Oregon Department of Forestry Habitat Conservation Plan

A Business Case Analysis

October 2018

Prepared for:

Oregon Department of Forestry

FINAL REPORT

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Acknowledgments

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ECONorthwest and ICF prepared this report to the Oregon Department of Forestry, with substantial assistance from Richard Haynes, and Robert Monserud. Numerous ODF staff contributed extensively to these analyses, as well as valuable review and comment by the project's Scoping Committee and Steering Committee members.

That assistance notwithstanding, ECONorthwest is responsible for the content of this report. The authors prepared this report based on their general knowledge of the Habitat Conservation Plan preparation process, forestry and forest economics, policy analysis, and financial analysis, and on information derived from government agencies, private statistical services, the reports of others, interviews of individuals, or other sources believed to be reliable. ECONorthwest has not independently verified the accuracy of all such information, and makes no representation regarding its accuracy or completeness. Any statements nonfactual in nature constitute the authors' current opinions, which may change as more information becomes available.

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Executive Summary

Key Findings

- *HCP preparation would cost ODF up to **$4.0 million** over three years.*
- *An HCP would reduce average annual ESA compliance costs by approximately **$2.2 million**.*
- *Over a 50-year timeframe, acres available for harvest would likely increase from the current 51 percent of all BOF forest lands to **63 percent** with an HCP. Without an HCP, available acreage is expected to decline to **46 percent**.*
- *Annual harvest net revenues would likely increase from current $50 million to **$53 million** with an HCP while dropping to **$26 million** by 2070 without an HCP.*
- *The cumulative net present value of the HCP investment over 50 years of implementation is worth over **$250 million** relative to without an HCP.*

Introduction and Background

State forestlands in western Oregon provide habitat for several fish and wildlife species protected under the Endangered Species Act (ESA). As such, forest management activities must comply with ESA requirements, ensuring that no "take"[1] of listed species occurs. Without an incidental take permit, provided by a Habitat Conservation Plan (HCP), the Oregon Department of Forestry (ODF) employs a "take avoidance" approach to ESA compliance. The take avoidance approach costs ODF millions of dollars in survey and monitoring costs annually, and creates uncertainties in timber harvest levels. As the number of listed species increases, ODF faces growing challenges to generate a sustainable and predictable stream of revenue from timber harvest activities while avoiding harm to listed species.

In November 2017, the Board of Forestry (BOF) directed ODF staff to evaluate whether or not pursuing an HCP, and an associated incidental take permit, makes sense from a business perspective. This report addresses the business case by providing analysis on two related questions: what are the estimated costs of developing and implementing an HCP, and how would an HCP affect ODF management activities including costs and revenue? The findings of the analysis allow ODF staff and the BOF to better understand how ODF revenue would respond over time under two scenarios: 1) adopting and implementing an HCP, versus 2) continuing the current "take avoidance" strategy. This executive summary provides a brief synopsis of analysis methods, assumptions, and findings. More detail is provided in the HCP Business Case Analysis Report.

ODF has a long history of adjusting management activities to avoid take of listed species. For almost thirty years, ODF management has been significantly affected by the northern spotted owl, marbled murrelet, and several fish species such as coho salmon. Additional species known

[1] Take is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 U.S. Code [USC] 1532). Harm includes "significant habitat modification or degradation."

to exist on or adjacent to ODF lands are expected to become listed in the near future; these listings are likely to further constrain ODF's management activities.

The take prohibitions of Section 9 of the ESA are strict, and come with serious penalties for violations. In addition, the ESA has provisions that allow citizens to sue ODF and the federal wildlife agencies for non-compliance. To avoid these risks, ODF may seek to obtain incidental take authorization from the federal government.

The incidental take permit application must include an HCP that describes the requested take authorization and the avoidance, minimization, and mitigation measures the applicant proposes to offset the take of each species covered by the HCP. The HCP must also describe a monitoring and adaptive management program and provide assurances to the federal agencies that the applicant is able to fully fund HCP implementation, among other requirements.

It is important to recognize that ODF operates under certain legal mandates, most significantly, BOF lands are managed to meet "Greatest Permanent Value" (GPV). This includes providing a full range of social, economic, and environmental benefits to the people of Oregon. A key component of GPV is to maintain these lands as forest lands and actively manage them in a sound environmental manner to provide sustainable timber harvest and revenues to the state, counties, and local taxing districts. Under the current revenue distribution law, approximately one-third of the revenue generated from the timber harvest goes to ODF for operating costs and the remaining revenue goes to the counties and local taxing districts.

The current Forest Management Plan (FMP) is the primary mechanism for achieving GPV, and serves as the baseline to evaluate costs for each scenario in this analysis. This study presents a range of possible outcomes (not negotiation starting points) to inform the BOF in its consideration of whether or not to continue pursuing an HCP. The actual details of an HCP for ODF would be the result of negotiations with state and federal wildlife agencies. Should the BOF continue to pursue an HCP, ODF would begin working with state and federal wildlife agencies to negotiate and evaluate potential strategies to be included in an HCP.

Scope of the Analysis

Timeframe. The analysis considers a 3-year HCP planning timeframe (2018-2020) followed by a 50-year time horizon (2021-2070) under all scenarios, which is approximately equivalent to the time period an HCP would likely cover, if implemented. Future costs and benefits are discounted at a 3 percent real rate. Values are in constant 2018 dollars (without inflation).

Geography. The analysis covers BOF lands in western Oregon, including those in all 8 districts from Astoria in the north to Southwestern Oregon to the south. It does not include lands in the Klamath-Lake district or in eastern Oregon. Due to uncertainty regarding ODF's future management of Common School Forest Lands, only BOF lands were included in the business case results. The included land is referred to as the "plan area".

Covered Species. The plan area includes a range of forest resources that support a variety of species, including several species listed under state and federal endangered species protection

laws. The analysis team worked with ODF staff to identify a list of 16 species expected to be proposed for coverage in an HCP (Table 1). This species selection process is preliminary, but it was reviewed by staff from the United States Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration Fisheries (NMFS), and Oregon Department of Fish and Wildlife (ODFW). If the BOF decides to pursue an HCP, ODF would verify this species selection process with additional data and with further input from state and federal agencies.

Table 1. List of Covered Species Assumed for the HCP Business Case

Aquatic Species (NMFS Jurisdiction)	Wildlife Species (USFWS Jurisdiction)
Oregon Coast coho *(Oncorhynchus kisutch)*	Oregon slender salamander (*Batrachoseps wrighti)**
Lower Columbia River coho (*O. kisutch)*	Columbia torrent salamander (*Rhyacotriton kezeri)**
Upper Willamette River spring chinook (*O. tshawytscha)*	Cascade torrent salamander (*R. cascadae)**
Upper Willamette River winter steelhead (*O. mykiss)*	Northern spotted owl (*Strix occidentalis)*
Lower Columbia chum (*O. keta)*	Marbled murrelet (*Brachyramphus marmoratus)*
South Oregon/Northern California coho (*O. kisutch)*	Red tree vole (*Arborimus longicaudus)**
Lower Columbia chinook (*O. tshawytscha)*	Coastal marten (*Martes caurina caurina)**
Lower Columbia steehead *(O. mykiss)*	
Eulachon *(Thaleichthys pacificus)*	

Notes: * Indicates species that are not currently listed as federal threatened or endangered, but which are expected to become listed during the analysis timeframe.

Methods and Assumptions for the Analysis

This analysis defines and models effects on ODF's costs and management activities for two scenarios: 1) continuing take-avoidance (the "**No HCP Scenario**") and 2) preparing and implementing an HCP (the "**HCP Scenario**"). Because the purpose of this analysis is to help ODF staff and the BOF decide whether to move forward in developing an HCP, the analysis team made some assumptions about what an HCP would include, but could not fully develop or define the HCP. Therefore, the analysis presents findings that are not precise or spatially explicit, but are accurate within appropriate ranges of assumptions to support ODF's decision process.

The project team (ECONorthwest and ICF) considered low and high bounding scenarios around the "most likely" scenario for both HCP and no HCP to provide more confidence in the findings should key assumptions differ from those incorporated into an HCP. Upper and lower bounds are primarily based on possible future cost and species conservation acreage requirements. Ranges do not incorporate changes in stumpage prices or deviation from the current FMP in terms of harvest scheduling principles. In general, ranges of outcomes are provided rather than point estimates to better demonstrate this uncertainty.

To develop the analysis, the project team worked closely with ODF staff to identify and interpret relevant data on costs, forest inventory, and management activities; develop assumptions about future conditions; and review model inputs and outputs. The project team contributed their subject-matter expertise and knowledge developed from experience preparing and implementing over 75 HCPs around the country to vet and affirm all data and assumptions that were ultimately used in the analysis. Timber inventory and harvest plans are based on comprehensive inventory data and district-level implementation plans for the six districts with the greatest BOF forest acreage: Astoria, Forest Grove, Tillamook, West Oregon, North Cascade,

and Western Lane. Harvest plans for Coos and Southwest are extrapolated from the above six districts with Implementation Plans based on inventory proportions.

Key Assumptions. Assumptions applied in this analysis include future species conditions and policy, market conditions, and a range of negotiated terms of a potential HCP. Although these assumptions hold a degree of inherent uncertainty, they are based on review of the best available data, and are described in more detail in the main report.

Key assumptions for the most likely HCP and No HCP Scenarios are:

- Agency costs will increase at a real (inflation adjusted) rate of 0.5 percent annually.
- Under the No HCP Scenario survey costs and ODF administrative costs will continue to rise due to increased effort over time at about 2.8 percent annually to maintain the no take approach to ESA compliance.
- Initial constraints are based on take avoidance protections associated with sites currently occupied by listed species.
- Under the HCP Scenario, increased stream buffers would decrease acres available for harvest by about 11,000 acres immediately based on HCP's covering similar species elsewhere.
- Under the HCP Scenario, conservation acreage for northern spotted owl and marbled murrelet would increase by 15,000 acres under the HCP, and an additional 20,000 acres for new species listings (for a total of 46,000 acres in both terrestrial protections and stream buffers).
- Under the No HCP Scenario, constrained acreage due to habitat requirements for the northern spotted owl, marbled murrelet, and future listed species would gradually increase over time by about 59,000 additional acres by 2070.
- Under the HCP Scenario, areas currently managed with limited harvest (about 10 percent)—landscape design and conservation (Terrestrial Anchor Sites)—would gradually be released back to available acres.
- Timber prices are the average of ODF stumpage prices from 2013 to 2017 ($350/MBF).
- Harvest schedules assume implementation of non-declining even flow.
- Harvest schedules were adjusted to update for current inventory levels.
- Future costs and benefits are discounted at a real (inflation-adjusted) discount rate of 3 percent.

Actions Affected

The HCP is likely to affect only a subset of actions that ODF engages in while fulfilling its mission. The analysis focuses on those actions that may result in changes in cost and revenue to ODF, if an HCP were pursued. It is based on the expert judgement of the project team and input from ODF staff. These actions include:

- **Administration of ESA Compliance**—Staff time is required to ensure ODF is operating in compliance with the ESA, including internal coordination with harvest planners, and coordination with USFWS, NMFS, and ODFW to confirm take avoidance. ***From a business case perspective, changes in these actions affect ODF costs.***
- **Pre-Harvest Species Surveys**—Efforts are undertaken to survey for species presence in harvest units prior to offering units for harvest. ***From a business case perspective, changes in these actions affect ODF costs.***
- **Species Habitat Management Actions**—Efforts are undertaken to monitor the forest and collect data to determine if species and habitat management activities are achieving their intended objectives. This monitoring is distinct from pre-harvest surveying. ***From a business case perspective, changes in these actions affect ODF costs.***
- **Harvest Activities and Inventory Management**—All activities involving planning and design of harvest units, redesign efforts should surveys identify the presence of listed species, and restrictions imposed on harvest to avoid take. ***From a business case perspective, changes in these actions affect ODF costs and revenues.***
- **Other Activities**—An HCP may affect the planning and implementation of actions affecting other forms of resource planning on ODF lands, including recreation and ecosystem management (which produces goods and services, such as carbon and habitat). Based on discussion with ODF staff, the effects of an HCP on these activities are likely indirect and limited. ***Changes in these actions primarily affect benefits enjoyed by the public, therefore these are less important for a business case analysis; the analysis addresses these effects qualitatively.***

Effects of an HCP

HCP Preparation and ESA Compliance Costs

Table 2 summarizes the costs to ODF for preparing an HCP. Total cost over three years to ODF would be about $4.0 million. In 2018, ODF was awarded a $750,000 USFWS Habitat Conservation Planning Technical Assistance grant to cover Phase 1 of the HCP, offsetting costs for the first year of HCP preparation. ODF would continue to seek grant funding to cover costs associated with developing an HCP, under the direction of the BOF.

Table 2. HCP Preparation Costs

Cost Category	Annual Cost (2018 Dollars)	Total Cost (Over 3 years)
ODF Staffing	$388,000	$1,164,000
HCP Consultant	$450,000	$1,350,000
Economic Consultant	$50,000	$150,000
Environmental Impact Statement (EIS) Consultant	$300,000	$900,000
HCP Facilitators	$165,000	495,000
Total	**$1,353,000**	**$4,049,000**

Annual ESA compliance costs are expected to decline substantially with implementation of an HCP. Starting in 2021, ESA compliance is expected to cost ODF an estimated $5.2 million in

direct administration and species survey costs (Table 3). This amount includes $2.5 million of current species surveys costs as well as an additional estimated $1.7 million due to future listings and increased regulations. Under an HCP, these costs are expected to be less by $2.2 million annually. Species management costs include stream restoration and barred owl control, much or all of which can potentially be provided via grants and partner agency contributions, reducing these costs potentially to zero. This suggests that approximately two years under the HCP should more than pay for the costs to ODF of preparing the HCP in terms of reduced direct costs of ESA compliance.

Table 3. ESA Compliance Costs for ODF With and Without HCP

Cost Category	No HCP	HCP	Annual HCP Cost Savings
Administration of ESA Compliance	$784,000	$490,000	$294,000
Pre-Harvest Species Surveys	$4,216,000[a]	$2,121,000	$2,095,000
Species Management Costs[b]	$150,000	$350,000	($200,000)
Total	**$5,150,000**	**$2,961,000**	**$2,189,000**

Notes: [a] Assumes new species listing would result in over $1.7 million of additional annual survey costs.
[b] Assumes continued grant-funding of stream restoration.

Changes in Timber Harvest and RevenuesFactors Influencing Changes in Harvest

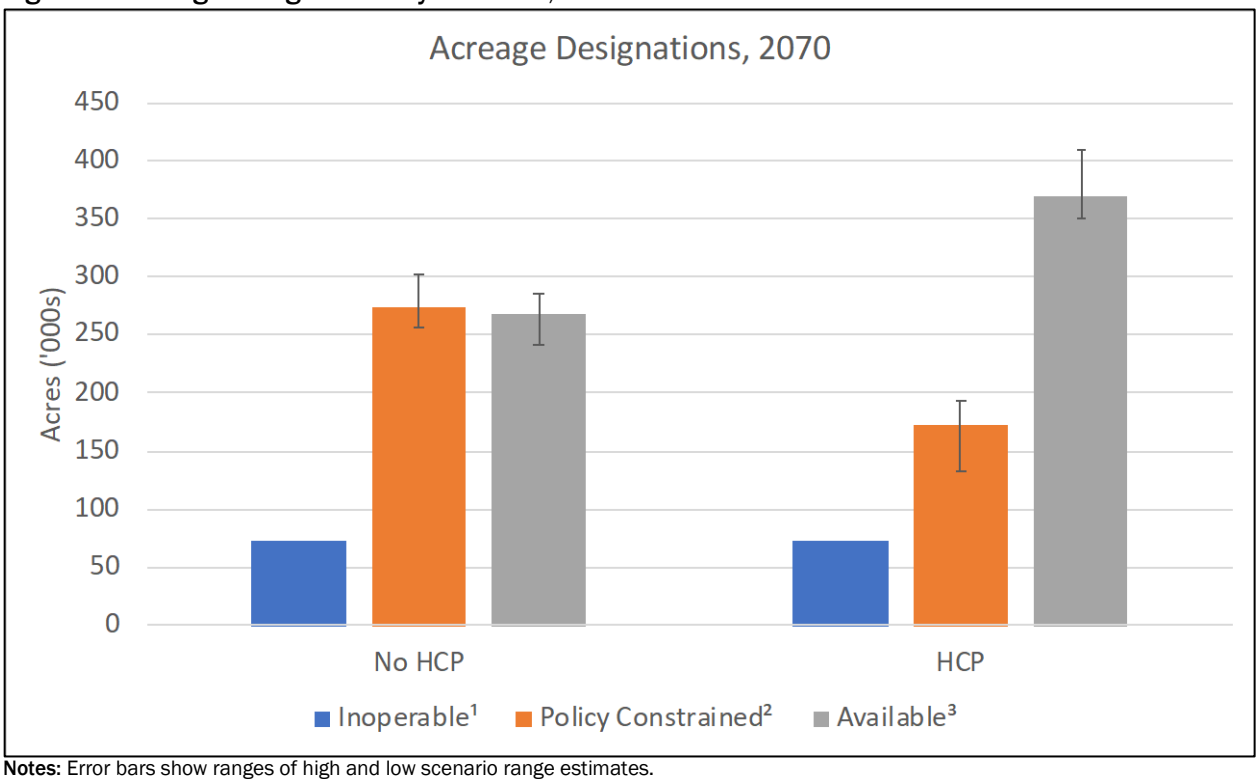
More acres are expected to be available for harvest with an HCP than without by the end of the 50-year implementation timeframe (Figure 1). Without an HCP, future acres available for harvest are expected to decline by approximately 59,000 acres over time due to the expansion of listed species into previously unoccupied areas and protections for newly listed species in areas where previous protections were not needed. These increasing constraints are estimated to occur in areas that are either policy constrained or currently available acres (about 29,500 of each).

In contrast, total available acres for timber harvest are expected to increase over time with an HCP. The expansion of listed species and proetctions for newly listed species are still expected to occur, but with an HCP in place, ODF will retain some operational flexibility to harvest in areas that would otherwise be constrained. Approximately 11,000 of currently available acres become unavailable under an HCP due to a potential increase in stream buffers. An additional 35,000 acres would be excluded from all harvest for protection of northern spotted owl, marbled murrelet and other covered species habitat. These 35,000 acres are primarily drawn from areas currently under policy constraints. With ESA compliance assured under the HCP, a portion of the acres currently constrained for policy objectives can transition over time to fully available for harvest. It is important to recognize that an HCP may require harvest practices that minimize environmental impacts in these areas, nonetheless, it is expected that more acres will be available for harvest over the long-term with an HCP than without.

Acres Available For Harvest

Without an HCP, acres available for harvest are expected to decline from current conditions of 51 percent of BOF forest lands to 46 percent. Under an HCP, acres available for harvest are projected to increase from 51 percent to 63 percent of BOF forest lands. In both scenarios, 72,000 acres are considered inoperable (i.e. roads, non-forest, unable to log and administratively removed areas).

Figure 1. Acreage Designations by Scenario, 2070



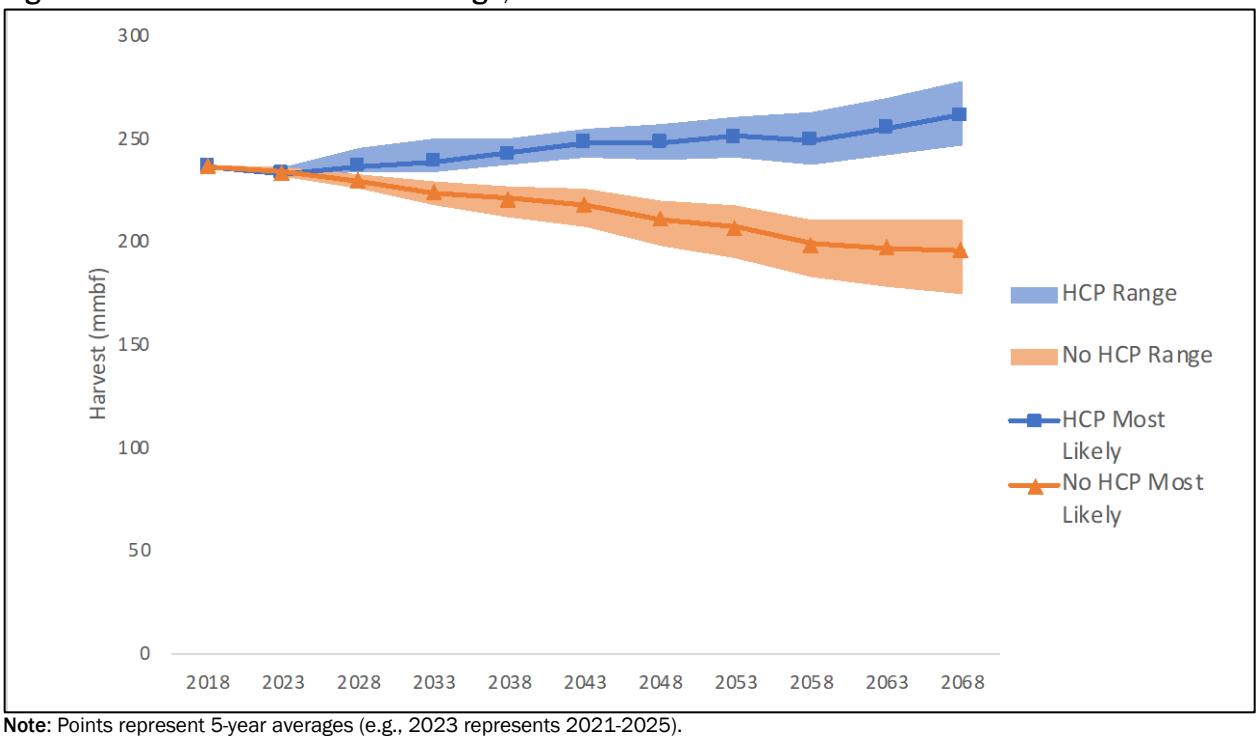
Notes: Error bars show ranges of high and low scenario range estimates.
[1] Inoperable acres either do not hold forest or would be impractical to harvest.
[2] Policy constrained acres are either unavailable for harvest or severely limited for harvest by policy and regulatory constraints (e.g., Oregon Forest Practices Act, federal Endangered Species Act and FMP stream buffers).
[3] Available acres would be available for harvest according to appropriate policy requirements.

Across the full range of scenarios analyzed, available acres are greater for all with HCP scenarios than all No HCP scenarios by 2070. These resulting acreage ranges are based primarily upon estimated acreage requirements for northern spotted owl, marbled murrelet, and newly listed species. These ranges correspond to available acres as a share of all BOF forest lands at 41 to 49 percent (about 241,000 to about 285,000 acres), for No HCP scenarios, and 59 to 70 percent (about 349,000 to about 409,000 acres) for the with HCP scenarios (Figure 1).

Harvest Volume

Under the HCP Scenario, harvests are expected to stay relatively consistent or slightly climb over time (Figure 2). Decline over the first 5-year period in the HCP Scenario is due to reduction in available acres associated with stream buffer constraints, which would occur immediately. Without an HCP, harvests are expected to consistently decline over time, falling farther and farther below planned harvests. This decline is primarily due to the expected increasein constraints on available acres from expansion of listed species and protections needed for newly listed species. Note that annual variability will cause actual harvest trends to vary more than the chart suggests, although the harvests are expected to be more consistent under an HCP than otherwise.

Figure 2. Annual Harvest Volume Range, With HCP and No HCP

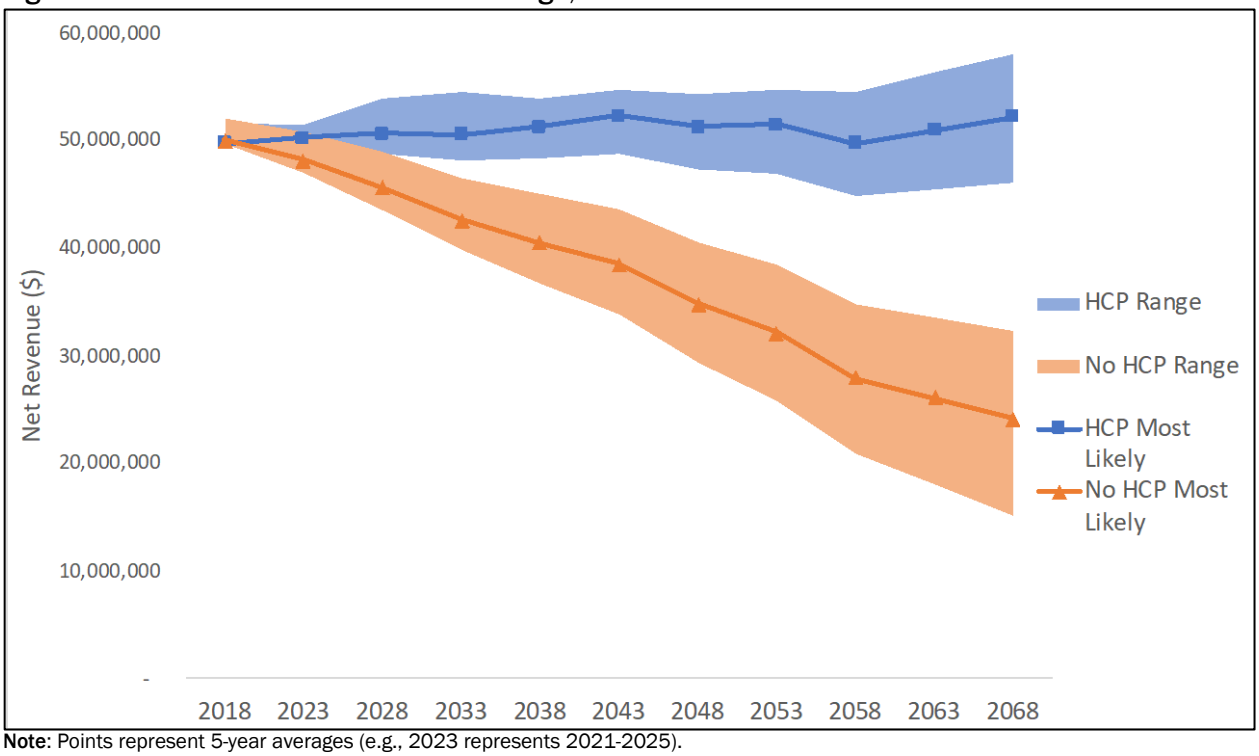


Note: Points represent 5-year averages (e.g., 2023 represents 2021-2025).

Net Revenue

Similar to harvest volume, net revenue is expected to increase under an HCP and decline without one. Net revenue in this case is gross timber revenue including county payments minus ODF costs. The most likely No HCP Scenario shows a decline from current net revenue levels of $50 million down to $26 million annually by 2070, compared to a slight increase to $53 million with an HCP (in 2018 dollars) (Figure 3). These trends are due to the declining available acres for harvest without an HCP combined with climbing cost assumptions across all scenarios, particularly without an HCP.

Figure 3. Annual Harvest Net Revenue Range, With and Without HCP



Note: Points represent 5-year averages (e.g., 2023 represents 2021-2025).

Summed over the 50-year timeframe of 2021 to 2070 and discounted at 3 percent, the cumulative net revenue under the most likely No HCP Scenario would be $900 million compared to $1.15 billion. This is a $250 million net revenue benefit of the HCP over a 50-year timeframe.

Across the range of assumptions for both scenarios, the financial (business case) outcome is better with an HCP than without. In all cases the costs are lower and harvests greater under an HCP. These ranges are based on the highest and lowest estimated costs and acreage constraints identified.

Reduction in Regulatory and Legal Risk

An important benefit of a comprehensive HCP are the regulatory assurances provided by USFWS and NMFS to ODF through the incidental take permits. These assurances guarantee that USFWS and NMFS will not require HCP permittees to provide any more land, water, or money than what is committed to in the HCP in the event of unforeseen circumstances. Unforeseen circumstances are defined as changes to the environment that may affect the status of the covered species that were not anticipated by those who prepared the HCP. These assurances provided by an HCP would enable ODF to greatly reduce the uncertainty and increase the predictability of its costs related to listed and other non-listed species. An HCP may also reduce litigation costs in the long-term, but the present value of these costs is probably not material to the business case. Rather it is the increase in predictability and certainty that is significant.

Conclusions

These analyses suggest that while there are initial costs to prepare an HCP to receive an incidental take permit, annual ESA compliance cost savings achieved by obtaining such a permit more than cover the preparation costs in the first couple of years of implementation. Furthermore, timber harvest revenue is expected to be much greater under an HCP. Without an HCP, harvest volumes and revenues are expected to consistently decline. This results in approximately $250 million in (cumulative) net present value of the HCP over 50 years of timber harvests, in terms of summed net revenue under an HCP vs. without an HCP. In addition, the HCP would reduce litigation risk and associated costs as well as the significant amount of staff time required for continued forest management plan revision processes.

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1 Introduction

1.1 Background

1.1.1 Project Purpose

State forestlands in western Oregon provide habitat for several fish and wildlife species protected under the Endangered Species Act (ESA). As such, forest management activities must comply with ESA requirements, ensuring that no "take" of listed species occurs. Without an incidental take permit, provided by a Habitat Conservation Plan (HCP), the Oregon Department of Forestry (ODF) generally employs a "take avoidance" approach to ESA compliance. This current approach costs ODF millions of dollars in survey and monitoring expenses annually, and creates uncertainties in timber harvest levels. As the number of listed species increases, ODF faces growing challenges to generate a sustainable and predictable stream of revenue from timber harvest activities while avoiding harm to listed species.

In November 2017, the Board of Forestry (BOF)[2] directed ODF staff to evaluate whether or not pursuing an HCP, and an associated incidental take permit, makes sense from a business perspective. ODF contracted with a project team comprised of ECONorthwest (ECONW) and ICF International, Inc. (ICF), hereafter referred to as "the project team" to conduct a Business Case Analysis (BCA). This report addresses the business case by providing analysis on two related questions: what are the estimated costs of developing and implementing an HCP, and how would an HCP affect ODF management activities including costs and revenue? The findings of the analysis allow ODF staff and the BOF to better understand how ODF revenue would respond over time under two scenarios: 1) adopting and implementing an HCP, versus 2) continuing the current "take avoidance" strategy.

1.1.2 Policy Context for ESA-Listed Species Management on ODF Lands

The ESA, Section 9, prohibits the "taking" of species listed as threatened or endangered. Take is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 U.S. Code [USC] 1532). Harm is further defined as including "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering" (50 Code of Federal Regulations [CFR] 17.3). Despite employing policies to avoid take of federally listed species, ODF runs the risk of of such take, incidental to to its forest management activities, including timber harvest.

The species listed under the ESA fall under the jurisdiction of one of two federal agencies. Anadromous fish and most marine species are regulated by the National Marine Fisheries

[2] The Board of Forestry is a citizen Board appointed by the Governor and confirmed by the state Senate, with a mission to lead Oregon in implementing policies and programs that promote sustainable management of Oregon's public and private forests.

Service (NMFS), which is part of the Department of Commerce. All other species are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) in the Department of the Interior.

The take prohibitions of Section 9 of the ESA are strict, and come with stiff penalties for violations. Furthermore, citizens have the ability to sue to enforce the ESA if they believe NMFS or USFWS is not properly enforcing it. Because of the risks of non-compliance, landowners and other non-federal entities must either avoid take of listed species or obtain take authorization from NMFS or USFWS in one of two ways.

If their project or activity requires a federal permit, has federal funding, or occurs on federal land, then the authorization for take can be provided by NMFS or USFWS through a formal consultation with the federal agency involved. This consultation is conducted through Section 7 of the ESA and results in a "Biological Opinion" and incidental take statement. If no such federal nexus exists, non-federal entities, including state agencies, must obtain take authorization by applying for an incidental take permit under Section 10 of the ESA. The incidental take permit application must include an HCP that describes the requested take authorization and the avoidance, minimization, and mitigation measures the applicant proposes to offset the take of each species covered by the HCP. The HCP must also describe a monitoring and adaptive management program and provide assurances to the federal agencies that the applicant is able to fully fund HCP implementation, among other requirements.

ODF has a long history of adjusting its management of state forests to comply with the ESA. The first listed species to substantially affect ODF management was the northern spotted owl, which was listed by USFWS as threatened in 1990. In 1992, USFWS listed the marbled murrelet as threatened. As these listings were proposed and finalized, ODF recognized that their timber harvest and other forest management activities had the potential to take these species on certain state forests. In 1995, ODF secured an incidental take permit for these two species on the Elliott State Forest with an HCP. That permit was valid for 60 years for northern spotted owl, but only 6 years for marbled murrelet due to the uncertainty in the species' biology at the time.

In the early 2000s, ODF began a two-pronged process to address ESA compliance issues more broadly on state forests. First, they began preparing a new HCP for the Elliott State Forest that was intended to replace the 1995 HCP and provide more durable take authorization for a wider range of species. Second, ODF began a detailed analysis of the implications for harvest revenue of pursuing a large-scale HCP across all of the other state forests in western Oregon except for the Elliott State Forest.

In 2008, ODF published a draft HCP for the Elliott State Forest. The 2008 draft HCP proposed covering more than the two listed bird species to include the Oregon coast coho salmon, which was first listed by NMFS as threatened in 1998.[3] The 2008 draft HCP also proposed covering a

[3] Following several court challenges and reviews of the species' status, NMFS reissued the coho listing in 2005, 2008, and 2011.

number of other non-listed species that had the potential to become listed in the future. For a variety of reasons, this HCP was not finalized.[4]

In 2006, ODF published and presented to the BOF the final report of their "Harvest & Habitat Model Project" that examined the economic feasibility of pursuing an HCP on all state forests west of the cascades including Common School Forest Lands besides the Elliott State Forest. This report made several findings after extensive modeling of timber harvest scenarios both with and without an HCP:

- The harvest scenario without an HCP (take avoidance) produced 15 percent greater harvest volume in all seven ODF districts than the harvest scenario with an HCP in the first 10 years and remained higher for the first 30 years.
- Over 150 years, the take avoidance harvest scenario (no HCP) produced 14 percent less harvest volume than the harvest scenario with an HCP because of the constraints of an expanding population of northern spotted owl and marbled murrelet when all take was avoided.
- Habitat quality for northern spotted owl and marbled murrelet improved more quickly with the HCP because more stands were actively managed to benefit the species.

Based largely on the findings of this report, in 2006 the BOF chose not to pursue a large-scale HCP for the western Oregon state forests. It is important to note that the assumptions on which this 2006 report were based are only partially valid today. Several important conditions have changed since 2006, as discussed in this current study. Furthermore, the 2006 analysis only considered costs associated with timber harvest. This current business case analysis considers a wider range of costs and benefits to provide the BOF with a more complete (and more current) assessment of the costs and benefits of an HCP.

Since 2006, ODF has faced increasing challenges in managing state forests consistent with state and federal laws and regulations, including the ESA. Without an incidental take permit, ODF must manage forests to avoid take of listed species. Avoiding take requires extensive and expensive field surveys. ODF biologists must determine annually where these listed species are present in order to determine where timber harvest can and cannot occur. Currently, ODF spends over $2 million annually on these field surveys. Listed species such as northern spotted owl, marbled murrelet, and coho salmon are expected to expand their populations and their range as recovery efforts take hold and begin to improve the species' status. In addition, more species are expected to become listed in the future as threats such as climate change and invasive species continue to expand. The Humboldt marten and red tree vole are current examples of species that USFWS is considering listing in the next several years that could impact ODF operations. Without any incidental take permits, the growing challenges of expanding species and new species listings will make ODF's current efforts to avoid take

[4] In 2017, land management oversight of the Elliott State Forest was transferred to the Department of State Lands. In 2018, this agency began preparing a new HCP for the Elliott State Forest focused just on the three listed species that occur there: northern spotted owl, marbled murrelet, and coho salmon. This HCP is expected to be completed by 2021.

increasingly expensive and restrictive. As discussed in this report, survey and monitoring costs under the current approach (i.e., no incidental take permit) are expected to increase dramatically with each new species listing.

The timing and extent of these expansions by listed species and new species listings are highly uncertain. The growing uncertainty in future harvest locations and harvest amounts creates an increasingly difficult and unpredictable regulatory environment in which ODF tries to operate. Furthermore, take avoidance policies and procedures alone do not constitute a meaningful long-term conservation benefit for listed species.

Continued timber harvest on state forests managed by ODF is critical to the local economies surrounding the forests. About two-thirds of all revenues from BOF lands are distributed to counties (who in turn distribute to local taxing districts) where harvests take place. The amount of local revenue is therefore directly proportional to the amount of timber harvest and the current market price of timber (stumpage price). Continuing the current strategy is expected to further limit timber harvest for the reasons described above. Limiting harvests reduces revenue that is critical to providing services in local communities and to ODF to maintain its operations. Eventually, the current strategy would likely become financially unsustainable.

Habitat conservation plans as an ESA compliance tool are increasingly common around the country. To date, there have been over 1,000 HCPs approved, including many in Oregon, Washington, and California by timber companies and state land management agencies. Table 4 lists examples of approved HCPs around the country with similar permittees, similar covered activities, and a similar scale to the HCP that the BOF is considering pursuing.

In addition to the approved HCPs listed in Table 4, state forestry agencies in five states (Michigan, Minnesota, Missouri, Pennsylvania, and Wisconsin) are currently pursuing large-scale HCPs to provide take authorization for listed species (primarily bats) for their timber harvest and other forest practice activities. The scale of these HCPs ranges from approximately 500,000 acres to over 8.7 million acres.

Table 4. Selected HCPs

HCP	Date Approved	Permittee(s)	Plan Area (acres)	# Covered Species	Permit Term (years)
Millicoma Tree Farm HCP, OR	1996	Weyerhaeuser	209,000	1	50
Plum Creek Central Cascades HCP, WA	2001	Plum Creek Timber Company	418,900	4	50
Washington State Trust Lands HCP	1997	WA Dept. of Natural Resources	1,630,000	9	70
Washington Forest Practices HCP	2009	WA Dept. of Natural Resources	9,300,000	60	50
Green Diamond Owl HCP, CA	1992	Green Diamond Timber (formerly Simpson Timber)	365,000	1	30
Green Diamond Aquatic HCP, CA	2007	Green Diamond Timber Company	365,000	6	50
HCP for Western Snowy Plover, OR	2010	Oregon Parks & Recreation Dept.	230 miles of beach	1	25
Plum Creek Native Fish HCP	2001	Plum Creek Timber Company	1,700,000	11	60
Montana State Lands HCP	2012	Montana Dept. of Natural Resources and Conservation	548,500	5	50
State of Georgia Forest HCP	2005	Georgia DNR	Statewide	1	94

1.2 Overview of the Analysis

This analysis is intended to inform the BOF's decision whether or not to continue to pursue development of an HCP covering forests in ODF's western districts where ESA compliance and valuable timber harvest issues intersect. Therefore it is based on the best available understanding and information regarding the differences in outcomes relative to the decision, projected over the likely life of an HCP. This involves estimating a range of potential requirements under an HCP and how these requirements translate through to outcomes of concern to ODF, in particular regarding financial conditions. The study also develops a comparable forecast of outcomes (with a financial priority) for continuation of ODF's current approach to ESA compliance. Analyses of both tracks (with and without an HCP) involve consideration of trends and likely relevant contextual changes over the timeframe of analysis. To do this work, the project team in collaboration with ODF staff addressed a series of research questions regarding the two future scenarios with and without an HCP:

1. What would it cost ODF to develop an HCP?
2. What species should be covered by an HCP for ODF's western forests?
3. What are the likely effects on management and timber harvest in the future under each scenario?
4. How would ESA compliance costs differ in the future under an HCP relative to the current approach to ESA compliance?
5. How do scenario effects translate to harvest volume, gross timber revenue, net revenue, and other financial considerations for ODF and its stakeholders?
6. Are there other non-timber outcomes where an HCP would likely generate different outcomes than the current no-HCP approach?

This report documents the analyses and results of these investigations and analyses for the purpose of assessing the bottom-line outcomes into the future associated with the decision either to implement an HCP or to continue the current approach.

A fundamental aspect of an HCP and the negotiation process to design the HCP is that both sides would be better off with the HCP than without if it proceeds to implementation. If at any point during HCP design either side, in this case ODF or the services responsible for ESA compliance, expects it would be more difficult to achieve its objectives with an HCP, the process can be canceled. Habitat and conservation objectives benefit from a landscape-scale, long-term set of protections as well as direct habitat improvement investments. From the timber harvest perspective, harvest activities are more predictable and easier to plan. Furthermore by definition, the permit allows for some incidental take as opposed to the required objective of take avoidance without such a permit.

1.3 Organization of this Report

This report documents our assumptions and analytical methods, and presents our findings for the Business Case Analysis.

Section 2 describes the conditions relevant to our analysis. These include the spatial scale, temporal scale (including how we address discounting future values), covered species and habitats, ODF management activities and other effects considered for review, and forest land categories used throughout the analysis.

Section 3 includes the description of effects for the two scenarios analyzed: the **No HCP Scenario** and the **HCP Scenario**, organized across the categories of activities and effects outlined in Section 2.

Section 4 describes the costs of drafting and implementing an HCP.

Section 5 summarizes the costs and benefits of implementing the **HCP Scenario** as they relate to ODF's bottom line. This section focuses on effects that have a direct financial effect on ODF's budget.

Section 6 summarizes the economic effects of implementing the **HCP Scenario** arising from goods and services produced from ODF lands included in the analysis, and arising from changes in ODF management activities that won't produce an effect on ODF's budget.

Section 7 summarizes the effects of adopting an HCP across all categories highlights conclusions from the analysis.

2 Costs of an HCP

2.1 Plan Preparation Costs

This section describes the estimated costs to prepare the HCP. In general, the costs of HCP preparation are proportional to the complexity of the plan in terms of the following major factors:

- **Plan area.** All else being equal, a larger plan area increases costs because of the need to assemble or collect larger datasets regarding topics such as land cover, protected areas, covered species occurrences, and mitigation and conservation opportunities. The Western Oregon State Forest HCP would be a relatively large plan (~613,500 acres) that covers a disparate set of state forests and forests tracts.
- **Time in the planning process.** HCPs are meeting-intensive planning efforts. The longer the time spent in the planning process, the more meetings are needed, and the more costs are driven up. It is assumed this HCP would take three years to complete, beginning in late 2018. Incidental take permits would therefore be issued in late 2021. This is an aggressive but realistic schedule.
- **Leadership of applicants**. In our experience, a key factor determining HCP cost is the level of leadership provided by the HCP applicant. Plans with a strong leader provide clear and timely direction to the HCP consultant and can efficiently guide plan development. Strong leaders are also helpful in managing stakeholder input. When such leadership is lacking, plans can drift and stall, creating delays and inefficiencies that drive up cost. ODF has shown strong leadership to date in this business case analysis and in their commitment to pursuing the HCP should the BOF decide to proceed. It is assumed this leadership would continue throughout HCP development to help drive the schedule and contain costs.
- **Commitment of wildlife agency staff.** Large-scale HCPs, when they work well, are collaborations between the HCP applicant and state and federal wildlife agencies. In this case, USFWS, NMFS, and the Oregon Department of Fish and Wildlife (ODFW) have stated their strong commitment to supporting ODF in the development of this HCP at the highest levels of their organizations. It is assumed that this commitment would continue and would help achieve the aggressive schedule and contain planning costs.
- **Complexity of covered activities.** Plans with few types of covered activities are simpler to evaluate and analyze than HCPs with a wide variety of covered activities. This HCP would have a modest level of complexity of covered activities, which would contribute to the cost of the HCP.
- **Number of covered species.** The number of covered species is directly related to the cost to prepare the plan (and to implement it). To issue their permits, USFWS and NMFS must make the same findings on each covered species, whether or not it is currently listed. Consequently, all covered species must be treated as listed species. Each covered

species must be evaluated for its threats, baseline conditions, impacts, mitigation and conservation needs, and monitoring needs. It is assumed that this HCP would have 14 covered species. This modest number of covered species helps explain a large fraction of the HCP costs.

- **Type of NEPA document.** The issuance of an incidental take permit by USFWS and NMFS is a major federal action that triggers the National Environmental Policy Act (NEPA). To comply with NEPA, USFWS and NMFS must prepare a NEPA document, either an environmental assessment (EA) or an environmental impact statement (EIS). Preparing an EIS to satisfy NEPA costs substantially more than preparing an EA. This is due to the additional substantive and procedural requirements of an EIS, but also because the EIS adds time to the planning process. The NEPA document is prepared by a consultant under the direction of USFWS or NMFS but paid for by the applicant. For this HCP, we assume that an EIS would be required to comply with NEPA.
- **Level of public involvement.** Some HCP applicants, particularly public agencies, opt to go beyond the minimum requirements for public involvement and hold additional public meetings, conduct public and stakeholder outreach, and develop tools that aid in the planning process (e.g., brochures, web sites, social media outreach, FAQ sheets, newsletters). All of these additional elements would add cost. For this HCP, ODF has already engaged professional facilitators to help organize and manage a large stakeholder group. These additional costs are incorporated into the planning cost estimate.
- **Level of controversy.** Most HCPs are not controversial. However, if the covered activities themselves generate controversy, the HCP could attract public and media attention and become the target of groups interested in stopping or slowing certain activities. High levels of public controversy add cost in several ways, including more or larger public meetings, large numbers of comments on the public draft HCP and EIS (and the necessary responses to those public comments), and extensive coordination with public interest groups. It is assumed that a relatively high level of public scrutiny and controversy for this HCP and EIS, which would add to HCP planning costs.

All of the cost factors and assumptions described above were used to estimate the planning costs to prepare and complete an HCP and its associated EIS (Table 4 and Table 5).

Table 4: HCP Preparation Costs for ODF

Cost	Annual Cost	Total Cost (3 yrs)	Notes
ODF Staffing	$388,058	1,164,175	See Table 5 for details
HCP Consultant	$450,000	$1,350,000	Includes subconsultants
Economic Consultant	$50,000	$150,000	
EIS Consultant	$300,000	$900,000	Includes subconsultants
HCP Facilitators	$165,000	495,000	
Total Cost	$1,353,058	$4,049,175	

Table 5: Assumptions for ODF Staff Time During HCP Preparation

ODF Staff	FTE	Monthly Salary + OPE (FY 2019)	Average Annual Cost	Total Cost (3 years)
Total ODF Staff Costs	2.8	$110,847	$388,058	$1,164,175

2.1.1 Federal Cost Share

Public agencies preparing HCPs are eligible to apply for federal grants to help pay for what can be a large share of HCP planning costs. The federal Cooperative Endangered Species Conservation Fund grant program, administered by USFWS, provides annual planning grants for large-scale HCPs throughout the country. Oregon Department of Forestry has already received one grant of $750,000 in FY 2017-18 (Table 6). The maximum grant allowed per plan each year is $1.0 million. ODF staff expect to apply for another grant as soon as the FY 2018-19 grant cycle opens. Although the grant allocations are subject to annual federal budget authorizations, the program is expected to continue for the foreseeable future because of its popularity.

This grant program requires that applicants provide a minimum of 25 percent matching funds. A larger match (up to 55 percent) results in more points awarded in the grant evaluation process and a greater chance of receiving funding. In their last grant, ODF provided the minimum match of 25 percent. It is highly likely this match would continue in subsequent grant applications. The analysis in this report does not assume that the grants would continue to be conservative for calculation of cost and revenue effects of the HCP.

Table 6: Assumptions for Federal Cooperative Endangered Species Conservation Fund Grants to ODF

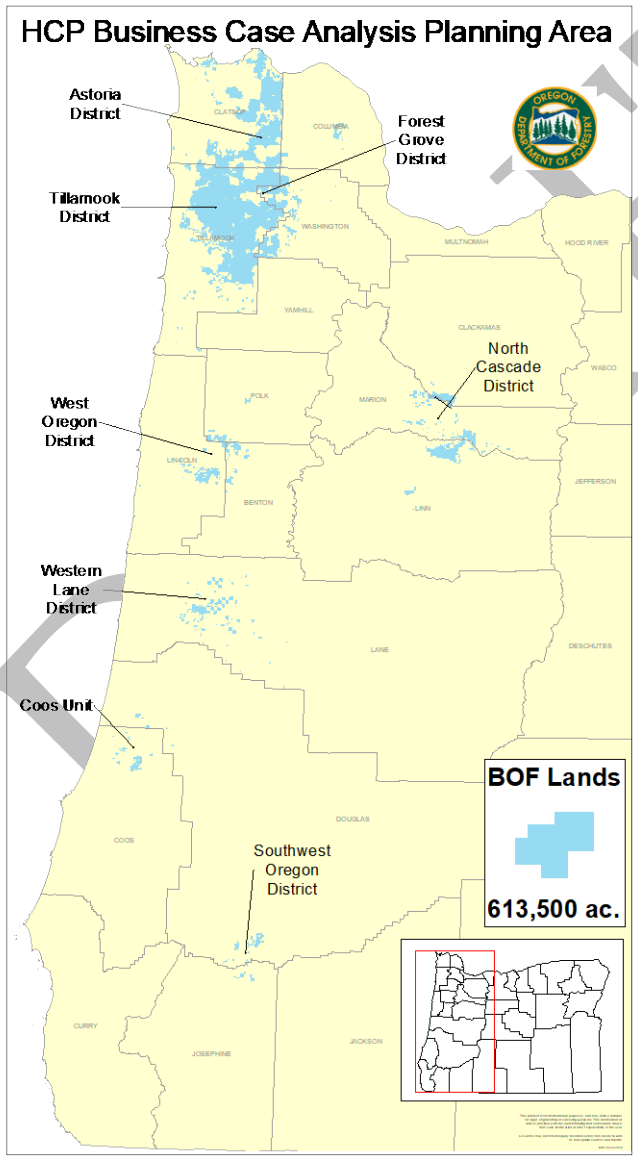
Grant Element	Assumption	Notes
Local matching funds provided by ODF	25-35%	Match through in-kind services of staff time
Grant awards	FY17-18: $750,000 FY18-19: $1,000,000 FY19-20: $750,000	FY17-18 was awarded; others are assumed. Total = $2,500,000
Local matching needed for grants	FY17-18: $250,000 FY18-19: $333,333 FY19-20: $250,000	Minimum match needed = $750,000
Grant funding available to ODF	6 months after award announcement	

3 Conditions for the Analysis

3.1 Spatial Scale

The analysis covers BOF (BOF) Lands in western Oregon, including those in all 8 districts from Astoria in the north to Southwestern Oregon to the south. It does not include lands in the Klamath-Lake district or in eastern Oregon. Results reported in this report also do not include Common School Forest Lands. Throughout the analysis, the included land is referred to as the "plan area". Figure 4 identifies the BOF lands in western Oregon.

Figure 4. Map of Oregon State Forest Lands



Source: Oregon Department of Forestry

3.2 Temporal Scale and Discounting

The analysis considers a 3-year HCP planning timeframe (2018 to 2020) followed by a 50-year implementation timeframe (2021 to 2070) for each scenario, which is approximately equivalent to the time period an HCP would likely cover, if adopted. Costs and benefits occurring within this timeframe are discounted at a 3 percent real rate. Values are reported in constant dollars (without inflation).

This analysis employs a 3 percent discount rate for the purpose of equalizing effects during different years when considering tradeoffs, differences between scenarios. It can be interpreted as suggesting that society as a whole is indifferent between 100 dollars of value for the resources at stake today vs. 103 dollars of the resource one year from now. The discount rate is only applied to monetary values (e.g., not applied to timber harvest volumes). This approach is a standard convention for economic analyses of this sort, and explicitly required in comparable guidance for economic analyses provided by federal agencies.[5] Furthermore 3 percent has become a convention for resource management agencies that must consider a variety of goods and services (market and non-market) across potentially long time-horizons covering multiple generations.[6] Results in this analysis are not particularly sensitive to the choice of discount rate because the two scenarios do not result in substantially different timing of costs and benefits. This study does provide results at different discount rates, up to 7 percent, in the sensitivity analysis section of this report.

3.3 Covered Species and Habitats

One of the most important early decisions in preparing an HCP is determining the species for which the applicant will request take authorization. These species, called "covered species" are named on the incidental take permit. In order to issue the permit, the USFWS and NMFS must make distinct and independent findings that the HCP has met permit issuance criteria for each of the covered species. As a result, the number of covered species in an HCP is an important determinant of project complexity, schedule, and cost, both for HCP preparation and HCP implementation.

To complete the business case analysis, it was therefore important for ODF to evaluate which species would be covered by the HCP for routine forest management practices in the future. In early 2018, ODF convened an HCP Scoping Team of species experts from ODF, ODFW, USFWS, and NMFS to evaluate which species should be covered by the HCP. The HCP Scoping Team applied a set of formal selection criteria to determine which species should and should not be covered by the HCP. This was an important step to determine costs of operations under an HCP

[5] For example, Office of Management and Budget. 2003. Circular A-4. https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A4/a-4.pdf; U.S. Environmental Protection Agency. 2010, revised 2014, 2016. Guidelines for Preparing Economic Analyses. December. https://www.epa.gov/environmental-economics/guidelines-preparing-economic-analyses.

[6] The OMB and EPA guidance referenced above generally recommend 3 percent for social discount rates, with sensitivity analyses at 7 percent. U.S. Department of Interior

because management and monitoring activities (and their costs) are required for any species covered. This section describes the species assumed to be covered in the HCP and the criteria used to determine this list.

3.3.1 Species Considered for Coverage

The assumed HCP plan area includes a range of forest resources that support a variety of species, including several species listed under state and federal endangered species protection laws. To determine which species have the potential to occur in the plan area the HCP Scoping Team reviewed the following data sources:

1. USFWS and NMFS lists of federally-listed candidate, threatened, or endangered species in western Oregon (USFWS 2018, NMFS 2018).
2. USFWS's iPaC web-based species database for the counties with ODF-managed state lands.
3. StreamNet and Oregon Department of Fish and Wildlife (ODFW) data on fish distribution.
4. Expertise of HCP Scoping Team members regarding species presence and data availability.
5. ODF File information regarding species occurrence on state lands.

Although many species have the potential to occur on state forest lands, not all species need to be included as covered species under the HCP. The list of species considered for coverage is shown in Table 7. Each species was evaluated against a set of criteria in order to determine which should be proposed for coverage.

3.3.2 Covered Species Screening Criteria

The covered species criteria listed below were applied to the list of species with potential to occur in the HCP plan area (i.e., on ODF-managed state forest lands). The species on the draft list meet all of the criteria below.

1. **Listing Status**. The species falls into one of the following categories: (1) listed under the federal ESA as threatened or endangered, or proposed for listing (candidate) or has a strong likelihood of being listed during the assumed 50-year permit term; (2) listed under the Oregon State ESA as threatened or endangered or a candidate for such listing or has a strong potential to be listed during the permit term. Potential for listing during the permit term is based on current listing status, consultation with experts from ODF, USFWS, NMFS, or ODFW, evaluation of species population trends and threats, and best professional judgment.
2. **Range**. Species proposed for coverage under the HCP are known to occur or are expected to occur within ODF-managed state forests based on a review of species locality and range data, a review of the species literature, and professional expertise. In

addition, species that are not currently known in state forests, but are expected to move into state forests during the permit term (e.g., through range expansion) were reviewed.

3. **Impact**. The species or its habitat would potentially be adversely affected by covered activities or projects at a level that is likely to result in take as defined by the federal ESA.
4. **Species Data**. Only those species where sufficient and reputable scientific data exist on the species' life history, habitat requirements, and occurrence in the plan area, allowing for the adequate evaluation of impacts on the species, and the development of conservation measures to mitigate those impacts would be proposed for coverage.

3.3.3 Covered Species List

The proposed covered species list includes 16 listed and non-listed species: 7 wildlife species and 9 fish species (Table 7). The 16 covered species were selected based on the criteria discussed above. This list of assumed covered species was used as the basis for costs associated with the development and implementation of an HCP on western Oregon state forests.

It is important to note that this species selection process is preliminary. Although USFWS and NMFS were involved in this preliminary selection process, covered species may still be added or dropped based on further review of a draft HCP by these agencies, or based on new information. If the BOF decides to pursue an HCP, ODF would verify this species selection process with additional data and with further input from USFWS and NMFS.

Table 7. List of Covered Species Assumed for HCP Business Case

Species Common Name (Scientific Name)	Status[a]		Primary Habitat
	State	Federal	
Fish			
Oregon Coast coho (Oncorhynchus kisutch)	--	FT	Habitat includes the Pacific Ocean and the freshwater and estuarine habitat (rivers, streams and lakes) along the Oregon Coast from the Necanicum River on the north to the Sixes River on the south
Lower Columbia River coho (O. kisutch)	SE	FT	Includes freshwaters from the Columbia River and its tributaries downstream from the Big White Salmon and Hood Rivers (inclusive) and from the Willamette River and its tributaries below Willamette Falls.
Upper Willamette River spring chinook (O. tshawytscha)	--	FT	Includes freshwaters originating from the Clackamas River and from the Willamette River and its tributaries above Willamette Falls.
Upper Willamette River winter steelhead (O. mykiss)	--	FT	Includes freshwater habitats below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River.
Lower Columbia chum (O. keta)	--	FT	Freshwater areas of the Lower Columbia River and tributaries; often limited to the lower 1/3 of the mainstem and tributaries in this area due to the high gradient nature of Lower Columbia River tributaries.
South Oregon/Northern California coho (O. kisutch)	--	FT	Coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California.
Lower Columbia chinook (O. tshawytscha)	--	FT	Freshwaters of the Columbia River and its tributaries downstream of a transitional point east of the Hood and White Salmon Rivers, and any such fish originating from the Willamette River and its tributaries below Willamette Falls.
Eulachon (Thaleichthys Pacificus)	--	FT	The major and most consistent spawning runs return to the mainstem of the Columbia River and the Cowlitz River. Spawning also occurs in other tributaries to the Columbia River, including the Grays, Elochoman, Kalama, Lewis, and Sandy Rivers

Species Common Name (Scientific Name)	Status[a]		Primary Habitat
	State	Federal	
Lower Columbia steelhead (O. mykiss)	--	FT	The DPS includes naturally spawned anadromous steelhead originating below impassable barriers from rivers between the Cowlitz and Wind Rivers (inclusive) and the Willamette and Hood Rivers (inclusive); excludes such fish originating from the upper Willamette River basin above Willamette Falls.
Amphibians			
Oregon slender salamander (*Batrachoseps wrighti)*	--	--	Late-successional and second-growth forests; often associated with large-diameter, decaying Douglas fir logs and bark debris mounds at the base of snags.
Columbia torrent salamander (*Rhyacotriton kezeri)*	--	--	Coastal coniferous forests in small, cold mountain streams and spring seepages; primarily in older forest sites since the required microclimatic and microhabitat conditions generally exist only in older forests.
Cascade torrent salamander (*R. cascadae)*	--	--	Coniferous forests in small, cold mountain streams and spring seepages.
Birds			
Northern spotted owl (*Strix occidentalis)*	ST	FT	Forests characterized by dense canopy closure of mature and old-growth trees, abundant logs, standing snags, and live trees with broken tops.
Marbled murrelet (*Brachyramphus marmoratus)*	ST	FT	Spend the majority life on the ocean, but come inland to nest; generally nest in old-growth forests, characterized by large trees, multiple canopy layers, and moderate to high canopy closure.
Mammals			
Red tree vole (Arborimus longicaudus)	--	FC	Found primarily in late-successional (older, structurally complex) forests in western Oregon and northwestern California.
Coastal marten (Martes caurina caurina)	--	--	Primarily found in near-coast forests with limited or no snow cover; prefer areas with dense shrub cover or areas with closed forest canopy.

Notes: [a] **Status: State Status:** SE= state listed as endangered; ST = state listed as threatened. **Federal Status:** FT = federally listed as threatened; FC = federal candidate

3.4 Management Activities Included in the Analysis

The HCP would likely affect only a subset of activities that ODF engages in while fulfilling its mission. To focus the analysis, the BCA addresses only those activities that the HCP would likely affect in some way and that would result in changes in cost or revenue to ODF, based on the best expert judgement of the project team and ODF staff. These activities are included in the analysis:

- Administration of ESA compliance
- Pre-harvest species surveys
- Species and habitat management actions
- Species and habitat monitoring
- Inventory management and timber harvest

The financial focus of the BCA drives the emphasis on these areas of potential effects of an HCP. For all of these categories of effects, the analysis provides descriptions and measures of outputs through to financial costs and revenues. Other activities with less direct financial implications of an HCP are also analyzed, described below.

3.5 Other Costs and Benefits Considered for Analysis

The BCA considers how an HCP would affect ODF management activities directly, by changing the costs incurred or revenues derived from the activities listed in the previous section. These effects directly impact ODF's budget and the income generated for timber payment recipients. Adopting an HCP may produce economically-relevant effects in other ways as well. These may not reflect in ODF's bottom line, but may impact the value of goods and services produced from ODF lands. With ODF staff, the project team evaluated whether an HCP might impact these goods and services:

- Carbon sequestration
- Recreation
- Water quality and drinking water source protection

After an initial screening assessment, we determined that ESA management is unlikely to impact drinking water source protection, because other regulatory protections establish standards that would not change if an HCP is adopted. The other two categories (carbon sequestration and recreation) may vary by scenario, so the project team and ODF elected to include them in the BCA.

In addition to these categories of effects, the BCA also includes analysis of the effects of an HCP on ODF staff planning effort. It also provides a brief overview of the potential effects of an HCP on litigation risk in terms of liability that could result in legal costs and court penalties. While these are both categories of ODF management activities, changes resulting from an HCP are not

anticipated to result in financial effects, but may allow ODF staff to reallocate their time to other activities.

3.6 Land Management Categories in the Analysis

Across all ODF lands there are areas where timber harvest does not occur because those areas are either not forested, or they are forested but classified in ways that prohibit harvest. All other areas are then technically available for harvest, when it is economically feasible. A summary of each land category is provided here with an assessment of whether timber harvest of these areas is expected to change with an HCP. Table 8 summarizes these land categories and the assumptions about what percentage of the areas would be accessible to harvest in the future with or without an HCP.

Table 8. Land Management Category Assumptions for Analysis.

		Proportion of Land Assumed Available for Harvest		
Land Code	**Category Definition**	**No HCP***	**With HCP**	**Affected by HCP?**
	NOT FORESTED			
Unavailable	**Unavailable for Harvest**			
Roads	Roads	0%	0%	No
NonForest	Nonforest land cover	0%	0%	No
Logsys	No feasible logging system identified due to physical limitations, cliffs, or other human safety hazards. Includes areas infeasible for road construction or helicopter logging.	0%	0%	No
AdminRem	Administrative Removals	0%	0%	No
	CONSTRAINED			
FPA	**Forest Practices Act (FPA) Compliance**			
FPAWild	Designated for wildlife	0%	0%	No
NSOCores	Mostly 70-acre polygons centered on activity center of owl, typically a nest. In North Coast, cores are 250-acre polygons.	0%	0%	No
FMP	**Forest Management Plan (FMP) Compliance**			
FMPStreams	Stream buffers designated by FMP	0%	0%	No
InnerGorge	Inaccessible areas	0%	0%	No
OldGrowth	Old growth stands designated by FMP	0%	0%	No

Land Code	Category Definition	Proportion of Land Assumed Available for Harvest		
		No HCP*	With HCP	Affected by HCP?
Take Avoidance	**Take avoidance areas due to presence of listed species**			
MMMA	Marbled Murelet Management Areas (MMMAs) are designed occupied habitat	0%	0%	No[2]
NSO40pct	40% best available habitat within northern spotted owl (NSO) circle (1.5-mile radius around active nest), typically the oldest stands.	0%	0%	No[2]
	LIMITED CONSTRAINTS			
Additional Policy	**Additional Policies for FPA Compliance**			
Landscape Design	Maintained to attain complex structure then released for harvest. Stands designated today expected to be released after ~30 years	35%-100% (variable by district)[3]	100%	Yes
Terrestrial Anchor Sites (TAS)	Maintained to attain wildlife habitat then released for harvest. Stands designated today expected to be released after ~30 years.	35%-100% (variable by district) [3]	100%	Yes
	UNCONSTRAINED			
Unconstrained				
Unconstrained	Can be harvested at any time; no constraints	95%[3]	100%	Yes
HCP				
HCP Streams	Additional stream buffers assumed for HCP (see separate tables)	100%	0%	Yes

Notes:
[1]Assumes populations of NSO and marbled murrelet will expand over 50 years and more species will be listed, increasing harvest restrictions.
[2]This is a conservative assumption for this analysis; with site-specific data and negotiations with USFWS, limited areas may be released for harvest under the HCP.
[3]See Section 4.3.2 for details and explanation.

3.6.1 Not Forested

ODF lands that support permanent roads or other non-forest land cover types are not being harvested now and will not be harvested in the future, with or without an HCP. Non-forest land cover types include wetlands, lakes, meadows, and developed areas. These constraints are not expected to change regardless of whether ODF pursues and HCP in the future.

3.6.2 Constrained

Some forests are constrained for policy-related, technical, or environmental reasons. The BOF in 1998 adopted a Forestland Management Classification System[7] that includes high value conservation areas and special use areas that are typically off-limits to timber harvest. In some districts there are areas considered administratively removed ("AdminRem") for stewardship reasons such as utility rights-of-way, rock quarries, cultural or heritage sites, or other protections. Some areas classified as off-limits to harvest because they are inaccessible by road or helicopter; these lands that have physical constraints such as steep cliffs are classified as "logging systems" ("Logsys"). Lands classified as "Inner Gorge" are riparian areas and "LSPSHighrisk" are areas of risk to roads, other infrastructure and public safety due to very steep slopes or landslide potential. These constraints are not assumed to change regardless of whether ODF pursues an HCP in the future.

Some constraints on harvest are due to designations mandated by the Forest Practices Act (FPA) or Northwest Oregon Forest Management Plan (FMP). For example, some areas have been designated to provide wildlife connectivity ("FPAWild"). Core habitat for northern spotted owl is not harvested and is classified as "NSO Core" areas. These NSO Core areas are generally 70-acre polygons centered on a northern spotted owl occurrence (in the North Coast Districts, Core Areas are 250 acres). In order to avoid take of northern spotted owl, ODF does not harvest the highest-quality 40 percent of northern spotted owl habitat ("NSO40pct") within a 1.2 - 1.5 mile buffer (depending on district) around, which includes the NSO Core area. Finally, ODF does not harvest timber in marbled murrelet management areas ("MMMA"), which are designated to protect habitat that has been determined to be "occupied" by murrelets. It is assumed that all of these land designations (FPAWild, NSOCore, NSO40pct, MMMA) will continue to be unavailable for harvest in the future regardless of whether ODF pursues an HCP. It is assumed that species recovery actions will prove successful regardless of whether an HCP is completed, so there is an assumption that both northern spotted owl and marbled murrelet will expand their range on ODF lands over time. This expansion would further limit harvest as areas occupied by NSO and MMMA expand. The assumptions are introduced below in this section and described in detail in Section 4.3.2.

The FMP also designates areas that are to be maintained as Old Growth ("Old Growth"). Those areas represent a small percentage of total acreage across ODF lands. Those areas are not harvested now, nor are they assumed to be harvested in the future. Similarly, stream buffers designated in the Forest Management Plan ("FMPStreams"), which are not available for harvest now, are assumed to remain unavailable for harvest in the future regardless of whether ODF pursues an HCP.

3.6.3 Limited Constraints

Some areas have very limited harvest now, but may be available for harvest in the future, once desired future conditions are reached. Areas designated as "Landscape Design" and "Terrestrial

[7] Oregon Administrative Record (OAR) 629-350-005.

Anchor Sites (TAS)" are included in this category. Both land categories are managed to attain complex or older forest structure with the intent of releasing the areas to harvest once that desired future condition is reached. The ability to harvest timber in Landscape Design areas and TAS is expected to change in the future. How accessible those areas are to timber harvest could depend on whether an HCP is in place. Older forests have a higher potential to support northern spotted owls and marbled murrelets, which could increase the need for take avoidance strategies under a no-HCP scenario. This is described in more detail in Section 4.3.2.

3.6.4 Unconstrained

All of the areas not constrained by the land categories described above are considered available for harvest at any time and categorized as "unconstrained." Timing of harvest is dependent on economic feasibility and ODF harvest management plans. ODF manages its forests for Greatest Permanent Value, so that the forests can provide benefits over the long run. Relatedly, ODF schedules harvests over time for non-declining even flow, which also corresponds to efforts to maintain the availability of consistent and sustainable harvests over time. There is potential for the amount of unconstrained land to change in the future depending on whether an HCP is completed or not. That is described in more detail in Section 4.3.2.

4 Effects of Adopting an HCP

To assess the effects of adopting an HCP, the project team compared the costs, revenues, and values associated with management under two scenarios:

1. Without an HCP (the baseline "**No HCP Scenario**"), which reflects current management conditions and assumed future management conditions if an HCP is not adopted; and
2. With an HCP (the "**HCP Scenario**"), which reflects changes in ODF's management practices if an HCP were adopted.

This section compares the physical and monetary changes that would occur in the HCP Scenario compared with the baseline No HCP Scenario.

4.1 Description of the HCP and No HCP Scenarios

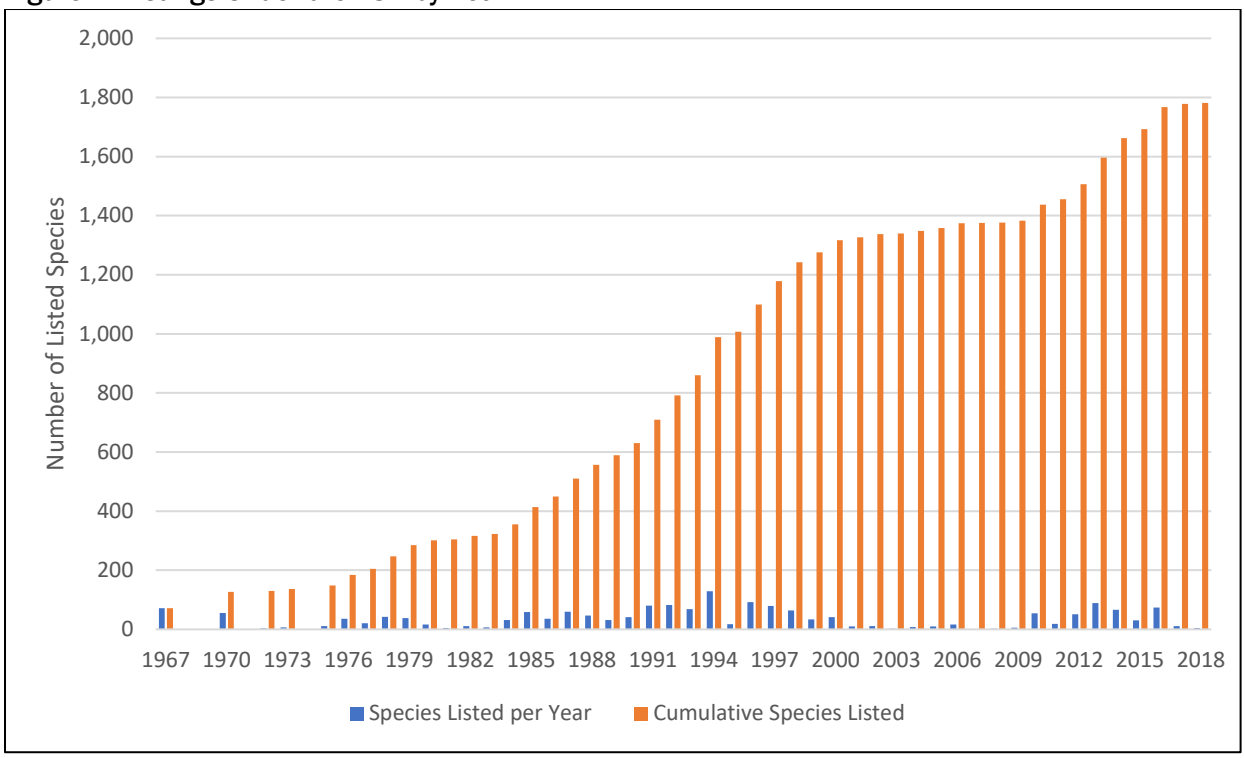
ODF does not currently have an incidental take permit for listed species, so all harvest and harvest-related activities are implemented in a fashion that attempts to avoid take of all listed species. This section also describes expectations for how current management conditions would change over time without an HCP. Based on the patterns of listed species in the past, the project team expects that the constraints posed by listed species to ODF operations will increase over time as three variables change:

1. The regulatory restrictions for listed species will increase (e.g., no harvest buffers get larger, seasonal restrictions increase).
2. The range of listed species shifts or expands in response to recovery efforts.
3. The number of listed species increases.

The timing of new species listings is difficult to predict but the pattern is clear. Over the last several decades, the number of new species listed has far exceeded the number of species removed from the list of threatened and endangered species. Figure 5 shows the pace of new listings annually through 2018.

In 2016 USFWS published a 7-year workplan of species intended to be considered for listing or uplisting each fiscal year. Of the hundreds of species on this list, 25 are found in Oregon. USFWS may still consider listing species not on the list, especially if a court orders them to do so, but this 7-year workplan provides a strong indication of which species they intend to consider and when. Table 9 lists species that, if listed, may have dramatic effects on ODF forest management and costs if ODF has no take permit for the species (i.e., no HCP) and must avoid all take.

Figure 5. Listings Under the ESA by Year



Source: Created with data from U.S. Fish and Wildlife Service. 2018. "U.S. Federal Endangered and Threatened Species by Calendar Year." *Environmental Conservation Online System.* Retrieved October 18, 2018, from https://ecos.fws.gov/ecp0/reports/species-listings-count-by-year-report

Notes: Includes Threatened and Endangered listings under the 1973 Endangered Species Act and its precursors (Endangered Species Preservation Act of 1966 and Endangered Species Conservation Act of 1969)

Table9: Species that may occur on ODF State Forests also on USFWS 7-Year Listing Decision Workplan

Species to be Considered for Listing	Proposed Fiscal Year (FY) for Listing Consideration	Notes
Northern spotted owl	FY17	Up-listing to endangered
Red tree vole	FY19	
Monarch butterfly	FY19	
California spotted owl	FY19	
Oregon slender salamander	FY20	
Foothill yellow-legged frog	FY20	
Columbia torrent salamander	FY21	
Western pond turtle	FY21	
Cascades frog	FY21	
Columbia Oregon snail	FY21	
Cascade torrent salamander	FY23	
Little brown bat	FY23	
Western bumble bee	FY23	

Source: USFWS National Listing Workplan (Sept. 2016 Version). Available at: https://www.fws.gov/endangered/esa-library/pdf/Listing%207-Year%20Workplan%20Sept%202016.pdf

4.1.1 Expected Changes in the Future

It is reasonable to assume that northern spotted owl, marbled murrelet, and coho salmon will remain listed for the next several decades. Therefore, constraints related to timber operations in listed species habitat will remain as well. In some cases those constraints are assumed to remain constant, and in other cases these constraints are assumed to become more restrictive.

The constraints related to coho salmon will remain generally the same. The distribution of coho salmon is not expected to change dramatically and the actions deployed for protecting steam habitat (e.g., riparian buffers) are assumed to remain unchanged. Without an HCP in place it is expected that ODF will continue to manage riparian buffers around fish-bearing and some non-fish bearing streams. While it is also expected that the need to increase stream buffers may occur in the future, there was no attempt to quantify changes in stream buffers under a No HCP scenario. The BCA assumes that ODF will employ stream buffers in much the same way that they do now without an HCP in place. ODF will likely continue to undertake occasional stream enhancement actions, but only when working with regional partners and when outside funding is available.

Modifying timber operations to avoid impacts to northern spotted owls and marbled murrelets is already a dynamic process. It is assumed to remain dynamic in the future. It is assumed that some proportion of ODF lands that are currently available for harvest or have Limited Constraints, will become constrained in the future without incidental take coverage provided by an HCP. Those assumptions are described in Section 4.3.2. The range of future constrained lands is expected to be from 3 to 10 percent, depending on the district and the likelihood that listed species would be discovered in new locations with expanded survey coverage. In some districts, survey coverage is thorough, so the chance of finding new occurrences is low, while in other districts survey coverage is not.

Currently no other species (listed or not) constrain ODF operations significantly. It is expected that over time additional species will be listed and the presence of those species on ODF lands will further limit where, when, and how harvest can occur. The most likely species to become listed is red tree vole. Red tree vole is a rare species, but it has a wide range. Early studies show that the species can use a wide variety of forest habitat types. Due to these factors, if red tree vole is listed, ODF is likely to experience significant constraints on where harvest can occur without resulting in take of red tree vole. Over time, once the species is better understood, it is possible that the locations where harvest limitations occur will be more refined, but that will require significant survey effort in order to determine how the species is using the forest and what practices can be put in place to reduce impacts. While some of the areas designated to avoid impacts on red tree vole will be the same as those already designated for northern spotted owl, marbled murrelet, and riparian buffers, there will undoubtedly be new areas that would have harvest limitations with a red tree vole listing. It is expected that habitat protections that are put in place for other listed species will be sufficient to avoid impacts to the other species proposed for coverage, even if they become listed. For example, the restrictions placed on harvest in riparian buffers would be sufficient to protect habitat for aquatic amphibians and the other fish species listed in Table 7.

A significant benefit of an HCP to applicants is the certainty it brings with respect to ESA compliance. With an ESA Section 10 incidental take permit comes strong regulatory assurances that no other measures will be required by the applicant while the permits are active in the event that circumstances occur that were not foreseen by the HCP. What this means is that the avoidance, minimization, and mitigation measures ODF commits to in the HCP conservation strategy are what will be required for the duration of the permits. Therefore, with an HCP in place it is reasonable to assume that changes in the future would be limited to those described in the HCP. For example, by including covered species that are not listed, but likely to become listed in the future, the risk of future species listings impacting ODF operations is greatly reduced. If covered species are listed in the future ODF would already have incidental take coverage for those species under an HCP and no operational changes are needed.

Once the HCP has been finalized, there would be no substantial unanticipated changes to ODF ESA compliance costs or operational impacts for the life of the HCP. This assumption relies on the HCP covering all species that may become listed during the next 50 years. If monitoring showed that the biological goals and objectives were not being achieved, then changes to the management program could occur through adaptive management, but generally within the

defined parameters of the HCP. To the extent possible the limitations on changes that result from adaptive management would be described in the HCP, so ODF would know what the potential outcomes of those changes would be.

Changed and unforeseen circumstances would be described in the HCP and the costs of potential changed circumstances would be included, so no additional unexpected costs should occur during HCP implementation. If unforeseen circumstances occur, for those circumstances which cannot be predicted and are generally out of ODF's control, ODF should not be responsible for those costs.

Because the HCP implementation costs would be predictable, ODF would also expect no change in the future to staff costs. Staff costs assumed during the first year of HCP implementation should be similar to staff costs throughout the permits in terms of time requirements. While staff costs may be somewhat higher at the beginning of HCP implementation (e.g., additional time needed to adapt to new procedures and reporting), ODF would expect staff costs to be lower later in HCP implementation, after procedures are well established and staff are more efficient at implementing the HCP.

4.2 Regulatory Impacts

4.2.1 Administration of ESA Compliance

Staff at ODF currently spend considerable time designing, managing, and overseeing the ESA compliance strategy to avoid take of listed species. This includes staff time at headquarters, coordination with state and federal wildlife agencies, and coordination with each district on management plans and individual harvest plans. All of this work is made more complicated by the fact that ODF must avoid take of listed species that move across the landscape. As a result, new survey and monitoring workload estimates must be created each season.

Table 10: ODF Staff Costs for Baseline ESA Compliance (without HCP)

ODF Staff	Percent FTE	Monthly Salary + OPE (FY 2019)	Average Annual Cost Today	Assumed Increase Every 5 Years[1]	Total Cost Over 50 Years[2]
All Staff	6.55	$131,939	$784,069	8%	$68,234,236

Notes:
[1] Due to increasing numbers of listed species, expanding species ranges, and increasing regulatory constraints for each species.
[2] Costs in 2018 dollars. Includes assumed increase in staff time every 5 years.

Table 10 shows estimates for the amount of time ODF staff currently spend on the administration of ESA compliance. These costs exclude the time spent to plan, oversee, implement, and analyze monitoring surveys and data.

However, without an HCP, it is expected that these administrative costs for ESA compliance will rise over time as listed species continue to shift and possibly expand their ranges as recovery efforts are successful. Furthermore, regulations protecting these listed species are expected, on average, to become more restrictive, requiring more time to adjust management

and harvest activities. And finally, new species will become listed, requiring even more work to ensure no-take approaches for these new species.[8] As an example, if red tree vole is listed in the next 5 – 10 years, this would dramatically increase ODF workload because of the wide range of the species and high potential to occur over most ODF lands. To account for these increasing demands on ODF staff, we assume that every five years, on average, staff time devoted to administration of ESA compliance will increase by 3 – 20 percent, depending on the staff position. These increases in staff time will be felt most when new species are listed, the timing of which is difficult to predict. For the purposes of this analysis we assume that a new species is listed or regulations dramatically change once every five years on average.

With an HCP staff at ODF would still need to spend considerable time overseeing ESA compliance. However, staff time would shift from overseeing their current ESA compliance processof implementing take avoidance strategies, to administering the HCP. HCP administration would include ensuring compliance with the incidental take permits, data tracking, and preparing annual compliance reports for FWS and NMFS. ODF staff time would still involve staff at headquarters, coordination with state and federal wildlife agencies, and coordination with each district on management plans and individual harvest plans, but much more of the time with an HCP would be concentrated in headquarters, relieving district biologist from their current and substantial duties of ESA take avoidance.

It is assumed that staff time with an HCP would be constant over the 50-year permit term because of the "No Surprises" assurances and certainty the HCP provides (see Section 6.2 for a more detail discussion of No Surprises assurances). Initially there may be an increase in responsibility as the HCP is implemented and new compliance procedures are established, but over time ODF staff would develop efficient approaches to HCP compliance, possibly even reducing staff effort over time. It is assumed that the net result is, on average, unchanged staff commitments over the 50-year permit. With an HCP annual staff costs would become much more predictable because staffing needs are not subject to annual changes in species distribution or new species listings to demonstrate take avoidance. With an incidental take permit, changes in species distribution and new species listings would be anticipated, and HCP implementation would continue as planned.

With an HCP there would be an increase in staff time related to habitat management and monitoring, but a decrease in time surveying for species ahead of harvest (to demonstrate take avoidance). The costs with an HCP are shown in Table 11.

[8] Some listed species will be de-listed over time, but based on historic patters of de-listing these will be more than offset by the new species expected to be listed over the same time period. In other words, there will be net increase in the number of listed species over time.

Table 11: Assumed ODF Staff Costs for ESA Compliance with an HCP

ODF Staff	Percent FTE	Monthly Salary + OPE (FY 2019)	Average Annual Cost Today	Assumed Increase Every 5 Years[1]	Total Cost Over 50 Years[2]
All Staff	4.02	$100,392	$490,145	0%	$24,507,264

[1] Due to increasing numbers of listed species, expanding species ranges, and increasing regulatory constraints for each species.
[2] Costs in 2018 dollars. Includes assumed increase in staff time every 5 years

4.2.2 Pre-harvest Species Surveys

Pre-harvest species surveys include coordination between ODF biologists and foresters. Because surveys are labor intensive, contractors are often used to conduct the surveys in order to properly survey all harvest areas within the limited time periods when species are detectable. The cost of conducting pre-harvest surveys is shown in Table 12. The cost consists of the "on the ground" survey effort and coordination between ODF biologists and foresters on survey activities.

Pre-harvest clearance surveys for listed species occur in all areas where harvest is planned and the forest contains forest structure suitable for northern spotted owl or marbled murrelet. Currently, no pre-harvest surveys occur for any other listed or non-listed species. The purpose of the pre-harvest surveys is to determine whether species are present in the areas that would be harvested. If species are detected then harvest is either cancelled or delayed, depending on the circumstances of detection. For example, if it is confirmed that northern spotted owls or marbled murrelets are nesting in an area planned for harvest, the harvest will not occur. If the species are detected, but nesting is not confirmed, there may be some flexibility in what occurs in the planned harvest area. That requires additional coordination with the USFWS to confirm that full avoidance of impacts is achievable. Once it is confirmed if northern spotted owls or marbled murrelets are nesting in an area, harvest in that area is then limited until surveys confirm that the species is no longer present. Often that is at least five additional years of surveys, meaning that the area cannot be harvested for at least that amount of time. If species are detected during surveys in subsequent years, that time would extend.

The cost to conduct pre-activity surveys is expected to increase over time in both HCP and No HCP scenarios, primarily because new species will be listed and these species will require surveys to avoid take. The relative cost to survey for northern spotted owl and marbled murrelet is also expected to increase as recovery efforts are successful and the species expand their range. Specifically, as ODF Landscape Design and TAS lands reach their desired future condition, those areas will provide suitable habitat for both northern spotted owl and marbled murrelet, increasing the likelihood that surveys would be required. Survey requirements are also expected for additional species as they become listed under the ESA. The species shown in Table 7 are the most likely to become listed in the near future, which is why they are recommended for coverage under an HCP. Without an HCP ODF will need to demonstrate avoidance of impacts to those species in the same way they are demonstrating avoidance of northern spotted owl and marbled murrelet now. That will require pre-activity surveys to determine species presence and modification of harvest plans as needed. For the purposes of this analysis, it is assumed that pre-harvest species survey costs would increase only as a result

of red tree vole becoming listed. The estimated cost for red tree vole surveys throughout ODF lands is shown in Table 12. It is assumed that new surveys will not be required for the other species shown in Table 7, if they are listed. These other species occur in areas that already have significant harvest restrictions (e.g., salamanders in riparian buffers), so demonstrating avoidance of impact is likely possible without an extensive new survey effort. These pre-harvest survey costs have a high degree of uncertainty; actual costs could be substantially larger than those estimated for this analysis.

With an HCP species monitoring will shift from pre-harvest take avoidance surveys to effectiveness monitoring outlined in the HCP. The cost difference between the two scenarios is shown in Table 10. Without an HCP annual surveys and monitoring costs are expected to be just over $4 million a year. That estimate assumes at least one new listing that could require significant survey effort (e.g., red tree vole). Over 50 years that results in approximately $211 million. By contrast, if an HCP were completed, it is estimated that annual monitoring costs would be reduced to just over $2 million per year and $106.5 million over 50 years. That is a reduction in monitoring costs of 50 percent. This funding is currently being spent on take avoidance but could be utilized for other uses. Note that these values are illustrative of current cost conditions, presented in real 2018 dollars (no inflation) with no discounting or projected increases in costs over time yet incorporated to the analysis.

Table 12: Summary of Monitoring Costs in Western Oregon Forests for Baseline and HCP Scenarios

	No HCP			HCP		
Species	**Annual Costs**	**Cost - 30 Yrs**	**Cost - 50 Yrs**	**Annual Costs**	**Cost - 30 Yrs**	**Costs - 50 Yrs**
All Fish	$0	$0	$0	$13,333 (30 yr)[1] $12,000 (50 yr)[1]	$400,000	$600,000
Oregon slender salamander	$0	$0	$0	$5,260[2]	$158,000	$263,000
Columbia torrent salamander	$0	$0	$0	$15,460[2]	$464,000	$773,000
Cascade torrent salamander	$0	$0	$0	$0[3]	$0[3]	$0[3]
Northern spotted owl	$1,583,000	$47,490,000	$79,150,000	$800,000[4]	$24,000,000	$40,000,000
Marbled murrelet	$900,000	$27,000,000	$45,000,000	$300,000	$9,000,000	$15,000,000
Red tree vole	$1,733,000[5]	$51,990,000	$86,650,000	$750,000	$22,500,000	$37,500,000
Coastal marten	$0	$0	$0	$250,000	$7,500,000	$12,500,000
Total	**$4,216,000**	**$126,480,000**	**$210,800,000**	**$2,120,720**	**$64,022,000**	**$106,536,000**

Note: Costs in this table are in real 2018 dollars, with no discounting and no assumed increase in costs over time included.
[1] Monitoring assumed to occur once every 10 years.
[2] Monitoring assumed to occur every six years. Annual costs are derived by dividing the 30 or 50 year totals by the respective permit term.
[3] Monitoring assumed completed in conjunction with Columbia torrent salamander surveys.
[4] Includes $700,000 for monitoring and $100,000 for barred owl control.
[5] Assumes that red tree vole is listed in the near term an all planned sales need to be surveyed to confirm avoidance.

With an HCP, pre-harvest species surveys would be limited to locations where species presence is possible (i.e., within suitable habitat) and harvest is planned. Generally, pre-activity surveys would be greatly reduced with an HCP because ODF would have an incidental take permit for harvest activities occurring in occupied habitat. The estimated cost of conducting pre-harvest surveys with an HCP is shown in Table 10. The cost consists of the "on the ground" survey effort and coordination between ODF biologists and foresters on survey activities in timber sale areas.

With an HCP is assumed for the purposes of this analysis that pre-harvest survey activities would occur for the three covered amphibians, as well as coastal marten and red tree vole. These surveys would be required due to the limited knowledge of these species' habitat requirements and the assumption that ODF would be able to access timber with their incidental take permit in areas previously off-limits due to no-take restrictions for northern spotted owl and marbled murrelet. Pre-harvest surveys would likely occur more frequently early in the HCP permit term and then decline over time, as the species and their habitat requirements are better understood.

4.2.3 Species and Habitat Management Actions

Under the baseline no HCP conditions ODF does not normally conduct specific habitat restoration actions for specific listed terrestrial species. ODF does implement management practices intented to promote a variety of habitat conditions on the landscape, including those that benefit listed terrestrial species.

Some specific, targeted stream enhancement activities occur on ODF lands with the goal of improving stream habitat for anadromous fish, including several listed species. Those actions include removing fish barriers and adding large wood structures to the stream in areas identified as lacking large woody debris. These projects are informed by stream assessments conducted by ODFW in 2007. These projects are typically funded through grants and with the support of other partners. The costs of those actions are not considered because they are so limited in scope and there are almost no costs to ODF (only the limited staff time to write and administer state and federal grants). This approach is assumed to be the same in the future with under both the HCP and No HCP scenarios.

The HCP would outline expectations for habitat management that would occur during the permit term in order to mitigate the effects of the taking on the covered species, from covered activities.

Covered Fish Species

While ODF currently conducts stream restoration and enhancement actions voluntarily, this analysis assumes that many of these same stream restoration and enhancement actions would be required by the HCP. The actions would continue to be targeted for maximum benefit to fish species and would focus on:

1. Increasing species distribution through removal or improvement of passage barriers.

2. Improving spawning and rearing habitat through strategic placement of large wood structures.
3. Management of riparian buffers to provide adequate shade to moderate stream temperature and provide nutrient inputs.

In the past, ODF has successfully secured state and federal grants for stream restoration and enhancement projects. It is assumed that these grants will continue and will offset all costs of these actions except for ODF staff time to write and administer the grants, and to oversee implementation. Therefore, the HCP scenario is assumed to have no net increase in cost for these stream restoration and enhancement actions.

Covered Terrestrial Species

Management actions for terrestrial species with an HCP would be focused on setting aside parts of the forest as species management areas. These species management areas would not be harvested. These areas may be refined over time as species monitoring reveals the highest priority areas for species management. Initially these areas would be focused on known northern spotted owl core areas and activity centers and marbled murrelet management areas. It is possible that these areas remain unchanged from current conditions, but that more active management is conducted in species habitat areas in order to achieve desired habitat conditions more quickly. This would only occur if the results from habitat monitoring indicated that habitat improvements were necessary and possible to increase species abundance. Examples of habitat management include:

1. Forest thinning to promote faster tree growth to achieve canopy closure or other advanced structure
2. Creation of snags or downed wood to create habitat for prey species and covered species such as red tree vole and coastal marten.

With an HCP in place it is assumed that ODF would begin to contribute to barred owl management to reduce impacts on northern spotted owls. This program would be coordinated with regional partners. The program would likely start as a pilot program and grow over time with the objective of reducing the presence of barred owl on ODF lands. It is estimated that the contribution would cost ODF an average of $100,000 annually over the 50-year permit.

4.2.4 Species and Habitat Monitoring

Currently ODF conducts no species or habitat monitoring beyond that necessary to minimize take. All species surveys are currently limited to areas that are planned for harvest (pre-harvest surveys) in order to confirm avoidance of listed species impacts. This condition is assumed to be unchanged in the future with the baseline (no HCP) scenario.

With an HCP in place there would be a general shift from pre-harvest surveys towards monitoring for species in species management areas to gain a better understanding of species population levels, species habitat needs, and current habitat condition. Monitoring would also

determine if management actions required by the HCP were achieving the biological goals and objectives in the HCP.

Covered Fish Species

It is assumed that monitoring for covered fish species would be completed using stream habitat assessments. These habitat assessments would be conducted by ODFW once every ten years to ensure that habitat conditions in streams are improving from the No HCP Scenario conditions and that they are achieving biological goals and objectives. The estimated cost of fish habitat monitoring is shown in Table 12. Fish habitat monitoring is expected to focus on four variables: water temperature, water quality, amount of large downed wood, and fine sediment.

Covered Terrestrial Species

With an HCP monitoring for northern spotted owl and marbled murrelet is assumed to focus on presence of species in the most important habitat for each species: NSO core areas and marbled murrelet management areas, respectively. It is assumed that monitoring would occur every year in those areas to document trends in the nesting and occupancy over time. These surveys would also record barred owl presence in monitored NSO core areas over time to determine if barred owl removal activities are effective.

With an HCP, monitoring of habitat structure and suitability for terrestrial covered species is assumed to be documented and tracked over time. This would include an assessment of forest structure to support northern spotted owl and marbled murrelet, but also habitat structure for red tree vole, coastal marten, and the covered amphibians.

Riparian buffers would also be monitored to ensure that the proper habitat structure is in place to support covered amphibians and that the riparian areas are protecting streams as predicted. Much of this would be determined by stream monitoring described above, but when stream monitoring shows that the instream habitat is not adequate, additional monitoring of riparian areas may be needed to determine what additional management actions need to occur to improve stream conditions.

4.3 Changes in Available Acres

4.3.1 Riparian Buffers

State Forests currently apply riparian buffers of various widths to protect water quality, habitat for native fish, salamanders, riparian birds, and other sensitive species. These riparian buffers typically require no harvest (no cut). Riparian buffer widths are defined in terms of three stream categories:

1. Stream size: large, medium, or small (defined in terms of streamflow in cubic feet per second)
2. Stream hydrology: perennial or seasonal flows
3. Fish bearing: yes or no

These three categories produce eight distinct types of streams in state forests.[9] As illustrated in Table 11, the majority of stream miles in state forests are in the last category of small, seasonal, and non-fish bearing; and most of them are on two districts, Astoria and Tillamook. ODF further distinguishes these small, seasonal, non-fish bearing streams into three categories with distinct riparian buffers: High debris flow potential, high energy, and other.

Table 13: Stream Types by District (Miles)

District	Fish Bearing				Non-Fish Bearing			
	Large, Perennial	Medium, Perennial	Small, Perennial	Small, Seasonal	Large, Perennial	Medium, Perennial	Small, Perennial	Small, Seasonal
Astoria	82.6	114.6	204.8	20.1	1.6	7.2	378.3	1260.8
Coos	12.5	4.9	9.4	3.3	0.0	0.1	11.6	67.0
Forest Grove	115.1	19.1	20.6	0.1	4.1	21.1	266.4	417.4
Klamath Lake	4.8	0.7	1.4	4.5	0.0	1.4	2.0	96.2
North Cascade	29.9	21.9	20.1	20.6	1.2	14.9	169.2	78.2
Southwest	0.9	6.5	5.9	0.3	0.0	0.3	51.9	91.4
Tillamook	231.4	142.3	137.1	0.1	1.8	32.0	851.2	2715.0
West OR	12.5	22.4	65.9	24.3	0.0	1.5	56.0	166.9
Western Lane	7.5	10.3	38.3	3.2	0.0	1.2	34.2	128.1
Total	497.2	342.6	503.5	76.5	8.7	79.8	1820.9	5021.0
Percent of All Streams	6.0%	4.1%	6.0%	0.9%	0.1%	1.0%	21.8%	60.1%

ODF has established minimum riparian buffers under the Northwest and Southwest Oregon State Forests Management Plans to maintain, enhance and restore properly functioning aquatic habitat, and comply with the Oregon Forest Practices Act and water quality regulations. 13 lists the current riparian buffers ODF applies by stream type. In some cases a wider buffer applies to sites designated as aquatic anchor, which are reaches in watersheds where salmon and aquatic amphibian conservation is a priority. Buffer widths of 115 feet for fish bearing streams of all sizes, or non-fish medium and large streams, reflect an average distance as applied in the field, recongnizing the stream bank zone (0-25 ft.), inner RMA zone (25-100 ft.) and some contribution from the outer RMA zone (variable from 100-170 ft.), where necessary.

[9] Four combinations of these variables do not exist in state forests because there are no large or medium seasonal streams.

Table 14: Minimum Riparian Buffer Widths in Feet[1,2]

	Fish Bearing				Non-Fish Bearing			
	Large, Perennial	Medium, Perennial	Small, Perennial	Small, Seasonal	Large, Perennial	Medium, Perennial	Small, Perennial	Small, Seasonal
2010 FMP	115	115	115	115	115	115	30	0-30[3]
Aquatic Anchor Reaches	115	115	115	N/A	115	115	50	0-50[4]

[1] Riparian buffer widths in the 2010 Forest Management Plan (FMP) are applied as a horizontal measurement from each edge of the stream bank.
[2] Assumed buffer widths of 115 feet for fish bearing streams of all sizes, or non-fish medium and large streams, recongnizing the stream bank zone (0-25 ft.), inner RMA zone (25-100 ft.) and some contribution from the outer RMA zone (variable from 100-170 ft.), where necessary.
[3] High debris flow potential streams and high energy streams = 30-foot buffer; all others = zero no-cut buffer (but other harvest and access limitations may apply).
[4] High debris flow potential streams and high energy streams with aquatic anchor = 50-foot buffer; all others = zero no-cut buffer (but other harvest and access limitations may apply).

Minimum riparian buffer widths would be an important component of the HCP to protect and allow for restoration of habitat for coho salmon and other listed fish. Some streams also provide important habitat for special-status salamanders that are expected to be covered by the HCP. Although these salamanders are not yet listed, they are all on the USFWS 7-year workplan for listing considerations, which indicates that listing is possible and even likely within the next 5-10 years.

Establishing riparian stream buffers for the HCP would be done as part of the extensive negotiations between ODF and the USFWS and NMFS. In the absence of those discussions, we used as an initial assumption the riparian buffers proposed in 2017 for the Elliott State Forest HCP.[10] These buffers were the result of several years of negotiation between ODF and NMFS to protect coho salmon and its habitat. The riparian buffers that ODF would negotiate for the Western Oregon State Forest HCP would likely be slightly different and more tailored to the conditions on these forests. However, the negotiated buffers on the Elliott State Forest represent the best available indication of a possible outcome for the Western Oregon State Forest HCP (Table 14). In most stream types, the difference in buffer width between the HCP assumption and current conditions is 5 feet on either side of the stream. Small perennial and small seasonal streams (in some cases), would experience a 20-foot increase in riparian buffer, but only outside of aquatic anchor watersheds.

[10] *Elliott 2017 Habitat Conservation Plan Framework Conservation and Mitigation Measures*. Available on-line at https://www.oregon.gov/dsl/Land/Pages/Elliott.aspx

Table 15: Minimum Riparian Buffer Widths Comparing Current Situation with HCP Assumptions (Feet)[1]

	Fish Bearing[1,2]				Non-Fish Bearing			
	Large, Perennial	Medium, Perennial	Small, Perennial	Small, Seasonal	Large, Perennial	Medium, Perennial	Small, Perennial	Small, Seasonal
2010 FMP	115	115	115	115	115	115	30	0-30[3]
Aquatic Anchor Reaches	115	115	115	N/A	115	115	50	0-50[4]
With HCP Assumption[5]	120	120	120	120	120	120	50	0-50[6]
Difference (effect of HCP)	5	5	5	5	5	5	20	0-20[6]

[1] Riparian buffer widths are applied as a horizontal measurement from the outer edge of aquatic feature.
[2] Assumed buffer widths of 115 feet for fish bearing streams of all sizes, or non-fish medium and large streams, recongnizing the stream bank zone (0-25 ft.), inner RMA zone (25-100 ft.) and some contribution from the outer RMA zone (variable from 100-170 ft.), where necessary.
[3] High debris flow potential streams and high energy streams = 30-foot buffer; all others = zero no-cut buffer (but other harvest and access limitations may apply).
[4] High debris flow potential streams and high energy streams with aquatic anchor = 50-foot buffer; all others = zero no-cut buffer (but other harvest and access limitations may apply).
[5] Based on Elliott State Forest HCP Conservation Framework (2017). More complex rules that affect a small fraction of reaches and situations were omitted for simplicity in the analysis. Buffers were applied for "fish watersheds" only (not "timber watersheds") because watersheds in other state forests have not been classified with this approach (this is a conservative assumption that produces more harvest restriction and more cost than may actually occur).
[6] For the purposes of the analysis the HCP is assumed to increase buffer width by 20 feet only for high debris-flow potential areas in non-aquatic anchor reaches. All other reaches remain the same and have no difference in buffer.

These assumed HCP riparian buffers can be used to calculate the potential increase in no harvest areas with an HCP as compared to current conditions. The project team calculated these no harvest areas by applying the data in the last row of Table 14 to the stream miles by stream type. Since this was not a spatial overlay, a correction factor was used to account for the estimated overlap in the expanded riparian buffer with other no-harvest designations (to avoid double-counting). Table 16 shows the results in acres of the expected increase in no harvest areas as a result of the assumed HCP riparian buffers.

Table 16: Estimated Increase in Permanent No Harvest Areas as a Result of Assumed HCP Riparian Buffers (Acres)

	Fish Bearing				Non-Fish Bearing				Total
	Large, Perennial	Medium, Perennial	Small, Perennial	Small, Seasonal	Large, Perennial	Medium, Perennial	Small, Perennial	Small, Seasonal	
Total Acres	542	395	610	93	10	92	5,709	3,894	11,344
Percent of Total Acres	5%	3%	5%	1%	0%	1%	50%	34%	100%

4.3.2 Changes in Terrestrial Acres

Factors Influencing Changes in Terrestrial Acres

More acres are expected to be available for harvest with an HCP than without by the end of the 50-year implementation timeframe. Without an HCP, future acres available for harvest are expected to decline by approximately 59,000 acres over time due to increased protections for currently listed species and new species listings the expansion of listed species into previously

unoccupied areas and protections for newly listed species in areas where previous protections were not needed. These take avoidance measures are estimated to occur in areas that are either policy constrained (limited constraints) or are currently available for harveys (about 29,500 of each).

In contrast, total available acres for timber harvest are expected to increase over time with an HCP. because policy objectives can be more deliberately aligned with potential HCP conservation strategiesThe expansion of listed species and proetctions for newly listed species are still expected to occur, but with an HCP in place, ODF will retain some operational flexibility to harvest in areas that would otherwise be constrained. Approximately 11,000 of currently available acres become unavailable under an HCP due to a potential increase in stream buffers. An additional 35,000 acres would be excluded from all harvest for protection of northern spotted owl, marbled murrelet and other covered species habitat. These 35,000 acres are primarily drawn from areas currently under policy constraints with limited harvest potential. With ESA compliance assured under the HCP, a portion of the acres currently constrained for policy objectives can transition over time to fully available for harvest. It is important to recognize that an HCP may require harvest practices that minimize environmental impacts in these areas, nonetheless, it is expected that more acres will be available for harvest over the long-term with an HCP than without.

Estimating Future Terrestrial Species Range Expansion and New Listings

Many unconstrained acres have been surveyed for northern spotted owls and marbled murrelets, but none of them have been surveyed for species that are not yet listed. It is assumed that species would expand their range during the permit term and that more acres would become constrained to avoid take, over time. The likelihood of ODF discovering listed species in unconstrained areas is related to the level of survey that has been conducted for those species to date. The more thorough the survey effort to date, the lower the probability that listed species occur and remain undiscovered.

In order to estimate the probability of species being present, but undiscovered, a simple assumption was made relative to the level of survey effort completed to date and the chance of finding new species occurrences in the future. Those rankings are shown in Table 17. In order to calculate the total likelihood that species expansion or new species discovery could constrain harvest in the future, the survey effort and potential for discovery of new occurrences was estimated separately for northern spotted owl, marbled murrelet, and chance of newly listed species being present. A value of “high”, “moderate”, or “low” was assigned to each district. The following rules were applied for each category:

- High – 5 percent of unconstrained acres become constrained in the future
- Moderate – 3 percent of unconstrained acres become constrained in the future
- Low – 1 percent of unconstrained acres become constrained in the future

Those values were then added in order to determine the total acreage that is likely to become constrained over time if listed species expand their range or newly listed species are discovered. For example, in the Astoria district there is a “low” (1 percent) likelihood of finding new

northern spotted owl occurrences, "moderate" (3 percent) likelihood of finding new marbled murrelet occurrences, and "high" (5 percent) likelihood that a newly listed species could result in future constraints. By applying the rules from above we would assume that collectively 9 percent of the unconstrained acres could become constrained in the future (low + moderate + high = 9 percent).

Table 16 shows the estimated reduction in acres available for harvest in each district applying these factors. The present reduction in harvested acres varies from 4 percent in the Southwest district to 11 percent in the Tillamook district. In the Southwest district, most habitat has been surveyed. In this district the likelihood of finding new occurrences of northern spotted owl are low and marbled murrelets are not present. The effect that a new listing would have on harvestable acres would be moderate. By contrast, in the Tillamook district the survey effort for northern spotted owl and marbled murrelet has been moderate. Some areas are still unsurveyed. Also in the Tillamook district a new listing (e.g., red tree vole) would have a high impact on the ability of ODF to harvest while remaining in compliance with the ESA.

These data and assumptions inform the calculations of timber harvest activity with and without an HCP and are described later in this report.

Table 17: Estimated Reduction in Harvestable Acres with No HCP, due to Expansion of Listed Species or Newly Listed Species Based on Previous Survey Effort

Unconstrained Harvest Areas	Percent Reduction over 50 Yrs in Baseline	Likelihood of Finding New NSO in Areas Not Surveyed Yet	Likelihood of Finding New MAMU in Areas Not Surveyed Yet	Risk of New Listings Constraining More Harvest
Astoria	9.0%	Low	Moderate	High
Forest Grove	9.0%	Low	Moderate	High
Tillamook	11.0%	Moderate	Moderate	High
North Cascade	6.0%	Low	Zero (Not Present)	High
West Oregon	7.0%	Low	Low	High
Western Lane	7.0%	Low	Low	High
Coos	5.0%	Low	Low	Moderate
Southwest	4.0%	Low	Zero (Not Present)	Moderate

Acres Available For Harvest

Without an HCP, acres available for harvest are expected to decline from current conditions of 51 percent of BOF forest lands to 46 percent. Under an HCP, acres available for harvest are projected to increase from 51 percent to 63 percent of BOF forest lands. In both scenarios, 72,000 acres are considered inoperable (i.e. roads, non-forest, unable to log and administratively removed areas).

Across the full range of scenarios analyzed, available acres are greater for all with HCP scenarios than all No HCP scenarios by 2070. These resulting acreage ranges are based primarily upon the identified ranges of possible estimated acreage requirements for northern spotted owl, marbled murrelet, and newly listed species listings. These ranges correspond to available acres as a share of all BOF forest lands at 41 to 49 percent (about 241,000 to about 285,000 acres), for No HCP scenarios, and 59 to 70 percent (about 349,000 to about 409,000 acres) for the with HCP scenarios.

5 ODF Costs and Revenues With and Without HCP

This section describes the costs, revenues, and values associated with both scenarios (with and without an HCP), and compares them to identify the *incremental* effect of adopting an HCP. As described in Section 3 the primary changes that would occur with an HCP are with regard to the number of available acres, the staff time requirements, as well as the resulting harvest and revenue changes. This section aggregates all values described thus far to estimate the total net value expected from the HCP.

This analysis defines and models effects on ODF's costs and management activities for two scenarios: 1) continuing take-avoidance (the "**No HCP Scenario**") and 2) preparing and implementing an HCP (the "**HCP Scenario**"). Because the purpose of this analysis is to help ODF staff and the BOF decide whether to move forward in developing an HCP, the analysis team made some assumptions about what an HCP would include, but could not fully develop or define the HCP. Therefore, the analysis presents findings that are not precise or spatially explicit, but are accurate within appropriate ranges of assumptions to support ODF's decision process.

The project team considered low and high bounding scenarios around the "most likely" scenario for both HCP and no HCP to provide more confidence in the findings should key assumptions differ from those incorporated into an HCP. Upper and lower bounds are primarily based on possible future cost and species conservation acreage requirements. See Table 24 in Appendix I for the full detail on the ranges. Ranges do not incorporate changes in stumpage prices or deviation from the current FMP in terms of harvest scheduling principles. In general, ranges of outcomes are provided rather than point estimates to better demonstrate uncertainty regarding future conditions and specifics of an HCP following negotiation and more detailed spatial analyses.

5.1 Key Assumptions

Assumptions applied in this analysis include future species conditions and policy, market conditions, and a range of negotiated terms of a potential HCP. Although these assumptions hold a degree of inherent uncertainty, they are based on review of the best available information at this time. These key assumptions were also presented in Section 3 where applicable, and are restated here as an overview.

- All agency costs would increase at a real (inflation adjusted) rate of 0.5 percent annually.
- Under the No HCP Scenario survey costs and ODF administrative costs would continue to rise over time in terms of the amount of effort required to implement, resulting in a net increase of about 2.8 percent annually to maintain the no take approach to ESA compliance.

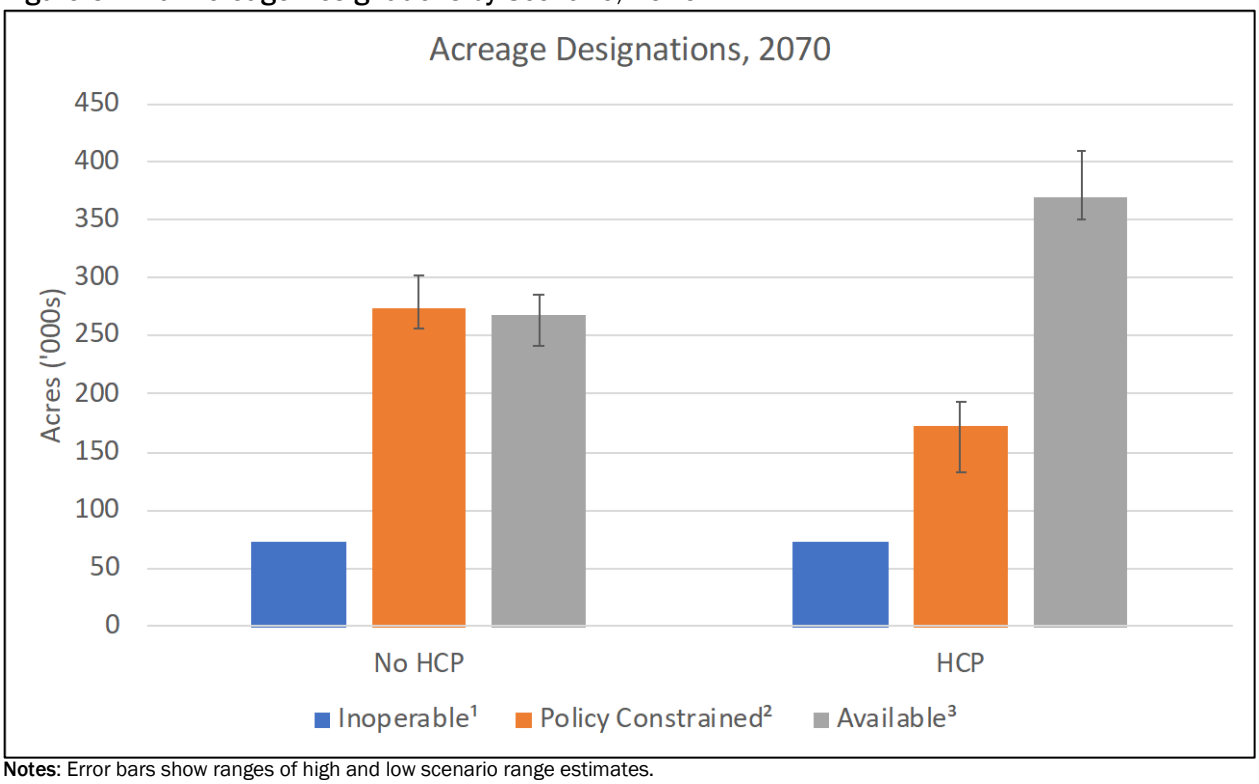
- Initial constraints are based on take avoidance protections associated with sites currently occupied by listed species.
- Timber prices are the average of ODF stumpage prices from 2013 to 2017 ($350/MBF).
- Harvest schedules assume implementation of non-declining even flow.
- Harvest schedules were adjusted to update for current inventory levels.
- Future costs and benefits are discounted at a real (inflation-adjusted) discount rate of 3 percent.

More detail on the specifics of the timber inventory and harvest modeling and associated assumptions are in Appendix II. The underlying Implementation Plan data provide the basis for these analyses. Implementation Plan data are provided in 5-year averages. The tables and figures with annual values in this analysis are similarly presented in five-year averages. In the following figures, the points represent the middle of each 5-year range (e.g., 2023 represents 2021 to 2025). 2018 in the figures represents the years 2018 to 2020.

5.2 Acreage Constraints and Harvest Availability by Scenario

Without an HCP, acres available for harvest are expected to decline from current conditions of 51 percent of BOF forest lands to 46 percent. Under an HCP acres available for harvest are projected to increase 51 percent to 63 percent of BOF forest lands. These ranges correspond to available acres as a share of all BOF forest lands at 41 to 49 percent (~241,000 to ~285,000 acres) for No HCP scenarios and 59 to 70 percent (~349,000 to ~409,000 acres) for the with HCP scenarios. In both scenarios, 72,000 acres are considered Inoperable (i.e. roads, non-forest, unable to log and administratively removed areas), and 126,000 acres are considered unavailable due to Policy and Regulatory requirements (i.e. Oregon Forest Practices Act, federal ESA and FMP stream buffers).

Figure 6. Final Acreage Designations by Scenario, 2070

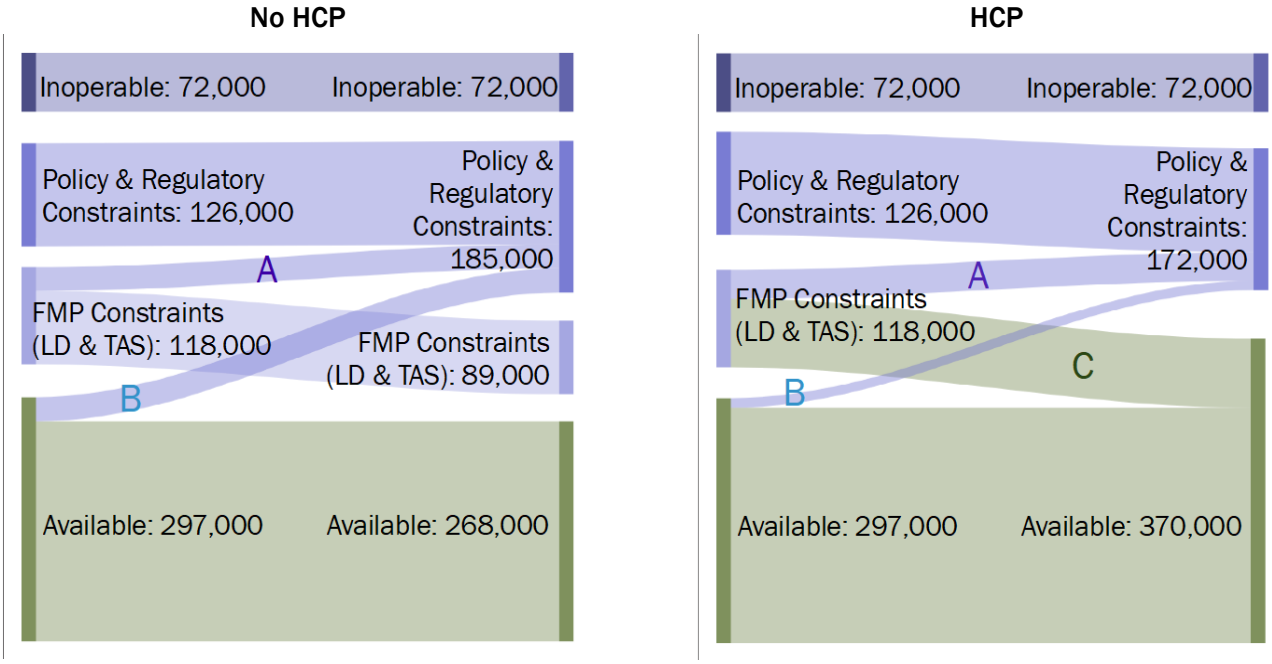


Notes: Error bars show ranges of high and low scenario range estimates.
[1] Inoperable acres either do not hold forest or would be impractical to harvest.
[2] Policy constrained acres are either unavailable for harvest or severely limited for harvest by policy and regulatory constraints (e.g., Oregon Forest Practices Act, federal Endangered Species Act and FMP stream buffers).
[3] Available acres would be available for harvest according to appropriate policy requirements.

The "Policy Constrained" acres include Landscape Design and Terrestrial Anchor Site designations. Neither of these current constraints is a regulatory mandate, but instead represent current ODF policy. Landscape Design currently represents approximately 14 percent of BOF acres beyond other policy and regulatory constraints and is a designation the restricts harvest in order to obtain layered and older forest structures. Terrestrial anchor sites are habitat areas intended to benefit terrestrial wildlife species of concern, especially those associated with older forest conditions or interior habitat conditions, are sensitive to forest fragmentation, or do not readily disperse across younger forest conditions. Terrestrial anchor sites currently represent 4 percent of total BOF acres beyond other policy and regulatory constraints.

Figure 9 illustrates the changes in acreage designations over time (2021–2070) with and without an HCP for the most likely scenarios. Without an HCP, future acres available for harvest are expected to decline over time because of the increasing constraints of expanding ranges of listed species, new species listings, and tightening regulations (flows A and B, No HCP). Under this scenario, this decrease in available acres is drawn from the FMP Constraints (i.e. current Landscape Design complex and Terrestrial Anchor Sites) and currently available acres (~29,500 of each), because these constraints occur in the context of attempted take avoidance, which are not planned but are in response to new species constraints.

Figure 7: Change in Acreage Designations from 2021 to 2070, Most Likely Scenarios



Note: Figure shows net changes in acreage designations from beginning (2021) on the left of each figure to end (2070) on the right of each figure of the 50-year HCP implementation timeframe for the Most Likely No HCP and With HCP scenarios. Flows labeled A, B and C represent net transitions of acres from one designation to another over time.

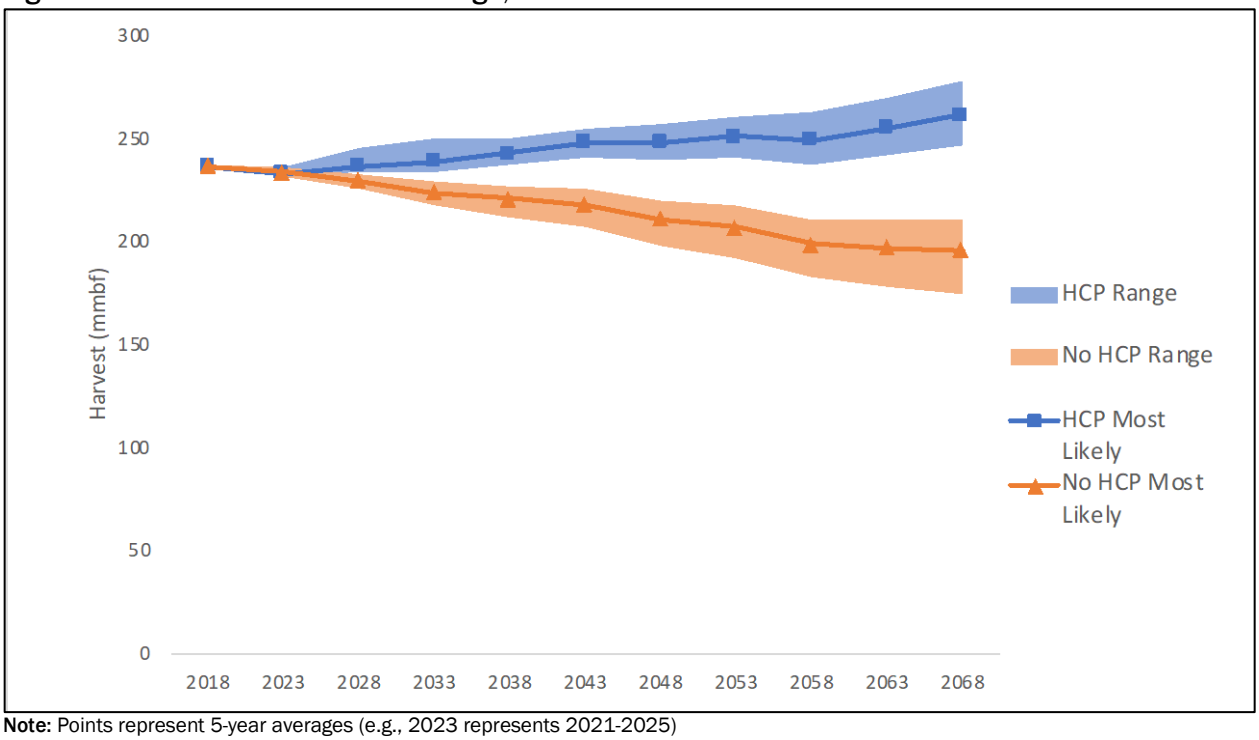
In contrast, on the HCP side, total available acres for timber harvest are expected to increase over time with an HCP, as FMP Constraints can be more deliberately aligned with potential HCP conservation strategies. Approximately 11,000 of currently available acres become unavailable under an HCP due to a potential increase in stream buffers. The relative difference between the projected future constraints is demonstrated in flows A and B (With HCP). Under the HCP, a portion of the current FMP Constraint acres can transition over time to being fully available for harvest, as shown in flow C. Corresponding charts representing the sources and destinations of these acreage changes for the high and low ranges of the scenarios can be found in the Appendix III in Figure 16 and Figure 17.

Under incidental take authorization with an HCP, ODF may have opportunities to harvest where listed species are discovered. Without an HCP, these acreages include a gradual increase of approximately 59,000 constrained acres by 2070 relative to current levels due to expected increasing constraints from current and future listings. Constraints decline over time under an HCP as areas currently avoided due to habitat conditions can be included in harvest plans.

Under the HCP Scenario, harvests are expected to stay relatively consistent or slightly climb over time (Figure 10). Decline over the first 5-year period in the HCP Scenario is due to reduction in available acres associated with stream buffer constraints. Without an HCP though, harvests are expected to consistently decline over the full timeframe, falling farther and farther below planned harvests. This decline is primarily due to increasing ESA constraints on available

acres and inability to access currently constrained acres anticipated to be accessible with an HCP. Note that annual variability would cause actual annual harvest trends to vary more than the chart suggests, although the harvests are expected to be more consistent under an HCP than otherwise.

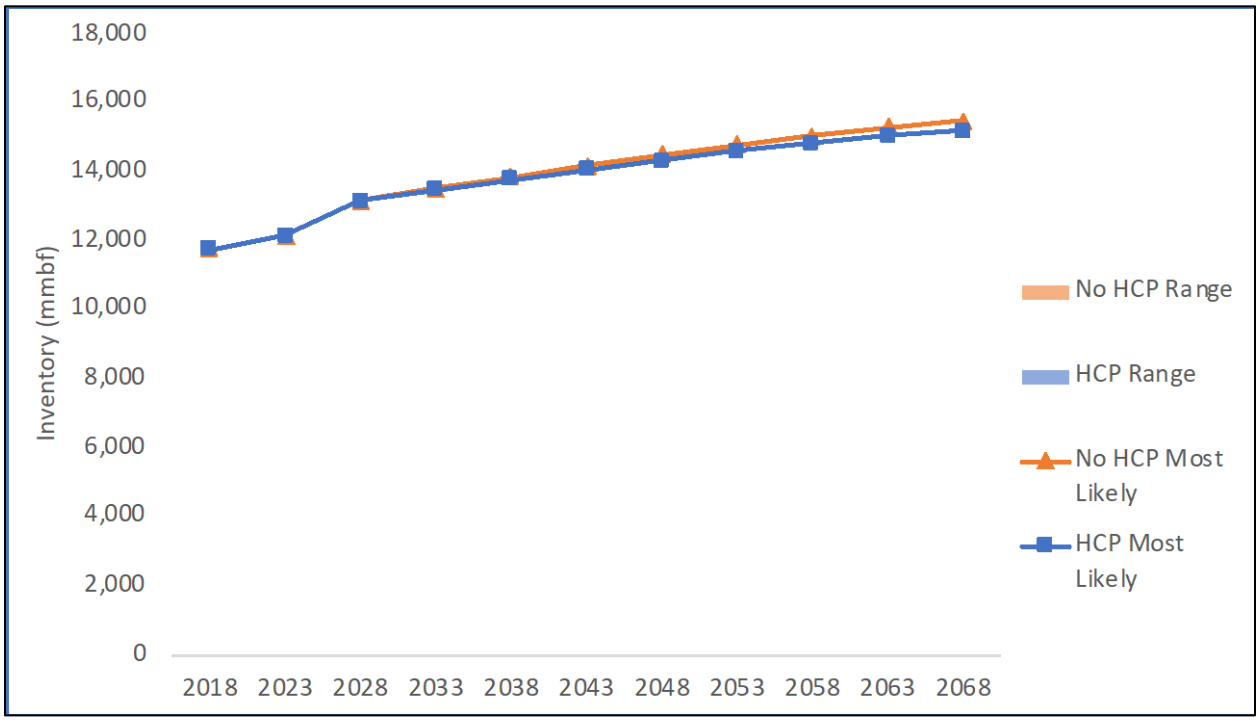
Figure 8. Annual Harvest Volume Range, With and Without HCP



Note: Points represent 5-year averages (e.g., 2023 represents 2021-2025)

The expected harvests under both scenarios result in increasing timber inventory over time (Figure 11). With reduced harvest inventory does increase more rapidly without an HCP than with an HCP. The range of effects on inventory for the high and low scenarios is too narrow for the figure to display.

Figure 9. Timber Inventory, With and Without HCP



5.3 Scenario Costs

Table 18 summarizes the costs to ODF for preparing an HCP. Total cost over three years to ODF would be about $4.0 million. In 2018, ODF was awarded a $750,000 USFWS Habitat Conservation Planning Technical Assistance grant to cover Phase 1 of the HCP, offsetting costs for the first year of HCP preparation. ODF will continue to seek grant funding to cover costs associated with developing an HCP, under the direction of the BOF.

Table 18. HCP Preparation Costs

Cost Category	Annual Cost (2018 Dollars)	Total Cost (Over 3 years)
ODF Staffing	$388,000	$1,164,000
HCP Consultant	$450,000	$1,350,000
Economic Consultant	$50,000	$150,000
Environmental Impact Statement (EIS) Consultant	$300,000	$900,000
HCP Facilitators	$165,000	495,000
Total	**$1,353,000**	**$4,049,000**

Annual ESA compliance costs are expected to decline substantially with implementation of an HCP. Starting in 2021, ESA compliance is expected to cost ODF an estimated $5.2 million in direct administration and species survey costs (Table 19). This amount includes $2.5 million of current species surveys costs as well as an additional estimated $1.7 million due to future listings and increased regulations. Under an HCP, these costs are expected to be less by $2.2 million annually. Species management costs include stream restoration and barred owl control, much or all of which can potentially be provided via grants and partner agency contributions, reducing these costs potentially to zero. This suggests that approximately two years under the HCP should more than pay for the costs to ODF of preparing the HCP in terms of reduced direct costs of ESA compliance.

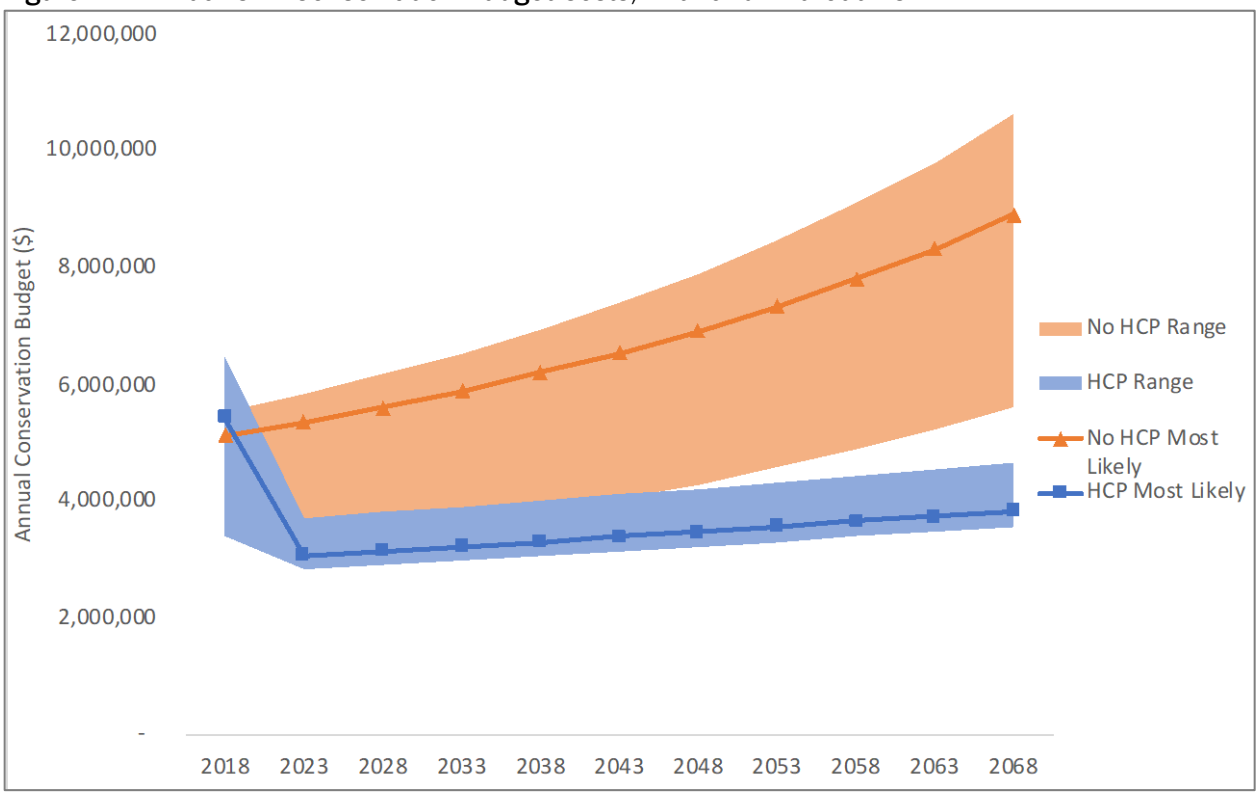
Table 19. ESA Compliance Costs for ODF, With and Without HCP

Cost Category	No HCP	HCP	Annual HCP Cost Savings
Administration of ESA Compliance	$784,000	$490,000	$294,000
Pre-Harvest Species Surveys	$4,216,000[a]	$2,121,000	$2,095,000
Species Management Costs[b]	$150,000	$350,000	($200,000)
Total	**$5,150,000**	**$2,961,000**	**$2,189,000**

Notes: [a] Assumes new species listing would result in over $1.7 million of additional annual survey costs.
[b] Assumes continued grant-funding of stream restoration.

Over time, ODF staff effort to administer ESA compliance is expected to increase, resulting in an average annual increase of 2.8 percent in costs for that category. This 2.8 percent is based on an observed rate of change in ODF staff compliance effort over recent years. Combining the HCP preparation costs with the ESA compliance costs collectively as a conservation budget over time shows that the HCP is expected to result in a drastic decrease in costs while no HCP leads to continued growth in costs (12).

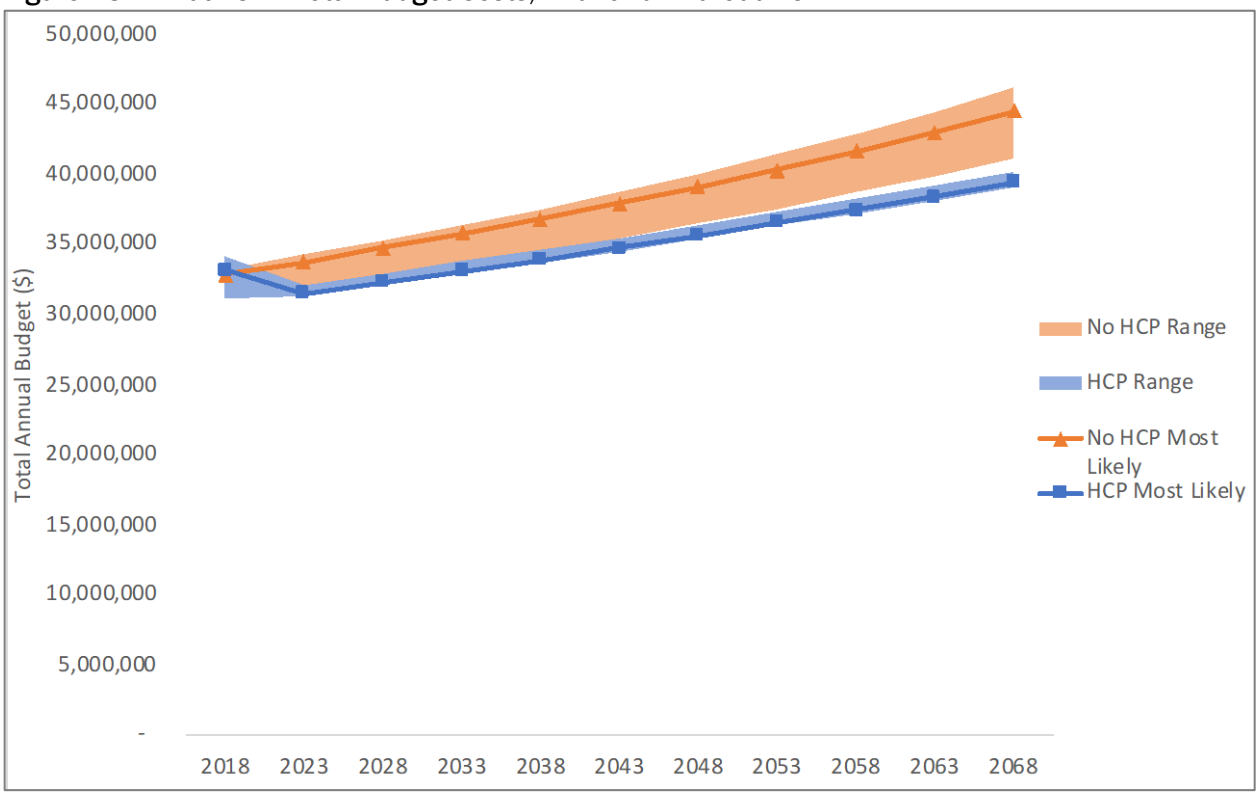
Figure 12. Annual ODF Conservation Budget Costs, With and Without HCP



Note: HCP range overlaps No HCP range in early years.

The HCP preparation costs (or lack of) as well as the ESA compliance costs are included with the remainder of overall ODF budget costs. These are based on actual recent ODF budgets with a real increase of 0.5 percent annually to reflect observed trends in costs. Collectively ODF's overall costs are expected to be consistently higher without an HCP after initial preparation years (13).

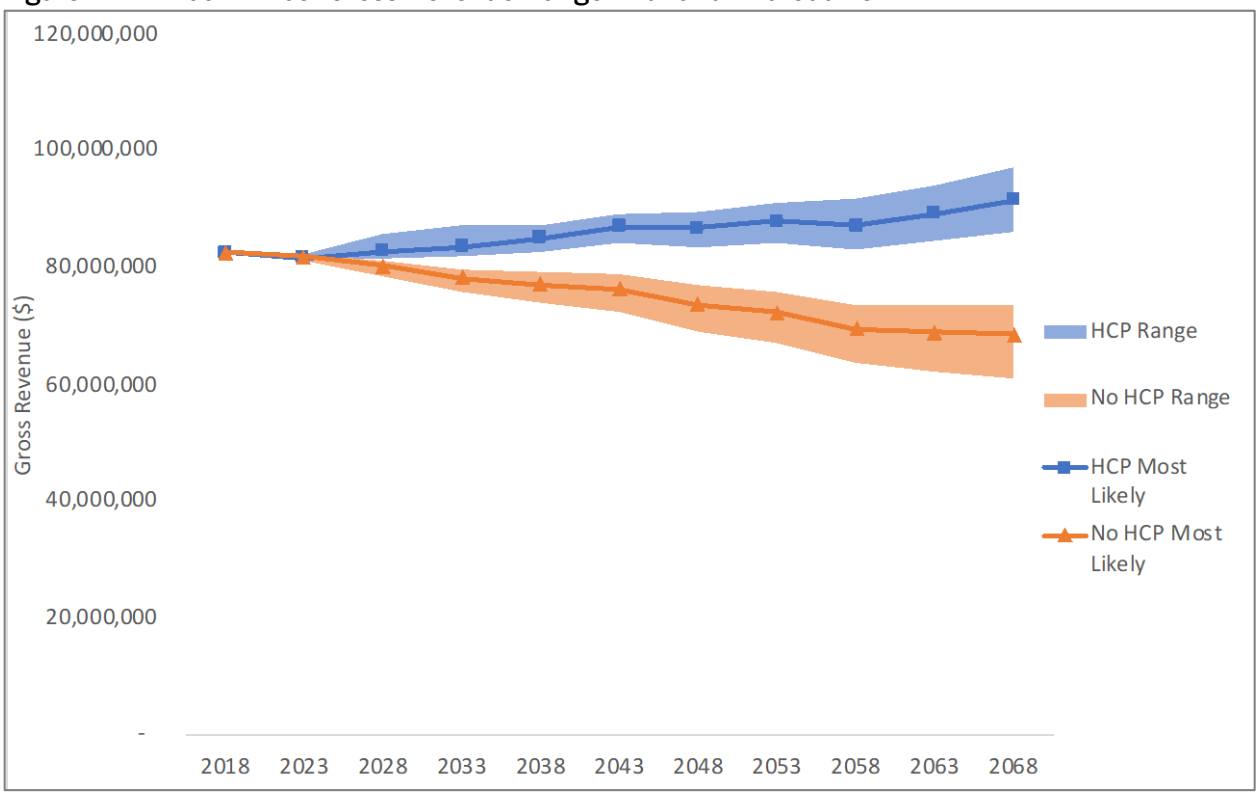
Figure 13. Annual ODF Total Budget Costs, With and Without HCP



5.4 Projected Future Timber Revenue

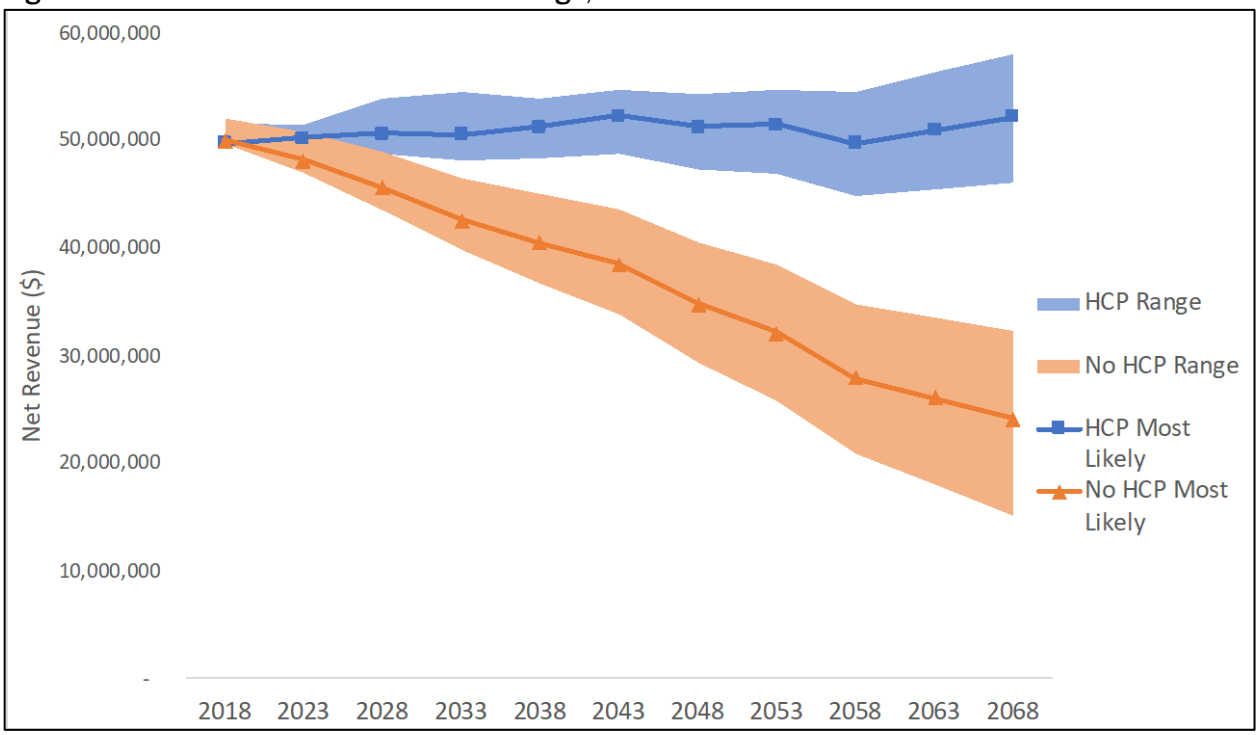
Similar to harvest volume, gross revenue is expected to increase under an HCP and decline without one. The most likely No HCP Scenario shows a decline from current levels of $82 million down to $69 million annually by 2070, compared to an increase to $92 million with an HCP (in 2018 dollars) (Figure 14).

Figure 14. Annual Timber Gross Revenue Range With and Without HCP



Due to gross revenue combined with the divergence in costs over time, net revenue is expected to increase under an HCP and decline without one creating an even greater gap than for gross revenue. Net revenue in this case is gross timber revenue including county payments minus ODF costs. The most likely No HCP Scenario shows a decline from current net revenue levels of $50 million down to $26 million annually by 2070, compared to a slight increase to $53 million with an HCP (in 2018 dollars) (Figure 15). These trends are due to the declining available acres for harvest without an HCP combined with climbing cost assumptions across all scenarios, particularly without an HCP. Revenues were calculated using a value of $350/MBF, based upon ODF revenue figures from 2013 to 2017.

Figure 15: Annual Harvest Net Revenue Range, With and Without HCP



Note: Points represent 5-year averages (e.g., 2023 represents 2021-2025).

Summed over the 50-year timeframe of 2021 to 2070 and discounted at 3 percent, the cumulative net revenue under the most likely No HCP Scenario would be $900 million compared to $1.15 billion for the most likely With HCP Scenario. This is a $250 million net revenue benefit of the HCP over a 50-year timeframe.

Across the range of assumptions for both scenarios, the financial (business case) outcome is better with an HCP than without. In all cases the costs are lower and harvests greater under an HCP. These ranges are based on the highest and lowest possible costs and acreage constraints identified, described in more detail in the full report.

Table 20. County Payments and ODF Net Operating Income, With and Without HCP

	No HCP			With HCP		
Year	Gross Revenue	County Payments	ODF Net Operating Income	Gross Revenue	County Payments	ODF Net Operating Income
2018	$82,842,000	$52,812,000	($2,839,000)	$82,842,000	$52,812,000	($3,151,000)
2023	$81,971,000	$52,256,000	($4,091,000)	$81,725,000	$52,100,000	($1,893,000)
2028	$80,415,000	$51,265,000	($5,630,000)	$82,934,000	$52,870,000	($2,251,000)
2033	$78,433,000	$50,001,000	($7,366,000)	$83,640,000	$53,320,000	($2,811,000)
2038	$77,321,000	$49,292,000	($8,833,000)	$85,225,000	$54,331,000	($3,073,000)
2043	$76,446,000	$48,734,000	($10,265,000)	$87,060,000	$55,501,000	($3,266,000)
2048	$73,924,000	$47,126,000	($12,350,000)	$86,956,000	$55,434,000	($4,183,000)
2053	$72,512,000	$46,227,000	($14,093,000)	$88,072,000	$56,146,000	($4,680,000)
2058	$69,624,000	$44,385,000	($16,439,000)	$87,291,000	$55,648,000	($5,887,000)
2063	$69,133,000	$44,072,000	($17,991,000)	$89,445,000	$57,021,000	($6,054,000)
2068	$68,656,000	$43,768,000	($19,620,000)	$91,644,000	$58,423,000	($6,229,000)
53-year Total	$1,702,370,000	$1,085,260,000	($213,451,000)	$1,891,880,000	$1,206,070,000	($75,963,000)

Note: 53-year totals represent cumulative present values discounted at 3 percent.

ODF's timber harvests generate gross revenue, approximately two-thirds of which is distributed as payment to counties where the forests are located. These county payments are expected to be greater with an HCP than without due to the corresponding greater gross revenue with an HCP (Table 20). In present, discounted value terms and real (constant) 2018 dollars, the estimated county payments over time analysis timeframe would be $1.2 billion with an HCP and $1.1 billion without. After accounting for ODF costs (budget) under current cost conditions and assumptions, ODF net operating income is expected to be negative on average in all years with and without an HCP. This fiscal budget deficit is expected to be substantially greater without an HCP than with an HCP under current operating cost conditions and trends. There is a present cumulative value of the HCP in terms of reduced budget deficits of approximately $137 million (difference between No HCP and With HCP totals).

5.5 Sensitivity Analyses

This section provides results of varying certain key assumptions in terms of consequences for gross revenue and net revenue. These sensitivity analyses address potential implications of changes to the discount rate, the stumpage price, and the assumed effects of an HCP on acreage availability for harvest management over time. These factors were chosen based on general interest in the importance of these categories of assumptions among reviewers of this study.

Table 21. Discount Rate Sensitivity Analysis

	No HCP		With HCP	
50-year Total Present Value	Gross Revenue	Net Revenue	Gross Revenue	Net Revenue
2% discount rate	$2,166,240,000	$1,088,850,000	$2,436,560,000	$1,450,450,000
3% discount rate	$1,702,370,000	$871,812,000	$1,891,880,000	$1,130,110,000
7% discount rate	$773,263,000	$418,393,000	$826,924,000	$499,325,000

Note: values based only on most likely scenarios.

Discounting future values can be an important assumption for economic and financial analyses that have effects spread over long timeframes. The choice of discount rate does have a substantial effect on the absolute magnitude of costs and revenues projected in this study (Table 21). But the difference between the HCP and No HCP scenarios is relatively consistent, with the magnitude greater with low discount rates and smaller with high discount rates. This outcome is intuitive in that the costs and revenues are relatively consistently distributed over the overall timeframe of analysis, and the timing of revenues and costs does not differ between the two scenarios.

Table 22. Timber Stumpage Price Sensitivity Analysis

	No HCP		With HCP	
50-year Total Present Value	Gross Revenue	Net Revenue	Gross Revenue	Net Revenue
1% decline in timber prices each 5-year period	$1,633,080,000	$802,523,000	$1,810,550,000	$1,048,780,000
Constant real timber prices (most likely)	$1,702,370,000	$871,812,000	$1,891,880,000	$1,130,110,000
1% increase in timber prices each 5-year period	$1,775,140,000	$944,575,000	$1,977,480,000	$1,215,710,000
3% increase in timber prices each 5-year period	$1,931,850,000	$1,101,290,000	$2,162,450,000	$1,400,680,000

Note: All other assumptions correspond to most likely scenarios.

Similar to discount rates, differences in assumed stumpage prices for timber sales over time can affect the magnitude of the values associated with each scenario, but has much less effect on the differences between scenarios for any single price assumption. Table 22 shows how gross revenue and net revenue change with changes in the core assumption regarding stumpage prices as constant based on the average sale price of recent years for ODF. If timber prices decline, so does revenue, and similarly if timber prices increase, so does revenue. If timber prices were to increase 3 percent every five years in real (inflation adjusted) terms, gross revenue with an HCP would be more than $200 million greater over time timeframe (3 percent discount rate).

Table 23. HCP Acreage Assumptions Sensitivity Analysis

	With HCP	
50-year Total Present Value	**Gross Revenue**	**Net Revenue**
Release of LD/TAS Acres delayed until 2046	$1,785,710,000	$1,023,940,000
No New species listings included	$1,931,850,000	$1,170,080,000
All LD+TAS acres released by 2035, no new species, additional 1800 constrained acres become available.	$2,101,430,000	$1,339,660,000

Note: All other assumptions correspond to most likely scenarios.

An important assumption driving the greater revenue under an HCP than without an HCP is the gradual transition to full availability for harvest of policy-constrained acres over time. One of the most important assumptions for the HCP Scenario that leads to greater harvest volumes than the No HCP Scenario is that much of the Landscape Design and Terrestrial Anchor Site acreage can gradually be released to availability for harvest with the improved regulatory predictability of an HCP. The most likely HCP Scenario assumes this release is gradual over the full 50-year HCP implementation timeframe. If the begin of this release is delayed until halfway through the 50 years, beginning in 2046, gross revenue would be $106 million less over the full timeframe ($1.786 billion vs. $1.892 billion) (Table 23). If the HCP terms include no designted areas for species currently unlisted, increased available acres would result in slightly greater net revenue of $1.932 billion. Finally one additional scenario was identified to represent what would be necessary for the HCP Scenario to achieve non-negative net operating income for ODF (elimination of the budget deficit). This would require all LD & TAS acres to be released by 2035, no new species listings, plus an additional 1800 constrained acres available for harvest beyond the most likely HCP Scenario. This would result in $2.1 billion in gross revenue and $1.3 billion in net revenue.

6 Non-Financial Effects, With and Without HCP

This section provides descriptions of the effects of an HCP in terms of relative difference to the current conditions for ODF staff forest management planning activity, ODF forest management effects on carbon sequestration, and a brief discussion of HCP expected effects on litigation risk. Technical details of calculations for the planning activity and carbon sequestration analyses are provided in Appendix IV and V respectively.

6.1 Planning Activity

ODF staff expend considerable time and effort planning forest management activities at multiple spatial and temporal scales. In recent years, those efforts have been complicated by the uncertainties associated with take avoidance strategies that can require more frequent revisions to planning effort than is generally considered necessary. This additional staff planning time required by take avoidance should be avoidable with the predictable management conditions achievable under an HCP. The reduced burden on staff time would allow staff to address a range of other important objectives, such as continuing to improve internal business practices or increasing recreation, education and interpretation opportunities. This section describes an estimate of the overall staff time associated with planning, and a potential range of reduced planning effort associated with an HCP.

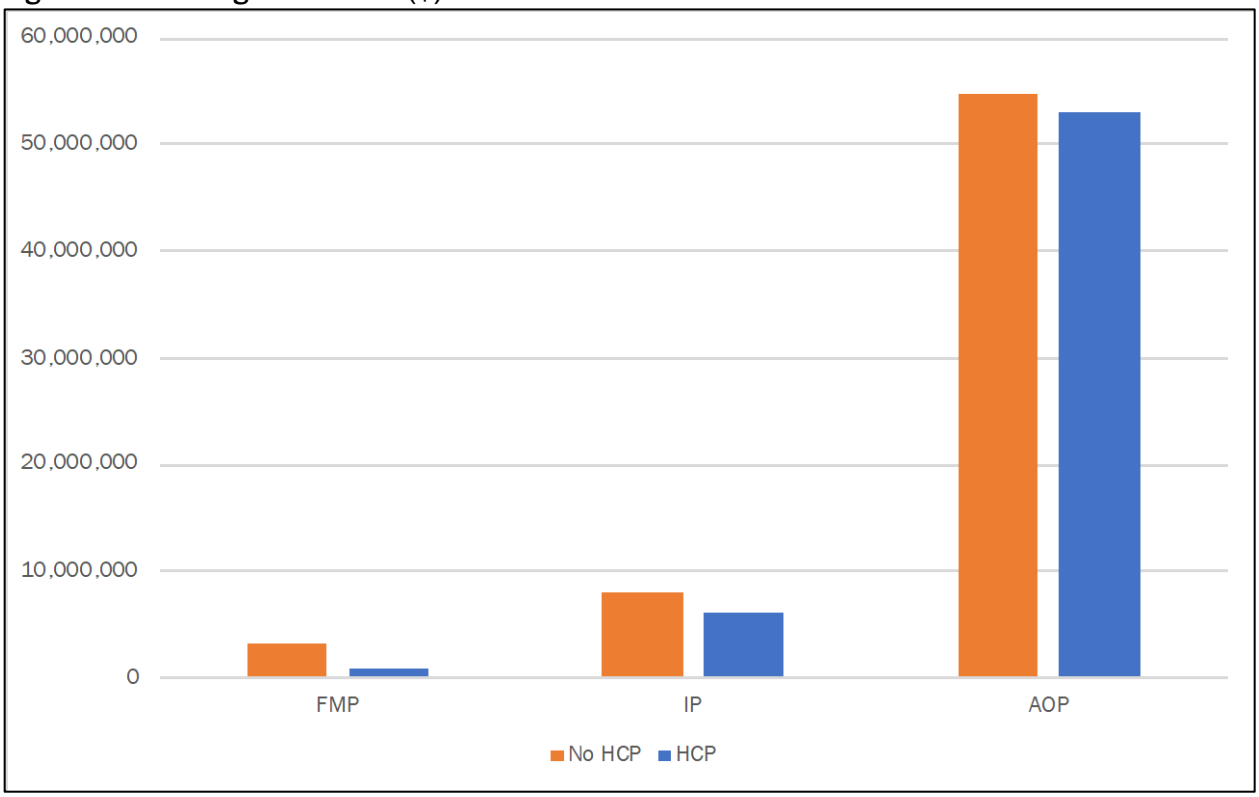
Planning by ODF for forest operations occurs at varying timeframe and levels of administration within the department. Forest Management Plans (FMP) are creation and revision efforts are led by ODF Salem staff, in collaboration with district representatives. The FMP is the over-arching plan that is used to guide the district-level planning efforts using resource management strategies. The FMP is intended to develop principles, goals and strategies for specific resources to fulfill the statutory mandate of providing "greatest permanent value" to the people of the State of Oregon. the Board of Forestry reviews the FMP is every 10 years, and revises as necessary. Guided by the FMP, district Implementation Plans (IP) are created that contain specific forest management objectives (harvest, forest structure, etc.) for the next ten years. Accordingly, these IPs are intended to be revised every 10 years by each district. Note that not all districts are on the same IP schedule. At a finer scale, the Annual Operations Plan (AOP) is created by each district annually. These AOPs contain specific budgeting, harvest levels, survey planning, road construction, and ongoing maintenance plans for the specified year.

The project team surveyed ODF to understand the amount of current time being spent on planning efforts and estimated costs. Based upon those survey results, the estimated times savings with and without an HCP were calculated. Figure 16 displays the differences in costs over the 50-year HCP for the HCP and No HCP scenarios. Note that a 0.5 percent real annual increase in cost was included in the calculations. This analysis indicates that approximately 9 percent of total planning costs could be saved with an HCP due to the reduction in unplanned

revisions to the planning documents. This 9 percent figure translates to roughly $6.1 million in savings over the 50-year period.

See Appendix IV for more detailed calculations of the planning effort costs.

Figure 16: Planning Effort Costs ($) over 50 Years for HCP and No HCP Scenarios



6.2 Regulatory and Legal Risk Management

An important benefit of a comprehensive HCP are the regulatory assurances provided by USFWS and NMFS to ODF through the incidental take permits. Section 10 of the ESA provides strong "No Surprises" assurances to incidental take permit holders. These No Surprises assurances, also known as "a deal is a deal," were created in 2000 to provide greater incentives for non-federal landowners to prepare HCPs. The No Surprises assurances guarantee that the USFWS and NMFS would not require HCP permittees to provide any more land, water, or money than what is committed to in the HCP in the event of unforeseen circumstances. Unforeseen circumstances are defined as changes to the environment that may affect the status of the covered species that were not anticipated by those who prepared the HCP. To receive these strong assurances, HCP applicants must describe foreseeable circumstances that could change, how they would address those "changed circumstances," and provide funding to implement remedial actions should they be needed. These strong No Surprises assurances are valid for the duration of the permit as long as two important conditions are met: 1) the HCP

permittee is properly implementing the plan and its terms and conditions, and 2) none of the covered species are in jeopardy of extinction.[11]

The practical effect of these No Surprises assurances are to lock in mitigation actions and mitigation costs for the duration of the permit, for all of the covered species, whether they are listed or not. Note that mitigation may still be adjusted to improve its performance according to the adaptive management program, but these adjustments are made within the boundaries set by the HCP, often including estimated costs. By covering non-listed species in an HCP, USFWS and NMFS provide assurances that no additional mitigation is required if and when the species becomes listed. Because mitigation requirements often escalate after new species listings, these regulatory assurances can be particularly valuable for species not yet listed and which are expected to become listed soon. In summary, the No Surprises assurances provided by an HCP would enable ODF to greatly reduce the uncertainty and increase the predictability of its costs related to listed and other non-listed species.

Overall, the HCP would distribute legal liability for ESA compliance more broadly as the Services approving the HCP bear responsibility for the HCP approval. Furthermore, the HCP would help reduce uncertainty regarding acreage management and habitat constraint requirements which should reduce potential ambiguities that can be a target for lawsuits. More specifically, lawsuits addressing ESA compliance can demand an HCP as an objective, a litigation objective removed with activation of an HCP.

6.3 Critical Habitat Protection and Species Recovery

When a species is listed, USFWS and NMFS are required to designate "critical habitat" on maps that delineates the specific geographic areas with features essential to the conservation of the listed species. Critical habitat is often designated in areas currently occupied by the species. In some cases critical habitat is designated in areas currently unoccupied but where suitable habitat historically supported the species. To date, critical habitat has been designated for approximately half of all listed species.

Critical habitat only applies to federal actions and consultations under Section 7 of the ESA. When a federal action agency consults with USFWS or NMFS, they must evaluate whether their action "adversely modifies" designated critical habitat. In practice, however, critical habitat is often used in wider contexts because of its rigorous technical basis and often intense public scrutiny. Critical habitat is also one of the most litigated aspects of the ESA. Critical habitat designations are often sued by industry for being too broad, while environmental groups sue critical habitat designations for being too narrow. This litigious situation creates tremendous uncertainty over where critical habitat would ultimately apply. In some cases, USFWS or NMFS have revised critical habitat for the same species three or four times in response to court decisions or settlement agreements.

[11] If either of these conditions are violated, USFWS or NMFS may suspend or revoke all or a part of their incidental take permit according to the ESA Section 10 permit revocation rule.

An important but often overlooked benefit of an HCP is that it can prevent new critical habitat designations in the HCP plan area, either for newly-listed species, or for species already listed that do not yet have critical habitat. Current ESA regulations for critical habitat allow USFWS and NMFS to consider draft or approved HCPs in critical habitat designations. The 2016 Final Rule on critical habitat exclusions states:

> "When [USFWS or NMFS] undertakes a discretionary [critical habitat] exclusion analysis, we will always consider areas covered by a permitted…HCP, and we anticipate consistently excluding such areas from a designation of critical habitat if incidental take caused by the activities in those areas is covered by the permit under section 10 of the [ESA]…"[12]

An example of this HCP benefit is provided by marbled murrelet in Oregon. USFWS first designed critical habitat for the species in 1996. At that time, USFWS chose to exclude critical habitat designations on the Elliott State Forest because of ODF's approved HCP (in 1995). Despite revisions to critical habitat for marbled murrelet in 2011 and 2016 in response to litigation, this critical habitat exclusion on the Elliott State Forest remains to this day.

An HCP also provides an intangible but real benefit to the State by increasing the chance that listed species would be down-listed (from endangered to threatened) or removed from the list altogether (de-listed). A recent example of this scenario was the 2018 de-listing of the black-capped vireo, a songbird found only in Texas. An important reason USFWS cited as contributing to the recovery and de-listing of the species was the 10 HCPs, some over a large scale, across the range of the species.[13] Many of these HCPs were put in place by state and local agencies.

Under the assumptions used in this analysis, the Western Oregon State Forest HCP would cover 16 listed and non-listed species that have the potential to become listed during the 50-year term of the permit. A real benefit of the HCP is that the mitigation and conservation actions implemented by ODF may help prevent the listing of these non-listed species by improving their status on state forests. The HCP may also help justify the eventual de-listing of the 16 species expected to be covered by the HCP.

6.4 Recreation Management

The project team spoke with representatives from user groups of OHV, equestrian, and hunting users who engage in activities on one or more state forest. Some of the common themes from the informational interview include:

- All of the representatives were able to provide examples of ways that their group coordinates with ODF staff for volunteer work parties, permitting for activities, and/or

[12] *Federal Resister* Vol. 81, No. 28, 7226-7248, February 11, 2016.

[13] *Federal Register* Vol. 83 No. 73, 16228-16242, April 16, 2018.

stakeholder engagement for planning efforts. Interviewees characterized the relationships between their recreation user groups and ODF as "good".

- Timber harvests were not characterized as having major impacts on recreation. Users said instances of not being able to use a trail because of harvest was infrequent (not every year) and there were plenty of alternative trails available.
- The BOF land provides opportunities for OHV, hunting, and equestrian recreation for which it is difficult to find substitutes, due to restrictions on private lands and a lack of other public lands available in the region that allow those specific activities at the scale of state forests.
- Interviewees expressed understanding that the forests are "working forests" and expressed sentiments that any inconvenience to them was offset by the importance and value of the timber from the land. Timber companies were characterized as doing their due diligence and following timber harvest contracts to restore trails post-harvest.
- Views for recreation are impacted by timber harvests. Users said they did not find a place as valuable for recreation after a clear cut harvest which can be seen from the trail, and that they do decrease use of a trail when these views are impacted.
- Rather than timber harvests, if there was any indication of disruption to activities, it appeared to be some potential for minimal conflict between user groups, and various users said they avoid areas if another type of group was using it. For example, the noise from target shooting disrupts the hunters. Another example is that mountain bikes and motorcycles can spook horses, so the equestrian riders try to avoid them. Interviewees expressed sentiments that all different types of user groups share the forest and need to be respectful of one another. The number of trails was also cited as a point of contention, with one user saying motorized trails in the Tillamook State forest are approximately 400 miles but non-motorized trails that allow horses are only about 50 miles.

Based upon the assumptions and information presented thus far in this report, harvest is expected to increase with an HCP. The informational interviews with recreational stakeholders indicate that harvest can impact recreation through trail closures and changing landscapes. By 2070 it is believed that there could be up to a 25 MMBF per year increase in harvest across all districts compared with current 2018 harvest levels. This marginal increase in timber harvests may impact recreational users by increasing instances of trail closures and locations where views are converted from forest to clear-cuts. Recreational use is largest in the Tillamook, Clatsop, and Santiam state forests, so changes in these forests in particular have the potential to impact the largest number of users. Because the HCP is intended to be protective of fish populations and habitat, to the extent that it improves fishing opportunities for anglers, it would have positive economic effects.

6.5 Carbon Storage and Sequestration

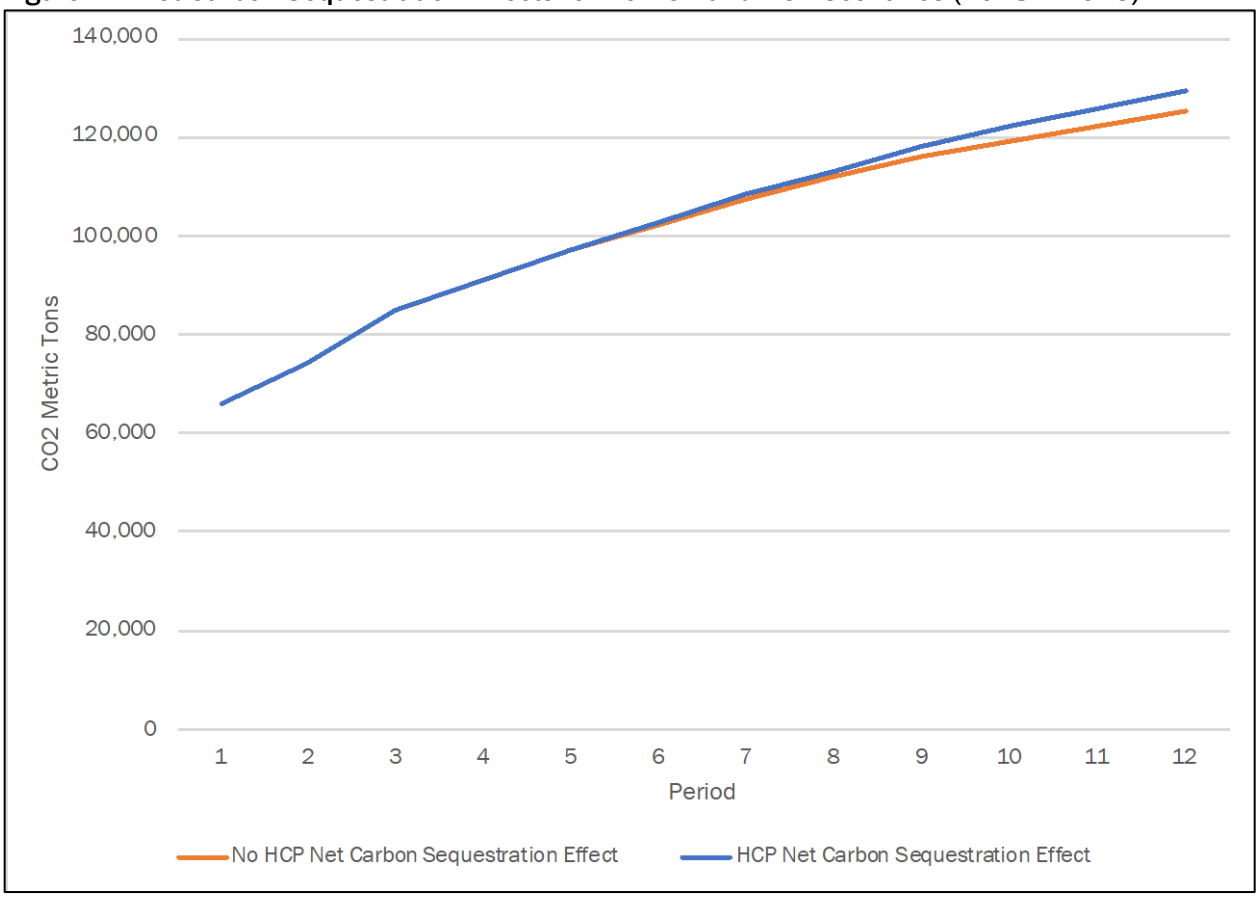
This section provides a high-level analysis of the potential carbon sequestration implications of HCP adoption relative to current forest management practices. Separately, ODF is engaged in more intensive and detailed analyses of its impact on carbon storage and options for potential carbon strategies moving forward. This analysis is not related to those more focused efforts.

Note that when the word "carbon" is used in this section of the report it is referring to carbon dioxide (CO_2). To calculate the total carbon impacts for the HCP and no HCP scenarios, the following formula was used for each period:

> Net Carbon Effect = Carbon Sequestered in Inventory – Carbon Removed via Harvest + Carbon Remaining in Post-Harvest Wood Products

Although an HCP results in higher harvest, and therefore less inventory than the No HCP scenario, the inventory discrepancy is made up for by the residual carbon remaining from prior harvests and the replanting on harvested lands. In 2070, the No HCP is expected to result in a 60,000 CO_2 metric tons increase in carbon sequestration from 2018, while the HCP is expected to result in a 56,500 CO_2 metric tons increase in carbon sequestration from 2018 (Figure 17).

Figure 17: Net Carbon Sequestration Effects for No HCP and HCP Scenarios (2018 – 2073)



Based upon the $42 per metric ton of CO2, the social value of sequestered carbon in 2070 is estimated as $5.1 million with the HCP and $5.3 million with No HCP. It should be noted that these estimates are well within the expected standard of error and should therefore be interpreted as there being no significant difference in the value of carbon sequestered for either scenario.

See Appendix V for full carbon calculations.

Additional Considerations

It should be noted that the increase in carbon sequestration with an HCP result does depend on various assumptions about the use of wood products and ODF activities following harvest. This analysis used the values for softwood lumber from Smith et al. (2006)[14] due to the amount of relatively high-quality Douglas Fir in the inventory, however paper (from mill residuals) and hardwood lumber have lower fractions of carbon remaining and thus would result in less carbon remaining in post-harvest products. This analysis also does not account for the carbon released in the harvest or wood manufacturing process, which would result in lower net carbon sequestration with an HCP.

The carbon sequestration values reflected here are purely for illustrative purposes to demonstrate the magnitude of the effects of an HCP. Although this analysis indicates that there would be an increase in carbon sequestration with an HCP, we recognize that there are a variety of reasons why the opposite may also be true. However, considering only the magnitude, what can be discerned from this analysis is that the difference in carbon sequestration rates with and without an HCP are minimal. This research does not support using changes in carbon sequestration rates as support for or against an HCP.

[14] Smith, J. E., Heath, L. S., Skog, K. E., & Birdsey, R. A. (2006). Methods for calculating forest ecosystem and harvested carbon with standard estimates for forest types of the United States. *Gen. Tech. Rep. NE-343. Newtown Square, PA: US Department of Agriculture, Forest Service, Northeastern Research Station. 216 p., 343*.

7 Summary of Effects of an HCP

Analyses in this Business Case Analysis suggest that while there are initial costs to prepare an HCP to receive an incidental take permit, annual ESA compliance cost savings achieved by obtaining such a permit more than cover the preparation costs in the first couple of years of implementation. Furthermore, timber harvest revenue is expected to be much greater under an HCP. Without an HCP, harvest volumes and revenues are expected to consistently decline. This results in approximately $250 million in (cumulative) net present value of the HCP over 50 years of timber harvests, in terms of summed net revenue under an HCP vs. without an HCP. In addition, the HCP will reduce litigation risk and associated costs as well as the significant amount of staff time required for continued forest management plan revision processes.

In summary the key findings for the Business Case Analysis in terms of financial effects an HCP would have relative to a future scenario for ODF with no HCP:

- **Greater gross timber revenue**, worth $200 million over the full timeframe due to greater volume of timber harvests relative to no HCP.
- **Reduced ESA compliance costs** due to stabilization of compliance effort and reduced surveys, worth $50 million.
- **Greater net revenue** of $250 million due to greater net gross revenue and reduced costs relative to no HCP.
- **Improved harvest certainty and reliability**, due to certainty of acreage designations and harvest availability acreage.

In addition to these financial outcomes, other non-financial outcomes of relevance include:

- **Improved species habitat conditions across the landscape and over time**, demonstrated by HCP support and agreement by NMFS and USFWS.
- **Reduced forest management planning effort by ODF staff**, allowing staff to complete other valuable activities.
- **Decreased legal or regulatory risk**, due to shared ESA compliance responsibility and greater certainty of acreage policy constraints and harvest availability

Also, the HCP is likely to maintain recreation conditions or potentially lead to improvements if more staff resources and budget become available for management and investment in recreation offerings and assets. The HCP can also potentially improve overall carbon sequestration volumes, although this result is preliminary. The HCP is unlikely to substantially affect the overall supply of other ecosystem services from ODF-managed forests such as air quality and water quality, although the landscape-scale ecological improvements should if anything lead to improved supplies of clean air and clean water.

Overall, this Business Case Analysis strongly suggests that an HCP would be in the best financial interests of the BOF. All evidence suggests that the investment in an HCP would have

financial benefits, and would likely have other important non-financial and legal liability benefits as well. Furthermore continued pursuit of an HCP would not eliminate the opportunity to withdrawal from the process at any time if terms of a negotiated HCP begin to appear unlikely to provide the net benefit relative to no HCP found in this study.

Appendices

I. High and Low Scenario Value Assumptions

Table 24 summarizes the assumptions made to create bounding ranges for the analyses, in part to reflect uncertainty in terms of how future conditions will develop over the timeframe out to 2070, as well as to reflect uncertainty regarding the specific terms of a negotiated HCP.

Table 24. Full Range of Scenario Assumptions

Cost/Revenue Parameter	No HCP			With HCP		
	Lowest Possible Cost	**Most Likely Cost**	**Highest Possible Cost**	**Lowest Possible Cost**	**Most Likely Cost**	**Highest Possible Cost**
Summary of Scenario	Status quo – no new listings or expansion of species distribution	Increasing listings, expansion of habitat, and tightening ESA restrictions resulting in more limits on harvest over time.	All possible listings and maximum expansion of species distribution	More favorable outcome of data and analysis and negotiations with USFWS and NMFS	HCP resulting in reasonable conservation commitments and take authorization allowing some harvest in suitable habitat.	Less favorable outcome of data and analysis and negotiations with USFWS and NMFS
Administration of ESA Compliance	Same annual spend as current (no increase over time)	Year over year increase in staff time related to ESA compliance due to 50-100% increase in species distribution and new constraints due to new listings.	50% increase in effort due to higher than expected species range expansion and new listings	Same as most likely	Following an initial investment no notable increase in staff time during the permit term. Staffing costs would be predictable as species range expansion or new listings would be	Same as most likely

Cost/Revenue Parameter	No HCP			With HCP		
	Lowest Possible Cost	**Most Likely Cost**	**Highest Possible Cost**	**Lowest Possible Cost**	**Most Likely Cost**	**Highest Possible Cost**
	Annual Cost: $551,000	Annual Cost: $551,000	Annual Cost: $827,000	Annual Cost: $355,000	anticipated by the HCP. Annual Cost: $355,000	Annual Cost: $355,000
Species surveys and monitoring	Pre-harvest surveys continue at approximately the same level (NSO and MAMU only). No RTV listing. Annual Cost: $2,483,000	Increase in monitoring resulting from an increase in listed species distribution and newly listed species on 58,735 acres. Annual Cost: $4,216,000	Same as most likely Annual Cost: $4,216,000	10% less cost resulting from HCP negotiations Annual Cost: $1,909,000	Transition away from pre-harvest surveys towards HCP effectiveness monitoring. Monitoring program will be more predictable, as defined in the HCP. Annual Cost: $2,121,000	25% more cost resulting from HCP negotiations Annual Cost: $2,651,000
Species management costs	Same as most likely	Stream restoration ~$150,000/yr. all grant/partner funded (cost to ODF = in kind services; staff time and wood) No capital cost to ODF.	Same as most likely	Stream restoration same as most likely Barred owl = $100,000/yr	Stream restoration ~$250,000/yr. all grant/partner funded (cost to ODF = in kind services; staff time and wood). Barred owl = $100,000/yr	Stream restoration ~$250,000/yr. reduced grant availability (capital cost to ODF) Barred owl = $200,000/yr

Cost/Revenue Parameter	No HCP			With HCP		
	Lowest Possible Cost	**Most Likely Cost**	**Highest Possible Cost**	**Lowest Possible Cost**	**Most Likely Cost**	**Highest Possible Cost**
	Annual Cost: $0	Annual Cost: $0	Annual Cost: $0	Annual Cost: $350,000	Annual Cost: $350,000	Annual Cost: $450,000
Harvest projections and net revenue	Currently constrained acres remain constrained; unconstrained and all LandDes and TAS acres are available for harvest with no new constraints in the future Remove risk of listings but retain chance of finding new NSO or MAMU occurrences **12,000** acres of reduced harvest (unconstrained	**59,000 acres** of reduced harvest (ICF est) in LandDes, TAS, and unconstrained	Currently constrained acres remain constrained; unconstrained and LandDes and TAS acres are partially constrained due to species range expansion and new listings 32,000 acres of reduced harvest from LandDes and TAS (ICF est) + 82,000 acres (ODF est of tree vole listing max effect) = **114,000 acres** max reduced harvest	10% of MMMA and NSO40pct can be harvested in all districts based on site data = 4,000 acres; no additional designated species areas. Riparian buffers same as in most likely ~ 11,000 acres Newly constrained acres = **11,000**	Designate 15,000 acres of TAS for NSO and MAMU (no unconstrained) + 20,000 acres for red tree vole (all other covered species addressed already) = 35,000 acres total Riparian buffers as estimated by ICF – 11,000 acres Newly constrained acres = **46,000 acres**	Designate 26,000 acres of TAS for NSO and MAMU (no unconstrained) + 30,000 acres for red tree vole (all other covered species addressed already) = 56,000 acres total Riparian buffers same as in most likely ~ 11,000 acres Newly constrained acres = **67,000 acres**

Cost/Revenue Parameter	No HCP			With HCP		
	Lowest Possible Cost	Most Likely Cost	Highest Possible Cost	Lowest Possible Cost	Most Likely Cost	Highest Possible Cost
	only, minus new listings)					
HCP Preparation Cost	No HCP prepared One-Time Cost: $0	No HCP prepared One-Time Cost: $0	No HCP prepared One-Time Cost: $0	Same as Most Likely Cost One-Time Cost: $1,559,000	One-Time Cost: $1,559,000	HCP preparation cost to ODF triples (fewer federal grants, and more time to prepare HCP) One-Time Cost: $4,678,000
Legal Risk	Lawsuits are infrequent. Costs could be lower than most likely cost without HCP.	Lawsuits increase as new species are listed. Costs could be several million dollars annually in legal costs.	Increasing lawsuits as more species listed. High cost could be twice or more the most likely cost.	Same as most likely cost.	Lawsuits related to ESA are rare or absent due to adequate ESA compliance. Costs are minimal over time.	Lawsuits less frequent than without HCP but continue. Costs are several hundred thousand $ to defend cases.

II. Timber Harvest Modeling and Valuation

Data Sources

Each of the ODF districts have Implementation Plans (IP) which project timber inventory and planned harvest in 5-year increments. The IP models have varying start dates (Period 0) of 2009, 2011, 2012, and 2017. When the period did not align perfectly with the 5-year increments (2009, 2012, 2017), the closest IP period was chosen (except TL in 2009 which was split between period 1 and 2). These IPs were used to understand planed total inventory (MMBF) and annual harvest (MMBF)

While the IP plans were used for future harvest and inventory projections, the current inventory and current constraints were based upon information provided directly by ODF. The following information by district was used from this inventory data to calculate the baseline current inventory in 2016:

- Acres and MMBF per district
- Acres and MMBF per harvest area constraint[15]
- Age of stand
- Stand structure type
- Stand cover type (species and density)

The values to estimate prices, revenues, and expenditures were obtained from ODF and are based upon the 5-year average from 2013 to 2017. The 5-year average for Expenditures, Value of Timber Removed, and Revenue were divided by the 5-year average for MBF harvested to obtain a $/MBF value. The results from this exercise are presented in Table 25.

Table 25: Baseline values based on 2013 to 2017 averages

$ Expenditure/MBF	$ Value Timber/MBF	$ Revenue/MBF
135.46	383.77	349.98

Based upon these $/MBF figures and the MMBF harvest value from the IP Model, adjusted by the actual Inventory, we calculated the baseline No HCP value of timber, costs, and revenues for each of the 5-year periods from 2016 to 2073. To estimate the payments to counties, we subtracted the calculated costs from the calculated revenue.

Note that inventory data is traditionally reported as the beginning of the time period while harvest and net growth are reported as taking place during that time period. Net growth was calculated as the change during the period based upon the following formula:

[15] Note that the constraints in the Inventory data are as follows: AdminRem, FMPStreams, FPAWild, InnerGorge, LandscapeDesign, Logsys, LSPSHighRisk, MMMA, NonForest, NSO40pct, NSOCores, NSOSHA, OldGrowth, Roads, TAS

$G_{\Delta t} = (I_{t+1} - I_t) + H_{\Delta t}$

where

$G_{\Delta t}$ Net growth in period t

I_{t+1} Inventory in period t+1

I_t Inventory at the beginning of period t

$H_{\Delta t}$ Harvest in period t

Modeling Future Inventory and Harvest

The MMBF in the Inventory was significantly higher than the available inventory in the beginning period of the IP models. Accordingly, the IP Model projections for available inventory and harvest were adjusted up to reflect the higher actual inventory available. See Table 26 below for the percent adjustments that were applied.

Table 26: Ratio of inventory to IP model (MMBF) by district

District	Inventory/IP Ratio
Astoria	1.023834502
Forest Grove	1.070713419
Tillamook	1.256043883
West Oregon	1.238702202
North Cascades	1.192894443
Western Lane	1.207922149

Additionally, the inventory data did not separate the contained common school fund lands, so an adjustment of 0.9593 was applied to acres and MMBF of inventory and 0.9647 was applied to planned harvest, based upon the total proportion of non-CSL land to district land. Additional adjustments were made to the first period inventory based on data discrepancies.

The growth rate was calculated based on changes to the adjusted inventory over time and divided by the number of acres included in the inventory to produce an average growth (MMBF) per acre by 5-year period. In the non-constrained forests we assume that harvests are assigned consistent with sustainable management practices where average harvest levels equal net growth. Harvest is calculated by multiplying the average growth (MMBF) per acre by the number of available/not constrained acres for each 5-year period.

If planned harvest is met from non-constrained available acres (excluding LD & TAS):

$H_t = G_t / A_{op} * A_{nc}$

If planned harvest is not met from non-constrained available acres:

$H_t = (G_t / A_{op} * A_{nc}) + (G_t / A_{op} * A_c * x_t)$

Where

H_t Harvest at time t (MMBF)

G_t Growth in total inventory at time t (change in inventory, MMBF)

A_{op} Area of operable forests (acres)

A_{nc} Area of no harvest constraints (acres)

A_c Area of LD and TAS constraints (acres)

x_tRecovery factor for constrained harvests (10 percent)

The total harvest is multiplied by the constant real value of MMBF to calculate the total gross revenue.

Landscape Design and Terrestrial Anchor Sites (LD+TAS)

Landscape Design (LD) and Terrestrial Anchor Sites (TAS) acres are assumed to have constraints imposed by management goals for achieving desired forest structure conditions and those imposed to protect habitat or taking of endanger or threaten species. Harvest on these lands are assumed to be limited at 10 percent of growth. Without an HCP it is assumed that species would be found on some LD+TAS lands and these would then be constrained at 0 percent harvest. Since it is unknown when this would occur, it is modeled as occurring linearly. Aside from these acres, remaining LD+TAS acres stay constrained through the end of the study period at 10 percent harvest. Under an HCP, additional conservation acres (current known species and potential future species such as the red tree vole) are taken first out of LD+TAS where possible but the rest of these acres are released linearly over time to 100 percent harvest. The additional conservation acres under an HCP are constrained from 10 percent harvest to 0 percent harvest linearly over time.

Available Acres

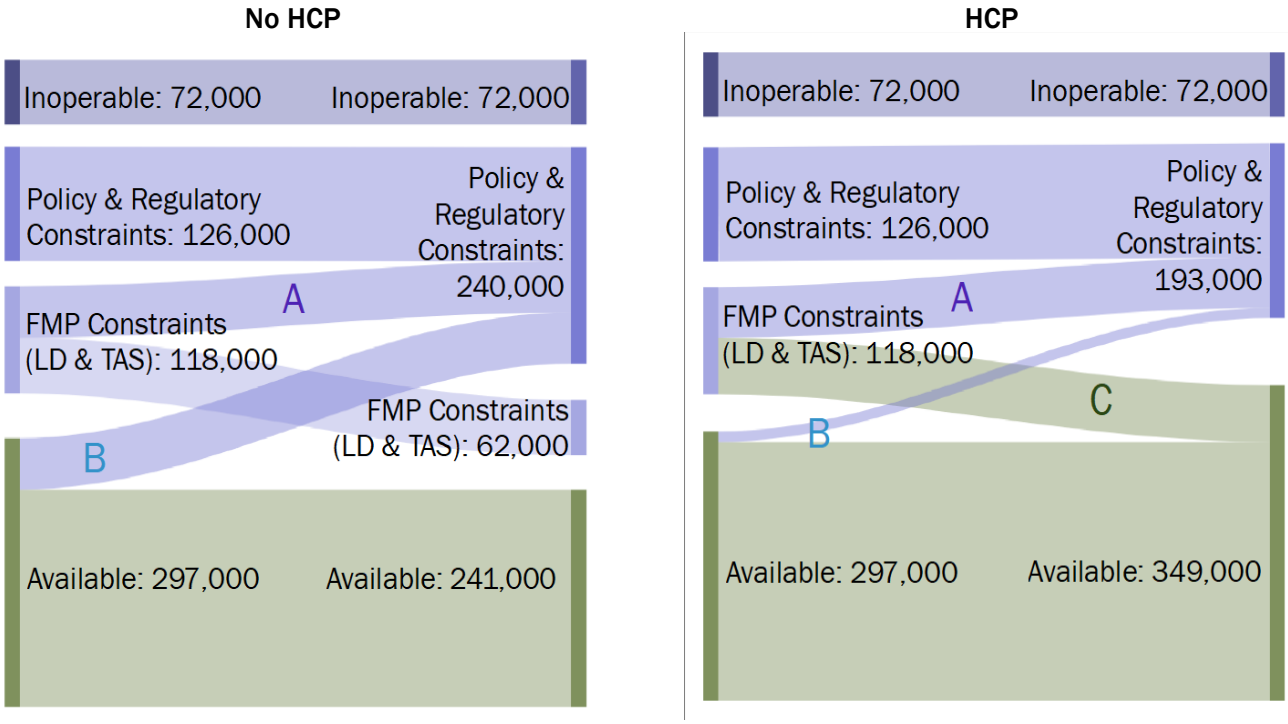
Available acres are assumed to be harvestable at 100 percent of growth. Without an HCP it is assumed that species would be found on some available lands and these would then be constrained at 0 percent harvest. Since it is unknown when this would occur, it is modeled as occurring linearly. Under an HCP, expansion of riparian buffers from available land as soon as the HCP is implemented and is then constrained at 0 percent harvest.

Percent Non-operable and Conservation, Inventory

The percent non-operable and conservation is calculated to show the forested lands that are not harvested. It includes LD+TAS and other conservation commitments like Forest Management Plan (FMP) and Forest Practices Act (FPA) land but excludes roads, administratively removed areas, and non-forest areas incapable of significant tree growth (e.g. rock outcrops, lakes). Inventory is calculated as the growth from the previous period minus current harvest over time.

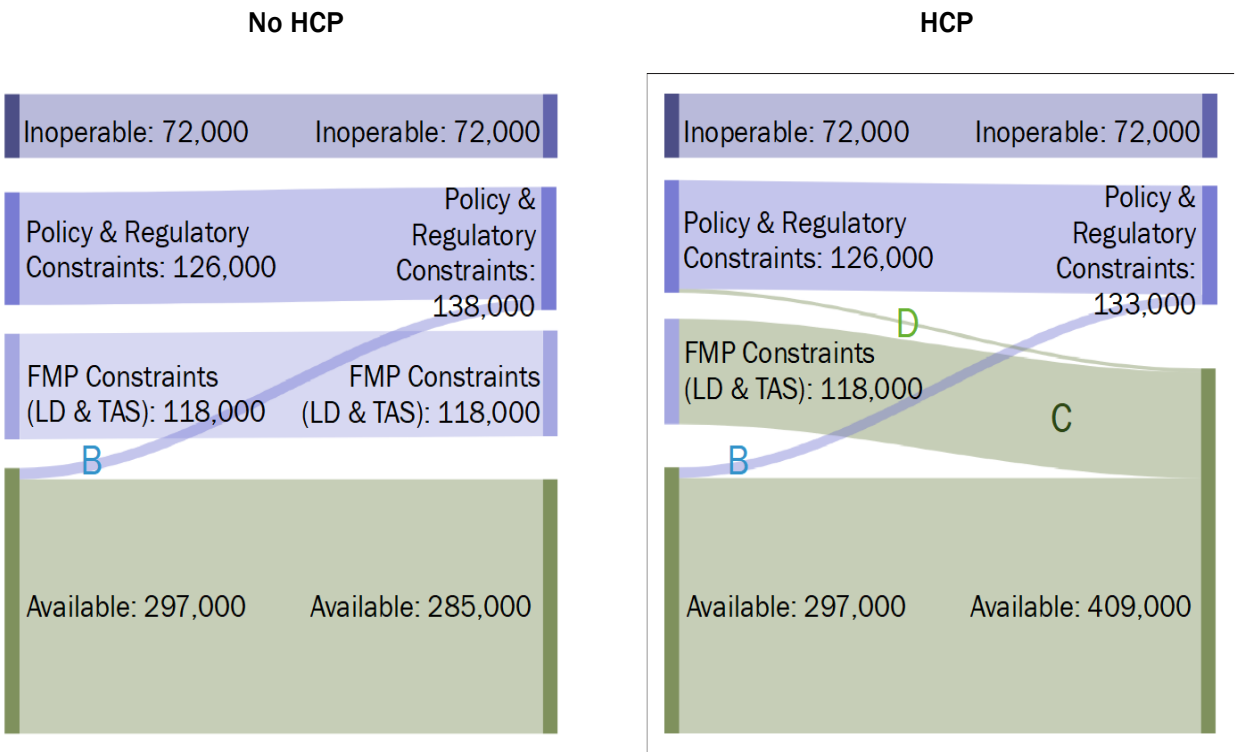
III. Changes in Acreages Over Time, High and Low Scenarios

Figure 18: Change in Acreage Designations from 2021 to 2070, Lowest Available Scenarios



Note: Figure shows net changes in acreage designations from beginning (2021) on the left of each figure to end (2070) on the right of each figure of the 50-year HCP implementation timeframe for the lowest available acreage No HCP and With HCP scenarios. Flows labeled A, B and C represent net transitions of acres from one designation to another over time.

Figure 19: Change in Acreage Designations from 2021 to 2070, Highest Available Scenarios



Note: Figure shows net changes in acreage designations from beginning (2021) on the left of each figure to end (2070) on the right of each figure of the 50-year HCP implementation timeframe for the highest available acreage No HCP and With HCP scenarios. Flows labeled A, B and C represent net transitions of acres from one designation to another over time.

IV. Planning Effort Costs

To estimate the ODF staff time associated with planning, ECONorthwest distributed a questionnaire to ODF staff involved with planning effort. The results are described below. It is assumed that any time made available for ODF via reduced planning effort would be available for other valuable functions. This analysis also shows the value of the time in terms of costs to ODF, representative of the avoided costs for other valuable activities that can be pursued with the additional time.

QUERY RESULTS

Given the various timelines and scales of the current ODF planning efforts, which include FMPs (50 years, ODF headquarters-level), IPs (10 years, district-level), and AOPs (1 year, district-level), there is temporal and personnel variation in the planning efforts. Without an HCP, changes in available harvest and required surveys due to species requirements result in more-frequent modifications to FMP, IPs and AOPs than just the 50, 10 and 1 year updates, respectively.

To understand the current no-HCP efforts by ODF and district-level staff, we distributed a survey to gauge the level of planning efforts at various levels. The project team used the responses to these survey questions to develop an understanding of the current costs of staff time directed towards planning efforts. Not all district level and headquarters level staff completed surveys, so answers were scaled up based upon estimates of total staff involved in planning.

Assumptions used for aggregating hours worked and calculating costs include:

- Range of $9,000 - 12,000 per month for costs of planning staff due to varying salary levels. "Low cost" estimates use the $9,000 figure for calculations, while "high cost" estimates use the $12,000 figure.
- Work week is defined as 40 hours (8 hours/day)
- Work days in a month is defined as 21 days
- The 50-year cost projections assume a 0.05 percent real increase in cost per year

PLANNING EFFORT – BASELINE CALCULATIONS

Based upon this sample of responses, the project team aggregated up attempt to determine the average annual amount on time currently spent on HCP, IP, and AOP efforts by ODF headquarters and district-level staff through the 50-year study period. Per consultation with ODF, six headquarter staff and five people in each of the six largest districts (30 people total) work on planning efforts.

Based upon the inferred staff levels and the results of the survey, the estimated annual time spent on planning efforts is estimated in Table 27. On average, total hours are largest for the AOP due to the amount of staff and more frequent updates. Costs of ODF planning efforts based on current conditions for the FMP, IP, and AOP is estimated between $1 million to $1.4 million per year, resulting in a total cost for the 50 years of $56.7 million to $75.6 million.

Table 27: Estimated Annual Average Planning Hours for All Involved Staff without HCP

Plan	Total Hours	Total Months
FMP	960	5.71
IP	2,310	13.75
AOP	15,750	93.75
Total	**19,020**	**113.21**

Respondents indicated that FMP revisions occur periodically (every few years), so although the plan itself is scheduled to be revised only every 50 years, there are hours and efforts spent on it between those times. Based upon the calculations outlined above, the total cost of FMP planning efforts for 50 years would be approximately $2.9 million to $3.8 million. The FMP has the lowest average annual hours and planning costs of the three planning efforts, due to the relative infrequency with which it is updated.

At the headquarter level, the IP are as needed and can require major time investments by the resource specialists. At the district-level, survey respondents indicated that the time spent can vary significantly from year to year, depending on the required update. Based upon the calculations outlined above, the total cost of IP planning efforts across the eight districts for 50 years would be approximately $6.7 million to $9.2 million. Annual average planning time for IP efforts are much lower than for AOP, but slightly higher than FMP planning time.

District forests and planners spend most of the time on AOP planning efforts, which is reflected in the high number of hours and cost for the plans. ODF headquarter staff assist with review, language, process questions, and creating deliverables, which also increases the hours spend on these annual plans. Because of the magnitude of effort, AOPs have the highest costs estimated as $46.9 million to $62.6 million for 50 years for the districts.

PLANNING EFFORT – HCP CALCULATIONS

With an HCP, ODF would have more predictability in terms of how they manage acres which would result in less frequent unplanned updates to the FMP, IP, and AOP. It should be noted that these planning efforts assume a status quo, without additional ESA species listings (e.g. Red Tree Vole) or other changes which might increase the number of planning hours required. The reduction in staff time dedicated to planning that could be realized by switching from the current take avoidance strategy to an HCP are as follows:

- FMP: 50 to 100 percent less hours
- IP: 20 to 30 percent less hours

- AOP: 5 to 10 percent less hours

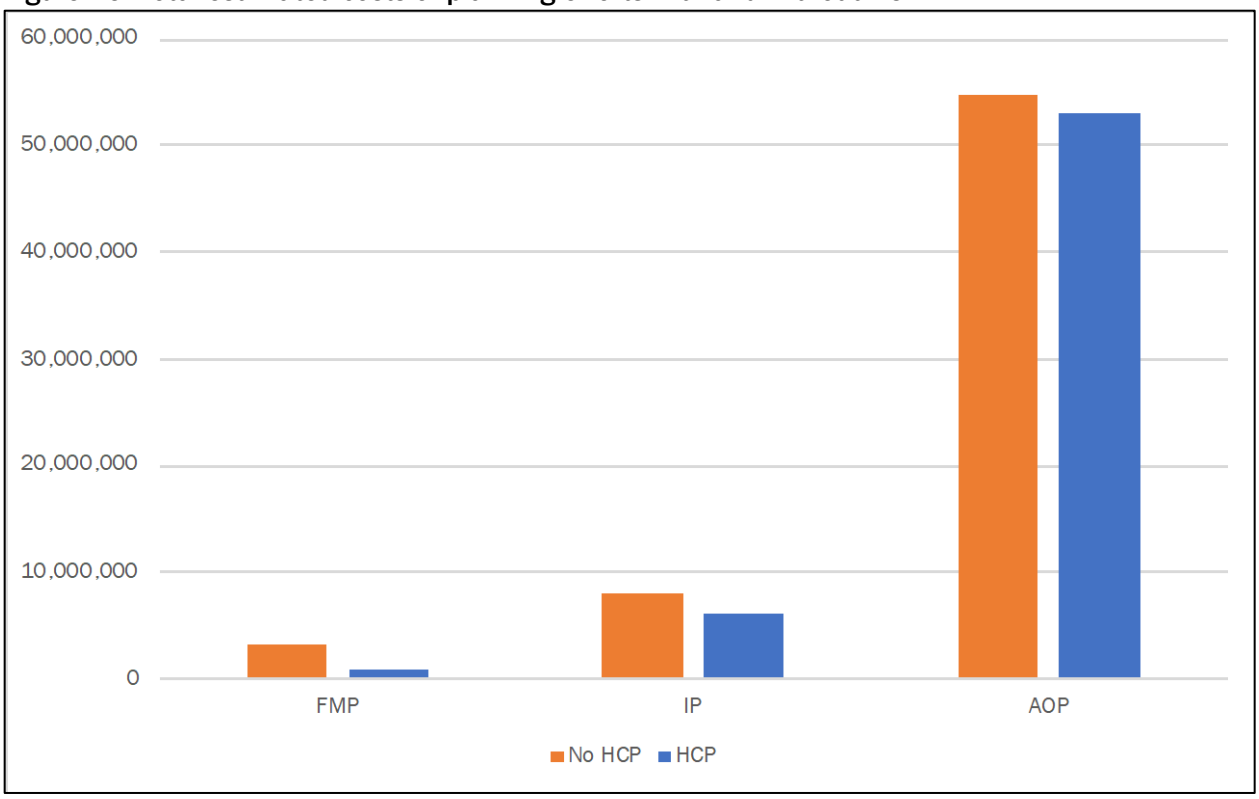
Based upon those reductions in hours, total planning hours decline from approximately 19,000 hours (113 months) per year to approximately 17,200 hours (102 months) per year, consistent with the percent time savings rates assumed. This approximate 9.6 percent reduction in staff time currently being used for unanticipated planning efforts represents a potential efficiency gain for ODF through the HCP. Table 28 presents the ranges of costs for planning efforts with an HCP. Note that the "Cost – Low (Large Reduction)" corresponds with the lower $9,000 monthly staff cost estimate and the larger range of reduction in hours to calculate the lowest possible costs of the planning efforts with an HCP; the "Cost – High (Small Reduction)" corresponds with the with the higher $12,000 monthly staff cost estimate and the smaller range of reduction in hours to calculate the highest possible costs of the planning efforts with an HCP. Based upon our assumptions, the estimated savings is between $5.4 million and $6.9 million over 50 years. The annual cost savings are between $97,000 and $124,000 a year with an HCP. It should be noted that these cost savings do not consider the planning efforts required to create the HCP or any changes needed due to ESA listing status.

Table 28: Estimated Annual Average Planning Hours for All Involved Staff with HCP

Plan	Reduction in hours with HCP (%)	Annual Hours (Small Reduction)	Annual Hours (Large Reduction)	Total Months (Small Reduction)	Total Months (Large Reduction)
FMP	50 – 100	480	0	2.86	0.00
IP	20 – 30	1,848	16,17	11.00	9.63
AOP	5 – 10	14,963	15,593	89.06	84.38
Total		**17,291**	**17,210**	**102.92**	**102.44**

The potential planning cost savings with an HCP compared with no HCP are presented in Figure 20. Based upon our assumptions, the estimated savings is between $5.4 million and $6.9 million over 50 years with an HCP compared to current projections without an HCP. The annual cost savings are between $97,000 and $124,000 a year with an HCP. It should be noted that these cost savings do not consider the planning efforts required to create the HCP or any changes needed due to ESA listing status.

Figure 10: Total estimated costs of planning efforts with and without HCP



The planning effort revisions are variable and unpredictable, so reducing those disruptions is likely to result in workflow improvements. Because these revisions due to species requirements are unpredictable, minimizing those represents potential efficiency gains for ODF, who would be better able to plan staff time. These indirect savings would be in addition to the direct time savings. The direct and indirect time saved with an HCP could be shifted to be spent on efforts with a current deficit in staff time, which would also position ODF to be better able to meet overall forest management goals.

V. Carbon Modeling and Valuation

Note that when the word "carbon" is used in this section of the report it is referring to carbon dioxide (CO_2).

Carbon Sequestered in Current Inventory

To calculate the carbon being sequestered by current and future inventory, we used the American Carbon Registry 2018 guidelines.[16] The steps to calculate tree carbon stock are on page 20 of that report.:

> *Step 1: Determine the biomass of the merchantable component of each tree based on appropriate volume equations published by USDA Forest Service (if locally derived equations are not available use regional or national equations as appropriate) and green volume inside bark, oven-dry tree specific gravity for each species.*
>
> **Outcome**: The merchantable cubic feet in the inventory data provided by ODF was used.
>
> *Step 2: Determine aboveground biomass by choosing a combination of the following components: stump, bark, tops and branches, and/or foliage, in addition to below-ground biomass, by applying component ratios from Jenkins et al. (2003) on Table 6, where biomass of each component is calculated as its component ratio * merchantable stem biomass from Step 1 * (1 / stem wood component ratio). If stump, top, and branch components are included, please use the quantification methodology found in Woodall et al. 2011. Note that the same components must be calculated for ex ante and ex post baseline and project estimates.*
>
> **Outcome**: The Jenkins et al. (2003)[17] equation was used as follows for the qdbh field in the inventory spreadsheet for each stand (converted from the original in inches to centimeters (2.54 cm per inch). Douglas-fir was used to calculate the b_0 and b_1 = coefficients.
>
> The general form of the Jenkins et al. (2003) equations is:
>
> $$B_m = e^{(b_0 + b_1 \ln(dbh_{cm}))}$$
>
> where
>
> B_m = total aboveground biomass (kg) for trees larger than 2.5 cm (1 in) in dbh,

[16] American Carbon Registry. 2018. *Improved Forest Management Methodology for Quantifying GHG Removals and Emission Reductions through Increased Forest Carbon Sequestration on Non-Federal U.S. Forestlands*. April. Pg. 20.

[17] Jenkins, J. C., Chojnacky, D. C., Heath, L. S., & Birdsey, R. A. (2003). National-scale biomass estimators for United States tree species. *Forest science*, *49*(1), 12-35.

dbh_{cm} = diameter in centimeter (cm) at breast height, and

b_0, b_1 = coefficients.

For Douglas-fir, b_0 = -2.2304 and b_1 = 2.4435. See table 1 for coefficients for other species. See table 2 for component ratio method.[18]

Step 3: Using the sum of the selected biomass components for individual trees, determine the per plot estimate of total tree biomass for each plot.

Outcome: Not needed since already at the stand level.

Step 4: Determine the tree biomass estimate for each stratum by calculating a mean biomass per acre estimate from plot level biomass derived in step 3 multiplied by the number acres in the stratum.

Outcome: Not needed since already at the stand level.

Step 5: Determine total project carbon (in tonnes CO_2) by summing the biomass of each stratum for the project area and converting biomass to carbon by multiplying by 0.5, kilograms to tonnes by dividing by 1000, and finally carbon to CO_2 by multiplying by 3.664.

Outcome: Done in spreadsheet for each stand per instructions to get the final CO2 per metric ton.

The total cubic feet of timber is also calculated for district, then divided from CO_2 metric tons to get CO_2 metric tons per cubic foot of timber. Based on the relationship of 4.7859 board feet in one cubic foot of carbon from the ODF Inventory, CO_2 metric tons per MMBF is then calculated as well. Table 30 presents the sum of CO_2 metric tons for each district.

Table 29: Baseline carbon sequestration calculations for ODF forests

	Sum of co2_tonne	Sum of cuft_total	Co2Tonne per cuft	CO2Tonne per MMBF	Social Value of sequestered carbon[19]
Total	92,772.99	3,880,742,002	0.00002391	5.00	$ 3,710,920
Average			0.00002695	5.63	

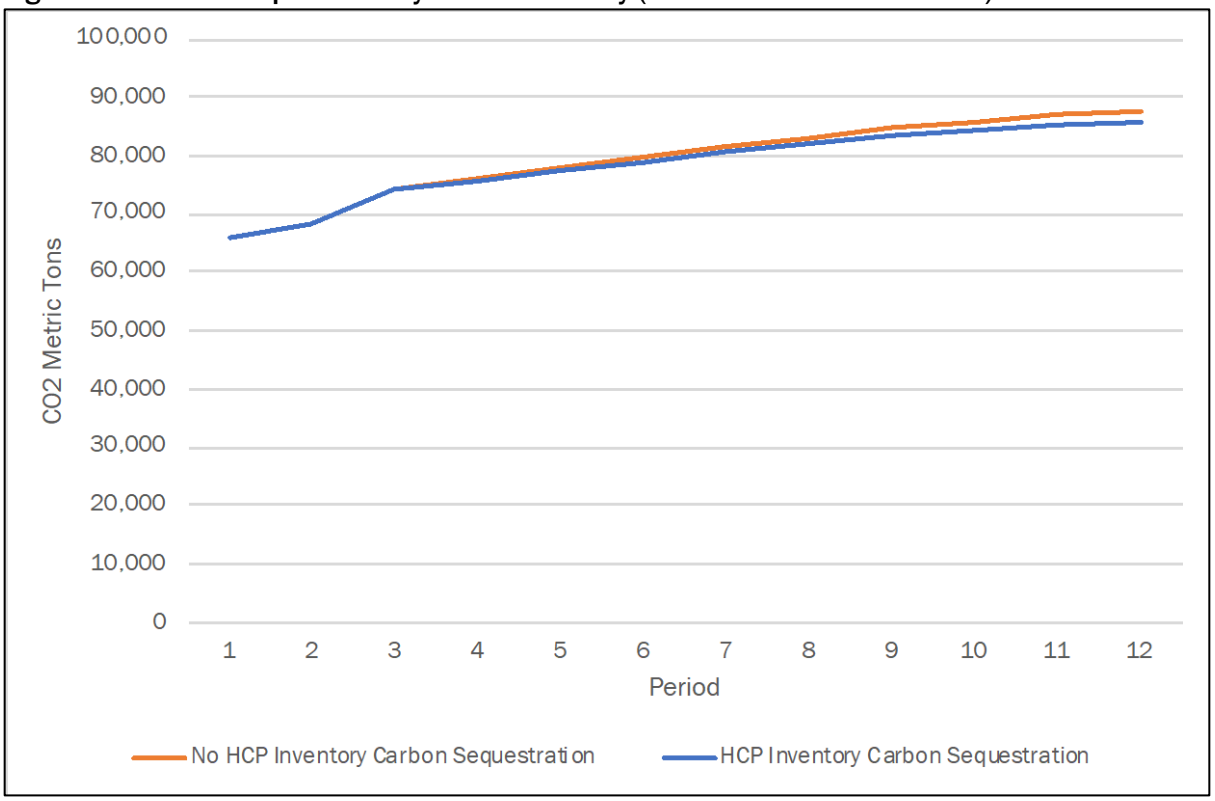
[18] Zhou, X., & Hemstrom, M. A. 2009. Estimating aboveground tree biomass on forest land in the Pacific Northwest: a comparison of approaches. *Res. Pap. PNW-RP-584*. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 18 p., 584.

[19] Based on $42 per metric ton 3 percent average for year 2020 social cost of carbon value, U.S. Environmental Protection Agency. 2016. EPA Factsheet: Social Cost of Carbon. Available from https://www.epa.gov/sites/production/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf

Carbon Sequestered in Future Inventory

Based upon the inventory information calculated earlier in this report for HCP and No HCP scenarios, the amount of CO_2 sequestered by future inventorywas calculated, see Figure 21 for results. Inventory (MMBF) was multiplied by 5.63 to estimate CO_2 sequestered by future inventory. Because inventory (MMBF) is higher without an HCP there is more carbon sequestered in inventory over time (88,000 CO_2 metric tons in year 2073) compared with the HCP scenario (86,000 CO_2 metric tons in 2073).

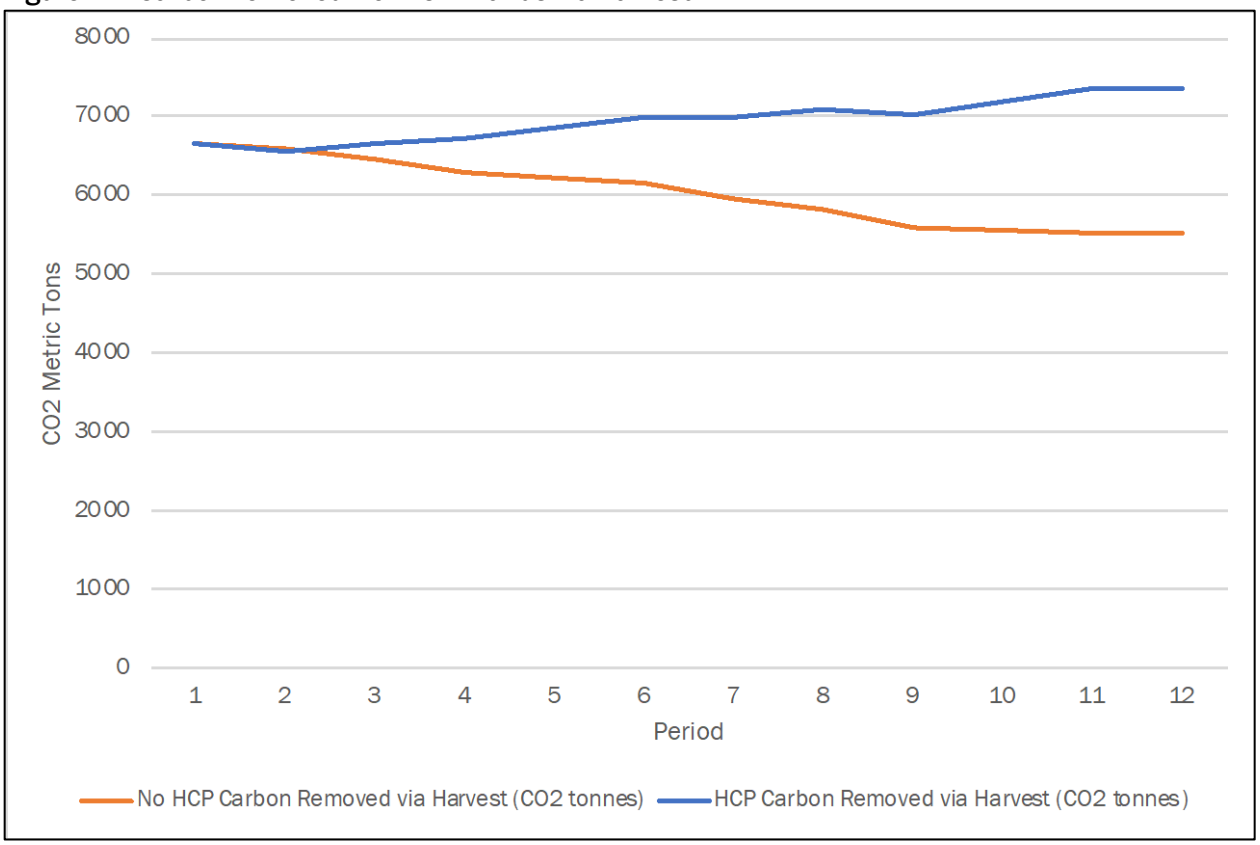
Figure 11: Carbon sequestered by future inventory (HCP and No HCP scenarios)



Carbon Removed from ODF Lands via Harvest

Based upon the harvest information calculated earlier in this report for HCP and No HCP scenarios, the amount of CO_2 removed from ODF land via harvest is calculated, see Figure 22 for results. Harvest (MMBF) was multiplied by 5.63 to estimate CO_2 sequestered by future inventory, and then multiplied by 5 to put in per period terms. Note that although the timber is being removed from the land, much of the stored CO_2 is not released and continues to be stored in post-harvest products. Because there is higher harvest with an HCP, there is more carbon removed with an HCP (83,500 CO_2 metric tons) compared to the No HCP scenario (72,000 CO_2 metric tons).

Figure 12: Carbon removed from ODF lands via harvest



Post-Harvest Carbon Impacts

To account for the amount of carbon remaining in post-harvest wood product Table 8 from Smith et al. (2006) was used (the value for softwood lumber).[20] These values of carbon remaining from are presented in Table 30. These fractions of carbon remaining were multiplied by the MMBF harvest per year to obtain the total carbon remaining in each period.

Table 30: Post-harvest fraction of carbon remaining for softwood lumber

Period	1	2	3	4	5	6	7	8	9	10	11	12
Carbon Remaining	0.973	0.875	0.922	0.698	0.633	0.579	0.533	0.494	0.459	0.429	0.402	0.378

Source: Smith et al. 2006

These fractions of carbon remaining were multiplied by the MMBF harvest per year to obtain the total carbon remaining in each period. For example, in period 1, only carbon from period 1 is considered; in period 12, remaining carbon from periods 1 through 11, as well as carbon from period 12, are included in the calculation. The result of this structuring of carbon accounting is

[20] Smith, J. E., Heath, L. S., Skog, K. E., & Birdsey, R. A. 2006. Methods for calculating forest ecosystem and harvested carbon with standard estimates for forest types of the United States. *Gen. Tech. Rep. NE-343*. Newtown Square, PA: US Department of Agriculture, Forest Service, Northeastern Research Station. 216 p., 343.

that the total amount of carbon remaining increases over time, since we do not consider carbon prior to period one for this analysis.

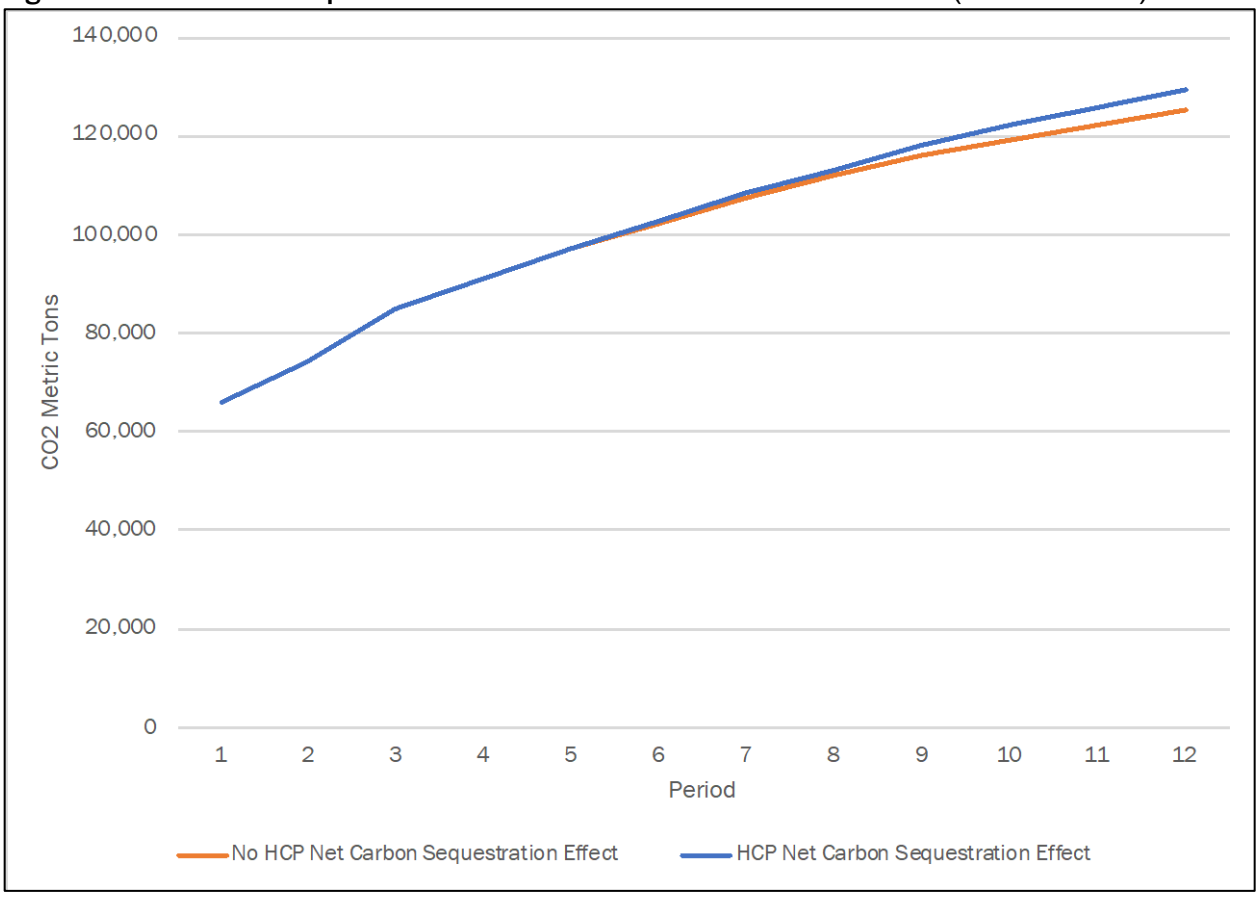
Total Carbon Impacts

To calculate the total carbon impacts for the HCP and no HCP scenarios, the following formula was used for each period:

> Net Carbon Effect = Carbon Sequestered in Inventory – Carbon Removed via Harvest + Carbon Remaining in Post-Harvest Wood Products

Although an HCP results in higher harvest, and therefore less inventory than the No HCP scenario, the inventory discrepancy is made up for by the residual carbon remaining from prior harvests and the replanting on harvested lands. In 2070, the No HCP is expected to result in a 60,000 CO_2 metric tons increase in carbon sequestration from 2018, while the HCP is expected to result in a 56,500 CO_2 metric tons increase in carbon sequestration from 2018 (Figure 23).

Figure 13: Net Carbon Sequestration Effects for No HCP and HCP Scenarios (2018 to 2073)



Based upon the $42 per metric ton of CO_2, the social value of sequestered carbon in 2070 is estimated as $5.1 million with the HCP and $5.3 million with No HCP. It should be noted that these estimates are well within the expected standard of error and should therefore be

interpreted as there being no significant difference in the value of carbon sequestered for either scenario.