THE EL DORADO COUNTY RESOURCE CONSERVATION DISTRICT
COLLABORATIVE REFORESTATION PROGRAM
REFORESTATION NEEDS ASSESSMENT

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INTRODUCTION

The El Dorado County Resource Conservation District (RCD) entered into a sales agreement with the U.S. Forest Service Placerville Nursery in July 2014. As a public agency, the RCD can act as an intermediary between private landowners and the nursery to facilitate production of seedlings for reforestation. Under the terms of the agreement, the Placerville Nursery provides tree seedlings to the RCD for a variety of reforestation needs. Seedlings are grown from native or approved seed sources including the CAL FIRE or Placerville Nursery seed banks. All seedlings are produced in accordance with U.S. Forest Service grading standards. Building upon this relationship, the RCD is promoting collaboration among state and federal agencies, Resource Conservation Districts throughout the state and potential reforestation clients. Utilizing funding from CAL FIRE, this Reforestation Needs Assessment has been prepared to assess the potential yearly demand for tree seedlings created by private and public land managers. This Assessment is intended to provide one basis for enhancing program delivery by both the agencies serving reforestation clientele and the producers of seedlings, including private nurseries, the Placerville Nursery and potentially, the CAL FIRE L.A. Moran Reforestation Center. There was a complementary project to evaluate the spatial distribution of reforestation needs (David Greenberg, U.S. Forest Service State and Private Forestry), the results of which have been incorporated into this report. Other efforts are underway to update the seed zone map used to select seed sources for reforestation (group effort of the State Tree Mortality Task Force Reforestation and Resilience Working Group) and to evaluate the adequacy of seed storage for meeting future reforestation needs (Arnaldo Ferriera, U.S. Forest Service).

Reforestation needs have historically been closely associated with regeneration after timber harvesting. This association was beneficial both from the standpoint of utilizing funds collected from timber sales to do the necessary reforestation work and because reforestation programs could be planned and scheduled to follow harvest activities under a timber sale contract with a finite contract period. This afforded the opportunity to schedule and complete needed site preparation work, collect cones and seed from appropriate sources, sow seed at nurseries, grow seedlings to desired specifications, prepare them for out-planting, and plant the seedlings and complete the other work needed to assure regeneration success.

Much of this program predictability is lost when the principal causal agent creating reforestation needs is a natural disturbance event, particularly those on a catastrophic scale. Since the location and magnitude of these events cannot be predicted from one year to the next, the job of planning orderly programs of reforestation is more difficult. This unpredictability is exacerbated by the fact that since the closure of the CAL FIRE nurseries there are no nurseries in the state that grow seedlings on a speculative basis in advance of orders. Consequently, there is at least a one-year lag time between the time when reforestation needs manifest and seedlings are available.

Moreover, this lack of predictability can also make it very difficult to secure tree seed from appropriate seed sources in sufficient quantities to address reforestation needs. Seed collection is not a standardized practice in the state and deficiencies in seed availability can be created when catastrophic mortality occurs in areas where cone collection has not recently occurred.

Reforestation work is time-sensitive. Without timely reforestation efforts, undesirable species can dominate a site, making establishment of desired tree species difficult. Once undesirable species become established, decades may pass before sufficient numbers of appropriate tree seedlings occupy the site. Delays also increase the cost of reforestation work by necessitating expensive site preparation. Delays also may adversely affect meeting other resource objectives including watershed protection and wildlife habitat.

The reforestation needs of private, nonindustrial forest landowners must be viewed within the context of seedling demand from other public and private land managers conducting reforestation. Therefore, this reforestation assessment attempts to quantify the yearly demand for seedlings associated with federal land (National Forests), timber harvesting on private land and federal and state cost-share programs that fund reforestation on nonindustrial private lands. The assessment provides a better understanding of the projected number of seedlings that might be required for the upcoming planting seasons (2018-2019) and describes approaches to encourage coordination between private, state and federal entities for enhancing program delivery. The overall objective of this project is to sustain the supply of viable seed and seedlings to produce resilient stands of productive forests. Ensuring this result requires

collaboration between forestland managers, responsible agencies and conservation planners in a coordinated, mutual interest, mutual benefit partnership to find solutions to adequately address California's reforestation needs for people dependent on ecosystem services that forests provide, now and in the future.

PAST REFORESTATION NEEDS ASSESSMENTS

In recent years, there has been the recognition that there are serious deficiencies in the infrastructure supporting reforestation in California. Part of the problem is due to the closure of the state nurseries and the lack of seedlings available on an immediate, as-needed basis. The CAL FIRE nurseries at Davis and Magalia grew seedlings on either a contractual or speculative basis. Production of seedlings more than contracted amounts allowed the flexibility for landowners to procure seedlings on an immediate basis if the seedling species from appropriate seed zones were available. Without that capability, landowners are faced with the requirement of estimating their seedling needs at least a year in advance and placing orders for growing them. The unpredictability of catastrophic mortality events and consequent need for reforestation makes this difficult. Many landowners are not aware that they need to order seedlings well in advance of when they will plant them.

Documentation of reforestation needs on California's National Forests is discussed in a following section of this report. For private lands, Jones (2012) prepared a reforestation needs assessment on behalf of CAL FIRE. Steve Smith, who was the State Forester for the Natural Resources Conservation Service (NRCS) at that time prepared a directive to NRCS field staff in 2012 informing them about how to obtain seedlings for their cost-share program funded reforestation projects. Jones and Smith identified needs for between 250,000 to over 1 million conifer seedlings per year for planting between 2012-2016. This need was based on projected planting by cost-share program grant recipients. No documentation of projects or acres was provided by Jones (2012) or in Smith's directive, but it is assumed that the data were provided by NRCS District Conservationists and foresters and CAL FIRE Forestry Assistance Specialists. No documentation exists regarding the actual number of acres planted during this period. The projection of seedling needs by Jones and Smith did not take into consideration reforestation on private land not involved with cost-share programs or demand for seedlings on public land, primarily the National Forests.

The work of Jones and Smith was pivotal in increasing awareness among entities concerned with reforestation in California of actual and potential problems with the growing and delivery of seedlings for restoring California's forests. The present effort is in part a response to that pioneering work.

POTENTIAL REFORESTATION NEEDS - BACKLOG OF DEFORESTED ACRES

We have approached the subject of potential reforestation needs for restoring forest cover on land deforested by past natural events in four ways. The U.S. Forest Service Forest Inventory and Analysis Program (FIA) provides statistical estimates of potential forest land in either a deforested (un-stocked) or understocked condition. Data on recent wildfires provide gross estimates of the numbers of acres affected by fire-induced tree mortality. We have also explored the availability of data on forest mortality associated with the recent prolonged drought and bark beetle epidemic in the Sierra Nevada. Finally, we have reviewed Forest Service reports on reforestation needs on the National Forests. These data are supplemented by spatial analyses prepared by Forest Service, State and Private Forestry that are presented in a complementary report and summarized here.

Forest Inventory and Analysis Data

The latest FIA report states that there are 582 thousand acres of potential forest land in the state that are not stocked with trees and potentially candidates for reforestation (Christensen et al. 2016). This estimate is based on a relatively small number of plots located throughout the state on all land ownerships and all forest types, including hardwood and non-commercial conifer types. No spatial depiction of this land is available.

Under contract to CAL FIRE FRAP, Tim Robards (unpublished data) conducted an independent analysis of the amount of forest land that is either non-stocked or poorly stocked based on the FIA data. The total amount of land in those categories exceeded seven million acres. Robards accepted the FIA estimate of 582 thousand acres of non-stocked land. Of the seven million acres about two million acres were in conifer forest types generally considered commercial timber. This included over one million acres of California mixed conifer (not exclusively Sierra mixed conifer) and over 800 thousand acres of ponderosa pine forest. Other conifer forest types have relatively small amounts of non-stocked and poorly stocked land. It should be noted that poorly stocked land may or may not represent land that is a candidate for reforestation. Some proportion of that land may be in plantations or in various phases of natural regeneration. Of the 1.8 million acres of California mixed conifer and ponderosa pine deemed non- or poorly stocked, slightly over 700 thousand acres is on private land.

The FIA analysis was based on data collected between 2001 and 2010, updated by Robards to include data collected through 2013. There have been catastrophic wildfire events that have occurred since 2013 that were represented. The massive tree mortality in the Sierra Nevada caused by drought and bark beetles is also not represented in the FIA data. For this reason and because the FIA data are not spatially explicit, and the estimates are based on relatively limited sampling, they have limited value for estimating reforestation needs. The FIA data do however, provide a general impression of the scale of the needs.

Wildfire Perimeters

A second source of information on land requiring reforestation is data on wildfire collected by CAL FIRE and the U.S. Forest Service. Data on wildfires collected by CAL FIRE with input from the Forest Service indicate that 5.9 million acres burned between 2005-2014. Of that total, about 1.9 million acres were private land. A substantial but unknown amount of the land burned was in non-forest vegetation types. It is not known how many of those acres were subsequently re-planted. Observations at the King, Rim, American fires and elsewhere indicate that the forest industry has aggressively pursued post-fire salvage logging and reforestation on its lands.

Research on wildfire perimeters conducted by the Forest Service, State and Private Forestry for the period of 2011-2016 indicates that over 95 thousand acres of nonindustrial conifer forestland was included within fire perimeters during that period (David Greenberg, *pers*. *comm*.).

There are problems associated with interpreting reforestation needs from wildfire occurrence data. Every fire varies in severity and degree of deforestation. For example, the King Fire in 2014 affected nearly 97 thousand acres. Of that total, about 46 thousand acres experienced greater than 90 percent tree mortality and might qualify for reforestation (U.S. Forest Service 2015). Management direction on private versus public (U.S. Forest Service) land differs and not all deforested land would be a candidate for reforestation. At the King Fire the Forest Service alternatives for restoration proposed planting on between 8-12 thousand acres or between 27 and 41 percent of the severely burned forest (U.S. Forest Service 2015). Slightly over 16 thousand acres of private land burned at >90 percent mortality, including about 2500 acres of nonindustrial private land. A reforestation project of the Georgetown Divide RCD replanted over 700 acres, leaving a potential need of at least 1800 acres of nonindustrial private land. A substantial amount of that land is not available for site preparation and planting due to environmental and other constraints.

The process of quantifying reforestation within a wildfire perimeter conducted by the Georgetown Divide RCD for the King Fire could be applied to any fire if post-fire tree mortality data are available. Unfortunately, those data are only available for fires where federal lands constitute most of the area. In those cases, as in the King Fire case, private land may be included in the post-fire analysis. If a wildfire primarily affects private land no agency conducts post-fire assessments of tree mortality. Fire severity studies by state agencies on private land quantify it in terms of soil characteristics i.e., hydrophobicity. That is not a surrogate for tree mortality.

Mortality Due to Drought and Bark Beetles in the Sierra Nevada

Along with areas of severe mortality due to wildfire, mortality associated with the prolonged drought and bark beetle epidemic in the Sierra Nevada contributes to the potential area of substantially damaged forest land that might be targeted for reforestation. CAL FIRE FRAP produced a map displaying tree mortality (dead trees/acre) for the 10 Sierra counties included in the current Governor's emergency proclamation. The map was derived from Forest Service aerial surveillance data. Tree mortality is rated from five to 40 trees/acre. Nearly four million acres in the western Sierra Nevada were mapped by FRAP with some level of mortality. The area of high mortality increases from north to south with highest levels occurring from Tuolumne County south to Kern County.

Although this map would seem to imply that there are large patches of mortality at different levels throughout the Sierra, the distribution of dead trees is not uniform, and the trees are not necessarily aggregated into large patches conducive to reforestation. Relatively large patches do exist, however, but in some cases high levels of mortality in one location may have been extrapolated to a larger area. We do not consider this mapping, or the quantified acres of mortality displayed on the FRAP map to be reliable indicators of reforestation need. Efforts to produce maps of mortality due to the recent drought and insect attacks are continuing.

In the southern Sierra Nevada, there are large contiguous patches of trees killed by drought and bark beetles. That is not the case in the northern counties where mortality is generally more scattered rather than concentrated. If these patches are cleared, the land would be a candidate for reforestation.

In April 2018 the State Tree Mortality Task Force produced a report entitled “Tree Mortality: Facts and Figures”. This was an update based on data produced the U.S. Forest Service annual overflights to determine the extent of new mortality. According to that report there are 3.9 million acres of tree mortality in the 10 Sierra Nevada “high priority counties”. Over 2.6 million acres of that total are private, state and local ownerships. The cumulative acres of mortality are shown in the following table.

County	Acres
Amador	88,000
Calaveras	178,000
El Dorado	381,000
Fresno	607,000
Kern	359,000
Madera	385,000
Mariposa	318,000
Placer	215,000
Tulare	831,000
Tuolumne	505,000
Total	**3,867,000**

As previously noted, nearly 70 percent of this land is in private, state and local ownership. Clearly, this extensive mortality represents a potential reforestation need of tremendous magnitude. However, as discussed above, mortality patches may be scattered rather than in larger contiguous areas conducive to reforestation. Furthermore, in many areas there is no economic incentive to remove the standing dead trees due to lack of milling and biomass energy infrastructure. It is likely that many of the acres affected by the tree mortality emergency of recent years will never be treated. Conversion to non-forest vegetation may occur in at least some locations.

National Forest Reforestation and Timber Stand Improvement Reports

The U.S. Forest Service is the principle public agency conducting reforestation in California. Every year the U.S. Forest Service prepares a report to Congress on its reforestation and timber stand improvement needs and accomplishments. In 2014, it was estimated that there were 400 thousand acres of National Forest requiring artificial regeneration (Joe Sherlock, *personal communication*). The 2016 report indicated a need for planting on 236 thousand acres. The yearly reporting includes not only projected reforestation by planting but also reforestation by natural regeneration. The data are presented by National Forest which is a valuable indicator of planting needs by

seed zone. It should be noted that the 2016 report and prior reports may not quantify reforestation needs due to the massive die-off in the Sierra Nevada.

Summary: Backlog of Reforestation Needs

Taking into consideration the different sources of information and varying estimates, it is reasonable to assume that there are several hundreds of thousands of acres of public and private forest land in the state that are potential candidates for reforestation. Some proportion of this land is in industrial ownership and would likely be already planted or slated for reforestation. For example, in the case of the King Fire, several thousand acres of industrial forest land were salvage logged and planted within two years after the fire. Some planting has also occurred on National Forest land affected by the King Fire and other fires. Nonindustrial land in need of reforestation may never be planted unless financial and technical support is provided to the landowner. In the case of National Forests, reforestation and other timber stand improvement measures depend on funding from Congress or other sources. Stewardship contracting, in which receipts from timber sales are retained at the Forest level has been of benefit in some locations and is a major piece of the revised Forest Plans being prepared in the Sierra Nevada (Harris 2017). The backlog of deforested land is of concern, especially since delays in reforestation creates obstacles and increased costs associated with capturing of sites by brush species.

Reforestation of existing deforested land is one source of reforestation need. The potential demand for seedlings associated with state and federal cost-share programs aimed at restoring substantially damaged timberland is addressed in the next section of this report, along with historical and projected restoration projects on National Forests.

QUANTIFYING CURRENT REFORESTATION NEEDS

Methods

One of this project's objectives is to create a system by which yearly reforestation needs can be repeatedly estimated. It is assumed that most of the yearly demand for seedlings is determined by three things: 1) acres harvested with even-aged methods where artificial regeneration is required to meet post-harvest stocking standards; 2) acres of existing, non-stocked or understocked land that are planted to restore forest cover (public and private) at the owner's expense; and 3) acres of non-stocked or understocked forest land that are planted with financial assistance from state or federal cost-share programs. These three sources of demand would create most of the needs for seedlings in any given year. The following data were used to quantify these needs:

- Acres of private land harvested with even-aged methods, along with acres that were salvage logged under emergency exemptions (substantially damaged forest land) and potentially available for reforestation were obtained from the CAL FIRE forest practices data base, with assistance from a CAL FIRE research analyst.

- Acres of U.S. Forest Service land that were historically planted and proposed for planting in the coming years were obtained from current and past years' "annual reforestation and timber stand improvement reports", with assistance from the Forest Service Regional Silviculturist.
- Acres of nonindustrial private land with CFIP and/or EQIP contracts where planting is an approved practice were obtained with assistance from the State Forester for NRCS and CAL FIRE Forestry Assistance Specialists.

It is acknowledged that some reforestation projects are not included in these projections, including planting that is financed exclusively by private landowners that is not a requirement of the Forest Practice Regulations, planting by public agencies other than the U.S. Forest Service such as State Parks, and reforestation in conjunction with projects that have objectives other than timber production. Also, not included are reforestation projects on private land funded by programs other than CFIP and EQIP e.g., the Greenhouse Gas Reduction Fund. Overall these additional sources of demand probably do not contribute substantially to the annual need for conifer seedlings.

Post-Harvest Reforestation on Private Land

Data on the amount of timber harvesting on private land is readily available from the CAL FIRE forest practices data base (see Table 1, below). In 2015-16 nearly 96 thousand acres were either salvage logged after wildfire or clear cut in California. Salvage logged land is not required to be restocked after harvesting under the Forest Practice Regulations. Conversely, all clear-cut land must achieve a post-harvest stocking of 300 "points" per acre within five years. Over 47 thousand acres of clear-cut harvest between 2015-2016 would equate to the demand for over 14 million seedlings, most likely within two years of harvest (2017-18). This illustrates the general magnitude of demand and does not include planting on salvage logged land which commonly occurs on industrial forest land. For a historical perspective, the amount of land that was clear-cut and presumably planted after harvesting ranged from 13 thousand to 40 thousand acres per year between 1997-2014 or an average of 22.5 thousand acres/year (Figure 1; Francesca Rohr, *personal communication*). Using that average, regeneration after clear cutting could generate demand for nearly seven million seedlings per year.

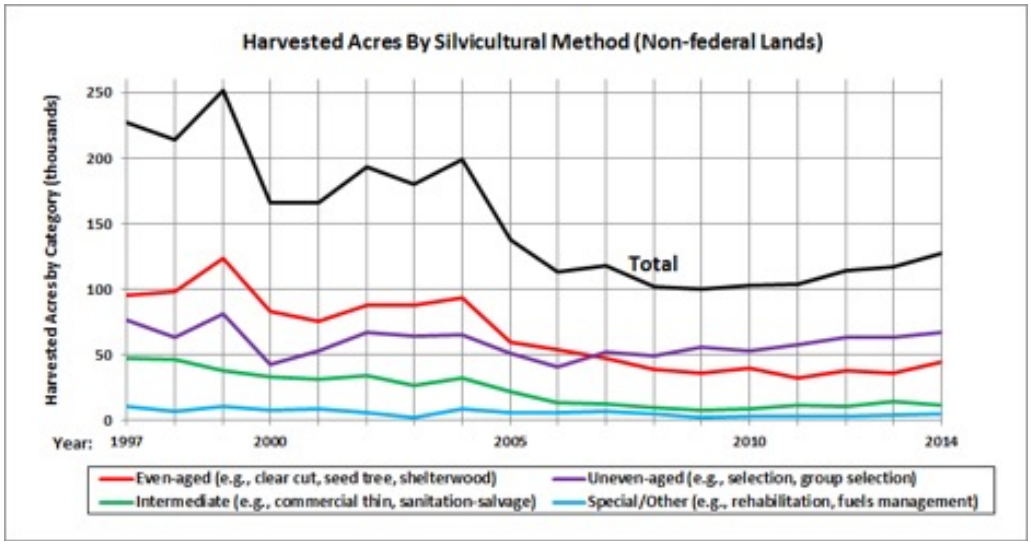
It should be noted that even-aged silviculture includes approaches other than clear-cutting such as shelterwood or seed tree. Generally, these approaches depend on natural regeneration to achieve post-harvest stocking requirements. There are always instances however, where supplemental planting is required. The demand for seedlings created by these other silvicultural approaches is not readily quantifiable.

Table 1: Acres of Post-Fire Emergency and Clear-Cut Harvests. 2015 and 2016

County	Fire Emergency Harvests		Clear-Cut Harvests		Total
	2015	2016	2015	2016	
Butte	0	0	2017	1,672	3,689
Calaveras	1,954	4,470	0	35	6,459
Del Norte	0	0	863	1,765	2,628
El Dorado	8,955	1,388	54	771	11,168
Humboldt	250	204	4,788	5,397	10,639
Lake	3,013	6,149	0	0	9,162
Lassen	0	1,354	574	1,073	3,001
Mariposa	296	0	0	0	296
Mendocino	10	0	526	331	857
Modoc	0	0	1,262	473	1,735
Nevada	633	158	0	67	858
Placer	2,755	400	0	142	3,297
Plumas	0	0	1,232	1,002	2,234
Shasta	2,420	0	5,006	5,007	12,433
Sierra	0	0	0	158	158
Siskiyou	8,058	1,046	4,304	3,240	16,648
Sonoma	0	190	89	85	364
Tehama	0	0	0	1,327	1,327
Trinity	2,491	1,535	1,218	1,654	6,898
Tuolumne	227	56	715	430	1,428
Yuba	0	0	0	169	169
Grand Total	31,062	16,950	22,648	24,798	95,458

Source: Forest Practices Data Base, Francesca Rohr, CAL FIRE.

Figure 1: Timber Harvest by Silvicultural Method 1997-2014 (zoom to view)



Source: Forest Practices Data Base, Francesca Rohr, CAL FIRE.

As noted above, land salvage logged after wildfire or other catastrophe is not required to be reforested after harvest. Observations on industrial forest land indicate that reforestation is almost always conducted, particularly on the more productive forest sites. Data on the amount of industrial forest land that is reforested after salvage logging is not readily available for some companies and would be considered proprietary information.

Reforestation on U.S. Forest Service Land

The annual reforestation and timber stand improvement reports cited previously provide estimates of overall restoration need by National Forest. In addition, they provide data on accomplishments. For the California Region, the number of acres planted between 2012-2016 is listed below:

2012 8,667
2013 7,868
2014 5,956
2015 14,844
2016 15,500

These numbers are indicative of the level of planting to be expected in the future, given funding constraints and agency management direction. The National Forests with the largest number of planted acres in 2016 were the Tahoe (4,680), Klamath (3,148), Lassen (1,334), Modoc (1,195), Sequoia (1,066) and Shasta-Trinity (1,048).

The Forest Service plants at variable density depending on site conditions, likelihood of survival and desired future forest conditions. For example, at the King Fire, proposed planting densities range from 50-300 trees/acre with most acres planted at less than 200 trees/acre. Between 8-12,000 acres at the King Fire are planned for planting (U.S. Forest Service 2015). This would equate to a maximum demand of around 2 million seedlings over the next two years (2017-2019).

Data for 2012-2016 appear to indicate a trend towards a greater number of acres planted per year. This trend may continue in response to the recent occurrence of several large fires (King, American, Rim). If this trend is maintained, the demand for seedlings could increase over time. For planning purposes, a need for 2-3 million seedlings/year might be anticipated for U.S. Forest Service projects.

Reforestation on Private Land Funded by Cost Share Programs

The two primary programs that offer financial assistance to private landowners for reforestation on substantially damaged forest land are the California Forest Improvement Program (CFIP) administered by CAL FIRE and the Environmental Quality Incentives Program (EQIP) administered by the NRCS. To quantify the potential yearly demand for seedlings due to these programs it is necessary to identify the number of

acres proposed for planting, which depends in part on the availability of funding and in part on landowner willingness to engage in the programs. Additional detail on the seed zones of the planting sites, the species to be planted and planting density is also needed to quantify the number of seedlings required and to assess availability of seed.

CAL FIRE Forestry Assistance Specialists located throughout the state are responsible for promoting and administering the CFIP application process. Landowners seeking reimbursement for forest management projects, including reforestation must retain the services of a Registered Professional Forester (RPF) to prepare and submit applications on their behalf. EQIP is administered through local NRCS offices throughout the state. Although CFIP resembles EQIP, CFIP's requirement for engaging the services of an RPF is a significant difference between the two programs. There are also differences in cost share reimbursement rates for management practices and minimum property size to qualify for the programs (20-acre minimum for CFIP; no minimum parcel size for EQIP).

CAL FIRE"s forest stewardship program director requested data on CFIP reforestation projects for input to this report. Reports were received from three Forestry Assistance Specialists, serving the north coast, central Sierra Nevada and southern Sierra Nevada. A total of 595 acres in the Sierra Nevada received approval for planting between 2015-2017 and would likely be planted in 2018-19. Species to be planted included the complement of mixed conifers common to the region (ponderosa pine, Jeffrey pine, sugar pine, white fir, incense cedar and giant sequoia). At an estimated planting density of 200-300 trees/acre this equates to a need for between 119 thousand and 179 thousand seedlings.

The report for the north coast indicated that CFIP contracts to plant 64 acres were in effect. The species to be planted are coast redwood and Douglas-fir at densities ranging from 50 to 200 trees/acre, equating to a demand for about 10 thousand seedlings.

NRCS maintains a statewide data base of EQIP projects that documents their location, approved practices and year of implementation. Data for 2015-2017 proposed tree/shrub planting projects to be implemented in 2018-19 are presented in Table 2. These data only include projects greater than 20 acres, located in counties with predominately conifer forests. There are many additional projects that are smaller in scale and/or located in regions where oak woodlands are the dominant forest type.

Table 2: Approved EQIP Planting Projects, 2015-2017

Year Approved	County	Acres (rounded to nearest acre)	Planned Implementation
2015	Amador	21	2018
	El Dorado	23	2018
	Placer	39	2018
	Sonoma	238	2018
	Tuolumne	30	2018
2016	Amador	23	2019
	Calaveras	496	2019
	Calaveras	287	2019
	Lake	150	2018
	Lake	502	2018
	Lake	81	2016
	Madera	21	2018
	Madera	39	2019
	Madera	86	2019
	Nevada	31	2018
	Tuolumne	31	2019
2017	Lake	86	2018
	Lake	43	2018
	Lake	91	2018
	Madera	73	2018
	Madera	72	2019
	Mariposa	26	2018
	Mariposa	47	2019
	Placer	82	2018
	Placer	26	2019
Total 2018-2019 = 2644			

No data on the species to be planted are included with the NRCS project summary. It is probable that all projects would be planted with conifers (Lake County projects in the Valley Fire already ordered seedlings from the RCD). If planted at densities ranging from 200-300 trees/acre, the demand from EQIP projects would equal between 529 thousand and 793 thousand seedlings.

Taken together and excluding other reforestation projects funded by state or federal programs (e.g., Greenhouse Gas Reduction Fund) the total demand for seedlings associated with cost-share programs would range from 648 thousand to 972 thousand seedlings. This demand would be expected in the years 2018-2019. It does not include CFIP projects in regions where the Forestry Assistance Specialists did not report.

Resource Conservation District Reforestation Needs

The El Dorado County and Georgetown Divide RCDs have initiated outreach to RCDs in the state to determine if they have reforestation projects planned within their districts or have estimates of reforestation needs. The Districts have established a relationship with a donor who has offered to provide conifer seedlings free of charge for these projects. In 2017-18 the donor purchased over 320,000 seedlings from the Districts for planting on private land. Over the next year additional outreach will be conducted to develop new projects. This outreach will be done through the California Association of Resource Conservation Districts. The amount of reforestation need that might result from these efforts cannot be estimated at this time.

Summary of Projected Reforestation Needs

The total reforestation needs generated by timber harvesting on private land, replanting on National Forests and cost share programs on nonindustrial private forest land projected over the next two years could range up to 20 million seedlings. Regionally, much of this demand will be associated with reforestation in the Sierra Nevada where there is a concentration of industrial forest land and National Forests. Demand from nonindustrial forest managers engaged in cost share programs represents about five percent of the total need.

SPATIAL DISTRIBUTION OF REFORESTATION NEEDS

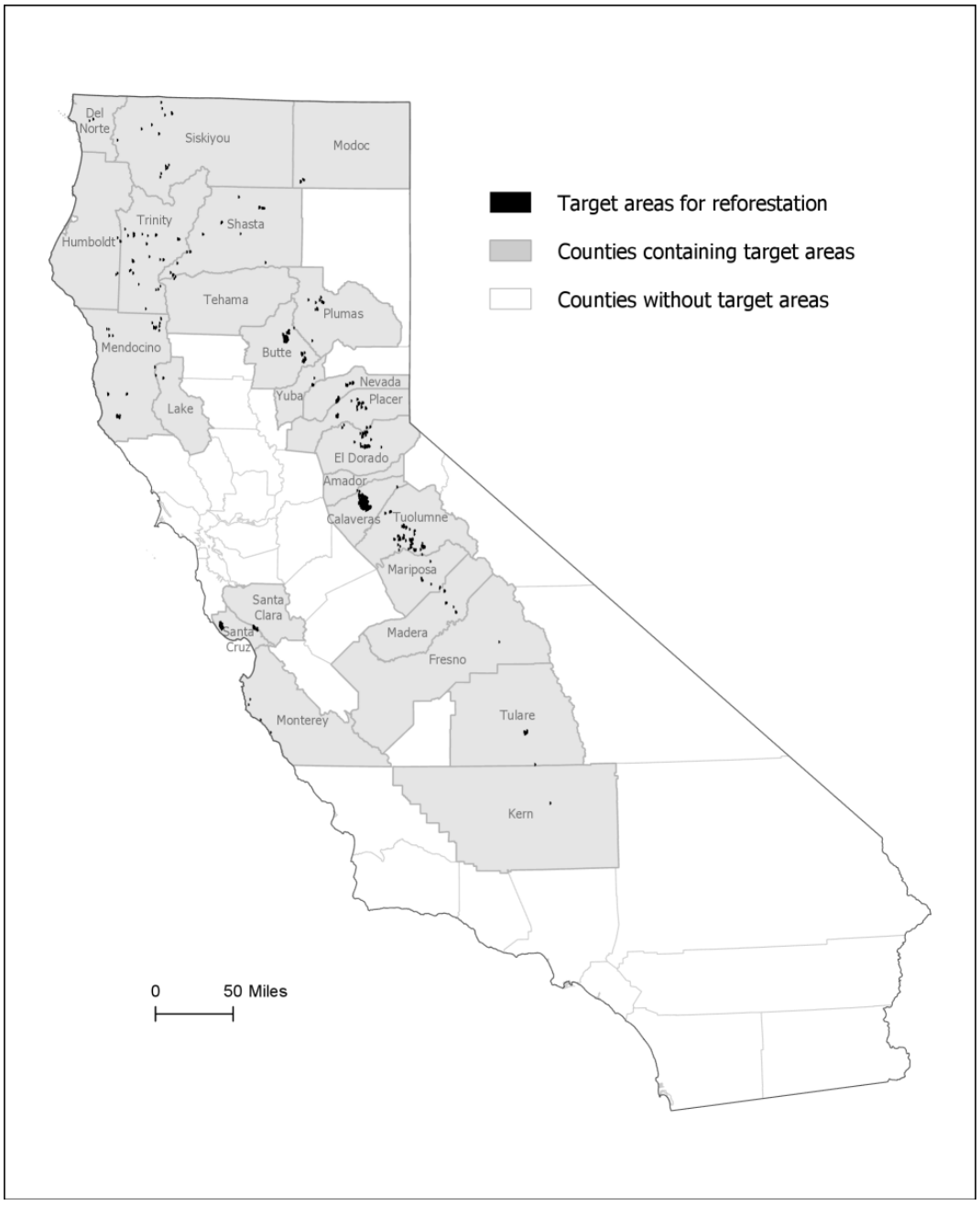
The U.S. Forest Service, in collaboration with the El Dorado County Resource Conservation District and CAL FIRE initiated a GIS-based research study to determine the spatial distribution of reforestation needs on nonindustrial private forest land. This study was intended to complement and in part, validate the results previously described in this report. The primary data sources used to conduct this study were digital maps of fire perimeters, vegetation and land ownership. These data were first used to determine the gross amount of nonindustrial conifer forest land potentially in need of reforestation based on recent fire history. For fires where post-fire tree mortality assessments were conducted, the estimates of reforestation need were refined to focus on land where basal area mortality exceeded 90 percent. It should be recalled that post-fire tree mortality information is only available for private land when it is included within a larger area comprised primarily of federal land, mainly National Forests. The "Burned Area Emergency Response" team studies that follow such fires have been modified in recent years to collect data on tree mortality.

Initial results indicated that between 2011 and 2016 nearly 32 thousand acres of nonindustrial private forest land within commercial conifer forest types experienced more than 90 percent basal area mortality. The analysis was then repeated using data from fires that burned between 2008 and 2017. The following criteria were used to determine “target areas” for reforestation:

- Privately owned nonindustrial ownership
- Pre-fire vegetation consisting of commercial conifer forest types
- Tree mortality equal to or greater than 90 percent basal area loss
- Topographic slope equal to or less than 60 percent
- Dominated by Productivity Site Classes I, II or III (more than 50 percent of the area)

The results are displayed by county in Figure 2.

Figure 2: Areas Potentially Targeted for Reforestation, by County (zoom to view)



State-wide 6564 acres met the classification criteria. The counties with the largest amount of potential reforestation land are:

Butte – 1178 acres
Calaveras – 2284 acres
El Dorado – 675 acres
Nevada – 295 acres
Placer – 387 acres
Santa Cruz – 285 acres
Tuolumne – 621 acres

Most counties have coterminous boundaries with Resource Conservation Districts. The acres potentially requiring reforestation were categorized by Resource Conservation Districts. The Districts with the greatest amounts of potential reforestation acreage are:

Butte County – 1178 acres
Georgetown Divide – 506 acres
Nevada County – 295 acres
Placer County – 387 acres
Santa Cruz County – 285 acres

The forest types with the largest acreage of potential reforestation need are:

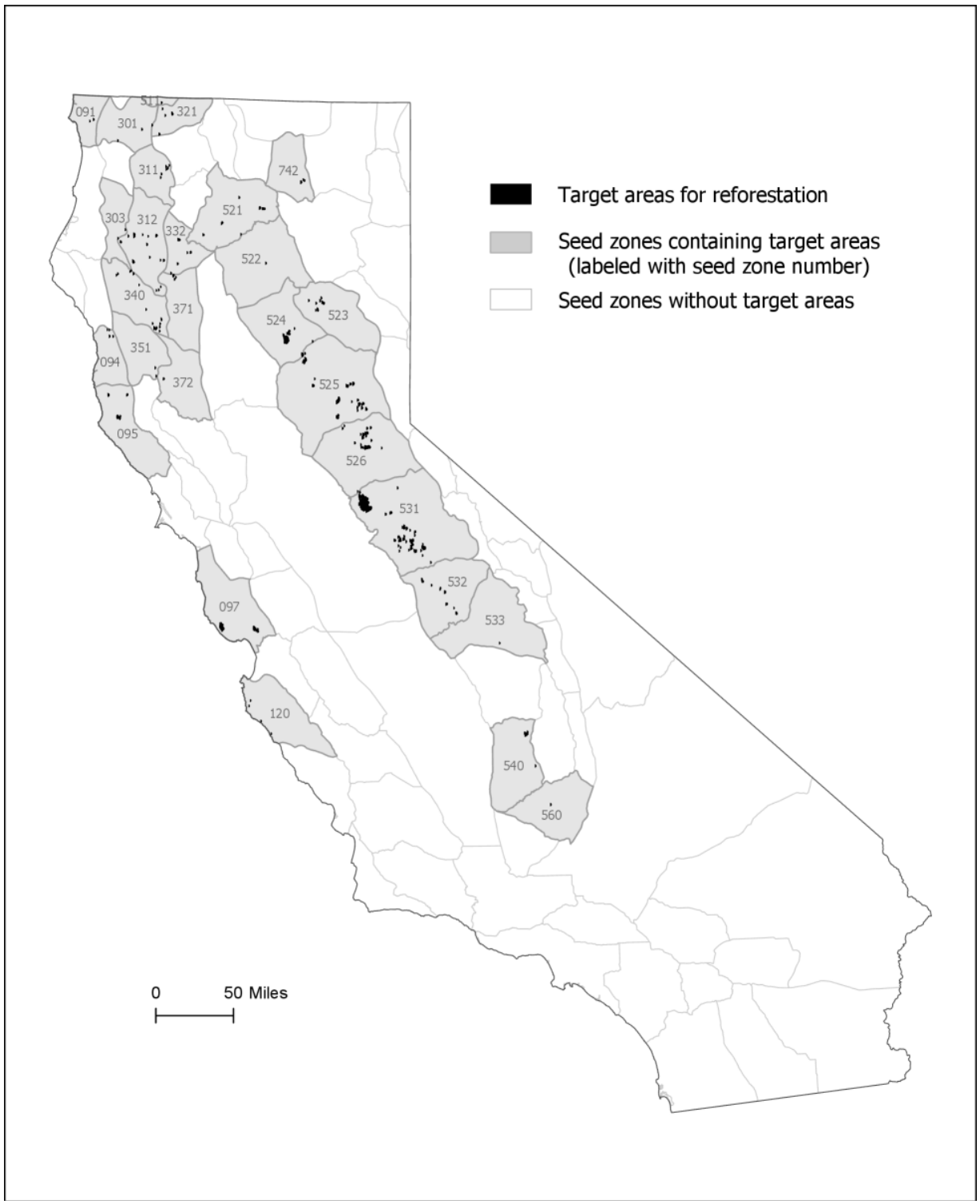
Ponderosa pine – 2958 acres
Sierra Mixed Conifer – 2075 acres
Douglas fir – 1087 acres
Coast redwood – 328 acres

In comparing these results to the results previously presented there is agreement that ponderosa pine and mixed conifer forests have the most substantial areas of reforestation need. The study also identifies relatively large amounts of reforestation need in counties that have suffered recent wildfires. However, the analysis clearly underestimates the amount of nonindustrial forest land that has been substantially damaged by wildfire to the extent that reforestation is needed. This is a consequence of the fact that private land is not evaluated for the extent of tree mortality after a fire unless it is within a landscape dominated by federal ownership. The state does dispatch "watershed emergency response teams" to wildfires on private lands but the emphasis of their work is on potential watershed impacts such as mass wasting or increased peak flows. It would be extremely useful if these post-fire evaluations included assessments of post-fire tree mortality in forested areas.

There is considerable interest within the state regarding the adequacy of existing stocks of seed for propagating seedlings. This topic is discussed in a following section of this assessment (Seed Availability). The spatial analysis presented here indicated that the seed zones with the largest amount of land potentially requiring reforestation are 524

(1132 acres), 525 (732 acres), 526 (708 acres) and 531 (2910 acres), all located in the central Sierra Nevada (Figure 3).

Figure 3: Areas Potentially Targeted for Reforestation, by Seed Zone (zoom to view)



The stratification process outlined above has potential for evaluating reforestation need for a specific wildfire. The process was generally applied to develop a reforestation needs assessment for the King and Sand fires by the El Dorado County and Georgetown Divide RCDs. The case of the King fire was briefly discussed in a previous section of this report. The results of this approach should indicate the number of acres of nonindustrial land potentially suitable for reforestation at the individual wildfire level. This method could be applied to any wildfire where tree mortality data are available.

SEED AVAILABILITY

There are two primary suppliers of seed to grow conifer trees for reforestation. These are the L. A. Moran Reforestation Center in Davis, operated by CAL FIRE and the Forest Service Placerville Nursery in El Dorado County. Additional sources of seed include collections made by forest landowners for their own use and several seed orchards maintained by the U.S. Forest Service and entities like the North Sierra Tree Improvement Association. The availability of suitable seed by species for some seed zones for future planting is uncertain. To the extent possible, L.A. Moran provides seed to the Placerville Nursery if the Nursey does not have the required seed stocks to fill specific orders.

The collection of cones to supply seeds by public agencies is not coordinated or necessarily effective. The Forest Service contracts for cone collection. CAL FIRE will accept cones that are certified by a Registered Professional Forester at the L.A. Moran Reforestation Center. There is a need to formalize and improve the cone surveying and collection process, including providing training to public and private field foresters.

Data obtained on timber harvesting and salvage logging, reforestation need by National Forest and CFIP/EQIP contracts can be used to obtain a general idea of where seed stocks may be limiting. For example, there were over 11 thousand acres in El Dorado County that were salvage logged or clear cut in 2015-16. The seed zone for that county is 526. The Tahoe National Forest has recently planted the most acres in the Region. It is also primarily in seed zone 526. Comparing seed availability for ponderosa pine and other species in that seed zone to potential anticipated post-harvest seedling demand from both public and private managers might reveal critical shortages. The counties that experience most clear cutting include Butte, Del Norte, Humboldt, Plumas, Shasta, Siskiyou and Trinity. A general impression of seed availability can be gained by comparing the demand associated with clear cutting in these counties with seed stocks from the appropriate seed zone. However, it should be noted that in some, perhaps many cases industrial land is reforested with seed collected by the companies or provided by seed orchards.

The U.S. National Forests' estimates of planting needs do not necessarily indicate the number of acres that will be planted in a year. Nevertheless, they can provide at least some evidence of what seed zones may be impacted. For 2016, the National Forests with the greatest potential for planting and impacted seed zones are listed below (Table 3).

Table 3: National Forest Anticipated Planting Needs and Affected Seed Zones

National Forest	Acres of Planting Needs	Impacted Seed Zones
Angeles	12,030	992, 993
El Dorado	28,102	525, 526, 531, 772, 781
Klamath	27,517	301, 302, 311, 312, 321, 322, 331, 511, 512, 516, 720, 741, 742
Lassen	34,417	521, 522, 523, 524, 732, 742, 760, 771
Plumas	24,664	523, 524, 525, 771
Shasta-Trinity	17,421	302, 303, 311, 312, 322, 331, 332, 340, 371, 516, 521, 741, 742
Stanislaus	59,161	526, 531, 781, 782, 962
Tahoe	10,384	525, 526, 772, 781

These planting needs are almost exclusively based on forests damaged by wildfire. None of the National Forests listed above estimated planting needs to address the tree mortality caused by drought and bark beetles.

Existing information on tree mortality due to prolonged drought and epidemic bark beetle attacks provides general guidance on what seed zones may be impacted in the future if and when reforestation to reverse the effects proceeds. Virtually every seed zone from Tuolumne County south to Kern County could be affected. These include seed zones 531, 532, 533, 534, 540, 550, 560 and 570. Compounding this problem is the impact of extensive mortality on the seed-producing mature trees. That will ultimately affect the supply of seed at state and federal seed storage facilities.

Reforestation practitioners have historically been keen proponents for reforestation using planting stock grown from seed collected in environments like the site being

planted. Seed zones were developed decades ago and to this day when seedlings are ordered from nurseries, the buyer must specify what seed zone their site is located in. Reforestation based on seed zones alone is being called into question because of uncertain future climate. Changes in climate and tree responses to them are already reflected in reproductive phenology in seed orchards and possibly failure of natural regeneration. Observations such as changes in the timing of bud burst and aborted seeds have been recorded. Other effects have been attributed to climate changes and forest managers have accepted the need to adapt reforestation practices to assure successful regeneration. Some experts have advocated abandonment of seed zones altogether in favor of using transfer distance as the basis for deployment of planting stock, a system currently in use in British Columbia. Short of such a radical approach, some of the practices that have been recommended by specialists include utilizing seed from sources that are one elevation band (500 feet) up and/or one seed zone south to north from the proposed planting site. Other recommendations include utilizing seed from seed orchards that contain broadly adapted selections from breeding zones, which are twice the size of a seed zone. These selections were based on their growth and adaptation to environmental variability. Seed orchards established by the U.S. Forest Service decades ago are currently producing large amounts of seed. Additional seed orchards were created by the North Sierra Tree Improvement Association and are expected to yield seeds capable of producing up to 10 million seedlings/year in the future (http://soperwheeler.com/about-us/stewardship/north-sierra-tree-improvement-association/).

Relevant experiments and studies are currently being conducted by U.S. Forest Service researchers. Some are modeled on the classic "common garden" approach which tests how trees derived from seed from different sources perform in replicated locations. In one experiment at the King Fire, 12 sources of ponderosa and sugar pines are being evaluated under "operational" conditions to determine if source influences growth. The source locations are correlated with climatic variables which can be evaluated in relation to observations of growth. The findings of this study and others like it will have application to future reforestation practices.

One very promising approach is the Seedlot Selection Tool (SST) (https://seedlotselectiontool.org/sst/). The SST is a web-based mapping application designed to help natural resource managers match seed lots with planting sites based on climatic information. The SST can be used to map current climates or future climates based on selected climate change scenarios. It is tailored for matching seed lots and planting sites but can be used by anyone interested in mapping climates defined by temperature and water availability. The SST is most valuable as a planning and educational tool because of the uncertainty associated with climate interpolation models and climate change projections. The SST allows the user to control many input parameters, and can be customized for the management practices, climate change assumptions, and risk tolerance of the user. SST was developed as a collaboration between the U.S. Forest Service, Oregon State University and the Conservation Biology Institute. The SST is not currently being used in California but there is effort underway to encourage its adoption by the U.S. Forest Service and others.

The adequacy of seed stocks to meet existing and future reforestation needs is currently being investigated by U.S. Forest Service researchers and the results may affect the how cone collection and storage occurs in the state. The sufficiency of the state seed zone map as a guide to choosing reforestation seed lots is also under study by a collaborative Seed Zone Working Group led by CAL FIRE and the U.S. Forest Service.

SEEDLING PRODUCTION CAPACITY AND SALES

There is no public or private nursery in the state that currently grows seedlings on a speculative basis. All seedlings are grown to order. Jones (2012) provides a list of the nurseries that grow conifer seedlings for reforestation in California. The U.S. Forest Service Placerville Nursery produces both container and bare root seedlings for planting on land owned by public agencies, mainly the Forest Service (the relationship between this nursery and the RCD has already been described). The Cal Forest Nursery located in Siskiyou County has a large capacity and grows container seedlings for industrial timber producers and other private clients. Other nurseries, including several smaller ones grow container and/or bare root seedlings for reforestation for specific property owners and for the public in general. In addition to nurseries in California, there are several nurseries in Oregon and British Columbia that will grow seedlings for reforestation in California. Refer to Jones (2012) for a comprehensive list.

Seedling sales procedures vary by nursery. The U.S. Forest Service Placerville Nursery holds an annual sowing meeting which is attended by potential clients who convey their seedling needs for the upcoming year. Cal Forest does not have a formal process and takes orders by e-mail messages and phone calls. The RCD has a seedling order form which specifies the species, seed zone, planting site location and elevation and other details.

No data on the actual yearly seedling production are available for private nurseries serving California. There has been no evidence that managers seeking to procure seedlings from private nurseries have experienced difficulties. The U.S. Forest Service Placerville Nursery appears to have sufficient capacity to meet demands from National Forests and the RCD. Between 2014-2017 the RCD ordered between 8600 and 425 thousand seedlings for use at a range of locations that included reforestation of areas affected by wildfire. The number of seedlings ordered by the U.S. Forest Service or other public clients of the Placerville Nursery is unknown.

CONCLUSIONS

- Reforestation is a time sensitive process. At least one year of lead time is required to procure seed and grow seedlings for planting. This is a constraint for projects that plan immediate reforestation after a catastrophic mortality event. There are no nurseries in California that grow seedlings on a speculative basis without pre-planting contracts or orders.
- There are hundreds of thousands of acres of potential forest land in California that require active management to restore forest cover. The amount of deforested land has increased dramatically due to the recent prolonged drought and bark beetle infestations. There is no end in sight to this catastrophe.
- The amount of nonindustrial forest land in the state deforested due to wildfire is uncertain because data on post-fire tree mortality on private land is commonly not available.
- Current reforestation needs are primarily created from three sources: 1) even-aged timber harvesting on private land; 2) reforestation on land undertaken at the owner's expense (including Forest Service); and 3) reforestation on nonindustrial private land funded by state and federal cost-share programs. It is acknowledged that data on reforestation of private land that is funded by the landowner is not currently available and may be considerable, particularly in the case of land owned by the forest industry.
- Of the three sources of demand, even-aged timber harvesting on private land subject to Forest Practice Regulations on re-stocking is by far the largest source. Reforestation on National Forests is second largest and reforestation under cost-share programs is the smallest, representing about five percent of annual demand.
- The spatial distribution of nonindustrial forest land requiring reforestation is not well understood primarily because data on post-catastrophic event mortality is rarely available.
- There is concern that the availability of seed to grow seedlings for reforestation may be limited, particularly in locations where cone collection is not systematic. There is also concern that reliance on the state's seed zone map to guide selection of seed may not be warranted due to existing and potential future climate changes.
- The current capacity of the state's nurseries to produce seedlings for reforestation does not appear to be a limiting factor. There are potential issues that arise due to the required time to produce seedlings.

RECOMMENDATIONS

- Efforts to educate nonindustrial private forest landowners about the process and timeframe for reforestation should continue under the programs of UC Cooperative Extension, the Northern California Society of American Foresters, Resource Conservation Districts and CAL FIRE.

- Better information on the amount of nonindustrial forest land deforested by catastrophic events such as wildfire, drought and insect attacks is needed. Where private land constitutes most of the land within a wildfire perimeter, CAL FIRE should conduct and report on assessments of tree mortality. This could be accomplished through modifications to the "watershed emergency response team" post-fire studies and/or through remote sensing evaluations by CAL FIRE and its Fire and Resource Assessment Program. The amount of land deforested by the recent drought and insect attacks should be mapped using remote sensing methods so that accurate estimates of the size and distribution of mortality patches can be quantified.
- To quantify the potential need for seedlings each year a system of reporting proposed planting on private and public lands should be established. This would include annual reporting by the U.S. Forest Service, cooperating forest industry, NRCS and CAL FIRE. Reports should include potential demand by seed zone and species. The El Dorado County RCD could act as the clearinghouse for this reporting.
- Current work on the sufficiency of existing seed stocks and on the adequacy of the state's seed zone map for selecting seed lots should be continued. Procedures for cone collection and developing planting prescriptions should be adjusted based on the results of that work. Educational outreach on those results will be necessary.

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