

Description of NPV discount rates for ACR's IFM methodology version 2.0

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Introduction

This document describes and justifies the discount rate values used in NPV calculations for eligible forestland ownerships within ACR's Methodology for the Quantification, Monitoring, Reporting and Verification of Greenhouse Gas Emissions Reductions and Removals from Improved Forest Management (IFM) in Non-Federal U.S. Forestlands v2.0.

The methodology was originally developed by Finite Carbon with an exclusive focus on private industrial ownerships greater than 1,000 acres in size. While private industrial ownerships are an important part of the forestland base in the U.S., they only represent 20% of the approximately 682 million acres of forestland in the continental US. Family forestland ownerships account for about 40% of the nation's forestland base, while public lands represent approximately 37% of the U.S. forestland base. Subsequent methodology versions have expanded eligibility, and now all non-federal timber rights owners can quantify their forest carbon benefits with the ACR IFM methodology.

Calculating carbon benefits from IFM projects requires long-term forecasting of carbon stock dynamics under with-project and without-project (baseline) scenarios. Private industrial ownerships generally practice intensive management of their wood fiber resources. Other ownership types, such as private non-industrial, tribal, non-governmental organizations (NGOs), and public lands may also maximize timber revenues, but also balance additional land management considerations in considering harvest decisions over time.

To address this variability in management objectives across ownership types, ACR assigns net present value (NPV) discount rates by ownership class. These discount rates are then employed in NPV maximizing forest management models for baseline setting. This approach is supported extensively in the literature as a consistent, transparent, replicable, and verifiable metric upon which management decisions are based across the major forestland ownership groups. Actual landowner discount rate assumptions are typically not publicized in the scientific literature, and companies, individuals, and organizations by and large do not share the values they use. However, discount rates have been estimated by leveraging forest economic theory and examining the age-class distribution of the relevant U.S. timberland ownership classes. This has been bolstered by scientific literature and landowner publications of discount rate assumptions where available.

Discount rates

In the ACR IFM methodology, discount rates are assigned to the following ownership classes: Private Industrial (PI), Private Non-Industrial (PNI), Tribal, Non-Federal Public, and Non-Governmental Organizations (NGOs). The PI consists of forest industry and forest management companies, timber investment management organizations, and other related companies. The PNI category consists of individuals, families, estates, trusts, clubs, associations, and other unincorporated groups. The tribal

ownership class applies to federally recognized tribes¹, while non-federally recognized tribes are considered private ownerships and must be classified under either the PI or PNI ownership classes, depending on ownership characteristics. NGOs are tax exempt non-profit organizations.

This methodology’s discount rate for the NGO ownership class was conservatively adjusted in version 2.0 from 4% to 3%. The basis for this adjustment was a literature review for rates used by this ownership class (Appendix 1) as well as newly available data regarding the age class structure of timberland owned by NGOs, as discussed further below.

In the following sections of this document, we describe the existing baseline determination approach used under an existing ACR IFM methodology. We then briefly discuss the literature related to PNI harvesting patterns, from which we infer the application of lowered discount rates to describe forest management for non-timber values. We follow that with a graphical presentation of the age class structure of PI, PNI, NGO, and non-federal public forest owners from FIA data. Finally, we present a description of the steps used to derive the annual discount rates assigned in the methodology (Table 1).

Table 1. NPV values by ownership class

TIMBER OWNERSHIP CLASS	ANNUAL DISCOUNT RATE
Private Industrial	6%
Private Non-Industrial	5%
Tribal	5%
Non-Federal Public	4%
Non-Governmental Organization	3%

NPV maximization as a framework for baseline determination

The ACR IFM Methodology takes a Faustmann approach to baseline determination using NPV maximization, with future cash flows discounted appropriately for various ownership classes. The literature is strong supporting Faustmann’s original 1849 work, which forms the basis for modern optimal rotation/investment decisions and forest economics. See Newman (2002) for a discussion of the development of the optimal forest rotation literature and references to over 300 works including textbook and peer-reviewed journal articles.

The discount rates assigned in this methodology are presented as informed proxies for how certain forest landownership classes consider forest management decisions. As assumed averages, Table 1’s discount rates are expected to be lower than half their respective landowners’ true discount rate, and higher than the other half’s. The basic Faustmann approach is a stand level investment analysis tool and

¹ <https://www.bia.gov/service/tribal-leaders-directory/federally-recognized-tribes>

does not account for all the complexities of a forest or entity-wide investment optimization. That said, the use of NPV maximization for baseline determination is appropriate in that it gives a common transparent metric by which landowners, project developers, verifiers, and offset purchasers can base their assessment of landowner motivation when considering a carbon project.

Landowner harvest behaviors

The original ACR IFM methodology assumed a 6% discount rate for PI ownerships, which is well supported in the literature (Appendix 1). Relative to the other discount rates in Table 1, this higher discount rate reflects PI's prioritization of profit maximization in forest management decision-making.

Amacher et al. (2003) and Beach et al. (2005) provide literature reviews and a basis of economic analysis of PNI harvesting decisions. These, and their reviewed studies, typically present harvest decision as a function of a range of variables, including timber price, interest rate, reforestation cost, presence of cost-share program, household income, tract size, education, landowner age, and other factors.

To explain the silvicultural planning decisions of PNI landowners within an optimal control framework, researchers began with the most basic Faustmann approach that allocates harvests over time to maximize returns. As this theory did not explain the age class structure difference between PI and PNI lands, the basic model was amended to include an amenity value for standing trees (Hartman 1976). This amenity value has the impact of lengthening rotation ages and more realistically simulating observable behavior. Newman and Wear (1993) further show that PI and PNI timber owners both demonstrate behavior consistent with profit maximization, yet the determinants of profit differ with the PNI owners deriving significant non-market benefits associated with standing timber.

Pattanayak et al. (2002) revisited PNI's joint production of timber and non-timber values and better described their objective as utility maximization in the absence of market derived prices for the amenity values associated with standing timber. The fundamental problem associated with the inclusion of amenities in the forest decision-making framework is that there are no such values established in the marketplace. Additionally, the actual amenity varies by individual owner, from habitat to recreation to hunting and more.

Gan et al. (2001) showed that the impact of a reduced discount rate actually had the same impact as the addition of an amenity value. This concept frees the optimal management/rotation analysis from requiring explicit non-market amenity values and allows economists instead to investigate lower discount rates for PNI and other forest ownership types.

Discount rate assignment

We can get an idea about the relative weights different land ownership classes place on standing timber by comparing their distribution of timberland age class structure. The United States Department of Agriculture (USDA) Forest Inventory and Analysis (FIA) group systematically collects inventory data on forests and associated resources across the United States (Oswalt et al. 2019). USDA FIA research foresters provided ACR data allowing for the analysis of total timberland acres in the continental U.S. (CONUS) by age class for several broad ownership classes, including non-federal public, private, and

NGO (Figure 1). Timberland is as defined by FIA (USDA 2021). The analysis was geographically constrained to CONUS due to incomplete FIA data for Alaska.

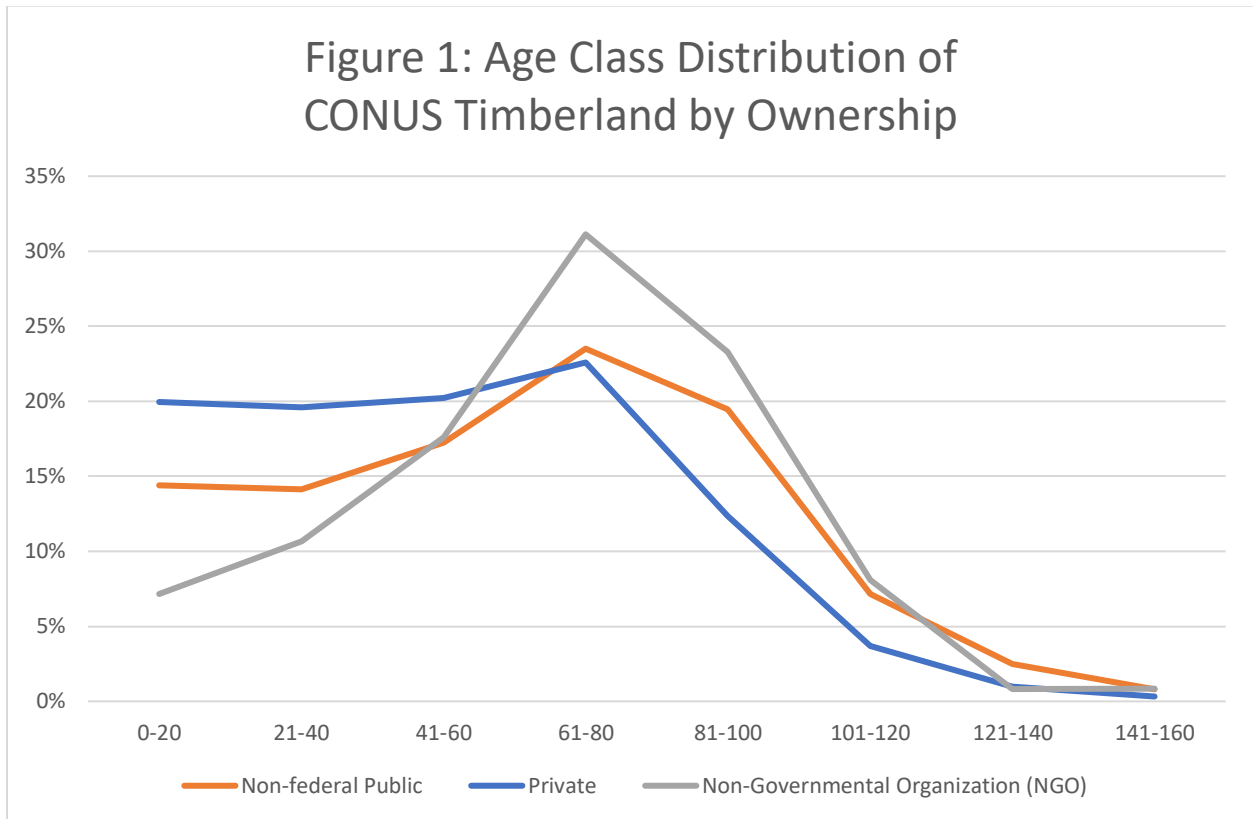
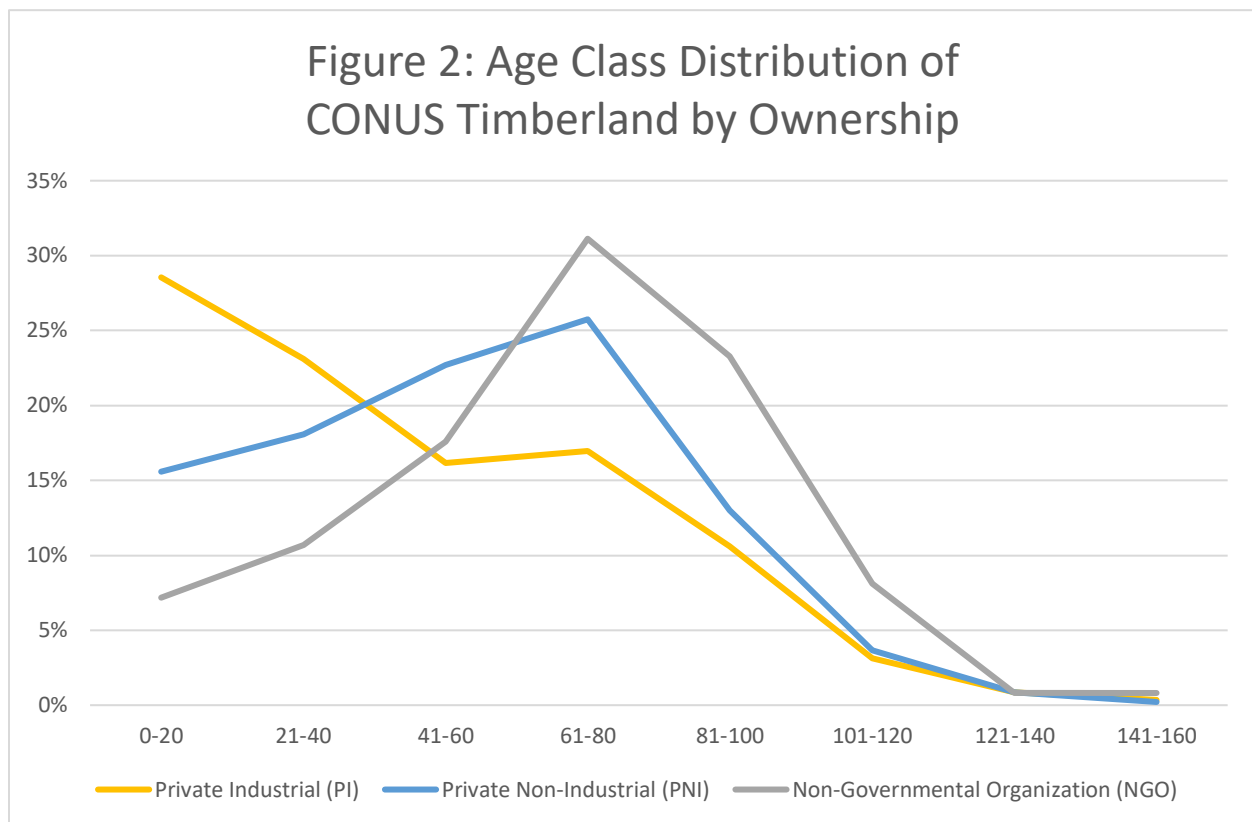


Figure 1 shows the relative differences on standing forest age class, with private lands placing the lowest amenity value on older age classes and NGO lands placing the most amenity value associated with older forests. Non-federal public lands were managed for rotations longer than private lands, yet not as long as NGO lands. The data presented above supports that private landowners generally manage at a higher discount rate than non-federal public owners, and NGO landowners use a lower discount rate than public landowners.

Figure 2: Age Class Distribution of CONUS Timberland by Ownership



The private land ownership class was further categorized into PI and PNI, and again compared to NGO land ownership class. Figure 2 demonstrates that while PNI landowners may not operate using the same profit maximization objective as PI ownerships, they do in fact display an age class structure indicating a slightly longer rotation. This is consistent with either joint optimization of timber and non-timber values per Pattanayak et al. (2002) or equivalent profit maximization optimization with a lower discount rate per Gan et al. (2001), supporting a lower discount rate value for PNI ownerships as compared to PI ownerships. Similar to Figure 1 above, the NGO ownership class manages for the longest rotations of those examined, supporting a lower discount rate for NGOs as compared to PNI ownerships.

Private Industrial

Previous versions of this methodology have used a discount rate of 6% for the private industrial ownership group. We reaffirmed the appropriateness of this value by collecting a wide range of literature (Appendix 1). Averaging the values found in this literature search yielded an NPV discount rate of 6%.

Private Non-industrial

FIA data (displayed in Figure 2 above) indicates that PNI ownerships are typically managed less intensively than PI ownerships. Private lands are harvested more aggressively as compared to public lands (Figure 1). PI discount rates in the literature averaged 6% and discount rates in the literature for state lands averaged 4%. Thus, by analyzing FIA data and consulting with forest economists, experienced

natural resource professionals, and a range of PNI forestland owners, we conclude that a Private Non-Industrial ownership NPV value of 5% is rational and reasonable (which is halfway between PI of 6% and Public land values of 4%).

Tribal

While some Tribal lands are managed in an identical fashion as Private Industrial ownerships, others are managed in a manner similar to public lands. We therefore determined that a NPV of 5% was a reasonable value to use for Tribal ownerships (since it is halfway between PI of 6% and public land values of 4%).

NGO

Discount rates representative of NGO owned lands were sourced from the available literature. NGOs typically manage with a conservation, habitat, or land preservation objective in mind. Timber production is often a secondary objective and typically not part of an NGO's core business. This variability of management objectives is reflected in the wide range (1-5%) of discount values observed. FIA data (Figures 1 and 2) indicates that NGO lands are managed for longer rotations than PI, PNI, or non-federal public lands. Both FIA data and available literature support a discount rate of 3% for NGOs.

Non-federal public lands

Based on values in the literature (Appendix 1), examination of the FIA data (Figure 1), and discussions with state government officials, a discount value of 4% was derived for non-federal public land ownerships.

References

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- Amacher, G.S., Conway, M.C., and J. Sullivan. 2003. Econometric analyses of nonindustrial forest landowners: is there anything left to study? *Journal of Forest Economics* 9, 137–164.
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- Pattanayak, S., Murray, B., Abt, R., 2002. How joint is joint forest production? An econometric analysis of timber supply conditional on endogenous amenity values. *Forest Science* 47 (3), 479– 491.

Appendix 1. NPV values and sources

Private Industrial

Based on a review of available literature, a 6% NPV discount rate was used for Private Industrial ownerships.

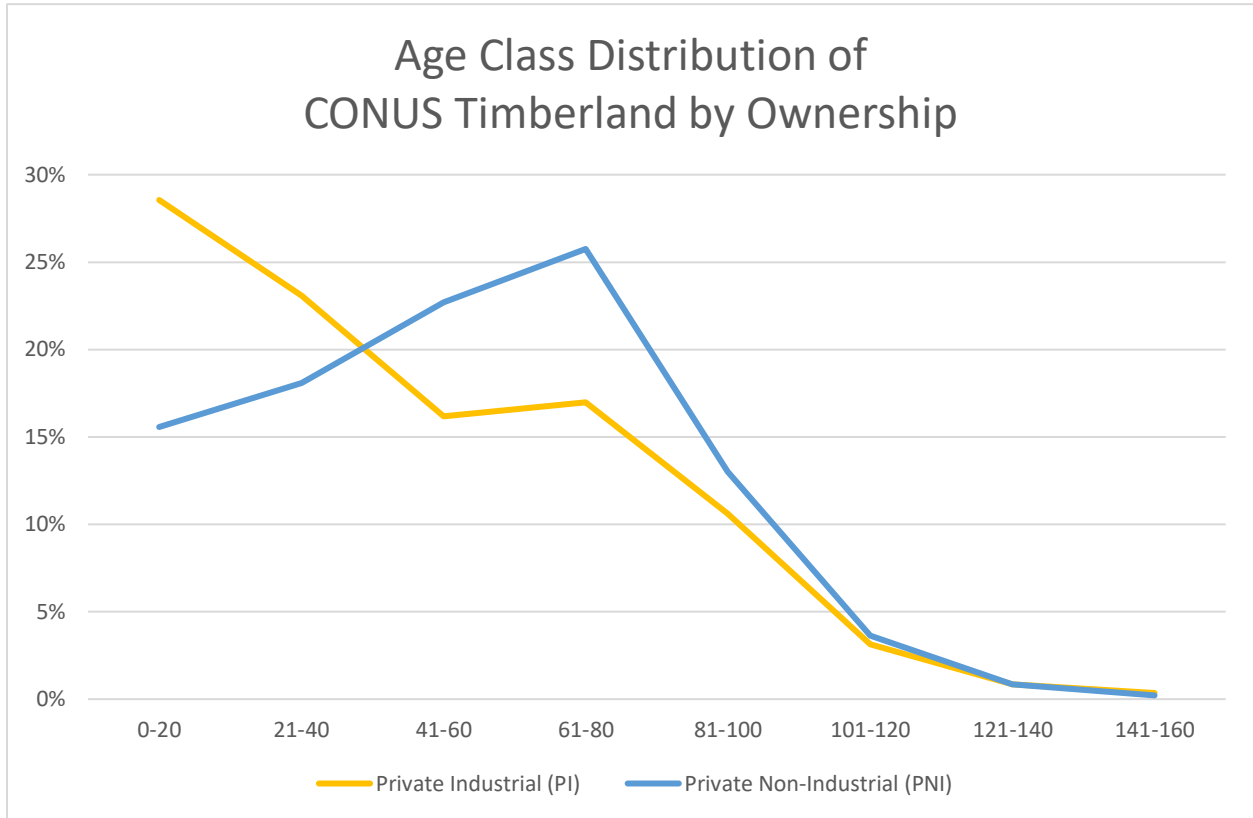
Ownership class: Private Industrial		
Source	Reported	
	NPV	Context
1	6%	Existing Approved ACR IFM methodology by Finite Carbon
2	6%	Timberlands Research Report
3	6%	Analysis of impact of changes in operating income or interest rates on timberland values (5.75% U.S. South and 6.0% PNW)
4	6%	Industry discount rate assumption (range of 5% - 6.5%)
5	6%	Estimate of risk-adjusted discount rate for overseas timberland investment (U.S. South)
6	6%	Timberland Investors discount rate survey
7	5%	Timber REIT yeilds based on dividends as a percent of share price
8	5%	Timber company discount rate assumption
9	7%	Average IRR for U.S. capital investment analysis (Table 2).
10	7%	Average IDR for forest valuers in NZ and Australia
11	8%	"Commercial" discount rate
Average	6%	

Citation

- 1 American Carbon Registry. Improved Forest Management Methodology by Finite Carbon (2010)
- 2 Brookfield Timberlands Management LP, Q4 2010 Global Timberlands Research Report
- 3 Brookfield Timberlands Management LP, Q2 2010 Global Timberlands Research Report
- 4 Brookfield Timberlands Management LP, Q1 2011 Global Timberlands Research Report
- 5 Forisk Consulting Blog September 2012
- 6 KMPG timberland investors discount rate survey 2017
- 7 Forisk Consulting Blog January 2016
- 8 Rayonier Q2 2016 Results - Earnings call transcript
- 9 Cubbage et al. 2020. Global timber investments, 2005 to 2017.
- 10 Manley 2018. Discount rates used for forest valuation - results of 2017 survey
- 11 Paul et al. 2013. Economic and employment implications of a carbon market for industrial plantation forestry

Private non-industrial

Figure 2 demonstrates that while U.S. PNI landowners may not operate using the same profit maximization objectives at PI ownerships, they do in fact display age class structure indicating a slightly longer rotation which is consistent with either joint maximization of timber and non-timber values per Pattanayak et al. (2002) or equivalency optimization of the profit maximization objective with a lower discount rate per Gan et al. (2001).



Tribal

While some Tribal lands are managed in an identical fashion as Private Industrial ownerships, others are managed in a manner similar to public lands. We therefore determined that a NPV of 5% was a reasonable value to use for Tribal ownerships since it is halfway between PI of 6% and Public land values of 4%).

Ownership class:		Tribal lands	
Reported			
Source	NPV	Context	
12	none	Discussion of volume removals as a percent of growing stock on MN tribal ownerships	
13	none	Harvest patterns of WA tribal ownerships	
14	none	Volume and acreage of Tribal ownerships in the US	

Citation

- 12 Impacts of increased timber harvesting on timber management activities
- 13 Washington's forests, timber supply and forest-related industries
- 14 Changing timberland ownership in the Northern forest and implications for biodiversity

Public Non-Federal lands

Based on values in the literature, examination of the FIA data (Figure 1), and discussions with state government officials, an NPV discount rate of 4% was derived for public non-federal lands.

Ownership class:		Public Non-Federal	
Reported			
Source	State	Discount Rate	Context
15	ID	4%	For state land harvest decisions
16, 17	WA	5%	Forestry state agency in Washington State (Department of Natural Resources)
18	MN	3%	Forestry state agency in Minnesota (Department of Natural Resources)
19	OR	5%	Forestry state agency in Oregon (Department of Forestry)
20	PA	4%	Forestry state agency in Pennsylvania (Department of Conservation & Natural Resources)
21	MT	4%	Forestry state agency in Montana (Montana Department of Natural Resources & Conservation)
22	CO	4%	Colorado Dept. of Transportation discount rate on borrowed funds
23	WA	5%	2013 Seattle Public Utilities discount rate for benefit-cost analysis
24	Various	3%	2002 survey of 72 American cities and their discount rates for city planning

Average **4%**

Citation

- 15 Legislature of the State of Idaho, Sixty First Legislature First Regular Session (2011) House Bill No. 11 by Revenue and Taxation Committee
- 16 Washington Department of Natural Resources. Forest Management Modeling. Appendix C.
- 17 Sustainable Harvest Calculation for Forested State Trust Lands in Western Washington (2007). WA DNR
- 18 Forest Management Lease Pilot Study Report. (2009) Report of the House and Senate Natural Resources Policy Finances Committees and Divisions
- 19 Northwest Oregon State Forests Management Plan (2006) Appendix 1. Decadal Analysis of Alternatives
- 20 State Forest Resource Management Plan (2003)
- 21 State Forest Land Management Plan (1996). Final Environmental Impact Statement. Record of Decision.
- 22 Demos 2016. Life cycle cost analysis and discount rate on pavements for the Colorado Dept. of Transportation
- 23 Flory, B. 2013. Updating the discount rate used for benefit-cost analysis at Seattle Public Utilities.
- 24 Zerbe Jr., Han, Layton, Leshine 2002. A history of discount rates and their use by government agencies. Appendix A

Non-governmental organization

Based on values in the literature, as well as examination of FIA age class data, an NPV discount rate of 3% was derived. This NPV discount rate reflects that NGOs typically manage with a conservation, habitat, or land preservation objective in mind, with timber production often as a secondary objective.

Ownership class: Private Industrial	
Source	Reported NPV Context
25	5% Typical annual asset distribution of foundations and endowed organizations
26	3% Approximated fixed asset inflation rate for low profit margin organization
27,28,29	1% "Social" discount rate
30	2% Long-term (25-75 years) timber investment discount rate for joint timber, biodiversity and carbon management

Average **3%**

Citation

- 25 Jansen and Katz 2002. For nonprofits, time is money. McKisney Quarterly.
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 29 Baral et al. 2014. Economic evaluation of ecosystem goods and services under different landscape management scenarios. Land Use Policy 33:54-64.
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