3"** – 0.0"	28 - **89** - 150	26 - **75** - 123

In one case where the WHR2 (1-6 inch diameter) increased to WHR3 (6-11 inch diameter), the QMD did not change, and basal area retention was not met under any criteria. This particular Notice reported 90% of the harvested volume as hardwood trees and only 10% as Douglas-fir, had 93% of all residual trees lacking any potential vertical fuel continuity, and finally, when considering *all* tree species of *all* diameters, increased QMD by 2.1 inches. This same Notice likely involved a misapplication of the correct harvest document, as the timberland owner, while having fire in mind per their own communication, also indicated a desire to perform a timberland conversion.

Within the Cascade FPA, six (c)(6) Notices potentially did not increase QMD, when considering all tree species over 8" DBH diameter; of these, only one failed to meet conifer basal area retention. Also of these six, five Notices likely did not increase QMD for conifers 8" and larger, of which one Notice did not meet conifer basal area retention requirements. Decreases in QMD of any kind were found only on Cascade Notices that either kept their WHR diameter class static, or decreased it. When considering only conifer species, one (c)(6) Notice in the Cascade FPA decreased QMD, decreased WHR size class, *and failed* to meet basal area retention requirements.

In the Coast FPA, two Notices did not increase QMD for either all species 8" DBH and larger, or for only conifers 8" DBH and larger, but only one Notice failed to meet basal area retention for either all species or conifer species. That single Notice also had a *decrease* in conifer QMD of 3.5".

The Sierra FPA (c)(6) Notice increased QMD for both all residual tree species and conifers 8" DBH and larger, but failed to meet basal area retention requirements. However, this Notice also minimized slash spatial extent and depth (**Table 4**,**Table 5**), and minimized presence of ladder fuels, with ladder fuels overwhelmingly two feet or less in height.

Stump Size

Generally, most (c)(6) Notices harvested trees less than 24 inches in diameter. Just over half of the sample also involved harvesting of hardwood tree species. A strong pattern was not evident regarding both the size of the trees that were harvested, and outcomes on Notices relative to QMD changes and basal area retention, indicating the importance of individual project details.

Once stump diameters were back calculated to DBH estimates, only one (c)(6) Notice, or 3% of the sample, had a majority of stumps come from the WHR5 size class, or greater than 24 inches diameter (**Table 13**). A total of 31% of the sample had the majority of post-harvest stumps in the WHR2 size class, or between 1-6 inches diameter, while 11% had a majority of stumps as WHR3 or 6-11 inches diameter (**Table 13**). The WHR4 size class, or 11-24 inches, was the most frequent stump size class on 43% of the sample (**Table 13**). Fourteen-percent of the sample had a tie between WHR size classes for most frequent stump size; these involved a split between WHR1 and WHR4, WHR2 and WHR4, WHR2 and WHR3, and between WHR4 and WHR5.

The Notice-wide QMD of harvested conifer trees, based on sampled stumps, was WHR3 on 26% of the sample, and WHR4 on 66% of the sample (**Table 13**). Three percent of the sample harvested WHR2 conifers, and 6% of the sample harvested conifers in the WHR5, or >24 inch diameter class, based on QMD. Hardwoods were harvested on 57% of the sample, with Notice-wide QMDs ranging from 0.8 to 18.8 inches (**Table 13**). Of the Notices with hardwoods harvested, 45% fell in to the WHR2 or 1-6 inch size class based on QMD.

Figure 21: Left, a (c)(6) Notice where the Notice-wide QMD indicated a residual stand of WHR4 (11-24 inch DBH) conifer trees, with harvested stumps averaging WHR3 (6-11 inch DBH). Right, a Notice with a Notice-wide QMD of WHR5 (>24 inch DBH) for residual conifer trees, and stumps of harvested trees that averaged WHR5 in size.

There was no clear trend in what the majority harvested tree WHR size class was, and QMD decreases or basal area retention; that is, results appear to be project-specific (**Figure 21**). However, when looking at the Notices with the most substantial QMD decreases (**Table 11**), one had a WHR size class decrease pre- to post-harvest and failed to meet basal area retention; one only failed to meet basal area retention, but did not change WHR; and two Notices did not change the overall WHR size class and met basal area retention requirements, despite QMD decreases. Additionally, these same Notices also had a variety of harvested tree sizes, as shown by (c)(6) #11 in the Coast FPA (**Table 13**), and #21, #22, and #23 in the Cascade FPA (**Table 13**). Of these four Notices, three of the four adequately treated surface fuels; only one did not, with only 48% of residual trees with an absence of vertical fuel continuity.

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Table 13: Stump data, by FPA, reported site class, with corresponding WHR size class for stumps; Notice-wide basal area of residual trees, QMD change, retention goals, and post-harvest QMD of conifers >=8 inches. Data is ordered by FPA and conifer QMD change. For FPA, 1=Coast, 2=Cascade, and 4=Sierra. Red text for basal area indicates retention targets were likely not met, and for QMD that a decrease likely occurred. Bold text for stump percentage indicates the majority value, which includes ties on some Notices.

(c)(6)	FPA	Site Class	% Stumps WHR 1	% Stumps WHR 2	% Stumps WHR 3	% Stumps WHR 4	% Stumps WHR 5	Conifer Stump QMD	Conifer Stump WHR	HW Stump QMD	HW Stump WHR	BA, All Species	BA, Conifer	QMD Change, All Species >=8"	QMD Change, Conifer >=8"	Conifer >=8" QMD
1	1	3	5	14	18	**59**	5	15.9	WHR4	NA	NA	355	336	3.6	5.4	29.7
2	1	3	0	17	33	0	**50**	35.0	WHR5	NA	NA	106	106	4.7	4.7	44.0
3	1	3	7	**41**	29	21	2	11.3	WHR4	6.1	WHR3	449	441	3.7	3.3	26.7
4	1	3	0	0	9	**91**	0	16.2	WHR4	13.4	WHR4	347	347	3.1	3.0	27.5
5	1	2	0	18	**39**	37	5	12.8	WHR4	7.9	WHR3	164	162	1.1	1.1	18.2
6	1	2	20	**45**	10	25	0	10.5	WHR3	0.8	WHR1	261	231	0.2	0.4	20.1
7	1	2	0	**50**	8	42	0	14.3	WHR4	NA	NA	412	412	0.4	0.4	24.0
8	1	3	19	**69**	12	0	0	2.1	WHR2	3.7	WHR2	91	11	0.0	0.0	12.0
9	1	1 and 2	3	31	3	**48**	14	17.2	WHR4	NA	NA	142	142	0.0	0.0	21.2
10	1	2 and 3	0	14	0	**45**	41	23.2	WHR4	NA	NA	300	300	-0.7	-0.7	23.3
11	1	3	5	**29**	18	**29**	18	19.4	WHR4	5.7	WHR2	37	35	-3.1	-3.5	16.2
1	2	2	7	**54**	24	15	0	8.7	WHR3	5.3	WHR2	77	77	6.1	5.2	21.7
2	2	3	0	**42**	**42**	14	1	9.2	WHR3	18.8	WHR4	90	90	4.9	5.0	19.6
3	2	2	15	**48**	21	14	1	8.2	WHR3	8.4	WHR3	127	90	4.0	4.7	21.3
4	2	3	0	**47**	40	13	0	8.2	WHR3	NA	NA	101	101	3.9	3.9	17.6
5	2	1	0	**37**	33	29	0	10.8	WHR3	6.1	WHR3	159	132	2.9	3.5	21.0
6	2	1	4	4	17	**61**	13	16.3	WHR4	NA	NA	240	239	3.0	3.0	19.1
7	2	3	0	0	8	**92**	0	14.0	WHR4	NA	NA	160	155	3.0	3.0	25.8
8	2	2	0	22	30	**48**	0	12.8	WHR4	4.4	WHR2	104	88	2.2	2.6	18.9
9	2	2	27	**52**	13	8	0	8.8	WHR3	3.0	WHR2	108	106	2.4	2.3	18.5
10	2	1	0	5	16	**68**	11	17.4	WHR4	NA	NA	197	154	0.7	1.9	22.8
11	2	1	2	26	**34**	32	6	13.9	WHR4	12.1	WHR4	143	128	2.7	1.5	23.0
12	2	2	0	18	9	**64**	9	19.0	WHR4	3.9	WHR2	111	104	0.5	1.5	21.8
13	2	3	0	14	**71**	14	0	10.2	WHR3	NA	NA	139	128	1.2	1.4	16.9
14	2	2	0	0	0	**100**	0	17.1	WHR4	NA	NA	80	79	0.3	0.7	18.6
15	2	1	**29**	18	24	**29**	0	15.4	WHR4	3.6	WHR2	211	149	0.5	0.6	19.0
16	2	3	0	7	14	**79**	0	14.3	WHR4	16.1	WHR4	39	39	0.5	0.6	16.4
17	2	3	3	**68**	12	18	0	8.3	WHR3	8.2	WHR3	102	95	0.0	0.1	14.3
18	2	1	0	17	28	**39**	17	19.3	WHR4	4.2	WHR2	150	123	-1.1	0.0	19.3
19	2	2	11	**47**	5	32	5	15.6	WHR4	2.4	WHR2	120	118	-0.5	-0.5	17.5
20	2	3	0	21	36	**43**	0	14.9	WHR4	6.2	WHR3	119	75	-0.8	-0.7	13.1
21	2	4	0	0	0	**50**	**50**	25.6	WHR5	NA	NA	73	68	-1.9	-1.1	23.4
22	2	3	0	46	0	**54**	0	13.0	WHR4	NA	NA	80	80	-1.4	-1.4	13.7
23	2	3	0	**33**	25	**33**	8	13.9	WHR4	NA	NA	28	26	-4.5	-4.5	10.4
24	4	1	0	14	**37**	31	17	15.3	WHR4	NA	NA	70	70	2.3	2.3	20.5

Exemption Intent

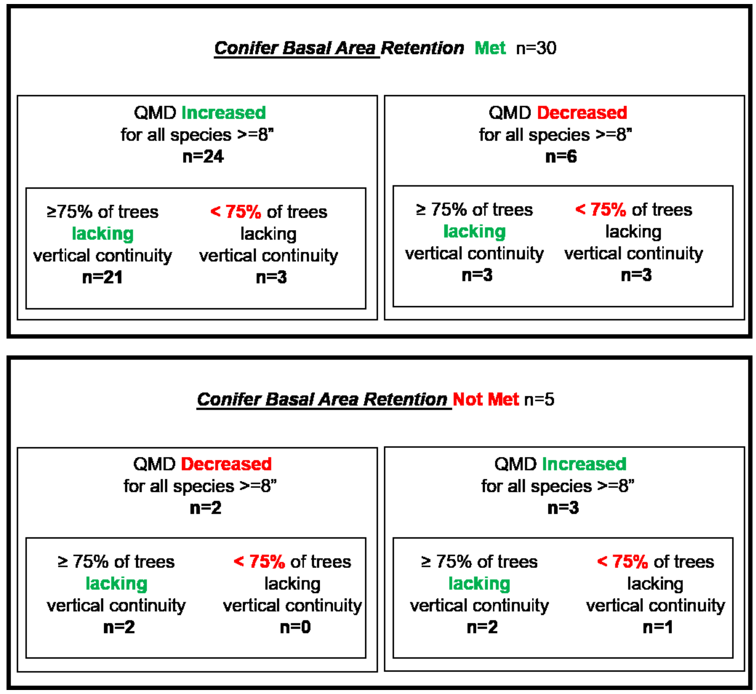

Figure 22: Example of various metrics by which to judge intent on (c)(6) Notices.

Intent is inherently difficult to assess quantitatively, outside of relying upon professional judgement. For example, assessing by conifer basal area retention standards, degree of residual trees lacking vertical fuel continuity, and QMD changes is one approach to determining intent (**Figure 22**). This approach aims to ensure that sufficient basal area remains consisting of larger diameter trees, while simultaneously disrupting vertical fuel continuity. The worst-case scenario, where retention isn't met, QMD decreased, and vertical fuel continuity is not interrupted on the majority of the Notice area, was not encountered during monitoring (**Figure 22**). In fact, where retention was not met and QMD likely decreased, both those (c)(6) Notices *did* disrupt vertical fuel continuity. Likewise, one (c)(6) failed to meet retention goals, and did not disrupt vertical fuel continuity on the majority of the Notice area, but *did increase* QMD (**Figure 22**).

For projects that met retention requirements, and increased QMD, only three (9% of the entire sample) did not disrupt vertical fuel continuity for at least 75% of the measured trees (**Figure 22**). Where retention was met for conifer species, and QMD was decreased per our sampling, half of these Notices also failed to disrupt vertical fuel continuity for at least 75% of the measured trees (9% of the entire sample) (**Figure 22**).

One approach to this is to observe that 20% of the sampled trees, post-harvest and within our monitoring, failed to disrupt vertical continuity on at least 75% of the Notice area, in contrast to the intent. Another is to observe that 69% of the sample, based on measured residual trees, met retention requirements and increased QMD, indicative of thinning from below. Yet another is that 66% of the sample increased QMD and disrupted at least three quarters of the vertical fuel continuity of the Notice area (based on sampled trees and tree harvesting practices), regardless of basal area retention (**Figure 22**).

Discussion

- **(c)(6) Notices generally are relatively small in footprint and intensity, with some exceptions when multiple structures are present.**
- **Watercourse protection on (c)(6) Notices was adequate.**
- **Surface fuel and slash treatments are generally adequate on treated Notices, although slash depth and spatial extent tend to increase together, along with larger pieces of slash from harvesting. Whole tree yarding of harvested trees is optimal for reducing surface fuels.**
- **While ladder fuels are adequately treated, or lower limbs on tree crowns removed, or both treatments occur on Notices, performance-based guidance could help decrease vertical fuel continuity.**
- **Areas with high unit area biomass, such as the North Coast, may require additional efforts to treat surface and ladder fuels.**
- **Timber harvesting generally was utilized to "thin from below" and alter canopy fuel loads; however, there may be better metrics to determine intent of harvesting than reliance upon QMD changes.**

General Observations of (c)(6) Notices

Overall, (c)(6) Notices had relatively small spatial footprints, as reported, averaging less than five acres sample-wide, reflective of the constraints and purpose of the Exemption type. While the presence of multiple structures, particularly when spread out on one ownership, dictates larger harvest footprints, this appears to be the exception rather than the norm. The 300 Foot Exemption is not meant for widespread forest management, but instead parcel-based forest and fuel management in proximity to residential homes. Unlike previous findings on the 0-150 foot 1038(c) Exemption (Olsen and Coe, 2021), many landowners are able to undertake (c)(6) operations either financially breaking even, or making a profit. This is likely reflective of both potentially easier operations (i.e., not in close proximity to structures and thus requiring specialized falling and operations), and economies of scale that allow the value of the timber to offset the fixed and variable costs of operations.

Where watercourses were present, they were adequately protected. As sediment discharges mainly occurred at Class III tractor crossings, it is worth emphasizing where LTOs adequately made use of slash packing and other BMPs for reducing impacts to water quality. These findings are similar to those of the 1038(c) monitoring (Olsen and Coe, 2021). While our sampling did not encounter Class I or Class II watercourses overlapping with timber operations, there have been past occurrences of this, where licensed professionals consulted with the appropriate Review Team agencies and reached mutually agreeable approaches to operations. As such, licensed professionals should continue this approach of ensuring the highest degree of watercourse protection. Furthermore, where watercourse presence is indicated by the Notice document, Review Team agencies could make active inspections a priority in order to continue ensuring a high standard of water quality protection.

Figure 23: An example of where harvesting was followed by mastication, resulting in continuous surface fuels of masticated fuels approximately 12” in depth.

Surface Fuel and Slash Treatment Efficacy

On average, the 300 Foot Exemptions adequately treated surface fuels and slash related to timber harvesting. However, 54% of Notices had instances of slash depth exceeding the regulatory requirement of 18 inches. It is unclear whether the requirement allows for limited concentrations of slash to exceed this depth requirement, or if there is an outright prohibition against slash depths exceeding 18 inches.

In areas of dry mixed-conifer forests, research has shown that effective treatment of surface and ladder fuels can reduce fire severity and increase forest resiliency to wildfire (Safford et al., 2012). However, mastication of fuels, particularly as depth increases or vegetative recovery outpaces masticated fuel decomposition, may alter and increase surface flame length and induce further tree mortality (Knapp et al., 2011). Research has shown the increased benefit from both mechanical fuel treatments and prescribed fire (Stephens and Moghaddas, 2005; Stephens et al., 2009).

However, the setting of most (c)(6) Notices within developed communities, including the wildland-urban interface (WUI) and intermix, and potentially higher building density, likely eliminates the use of prescribed fire following work done under a (c)(6) Exemption, in addition to other factors.

From the perspective of the *intent* of the Exemption, creating a fuel break around habitable and permitted structures to reduce fire behavior, the majority of our sample was highly effective at reducing ladder fuel and surface fuel loads. However, some Notices did effectively create continuous low-level surface fuel beds with mastication. For instance, one Notice was indicated as effectively having widespread mulch from treatment operations that was 12” in depth (**Figure 23**). Examples such as this likely have a post-operations window where surface fuel hazard is elevated, but surface erosion potential is greatly reduced as well. Selective mulching with wood chips for erosion control is preferred (e.g., road and skid trail surfaces, watercourse crossing approaches).

Observationally, it is clear that when and where possible, the use of whole-tree yarding, where trees are felled and transported in full to a landing for processing and loading, lends towards the elimination of larger slash piles and deeper fuel depths, such as seen in **Figure 8**. Monitoring found that average slash depth and maximum slash depth, along with the spatial extent of slash and prevalence of larger fuel class sizes, increased all together, indicative of an increasing potential fire hazard post-operations. In particular, the Coast FPA, where unit area biomass is generally higher, had the most substantial slash depths within the sample. However, our results did indicate that ladder fuels in the Coast FPA were frequently either absent or treated to a less hazardous height and spatial extent. While no 300 Foot Exemption within our sample exceeded the 18” slash depth on average across harvest areas, individual accumulations of slash over 18” in depth occurred on 54% of Notices. It is unclear how slash depth requirements are enforced in the field, but it is worth revisiting if 18” is the appropriate depth target, especially proximal to untreated ladder fuels.

While some research has indicated that defensible space within the first 100 feet, and within 15 feet to a greater degree, is statistically important (Syphard, Brennan, and Keeley, 2014), it has also been acknowledged that frequent structure loss occurs through ember ignition or exposure to adjacent burning structures (Syphard and Keeley, 2019). House to house ignition, where structures are in close proximity, can be critical in determining damage outcomes (Cohen and Stratton, 2008), and past monitoring has identified the prevalence of structures in close proximity to each other within structure-centric fuel treatments (Olsen and Coe, 2021). However, recent research has also shown the importance of source fire area relative to fire spotting ahead of flame fronts (Storey et al., 2020), and fuel treatments have been identified as a critical factor in minimizing extreme fire behavior (Rogers et al., 2008). Increasing cover of shrubs and trees within 40m (approximately 130 feet) of the upwind direction of residences was found to increase chances of home damage and destruction, while when fuel continuity was disrupted, home destruction probability decreased (Gibbons et al., 2018). One study of the 2018 Camp Fire identified percent overstory canopy cover within 100 meters (328 feet) of homes as a strong influence on home damage and destruction (Knapp et al., 2021), with homes with less than **53% *overstory canopy cover*** in that 100 meter zone having a lower chance of destruction.

Taken together, the monitoring results on the 1038(c)(6) point towards adequate treatment of harvest-related slash per the FPRs, and proactive surface fuel treatments and elimination of ladder fuels within project areas. Previous monitoring of 1038(c) 0-150 foot Exemptions identified very high levels of conformance with the stricter slash treatment standards within 150 feet of treated structures (Olsen and Coe, 2021). With that, there is currently a lack of explicit science-based guidance on what constitutes successful elimination of ladder fuels, what acceptable slash depth levels are, and what constitutes a desirable outcome for treating non-commercial fuels in the context of timber harvesting.

Tree Harvesting Under the 1038(c)(6)

While focus on surface fuel treatments and ladder fuels, in addition to home hardening, both are critical to altering fire behavior, the additional intent of the 300 Foot Exemptions is to reduce horizontal crown continuity through the removal of commercial tree species. Forest treatments that reduce density and remove the smaller diameter ladder fuels have been shown to reduce fire behavior and intensity in California, resulting in reduced scorch height, fire spread, crowning, and tree mortality, and a decrease in fire intensity moving inward from treatment boundaries (Skinner et al., 2005; Rogers et al., 2008; Safford, Schmidt, and Carlson, 2009; Safford et al., 2012; Lydersen et al., 2017). In addition to vegetation and canopy in close proximity to structures, Gibbons et al. (2012)

indicated that where treatments occurred within approximately 0.3 miles (approximately 1,580 feet) of structures, home damage and destruction was greatly minimized, as opposed to treatments further away. Of course, areas in California with higher biomass, where wildfires are not necessarily fuel limited but rather climate limited (i.e., coast redwood), the level of treatment required to address severe wildfire may come at the expense of the ecological integrity of these areas (Halofsky et al., 2018). However, given the limited implementation of this Exemption (i.e., an average of 41 Notices from 2016-2020), it is unlikely that the ecological tradeoffs are significant.

While many Notices were frequently removing a majority small diameter trees with the Exemption (**Table 13**), others may remove larger timber, dependent upon each project and pre-harvest stand conditions. It is likely that past management, wildfires, landowner objectives, and development all may influence how a particular (c)(6) is harvested, and what timber is removed.

Our analysis investigated if QMD was being increased by tree removal. Depending on how data were lumped and categorized, between one-fifth and one-quarter of the (c)(6)s may not have increased QMD. However, very few of these Notices additionally failed to meet basal area retention standards, and very few resulted in WHR size class decreases, based on the Notice-wide QMD. While our approach utilized estimations of pre- and post-QMD, from a regulatory standpoint, a rigorous determination of QMD change would require much more intensive, project-stand specific investigation and analysis.

While we presented a potential approach to assessing **Exemption Intent**, any approach, while addressing some of the core quantitative requirements expressed in the FPRs, does not lend realistically enforceable standards per the underlying intent of 1038(c)(6) for the "***purpose of reducing flammable materials and maintaining a fuelbreak"***, outside of a reliance on professional judgement.

In the absence of a QMD requirement, it is possible that a basal area retention requirement in conjunction with narrative and/or performance-based standards might be a viable option to simplify the Exemption requirements. For instance, a narrative requirement to retain or increase the underlying diameter class or WHR size class of a stand while meeting explicit, performance-based outcomes relative to surface and ladder fuel treatments would be the next best approach to ensure the largest, most fire-resilient trees are not being harvested in place of smaller, fire-prone trees. Projects could readily be addressed through active inspections as needed, and licensed professionals would have flexibility in the treatment of forest stands to achieve the intent of 1038(c)(6).

Overall, it is important to note that the (c)(6) Notice treatment alone will not stop a wildfire. Rather, the goal is to mitigate against rapid crown fire proximal to structures. As discussed above, ample research has shown the importance of home hardening and the home-ignition zone (Cohen, 2001). A limited case-study on the 2020 North Complex found that despite the degree to which treatment occurred, timber harvesting within 150 feet of homes did not ensure home survival in the face of extreme fire behavior (Olsen and Coe, 2021). However, each aspect should be taken together; that is, hardening homes, creating defensible space within Zone 1 (Ready For Wildfire), and ensuring that the more extensive area within 300 feet of homes within forested settings is treated to reduce fire behavior to minimal surface fires, at worst. As such, the (c)(6) Notice likely acts in synergy with other activities to reduce the likelihood of structure loss, especially in the absence of extreme fire conditions.

Recommendations

Recommendations are presented below, split into two separate distinctions: Operational recommendations and policy recommendations.

Operational Recommendations

1) LTOs utilize whole-tree yarding as possible and appropriate in order to minimize residual slash within project areas that could negatively influence fire behavior. This is particularly important in areas with high unit area biomass.
2) Ensure that mastication and chipping treatments do not result in continuous fuel beds of small diameter, 1- and 10-hour fuels that may be receptive fuelbeds during hot and dry conditions.
3) Actively focus on removal of the smallest diameter trees, and in stands where only larger diameter trees are present, ensure horizontal continuity of tree crowns has been disrupted, in addition to eliminating vertical fuel continuity through surface fuel treatments and/or pruning the lower limbs of residual trees.

Policy Recommendations

1) CAL FIRE and the Board of Forestry and Fire Protection (BOF) revisit Technical Rule Addendum #4, and integrate explicit, science-based guidance for both the 1038(c) and 1038(c)(6) Notices relative to surface and ladder fuel treatments, with discrete performance-based outcome expectations.
2) Develop a regulatory framework outside of increasing QMD that is flexible, enforceable, and ensures modification of fire behavior.
    a. Basal area retention requirements in conjunction with expectations that post-harvest stands do not depart from a pre-harvest average diameter class (e.g., the wildlife habitat relationship size classes) may ensure both environmental protection and fire behavior modification, while being readily enforceable.
3) CAL FIRE and the BOF determine acceptable slash depth requirements and the acceptable methodology by which target metrics for slash treatment can be regulated.
    a. The best available science should be used to determine if 18 inches is in fact an acceptable depth of slash following timber harvesting, and determine if small concentrations of slash exceeding this depth are allowable.

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Appendix 1

Equation for stump diameter to diameter at breast height, non-redwood conifer species:

DBH = $e^{-0.170+0.966[\ln(\text{stump\_diameter})]+(0.002557)}$

Maranto, C., 2007. "Report findings on QMD rule compliance for EX #4-05EM-058-CAL". *California Department of Forestry and Fire Protection, Forest Practice Administration.* Sacramento, CA. 13 p.

Equation for stump diameter to diameter at breast height, redwood conifer species:

DBH = 0.8759*(stump_diameter)-0.6486

Howe, R.A. 2014. "Coast Redwood Response to Herbicide Treatment of Tanoak". MS Thesis, Humboldt State University, Arcata, CA.

Equation for stump diameter to diameter at breast height, hardwood species:

DBH = stump_diamater – [(stump_dimater/10)+1]

Horn, A.G., and Keller, R.C. 1957. Tree diameter at breast height in relation to stump diameter by species group. Technical Note 507. *US Department of Agriculture, Forest Service, Lake States Forest Experiment Station*. St. Paul, MN. 2 p.

QMD calculation, Notice-wide (with alterations for conifer species only, and species 8" or greater in size):

$\sqrt{((\sum \mathrm{DBH}^2)/(\#\ \text{trees}))}$

QMD calculation, Plot-mean (with alterations for conifer species only, and species 8" or greater in size):

$\sqrt{((\sum \mathrm{DBH}^2)/(\#\ \text{trees}))/\#\ \text{Plots}}$

Trees per acre (with alterations for conifer species only, and species 8" or greater in size):

((# of trees)*10)/ (# of plots)

Basal Area calculation(with alterations for conifer species only, and species 8" or greater in size):

$$\frac{10}{\#\ Plots} * \left(\sum \mathrm{DBH}^2 * 0.005454\right)$$