CALIFORNIA
WILDFIRE & FOREST RESILIENCE
TASK FORCE

SUMMARY OF EXPERT CONSULTATION

Effectiveness and Ecological Impacts of Wildfire Mitigation Treatments in Chaparral and Coastal Sage Scrub

MAY 2026

SCIENCE ADVISORY PANEL

Prepared for the California Wildfire and Forest Resilience Task Force by the Science Advisory Panel and subject matter experts.

Purpose

In Spring 2026, the California Board of Forestry and Fire Protection (Board) engaged the California Wildfire and Forest Resilience Task Force (Task Force) to provide an independent scientific review of the treatment effectiveness and ecological impacts of wildfire mitigation measures in chaparral and coastal sage scrub communities. The request followed a judicial Writ of Mandate that identified deficiencies in the Program Environmental Impact Report for the California Vegetation Treatment Program (CalVTP). Task Force leadership assigned the request to the Science Advisory Panel (SAP). To guide the effort, the Board provided a series of questions on the effectiveness and impacts of the measures prescribed in the CalVTP and noted a court-mandated timeline for response. This document was drafted in response to the Board's request.

Process

To ensure the timely completion of this task, SAP staff developed a structured expert consultation to produce an evidence-based summary addressing the key elements. Subjective judgment is inherent in scientific inquiry (O'Hagan 2019). To minimize potential bias, the approach followed best practices for structured expert elicitation (Hemming et al. 2018), including: (1) careful expert selection; (2) structured question design; (3) individual or dyadic interviews; (4) iterative review; (5) response synthesis; and (6) transparent process documentation.

SAP staff contacted 13 subject matter experts, five of whom serve as members of the SAP, to gauge their willingness and availability to participate. Eight were available. This initial list of experts recommended three additional scientists, two of whom participated (for a total of ten subject matter experts).

Prior to the interviews, staff reorganized and revised the Board's questions for clarity while taking care to minimize leading or biased phrasing (*sensu* O'Hagan 2019). The revised questions were shared with the Board for informational purposes only, not for approval, prior to conducting any interviews. The production of the summary of expert consultation remained entirely within the purview of the SAP.

SAP staff conducted interviews with the subject matter experts, asking them to respond based on their expertise. Drawing on responses from these meetings, SAP staff drafted an initial summary of the synthesis. Citations included in this document were provided by the experts as examples to support their answers. Note that these references do not constitute a comprehensive literature review of the topics.

A draft was reviewed by participating experts for accuracy and completeness. Their comments were integrated by SAP staff into a revised version. This revised draft was circulated to the full SAP for review. An additional subject matter expert who was invited but unable to participate provided in-depth responses to the revised draft. These insights were incorporated into the summary of expert consultation sections. During the start of the SAP review period, two subject matter experts requested the inclusion of an additional statement. This statement was circulated via email to all interviewed subject matter experts, who were asked to indicate agreement or disagreement to appropriately categorize the new statement as a consensus, shared, or individual perspective.

Comments from subject matter experts and SAP panelists are reflected in the final draft. All critiques, comments, and responses were retained for transparency and documentation.

Background on Plant Communities

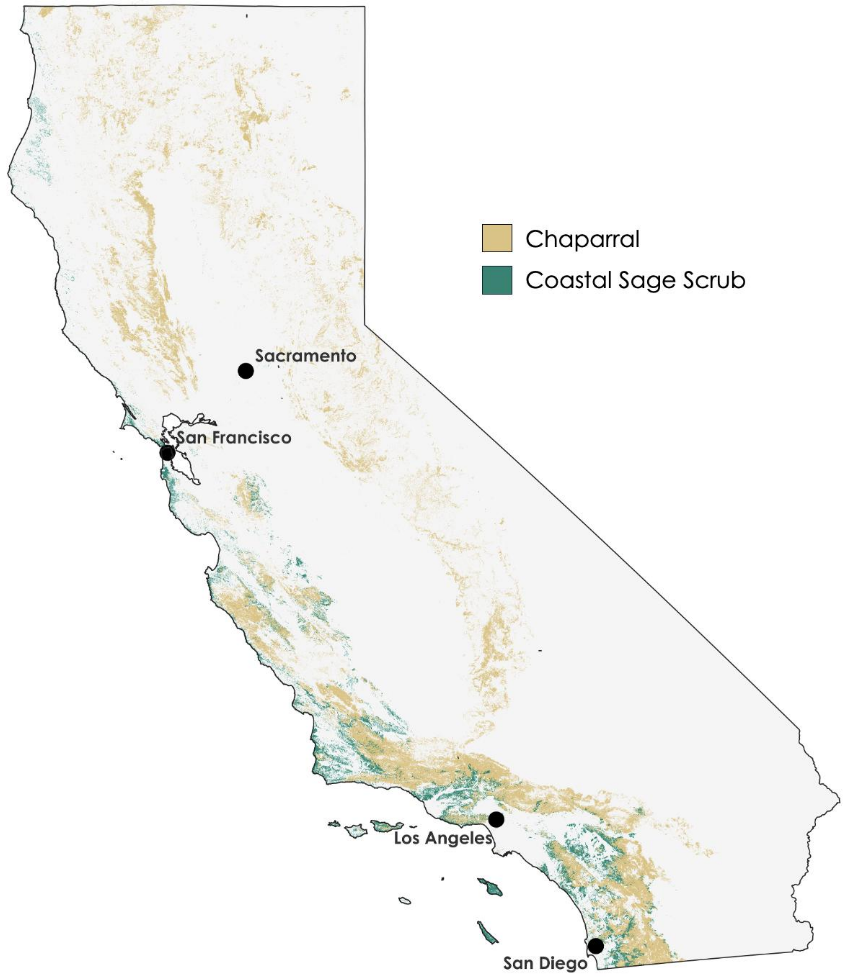

Figure 1. Distribution of chaparral (including Chamise-Redshank Chaparral, Mixed Chaparral, and Montane Chaparral types) and coastal sage scrub (Coastal Scrub) based on the California Wildlife Habitat Relationships (WHR) vegetation type (CALFIRE, 2022).

Chaparral

Characteristics. Widely distributed statewide (Fig. 1), chaparral is defined as evergreen, drought-tolerant shrubs growing 1.5-3m tall with stiff branches and sclerophyllous (leathery) leaves. The Board noted that alliances dominated by coyotebrush (*Baccharis pilularis*) should be excluded from the definition of chaparral in this report. Chaparral stands tend to occur at elevations between 300 and 1500m, but can extend outside of this range (Barbour et al. 2007).

Reproduction. Chaparral systems are subject to high-intensity stand-replacing wildfires, and the species that make up these ecosystems have adapted different means to recover post-disturbance. Species are either obligate seeders, meaning they rely on fire to stimulate seed germination, obligate resprouters, meaning shrubs can resprout via lignotubers after disturbance, but their seeds do not generally survive a fire, or facultative seeders, meaning they regenerate post-fire via both fire-stimulated seeds and resprouting. The regeneration strategy of the latter can change depending on characteristics of the site. Many chaparral species are obligate seeders.

Fire regime. Because active crown fires consume aboveground shrubs rather than producing fire scars that can be dated, it is difficult to determine the historic range of variation of fire return intervals for the different chaparral communities across the state. Van de Water and Safford (2011) estimate pre-European fire return intervals for chamise redshank chaparral as 30-90 years and montane chaparral as 15-50 years (mean min to mean max). In Santa Barbara county, fire scars in stands of Big Cone Douglas-fir (*Pseudotsuga macrocarpa*) trees adjacent to chaparral indicate a mean fire return interval of 25 years (range 13-39 years; Lombardo et al. 2009). Natural sources of ignitions are rare in coastal areas. In the past few decades, human-caused ignitions have resulted in relatively frequent fires in chaparral systems (Keeley and Syphard 2019).

Local winds in chaparral systems strongly influence fire behavior and size. Large, destructive fires are more likely to occur under strong wind events. In western California, severe fire weather conditions (i.e., Santa Ana winds in southern California and North winds in northern California) occur after the annual summer drought period. In northern California, some chaparral stands experience North winds that are not as strong as the Santa Ana winds in southern California and may experience comparatively longer fire return intervals (Barbour et al. 2007, Keeley and Syphard 2019). However, many fires occur in chaparral during the spring and summer seasons when winds are mild and fire spread can be controlled (see Safford et al. 2018).

Coastal Sage Scrub

Characteristics. Coastal sage scrub is dominated by drought-tolerant, deciduous, lower-growing (typically 1-1.5m tall), shallow-rooted aromatic shrubs with soft, flexible branches and soft deciduous leaves that may drop in response to drought. The Board noted that alliances dominated by coyote brush (*B. pilularis*) or non-native shrub species should be excluded from the definition of coastal sage scrub in this report. Multiple experts have noted that stands of pure, intact coastal sage scrub are rare, and almost all stands have a nonnative component. One expert noted that coyote brush is best considered as an indicator of sage scrub-like environmental conditions. Coastal sage scrub is limited to coastal areas in central California, while in southern California, the community grows in both coastal areas and semiarid interior areas (Figure 1).

Reproduction. Like species in chaparral communities, coastal sage scrub species are adapted to stand-replacing wildfires. The majority of species are facultative seeders (Keeley & Keeley 1984).

Fire regime. The mean fire return interval for coastal sage scrub before European settlement has been estimated as 76 years, though the range of interval estimates is as wide as 20 - 120 years, which reflects uncertainty due to limited historical evidence, as well as regional differences in physical setting and the amount of indigenous burning (Keeley 2002, Van de Water and Safford 2011, Lightfoot et al. 2013). Natural sources of ignition are rare in coastal areas. More frequent fires in recent decades have been caused by increases in human ignitions (Keeley and Syphard 2019). As in chaparral systems, local winds have a strong impact on fire behavior and size in coastal sage scrub.

Summary of expert consultation

This section documents the subject matter expert responses. Questions are divided into two sections; the first focuses on changes in fire regimes and their impacts on chaparral and coastal sage scrub. The second focuses on treatment impacts. For each question, experts were prompted to specify if their answer was relevant for chaparral and/or coastal sage scrub. When summarizing answers, we specify applicability to chaparral and/or coastal sage scrub and provide information about regional variation (i.e., southern California v. northern California) where applicable. Answers are further organized to reflect the level of agreement among experts:

- **Consensus** means that the majority of experts expressed this opinion and no expert offered a contrary view.
- **Shared perspective** indicates that more than one expert expressed this view.
- **Individual perspective** indicates that only one expert expressed this view, and no other experts agreed when asked.

Several common terms require definition:

- **Active management** refers to treatment activities focused on wildfire mitigation in the WUI and to the construction of fuel breaks. Specific treatments include prescribed fire, mechanical and hand treatments, herbicides, and prescribed herbivory. During the expert consultation process, experts described the effects of wildfire mitigation and restoration activities, but the implementation and impacts of these treatments are distinct. Consequently, in the response summaries, we distinguish restoration activities from active management.
- **Type conversion** refers to the change from one vegetation type to another (e.g., change from a shrubland to a grassland) in which the original vegetation does not recover. In this report, we use the term "type conversion" to describe a *trajectory* towards an irreversible state change. Multiple experts noted that the impacts of climate change, a single wildfire, or wildfire mitigation treatments will likely not result in permanent type conversion, but will favor increased abundance of nonnative grasses over shrubs.
- **Climate** is a broad term that refers to long-term patterns of temperature and average weather, whereas **hydroclimate** describes how water processes interact with climate.
- **Shrubland** refers to both chaparral and coastal sage scrub.

Fire regimes in chaparral and coastal scrub

Q1. How are fire regimes in chaparral and coastal shrub communities projected to be altered by climate change?

Chaparral and coastal shrub communities
Consensus:

- Impacts of climate change will vary at regional and local scales.

Shared perspectives included:

- Lower-elevation chaparral and coastal sage scrub will be less affected by climate change than higher-elevation forests. Large, destructive fires in shrublands tend to be driven by extreme wind events and human-caused ignitions whereas fires in forests tend to be fuel-driven (see Keeley and Syphard 2025).
- Climate change projections indicate hotter, drier conditions. In shrublands, prolonged droughts and delayed autumn precipitation result in lower fuel moisture in shrublands which can increase ignition likelihood and potential fire size (Dennison et al. 2008, Dennison and Moritz 2009, Cayan et al. 2022, Park et al. 2022).
- Large southern California fires are often wind-driven events and are generally more influenced by weather than by fuels. However, future wind patterns may differ. Some studies indicate a potential reduction in Santa Ana frequency and a restriction of the Santa Ana period, but projections of decreased relative humidity and increased temperature favor more severe fire events (see Miller and Schlegel 2006, Abel et al. 2011, Guzman-Morales and Gershunov 2019).
- Rather than altering fire regimes, climate change will likely have a greater impact on the recovery of shrublands after burning. Hotter, drier post-burn conditions have resulted in slower shrub recovery and mortality among resprouting species (see Pratt et al. 2014). Wetter, cooler conditions tend to support faster recovery post-burn. Hotter and drier conditions post-burn have been shown to directly translate to reduced shrub cover and higher rates of post-fire type conversion to non-native grass (see Dewees et al. 2022; Syphard et al. 2019; and Storey et al. 2021). In addition, drought conditions prior to burns may also impact the recovery of shrubs post-fire.
- Climate change may have indirect effects that would alter fire regimes in shrublands. Prolonged droughts are leading to dieback, increasing the amount of dead fuels on the landscape and potentially increasing ember production during wildfire events. These embers can be transported long distances by wind-driven fires, thereby increasing fire size and ultimately area burned (see Keeley et al. 2022).

- An increasingly dry climate may favor type conversion of shrubs to nonnative grasses. Understood as the grass/fire cycle, the invasion of nonnative grasses into native vegetation leads to an increased or greater flammable fuel component allowing for more frequent (often human-ignited) fires. More frequent fires create a positive feedback loop that promotes nonnative grasses that can outcompete native shrub species under a more frequent fire regime (see D'Antonio and Vitousek 1992 and Fusco et al. 2021).

Q2. In the absence of active management, what is the potential for type conversion in these landscapes given observed and predicted changes in the disturbance regime and hydroclimate?

Chaparral and coastal shrub communities
Consensus:

- Active management in shrublands promotes the presence of herbaceous, flashy fuels, which increase the likelihood of ignition. This may accelerate the grass/fire cycle explained in Q1, but see Q4 for notes on regional variation.
- The potential for type conversion is high, even in the absence of active management.
- In the absence of active management, the only way to prevent type conversion is to minimize disturbance, keep frequent fires out of these systems, and commit to the continued development and implementation of restoration activities in post-fire areas with high conversion potential (see Underwood et al. 2021).
- WUI expansion and associated infrastructure such as power lines, increase the probability of ignitions. This increase is a more likely driver of shrubland-to-grassland conversions than changes in hydroclimate (see Syphard et al. 2017).
- The potential for type conversion varies across the landscape. Areas that are more accessible and closer to the WUI are more vulnerable to type conversion because of the increased likelihood of ignitions in these areas. These areas are also more likely to already have nonnative species present.

Chaparral
Consensus:

- On-site active management does not prevent type conversion.
- The main driver of type conversion in chaparral is too-frequent disturbance, whether caused by fire or other agents such as wildfire mitigation treatments and drought. The only preventative measure would be to protect chaparral stands recovering from wildfire or vegetation treatment from additional fire for at least 25 years. The impacts of additional mechanical disturbance after wildfire or first-entry wildfire mitigation treatment are less certain.

Shared perspectives included:

- Changes to the disturbance regime occur at a local scale. Chaparral stands in areas with more frequent fire, often closer to the WUI, have a higher risk of type conversion than those farther from frequent ignition sources.
- Changes in hydroclimate have a regional-scale impact. The occurrence of hotter, drier drought will impact chaparral recovery trajectories (see Pratt et al. 2014, Storey et al. 2021, and Dewees et al. 2022)

Coastal Sage Scrub

Consensus:

- Coastal sage scrub communities have several characteristics that may make them less vulnerable to type conversion in the absence of active management. Relative to chaparral, coastal sage scrub has greater seed dispersal potential and is able to colonize disturbed areas more quickly, which can minimize dominance of nonnative grasses.
- There is a geographic gradient to stressors affecting coastal sage scrub. Drier systems to the south (e.g., Riverside and San Diego) are more vulnerable to type conversion after repeated fires because of increased aridity and other stressors such as air pollution and nitrogen deposition (see Allen et al. 1998 and Allen et al. 2005).

Q3. What are the ecological impacts of too frequent fire in these communities compared to a natural fire regime?

Chaparral and coastal sage scrub communities

Consensus:

- Once grasslands have been established, it is difficult to restore shrublands (see Dewees et al. 2022).

Shared perspectives included:

- The loss of shrub cover and potential for type conversion lead to the loss of many ecosystem services including alteration of carbon and nitrogen cycling (see Underwood et al. 2018). However, differences in ecosystem service delivery between shrublands and grasslands are not well quantified (see Pratt 2022).

Chaparral

Consensus:

- Too frequent fire is the main driver of type conversion in chaparral systems (see Syphard et al. 2019, 2022).
- The health of chaparral communities declines when fires occur too frequently due to key life history characteristics:

- It takes roughly 25 years for seedlings in chaparral communities to mature and replenish the seed bank to a point where the stand could recover after another fire. When fires occur too frequently, the seed bank of obligate seeders is depleted.
- For resprouting species, carbohydrate stores in root systems are used to resprout after a fire (see Grupenhoff and Safford 2024). It takes time for resprouting species to replenish these carbohydrate stores. Multiple frequent fires will decrease sprouting ability and they will also decrease stand density, but landscape-scale extirpation is unlikely.
- Chaparral species have limited dispersal distances and do not readily recolonize fire footprints or grasslands.

Coastal sage scrub

Shared perspectives included:

- Too frequent fire will reduce the abundance of shrubs in the system. There are no obligate seeders in coastal sage scrub systems, although some coastal sage scrub species may have increased germination post-fire (Keeley 1987). Instead, species rely on resprouting for recovery or on seed dispersal from off-site to recolonize fire footprints or grasslands. As with resprouting chaparral species, too frequent fire limits the ability of shrubs to resprout by depleting carbohydrate stores.
- Compared to chaparral, coastal sage scrub may recover in 5-15 years after fire, which means it has a narrower "window of vulnerability", or timeframe in which it is susceptible to invasion by nonnative annual species and potential type conversion if another fire occurs.

Q4. In long-unburned communities, are there conditions where emulating natural disturbances through either prescribed fire or mechanical treatments would provide additional benefits other than wildfire mitigation and suppression facilitation?

Chaparral and coastal sage scrub communities

Shared perspectives included:

- Chaparral and coastal sage scrub systems generally experience a temporary "pulse" of increased plant diversity after fire (either wildfire or prescribed fire). However, this pulse lasts only 1-3 years, and if additional treatments are conducted at the site or if a wildfire burns it within the window of vulnerability, diversity levels will decline.

Chaparral

Shared perspectives included:

- There is likely no direct ecological detriment to implementing prescribed fire in mature stands (i.e., that have not experienced fire in many decades), but doing so invokes inherent risk to the stand that outweighs any ecological benefit: The risk is that burning a mature stand can create a "window of vulnerability" such that if another fire occurs within 20-30 years, the site becomes susceptible to invasion by nonnative annual species and potential type conversion.
- There is potential for mature, intact chaparral to senesce in the absence of fire, but these dynamics are not well documented. A Sierra Nevada study found that 90+ year-old chaparral stands were nearly as resilient to wildfire as 50 year-old stands. Even though the obligate seeder component had largely died out, the old stand regenerated from the seed bank, indicating the seed bank's extreme longevity (Keeley et al. 2005). But, few chaparral stands in California are old enough to raise concern about senescence.
- In general, chaparral in northern California is not yet experiencing such broad exposure to high fire frequencies as southern California chaparral. As a result, there may be more opportunities for active management targeting specific objectives, including restoring some rare plant species (see Wilkin et al. 2017). However, frequent fires on some sites in northern California have resulted in reduced regeneration for both obligate and facultative seeders and reduced native plant diversity (see Grupenhoff and Safford 2024).
- Even chaparral in northern California that has not burned recently (i.e., may be outside of the "natural range of variation") is not necessarily ecologically in need of fire.

Coastal sage scrub

Shared perspectives included:

- There is no need to emulate natural disturbances in coastal sage scrub because these species are not obligate seeders and do not require fire to regenerate. However, some associated herbaceous plant species do require fire for regeneration and may benefit from prescribed fire.

Individual perspectives included:

- Emulating natural disturbance with mechanical treatments (i.e., fire surrogate treatments) in coastal sage scrub does not achieve objectives related to increasing biodiversity, as this treatment type does not promote the emergence of fire-following native species, and any reduction in wildfire hazard may be short-lived (1-3 years) as a result of resprouting.
- Emulating natural disturbance with prescribed fire may benefit coastal sage scrub species by limiting the accumulation of deciduous leaves as fuel, which could otherwise increase the risk of severe fires that burn so hot that coastal sage

scrub species are unable to resprout. Prescribed fire may also benefit coastal sage scrub by killing non-native grass seeds in the soil .

Treatment Impacts

Q5.a Are wildfire mitigation treatments in chaparral or coastal sage scrub effective at: (1) reducing ignitions, (2) reducing fuel loads and (3) improving suppression efforts?

Chaparral and coastal sage scrub communities

Consensus:

- Wildfire mitigation treatments in chaparral or coastal sage scrub do not reduce ignitions but rather increase the likelihood of ignitions, because the disturbance that comes with treatments often favor the dominance of species characterized by finer, flashier fuels that ignite more easily. Additionally, establishing fuel breaks increases public access, which may raise the likelihood of human-caused ignitions.
- Wildfire mitigation treatments in chaparral or coastal sage scrub are effective at reducing fuel loads, but the impact on wildfire behavior is marginal in wind-driven head fires in southern California without suppression efforts.
- Fuel treatments can improve suppression efforts and incident management strategic decisions by serving as pre-established locations with reduced fuel profiles to control fire spread and provide safe access to the fire's edge. Successful use is determined by whether they are placed in accessible, strategic locations, if they are maintained, if their locations are known, and if they are large enough (see Greiner et al. 2025). Strategic placement should consider ease of access for firefighting resources and proximity to protection objectives (Syphard et al. 2011). Additionally, fuel breaks must have firefighting resources present to be effective. Research has shown that firefighting resource type (hand crews, engines, aviation, etc.) and tactics (direct line construction, firing operations), and direction of fire spread (fuel breaks in shrubs are more likely to halt backing fire) all determine treatment effectiveness (Gannon et al. 2023; Young et al. 2024). Improving suppression efforts results in smaller fire sizes and limits the area burned, thus increasing areas of intact chaparral (Johnson et al. 2026).

Shared perspectives included:

- Wildfire mitigation treatments are more likely to be effectively used to stop fire spread during the spring and summer when winds are milder and fuel moisture is higher.

Q5.b If so, what are the factors that are changed that make the post-treatment area more or less hazardous (in terms of fuels or suppression)?

Chaparral and coastal sage scrub communities

Shared perspectives included:

- A treated area is more or less hazardous depending on what kind of vegetation cover the treatments promote, because suppression difficulty and firefighter safety vary with vegetation type. Grass fires were consistently identified as the most manageable due to their low flame lengths relative to those in woody fuels. One expert further noted that air attacks are the most effective for grass fires because of the increased surface area provided by fine fuels. Coastal sage scrub, because of its relative openness, is similar to a grass fire and fires in it are often easier to contain. Within chaparral ecosystems, firefighters prefer to suppress fire in younger stands over older, denser stands.
- Repeated followup treatments to reduce fine fuels are necessary to maintain treatment effectiveness for fire suppression and essential to decrease ignition risk inside of treatments.

Chaparral

Consensus:

- The spatial configuration of treatments in chaparral can affect the hazard level of an area post-treatment. In chaparral systems, linear fuel breaks are of the highest value for wildfire mitigation and suppression, and spatially dispersed treatments common in forests (e.g., broadcast burning, thinning, or prescribed fire) are not recommended for chaparral.
- Linear fuel breaks are only effective if they are staffed (see Syphard et al 2011 and Johnson et al 2026). For fuel breaks to be staffed during incidents, they should be maintained and connected to a road. A recent modeling effort has shown that unstaffed fuel breaks not constructed around roads may result in increased burned area (see Johnson et al. 2026). Additional benefits of fuel breaks are likely to include improved firefighter safety and enhanced access for containment, but accurate evaluations of effectiveness are challenged by the limited availability of high-quality suppression and treatment data.
- Reducing fuel loads can improve suppression efforts in mild fire weather by providing safer locations to conduct suppression operations. However, fuel reduction does not impact fire spread in a wind-driven fire in southern California.

Shared perspectives included:

- If placing a fuel break in a contiguous area of chaparral, the introduction of fine fuels after clearing chaparral in the fuel break could result in a higher likelihood of a fire starting in those flashier fuels and moving into nearby chaparral, which could create a more intense and dangerous fire.

- Strategic locations have been identified by convening an interdisciplinary team of incident command leaders and natural resource specialists to discuss areas where firefighters are likely to intercept a fire and which natural resources managers would be willing to "sacrifice" to support suppression (see Potential Operational Delineations in Thompson et al. 2022).
- Implementing fuel treatments may reduce suppression workload and provide locations where firefighters can conduct firing operations (see Ostoja and Battles 2026). These fuels reduction treatments should be placed to protect areas of high value, which might include both human infrastructure and areas of biological importance.

Coastal Sage Scrub

Shared perspectives included:

- In coastal sage scrub, prescribed fires effectively reduce fuel loads for ~10 years. By comparison, mechanical treatments alone result in faster recovery of the shrub layer through resprouting and increase the abundance of weedy species.

Q6. Do vegetation management treatments intended to mitigate fuels promote non-native species invasion(s), lead to increased dominance of invasive species, or lead to type change (shrub or scrub to herbaceous-dominated)? In your response, please consider the following: scale of treatment, type of treatment, location, or other context of treatment that may influence the outcome.

{Note: we included the question asked verbatim. However, the responses provided did not explicitly consider how the context of the treatment (i.e., scale, type and location) impacts the outcome.}

Chaparral and coastal sage scrub communities

Consensus:

- Vegetation treatments in both chaparral and coastal sage scrub lead to increased dominance of invasive species and potential type conversion.
- It is critical to understand that wildfire mitigation in the chaparral incurs ecological costs, in contrast to some forest ecosystems (e.g., Sierran mixed-conifer forests) where mitigation treatments can both reduce hazard and improve forest health. Managers should carefully evaluate the trade-offs and decide whether enhancing suppression activities in a chaparral area is worth the ecological consequences of the treatment.
- Mechanical treatments pose an additional threat of invasion or increased dominance, as new or additional nonnative grass seeds can be introduced into the system on equipment used to implement them.

- Continued maintenance or wildfire following a first-entry treatment (see Merriam et al. 2006) increases the likelihood of type conversion. However, this intentional type conversion is preferred for suppression support.

Chaparral
Consensus:

- Mature chaparral forms a dense canopy, and does not support a significant understory component (nonnative grasses do not grow beneath it). This makes chaparral stands relatively resistant to invasion in the absence of disturbance. Disturbances (including wildfire and wildfire mitigation treatments) create vectors for nonnative grasses and forbs to establish.
- Under historical fire regimes, burned chaparral is often succeeded by herbaceous plant communities until shrub seedlings grow or chaparral species resprout. Given enough time without disturbance, the recovering chaparral will outgrow the herbaceous plants. However, these stands are vulnerable to type conversion if reburned during this recovery period. Today, due to increased fire frequency from human-caused ignitions, fires are increasingly likely to return before seedlings have grown enough to outcompete grasses.
- Fuel breaks will promote the invasion and dominance of non-native species, as the intention in establishing and maintaining a fuel break is to convert the treated area into an herbaceous plant community that provides safer areas for firefighters to conduct suppression operations. To balance the degradation of chaparral for this purpose, fuel breaks should be placed near the WUI and, as noted in Q5.b, in locations firefighters believe they can intercept a fire.

Coastal Sage Scrub
Shared perspectives included:

- Coastal sage scrub systems have relatively open canopies compared to chaparral systems, and at many sites, non-native annual grasses are present even in the absence of burning. Multiple experts noted that the majority of coastal sage scrub systems already have nonnative grasses established.

Q7. Are there treatment characteristics that minimize impacts (including type change) from non native or herbaceous species?

Chaparral and coastal sage scrub communities
Shared perspectives included:

- Hotter prescribed fires (including the use of pile burning) may kill nonnative annual grass seed in seedbanks, while seed from chaparral species will germinate after the fire, and resprouting species can recover. Coastal sage scrub species can recolonize the site through seed dispersal. However, as noted in Q3 and Q4, implementing prescribed fires creates a window of vulnerability to reburning.

Chaparral

Shared perspectives included:

- Long-term fuel break monitoring and weed abatement should be considered when planning fuel break establishment to minimize impacts.
- The establishment of fuel breaks or other treatments could be coupled with restoration activities to promote native perennial grasses instead of nonnative herbaceous grasses, thereby reducing the ecological impact of the fuel break. However, these treatments require funding for implementation, monitoring, and maintenance. Furthermore, these investments must be weighed against the risk of being undone during an active fire. In particular, when fuel breaks are used operationally for wildfire management, incident command may remove herbaceous vegetation to facilitate suppression, potentially negating prior restoration efforts.
- Treatment location can affect the likelihood of nonnative invasion. Nonnative grasses are more likely to invade treated areas if those areas are positioned near existing invaded sites. Treatments farther from invaded areas are less likely to be invaded. However, areas of intact chaparral without nearby invasive species are rare.
- Treatment type and seasonality may impact the abundance of nonnative species on post-treatment areas. In northern California (Mendocino County), masticated chaparral had a higher density of nonnative grasses than areas treated with prescribed fire or untreated areas. Fall treatments, including mastication and prescribed fire, had more nonnative species present than spring treatments, but also reduced fuels for a longer period (see Wilkin et al. 2017).

Individual perspectives included:

- Goat herbivory can be an effective method for reducing both native and nonnative herbaceous cover within fuel breaks, but it is less effective for reducing shrub cover (see Grupenhoff and Molinari 2021).
- The use of herbicides to remove and control invasive species could minimize impacts, but treatment prescription and effectiveness would likely need to be site-specific.

Coastal Sage Scrub

Consensus:

- The establishment of new fuel breaks or containment lines for prescribed fires will increase the abundance of nonnative species and create more continuous fine and flashy fuels.
- There are higher densities of weedy species at the perimeters of treatments, so minimizing mechanical treatments along the perimeters of prescribed fires is one way to reduce the increased abundance of nonnative grasses.

Q8. Does type conversion after treatment increase the risk of wildfire? If so, how?

Chaparral and coastal sage scrub communities

Consensus:

- As noted in the explanation of the grass/fire cycle in Q1, conversion from shrub-dominated cover to nonnative grasses after treatment increases fire frequency.
- The degree of wildfire risk from type conversion is linked to warm rains that promote the growth of nonnative annual grasses statewide. Risk will vary based on annual and multi-year patterns of environmental factors such as temperature and precipitation. For example, multiple years of high precipitation will result in greater fuel accumulation than a single year of high precipitation followed by a relatively dry year.
- If native perennial grasses are established after treatment, rather than annual nonnative grasses, the wildfire hazard is reduced because native perennials remain alive over the summer and are less ignitable than the dead fuels produced by annual nonnative grasses. Nonnative grasses produce thicker, longer-lasting thatch layers that create more continuous fuels, thereby increasing the wildfire hazard. However, in severe fire weather, this distinction is less important, as both native and nonnative grasses are flammable and will carry fire.

Individual perspectives included:

- Nitrogen deposition may favor the growth of nonnative annual grasses over native species (see Allen et al. 2018).

Available data

Table 1. Description of available spatial shrubland vegetation cover datasets provided by experts. This table was developed to answer the following question posed by the Board: "What is the most detailed and reliable geospatial information available for delineating stands of chaparral and coastal sage scrub, including within the WUI and beyond the WUI?" Because the extents and metrics used to develop each dataset vary, users may choose different datasets to answer their specific questions.

Dataset	Resolution	Extent	Notes
California Wildlife Habitat Relationship Vegetation Type	30m raster	statewide	Dataset from CalFIRE describing vegetation type
LandFire Existing Vegetation Type	30m raster	statewide	Dataset describing vegetation type by lifeform (e.g. shrub)
National Agricultural Imagery Program (NAIP)	60cm raster	national	High resolution aerial imagery. An emerging area of research is to link these high resolution image products to field data or photos collected on the ground to try to map vegetation and individual species.
Vegetation Classification and Mapping Program (vegCAMP)		distinct regions in CA - not statewide yet	Field-based dataset; ongoing data collection
Center for Ecosystem Climate Solutions	30m raster	statewide	Based on LANDSAT and available annually from 1985-2023. Fractional vegetation cover of trees, shrubs, herbaceous, and bare ground, along with estimates of biomass. Public data available on Harvard Dataverse.
Annual biomass data (2001-2023) for southern California: above- and below-ground, standing dead, and litter	30m raster	southern California USFS National Forests	Dataset describes four vegetative biomass pools from 2001-2023 for areas within USDA Forest Service lands in southern California
Obligate resprouting, obligate seeding, and facultative seeding shrub species in California's Mediterranean-type climate region	30m raster	southern California	Dataset predicts distribution of three shrub post-fire regeneration strategies, plus trees and

			herbs, in southern California
Annual National Land Cover Database (NLCD) Product Suite	30m raster	national	Dataset describes Land Cover, Land Cover Change, Land Cover Confidence Index, Fractional Impervious Surface, Impervious Descriptor, and Spectral Change Day of Year from 1985 - 2024.

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