Chapter 2:
Investing in Reforestation

William Stewart, University of California, Berkeley

Richard Standiford, University of California, Berkeley

Susie Kocher, University of California Agriculture and Natural Resources

Jeff Webster, Jefferson Resources Company, Redding, CA

Table of Contents

Why Invest in Reforestation?

Decades of experience have proved that successful reforestation can not be done inexpensively but it can be done cost-effectively. California has significant challenges to successful reforestation 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 the revenues and other future benefits rarely occur in the first one or two decades when the investments must be made. Experience has generally shown that the full costs of not completing reforestation may be greater than the costs of not undertaking the necessary reforestation steps. In addition to the benefits of a sustainable stream of renewable wood products, young forests also provide important early seral stage wildlife habitats, vegetative biodiversity, greater carbon sequestration rates and numerous aesthetic benefits that exceed those of most brushfields or fields of invasive or exotic plants.

The focus of this chapter is on the investment decision and actions that landowners of all types will need to consider as they embark on any reforestation project. While the financial returns from any individual reforestation projects will be decades out, ensuring that forests maintain their productivity is essential to the long term viability of sustainable forestry enterprises. The numerous public benefits that come from successful reforestation investments are key justifications for federal and state governments to provide technical and material assistance, federal and state cost-share programs, and favorable tax considerations for reforestation expenses. Greater public support for reforestation on both private and public forest lands can substantially improve the overall rate of successful reforestation in California by reducing the immediate financial hurdles that can impede action. The chapter will go over 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 will be critical to get the relevant decision makers to support investing in reforestation. The key steps include estimating costs of different packages of actions and the management and planning required, estimating potential revenues and non-economic benefits, conducting a systematic economic analysis that integrates the costs and benefits that occur across decades, and finally developing an operational plan.

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 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 cover or vegetation cover, what treatments are chosen, how challenging the site is, and what logistical efficiencies can be achieved. Larger organizations will typically have experiences and costs for similar recent projects that

they have recently completed. Forestry consultants and landowners with more limited recent reforestation experience should consult with local experts and review the reimbursable cost rates assembled by the USDA Natural Resource Conservation Service (NRCS) and Calfire's CFIP for their cost-share programs to develop their initial estimates of their potential project costs. After developing a reasonable estimate of the projected reforestation costs for a project, the next step is to assess the potential financing options. Finally, landowners should also consider when future revenues will eventually be produced from the reforested sites.

Assessing financing options

How reforestation projects are going to be financed varies considerably across owners. Large forest landowners and owners of investment properties 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. Each individual project need not undergo a detailed economic analysis if the owners are invested in long term character of their forest enterprise and have confidence that their standard procedures have been proven to be cost-effective. Although it is rarely possible to borrow against future revenues to finance immediate restoration expenses, it is worthwhile to consider the potential future revenues related to healthy and growing stands that could come from new products and 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 rather than 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 can reduce the overall 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 there are also a number of federal and state cost-share programs that are available mainly for small landowners. Finally, accessing publicly maintained resource such as seed banks or University based technical assistance that often provide services to landowners at less than full cost can also be used to create a more favorable financing package for private landowners.

Unexpected mortality event and reforestation needs after severe wildfires can place severe financial constraints on landowners. Landowners may have also experienced significant financial losses to their residences and other assets within the fire. Small diameter trees burned in a wildfire have little value and it is often very difficult for smaller landowners to contract with loggers for salvage harvesting. After large

wildfires, it is common for the limited number of loggers in a region to be contracted by the larger private forest owners. Delays in initiating reforestation projects or choosing more expensive reforestation practices can severely limit the number of successfully reforested acres that landowners with limited budget can undertake. Because smaller properties often lack the ability and economies of scale necessary to capture the financial value in fire damaged stands, they often rely on governmental technical assistance and cost share programs to assist with successful reforestation projects.

The USDA Forest Service explicitly defines a broad range of non-economic goals for reforestation on National Forest lands. Federal Environmental Quality Improvement Program (EQIP) cost-share payments also consider the non-economic benefits of successful reforestation. Understanding and properly accounting for these non-economic benefits will be important in getting federal funding for reforestation efforts. After applying consistent values to desired non-economic and economic outcomes, the use of standardized economic analysis tools can help identify the projects that will deliver the best outcomes given budget constraints.

On National Forest lands, the Forest Service was historically able to finance much of their reforestation by reinvesting a portion of the timber revenues into regenerating the forest. Current federal funds for USFS reforestation projects now come mainly from the Vegetation and Watershed management program and the Reforestation Trust Fund (USDA 2018). The large increases in wildfire damage on Forest Service lands in California has not been matched by an increase in successfully reforested areas and is leading to a growing backlog of area in need of reforestation.

Tax treatment of private reforestation investments – deduction, amortization, and cost-share payments

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, etc.), and any changes in federal and state tax law. As of 2016, small landowners could deduct up to $10,000 per year for reforestation costs while larger expenditures would have to be 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 their local Natural Resources Conservation Service (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).

Post wildfire loss responses of small landowners

One of the fastest growing needs for reforestation in California is after California's increasingly common severe wildfires. These fires often destroy the majority of the timber value as well as damage public benefits such as diverse wildlife habitats, erosion protection, and carbon sequestration by these forests. There are numerous public and private benefits that can come from successful reforestation projects in addition to the financial benefits of reforestation. Owners of smaller forested properties often place less emphasis on future financial returns of forestry compared to other benefits from their forest (Ferranto et al. 2011). Management activities that improve wildlife habitat and forest health are the most common activities across family ownerships of all sizes (Stewart et al. 2012) and should be considered as important benefits when planning reforestation projects.

The complexity and high costs for many small landowners can limit the level of forest restoration after wildfires if they can not 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 that "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." (Waks et al. 2019). Economic analyses for 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 of sites that otherwise would often revert to brushfields 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 USDA Natural Resources Conservation Service (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. It can be challenging to keep up with the latest requirements or understand the application processes, 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 wise to check with the agencies on the current guidelines and funding.

Landowners, and professionals working with them, should check the most recent program details on the CAL FIRE and NRCS websites and with agency staff to help ensure a reforestation project's funding needs can be supported as well as well timed. 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 wildfires and severe insect mortality. The federal Farm Service Agency's Emergency Forest Restoration Program (FSA EFRP) is another program that uses EQIP 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 the most recent reimbursement schedules. As a matter of standard practice, the federal or state programs do not offer payment in advance but EQIP has provisions for contract waivers that need to be approved in advance on a project by project basis. Calfire's CFIP program also has the potential for loans that can be made to clients implementing projects. Matching a landowner's objectives and needs to the appropriate cost-share program is an important consideration in selecting which program to pursue. Forest management plans are also required for each of the cost-share programs.

California Forest Improvement Program (CFIP):

This long-standing state grant effort has a stated purpose "to encourage private and public investment in, and improved management of, California forest lands and resources." Cost-share assistance of up to 75% of project costs is usually available to private and public ownerships containing 20 to 5,000 acres of forest land. A 90% rate currently applies to lands substantially damaged by fire, insects and disease, for all Cooperative Forest Management Plans, and for lands with less than 500 acres of forestland. Consultation with and project supervision by a Registered Professional Forester (RPF) is required with some of the costs covered by the grant.

Funded activities include management planning, site preparation (e.g., 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 (THP) is not allowed. The CFIP website lists the 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 (TRFRF) and California Climate Investments (CCI), but future funding levels are uncertain.

CAL FIRE's Forest Health Grant Program

Beginning in 2018, Calfire's new program awards Greenhouse Gas Reduction (GHG) Funds allocated by the legislature for California Climate Investments (CCI) to implement larger-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 California Global Warming Solutions Act of 2006 (Assembly Bill 32, Health and Safety Code Section 38500 et seq.) (AB 32).

In 2018 California committed to spending $1 billion over five years from the Greenhouse Gas Reduction Fund for forest health, fire prevention, and fuel reduction activities. Reforestation projects are one of the types of projects that can be funded and one where the benefits 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 composed of one or more landowners, which may cover multiple jurisdictions. Large landscapes usually mean sub-watersheds, firesheds, or larger logical management units. (Includes projects of 10,000 acres or more.)
- Generate a net increase of on-site carbon storage over no project 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.

NRCS's Environmental Quality Incentives Program **(EQIP)**

The EQIP program is designed to support various reforestation activities through several funding "pools", such as Catastrophic Fire Recovery, Tree Mortality, or Forest Health pools. Funding can be provided for many reforestation practices, including site preparation, seedling planting, and post-planting weed control (Natural Resources Conservation Service 2020). EQIP payments made to clients are fixed rates, meaning regardless of actual cost paid by a client to a contractor to complete work, the payment made by EQIP is fixed. NRCS pays a fixed rate to clients completing reforestation practices, usually intended to provide approximately 50-75% percent of the actual costs. Payment rates to clients can be higher for post-wildfire

efforts. A forest management plan is required and can be partially financed as part of NRCS's Conservation Plan assistance.

The stated goals of the EQIP funds include wildfire reduction, forest health improvement, erosion control and water quality protection on working lands. The funding priorities are determined by the Farm Bill that was most recently reauthorized by Congress in 2018. It currently includes reforestation and fuel reduction. There is no parcel size limitation in EQIP. NRCS also delivers conservation technical assistance through its voluntary Conservation Technical Assistance Program (CTA) and has foresters on staff in some county offices as well as in the state office. The CTA, or your RPF, can assist with the EQIP application.

Generalized 2019 Reforestation Costs for Federal and State Cost Share Programs

The following table provides a summary of the generalized cost reimbursement range for different practices from the most recent cost-share programs of NRCS and Calfire's CFIP. The more extensive full list of treatments and reimbursement rates are available at the respective websites.

Table 2.1 Generalized Cost Range for Reforestation Costs for Cost-Share Programs in California

		NRCS	NRCS	CALFIRE	CALFIRE
NRCS EQIP # or CFIP	**Practice**	**Low $/acre**	**High $/acre**	**Low $/acre**	**High $/acre**
490	Tree/shrub site prep	100	1000	350	800
612	Tree/shrub establishment				
612	without browse protection	300	500	225	550
612	with browse protection	500	800	575	900
314	Brush Management			350	800
314	mechanical	200	400		
314	hand	30	500		
314	chemical	30	100		
315	Herbaceous Weed Management			250	750
315	mechanical	70	1000		
315	hand	200	300		
315	chemical	30	200		
338	Prescribed Burning	10	130		
CFIP	Pre-commercial thinning			350	700
CFIP	Pruning			350	450
CFIP	Mechanical Release			350	800
CFIP	Other Release Treatment			250	700
CFIP	Follow-up			400	1000

Source: (California Department of Forestry and Fire Protection 2019, Natural Resources Conservation Service 2019).

Some of the key points from the comparison of federal and state cost estimates are the different ways that the federal and state programs 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 compared to post planting mechanical release and other release treatments. The forester or landowner submits their cost estimates but maximum reimbursement rates are fixed by federal and state regulations. Landowners will have to finance the difference between the actual costs and allowable reimbursements. In general, smaller projects will often have costs per acre due to the lack of economies of scale. Within the site prep 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, Calfire permits are

required for prescribed fires on private lands and they often will provide some of the necessary fire protection resources.

Comparison of Two Programs

The following table summarizes the major differences between two popular state and federal cost-share programs for individual landowners: CFIP and EQIP.

Table 2.2 Comparison of CAL FIRE's CFIP and NRCS's EQIP Programs

Criteria	CAL FIRE'S California Forest Improvement Program (CFIP)	NRCS's Environmental Quality Incentive Program (EQIP)
Ownership Size	20 acres. 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 non-industrial forest land.*
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 practice lifespan (variable).
Covered activities	Preparation of management plans, RPF supervision, site preparation, planting, pre-commercial thinning, pruning, release treatments, slash disposal.	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 (FMP) for smaller size projects
THP Work	Will not cover THP stocking requirements.	Does not pay for work to be planned or implemented in a THP.
Pre-Qualify	Pre-review with Cal Fire Forester.	All projects are based on submitting applications.
Management Plan Requirements	A plan is required, Cal Fire will fund. The plan must be done before doing any work.	Forest Management Plan is required for all forestry projects. Funding may cover plan cost if requested and receives priority for funding in some cases.
Supervision	RPF supervision required & funded.	No requirement for supervision, but clients are recommended to hire RPF for supervision of field work, use a qualified contractor to do the work, and a Pesticide Control Advisor (PCA) report is required for all projects which involve use of herbicides..
Funding Rates	For live tree/green projects 75% of expense to maximum in contract. For substantially damaged lands 90% cost share activities over following 10 years.	Fixed rate paid to clients for completed work, to cover about 50-75% of actual costs. Rate can be higher for post-wildfire efforts.
Available Funds	$3+ million from TRFRF, with considerable additional funding from CCI 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 occurs 3-4 times / 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 & meet requirements and specifications prior to payment.
Adjusted Gross Income (AGI) Cap		AGI > $900,000 is ineligible.

Federal definition of "non-industrial forest land" is "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."

Getting Additional Help

Some owners of smaller parcels may find the cost-share process too time-consuming or intimidating to undertake by themselves, especially following the trauma of a catastrophic event. Having a local organization, such as Resource Conservation District (RCD), create a cooperative program offering reforestation assistance to all small landowners can reduce financial and technical barriers and allow for more overall acres to be reforested. After the 2014 King wildfire in the central Sierra, owners of nonindustrial forest land whose properties were burned participated in an innovative and positive program offered by the local resource conservation districts. The district contracted with a RPF and with crews to carry out the project.

Estimating potential revenues

A business challenge of reforestation is that potential future revenues will not come for decades when the future prices of both traditional products such as sawlogs and potential new products and services are hard to predict. While timber revenues from mature trees will usually be the main source of value, hunting or other recreation-oriented leases can 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 value. Since the potential revenue from this 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 the 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 different scenarios with different price and products.

Reforestation investments based primarily on future timber revenues benefit from a good understanding of how timber prices are calculated and vary by region, species, harvest method, and the overall size of

the harvest. The most comprehensive timber values available to the general public are the harvest values published by the California Department of Tax and Fee Administration (CDTFA) that took over some of the timber tax activities that had historically been undertaken by the California Board of Equalization (BOE). The timber harvest values in California are tied to the stumpage value of the unharvested trees rather than the delivered 'pond values' published for Oregon (Oregon Department of Forestry 2020). In California, the stumpage value is calculated as the final product value minus harvest, transportation, and processing costs. In California, the harvest values that are the basis for timber taxation are published twice a year for nine different regions of the state. The published timber harvest values are in dollars per thousand board feet (Scribner mbf) that is the standard unit of harvest measurement in California. The 'Hem/fir' species group includes white fir, red fir, grand fir and the hemlock and has no price differentiation based on volume per log. The size code captures any price premium for larger logs measured in board feet per log. A size code 2 log containing 200 board feet per log means that five logs are needed to make up one thousand board feet (mbf) that is the basis of the values listed in the tables. Timber value areas where there is a N/A value for a species means that little or none of that species is purchased and milled in that region.

2019 Stumpage Values

TABLE G – GREEN TIMBER HARVEST VALUES - This table shows the harvest values for timber by species, size, and timber value area. The taxpayer makes the adjustments for the logging system, for small total volume on the harvest operation, and low volume per acre on the harvest operation.

GREEN TIMBER

Tractor Logging (Logging Code T)

SPECIES	SPECIES CODE	VOLUME PER LOG	TIMBER VALUE AREA									
			SIZE CODE	1	2	3	4	5	6	7	8	9
		Over 300	1	160	160	60	140	250	220	240	190	140
Ponderosa Pine	PPG	150-300	2	120	150	50	120	230	200	200	170	120
		Under 150	3	80	90	30	100	210	180	190	160	110
Hem/fir	FG	N/A	N/A	120	60	N/A	150	240	180	210	140	100
		Over 300	1	260	240	60	280	390	220	350	320	N/A
Douglas-fir	DFG	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
		Over 300	1	950	1000	960	N/A	N/A	N/A	N/A	N/A	N/A
Redwood	RG	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 & Under	2	200	N/A	N/A	200	N/A	N/A	N/A	N/A	N/A

Figure 2.1 Green Timber Harvest Value Schedule from the CDTFA July-December 2019 Schedule.*Source:* (California Department of Tax and Fee Administration 2019) https://www.cdtfa.ca.gov/taxes-and-fees/timber-tax.htm.

In general, regions with many competing sawmills have higher prices than regions with fewer mills. As shown in figure 2.1 for CDTFA green timber stumpage value chart for the July-December 2019 period, there is also a slight premium for larger logs in California and for sales that contain more logs. The stumpage value is also reduced for more expensive logging systems, smaller total sale volumes, and lower volumes per acre. In the event of a future major mortality event such as a wildfire, the salvage value of Ponderosa Pine logs is estimated to decrease by more than half, with lesser reductions for other species.

Price Trends for Green Tree Stumpage Values in California 1977-2019

Since the mature trees will eventually be valued after many decades, it is worthwhile to consider what recent price trends have been and what this suggests for future prices. Because the most recent prices by species and by log size when the reforestation project is planned and implemented are not necessarily the most accurate prediction of the future harvest values, reforestation project planners must make their own estimates of the future harvest values for seedlings that will not be harvested for decades. Figure 2.2 shows the trends in stumpage values by species in the Shasta County, California region (with the redwood prices from Humboldt County) from 1977 to 2019. It is important to note that the prices for fire-damaged trees are lower and calculated separately by the California Department of Tax and Fee Administration.

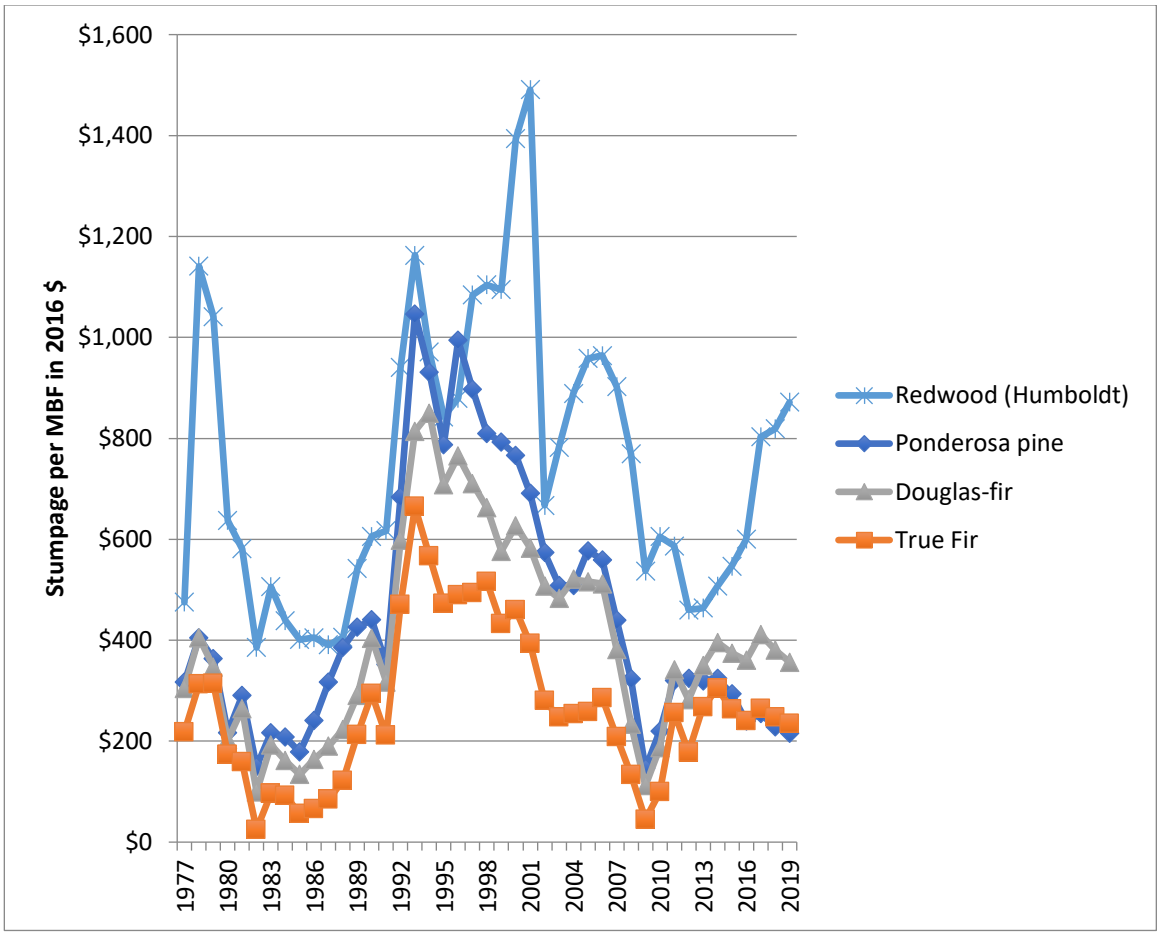

Figure 2.2 Inflation adjusted stumpage price trends for major species in Shasta County, California.*Source:* CDTFA green timber harvest values.

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 in a historical context but remain volatile. Douglas-fir, pines, and true firs are the three most significant species by volume harvested. The most significant trends over the past few decades has been the decline in what had been a significant price premium for pine, and the relative increase in the value of true fir species. Since most of the 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, would be 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 an untenable situation for the landowner.

Basic Economic Analysis Tools for Reforestation

The physiological basis for investing more expertise and money in restoration is the ability to shift more of the total vegetation growth of the site away from shrubs and grasses and towards the well-spaced planted trees. In the Mediterranean climate common in the interior forests in California, small conifer seedlings have a well-documented growth disadvantage compared shrubs for their first decades unless active and successful control of competing vegetation is undertaken (McDonald and Fiddler 2010). This pattern was also well documented across twelve Long-Term Soil Productivity (LTSP) sites in California (Zhang et al. 2017) summarized in figure 2.3. The Y-axis in figure 2.3 below is aboveground biomass in Mg/ha (figures G and H) and trees per hectare (figure I). The X-axis shows the results across three levels of soil compaction (C0, C1, and C2). The light colored bars had no competing vegetation control and the dark colored bars had fully effective vegetation control.

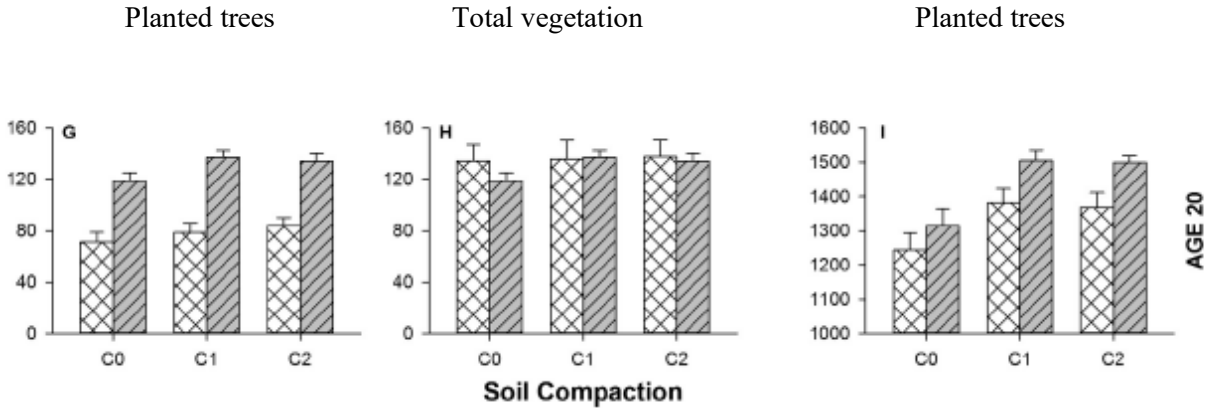

Figure 2.3 Planted tree biomass, total vegetation biomass, and planted trees per hectare for 20 year old LTSP plots in Northern California.*Source:* Zhang et al. 2017, figure 2.

After 20 years, the no vegetation control and full vegetation control treatments had essentially identical amounts of biomass in total vegetation, but the full vegetation control had more than 50% more biomass in the planted conifer trees (Zhang et al. 2017). For our economic analysis of reforestation, we will use a simplified example where increased investment in vegetation control leads to increases of 50% in the eventual commercial harvest volume.

The economics of conifer reforestation projects also needs to compared to other long term investments that private parties or government entities can take. The value growth for both the private benefits and the public benefits of a healthy forest stand will go up based on the stumpage value of the sawlogs, improving recreational and amenity values, and potentially improved grazing opportunities if the understory is grass rather than shrubs. In addition to helping to organize the different steps that need to occur in different

years and the timing of various benefits, basic economic analysis tools are often required by private and public funding entities. Forest land investment costs include annual management costs, specialized professional assistance, taxes, fees, as well as the opportunity cost of capital or the direct costs of loans. In California, a very successful reforestation project typically will not produce any 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, an owner must also consider the usually uninsurable risk of loss from severe wildfires or large insect outbreaks, major regulatory changes, unpredictable future market prices and conditions, and the actual rate of growth of the newly planted forests.

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 very different effective interest rates that are higher for investments that have greater variability and greater risks of very high and very low returns. It is important to also consider 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$) and 'nominal' prices as values that may include different levels of inflation.

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 $ that are used in the following examples), that they can be accurately compared. If an alternative investment to a reforestation project is estimated to deliver a 5% real rate of return, that means that $1 today will be worth $1.05 next year and $1 next year is only worth $0.95 today. Over time, the effect of an annual interest rate compounds or discounts according to the formulas - Future value = Present value * (1+i)^t and Present value = Future value/ (1=i)^t. For example if you invest $400 in thinning costs today, it would need to increase the forest stand value to $1,355 in 25 years if you wanted to equal a 5% rate of return over the period. When returns are reinvested, the benefits compound so that the relative advantage of higher rates of return is not linear.

For example, if you expect that a precommercial thinning of a reforested stand to increase the diameter at breast height (DBH) from 16" to 22" over the next 35 years to garner the higher value that larger trees often receive, you can calculate how much you could invest now that would be equal to the increased revenue in 35 years. Assuming that the stumpage value of the larger trees would increase from $300 to $400 per mbf in real terms, the additional harvest volume would be 10 thousand board feet (mbf)/ acre, and that your benchmark real interest rate is 5% per year, the breakeven amount you can invest today would be $181 ($1000/ (1+.05)^35 = $181) to justify the investment.

The FORECON financial analysis spreadsheet tool for forestry investments

The FORECON spreadsheet tool that can be downloaded from both the UCANR Forest and the UC Berkeley Forests web sites is a simple tool that allows users to conduct a basic financial analysis of any reforestation project or other forest investments. While the model does not include detailed annual cash flow estimates or tax implications, it does allow the user to quickly assess the overall impact of different cost and revenue assumptions. More sophisticated spreadsheet tools are available and may be necessary to secure external financing, but this model is presented to illustrate the basic concepts with realistic scenarios.

The example we use here 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 the increased investment in effective vegetation control to mirror the increased tree growth document in the Zhang et al. (2017) article that is referenced earlier. We used recent NRCS EQIP and Calfire CFIP activity costs as well as current stumpage prices for small log and large logs for revenues. In year 1, the operation is planned out before the actual planting and the site prep is done to control competing vegetation. Planting is done in the following year with an additional weed control conducted two years after the planting to ensure the successful release of the seedlings. Finally, a pre-commercial thin is conducted six years after planting to select the desired number, spacing, and and mix of trees species that will be the eventual crop trees for a first commercial thin operation at year 40. We assume that the first commercial only removes the smallest diameter trees with relatively limited stumpage values. We also project the revenue from a final harvest at year 60. As described earlier, we use a discount rate of 5% to account for the 'time value of money'. This means that revenue in later years is calculated to be worth considerably less than the same sum would be worth now. For this scenario we did not estimate any increases in future real prices so everything is calculated in current dollars.

Table 2.3 FORECON model for financial analysis of forestry investments (baseline estimates)

Discount Factor	0.05				
Inflation Rate	0.02				
Real Price Increase	0				
Real Cost Increase	0				
Period of Investment					
	Cost Summary				
				Inflated Cost	Discounted Cost
Item	Year	Cost			
Site Prep	1	200		-200	-200
Planning and supervision	1	100		-100	-100
Prescribed burn	2				
Plant 200 TPA	2	300		-306	-291
Additional weed control	4	200		-212	-183
Pre commercial thin	7	350		-394	-294
Additional brush removal	1				
	Return Summary				
Future/Base $ Ratio	1.0				
Item	Year	Cut (MBF)	Stumpage Price	Inflated Returns	Discounted Returns
Commercial thin	40	4	50	433	65
Final harvest	60	31	250	29,754	1,673
Other items	Year		Actual Price	Inflated Returns	Discounted Returns
CFIP cost share	2		0	0	0
Other revenue					
Other revenue					
Amount of loan	Year of loan	Period of loan	Interest rate	Annual payment	Discounted net value
Present Net Worth (1 investment period)					668
Present Net Worth (infinite investment periods)					1,288

Source: Berkeley Forests website

Comparing baseline and alternative scenarios

In the baseline example we assumed that the site prep step was effective, only one post planting weed control was required and that the later pre commercial thin achieved the desired stand of trees that followed the average growth rate expected by forest growth models. We estimated fairly low prices for the smaller diameter trees that will be harvested during the first commercial thin and moderate prices for the trees in the final harvest. Since we can not accurately predicted timber prices in future decades, the

purpose of considering a range of alternative scenarios is to provide guidance on the relative value of different immediate investments. We use four scenarios to illustrate the potential benefits of different approaches to controlling competing vegetation.

1. Baseline scenario with ineffective weed control and no additional brush control (akin to the 'no vegetation control' variants in Zhang et al. 2017).
2. Scenario with similar expenditures but where site prep was sufficient to control herbs, grasses and shrubs.
3. Scenarios with an additional $100/acre for additional investment in brush control, with and without 75% cost share payments from EQIP or CFIP.
4. Scenarios with an additional $200/acre for additional investment in brush control, with and without 75% cost share payments from EQIP or CFIP.

For this example we are assuming that the effective control of competing represents the capture of 100% of the potential benefits measured by Zhang et al. 2017. Scenarios 3 and 4 illustrate the impact of additional expenditures for required shrub control that may be needed on some sites.

The model also makes it simple to evaluate other scenarios such as increased costs to control the competing brush, both with and without 75% cost share payments. Without cost share payments, the additional costs will significantly reduce the present net worth of the project since the costs are immediate but the revenues will only occur many decades in the future. If the project proponents apply for and receive 75% cost share 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 would only be 75% of what current growth models and prices would suggest, then the financial viability of the project based solely on costs and projected timber revenues would be substantially diminished.

Table 2.4 Estimated per acre costs, revenues, and present net worth for different reforestation scenarios

Tmt #	Treatment	1st decade costs	Estimated intermediate and final harvest volume (mbf)	Present Net Worth (no cost share)	Present Net Worth (75% cost share)
1	Ineffective weed control	$1,069	29	$242	
2	Effective weed control (baseline)	$1,069	41	$1,288	
3	+ $100 additional brush control (if needed to achieve effective vegetation control)	$1,169	41	$1,095	$1,235
4	+ $200 additional brush control (if needed to achieve effective vegetation control)	$1,269	41	$902	$1,183

In all cases, the landowner had to invest over $1,000 per acre in the first decade even though they would not realize significant revenue for 60 years at the first large commercial thin. The estimated present net worth for the total project from site prep to harvest was $242 per acre for the baseline scenario when the control of competing vegetation was not effective. If effective control of competing vegetation could be accomplished with standard site prep treatments without additional expenditures on brush control, the present net worth increased to $1,288 per acre. If additional brush control was required to achieve the growth potential documented in Zhang et al (2017), first decade costs increased and present net worth decreased. When additional treatments were necessary to achieve potential forest growth, 75% cost share payments were effective in assisting landowners in making the significant up front investments necessary to generate long term public and private benefits.

The economic analysis illustrates that importance of controlling initial costs and ensuring projected growth rates for a well-managed reforestation project to achieve a net positive value. The analysis highlights the financial challenges created by the multi decade gap between initial costs and delayed revenues. Additional costs related to more expensive site preparation activities will reduce the present net worth of reforestation to landowners if cost-share programs are not available. 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 share, it is possible that the public benefits accruing from successful reforestation efforts may not materialize if the landowners underinvest in controlling competing vegetation. The spreadsheet tool can also be used to assess the outcome if future intermediate and final yields are higher or lower than the estimated average value, if future prices are higher or lower, or if costs are different for intermediate treatments.

A value of using an economic model is not to develop an accurate estimate of the financial value of a hypothetical investment, but to have a decision support tool to better understand the influence of different specific activities. The long term price trends in California with two crashes and three booms since 1977 makes 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, insects 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 with 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, there will be many public and private benefits from successful reforestation projects. Documenting the necessary actions, their costs, and the eventual impact on future forest growth and revenues will be critical for convincing the landowners and other potential cost-share partners to invest in reforestation. The simple economics analysis tool illustrates how to assess the implications of various initial site preparation costs, cost-share payments, and assumptions about future revenues can have on the overall economics of a reforestation project. A clear and simple economic analysis can assist different forest land owners 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/grants/california-forest-improvement-program/)

California Department of Tax and Fee Administration. 2019. Tax Guide for Timber Yield Tax. Timber Advisory Committee. (https://www.cdtfa.ca.gov/taxes-and-fees/timber-tax.htm - committee)

Ferranto S, Huntsinger L, Getz C, Nakamura G, Stewart W, Drill S, Valachovic Y, DeLasaux M, Kelly M. 2011. Forest and rangeland owners value land for natural amenities and as financial investment. California Agriculture 65:184-191.

Greene JL, Siegel WC, Hoover WL, Koontz M. 2012. Forest landowners' guide to the Federal income tax. Agricultural Handbook No. 731 in Agriculture USDo, ed. Washington, D. C.

McDonald PM, Fiddler GO. 2010. Twenty-five years of managing vegetation in conifer plantations in northern and central California: results, application, principles, and challenges. PSW-GTR-231.

Pages 87 in PSW-GTR-231 GTR, ed. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.

National Timber Tax Website. 2019. Tax Management for Timberland Owners. (www.timbertax.org)

Natural Resources Conservation Service. 2019. Environmental Quality Incentives Program. (https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/)

---. 2020. Environmental Quality Incentives Program. (https://www.nrcs.usda.gov/wps/portal/nrcs/main/ca/programs/financial/eqip/)

Oregon Department of Forestry. 2020 Timber Sales. (https://www.oregon.gov/ODF/Working/pages/TimberSales.aspx)

Stewart W, Ferranto S, Nakamura G, Getz C, Huntsinger L, Kelly M. 2012. Subdivide or Silviculture: Choices Facing Family Forest Owners in the Redwood Region. Pages 626 in Standiford RBW, Theodore J.; Piirto, Douglas D.; Stuart, John D, ed. Proceedings of coast redwood forests in a changing California: A symposium for scientists and managers. PSW-GTR-238, vol. Gen. Tech. Rep. PSW-GTR-238. . Santa Cruz, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, Albany, CA.

USDA. 2018. Reforestation Overview. (November 16, 2018; https://www.fs.fed.us/restoration/reforestation/overview.shtml)

Waks L, Kocher SD, Huntsinger L. 2019. Landowner perspectives on reforestation following a high-severity wildfire in California. Journal of Forestry

Wang L. 2019. Tax Tips for Forest Landowners for the 2018 Tax Year. US Forest Service Southern Region

Zhang J, Busse MD, Young DH, Fiddler GO, Sherlock JW, TenPas JD. 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.