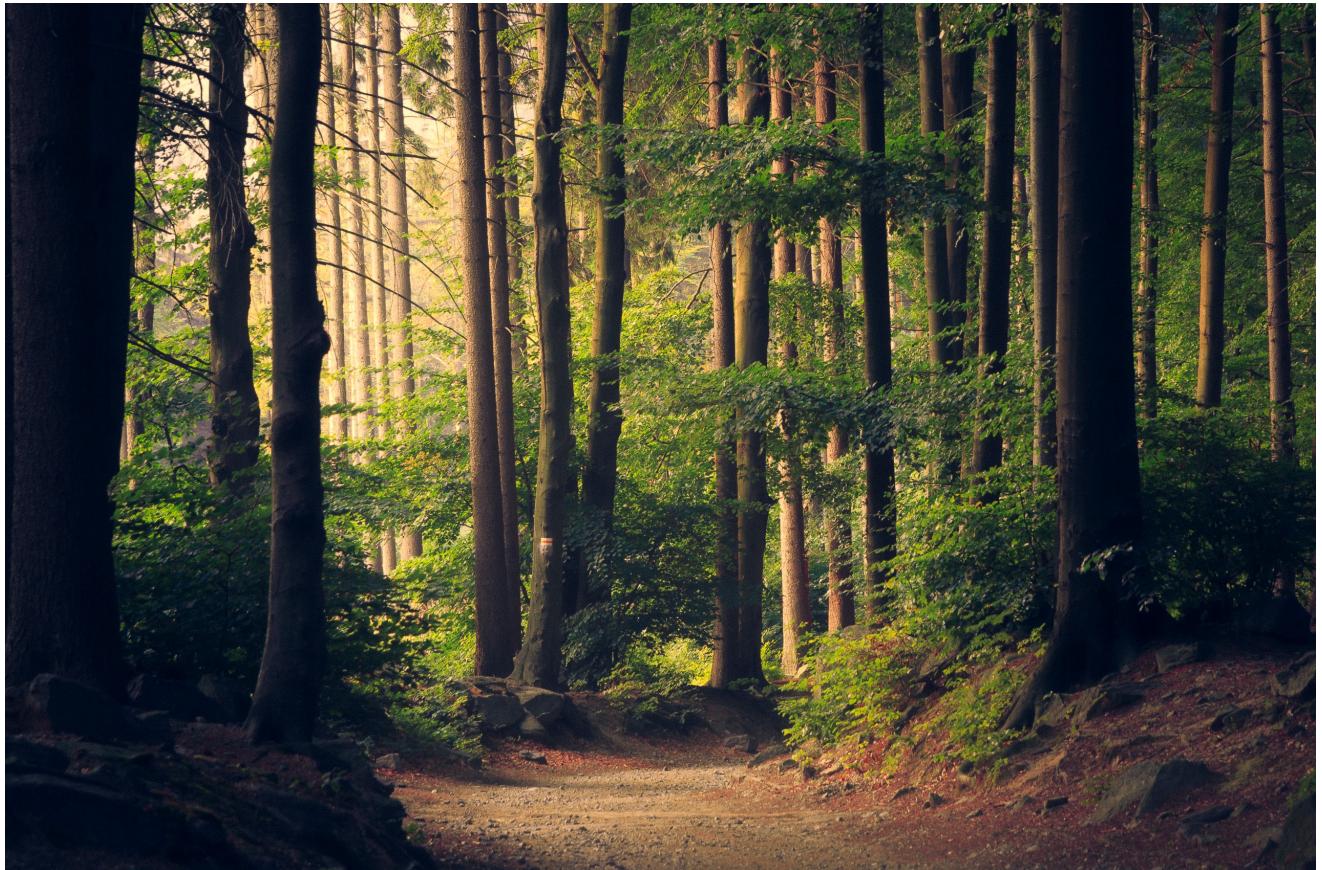


Decreasing National Forest Spending on Preparing Forests for Timber Sales



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Disclaimer

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Executive Summary

Each year, taxpayers subsidize timber sales by the National Forest Service by \$1.5 billion (Talberth, 2019). In addition to the economic consequences, there are many unrealized benefits society does not reap from forests when they are harvested for wood and wood products. When these social costs are included, overharvesting by the National Forest Service costs American citizens over \$11 billion per year.

This problem stems primarily from intentionally confusing budget requirements as well as constantly shifting government priorities. The National Forest Management Act, which governs how forests are managed, is quite vague and leaves a large amount of discretion to the Secretary of Agriculture (*National Forest Management Act*, 1976). In turn, the Secretary tends to leave most managing decisions to individual forest directors, which leads to high levels of variation across forests/regions.

Over the last two decades, timber sales from National Forest lands have amounted to a steady 2.5 billion board feet of timber per year, comprising about 5% of all timber sales in the United States (Lawrence, 2018). This timber is mostly sold below market value, sometimes discounted by as much as two-thirds. Because of this, many sawmills face backlogs and are unable to sell the wood they have stored, risking rot, pine beetles, or other infestations in their stockpiles. In addition, the timber market is heavily dependent on the housing market and only recently has recovered from the 2008 Recession.

Forests provide many benefits when they are left standing. Trees capture carbon out of the atmosphere and store it in their trunks as well as depositing it into soil, where it is stored indefinitely. In addition, water quality and quantity are improved by forests, as they both increase the speed of the water cycle and filter out sediment. People value national forests for recreational purposes as well as impart “passive use” value, meaning the value of forests intrinsically is recognized. When these benefits are not realized, the social cost of overharvesting increases from the \$1.5 billion actually spent to over \$11 billion.

This analysis will assess four options, in addition to the status quo, for reducing the amount of money the National Forest spends preparing trees for harvesting. These options include subsidizing forests as carbon sinks, prohibiting old growth logging, amending the National Forest Management Act, and requiring that timber contracts reflect market prices.

After assessing the impact each of these alternatives has on board feet of timber harvested, including a cost-effectiveness analysis, I recommend prohibiting old growth logging. This option is the most cost-effective, adequately feasible on multiple dimensions, and highly equitable. This paper concludes with some advice on implementation, including what can be done if Congressional action is not taken and what risks and limitations must be considered.

Problem Statement

The National Forest Service allocates too much of their budget to preparing forests for timber sales.

Over the last 20 years, timber harvests from national forests have declined by nearly 800 million board feet¹ from 3.3 billion board feet (BBF) in 1998 to 2.5 BFF in 2017 (Lawrence, 2018). After a dip during the 2008 recession, however, the volume of timber harvested has grown by 600 million board feet (Lawrence, 2018). Despite this overall decrease, approximately \$1.5 billion – nearly one-third of the \$5 billion budget of the National Forest Service (NFS) – is spent annually preparing national forest lands for timber harvesting (Talberth, 2019; *Budget & Performance*, n.d.). However, only about \$35 million, or roughly one-third of the revenue, is “returned” to taxpayers in the form of deposits to the National Forest Fund (Talberth, 2019). The NFS’s stated mission is to “sustain the health, diversity, and productivity of the Nation’s forests and grasslands to meet the needs of present and future generations.” However, the subsidies for timber sales indicate that current levels of timber harvesting are not sustainable. In addition, overspending on timber sales reduces available funds for other projects such as conservation initiatives that further the NFS mission statement.

Experts in the forestry field have spent decades trying to address this problem. However, due to economic pressures put on politicians, they have been unable to reduce the amount of money spent preparing trees for harvest; in fact, the NFS has regressed in some ways to what one calls a “tree farm,” an organization more interested in selling timber than engaging in the sustainable activities for which its mission calls (Coleman, 2019).

Reasons for the Problem

Confusing Budget Requirements

In 1988, an exposé on the public cost of timber sales led the NFS to intentionally obscure parts of their budget, creating confusing line items that are nearly impossible to follow. Congressional appropriations make up the majority of their funding, but revenue sources such as timber sales also contribute to their operating budget. In particular, funds used to prepare forests for timber sales come from appropriated spending, but revenue from timber sales goes into a fund for mandatory spending for conservation efforts and other programs (Shankaran, 2020, personal communication). This allows the NFS to claim they *need* timber sales to fund conservation projects even while subsidizing those sales. Approximately 25% of revenues are returned to the county from which timber was harvested; the remainder is retained by the NFS. Of the money retained, some goes into the National Forest Fund (NFF),² though it also can be funneled into the general Treasury by the Secretary of Agriculture (*National Forest Management Act*, 1976). The lack of clarity in the NFS budget

¹ A board foot of timber is the volume of a block of wood 1 foot long by 1 foot wide by 1 inch thick, or any equivalent 144 cubic-inch block. For context, an average single-family home takes about 16,000 board feet of timber to build. The number of board feet per tree depends on its height and diameter (Heiligmann & Bratkovich, 2016).

² Money from the NFF goes into both projects related to future timber sales and projects unrelated to timber sales such as habitat management, fire suppression, etc. (Talberth, 2019).

has allowed for this problem to continue for over twenty years, as only a handful of experts have been able to identify it (Talberth, 2019). No one thus far has been able to acquire widespread support for policy change.

Shifting Government Priorities

The last several administrations have all clearly shown different preferences when it comes to climate policy. President Obama passed rules that, while designed to protect forests, may have gone too far in prohibiting logging – mostly through increase bureaucratic processes – which some say led to the increase in wildfires California and other states have recently experienced (Barth & Grimes, 2018). A 2019 Executive Order by President Trump actually *increased* the amount of logging NFS was instructed to consider (Fears & Eilperin, 2019). Many timber harvesting contracts last several years, so the ever-changing policies mean that contracts are constantly made under new rules than previous contracts were, leading to confusion and inefficiencies (Columbia Center on Sustainable Investment, 2015).

Costs to Society

If the NFS does not address this problem, society will bear many costs. First, the direct accounting costs to taxpayers must be considered. Second, overharvesting reduces the volume of carbon forests can sequester from the atmosphere. In addition, trees provide important filters for water, increasing both quantity and quality of aquatic resources available. National Forests are visited by millions of visitors each year, contributing to a large portion of the economy. Finally, forests provide value to people who may never visit them, which should not be excluded from this valuation. These categories are elaborated on below, and a full explanation of the costs to society can be found in Appendix B.

Accounting Costs

The fiscal cost of over-harvesting timber in the United States is \$1.5 billion annually (Talberth, 2019). This number was determined by assessing the costs that go into preparing the forests for harvest, including research, building and maintaining roads, and other similar activities, and then subtracting out funds put into the National Forest Fund (i.e. “returned” to taxpayers). This does *not* include fire suppression activities related to timber, though an argument could be made for including these; this would increase the cost by about \$500,000.

Carbon Sequestration

In addition, living trees sequester carbon – that is, remove existing carbon from the atmosphere – at a rate of 13 (young trees) to 48 (mature trees) pounds annually, and trees used for timber are often mature (*Trees Improve Our Air Quality*, n.d.; *Could Global CO₂ Levels be Reduced by Planting Trees*, 2018). In 2017, 2.6 billion board feet of timber was harvested from National Forests, or roughly 12.5 million trees (Howard & Liang, 2019; *Measuring Standing Trees*, n.d.). The social cost of carbon (SCC) has been extensively studied, finding the average SCC as over \$200 per ton (Wang et al., 2019.).

Therefore, an additional \$30 million is lost due to the lack of carbon sequestration, which would occur if trees were not harvested.

Water Filtration

Trees provide important water filtration mechanisms, and healthy forests lead to healthier rivers and less polluted groundwater (Lyons & Gartner, 2017). According to the NFS, over 60 million Americans receive their drinking water from NFS lands, making it the single largest provider of drinking water in the country (*Water Facts*, n.d.). The EPA estimates that the average American uses 88 gallons per day, and the average cost of water for a family of four in 2018 was about \$70 per month (US EPA, 2017; Walton, 2018). Given this, if too many trees continue to be harvested, the water quantity and quality both will drop, resulting in lost value of \$5.7 billion.

Recreation

Visitors to NFS lands contribute over \$13 billion annually to the U.S. GDP, both directly through entry fees, etc., and through the support over 205,000 jobs (Wagner, 2013). Even if the \$4 billion of this coming from visitors to ski resorts on NFS lands is subtracted, this is still a substantial amount of money. In total, overharvesting costs taxpayers \$3.5 billion in lost recreational revenue.

Passive Use

A report from 2000 estimates passive-use values of roadless NFS lands to surpass \$280 million. “Passive use” refers to the extent to which people prefer a forest’s existence even if they derive no personal benefit. This may be because they wish to visit in the future, believe the idea of a forest existing has its own merit, or support forests now for the benefit of future generations (Loomis & Richardson, 2000). This estimate initially assessed 42 million acres of roadless NFS lands; this number has since grown to 58.5 million acres (*Roadless*, n.d.). The potential loss of passive use value from forests totals about \$612 million.

Total Societal Cost

Altogether, the cost of not addressing overharvesting of NFS lands is over \$11 billion annually (see Table 2). This is a conservative estimate as it only considers the economic value of recreation, excluding the emotional benefits to society of time in nature. In addition, this estimate cannot adequately account for the value of the biodiversity supported by NFS forests.

Table 1. Summary of societal cost

Category	Cost (annual)
Financial costs (cash flow)	\$1.5 billion
Carbon sequestration lost	\$0.03 billion
Water quality lost	\$5.7 billion
Recreation value lost	\$3.5 billion
Passive use value lost	\$0.61 billion
Total	\$11.34 billion

General Overview of Forests and Timber Sales

Profile of All Forests in the United States

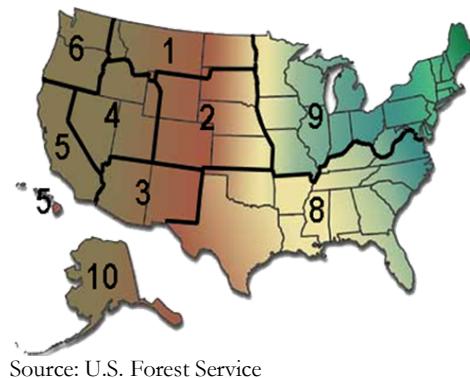
As of 2016, forests make up approximately one-third of the United States, or over 766 million acres, and this has been stable since 2012 (World Bank, n.d.). Over half (56%) of the total forested land in the U.S. is owned privately, and this is dramatically concentrated in the eastern U.S. In the western part of the country, especially the Northwest, land is primarily owned publicly, although this is split among federal and state or county jurisdictions. Of the total forested land in the U.S., about two-thirds are considered timberland while only 10% is protected³ (Laporte, 2017; Oswalt & Smith, 2014). Most timberland exists in the Southeastern U.S., whereas most protected forests are in the Pacific Northwest (Oswalt & Smith, 2014). For more detailed maps of forest ownership and use, see Appendix A.

Profile of NFS Forests

The NFS manages 193 million acres of land, 188 million acres of which is forested (the remainder consists of grasslands, research areas, or other ecosystems) (USDA Forest

Service, 2018). The NFS divides land into 10 regions; see Figure 1. Overwhelmingly, NFS controls land in the Pacific Northwest; 103 out of 151 national forests, or 163 million acres of the 188, are in Regions 1-6 and 10. The NFS only controls 25 million acres of forest in Regions 8-9.

Figure 1. Map of NFS Regions



Source: U.S. Forest Service

Governance

The National Forest Management Act (NFMA), the law which asserts how the NFS can conduct timber sales, leaves most decisions to the Secretary of Agriculture, who is appointed by the President. Every ten years, the Secretary must determine how much timber can be sold that decade based on sustainability requirements; however, the Secretary may depart from those requirements

for any given decade in order to meet multiple-use requirements set by other laws. The NFMA also dictates the auction process for timber contracts,⁴ though once again leaves most specifics to the discretion of the Secretary (*National Forest Management Act*, 1976). In practice, it appears that individual forest directors have the most discretion over actual land management.

³ Timberland refers to areas where harvesting wood is permitted; all private lands are categorized this way, even if owners have no intention of ever logging. Protected lands have specific prohibitions on logging and cannot be harvested. Protected areas are also sometimes called “reserved.”

⁴ Public timber sales are contracted via sealed-bid auctions. However, the specific mechanics of these auctions is beyond the scope of this paper.

The rules and regulations set forth by the USDA are also vague. In general, timber can be harvested on National Forest lands except for those designated otherwise. Though most sales have to go through a bidding process and contracts, timber in certain situations can be harvested without a contract written up or without being sold (i.e. is given away without payment) (Sale and Disposal of National Forest System Timber, 2019).

Overview of Timber Sales

National forests do *not* have a statutory mandate to generate revenue, but most do anyway; in FY2018, over \$280 million in revenue was generated, and more than half (57%) came from timber sales (Hoover & Riddle, 2019). In 2017, nearly 2.6 BBF were harvested; this is similar to trends since 2000, though there have been some fluctuations. For information on timber harvest quantity since 2000, see Table 1 (Lawrence, 2018).

Table 2. Annual timber harvested from NFS forests from 2000-2017 (MBF)

2000	2001	2002	2003	2004	2005	2006	2007	2008
2,542,427	1,938,198	1,727,556	1,817,751	2,031,607	2,097,611	2,296,491	1,960,363	2,048,928
2009	2010	2011	2012	2013	2014	2015	2016	2017
1,954,052	2,137,859	2,440,432	2,500,321	2,408,161	2,437,488	2,543,144	2,536,601	2,595,688

Of all timber harvested in the United States, though, only 5% of it comes from publicly owned lands (Kinney, 2014). This means the total volume of timber harvested in the U.S. is around 52 BBF annually.

Below Cost Timber Sales

As mentioned, timber sold by the NFS from public lands is heavily subsidized by taxpayers. In 2017, NFS sold timber for an average of \$72.29 per thousand board feet (MBF)⁵ of timber (Lawrence, 2018). Reports from South Carolina and Washington indicate that private timber was sold over \$200/MBF in that same year (SCFC, n.d.; *Stumpage Value Determination Tables*, n.d.).

These subsidies have deep historical roots. Since the mid- 1960s, the NFS has been involved in below-cost timber sales across the country, especially in the Pacific Northwest and in New England. Various administrations, including those under both Bush Sr. and Clinton, tried to reduce below-cost sales, but none have been successful. These were in part instilled in order to promote timber sales as a mean of forest management (e.g. thinning overgrown forests, preventing wildfires, etc.) in places with higher operating costs. The Multiple-Use Sustained-Yield Act of 1960 also implicitly asserts that the NFS's role is to provide resources, perhaps regardless of financial outcomes (Gorte, 1994; Gorte, 2004).

Despite the arguments that below-cost timber sales are not truly a problem, many sawmills face huge backlogs (Martinelli, 2019; Daniel, 2015). In part, these stem from “salvage material,” or trees

⁵ MBF refers to thousand board feet of timber (M as in the Roman numeral). This is standard notation across the industry, and as such will be used throughout this paper.

harvested after damage from wildfires, etc., which do not count toward sustained-yield totals but nonetheless can be processed and sold. The excesses also come from reduced demand during the Great Recession, from which the housing market (which has a strong demand for wood products) only very recently rebounded (Bennett, 2019).

Benefits of National Forests

Forests as Carbon Sinks

For the last few years, it has been increasingly important for researchers to find ways to capture carbon out of the air, generally using new technology (Temple, 2018). Researchers have begun looking into “afforestation” or “reforestation” as additional methods of carbon capture, as both trees themselves and the soil in healthy forests sequester carbon (Walheimer, 2019). Most researchers conclude that increasing forestland to reduce carbon in the atmosphere is economically efficient and effective, but not necessarily scalable (Walheimer, 2019).

In 2019, the US Department of Energy put out three “funding opportunity announcements,” or FOAs, for projects that engage in carbon-capturing activities. These three FOAs totaled \$110 million in government grants across over a dozen different projects (*U.S. Department of Energy Announces \$110M for Carbon Capture, Utilization, and Storage*, 2019). Other groups, like the Boston-based organization Indigo AG or the state of California (Temple, 2019), are also providing incentives in the form of subsidies for those looking to engage in more carbon-capturing methods of agriculture.

Water Quality

Forests improve water quality locally. They reduce runoff when it rains. This slows the speed with which rainwater travels to rivers, etc., and allows rainwater to “purify” by leaving sediments behind. Trees also assist with the water cycle by releasing water vapor from its leaves back into the air (Lyons & Gartner, 2017). Trees are also particularly adept at absorbing both nutrients and contaminants from the water, leading to lower purification costs and healthier waterways (Lyons & Gartner, 2017). In addition, increased biodiversity – present in healthy forests – both indicates and leads to benefits like reduced water pollution and improved soil health, both of which have positive impacts on nature and human life alike (Unity College Online, 2017).

Recreation

Over 145 million visits are made annually to national forests, and this number has generally been increasing since 2005 despite recent dips (Warren, 2016). In surveys, most visitors who visited forests said they did so to “improve their physical, psychological and/or spiritual wellbeing,” indicating a high value of forests to visitors (Warren, 2016, p. 3).

A Deeper Look: Specific Benefits of Old Growth Forests

As of 2010, only a quarter of the over 750 million acres (around 190 million acres total) of forests in the United States were considered “old growth,” usually defined as areas with trees that are at least

150 years old and generally untouched by human activity (Becker, n.d.). By definition, old growth forests cannot be replaced or repaired by reforestation efforts.

Old growth forests serve as carbon sinks at higher rates than new forests, as the trees have had decades if not centuries to absorb carbon. In addition, rate of carbon uptake by trees increases with age and size, so older trees are even more effective at removing carbon from the air than younger trees (Cotter, 2014). Old growth forests are also less susceptible to wildfires, making them an important refuge for animals whose regular habitats are at risk (Lesmeister, 2019). This may seem counterintuitive, as older growth seems like it would provide more fuel for wildfires; however, older trees contribute to the atmosphere both by lowering temperatures and by increasing humidity via transpiration (the process by which water moves through a plant's roots and eventually out of its leaves). These two elements in combination with each other reduce the risk of fire in old growth forests. Finally, old growth forests are hubs of biodiversity of both plant and animal life. In fact, most threatened forest species make their homes in old growth forests, making them especially valuable as standing forests rather than timber (Hernández et al., 2017).

Best Practices

Carbon Subsidies in Alaska

The Sealaska Corporation in southeast Alaska is a for-profit collective owned and managed by several indigenous tribes in the area that primarily earned money through timber sales (Bullinger, 2018). Recently, however, they began selling carbon offset credits through California's cap-and-trade market ("Sealaska Forests Provide Benefits...", 2019). A primary purchaser is oil giant BP, though the specifics of the contract are confidential (Harball, 2019).

Sealaska has promised to maintain 165,000 acres of forests for 100 years, which is expected to bring in over \$100 million in revenue (Bullinger, 2018). This could be even more if the areas not harvested are used for tourism and recreation. Previously, a study in British Columbia found that trees are more valuable in the long-term for capturing carbon than used as lumber (Sullivan, 2008). As the Alaska policy is currently less than two years old, the impact of such a practice has not been thoroughly evaluated yet. However, the projects of this project are immensely promising for conservations and economists alike.

Old Growth Ban in Northwest Forest Plan

In the 1990s, old growth logging was severely limited in northern California, Oregon, and Washington, primarily to protect the endangered Northern Spotted Owl. The Northwest Forest Plan (NWFP) applies to 26 different forests in the region and was the result of months of litigation and negotiation between timber industry advocates and environmentalists ("Ecosystem Mgmt....", 2015). Opponents argued that this ban hurt the economy; however, the actual economic value of the forests left standing outweighed the value of the trees as timber (ECONorthwest, 2006).

A recent study showed that the NWFP succeeded in at least slowing the rate of old growth loss in the region, though other expected benefits have yet to be realized (Phalan et al., 2019). The NWFP is meant to be a 100-year plan, with some adaptations, and it included monitoring measures to

ensure revisions are based on appropriate science (“Northwest Forest Plan”, n.d.). As such, in the future it will continue to illustrate how old growth timber limitations impact both the economy and the environment.

Criteria

Cost Effectiveness (40%)

To calculate cost-effectiveness, the total costs will be divided by the outcome – the change in board feet of timber harvested – under each policy alternative. Total costs will include changes to costs of cutting timber, personnel, space, and other overhead during implementation as dictated by each alternative; all be calculated as changes off of the status quo. For each alternative, both costs and amount of wood harvested (in MBF) will be projected out 10 years, then discounted at the OMB-suggested rate of 7% to determine a single net present value per MBF.

Political Feasibility (30%)

All proposed alternatives require legislative action.⁶ Given the current administration’s lack of focus on environmental policy, any effort to reduce the amount of money spent preparing forests for timber sales will be difficult. However, some alternatives may be more likely than others to garner bipartisan support and succeed in effecting change. This criterion will assess how likely each alternative is to succeed in the given political climate of today.

Senator Pat Roberts (R-KS) is the Chair of the Senate Committee on Agriculture, Nutrition, and Forestry (*Committee Membership*, n.d.). Neither he nor any other members of the committee come from states that are heavily forested, so the biggest issue here will be getting overharvesting onto the agenda at all. In the House, Representative Abigail Spanberger (D-VA-07) chairs the subcommittee on Conservation and Forestry under the House Agriculture Committee (*Conservation and Forestry*, n.d.). Similarly, no committee members here come from large timber states. However, that this committee exists means a bill is more likely to make it onto their agenda. As such, if a strong case can be made, there is reason to believe that one of the five members may take up the cause of reducing the amount of the FS budget allocated to preparing trees for harvest.

I will evaluate political feasibility on a scale of *low*, *medium*, or *high*, with high being the best. A *low* score indicates that one or more key stakeholders – such as committee chairs in Congress or the President, for example – are opposed to the policy option. A score of *medium* will indicate that some stakeholders, but not key decisionmakers, may oppose the idea. A *high* score will be awarded to any policy that is likely to have support from all essential actors, including bipartisan backing.

Administrative Feasibility (20%)

Already, the process surrounding timber sales is complicated and requires ensuring the use of proper paperwork, which can be challenging to identify (Timber Sale, Stewardship, and Forest Products

⁶ For the recommended option, alternatives to legislative action will be also considered in the implementation portion of the paper.

Contracts and Permits, n.d.). Changing the process in any way may add to the ambiguity and confusion of proper permitting and contracting. In order for an alternative to be realistic, the implementation would need to be relatively straightforward, or at least within the means of the NFS to successfully carry out. In addition, rangers and other NFS employees who would be carrying out the new policy would need to buy in to the changes in order for a program to be sincerely managed.

Administrative feasibility will be assessed on a scale of *low*, *medium*, or *high*. A *low* score will be applied to any alternative that increases the complexity of the process, or that requires resources the NFS is unlikely to be able to acquire. A *medium* score will be given for any alternatives that do not exacerbate, but also do not mitigate, the complexity of NFS timber sales. Finally, a *high* score will be awarded to any alternative which clearly falls within NFS's means, and/or decreases how complicated timber sale paperwork currently is.

Equity (10%)

The forestry industry employs over 950,000 workers in the United States, primarily in the Pacific Northwest region (Laporte, 2017). Decreasing the amount of funding for timber sales could impact the employment of thousands of people. Working as a logger is dangerous, requires only a high school diploma or equivalent in most cases, and pays an average of just over \$40,000 annually (Bureau of Labor Statistics, 2019). Given these facts, reducing timber sales could negatively impact the job opportunities of many at or just above the poverty line.

Equity will also be evaluated as a *low*, *medium*, or *high* score. An alternative will score *low* if the costs accrue to those worst off while benefits accrue to those who are not negatively impacted, particularly by job loss. A score of *high* will indicate that the outcomes of the alternative disproportionately benefits those who are worst off, making them better off than before. A *medium* score will indicate that the outcomes of an alternative lie somewhere between these two extremes.

Explanation of Weighting

Cost effectiveness is weighted highest because it is imperative that a proposed alternative has outcomes proportional to its costs. However, given the uncertainty inherent in predicting future values, this is only weighted at 40%.

Political feasibility is considered second, as infeasible alternatives are unlikely to be recommended. However, the low feasibility of any alternative in this field given the current political climate is not lost, so the weighting is downsized accordingly.

Administrative feasibility is next, as a program should be implementable before it is recommended. However, given the long timeframe of NFS programs, it is possible that a seemingly infeasible option could be addressed in the future after it is enacted; as such, this is lower on the list.

Finally, equity is important enough to be included, but difficult to estimate. Additionally, one non-profit asserts that decreasing timber sales could save enough money to employ everyone who lost their job due to the decrease (National Forest Protection, n.d.). For this reason, equity is weighted only at 10%.

Alternatives

Option 1: Let Present Trends Continue

Under current policy, national forests in the U.S. are experiencing net growth; that is, more trees are being planted than are being cut down (Oswalt et al., 2017). As such, it may be prudent to simply continue monitoring NFS activities, including spending, without engaging in any other direct action. It is not inherently a problem that money is spent on preparing forests for timber sales, and if forests are growing, it may imply that current timber harvesting is occurring at a sustainable rate. As seen in Table 2 (above), timber harvests have remained relatively stable over the last decade.

In addition, many of the actions taken in preparing forests for timber, such as the building and maintenance of roads, serve multiple populations. In addition to loggers, hunters and recreational visitors use these roads as well (*USDA Forest Service Roads*, n.d.). Merely recategorizing this spending as “recreational” would not change any real-life practices, though it would address the stated problem, so it may be best not to bother and allow present trends to continue. If present trends continue, an expected 2.5 BBF of timber will be harvested each year for the next ten years, for a total of 25 billion board feet of timber harvested.

Option 2: Subsidize Maintenance of Carbon Sinks by Local Forest Services

For the last few years, it has been common practice to subsidize private companies who engage in carbon sequestration through tax credits (Temple, 2018). This sequestration usually involves “carbon capture” technology used to remove carbon out of the atmosphere; the subsidies are justified by the price of the technology. This alternative proposes a similar program: subsidizing local Forests for trees that are *not* cut down in the name of carbon sequestration. This would incentivize local Forest Services to limit timber harvesting, thus redirecting money from preparing for timber sales to other efforts such as conservation.

Studies of forests in other countries have shown that monetizing the value of carbon to would-be loggers reduces deforestation (Guthrie & Kumareswaran, 2007). In addition to improving environmental outcomes, a reduction in timber supply would also drive prices up, eliminating at least some of the need for government subsidies; that is, if nominal timber prices reach market value, the government will no longer need to subsidize timber harvesting.

The subsidy should vary by forest and be competitive with the average market price for timber for that area. For example, in Virginia, costs range from \$8.00 to \$30.00 in per stumpage ton (the price of timber before it is cut) depending on tree type and use (ex. pine pulpwood versus hardwood sawtimber), but on average timber costs \$18.00 per stumpage ton (Stelzer, 2011; *Timber Prices*, n.d.). Given current costs of carbon in regions with a carbon market, a subsidy for \$50 per ton of carbon sequestered should be offered. This subsidy is high enough to incentivize saving some trees from harvest, but low enough to be realistically implemented and offset the costs of harvest. This would result in a ten year decrease of roughly 3 billion board feet of timber.

Option 3: Completely Limit Logging of Old Growth

Old growth forests are still being harvested, to the dismay of environmental groups across the country. For example, a recent contract in Alaska's Tongass National Forest includes logging of over 6,000 acres of old growth and is the largest old growth timber sale in over two decades (Earth Justice, 2015). This decision comes in spite of a 2016 commitment by the NFS to move away from old growth logging (Dobbs, 2018). Despite numerous appeals, the decision was maintained and the logging company was allowed to harvest the old growth trees (Lenhart, 2017). Even before this contract, over 96% of the old growth in the Tongass National Forest has been cut down, and similar numbers are mirrored around the country (Davis, 2018).

As it stands now, old-growth harvesting laws differ by state. Protecting these sections of forest has garnered bipartisan support recently, indicating that the political climate is at least receptive to a policy like this (Greene, 2019). Given the extreme level to which old growth has already been harvested, old growth forests should be 100% protected from all harvesting; this could be accomplished via Congressional action to ban old growth harvesting on federal lands. For feasibility purposes, this limit could be phased in, with an immediate 75% protection limit imposed, with this limit increasing by five percentage points each year for the next five years. This translates to 0.5 billion board feet of timber saved over ten years of the program by eliminating old growth logging.

Option 4: Amend National Forest Management Act

The National Forest Management Act authorizes the NFS to manage timber and other resources. It is revised at least every 15 years. One important criterion is that the NFS must designate lands that are *not* suited for timber harvesting (Riddle, 2019). Any land not identified in this way is eligible for timber sales; though there are still some other limits on timber sales, this requirement works as an “opt-in” policy, where some areas “opt” into protected status by the NFS. This could be amended such that the NFS must positively identify land that is approved for harvesting.

Research in social psychology has illustrated that opt-in and opt-out policies work in dramatically different ways (Yan & Yates, 2019). In this case, protected status is a desired label. Therefore, changing this policy to an opt-out system, whereby NFS must positively identify areas that are not protected (i.e. eligible to be harvested) could reduce exploitative contracts.

Obviously, at least theoretically, NFS designations are based in objective observations about the different regions of each forest, not psychological tendencies of rangers. However, given the fact that there are 188 million acres of forest under NFS jurisdiction, it is likely that many of these areas are never explored by the rangers who set the designations. Changing this policy could ensure that only areas adequately assessed are set as suitable for timber harvesting, rather than leaving areas only cursorily analyzed as vulnerable to timber sales.

By switching to a proactive designation, exploitative contracts would be less likely. This also could create jobs as more NFS employees may be needed to survey the land. Switching this policy to an “opt-out” of protected status rather than opt-in would decrease the amount of land available to harvesting, thus decreasing the amount of money spent preparing forests for timber sales.

In the state Washington, private landowners can apply to designate their lands as forests in order to harvest the timber, qualify for tax breaks, and other benefits (*Washington – National Timber Tax*, n.d.). Using data from this program, switching to an opt-in system would result in a decrease by 25% in land designated for timber use (*Washington State Property Tax*, n.d.). Using this ratio, we can predict this option would save 7 billion board feet of timber during implementation.

Option 5: Mandate Timber Contracts Reflect Market Prices

For nearly two decades, timber sales have been subsidized by the federal government and sold below market value, costing taxpayers nearly \$2 billion (Talberth, 2019). These subsidies come from an interpretation of a 1976 Alaskan law permitting sales up to 450 million board feet of timber per year as a requirement to sell that much timber (Daugherty, 1994). Since then, the federal government has provided money to state-level Forest Services to prepare lands for timber. The subsidies mean that local Forests have no incentive to sell the wood at market price, and as such are harvesting too much wood (MacCleery, n.d.).

By requiring contracts to sell timber at fair market value, the NFS can decrease the amount of money spent preparing forest for timber to match revenues. This will need to be phased in, as the NFS certainly has ongoing contracts that do not meet this requirement; these could be grandfathered in, but their possibility for extension should be eliminated. Accounting for a slow implementation, this would total a decrease of 12 billion board feet of timber after ten years.

Outcomes Matrix

	Cost - Effectiveness (40%)	Political Feasibility (30%)	Administrative Feasibility (20%)	Equity (10%)	Weighted Total
Status Quo	\$69.60 / MBF	High (1)	High (1)	Medium (2)	28.44
Subsidize Carbon	\$69.60/ MBF	Medium (2)	High (1)	Medium (2)	28.74
Eliminate Old Growth Logging	\$51.44 / MBF	Medium (2)	Medium (2)	High (1)	21.68
Amend the NFMA	\$89.34 / MBF	Low (3)	Low (3)	High (1)	37.34
Mandate Market Prices	\$69.52 / MBF	Low (3)	High (1)	Low (1)	29.01

Notes: A lower total score indicates a better policy. Since cost-effectiveness is better when lower, I coded qualitative scores as high = 1, medium = 2, and low = 3 in order to find a weighted total. For a technical description of cost-effectiveness, see Appendix C.

Explanation of Findings

Cost-Effectiveness

Both subsidizing carbon and mandating market prices have cost-per-million-board-feet quite close to the status quo because both of these options attempt to reduce cost by reducing total harvest, and because the carbon subsidies, at \$50/ton, are – by design – negligible compared to the cost of harvesting the timber. Amending the NFMA to require identifying permissible timberland (rather than protected land) has heavy upfront costs due to increased personnel needs. Eliminating old growth logging is most cost-effective because old growth costs approximately 30% less than younger forests (Alexander, Henderson & Coleman, 2010).

Political Feasibility

Unfortunately, amending the NFMA and mandating market prices have no real support in Congress and would likely take massive efforts by advocates in order for change to occur via either of those methods, so they are rated low. However, there is already precedent for carbon subsidies of forests in Alaska and California (Friedman, 2018). Additionally, the Northwest Forest Plan gathered bipartisan support in 2015 and included a ban on all of old growth logging (“Northwest Forest Plan,” n.d.). Given these past practices, it is possible that both of these could gain traction in Congress and earn a medium ranking.

Administrative Feasibility

While all options can be handled internally within the NFS, subsidizing carbon and mandating market prices are by far the easiest – besides the status quo – to implement. They would both mandate new requirements for timber contracts, but would not require any changes in how timber is actually harvested, so they are highly feasible. While it would be cheaper to eliminate old growth logging, initially some timber practices would have to change, including most likely the removal of roads heading into old growth areas and perhaps more road building in younger forests; ultimately, this could lead to some trouble with implementation initially. Finally, managing the National Forests would look entirely different under the NFMA Amendment, leading to staffing changes and new practices that would be difficult and time-consuming to implement.

Equity

Amending the NFMA is the only alternative that would create jobs, leading this alternative to rank high in equity. Mandating market-price contracts would reduce timber harvesting the most, leading to the highest loss of jobs. Both carbon subsidies and old growth logging bans would only have a moderate impact on timber harvests, so few jobs would be lost. However, the elimination of old growth logging has been advocated for by indigenous groups (“Sealaska Forests Provide Benefits...”, n.d.); since indigenous Americans are a historically marginalized population, the fact that this option benefits them leads it to rank high.

Recommendation: Option 3, Eliminate Old Growth Logging

Given the findings above, I recommend Alternative 3, eliminating all old growth logging in the U.S. via legislation. This option is by far the most cost-effective, and in progressing toward the goals of indigenous Americans, is highly equitable. While there are some feasibility trade-offs, both with political feasibility and implementation, these can be addressed. With concentrated efforts from NGOs and other advocates, enough public support can be built in order to overcome potential political opposition. All administrative feasibility problems would likely be short-lived, meaning they too could be managed.

Implementation

The best way for this option to be enacted would be Congressional action. If a law is passed outlawing the harvesting of old growth, the ecological benefits would be even greater because it would also apply to privately owned and managed forests. Short of this, individual forests could choose to enact this on their own. With 116 (out of 130) forest plans soon to be revised or currently under revision, target advocacy campaigns focused on each plan could be successful in eliminating old growth timber harvesting as well (“Status of Forest Service...”, 2018).

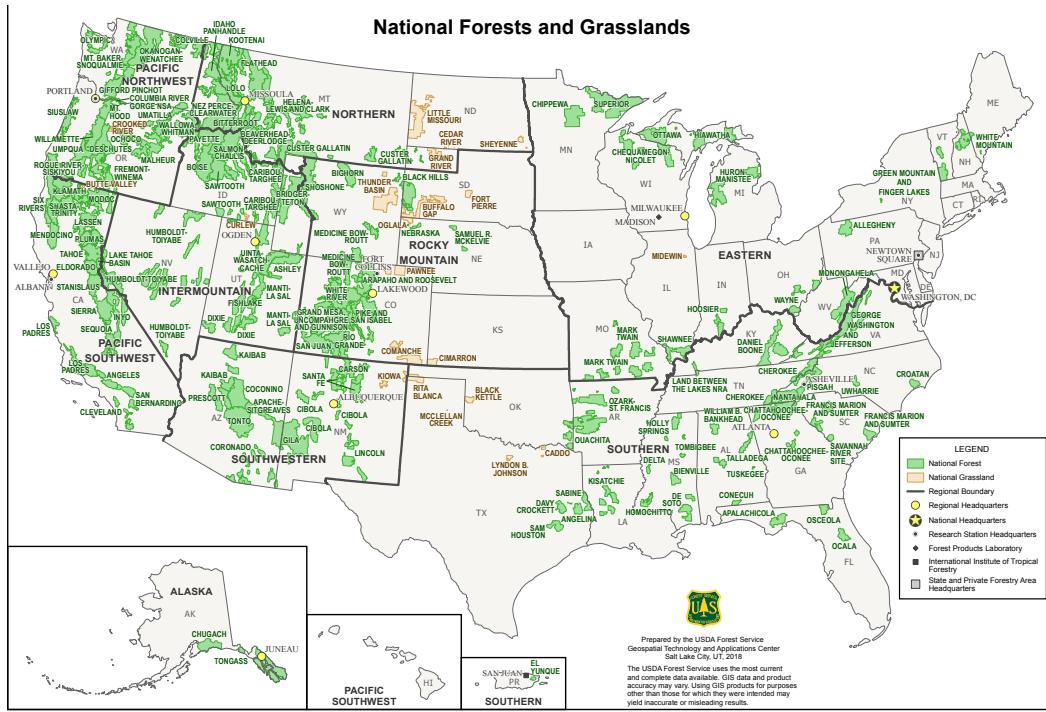
The most pushback on this initiative will come from loggers, who often are willing to engage in higher-cost harvesting because older trees are typically larger and thus yield more wood than newer growth. However, since only 1-2% of all national forest logging is old growth, this should not be too big of a problem. If necessary, some of the money saved could be used to initially compensate, or perhaps even buy out, old-growth loggers in order to mitigate any opposition.

Environmental groups should support this option, as it not only reduces logging but also increases funds available for other projects such as wildlife management or conservation initiatives. For the same reasons, forest rangers and other local managers are also likely to be on board. Finally, legislators in both chambers of Congress have little reason to be against this initiative, so the bigger challenge will be making sure it becomes a high enough priority to be enacted. President Trump recently passed an executive order permitting old growth logging in Alaska; a new president could overturn this – and a Democratic candidate would be likely to do so – or efforts could be made to repeal it, including leveraging the fact that Alaska is a traditionally Republican state and doing so could boost Trump’s image in the eyes of voters.

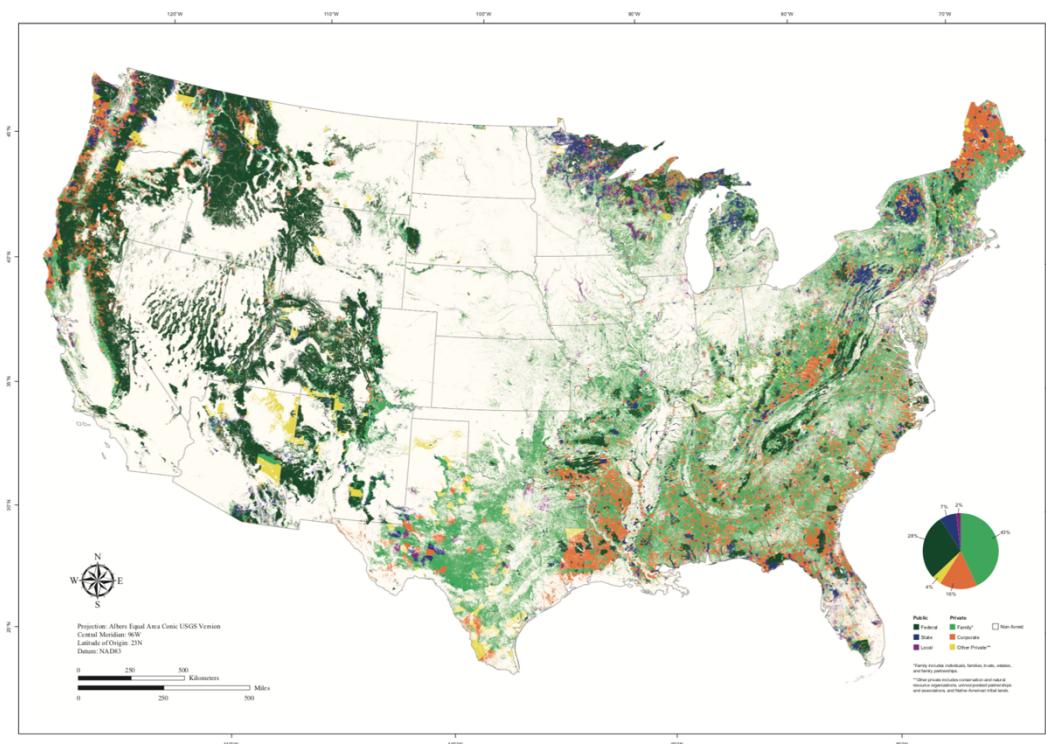
A potential “worst-case-scenario” for this problem could be further action taken to increase old growth logging. However, given both the long-term nature of contracts (i.e. the potential to buy loggers out early before too much harvesting has occurred) and the high expense of old growth logging, this is not very likely to occur. Another risk could be sudden mass organization by timber companies that oppose this plan, which would make enactment more difficult, but again seems unlikely to occur. Finally, if the implementation of this plan leads to NFS budget cuts, it may not leave enough money for conservation projects to satisfy ecological groups and therefore leave the original problem unresolved; this is the biggest and most likely risk, and it will be important to address during implementation to be sure that it cannot happen.

Appendix A: Maps regarding forest ownership and use

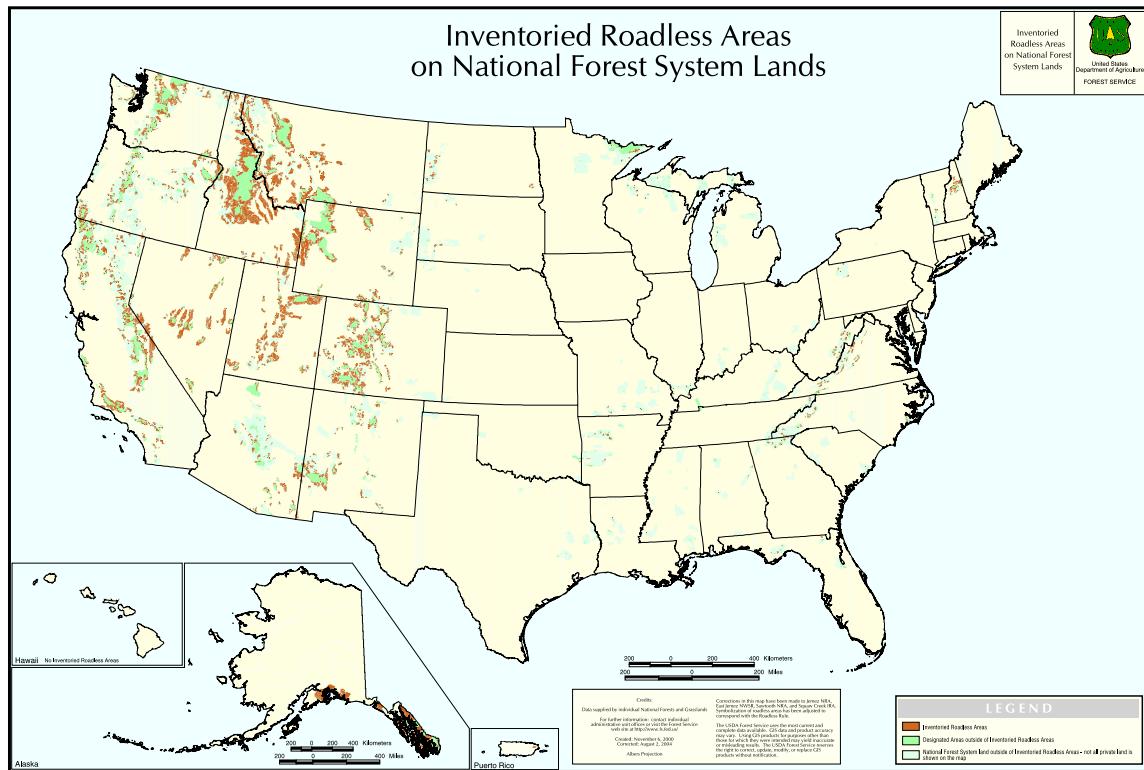
Map 1: National Forests and Grasslands in the United States (managed by NFS)



Map 2: Ownership of forests in contiguous United States



Map 3: Roadless areas in NFS lands



Roadless areas, though not all protected/reserved, are a good proxy for which regions of the country *are* protected federally from harvesting.

Appendix B: Detailed explanation of costs to society

Assumption: Overharvesting is occurring by 50%.

Accounting Costs

The \$1.5 billion per year figure was estimated by the Center for Sustainable Economy (Talberth, 2019).

Carbon Sequestration

Assuming an average 208 board feet per tree:

2.6 billion board feet \div 208 = 12.5 million trees

12.5 million trees * 48 pounds CO₂ sequestered per year = 600 million pounds CO₂ sequestered per year

600 million pounds CO₂ sequestered per year \div 2,000 pounds per ton = 300,000 tons CO₂ sequestered per year

300,000 tons CO₂ sequestered per year * \$200.57 per ton = \$60.171 million per year

\$60.171 million per year * 0.5 overharvest = \$30,085,500

Water Filtration

\$70.39 average cost of water per family per month \div

(4 people * 100 gallons * 30 days) = \$0.005865 per gallon per day

60 million people * 88 gallons per day = 5.3 billion gallons of water per day

5.3 billion gallons of water per day * \$0.005865 per gallon = \$31 million per day

\$31 million per day * 365 days = \$11.3 billion per year

\$11.3 billion per year * 0.5 overharvest = \$5.7 billion

Recreation

\$13 billion per year - \$4 billion revenue from ski resorts = \$7 billion

\$7 billion * 0.5 overharvest = \$3.5 billion

Passive Use

\$280 million per year in 2000 * (106.10422 / 67.619) = \$439,358,392 in 2017 USD

\$439 million per year / 42 million acres = \$10,460,914 per acre

\$10.4 milion per acre * 58.5 million acres = \$611,963,474 per year

Appendix C: Detailed explanation of cost-effectiveness analysis

For all options, both board feet of timber (in thousands) and costs to harvest were projected out over a ten-year period and then discounted back at the OMB suggested rate of 7%. Finally, total discounted costs were divided by total discounted board feet harvested to determine the present cost-per-MBF harvested.

Status Quo:

Assumption: Board feet harvested will increase linearly by 67,832.55 MBF each year (as they did on average from 2007-2017).

Assumption: Costs to harvest will increase linearly by \$5,105,342 each year (as they did on average from 2007-2017).

Carbon Subsidies:

Assumption: Board feet harvested will be 10% less than the status quo each year based on Sealaska predictions.

Assumption: Costs to harvest will be 10% less than the status quo each year, since trees saved for carbon sequestration are not inherently more or less expensive to harvest.

Eliminate Old Growth Logging:

Assumption: Board feed harvested will be phased in over 5 years to reach 2% less than the status quo each year, then continue at 2% below the status quo each year.

Assumption: Costs to harvest will be phased in to reach 30% less than the status quo each year, as old growth is more expensive to harvest (Alexander, Henderson, & Coleman, 2010).

Amend the NFMA:

Assumption: Board feet harvested will be 25% less than the status quo each year based on Washington private forestry tax program.

Assumption: Costs to harvest will be 25% less than the status quo each year since changing regions permissible to harvest does not inherently change costs to harvest, but include an added \$90 million in years 1-4 to include additional land management costs (increase of 50% from current land management costs).

Market Prices:

Assumption: Board feet harvest will decrease by 10 percentage points off the status quo for 5 years, then hold steady at 50% of the status quo. This is conservative, as market prices are 1/3, not 1/2, current sale prices.

Assumption: Costs to harvest will decrease the same way, since selling trees at market value does not change the costs to harvest.

Status Quo		
	Cost	Harvest (mbf)
Year 0 (2017)	\$ 178,752,817.00	2,595,688.00
Year 1	\$ 183,858,159.00	2,663,520.55
Year 2	\$ 188,963,501.00	2,731,353.10
Year 3	\$ 194,068,843.00	2,799,185.65
Year 4	\$ 199,174,185.00	2,867,018.20
Year 5	\$ 204,279,527.00	2,934,850.75
Year 6	\$ 209,384,869.00	3,002,683.30
Year 7	\$ 214,490,211.00	3,070,515.85
Year 8	\$ 219,595,553.00	3,138,348.40
Year 9	\$ 224,700,895.00	3,206,180.95
Year 10	\$ 229,806,237.00	3,274,013.50
	NPV cost (7%)	NPV harvest (7%)
	\$ 1,432,840,141.89	20,587,470.32
		Cost/mbf
		\$ 69.60

Carbon Subsidies		
	Cost	Harvest (mbf)
Year 1	\$ 165,473,879.75	2,397,168.50
Year 2	\$ 170,068,726.68	2,458,217.79
Year 3	\$ 174,663,573.61	2,519,267.09
Year 4	\$ 179,258,420.55	2,580,316.38
Year 5	\$ 183,853,267.48	2,641,365.68
Year 6	\$ 188,448,114.42	2,702,414.97
Year 7	\$ 193,042,961.35	2,763,464.27
Year 8	\$ 197,637,808.29	2,824,513.56
Year 9	\$ 202,232,655.22	2,885,562.86
Year 10	\$ 206,827,502.15	2,946,612.15
	NPV cost (7%)	NPV harvest (7%)
	\$ 1,289,568,005.09	18,528,723.28
		Cost/mbf
		\$ 69.60

Eliminate Old Growth Logging		
	Cost	Harvest (mbf)
Year 1	\$ 142,490,073.23	2,623,567.74
Year 2	\$ 143,612,260.76	2,687,651.45
Year 3	\$ 144,581,288.04	2,751,599.49
Year 4	\$ 145,397,155.05	2,815,411.87
Year 5	\$ 146,059,861.81	2,879,088.59
Year 6	\$ 146,569,408.30	2,942,629.63
Year 7	\$ 150,143,147.70	3,009,105.53
Year 8	\$ 153,716,887.10	3,075,581.43
Year 9	\$ 157,290,626.50	3,142,057.33
Year 10	\$ 160,864,365.90	3,208,533.23
	NPV cost (7%)	NPV harvest (7%)
	\$ 1,039,650,243.32	20,211,031.83
		Cost/mbf
		\$ 51.44

Amend the NFMA		
	Cost	Harvest (mbf)
Year 1	\$ 227,893,619.25	1,997,640.41
Year 2	\$ 231,722,625.75	2,048,514.83
Year 3	\$ 235,551,632.25	2,099,389.24
Year 4	\$ 239,380,638.75	2,150,263.65
Year 5	\$ 153,209,645.25	2,201,138.06
Year 6	\$ 157,038,651.75	2,252,012.48
Year 7	\$ 160,867,658.25	2,302,886.89
Year 8	\$ 164,696,664.75	2,353,761.30
Year 9	\$ 168,525,671.25	2,404,635.71
Year 10	\$ 172,354,677.75	2,455,510.13
	NPV cost (7%)	NPV harvest (7%)
	\$ 1,379,479,119.50	15,440,602.74
		Cost/mbf
		\$ 89.34

Mandate Market Prices		
	Cost	Harvest (mbf)
Year 1	\$ 165,472,343.10	2,397,168.50
Year 2	\$ 151,170,800.80	2,185,082.48
Year 3	\$ 135,848,190.10	1,959,429.96
Year 4	\$ 119,504,511.00	1,720,210.92
Year 5	\$ 102,139,763.50	1,467,425.38
Year 6	\$ 104,692,434.50	1,501,341.65
Year 7	\$ 107,245,105.50	1,535,257.93
Year 8	\$ 109,797,776.50	1,569,174.20
Year 9	\$ 112,350,447.50	1,603,090.48
Year 10	\$ 114,903,118.50	1,637,006.75
	NPV cost (7%)	NPV harvest (7%)
	\$ 881,545,005.12	12,680,861.95
		Cost/mbf
		\$ 69.52

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