

Chapter 2

Investing in reforestation

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Decades of experience prove that successful reforestation cannot be done inexpensively but it can be done cost-effectively. Successful reforestation is challenging in California due to competing vegetation, hot summers, snow and frost, and many varied agents that can damage or kill seedlings. The necessary planning, implementation, and monitoring costs stretch out over years, and revenues and other benefits rarely occur within the first one or two decades of when the investments were made. However, experience shows that the full costs of not completing reforestation may be greater than the costs of undertaking the steps necessary for reforestation.

This chapter focuses on the investment decisions and actions that landowners should consider as they embark on a reforestation project. While the financial returns from individual reforestation projects are decades out, ensuring that forests maintain their productivity is essential to the long-term viability of sustainable forestry enterprises. In addition to the ensuring a future supply of wood products, young forests provide early seral stage wildlife habitats, vegetative biodiversity, greater carbon sequestration rates, and aesthetic benefits exceeding those of most fields of brush or invasive and nonnative plants. The numerous public benefits of successful reforestation investments are key justifications for federal and state governments to provide technical and material assistance, cost-share programs, and favorable tax considerations for reforestation expenses. Greater public support for reforestation on private and public forest lands can also improve the rate of successful reforestation in

California by reducing the immediate financial hurdles that impede action.

The chapter reviews the key steps of a reforestation project undertaken by private landowners or public agencies. While the mix of private and public financing will vary for different projects, having a clear view of the costs and benefits is critical when securing support from decision-makers to invest in reforestation. The key steps include estimating the costs of different reforestation management, planning, and operational activities; estimating potential revenues and noneconomic benefits; conducting a systematic economic analysis integrating the costs and benefits that occur across decades; and planning out the specific project steps.

Estimating costs and revenues

The first step in financing reforestation is estimating the potential range of project costs that must occur, decades before any revenue results from newly planted trees. The total costs will depend on how many acres will be reforested, how much emphasis is placed on forest growth rather than simply forest or vegetation cover, which treatments are chosen, how challenging the site is, and what logistical efficiencies can be achieved. Larger organizations typically have experience with and know the costs of similar, recently completed projects. To develop initial estimates for project costs, forestry consultants and landowners with more-limited reforestation experience should consult with local experts and review the reimbursable cost rates offered by the U.S. Department of Agriculture's

Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program and the California Department of Forestry and Fire Protection (CAL FIRE) California Forest Improvement Program. After developing a reasonable estimate of projected reforestation costs, the next step is to assess potential financing options. Finally, landowners should consider when revenues will be produced from reforested sites.

Assessing financing options

How reforestation projects are financed varies considerably across landowners. Large forest landowners and investment property owners typically treat reforestation as a long-term investment in a sustainable business that is judged by comparing the value of future returns to the more immediate costs that must be undertaken to bring seedlings to an age where they can be profitably and sustainably managed. Not every project will need a detailed economic analysis, especially if the landowners are invested in the long-term character of their forest enterprise and have confidence that standard procedures will be cost-effective. While it is rarely possible to borrow against future revenues to finance immediate restoration expenses, it is worthwhile to consider potential future revenues related to healthy and growing stands, including ecosystem services such as mitigation credits for certain habitats, conservation easements, recreational leases, and climate benefits.

Long-term investments on private lands will be taxed as capital gains and thus avoid the usually higher ordinary income tax rates. Tax rules that allow initial costs to be immediately deducted rather than amortized over a number of years vary for different types of private owners, and they can reduce the overall net cost of a project. The rules can change with revisions to the federal tax codes, so it is important to consult the most recent official information on taxation relating to forestlands. In addition, federal and state cost-share programs targeting small landowners may be available. Finally, publicly maintained resources such as seed banks and university-based technical assistance can often provide services to landowners at lower cost, allowing more favorable financing packages for private landowners.

Unexpected mortality events and reforestation after severe wildfires can place significant financial constraints on landowners, who may have also lost residences and other assets in the fire. Small-diameter trees burned in a wildfire have little value, and small landowners may find it very difficult to contract with loggers for salvage harvesting. After large wildfires, it is common for private owners of large forest areas to contract with the limited number of loggers in a region. Delays in initiating reforestation projects or

choosing more expensive reforestation practices can severely limit the number of successfully reforested acres that landowners with limited budgets can undertake. Because owners of smaller properties often lack the ability and economies of scale necessary to capture financial value from fire-damaged stands, they often rely on government technical assistance and cost-share programs to achieve successful reforestation projects.

Understanding and properly accounting for noneconomic benefits is important for securing federal funding of reforestation efforts. The USDA Forest Service explicitly defines a broad range of noneconomic goals for reforestation on national forest lands. Federal landowner cost-share programs also consider the noneconomic benefits of successful reforestation such as erosion protection and more tree-based wildlife habitat in determining landowner payments. After applying consistent values to desired noneconomic and economic outcomes, the use of standardized economic analysis tools can help identify projects that will deliver the best outcomes given budget constraints.

On national forest lands, the Forest Service historically financed much of their reforestation by reinvesting a portion of timber revenues into regenerating the forest. Current federal funds for Forest Service reforestation projects now come mainly from its vegetation and watershed management programs and the Reforestation Trust Fund (USDA 2018). The large increases in wildfire damage on Forest Service lands in California have not been matched by increases in successfully reforested areas, resulting in a growing backlog of areas in need of reforestation.

Tax treatment of private reforestation investments

The tax treatment of reforestation investments depends on the purpose of the investment (personal enjoyment, investment, or business); the ownership structure (small family ownership, commercial timber business, partnerships, trusts, or other); and any changes in federal and state tax law. As of 2019, small landowners could deduct up to \$10,000 per year for reforestation costs, while larger expenditures were amortized over 84 months. Larger landowners can deduct some of their reforestation costs if they are closely related in time and purpose to revenue-generating harvest events.

Unexpected costs related to declared disasters such as severe wildfires are treated more favorably. Some cost-share payments from certain defined federal and state programs can be excluded from reported income. Reforestation activities that are undertaken as part of a federally funded conservation activity may not be counted against the overall caps on reforestation costs. Landowners should discuss their plans with

local NRCS staff to understand the potential tax implications. Given the large expenditures required for reforestation and the technical details of specific cases, it is always important to consult timber and forest taxation specialists who are up to date on current policies (Greene et al. 2012; National Timber Tax website 2019; Wang 2019).

Postwildfire loss responses of small landowners

With severe wildfires increasingly common in California, the need for reforestation is growing. These fires often destroy the majority of the forest's timber value and reduce the public benefits that they provide, including diverse wildlife habitats, erosion protection, and carbon sequestration. In addition to financial benefits, successful reforestation projects can provide numerous public and private benefits. Owners of smaller forested properties often place less emphasis on the future financial returns of forestry compared to other benefits from their forests (Ferranto et al. 2011). Management activities that improve wildlife habitat and forest health are the most common activities across family-owned forests of all sizes (Stewart et al. 2012) and accounted for important benefits when planning reforestation projects.

The complexity and high costs of restoration can limit the ability of many small landowners to undertake projects after wildfires if they cannot quickly access technical and financial resources. A recent study of family forest owners whose properties burned in a 2014 wildfire in the central Sierra Nevada provides insights into the goals and challenges for owners of smaller properties who want to reforest their land (Waks et al. 2019). The study noted, "All [landowners] wanted to reforest, but a third would not have without the free reforestation program offered by the local resource conservation district to mitigate climate change through increased carbon sequestration. The rest of the landowners would have tried to do the work themselves or pursued other programs despite complicated logistics and high upfront costs."

Economic analyses of programs designed to assist smaller landowners should also consider the non-timber benefits that accrue to the owners as well as the social benefits of successful reforestation such as the viewshed benefits of healthy forests at sites that otherwise would revert to brush fields in many parts of California. Access to well-funded state and federal cost-share programs will be an increasingly important component of a successful reforestation strategy at a statewide level in California.

State and federal cost-share programs

To help landowners who lack the needed financial and technical resources to undertake reforestation, CAL FIRE and the NRCS both offer cost-share programs for reforestation projects. The full suite of activities covered in this reforestation publication may be eligible for cost-share funding but the two funding agencies have different definitions of treatments and relevant reimbursement rates. Keeping up with the latest requirements and understanding the application processes can be challenging, especially for landowners suffering the many consequences of a high-severity wildfire. Financial assistance programs continually change and are subject to swings in government policy priorities and budgets, so it is necessary to check with the agencies on current guidelines and funding.

Landowners and the professionals working with them should check the CAL FIRE California Forest Improvement Program (CFIP) and NRCS Environmental Quality Incentives Program (EQIP) websites for the most recent program details; and with agency staff to ensure that a reforestation project's funding needs can be supported and timed appropriately. Specific activities have different reimbursement schedules based on a number of factors. The level of cost-share, for example, can be higher for reforestation activities after disasters such as severe wildfire and mortality from pest insects. The federal Farm Service Agency's Emergency Forest Restoration Program uses EQIP's practices and payment rates.

It is important to understand that grants only reimburse the recipient after project expenses, and reimbursements are limited by the applicable cost-share rates and most recent reimbursement schedules. As a matter of standard practice, federal and state programs do not offer payment in advance, but provisions of EQIP allow for contract waivers, which need to be approved in advance on a project-by-project basis. CAL FIRE's CFIP also has the potential for loans that can be made to landowners implementing projects. When selecting which program to pursue, matching the landowner's objectives and needs to the appropriate cost-share program is an important consideration. Forest management plans are also required for each of the cost-share programs.

California Forest Improvement Program

The purpose of this long-standing state grant program is "to encourage private and public investment in, and improved management of, California forestlands and resources." Cost-share assistance of up to 75 percent of project costs is usually available to private and public ownerships containing 20 to 5,000 acres of forestland. A 90 percent rate currently applies to lands substantial-

ly damaged by fire, insects, and disease; all cooperative forest management plans; and lands with less than 500 acres of forest. Consultation with and project supervision by a Registered Professional Forester is required, with some of the costs covered by the grant.

Funded activities include management planning, site preparation (such as mechanical or herbicide treatments), tree seedling purchase and planting, precommercial thinning or release, pruning, forest road repair and upgrading, and other conservation practices. However, paying for seedling restocking requirements after a timber harvest plan is not allowed. The [California Forest Improvement Program](#) website includes current user guides, requirements, cost-share rates, and how to contact a CAL FIRE forest assistance specialist. Available funding has increased over recent decades with more financing, including the Timber Regulation and Forest Restoration Fund and California Climate Investments, but future funding levels are uncertain.

CAL FIRE Forest Health Grant Program

Beginning in 2018, CAL FIRE's Forest Health Grant Program has awarded grants from the Greenhouse Gas Reduction Fund, as allocated by the state legislature for California Climate Investments to implement large-scale projects that seek to

- proactively restore forest health to reduce greenhouse gases
- protect upper watersheds where the state's water supply originates
- promote the long-term storage of carbon in forest trees and soils
- minimize the loss of forest carbon from large, intense wildfires
- further the goals of the AB32, the [California Global Warming Solutions Act](#) of 2006

In 2018 California committed to spending \$1 billion over 5 years from the Greenhouse Gas Reduction Fund for forest health, fire prevention, and fuel reduction activities. Reforestation projects can be funded, and they are projects with benefits that will continue to grow as the trees grow. Eligible applicants include local, state, and federal agencies including federal land management agencies (excluding conservation easements), state land management agencies, Native American tribes, private forest landowners, resource conservation districts, fire safe councils, land trusts, landowner organizations, conservation groups, and non-profit organizations.

To be eligible for funding under CAL FIRE's Forest Health Grant Program, projects must

- focus on large, landscape-scale forestlands com-

posed of one or more landowners, which may cover multiple jurisdictions (such as subwatersheds, firesheds, or larger management units of 10,000 acres or more)

- generate a net increase of on-site carbon storage over a no-project baseline as calculated by the California Air Resources Board's California Climate Investments Quantification methodology
- be designed to ensure the project benefits are as permanent as possible

Environmental Quality Incentives Program

EQIP is designed to support various reforestation activities through funding pools such as their catastrophic fire recovery, tree mortality, and forest health pools.

Funding is provided for many reforestation practices, including site preparation, seedling planting, and post-planting weed control. EQIP payments made to clients are fixed rates, meaning that regardless of actual cost paid by a client to a contractor to complete work, the payment made by EQIP is fixed. The program pays a fixed rate, usually intended to provide approximately 50 to 75 percent of actual costs, to clients completing reforestation practices. Payment rates to clients can be higher for postwildfire efforts. A forest management plan is required and can be partially financed as part of the NRCS's Conservation Plan assistance.

The goals of EQIP funding include wildfire reduction, forest health improvement, erosion control, and water-quality protection on working lands. The funding priorities are determined by the federal Farm Bill periodically reauthorized by Congress: the 2018 Farm Bill included reforestation and fuel reduction, with no parcel size limitations. The NRCS also provides support through its voluntary Conservation Technical Assistance program, with staff foresters in some county offices and the state office. Registered Professional Foresters can also assist with EQIP applications.

Generalized 2019 reforestation costs for federal and state cost-share programs

Key points from a comparison of federal and state cost estimates include the different ways that they define reimbursable treatments, the wide range between low and high cost-per-acre estimates for all activities, and the lower range of estimated costs for site preparation treatments versus postplanting mechanical and other release treatments (table 2.1).

The forester or landowner submits their cost estimates, but maximum reimbursement rates are fixed by federal and state regulations. Landowners must finance the difference between the actual costs and allowable reimbursements. In general, smaller projects will often have higher costs per acre due to the lack of economies

TABLE 2.1. Comparison of state (CAL FIRE) and federal (NRCS) cost-share programs

Criteria	CAL FIRE California Forest Improvement Program	NRCS Environmental Quality Incentives Program
Ownership size	20 acres, with maximum of 5,000 acres. Forestland is 10% or more cover, including oaks.	No minimum or maximum size. Management can be limited to improving forest health or initiating restoration. Forest management does not require explicit plans for future timber harvests. Must meet the federal definition of nonindustrial forestland.*
Zoning	Must be zoned to allow forest management, via Timber Production Zone or other land-use addendum.	N/A
Maintenance	Projects must be maintained for at least 10 years.	Maintenance of project varies by activity; projects must be maintained for treatment practice lifespan (variable).
Covered activities	May include preparation of management plans, Registered Professional Forester supervision, site preparation, planting, precommercial thinning, pruning, release treatments, and slash disposal.	May include preparation of management plans, brush management, herbaceous weed treatment, prescribed burning, woody residue treatment, fuel breaks, tree/shrub site preparation, tree establishment, forest stand improvement, and forest road and trail erosion control.
Activity size	5 acres minimum for forest management. No minimum on habitat improvement.	NRCS staff may also provide a forest management plan for smaller projects.
Timber Harvest Plan work	Will not cover Timber Harvest Plan stocking requirements.	Does not pay for work to be planned or implemented in a Timber Harvest Plan.
Prequalify	Prereview with CAL FIRE forester.	All projects based on submitting applications.
Management plan requirements	Plan is required, and CAL FIRE will fund. The plan must be done before any work.	Forest management plan is required for all projects. Funding may cover plan cost if requested and receives priority for funding in some cases.
Supervision	Registered Professional Forester supervision required.	No requirement for supervision, but clients are recommended to hire Registered Professional Forester for supervision of field work and use a qualified contractor. A Pest Control Advisor report is required for all projects that involve the use of herbicides.
Funding rates	For live tree/green projects, 75% of expense is funded to maximum in contract. For substantially damaged lands, 90% of cost-share activities are funded over the following 10 years.	Fixed rate paid to clients for completed work, to cover about 50–75% of actual costs; rate can be higher for postwildfire efforts.
Available funds	\$3+ million is available from Timber Regulation and Forest Restoration Fund, with considerable additional funding from California Climate Investments after 2018.	Forestry fund allocates \$5–10 million per year for highest-ranking projects.
Fund timing	First come, first served. Budget year is July through June.	Applications accepted continuously; ranking and funding occur 3–4 times per year.
Payment by activity	Interim payments allowed.	Interim payments allowed.
Proof of payment	Proof of payment to contractors required before payment to landowner.	Practice must be field-certified by NRCS staff and meet requirements and specifications prior to payment.
Adjusted gross income (AGI) cap	N/A	Adjusted gross incomes greater than \$900,000 are not eligible.

*Federal definition of nonindustrial forest land: "Rural land that has existing tree cover or is suitable for growing trees; and is owned by any nonindustrial private individual, group, association, corporation, Indian tribe, or other private legal entity that has definitive decision-making authority over the land."

of scale. Within the site preparation treatments, chemical treatments for controlling competing vegetation are estimated to be more economical than mechanical or hand treatments. Prescribed burning reimbursement rates suggest that such treatments can be economical compared to other methods. In many cases, CAL FIRE permits are required for prescribed fires on private lands, and the agency often will provide some of the necessary fire protection resources.

Table 2.2 summarizes the generalized cost reimbursement range for different practices from the cost-share programs of EQIP and CAL FIRE's California Forest Improvement Program in 2019. For full lists of available treatments and reimbursement rates, visit their respective websites.

Getting additional help

Some owners of smaller parcels may find applying for cost-sharing funds too time-consuming or intimidating

TABLE 2.2. Generalized cost ranges for reforestation cost-share programs in California, 2019

Program	Practice	NRCS EQIP (\$/acre)		CAL FIRE CFIP (\$/acre)	
		Low	High	Low	High
EQIP 490	Tree/shrub site preparation	100	1,000	350	800
EQIP 612	Tree/shrub establishment Without browse protection	300	500	225	550
	With browse protection	500	800	575	900
EQIP 314	Brush management	N/A	N/A	350	800
	Mechanical	200	400	N/A	N/A
	Hand	30	500	N/A	N/A
	Chemical	30	100	N/A	N/A
EQIP 315	Herbaceous weed management	N/A	N/A	250	750
	Mechanical	70	1,000	N/A	N/A
	Hand	200	300	N/A	N/A
	Chemical	30	200	N/A	N/A
EQIP 338	Prescribed burning	10	130	N/A	N/A
CFIP	Precommercial thinning	N/A	N/A	350	700
CFIP	Pruning	N/A	N/A	350	450
CFIP	Mechanical release	N/A	N/A	350	800
CFIP	Other release treatment	N/A	N/A	250	700
CFIP	Follow-up	N/A	N/A	400	1,000

Sources: CAL FIRE California Forest Improvement Program (CFIP) (<https://www.nrcs.usda.gov/programs-initiatives/eqip-environmental-quality-incentives>) and Natural Resources Conservation Service (NCRS) Environmental Quality Incentives Program (EQIP) (<https://www.fire.ca.gov/what-we-do/grants/california-forest-improvement>), accessed 2019.

to undertake by themselves, especially following the trauma of a catastrophic event. Local organizations such as resource conservation districts can create cooperative programs offering reforestation assistance to all small landowners, to reduce financial and technical barriers and allow for more acres to be reforested. After the 2014 King wildfire in the central Sierra, for example, owners of nonindustrial forestland whose properties were burned participated in an innovative program offered by their local resource conservation districts, which contracted with a Registered Professional Forester and crews to carry out the reforestation project.

Estimating potential revenues

A business challenge of reforestation is that potential revenues will not come for decades, and future prices are difficult to predict for both traditional products such as sawlogs and potential new products and services. While timber revenues from mature trees are usually the main source of value, hunting or other recreation-oriented leases may also become more valuable with increasing forest cover and generate future cash flows. In addition, new services such as conservation

easements, habitat mitigation credits, and forest carbon offset credits may also develop into financial value.

Since the potential revenue from these innovative services is somewhat speculative and may involve considerable transaction costs, a conservative estimation method is to initially focus on potential timber revenues and assume that future prices and revenues will be similar to current or recent prices. Potential timber revenues can be estimated from a combination of forest models of biological growth and available information on historic and current price trends. Once a baseline analysis is completed, it is easier to assess scenarios with different prices and products.

Reforestation investments based primarily on future timber revenues benefit from a good understanding of how to estimate future net revenues from timber harvests for the landowner. Net timber revenues will vary significantly by region, tree species, average tree sizes, and harvest method. The California Department of Tax and Fee Administration—which took over some timber tax activities that historically were undertaken by the California Board of Equalization—publishes the green-timber and salvage-timber harvest values based on a sample of timber sales and form the basis

for taxes on all harvests (table 2.3). In California, the stumpage value is calculated as the final product value minus harvest, transportation, and processing costs.

2019 stumpage values

As shown in table 2.3, the California Department of Tax and Fee Administration’s green timber stumpage value chart for July to December 2019, larger logs and sales that contain more logs get a slight premium in California. The stumpage value is also reduced for more expensive logging systems, smaller total sales volumes, and lower volumes per acre. In general, regions with many competing sawmills have higher prices than regions with fewer mills. In the event of a future major mortality event such as a wildfire, the salvage value of ponderosa pine logs, for example, is estimated to decrease by more than half, with lesser reductions for other species. The decrease in value of logs salvaged after fires or major mortality from insects is due to both decreased log quality as well as the temporal oversupply of logs compared to the local mill’s processing capacity.

Price trends for green tree stumpage values in California, 1977–2019

The most recent prices (by species and by log size) when reforestation projects are planned and implemented are not necessarily the most accurate prediction of future harvest values; as a result, reforestation project planners must make their own estimates of future harvest values for seedlings that will not be harvested for decades. Figure 2.1 shows trends in stumpage values by species in the Shasta County region of California (with redwood prices from Humboldt County) from 1977 to 2019. It is important to note that prices for fire-damaged trees are lower and calculated separately by the California Department of Tax and Fee Administration.

The most noticeable pattern over time is the high variability of prices from year to year as well as between species. Prices climbed rapidly after the 1983 recession and continued to increase until the large reduction in home building following the 2008 recession. Since then, prices have stabilized when compared to previous decades but remain volatile. Douglas-fir, pine, and true fir are the three largest species by

TABLE 2.3. California Department of Tax and Fee Administration green timber harvest values, July–December 2019 schedule

Species	Species code	Volume per log	Timber value area ¹									
			Size code*	1	2	3	4	5	6	7	8	9
Ponderosa pine	PPG	Over 300	1	160	160	60	140	250	220	240	190	140
		150–300	2	120	150	50	120	230	200	200	170	120
		Under 150	3	80	90	30	100	210	180	190	160	110
Hemlock/fir ⁴	FG	N/A ⁵	N/A	120	60	N/A	150	240	180	210	140	100
Douglas-fir	DFG	Over 300	1	260	240	60	280	390	220	350	320	N/A
		150–300	2	250	210	50	270	380	210	330	300	N/A
		Under 150	3	240	200	30	260	370	200	310	290	N/A
Incense cedar	ICG	N/A	N/A	100	130	N/A	260	350	320	370	330	160
Redwood	RG	Over 300	1	950	1000	960	N/A	N/A	N/A	N/A	N/A	N/A
		150–300	2	930	880	820	N/A	N/A	N/A	N/A	N/A	N/A
		Under 150	3	830	830	780	N/A	N/A	N/A	N/A	N/A	N/A
Port Orford cedar	PCG	Over 125	1	300	N/A	N/A	300	N/A	N/A	N/A	N/A	N/A
		125 and under	2	200	N/A	N/A	200	N/A	N/A	N/A	N/A	N/A

Source: California Department of Tax and Fee Administration, 2019.

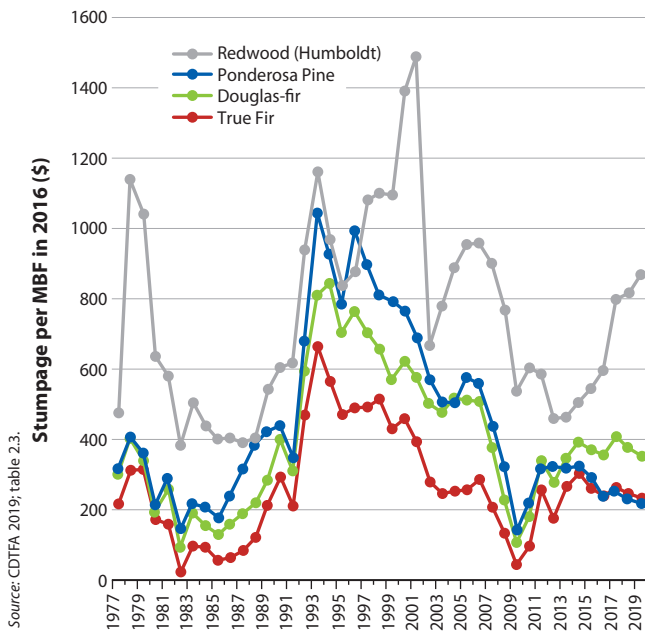
Notes: Table shows harvest values for timber by species, size, and timber value area. The taxpayer makes the adjustments for the timber value area, logging system, small total volume on the harvest operation, and low volume per acre on the harvest operation. More descriptions and clarifications are available on the CDTFA website.

*Size codes capture price premiums for larger logs (board feet per log); a size code 2 log containing 200 board feet per log means that five logs make up 1,000 board feet.

¹Timber harvest values are in dollars per 1,000 board feet Scribner, the standard unit of harvest measurement in California.

⁴Hemlock/fir species group includes white fir, red fir, grand fir, and hemlock, and it has no price differentiation based on volume per log.

⁵N/A means that little or none of the species is purchased and milled in that region.



Source: CDTFA 2019; table 2.3.

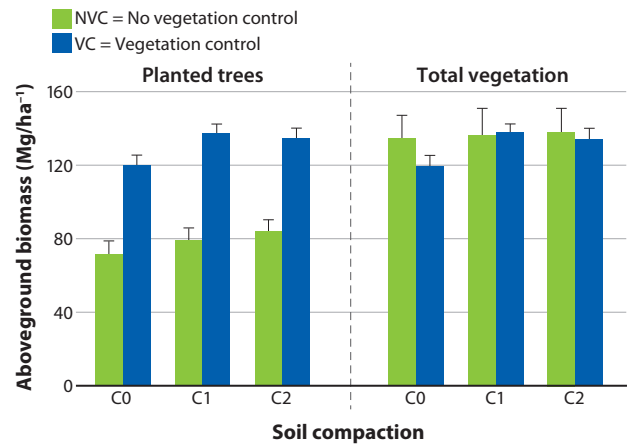
Figure 2.1. Inflation-adjusted stumpage price trends for major species in Shasta County, California.

volume harvested. The most significant trends over the past few decades include a decline in the historically large price premium for pine and the relative increase in value of true fir. Since most trees planted now will not be harvested for 40 years or more, it is difficult to predict future prices accurately. A reasonable economic strategy, beyond planting the highly valuable redwood in its natural region, is to diversify by planting a wide variety of species in forest types that historically had those species, so that the drop in price for one species does not create a total loss of future income for the landowner.

Basic economic analysis tools for reforestation

The physiological rationale for investing more expertise and money in reforestation is that well-spaced, planted trees allow for more valuable tree vegetation to grow on the site, as opposed to a mix of smaller trees, shrubs, and grasses. In the Mediterranean climate common in California's interior forests, small conifer seedlings have a well-documented growth disadvantage compared with shrubs for their first decades, unless competing vegetation is actively and successfully controlled (McDonald and Fiddler 2010).

This pattern was also well-documented across 12 Long Term Soil Productivity network sites in California, as summarized in figure 2.2 (Zhang et al. 2017). After 20 years, the no vegetation control and full vegetation control treatments had essentially identical amounts of biomass in total vegetation, but the



Source: Recalculated from Zhang et al. (2017), fig. 2.

Figure 2.2. Planted conifer tree biomass and total vegetation biomass (Mg/ha) from 20-year-old Long-Term Soil Productivity plots in Northern California. Early control of competing shrubs shifted nearly all biomass to a similar number of larger trees.

full vegetation control treatment reallocated over 50 percent more biomass into the planted conifer trees.

The economics of conifer reforestation projects also must be compared to other long-term investments that private parties or government entities could make. Private and public benefits from a healthy forest stand increase with improved stumpage value of its sawlogs, better recreational opportunities and amenities, and improved grazing opportunities if the understory is grass rather than shrubs. In addition to organizing the different reforestation steps that occur in different years and the timing of various benefits, basic economic analysis tools are often required by private and public funding entities. Forestland investment costs include annual management costs, specialized professional assistance, taxes, and fees, as well as the opportunity cost of capital or the direct costs of loans.

In California, a successful reforestation project typically will not produce significant net revenue for at least 30 to 40 years, and the full value of the trees will not be realized for 50 to 100 years. Over that period of time, owners must also consider the usually uninsurable risk of loss from severe wildfires or large pest outbreaks, major regulatory changes, unpredictable future market prices and conditions, and the actual rate of growth of newly planted forests. For our economic analysis of reforestation, we use a simplified example where increased investment in vegetation control leads to an estimated increase of 50 percent in eventual commercial harvest volume and a premium based on larger average log sizes.

A key for conducting an economic analysis of a major reforestation project is properly accounting for the time value of money. Different alternative investments such as stocks, bonds, or fully liquid cash accounts have different effective interest rates, which

are higher for investments with greater variability and risks of very high or very low returns. It is also important to know if inflation rates are included in prices when considering long-term investments. Economists refer to prices that are corrected for inflation over years as real prices (often quoted as dollars in a specific year, such as 2016 dollars) and nominal prices as values that may include different levels of inflation. It is also important to consider the potential loss of value if a historically forested site is permanently converted to a less valuable shrub-dominated site.

When conducting an economic analysis over a long time period, it is important to bring all the costs and returns to the same point in time (such as in 2016 dollars, which are used in the following examples), so that they can be accurately compared. If an alternative investment to a reforestation project is estimated to deliver a 5 percent real rate of return, that means that \$1.00 today will be worth \$1.05 next year and \$1.00 next year is only worth \$0.95 today. Over time, the effect of an annual interest rate compounds or discounts according to the formulas:

$$\text{future value} = \text{present value} \times (1 + i)^t$$

or

$$\text{present value} = \text{future value} / (1 + i)^t$$

For example, if you invest \$400 in thinning costs today, that thinning would need to increase the future value of the forest stand to \$1,355 in 25 years (t), to achieve a 5 percent rate of return (i; 0.05) over the period. When returns are reinvested, the benefits compound so that the relative advantage of higher rates of return is not linear.

Or, if you expect a precommercial thinning of a reforested stand to increase the diameter at breast height from 16 to 22 inches over the next 35 years (t), you can calculate how much you could invest now that would equal the increased revenue garnered from harvesting the larger trees in 35 years. Assuming that the stumpage value of the larger trees would increase from

\$300 to \$400 per thousand board feet in real terms, the additional harvest volume would be 10 MBF (thousand board feet) per acre. If your benchmark real interest rate is 5 percent per year (i; .05), the break-even amount you can invest today would be \$181 ($\$1,000 / (1 + .05)^{35} = \181) to justify the investment.

FORECON financial analysis tool for forestry investments

The FORECON spreadsheet tool can be downloaded from UC Agriculture and Natural Resource’s Forest Research and Outreach website. This simple tool allows users to conduct a basic financial analysis of any reforestation project or forest investment. While the model does not include detailed annual estimates of cash flow or tax implications, it allows the user to quickly assess the overall impact of different activities, such as the cost and revenue assumptions related to user-defined projections of future growth rates of the planted trees. More-sophisticated spreadsheet tools are available and may be necessary to secure external financing, but the FORECON model is presented here to illustrate the basic concepts with realistic scenarios (table 2.4).

Our baseline example is a single acre of a post-harvest reforestation under California’s 2019 Forest Practice Rules requirement of planting 200 trees per acre on high site land. We modeled effective vegetation control of competing grasses, forbs, and shrubs to mirror the approximately 50 percent increase in planted tree growth documented in the 20-year data from Zhang et al. (2017). We used recent EQIP and CAL FIRE CFIP reimbursement costs as well as current stumpage prices for small and large logs for revenues. The operation is planned out in year 1, before site preparation is done to control competing vegetation. Planting is done in year 2 with additional weed control conducted in years 4 and 5 to ensure the successful release of seedlings. Finally, a precommercial thinning is conducted 6 years after planting to select the desired number and spacing of trees species that will be

TABLE 2.4. FORECON model for financial analysis of forestry investments (baseline estimates)

Treatment	1st-decade costs	Harvest volume *	\$ Present net worth
1. Ineffective weed control	\$1,069	\$29	\$242
2. Effective weed control (Baseline)	\$1,069	\$41	\$1,288
3a + \$100 additional brush control**	\$1,169	\$41	\$1,095
3b + \$100 additional brush control**(with 75% cost -share)	\$1,169	\$41	\$1,235
4a + \$200 additional brush control**	\$1,269	\$41	\$902
4b + \$200 additional brush control**(with 75% cost -share)	\$1,269	\$41	\$1,183

* Estimate intermediate and final harvest volume
 ** If needed to achieve effective vegetation control

harvested in future commercial thin and final harvest activities.

Comparing baseline and alternative scenarios

In the baseline scenario we assumed that the site preparation step was effective, only one postplanting weed control was required, and the later precommercial thinning achieved the desired stand of trees that followed the average growth rate expected by forest growth models. Since we cannot accurately predict timber prices in future decades, the purpose of considering a range of alternative scenarios is to provide guidance on the relative value of immediate investments. In table 2.4, we summarize six scenarios to illustrate the potential benefits of different approaches to controlling competing vegetation:

1. Suboptimal scenario with ineffective weed control and no additional brush control, akin to the no-vegetation-control variants in Zhang et al. (2017)
2. Baseline scenario with similar expenditures but where site preparation was sufficient to control herbs, grasses, and shrubs
3. Two scenarios where an additional \$100 per acre is needed for brush control to allow the planted trees to grow to their potential, with and without 75 percent cost-share payments from EQIP or the California Forest Investment Program
4. Two scenarios where an additional \$200 per acre is needed for brush control to allow the planted trees to grow to their potential, with and without 75 percent cost-share payments from EQIP or the California Forest Investment Program

For this example, we assume that effective control of competing vegetation represents the capture of 100 percent of the potential benefits measured in Zhang et al. (2017). Scenarios 3 and 4 illustrate the impact of additional expenditures if even more shrub control is needed on some sites.

The model also makes it simple to evaluate other scenarios such as increased costs to control competing brush, both with and without 75 percent cost-share payments. Without cost-share payments, the additional costs significantly reduce the present net worth of the project since the costs are immediate, but the revenues only occur many decades in the future. If the project proponents apply for and receive 75 percent cost-sharing only for the additional brush removal activities, the long-term value of the reforestation is protected. In addition to assessing the impact of early reforestation costs and the potential role of cost-share payments, the FORECON model can also assess the potential impacts of higher- or lower-than-expected revenues in the future. The change in revenues could be due to

differences in growth rates or future prices. If future revenues are only 75 percent of what current growth models and prices suggest, the financial viability of a project based solely on costs and projected timber revenues would be substantially diminished.

In all scenarios, the landowner invests over \$1,000 per acre in the first decade, even though they would not realize significant revenue for 40 years. If competing vegetation is not successfully controlled, the estimated present net worth for the total project from site preparation to harvest is \$242 per acre (scenario 1). If effective control of competing vegetation can be accomplished with standard site preparation treatments without additional expenditures on brush control, the present net worth increases to \$1,288 per acre. If additional brush control is required to achieve the growth potential documented in Zhang et al. (2017), costs in the first decade increase and present net worth decreases (scenarios 3a and 4a). When additional treatments are necessary to achieve potential forest growth, 75 percent cost-share payments effectively assist landowners in making the significant up-front investments necessary to generate long-term public and private benefits (scenarios 3b and 4b).

This economic analysis illustrates the importance of controlling initial costs and ensuring projected growth rates for a reforestation project to achieve a net positive value. The analysis highlights the financial challenges created by the multidecade gap between initial costs and delayed revenues. Site-preparation and competing vegetation control costs will reduce the present net worth of reforestation to landowners but will still be economically preferable to the much-lower expected growth rates with competing vegetation. If lower-than-predicted harvest volumes or prices substantially reduce future revenues, they can reduce a reforestation project to a break-even or money-losing situation. Without cost-sharing, it is possible that the public benefits accruing from successful reforestation efforts may not materialize, such as if the landowners underinvest in controlling competing vegetation.

A key value of using an economic model is not only to develop an accurate estimate of the financial value of a hypothetical investment, but also to have a decision support tool to better understand the influence of different reforestation activities. The long-term price trends in California, with two crashes and three booms since 1977, make it very difficult to estimate future revenues accurately. What is clear is that cost-effective investments to improve growth and reduce mortality risks from fires, pests, and disease can deliver financial benefits. Not making the correct timely investments can result in forest stands with much of the potential growth going into shrubs and trees that have little or

no commercial value. Investing in effective vegetation control is the key component of successful reforestation in California. In many cases, effective site preparation before the harvest and basic vegetation control during planting will be sufficient. In other cases, such as the scenarios presented here, additional timely investments in brush control may be necessary to fully achieve the potential conifer growth of a site.

Conclusion

While the immediate costs per acre for any reforestation project are substantial, many public and private benefits accrue from successful reforestation projects. Documenting the necessary actions, their costs, and the eventual impact on future forest growth and revenues is critical for convincing landowners and other potential cost-share partners to invest in reforestation. The FORECON economic analysis tool illustrates one way to assess the implications of various initial site-preparation costs, cost-share payments, and assumptions about how future revenues influence the overall economics of a reforestation project. A clear and simple economic analysis can assist forest landowners and managers who have different constraints and goals in planning and executing a successful reforestation project.

References

- California Department of Forestry and Fire Protection. 2019. California Forest Improvement Program. <https://www.fire.ca.gov/what-we-do/grants/california-forest-improvement>
- California Department of Tax and Fee Administration (CDTFA). 2019. Tax guide for timber yield tax. Timber Advisory Committee. <https://www.cdtfa.ca.gov/taxes-and-fees/timber-yield-tax/>
- 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. *California Agriculture* 65:184–191.
- Greene, J. L., W. C. Siegel, W. L. Hoover, and M. Koontz. 2012. Forest landowners' guide to the federal income tax. Washington, DC: USDA Forest Service. Agricultural Handbook No. 731.
- McDonald, P. M., and G. O. Fiddler. 2010. Twenty-five years of managing vegetation in conifer plantations in northern and central California: Results, application, principles, and challenges. Albany, CA: USDA Forest Service, Pacific Southwest Research Station. General Technical Report PSW-GTR-23.
- National Timber Tax website. 2019. Tax management for timberland owners. www.timbertax.org
- Stewart, W., S. Ferranto, G. Nakamura, C. Getz, L. Huntsinger, and M. Kelly. 2012. Subdivide or silviculture: Choices facing family forest owners in the redwood region. In: Standiford, R. B., T. J. Weller, D. Douglas, and J. D. Stuart, eds. 2012. Proceedings of coast redwood forests in a changing California: A symposium for scientists and managers. Albany, CA: USDA Forest Service, Pacific Southwest Research Station. General Technical Report PSW-GTR-238.
- Waks, L., S. D. Kocher, and L. Huntsinger. 2019. Landowner perspectives on reforestation following a high-severity wildfire in California. *Journal of Forestry* 117(1):30–37. <https://doi.org/10.1093/jofore/fvy071>
- Wang, L. 2019. Tax tips for forest landowners for the 2018 tax year. U.S. Forest Service Southern Region.
- Zhang, J., M. D. Busse, D. H. Young, G. O. Fiddler, J. W. Sherlock, and J. D. TenPas 2017. Aboveground biomass responses to organic matter removal, soil compaction, and competing vegetation control on 20-year mixed conifer plantations in California. *Forest Ecology and Management* 401:341–353. <https://doi.org/10.1016/j.foreco.2017.07.023>

Web addresses

AB 32, the California Global Warming Solutions Act of 2006 <https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006>

CAL FIRE California Forest Improvement Program www.fire.ca.gov/what-we-do/grants/california-forest-improvement

California Air Resources Board California Climate Investments Quantification methodology <https://ww2.arb.ca.gov/resources/documents/california-climate-investments-quantification-benefits-and-reporting-materials>

California Climate Investments caclimateinvestments.ca.gov

Natural Resources Conservation Service Conservation Technical Assistance program nrcs.usda.gov/wps/portal/nrcs/main/national/programs/technical

Natural Resources Conservation Service Environmental Quality Incentives Program (EQIP) nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip

UC Agriculture and Natural Resources Forest Research and Outreach ucanr.edu/sites/forestry