

fire & fuels management

Landowner Perspectives on Reforestation following a High-Severity Wildfire in California

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We interviewed 27 nonindustrial forest landowners whose properties burned in a wildfire in California's central Sierra Nevada in 2014 about postfire reforestation and local and government-assisted reforestation programs. All wanted to reforest, but a third would not have without the free reforestation program offered by the Resource Conservation District. The rest would have tried to do the work themselves or pursued other programs despite complicated logistics and high upfront costs. Many experienced distress, or "solastalgia," at the loss of forest and wanted to "put the forest back the way it was" as quickly as possible. This may limit reforestation suited to climate change. Reforestation is a way of assuring carbon sequestration and regrowth, and may have an important role in helping to heal the emotional distress of those who have lost their forests to wildfire.

Keywords: carbon sequestration, nonindustrial private forest landowners, wildfire, solastalgia, family forests

California's Sierra Nevada forests developed under a frequent, low-severity fire regime for thousands of years (Stephens et al. 2018). The buildup of forest fuels after more than 100 years of fire suppression, combined with warming temperatures and more extreme droughts, has increased fire risk (Starrs et al. 2018) and resulted in high-severity fires in which all or most trees are killed (Miller et al. 2009, Stephens et al. 2018). Forest regeneration is then hindered by the lack of a seed source and vigorous regrowth of shrubs, which suppress re-establishment of trees for 30 to more than 60 years (Welch et al. 2016). As a result, reforestation is a critical need in the Western United States, on private as well as public forestland, in order to protect watersheds, enhance carbon sequestration, and

recover habitat (Sample 2017). This study uses a qualitative, interview-based approach to examine forest landowner response to a reforestation program after a wildfire in the central Sierra Nevada.

Although the California Forest Practices Act regulates forestry practices in California, including reforestation, the Act does not require reforestation when forests are "substantially damaged" by high-severity fire or large-scale drought-induced tree mortality (CalFire 2017). Industrial timber companies typically salvage dead trees and plant new seedlings immediately after wildfire to re-establish forests quickly. However, the desire and ability of nonindustrial private forest (NIPF) landowners to reforest are less assured. As of January 2018, more than 10 million acres of California's private

forestland was owned by 202,000 NIPF landowners (USDA Forest Service 2018). Most landowners owning 494 acres or less value their land for its natural amenities and as a financial investment more than as an ongoing source of income (Ferranto et al. 2011). These landowners may not have the time, capital, or expertise to reforest on their own, particularly considering the added emotional and economic stress that comes with the loss of a home to wildfire (Eisenman et al. 2015).

As the amount of California forestland burned at high severity continues to increase (Starrs et al. 2018), reforestation decisions made by NIPF landowners have implications for the future of California forests and their resilience to fire and climate change. This in turn has implications for human well-being and ecosystem sustainability. Although there is ample literature on the topic of forest management for fire risk mitigation among NIPF landowners (Fischer 2011), research on their preferences for vegetation management following fires is scant (Olsen and Shindler 2010, Toman et al. 2013). The goals of this study were to understand, for a recently burned area of the central Sierra Nevada, NIPF landowners' (1) experiences and perceptions about the forest following a

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high-severity wildfire; (2) decisions about postfire vegetation management; and (3) experience with reforestation assistance programs. In summer 2017, 27 NIPF landowners whose properties burned in a 2014 wildfire were interviewed. Confidentiality of site and respondents is preserved in this paper.

Study Area and Context

In fall 2014, a large area of mixed conifer forest on the western slope of the Sierra Nevada burned. The fire blazed through 97,717 ac, including approximately 63,536 ac of national forest land and 34,181 ac of private land. About half burned at high severity, with greater than 90 percent loss of tree basal area (USDA Forest Service 2015). The prefire vegetation community included ponderosa pine (*Pinus ponderosa*), sugar pine (*Pinus lambertiana*), incense-cedar (*Calocedrus decurrens*), white fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), and black oak (*Quercus kelloggii*) (Resource Conservation District 2017). Twelve residences and 68 accessory structures were also destroyed.

A large industrial timber company owned most of the private land burned. However, 75 additional landowners owned approximately 2498 ac in the burn area, with parcels ranging in size from 1 to 160 ac. The local Resource Conservation District (RCD) determined that of this, 1613 ac owned by 46 NIPF landowners was in need of reforestation because of levels of forest loss (Resource Conservation District 2017), and they became our study population. The rest of the NIPF landownerships remained adequately stocked after the fire so were not in need of a reforestation program.

Currently, California NIPF landowners with a forest management plan that meet property size requirements have access to two major reforestation programs: the California Forest Improvement Program (CFIP) of the California Department of Forestry and Fire Protection (CAL FIRE), and the Environmental Quality Incentives Program (EQIP) of the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS). These programs are designed to provide eligible landowners with technical and financial assistance for forest management projects, including reforestation, by partially reimbursing landowners after

they have implemented and paid for the activities.

The local RCD took a different and novel approach: they applied for and received \$1.9 million in Greenhouse Gas Reduction Fund (GGRF) monies from CALFIRE to plan and implement a reforestation program on up to 1300 ac in NIPF ownership. Participation was voluntary and free to the landowners needing reforestation. The desired future forest conditions were the same across the entire project area—“diverse in structure and composition and resilient to disturbances from fire, insects and disease,” with future tree density “managed to accelerate the development of large trees and favor a fire-resistant stand structure in which understory shrubs are separated from tree crowns” (Resource Conservation District 2017). The purpose of all GGRF Forest Management Projects is to ensure California’s forests continue to be a significant carbon storage “sink” and to reduce or avoid GHG emissions because of wildfire, loss of forest cover, and pest damage.

The proposed project was presented to affected landowners through a series of onsite, community meetings in fall 2014, and thereafter through individual consultations with landowners. The project goal of increasing carbon sequestration by replanting after fire was discussed, although climate adaptive planting was not a focus of these conversations. Project foresters did decrease the number of trees to be planted from the norm for traditional planting schemes, which can be considered a climate-adapted practice. To the extent possible, the RCD’s project manager and registered professional

forester worked with each participating landowner to incorporate their individual objectives into the planting plan for their property. The RCD hired the contractors, monitored the work, and paid for the activities with the grant funding (Figure 1).

Methods

With collaboration from the RCD, we sent an introductory letter in May 2017 from the local University of California Cooperative Extension office to the 46 eligible landowners (IRB Protocol #2016-10-9269). These were followed up with phone calls and e-mails requesting interviews. We reached 38 landowners; 27 agreed to be interviewed. In-person and phone interviews were semi-structured with open-ended questions that asked about the fire’s impacts on the landowner’s property, postfire land management efforts, restoration plans, and vegetation goals. Interviews were recorded, transcribed, and thematically coded using the web-based qualitative data analysis software, Dedoose.

Thirty-eight landowners chose to participate in the reforestation program. Twenty-five of the 27 interviewed were participants in the program, owning approximately half of the burned NIPF land in the study area (Table 1).

This study used a qualitative approach designed to explore the nuances of landowner response to the revegetation program. Qualitative studies encourage respondents to expand on a topic, incorporating their own experiences and ideas, rather than limiting them to the researcher’s anticipated responses (Neuman 2011).

Management and Policy Implications

Reforestation programs are becoming increasingly important with the rise of high severity wildfires in the Western United States. In California’s Forest Carbon Plan, reforestation is one way to increase carbon sequestration to mitigate climate change. The free reforestation program offered by a Resource Conservation District in our study area resulted in more acres reforested and more potential carbon sequestration. The upfront costs of alternative state and federal assistance programs meant some landowners would not have reforested otherwise. Reforestation programs need to be sensitive to the powerful emotions landowners feel about their losses from wildfire. Landowners generally want to reforest, as soon as possible, as part of their healing process, and the reforestation process should be expedited whenever possible. Tree planting delays, though often inevitable, increase the cost and effort of site preparation and cause greater landowner distress. Providing regular progress reports to landowners throughout the entire reforestation process can help relieve this distress. Landowners did not think of adapting reforestation prescriptions in order to re-establish a forest more resilient to climate change. Overwhelmingly, they desired to restore the forest to its pre-fire condition. This could hinder climate-adapted reforestation. Outreach to nonindustrial private forest landowners about replanting in accordance with a changing climate should be developed and included with outreach on the need to replant forests for climate change mitigation.



Figure 1. Three years after a wildfire, site preparation is under way in the reforestation project area. Contractors were hired to remove the dead standing trees. Photo credit: Lulu Waks.

This is particularly useful for new research areas, as with this study, in that it educates the researcher on the nuances of the topic, interviewee perspectives, and the study area (Gutwein and Goldstein 2013). There is a growing consensus about the need to complement standardized data with insights about the contexts and perspectives of participants (Luborsky and Rubinstein 1995). It should be noted that our results are not intended to represent a larger population, so inferential statistics are inappropriate and were not used. The results of this study provide insights into the range and variety of landowner responses in a new research area and can provide a foundation for randomized quantitative sampling of a larger population to assess landowner characteristics, and to understand how different groups or types of landowners in diverse locations might respond to reforestation scenarios.

Results

Landowner Characteristics

Of the 27 interviewees, about a third had a graduate degree, more than half were

retired, and most were male (Table 2). The average age of interviewees was 60, not far from the average of 62 for NIPF landowners in a 2013 nationwide survey (Butler et al. 2016), and for California forest and rangeland landowners (Ferranto et al. 2011). In both California and nationwide surveys, respondents were more highly educated, and more likely to be male than expected based on the US landowner population (Ferranto et al. 2011, Butler et al. 2016).

Themes from the Interviews

A number of themes emerged from the interviews, including the emotional impacts of a changed landscape; restoring the forest; climate change and forest adaptation; alternatives to the reforestation program; and impacts of project implementation timing.

Emotional Impacts of a Changed Landscape

As similar research has found (Burns et al. 2008, Ryan and Hamin 2008), landscape change had an intense and lasting emotional impact on many of the interviewees. People grieved the loss of trees; for some,

this loss was felt more intensely than the loss of their home or other structures (Figure 2).

I wasn't even sure how I was going to live here again. For me, it wasn't even that I lost all my stuff and the house, cuz I was so emotionally attached to the forest. We can rebuild, but we can't rebuild the forest.—Interviewee 1

The biggest loss for my family, and me in particular, was emotional—the structures I could've cared less about, it was the trees that really broke my heart. Trees that I grew up with.—Interviewee 24

I hate my view now. My view used to be nothing but trees. Now all I've got is deerbrush.—Interviewee 2

One landowner expressed a sorrowful nostalgia for her forest:

There's nothing pleasurable about going back there now. There's no forest. I really, really miss being in the trees. It's not the same, it doesn't feel the same. Now I live on a mountain where I'm getting heated up by the sun, I don't have the coolness of the trees. We used to sit outside and watch—you could hear the wind coming from below before it would come through the tops of the trees. That was one of my favorite things to do—was to sit out on the deck, and you could hear it, and then you'd see the tops of the trees start to sway. It was just stunning. We'll never have that again.—Interviewee 11

All of these comments imply a loss of solace and place identity formerly derived from the forested landscape. Six of the interviewees also lost their primary residences to the fire, and the distress associated with the changed landscape was felt in addition to the suffering that comes with losing a home and myriad personal belongings of sentimental value. An absentee landowner empathized:

I think if I would've been living there, I would've moved. It takes a special person to live up there—and a lot of those people really identify with the forest and the wildlife, and it's really hard on them.—Interviewee 13

Some of the interviewees did not express sorrow over the loss of their forest, usually because the fire did not substantially impact their view and/or relation to their property, or because they were absentee owners.

Restoring the Forest

All 27 interviewees, including the two not participating in the reforestation program, expressed a desire to replant at least portions of their properties. Several wanted

Table 1. NIPF ownership within the fire area.

NIPF landownership	No. of landowners	Area (acres)
NIPF owners of land burned	75	2501
NIPF owners of land in need of reforestation	46	1613
Landowners participating in the reforestation program	38	1391
Landowners we reached	38	1411
Landowners who agreed to be interviewed	27	1011
Interviewed landowners participating in the program	25	959
Interviewed landowners not participating in program	2	49

NIPF, nonindustrial private forest.

Table 2. Interviewed landowner demographics.

Age	Minimum = 40	Maximum = 80	Average = 60
Race	White = 24	Other = 1	Declined to answer = 2
Education level (two unreported)	High school/some college = 10	Bachelor's/Associate's degree = 7	Graduate degree = 8
Employment status	Unemployed = 1	Employed (full/part time) = 11	Retired = 15
Gender	Female = 5	Male = 22	
Residence status on burned property	Full-time = 9	Part-time/absentee = 18	
Marital status	Single = 6	Married = 21	
Income	Lowest reported ≤\$20,000	Highest reported ≥\$400,000	

to keep select areas open to maintain their new view or to plant row crops, but overall landowners felt compelled to reforest most of their land. We identified 18 reasons respondents believed reforestation is important both on the property and at the landscape scale (Table 3). People frequently said they wanted to “put things back the way they were” before the fire—the majority wanted to plant the same suite of species, while the occasional landowner also named the regionally non-native giant sequoia (*Sequoiadendron giganteum*), also known as the Sierra redwood, as a desired component of their new forest.

We and everybody else up here live here because we like the forest. It's important to get it back like it was. It's nature at its finest.—Interviewee 6

I want it to go back the way it was. Ponderosa pine and white fir ... I think there were four main species that were there. Some people are planting redwood

trees and apparently they do grow well at that elevation, but it's not what nature planted so I don't want to go there. I've seen those redwood trees and they're magnificent, so I can understand why people would want to plant them there, but like I said, this has been in our family for 50 some years and I just want it to be the way it was.—Interviewee 22

Climate Change and Forest Adaptation

The need to adapt ecosystems in anticipation of climate change—particularly, in this region, warmer temperatures and drought—has been discussed in the literature (Millar et al. 2007, Alfaro et al. 2014). Recommended adaptation strategies for forests in the Sierra Nevada generally focus on encouraging resilience to drought, fire, and insect outbreak by thinning trees to reduce competition and managing for multiple species. During planting, choosing seed stock likely to thrive in a warmer environment and spacing new seedlings

more widely are also suggested (Marshall et al. 2017).

Most landowners did not consider climate change when thinking about their tree planting preferences.

If I thought about it long enough, I would say yes, but we aren't thinking that way. We want everything back. It won't ever be like it was but we want to do as much as we can to make it as close to possible. But we are worried about climate change—you know if it wasn't my property I'd probably be thinking about it, in terms of other people.—Interviewee 23

It's hard for me to think about climate change in terms of my property. I think of climate change globally. Have we thought about based on climate change, how would we plant our land? No, have not even thought about that.—Interviewee 5

If landowners did perceive climate change as impacting the vegetation on or near their land, they were unclear how they might adapt.

I think it's obvious that there is a climate change—you can see the mortality of our existing forest just going for a drive. It's pretty scary—bark beetles and drought—it's nasty. So I think because of that, I'm not sure what species are going to be the most resilient.—Interviewee 13

Some landowners said they trusted that the professional foresters implementing the project were adequately addressing climate change in the reforestation plan.

I do wonder if there are other species that might be better to plant because I assume we're getting hotter and probably drier. I kind of assume that the foresters working for [the industrial timber company] and the federal foresters know what they're doing so I'm kind of following their lead on the mix of species.—Interviewee 20

Alternatives to the Reforestation Program

Reforestation after wildfire in this forest type typically involves cutting merchantable trees for milling, removing small trees for chips, and site preparation—piling and burning the remaining material on site, before planting trees. Without access to the



Figure 2. Wildfire burn area as seen from a nearby landowner's porch. The cleared area looked like the intact forest in the distance before the fire in 2014. Photo credit: Susan Kocher.

Table 3. Landowner-stated reasons to reforest.

Reasons to reforest:
Trees will eventually reduce my exposure to sun and wind
To control weeds—trees will crowd them out
Planting trees is faster than waiting for natural regeneration
To produce timber
Trees are a benefit to the environment
Trees build soil
Trees can create jobs
To increase land values
To reduce greenhouse gases
I like trees
I want to put it back to the way it was
Trees are a good investment
Trees improve air quality
Trees help control erosion and stabilize slopes
To give the gift of trees to future generations
Trees are beautiful
Trees increase privacy on my property
Trees provide wildlife habitat

free reforestation program, landowners said they would have used cost-share assistance programs, completed the work themselves with or without a contractor, or done nothing (Table 4).

Eight landowners who participated in the RCD program stated they would have considered the EQIP and CFIP cost-share programs had the free RCD reforestation program not been offered.

EQIP. Absolutely. It was financially feasible, and I also had the knowledge to use the grant. The responsibility falls to the landowner to put it all together.—Interviewee 10

Several of the same people spoke to the difficulty of organizing the reimbursement projects, both logistically and financially ...

For CFIP—you expend the money and then they pay you back. That would have been a good option for me, but I still would have had to line up a contractor and manage a contractor and I don't know if I would have done as good of a job as they're doing at the RCD.—Interviewee 16
We were interested in those programs but don't know how we would have done them, because you have to come up with the money first. We're not talking about \$500, we're talking about tens of

thousands of dollars to put up an advance like that.—Interviewee 5

Some felt overwhelmed by the thought of entering into state or federal-issued assistance programs despite having the money required to participate in them. The following participant explained some of the benefits of the free area-wide approach over the cost-share model:

The other factor that made the RCD implementation of the grant more favorable to us, was that we no longer had to enter into a contract with the state to do the reforestation on our property ... Essentially what we signed with them was an access agreement, which said that we agree to provide them access to our property for them to do this work. Having an agreement with the state as a family to do the reforestation work—what it would've required of us is that we would've then had contracts and agreements with our consultants that would do the work, we would have to pay our consultants for their work, and then we would have to submit a reimbursement request pursuant to our agreement with the state for the state to reimburse us for the cost that we incurred to implement the work. I was relieved to not have to deal with that and have the RCD essentially do everything.—Interviewee 24

Nine people said they would have attempted the work themselves, or would have hired a contractor to do it, if the free RCD reforestation program had not been available:

I think I probably would have selected some very small but high-value areas in the viewshed to do my own mechanical clearing, go to battle with the weeds, and plant 20 trees one summer, plant 20 trees the next.—Interviewee 11
[We would have] hired our guy and done it on our own at \$1000 per day. We would've gotten it cleared but I don't know what we would've done for planting because neither of us have the legs that we can do planting. And finding people to do stuff up here is not easy ... Nobody wants to come up this far.—Interviewee 9

Nine people said they would have taken no action:

That grant was a lifesaver for us. I doubt very much if we would've taken it upon ourselves to reforest without that grant, we just didn't have the resources to do it. It's expensive, as you know. We're very grateful for it.—Interviewee 20

Impacts of Implementation Timing

A number of factors led to the reforestation project not being completed until the fourth year after the fire. The fire burned in September and October 2014. The RCD submitted its reforestation proposal in June 2015, and the project was approved in March 2016. Site preparation began in fall 2016 but was delayed because of issues with hired contractors and the record-setting precipitation in the winter of 2016/17. At the time of the interviews in summer 2017, site preparation was continuing in order to remove burned woody debris and the now densely established shrubs such as buckbrush (*Ceanothus cuneatus*), whitethorn (*Ceanothus cordulatus*), and manzanita (*Arctostaphylos patula*) (Figure 3). Site preparation was completed in fall 2017, and planting was completed by spring of 2018. Although reforestation programs typically require some time to implement, a project of this scale—involving a government agency and many landowners—requires additional time to work with the granting agency and the many individuals, and to coordinate across multiple parcels.

At least 13 landowners spoke about the slow pace of implementation in their interviews. Some residents experienced the delays on a personal emotional level:

I was trying to save as many of the oaks as I could where they were bulldozing—because they've had three years of growth already. It's kind of like putting salt in the wound for me. I see it all coming back and then it's compromised again.—Interviewee 1
I have not felt negatively about the whole thing until recently because it's just going on too long, and I'm tired.—Interviewee 5

An absentee landowner recognized the added inefficiency of the project's timing, but did not feel additional stress as a result:

They obviously know what they're doing, it's just that when the government is working on something like that their timetable doesn't match the biological timetable. So they ended up creating a lot more work for themselves by being so slow to implement the thing ... Now they have

Table 4. Landowner-stated reforestation strategies without the free, area-wide grant.

Reforestation strategy without grant	No. of landowners	No. of acres owned
Sign up for an individual grant program	8	470
Do the work themselves or hire contractors	9	240
Take no reforestation action	9	250

to battle the infestation of Costa Rican jungle.—Interviewee 21

Another absentee landowner expressed concern about the need for additional herbicide to remove competition from resprouting shrubs, but maintained that it was less problematic for him because he did not live onsite:

I wish it had happened before we got the big rain. Now we are fighting an uphill battle against established vegetation—they gotta use heavy chemical application 4–5 times—I got a little 14 month old and I'm going to be worried about residue. But the reality is, because I don't have a house up there ... I can afford to ignore it for another year if I have to. I'm in a better position than the folks that are living in it.—Interviewee 16

Not surprisingly, the time it took to implement the project provoked more stress for those residing in the burn area than for absentee landowners. Full-time residents reported feeling anxious for closure. Eight out of nine full- or part-time residents felt negatively about the project delays, whereas five out of 18 absentee landowners mentioned the delays, though with far less emotional charge.

Discussion

Landowners, Fire, and the Loss of Landscape

Forests are highly valued by NIPF landowners on an emotional level as well as for their perceived ecological benefits (Ferranto et al. 2011). Many interviewed landowners felt a deep sense of loss and distress because of the changed environment, particularly the destruction of trees.

Intense environmental changes like those caused by wildfire have been shown

to result in emotional stress to people accustomed to the former environmental conditions (Eisenman et al. 2015). The term “solastalgia,” coined by environmental philosopher Glenn Albrecht in 2003, describes a form of psychological distress specific to environmental change:

the pain experienced when there is recognition that the place where one resides and that one loves is under immediate assault. It is manifest in an attack on one's sense of place, in the erosion of the sense of belonging to a particular place and a feeling of distress about its transformation. It is an intense desire for the place where one is a resident to be maintained in a state that continues to give comfort or solace. (Albrecht 2005, p. 48)

The homesickness expressed by some respondents fits Albrecht's (2005) description of solastalgia as, “the homesickness one gets when one is still at ‘home’” (p. 48).

Solastalgia has been identified in wildfire-impacted residents and linked to clinically significant psychological distress, especially when combined with adverse financial impact from fire (Eisenman et al. 2015). In another study (Paveglio et al. 2015), a survey of residents affected by 25 fires revealed that personal losses such as damage to property, perceptions about wildfire impact in their locality, and disruption of routines were highly correlated with residents' self-reported well-being after fires. Most interesting, according to the authors, was that “loss of the landscape” was “robustly correlated” with well-being (Paveglio et al. 2015, p. 7). Our interviews similarly revealed that many residents experienced the loss of landscape and resulting solastalgia—a likely motivator to restore the forest to its prefire condition. This desire to restore at least portions, if not all, of their forest was unanimous among those

interviewed, even when the interviewee did not mention psychological distress. Ryan and Hamin (2008) found that community members living near burned public lands felt that the opportunity to participate in land restoration and replanting helped them reconnect to the forest and their “special places.”

Reforestation Programs

Most landowners took advantage of the grant-funded reforestation program offered by the local RCD and were thus able to re-establish a young forest on their landscape. Had the program not been offered, about a third of those interviewed said they would not have had the expertise, time, or funds to take part in state or federal cost-share programs and would have taken no action. They considered federal and state cost-share programs infeasible because of their upfront costs and complexity. Research has shown that participation in cost-share afforestation programs is not widespread, and that reducing costs to the landowner significantly increases the probability of reforestation following timber harvest (Arano et al. 2004). Considering the emotional and financial stresses of a destructive wildfire, one might expect these barriers to be exacerbated for NIPF landowners following loss of forest to fire.

Most participants expressed gratitude for the grant-funded program, but the delay in getting trees in the ground due to a variety of circumstances beyond the RCD's control caused some distress. Interviewees were frustrated by the postponements, recognizing the added difficulty and cost. Delays prevented some from moving on emotionally from the trauma of the fire.

Climate Change

There has been considerable discussion in the literature and public venues about the need to think about warmer temperatures and more frequent drought when planning for reforestation (Millar et al. 2007, Williams and Dumroese 2013). The effects of a changing climate are evidenced in the unprecedented levels of tree mortality caused by the historic 2012–16 drought (Stephens et al. 2018). Climate projections for the future show an increasingly warm, dry, and fiery environment for trees (Cornwell et al. 2012).

Many landowners recognized the value of planting trees for climate change



Figure 3. Burn area nearly 3 years after a wildfire. Note the regrowth of dense shrubs that make reforestation more difficult and costly. Photo credit: Lulu Waks.

mitigation - including improved air quality and reduced greenhouse gases. Few, however, had considered the potential benefits of adapting reforestation prescriptions in light of climate change - that is, what species planted in what densities might be more resilient to a warmer, drier environment. For this project, reforestation plans were developed by California Registered Professional Foresters, as is required by state law (CalFire 2017). However, in situations for which involvement of professional foresters is not required, it is possible that a desire to “put the forest back the way it was” could impede the use of climate-adapted reforestation practices. Outreach to NIPF landowners that discusses climate-adapted reforestation and management would promote planting of more fire-resistant forests.

Conclusions

Nonindustrial private forest landowners experience a variety of impacts from high-severity fire on their properties. It is important to expedite the reforestation process to reduce landowner distress as well as the additional costs incurred because of delays, and to keep regular channels of communication open so that landowners know what to expect. Building relations with private forest owners, or drawing on existing relations, such as those with Extension, RCD, or NRCS programs, will likely increase the influence of reforestation programs.

Information on how climate trends might affect local forests should be included in communication about private forest management. More locally applicable adaptation strategies should be developed with and explained to NIPF landowners to assist sound reforestation decisionmaking. These include options for reducing the impacts of future fires. Solastalgia, while a powerful motivator to replant, could in some cases limit landowner willingness to plan and implement climate-adapted reforestation.

This study suggests several opportunities for future research. Conducting followup interviews with landowners a few years after the completion of a reforestation project would provide more information about the impact of the program and status of the reforestation effort. Goals might be to find out if reforestation reduced landowner distress because of solastalgia, or if landowners need more support while young trees are

growing. There is also potential for a comparative study in an area with similar levels of tree mortality and loss of infrastructure because of wildfire, but no agency-implemented cost-free reforestation program in place, to find out what landowners actually do in the absence of such a program. This would deepen our understanding of the ecological and social implications of high-severity wildfires for NIPF land and landowners. Finally, this in-depth but small-scale research provides the foundation for broader quantitative or qualitative research sampling from regional, state, or national populations of forest landowners, allowing assessment of landowner demographics and typologies representative of forest landowners, as in Ferranto et al. (2011). It is likely that landowner experiences differ not only by individual demographic characteristics and local economy, but also by disturbance type, with possibly different attitudes about forest loss because of wildfire versus drought and bark beetles. This study contributes hypotheses, topics, and questions for such a study.

The grant program enabled reforestation that would otherwise not have occurred. “Restoring ecosystem health of wildfire- and pest-impacted areas through reforestation” is listed as a key strategy for securing California’s forests as healthy, resilient carbon sinks in the state’s new Forest Carbon Plan (Forest Climate Action Team, 2018, p. 35). We found that the no-cost area-wide reforestation program offered by the RCD was effective at increasing the area replanted by small nonindustrial forest landowners after a wildfire by at least a third, increasing the total area reforested to 960 ac, and the potential carbon sequestered to 71,500–83,500 tonnes of carbon dioxide equivalent 50 years after planting, and 200,800–212,800 tonnes 100 years after planting (RCD pers. comm. 2018). We suggest that reforestation projects for climate change mitigation should also include outreach on benefits of climate-adapted forest management to maintain and enhance resilience in the face of climate change. Carbon sequestration is exceedingly important, and the reforestation of these lands is crucial to the emotional healing of forest owners. Recognizing this, along with collaboration and communication with landowners and more research on climate adapted reforestation methods, can have a powerful effect on the future of California’s forests.

Literature Cited

- ALBRECHT, C. 2005. “Solastalgia”: A new concept in health and identity. *Philos. Activ. Nat.* 3:44–59.
- ALFARO, R.I., B. FADY, G.G. VENDRAMIN, I.K. DAWSON, R.A. FLEMING, C. SAENZ-ROMERO, R.A. LINDIG-CISNEROS, T. MURDOCK, B. VINCETTI, C.M. NAVARRO, T. SKROPPA, G. BALDINELLI, Y.A. EL-KASSABY, AND J. LOO. 2014. The role of forest genetic resources in responding to biotic and abiotic factors in the context of anthropogenic climate change. *For. Ecol. Manage.* 333:76–87.
- ARANO, K.G., I.A. MUNN, J.E. GUNTER, S.H. BULLARD, AND M.L. DOOLITTLE. 2004. Modeling landowner participation in a proposed reforestation loan program. *Small-Scale For. Econ. Manage. Pol.* 3(2):177–190.
- BURNS M.R., J.G. TAYLOR, AND J.T. HOGAN. 2008. Integrative healing: The importance of community collaboration in postfire recovery and prefire planning. P. 81–97 in *Wildfire risk: Human perceptions and management implications*, W.E. Martin, C. Raish, and B. Kent (eds). Resources for the Future, Washington, DC.
- BUTLER, B.J., J.H. HEWES, B.J. DICKINSON, K. ANDREJCZYK, S.M. BUTLER, AND M. MARKOWSKI-LINDSAY. 2016. Family forest ownerships of the United States, 2013: Findings from the USDA Forest Service’s National Woodland Owner Survey. *J. For.* 114(6):638–647.
- CalFire. 2017. California forest practices rules 2017. Available online at http://www.fire.ca.gov/resource_mgt/resource_mgt_forest-practice; last accessed October 22, 2018.
- CORNWELL, W.K., S.A. STUART, A. RAMIREZ, C.R. DOLANC, J.H. THORNE, AND D.D. ACKERLY. 2012. *Climate change impacts on California vegetation: Physiology, life history and ecosystem change*. California Energy Commission, Sacramento, CA. Publication number: CEC-500-2012-023.
- EISENMAN, D., S. MCCAFFREY, I. DONATELLO, AND G. MARSHAL. 2015. An ecosystems and vulnerable populations perspective on solastalgia and psychological distress after a wildfire. *Ecohealth* 12(4):602–610.
- FERRANTO, S., L. HUNTSINGER, C. GETZ, G. NAKAMURA, W. STEWART, S. DRILL, Y. VALACHOVIC, M. DELASAUX, AND M. KELLY. 2011. Forest and rangeland owners value land for natural amenities and as financial investment. *Calif. Agr.* 65(4):185–191.
- FISCHER, A.P. 2011. Reducing hazardous fuels on nonindustrial private forests: Factors influencing landowner decisions. *J. For.* 109(5):260–266.
- FOREST CLIMATE ACTION TEAM. 2018. *California forest carbon plan: Managing our forest landscapes in a changing climate*. Sacramento, CA. 178 p.
- GUTWEIN, M., AND J.H. GOLDSTEIN. 2013. Integrating conservation and financial objectives on private rangelands in Northern Colorado: Rancher and practitioner perceptions. *Rangeland Ecol. Manage.* 66(3):330–338.

- LUBORSKY, M.R., AND R.L. RUBINSTEIN. 1995. Sampling in qualitative research. *Res. Aging* 17(1):89–113.
- MARSHALL, A., S.D. KOCHER, AND A. KERR. 2017. *Adapting forests to climate change*. Forest Stewardship Series #25. University of California Agriculture and Natural Resources Publication #8574. 14 p.
- MILLAR, C.I., N.L. STEPHENSON, AND S.L. STEPHENS. 2007. Climate change and forests of the future: Managing in the face of uncertainty. *Ecol. Appl.* 17(8):2145–2151.
- MILLER, J.D., H.D. SAFFORD, M. CRIMMINS, AND A.E. THODE. 2009. Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade Mountains, California and Nevada, USA. *Ecosystems* 12(1):16–32.
- NEUMAN, W.L. 2011. *Social research methods: Qualitative and quantitative approaches*. 7th ed. Allyn & Bacon, Boston, MA. 640 p.
- OLSEN, C.S., AND B.A. SHINDLER. 2010. Trust, acceptance, and citizen–agency interactions after large fires: Influences on planning processes. *Int. J. Wildland Fire* 19(1):137–147.
- PAVEGLIO, T.B., C. KOOISTRA, T. HALL, AND M. PICKERING. 2015. Understanding the effect of large wildfires on residents' well-being: What factors influence wildfire impact? *For. Sci.* 62(1):59–69.
- Resource Conservation District. 2017. *California cooperative forest management plan: Fire restoration and reforestation project*. 39 p.
- RYAN, R.L., AND E. HAMIN. 2008. Wildfires, communities, and agencies: Stakeholders' perceptions of postfire forest restoration and rehabilitation. *J. For.* 106(7):370–379.
- SAMPLE, V.A. 2017. Potential for additional carbon sequestration through regeneration of nonstocked forest land in the United States. *J. For.* 115:309–318.
- STARRS, C.F., V. BUTSIC, C. STEPHENS, AND W. STEWART. 2018. The impact of land ownership, firefighting, and reserve status on fire probability in California. *Environ. Res. Lett.* 13(3) 034025.
- STEPHENS, S.L., B.M. COLLINS, C.J. FETTIG, M.A. FINNEY, C.M. HOFFMAN, E.E. KNAPP, M.P. NORTH, H. SAFFORD, AND R.B. WAYMAN. 2018. Drought, tree mortality, and wildfire in forests adapted to frequent fire. *BioScience* 68(2):77–88.
- TOMAN, E., M. STIDHAM, S. MCCAFFREY, AND B. SHINDLER. 2013. *Social science at the wildland–urban interface: A compendium of research results to create fire-adapted communities*. Gen. Tech. Rep. NRS-111. USDA Forest Service, Northern Research Station, Newtown Square, PA. 75 p.
- USDA Forest Service. 2015. *Environmental impact statement, fire restoration project*. 413 p.
- USDA Forest Service. 2018. *State and private forestry fact sheet: California 2018*. Available online at <http://www.stateforesters.org/sites/default/files/publication-documents/California-2018.pdf>; last accessed November 9, 2018.
- WELCH, K.R., H.D. SAFFORD, AND T.P. YOUNG. 2016. Predicting conifer establishment post wildfire in mixed conifer forests of the North American Mediterranean-climate zone. *Ecosphere* 7(12) e01609.
- WILLIAMS, M.I., AND R.K. DUMROESE. 2013. Preparing for climate change: Forestry and assisted migration. *J. For.* 111(4):287–297.