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Chapter 5

CUMULATIVE EFFECTS

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Chapter 5

Cumulative Effects

This chapter characterizes the cumulative effect of each alternative on the human environment in accordance with applicable regulations identified in this chapter. The cumulative effects analysis in this chapter focuses on cumulative effects relative to the marbled murrelet and both forest management and non-forest land uses. This chapter also includes an analysis of socioeconomic effects on private, state, and federal forestlands.

5.1 Regulations Governing the Assessments of Cumulative Effects

The National Environmental Policy Act (NEPA) and State Environmental Policy Act (SEPA) rules require analysis of the cumulative effects of proposed federal and state actions, respectively. The Council on Environmental Quality (CEQ) regulations include the following definitions and requirements for cumulative impacts:

- 40 C.F.R §1508.7 defines cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."
- 40 C.F.R. §1508.25 identifies "cumulative actions" as "actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement." Section §1508.25 also defines that the scope of impacts to be considered in a NEPA document includes direct, indirect, and cumulative impacts.

Under Washington State SEPA rules, the scope of impacts analyzed in an environmental impact statement (EIS) includes cumulative impacts (WAC 197-11-060(4)(e); WAC 197-11-792). WAC 197-11-792 states that to determine the scope of environmental impact statements, agencies consider three types of impacts. Those impacts may be direct, indirect, or cumulative.

5.2 Evaluation Criteria

Two main questions are used in this chapter to analyze potential cumulative effects:

- *Would the alternatives involve individually minor but collectively significant actions taking place over a period of time?*

- *Would the incremental impacts of the alternatives, when added to other past, present, and reasonably foreseeable future actions, result in significant adverse effects?*

An action cannot contribute to a cumulative effect on any particular element of the human environment if the action does not have any direct or indirect impacts on that element of the environment. Therefore, a primary criterion for determining cumulative effects is whether any individual adverse impacts have been identified for the specific elements of the human environment included in the scope of this final EIS (FEIS).

5.3 Individually Minor but Collectively Significant Actions

All action alternatives would establish new designations of marbled murrelet conservation areas, apply new conservation measures, and release some lands for harvest. The underlying regulatory and policy framework governing the management of the affected Washington State Department of Natural Resources (DNR)-managed forestlands would remain largely unchanged, but the addition or subtraction of acres in murrelet conservation or the change in management of specific conservation areas could result in positive or negative cumulative impacts.

Chapter 4 of this FEIS includes analyses of whether these individual changes could be collectively significant for an element of the human environment over the entire analysis area and during the term of the 1997 HCP.

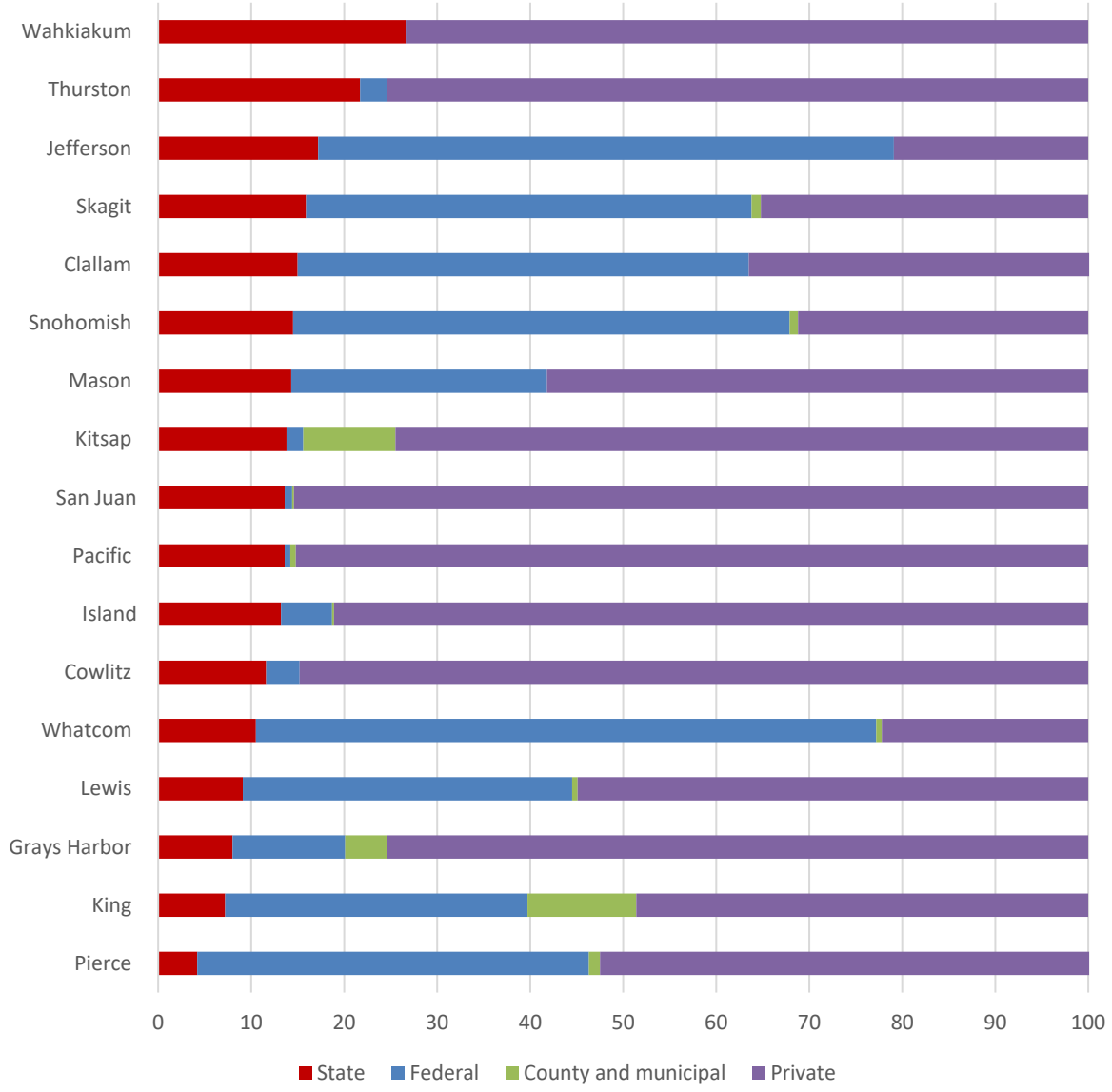
5.4 Forest Management in the Analysis Area: Past, Present, and Future Trends

■ Forestland Ownership Context

An important aspect of cumulative effects is the mix of land ownership within the landscapes upon which cumulative effects may occur. Within the approximately 16-million-acre analysis area (terrestrial lands within 55 miles of the marine waters), 26 percent of lands are federal (primarily national forest and national park), 9 percent are managed by DNR, and approximately 65 percent are in other non-federal ownership.

Based on acreages presented by Daniels (2004), private lands make up more than half of forestlands within Lewis, San Juan, Pacific, Cowlitz, Island, Grays Harbor, Kitsap, Wahkiakum, Mason, Thurston, and Pierce counties, and federal lands make up more than half of the forestlands within Whatcom, Jefferson, Columbia, Skamania, and Snohomish counties. Figure 5.1.1 breaks out the acres of land ownership by county (Daniels 2004).

Figure 5.1.1. Proportion of State Trust and Other Forestland Ownership Within Analysis Area, by County[a]



[a] Numeric percentages shown for state trust lands only. Portions evaluated based on entire county land base (not just within analysis area). Source: Daniels 2004.

■ Effects of Past Forest Management on the Marbled Murrelet[1]

Historically, habitat has been lost throughout the range of the marbled murrelet largely due to timber harvest and some due to fire, windstorms, and other stochastic events. Refer to Section 4.6 of the FEIS for analysis of the potential environmental impacts of the alternatives on marbled murrelets. Section 4.6 also describes in detail the trends in population decline of the marbled murrelet in Washington and projects how the alternatives might affect that trend under different demographic scenarios. Regional trends and other impacts from outside the analysis area or the scope of the proposed action are summarized in this section.

Past Habitat Loss Throughout the Range of the Marbled Murrelet

The loss of inland habitat was a major cause of marbled murrelet population declines over the past century. It is expected that habitat loss will remain a major contributing factor to the current decline in marbled murrelet populations (USFWS 2012). Throughout the range of the marbled murrelet, ongoing habitat loss rates are highest in Washington and this is also where the steepest declines in murrelet populations are currently being observed (Raphael and others 2016, Pearson and others 2018). Fires, logging, and wind storms all contribute to ongoing habitat loss (Falxa and Raphael 2016). The *Northwest Forest Plan* (U.S. Department of Agriculture and U.S. Department of the Interior 1994) effectiveness monitoring program identified and mapped murrelet habitat across California, Oregon, and Washington and estimated changes in habitat amount, distribution, and quality over time. At the start of the *Northwest Forest Plan* in 1993, the USFS model estimated 2.53 million acres of habitat across the *Northwest Forest Plan* area; approximately 59 percent of all habitat was on federal lands. The plan-wide habitat estimate was 2.23 million acres in 2012, representing a net loss of 12 percent (Raphael and others 2015). Habitat loss was greater on non-federal lands, a net 27 percent loss over twenty years due to wildfire, timber harvest, windthrow, and landslides. A net habitat loss was observed on federal lands as well, approximately 2 percent overall, with most loss due to fire and other natural disturbances. Currently, only about 12 percent of the habitat-capable lands within the listed range of the marbled murrelet contain habitat (Falxa and Raphael 2016).

Murrelet population size and distribution is strongly correlated between stands of cohesive and higher suitability habitat (Falxa and Raphael 2016). The largest marbled murrelet subpopulations now occur off the coast of Oregon and northern California, while subpopulations in Washington have experienced the greatest rates of decline. Rates of habitat loss also have been highest in Washington due to wildfire, timber harvest, windthrow, and landslides on non-federal lands (Falxa and Raphael 2016), which suggests that the loss of habitat continues to be an important limiting factor for the recovery of murrelets. The 20-

[1] CEQ's cumulative effects guidance recommends "analysis and a concise description of the identifiable present effects of past actions to the extent that they are relevant and useful in analyzing whether the reasonably foreseeable effects of the [proposed action] and its alternatives may have a continuing, additive and significant relationship to those effects." (*Guidance on the Consideration of Past Actions in Cumulative Effects Analysis* (CEQ 2005)).

year monitoring report for the *Northwest Forest Plan* notes that conservation of the marbled murrelet will not be possible if trends in habitat loss continue at the rates estimated over the past 20 years (Falxa and Raphael 2016). Even if continued habitat loss were halted, the murrelet population likely would continue to decline for a time, as long as the population remained larger than the reduced amount of habitat could support (Appendix C). It is uncertain the degree to which marine conditions are likely affecting murrelet population decline, but marine conditions that reduce the abundance and distribution of prey are expected to also be a factor in the continued population decline (USFWS 2012).

Past Forest Management on State Trust Lands

Throughout much of the 20th century, timber management on state trust lands was primarily focused on clearcut harvesting of structurally and biologically diverse stands and converting them into even-aged young stands dominated by Douglas fir. For some time, DNR policy was to harvest the oldest stands first (DNR 1979). In many cases, harvested stands were broadcast burned and planted to Douglas-fir, which rapidly became densely stocked with little understory vegetation or structural complexity. As a result, most of the DNR-managed lands have been managed for timber production, resulting in the potential loss of marbled murrelet habitat prior to the listing of the marbled murrelet as a threatened species in 1992 (57 FR 45328).

DNR-managed lands in the analysis area encompass over 1.38 million acres and represent about 9 percent of the total land area within the range of the marbled murrelet in Washington. While much of this area is conserved in long-term forest cover, only about 207,000 acres is currently classified as murrelet habitat, representing about 15 percent of DNR-managed lands and about 14 percent of the total estimated murrelet habitat in Washington. The U.S. Fish and Wildlife Service (USFWS) recovery plan for the marbled murrelet (USFWS 1997) considers habitat on DNR-managed lands as essential for the conservation and recovery of murrelets, particularly in landscapes that have little or no federal lands.

The *State Trust Lands Habitat Conservation Plan* (1997 HCP) established landscape-level strategies to support endangered species conservation on state trust lands through a combination of active and passive habitat management. These HCP conservation strategies also increased protection of riparian and northern spotted owl habitat, which supports marbled murrelet habitat. Since signing the 1997 HCP, DNR has also increased the acres of protected natural areas (natural area preserves and natural resources conservation areas) and increased protection of old-growth forests.

Management for marbled murrelets under the 1997 HCP has occurred under an interim strategy that focused on identifying marbled murrelet habitat and generally avoiding timber harvest in areas deemed likely to be occupied by marbled murrelets. Since signing the 1997 HCP, DNR also has established marbled murrelet habitat protection measures in the North and South Puget HCP planning units and restricted harvests in southwest Washington. In sum, DNR established protections of habitat across approximately 190,000 acres within the analysis area, which dramatically reduced the harvest-related loss of habitat on DNR-managed lands to only the lowest-quality habitat.

The interim strategy authorized the removal of low-quality (“marginal”) murrelet habitat that would be expected to contain a maximum of 5 percent of potential occupied sites (DNR 1997, p. IV.40, Step 3) and allowed for some harvest of habitat that was surveyed but determined to be unoccupied (DNR 1997, p.

IV.40, Step 4). To date, approximately 29,000 acres of marginal habitat and 3,300 acres of surveyed unoccupied habitat have been harvested.

Additionally, natural disturbance events, including the "Great Coastal Gale of 2007," resulted in a loss of marbled murrelet habitat, and salvage activities have occurred on approximately 1,200 acres of windthrow-damaged murrelet habitat throughout the analysis area. While most murrelet habitat has been retained on DNR-managed lands since 1997, timber management in interspersed areas of non-habitat may have fragmented remaining habitat patches and contributed to edge effects.

Past Forest Management of Federal Lands

Federal lands within the range of the marbled murrelet in Washington include national parks and national forests, as well as smaller areas associated with national wildlife refuges and Department of Defense military reservations. As with DNR-managed lands, much of the historic marbled murrelet habitat that existed on federal lands outside of the national parks was harvested prior to the listing of the marbled murrelet as a threatened species in 1992 (USFWS 1997). As a result, large areas of national forest lands now contain densely stocked tree plantations, and much of the remaining old-forest habitat is highly fragmented (Falxa and Raphael 2016). Federal lands in the analysis area encompass approximately 4.17 million acres and represent about 26 percent of the total land area within the range of the marbled murrelet in Washington. Current estimates indicate over 887,000 acres of marbled murrelet habitat occur on federal lands, which represent about 66 percent of the total estimated murrelet habitat remaining in Washington. Currently, about 26 percent of the habitat-capable area on federal lands contains murrelet habitat (Falxa and Raphael 2016).

The *Northwest Forest Plan* established a large network of late-successional reserves on national forest lands for the specific purpose of maintaining and recruiting late-successional and old-growth forests. These areas, along with national parks and designated wilderness areas, are all considered federal reserves. In Washington, nearly 90 percent of federal lands within the range of the marbled murrelet are in federal reserves. Federal reserves are expected to provide the primary role for the conservation and recovery of the marbled murrelet in most areas (USFWS 1997). Murrelet habitat in conservation reserves on federal lands is expected to increase over the next 50 years as young forests transition to more mature forests and the quality of current habitat increases through a reduction of past habitat fragmentation and edge effects.

Under the *Northwest Forest Plan*, the focus of forest management in national forests has shifted from regeneration timber harvest to ecological restoration. Examples of recently planned projects within the analysis area are the Queets Vegetation Management Project in Olympic National Forest (USFS 2015a) and the Hansen Creek Vegetation Project in Mount Baker-Snoqualmie National Forest (USFS 2015b). The Queets project is located adjacent to lands proposed for marbled murrelet conservation in DNR's long-term murrelet conservation strategy alternatives in the Upper Clearwater and Queets landscape units.

Past Management of Private Forestlands

Private industrial forestlands are intensively managed and typically have trees less than 60 years old. Very few late-successional forests are present on such lands. Private industrial forestlands are focused on timber production, with many areas being harvested on relatively short rotations (40 to 50 years) (Davies 2011). Private forestlands within the analysis area also are being converted to other uses, including industrial and residential developments[2].

Private forestlands (industrial and non-industrial private lands) in the analysis area encompass over 6 million acres of habitat-capable lands within the range of the marbled murrelet in Washington. Current estimates indicate over 260,000 acres of murrelet habitat occur on private lands, which represents about 20 percent of the total estimated murrelet habitat remaining in Washington. Most habitat remaining on private lands is highly fragmented and occurs in small, scattered patches. Currently, only about 4 percent of the habitat-capable area on private lands contains murrelet habitat (Falxa and Raphael 2016).

Private timber harvest in Washington must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington forest practices rules (Title 222 WAC), although the requirements could vary if the landowner has a federally approved HCP. Washington forest practices rules require murrelet surveys in habitat as defined in WAC-222-16-010 and provide protection for known occupied and presumed-to-be occupied marbled murrelet habitat until it is shown not to support murrelets.

Monitoring for the *Northwest Forest Plan* indicates that potential murrelet habitat on non-federal lands (state, private, tribal, and county ownerships) in Washington has declined over the past 20 years due to wildfire, timber harvest, and other natural disturbances (Falxa and Raphael 2016). It is important to note that estimates of potential murrelet habitat identified through remote sensing models are not directly comparable to field-based habitat delineations required under the Washington forest practices rules. However, habitat models derived from remote-sensing data indicate that most of the potential murrelet habitat on private lands is now largely confined to areas associated with known occupied marbled murrelet sites, riparian corridors, potentially unstable slopes, and other areas deferred from harvest through existing HCPs or other deferrals under the Washington forest practices rules.

■ Present and Potential Future Actions and Threats to Marbled Murrelets

This section considers the present and reasonably foreseeable future actions that may influence the marbled murrelet population in Washington State. Based on a 2012 review of the species status by a USFWS recovery implementation team (USFWS 2012) and other recent USFWS analyses, known and potential cumulative effects on marbled murrelets in addition to loss of habitat and predation include the following:

[2] Refer to http://file.dnr.wa.gov/publications/em_fwflanduse.pdf.

- Changes in marine forage conditions, affecting the abundance, distribution, and quality of murrelet prey.
- Post-fledging mortality from oil spills, fisheries bycatch, derelict fishing gear, and wind energy projects.
- Cumulative and interactive effects of factors on individuals, populations, and the species (includes human development close to foraging areas that forces marbled murrelets to commute further to find suitable habitat; in other words, urbanization in the Puget Sound lowlands)

In a 2010 finding regarding a petition to delist the marbled murrelet (USFWS 2010), USFWS determined that it was reasonable to expect that the species will continue to be exposed to a broad range of threats across its listed range. Although some threats have been reduced, most continue unabated and new threats now strain the ability of the murrelet to successfully reproduce. In the 2010 finding, USFWS concluded that reproductive success was too low to sustain the population and that manmade and natural threats were likely to continue at current or increased levels, resulting in the population continuing to decline.

Ongoing actions that may affect the marbled murrelet in Washington include the U.S. Department of the Navy training and testing operations and impacts associated with Growler jets from the Whidbey Island Naval Air Station. As a federal agency, the U.S. Navy is required to consult with both the USFWS and National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act to evaluate the impact of these training programs on federally-listed species, including the marbled murrelet. The USFWS reviewed these actions and determined that Growler flights from Whidbey Naval Air Station and the Navy's Northwest Training and Testing program "may affect, and is likely to adversely affect" the marbled murrelet by exposing marbled murrelets to aircraft noise and underwater sound impacts in marine foraging areas in Puget Sound, and by exposing murrelets to aircraft noise over murrelet habitat on the Olympic Peninsula[3]. These activities contribute to the complex suite of environmental and human-caused stressors to marbled murrelets in Washington. While it is recognized that these training programs are likely to impact individual marbled murrelets, the impact of these ongoing and future programs on marbled murrelet population trends is difficult to quantify, due to the broad area of habitat exposed to these stressors and the patchy and variable distribution of marbled murrelets in Puget Sound and adjacent forests capable of providing murrelet habitat.

In May 2019, the USFWS completed an FEIS on an HCP application for the Skookumchuck Wind Energy Project located in Thurston and Lewis Counties, and issued a record of decision authorizing USFWS to issue an incidental take permit for project operations. This HCP covers the operation of up to 38 wind turbine generators over a period of 30 years. The wind turbine generators pose a collision risk for marbled murrelets flying through the project area, and the FEIS estimates that the project could directly kill an average of 2.5 murrelets per year. Mitigation measures are anticipated to offset the impacts

[3] The U.S. Navy's EIS, supplemental EIS, and other associated documents for the Northwest Training and Testing program are available at https://www.nwtteis.com/. The U.S. Navy's EIS and record of decision for the use of Growler jets at Whidbey Island Naval Air Station is available at http://www.whidbeyeis.com/.

of the take associated with this project. These measures include the acquisition of conservation lands for murrelet habitat and removal of derelict fishing gear in Puget Sound[4].

Operation of wind energy facilities in western Washington would be expected to cause collision-related mortality to marbled murrelets over the next 30 to 50 years. In addition to the proposed Skookumchuck Wind Energy Project and an existing facility located in Pacific County, the Coyote Crest Wind Park has been proposed for development in Lewis, Pacific, and Grays Harbor counties. That project, as permitted but not yet constructed, proposes to develop 47 wind-turbines generating approximately 120 megawatts (Lewis County 2010).

Other sources of human-caused mortality to murrelets include oil spills and gillnet fisheries. Several studies have documented murrelets becoming entangled in gill-nets in Washington and British Columbia (USFWS 2019). While efforts to reduce fisheries bycatch remain in place, the USFWS estimates that about five murrelets per year may be killed in Washington fisheries (USFWS 2019). While there have been no recent major oil spills with documented mortalities of marbled murrelets in Washington, the risk of oil spills remains and may be increasing as result of new and expanded oil transportation facilities being developed in Washington and British Columbia (USFWS 2019). Impacts can result from direct mortality through oiling, and through changes in prey base, marine habitat, and vessel disturbance.

This FEIS does not determine whether the alternatives would "jeopardize the continued existence" of the Washington/Oregon/California distinct population segment of the marbled murrelet. Once DNR submits an application for an amendment to its incidental take permit, USFWS prepares a biological opinion to determine whether the final strategy would "cause jeopardy" to the species. Cumulative impacts of the action alternative will be a factor that USFWS considers when making determinations regarding jeopardy. Population viability analyses conducted for the proposed alternatives will be among the information sources considered for this determination (refer to Section 4.6 and Appendix C).

Changes in Long-Term Forest Cover

The no action alternative would continue to protect murrelet habitat designated under the interim strategy, and more habitat would develop in long-term forest cover. The differences in long-term forest cover under the alternatives considered in this FEIS are shown in Table 5.3.1.

[4] The FEIS for the Skookumchuck Wind Energy Project is available at https://www.fws.gov/wafwo/documents/SWEP/SWEP_FEIS_20190516.pdf.

Table 5.3.1.Differences in Long-term Forest Cover under Each Alternative Considered in this FEIS
"LTFC" indicates long-term forest cover

Alternative	Acres of DNR-managed land in the Analysis Area	Acres of existing Conservation *(not including marbled murrelet specific conservation)*	Acres of Marbled murrelet specific conservation under the Alternative	Total acres of LTFC (existing conservation plus marbled murrelet specific conservation)	Change in LTFC acres from the no-action alternative (Alt. A)	Cumulative percent of DNR-managed lands in LTFC
Alt. A (no-action)	1,380,000	567,000	33,000	600,000	n/a	43%
Alt. B			9,000	576,000	(24,000)	42%
Alt. C	1,380,000	567,000	49,000	617,000[a]	17,000	45%
Alt. D			51,000	618,000	18,000	45%
Alt. E			54,000	621,000	21,000	45%
Alt. F			176,000	743,000	143,000	54%
Alt. G			75,000	642,000	42,000	46%
Alt. H			37,000	604,000	4,000	44%

[a]Numbers may not sum due to rounding.

The cumulative result of maintaining more acres long-term forest cover over time would be an increase in structurally complex forest within these acres, a decrease in available timber volume for harvest in these areas, and a potential shift in other forestland uses (such as recreation, leases, and road building) to other areas of the forest. With Alternative B, the cumulative effect of maintaining fewer acres in long-term forest cover would mean an increase in available timber volume and fewer impacts to other non-harvest land uses. These incremental changes can be analyzed in the context of other actions, trends, and activities affecting elements of the environment in the analysis area in order to determine their significance.

Future Forest Management Within the Analysis Area

On private forestlands in Washington, commercial forest management is expected to continue on a rotation schedule of 40 to 50 years. Forests managed on short rotations are not expected to grow into marbled murrelet habitat. Riparian zones are managed differently than the uplands, and over long periods of time, and in some cases habitat may develop in limited areas. However, due to their narrow width, riparian zones are not expected to develop extensive areas of habitat, nor is that habitat expected to provide secure areas for marbled murrelet nesting (refer to Section 4.6 and Appendix H for discussion of edge effects) due to the short rotation in the adjacent uplands.

National forests are expected to provide increasing amounts of habitat into the future. In Washington, nearly 90 percent of federal lands within the range of the marbled murrelet are in federal reserves. Federal reserves are expected to provide the primary role for the conservation and recovery of the marbled murrelet (USFWS 1997) in most areas. Habitat in federal reserves is expected to increase over the next 50 years as young forests transition to more mature forests, and as the quality of current habitat increases through a reduction of habitat fragmentation and edge effects. USFS is intentionally managing for older forests, which will benefit the marbled murrelet into the future. If management for late-successional and

old-growth forests continues, there will be substantial increases in habitat amount and quality on federal lands. Current estimates indicate over 1.5 million acres on federal lands in Washington are young forests (43 percent) that are habitat capable (Falxa and Raphael 2016). Much of this forest is likely to transition into habitat over the next 50 to 100 years. National parks within the range of the murrelet are expected to continue providing high-quality habitat for the species.

Forest Conversion

The Washington state population is estimated to have increased 12.1 percent from 6.7 million in 2010 to 7.5 million in July 2018[5]. This population growth contributes to forestland conversion for homes and businesses. As the forest land base is reduced, demand for wood may put increased pressure on the remaining forests to meet that demand. Forest conversions may be happening close to habitat, for example near Port Angeles. Conversions reduces the effectiveness of the current habitat for murrelets, for example by providing enhanced habitat for corvids. Section 4.6 describes these types of effects. As the population of Washington continues to grow, so will forestland conversion, which can result in reduced habitat effectiveness.

Washington State Marbled Murrelet Listing

Following a periodic status review of the marbled murrelet in Washington by the Washington Department of Fish and Wildlife (Desimone 2016), the State Fish and Wildlife Commission changed the listing from state threatened to state endangered in February 2017. This change may prompt a state recovery plan, which could provide guidance on recovery efforts at the state level.

Climate Change

In 2019, USFWS completed a five-year status review for the marbled murrelet (USFWS 2019). The status review provides a detailed analysis of projected climate change effects that are likely to continue exacerbating the existing threats to marbled murrelets posed by loss and fragmentation of habitat and changes in the marine ecosystem.

The climate in the coastal areas of the Pacific Northwest where murrelets nest has been changing and is projected to continue changing through the 21st century (USFWS 2019). Although considerable uncertainty exists with respect to any regional-scale impacts of climate change due to the differences in trajectories of climate change scenarios, modeling results underscore the potentially large impacts on the Pacific Northwest ecosystems.

CHANGES TO THE MARINE ENVIRONMENT

Climate change effects that reduce the abundance and quality of prey in the marine environment is likely to negatively affect murrelet survival and reproduction. In British Columbia, there is a strong negative correlation between sea surface temperature and the number of marbled murrelets observed at inland sites

[5] Refer to https://www.census.gov/quickfacts/WA

displaying behaviors associated with nesting (Burger 2000). In central California, marbled murrelet diets vary depending on ocean conditions, and there is a trend toward greater reproductive success during cool water years, likely due to the abundance of prey items such as euphausiids and juvenile rockfish (Becker and others 2007). In the Georgia Basin, much of the yearly variation in marbled murrelet abundance from 1958 through 2000 can be explained by the proportion of fish (as opposed to euphausiids or amphipods) in the birds' diet (Norris and others 2007). If climate change leads to further declines in forage fish populations, those declines are likely to be reflected in marbled murrelet populations.

In addition to effects on foraging ecology and breeding success, climate change may expose adult marbled murrelets to health risks. For example, it is likely that they will experience more frequent domoic acid poisoning, as this toxin originates from harmful algae blooms that are expected to become more prevalent with climate change. In central California, domoic acid poisoning was determined to be the cause of death for at least two marbled murrelets recovered during a harmful algae bloom in 1998 (Peery and others 2006). Poisoning from toxins transmitted through the food chain to seabirds via forage fish that feed on the toxic algae has been found to be a significant source of nesting failure in Kittlitz's murrelets in Alaska (Lawonn and others 2018). A different species of harmful algae produces a foam that led to plumage fouling and subsequent mortality of common murres and other seabirds off of Oregon and Washington during October of 2009, and similar events may become more frequent with climate change (Phillips and others 2011).

CHANGE TO THE TERRESTRIAL ENVIRONMENT

Climate change is predicted to alter the terrestrial environment within the range of the murrelet by changing precipitation (amount, type, and timing) and temperatures (timing and location). Predicted climate changes in the Pacific Northwest have implications for forest disturbances that affect the quality and distribution of murrelet habitat. One of the largest projected effects on Pacific Northwest forests is likely to be an increase in fire frequency, duration, and severity. The area burned annually by wildfires in the Pacific Northwest is expected to double or triple by the 2080s (Littell and others 2010). Wildfires are now the primary cause of murrelet habitat loss on federal lands, with over 21,000 acres of habitat loss attributed to wildfires from 1993 to 2012 (Raphael and others 2016).

Higher temperatures and/or below average precipitation can result in drought conditions, which can increase tree stress and mortality risk, and increase the frequency of drought-related disturbances such as insect outbreaks. Existing tree species may shift upward in elevation to the extent possible, while forest types in the southern end of the range and in lower elevations may be lost and replaced with different forest types. Hotter droughts could exacerbate all of these impacts (USFWS 2019).

The ability of the species to respond to shifts in prey conditions is constrained by several factors. Inland habitat distribution is limited, and nesting marbled murrelets in Washington already travel long distances between their nest sites and at-sea foraging areas, likely at a large energetic cost (Lorenz and others 2017, p. 313). Shifts in productive foraging locations may make the nest-to-sea commute prohibitively difficult, limiting the ability of marbled murrelets to attempt breeding.

EFFECT OF THE ALTERNATIVES ON CLIMATE CHANGE IMPACTS

Within the planning period of this FEIS, it is unlikely that the conservation approaches proposed under the alternatives will exacerbate expected climate change impacts (refer to Section 4.2).

5.5 Incremental Impacts of the Alternatives

Potential environmental impacts of the alternatives on marbled murrelets and social and economic values are analyzed in Sections 4.6 and 4.11, respectively, of this FEIS. This section examines whether the effects of each alternative, when added to the effects of other past, present, and reasonably foreseeable future actions, could result in collectively significant cumulative impacts to marbled murrelets and non-forest land uses.

■ Incremental Impacts, Marbled Murrelets

Alternatives F, G, and H (the Joint Agencies' preferred alternative) have no net losses of adjusted acres. Alternatives A through E result in short-term losses of current habitat and long-term increases in habitat in areas conserved as long-term forest cover. Depending on the alternative, habitat losses balanced with habitat gains on DNR-managed lands are projected to result in a net increase from the current level of 207,000 acres (15.0 percent of DNR-managed lands in the analysis area) to between approximately 262,000 (Alternative B) and approximately 314,000 (Alternative F) acres of habitat (19 percent to 23 percent) over the next 50 years.

Alternative B represents the greatest risk for negative cumulative effects to marbled murrelets because it would release for harvest the greatest amount of current habitat (45,000 acres, including over 5,700 acres of higher-quality habitat). This amount represents approximately 3.4 percent of the estimated 1.34 million acres of higher suitability murrelet habitat in Washington State (Falxa and Raphael 2016). Alternative B does not buffer occupied sites, so the chance of sites persisting are likely to be reduced by edge effects. Alternative D does buffer occupied sites; however, neither alternative B nor D recover the amount of raw acres of habitat harvested during the planning period and both take two decades to recover adjusted acres.

Alternatives C and E through H have the potential to provide positive cumulative effects by conserving current habitat and recruiting additional habitat in key landscapes that are essential for the conservation and recovery of marbled murrelets. Alternative F has the greatest potential to contribute toward reversing or restricting the decline of the marbled murrelet population because it would remove the least amount of habitat outside long-term forest cover and provide the most acres of long-term forest cover, and is likely to result in substantial increases in habitat in strategic locations over the next five decades.

Once DNR updates its incidental take permit, all take would be considered incidental take. Incidental take would likely include take from harvest of murrelet habitat in areas outside long-term forest cover, take from some limited road construction and maintenance in certain occupied sites, and take from edge impacts, roads, and disturbance from forest management and land use within long-term forest cover. As described in Section 4.6, road building in occupied sites or their buffers will be avoided if possible;

however, it may occur. The amount and location of road building in occupied sites or their buffers is not known. The alternatives would minimize take through conservation of habitat in long-term forest cover and mitigate take by the growth of habitat, softening of edge effects over time, and conservation measures that reduce disturbance and road impacts. Provided that forest growth occurs as projected, the resulting impact and mitigation analysis shows that mitigation exceeds take for all alternatives except Alternative B.

Because the murrelet population trend has been linked to trends in habitat, minimizing the loss of habitat and recruiting additional high-quality habitat are necessary to minimize future declines. All the alternatives include impacts to marbled murrelets, including removal of habitat and other actions. The alternatives have varying levels of conservation intended to minimize and mitigate timber harvest and other impacts. Considering the threats to the species (refer to preceding sections), there is increased risk to the species from the alternatives if the intended conservation does not perform as expected. For example, Alternative B has the most timber harvest and least conservation; thus, there is a higher risk of this alternative having cumulative impacts in comparison to the other alternatives.

Results of the population viability analysis show that Alternative F and G generally resulted in the greatest numbers of murrelets and the lowest quasi-extinction probabilities, whereas Alternative B always resulted in in the lowest murrelet population size and highest quasi-extinction probabilities in both the risk and enhance scenarios at both the DNR-managed lands and the state of Washington scales. All alternatives except Alternative B were projected to lead to larger murrelet population sizes at year 50 than Alternative A (the no-action alternative), regardless of spatial scale or scenario (one exception was Alternative D in the risk analysis, which resulted in slightly lower murrelet populations sizes than Alternative A). However, cumulative, ongoing impacts from stressors in the marine and terrestrial environments that are outside the scope or control of the proposed action also may be contributing to ongoing population decline.

■ Incremental Impacts, Non-Forest Land Uses

The existing, underlying policy and regulatory framework governing forest management remains largely unchanged under the action alternatives. Alternative B would increase land available for harvest compared to the no action alternative; all other alternatives decrease land available for harvest. Impacts of these existing state policies and regulations, including harvest impacts, have been previously analyzed[6].

Alternatives C through H would increase lands conserved for marbled murrelet, and while this conservation of land largely has neutral or beneficial impacts to other elements of the environment, some minor to moderate adverse effects can be identified for road networks and associated recreational opportunities or development of other non-forestland uses (such as mineral extraction and

[6] Refer to *Final Environmental Impact Statement for the Alternatives for Sustainable Forest Management of State Trust Lands in Western Washington* (DNR 2004); *Final (Merged) Environmental Impact Statement for the Habitat Conservation Plan* (DNR 1996); *Final Environmental Impact Statement for the Proposed Issuance of Multiple Species Incidental Take Permits or 4(d) Rules for the Washington State Forest Practices Habitat Conservation Plan* (DNR 2006c); *Final Environmental Impact Statement of the Policy for Sustainable Forests* (DNR 2006a).

telecommunications). Reductions in area available for non-forest land uses could shift demand to elsewhere within the range of the marbled murrelet; however, existing uses would remain unchanged. Future recreational or leasing demands for state trust lands would be managed at the tactical level through forest land plans and at the operational level for project-specific facilities and plans.

■ Incremental Impacts, Socioeconomic Effects on Private, State, and Federal Forestlands

An important question being considered in this FEIS is whether the incremental effects of additional restrictions under any of the alternatives considered in this FEIS would contribute to existing socioeconomic trends in declining timber harvest, resulting in significant adverse effects to local communities.

As described in Chapter 3, "Affected Environment," state trust lands have undergone major shifts in policy and associated changes in on-the-ground management. Major policy and procedural changes include the following:

- 1997 HCP
- *Policy for Sustainable Forest* (DNR 2006a)
- *Riparian Forest Restoration Strategy* (DNR 2006d)

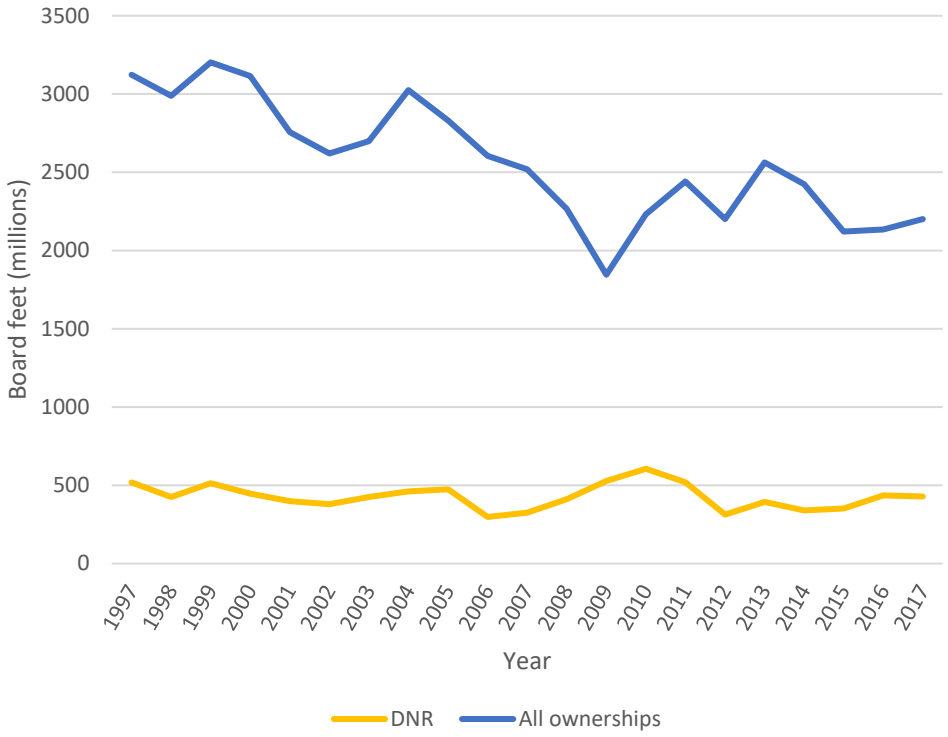
From 1997 to 2018, harvest volumes from state trust lands have fluctuated between 298 and 605 million board feet per year in counties in the analysis area. In the same period, harvest on all ownerships in counties in the analysis area have declined slightly, although harvest volumes were lowest during the economic downturn in 2009 (Figure 5.1.2). At the county level, harvest volumes from state trust lands have been relatively consistent in all counties. Total harvest volume has generally decreased since 1997 in Grays Harbor, Mason, Pierce, and Skagit counties and has increased in Jefferson County. The harvest level in other counties has been relatively stable.

Based on the 1997 through 2017 *Washington Timber Harvest Report*, DNR-managed lands in counties located in the analysis area produced approximately 17 percent of the total volume harvested in that period. The harvest volume ranged from 11 percent in 2006 to 29 percent in 2009 of the total volume. Harvest from private lands accounted for approximately 81 percent of the total harvest volume from 1997 to 2017 and ranged from 87 percent in 2006 to 67 percent in 2009. Federal lands and other public lands produced between 1 and 2 percent of the total harvest volume.

Due to the abundance of private forestlands within the analysis area, private forestlands are expected to continue to provide the majority of timber products to industry into the future, regardless of actions on state trust lands.

Considered collectively, socioeconomic trends have contributed to a cumulative reduction of timber harvest, which has led to associated adverse socioeconomic effects on local communities. It is uncertain whether the effects of the proposed alternatives, when added to existing trends, would be significant at the statewide scale.

Figure 5.1.2. Timber Harvest Levels in the Analysis Area



Incremental Reductions in Available Timber

Alternatives C through H would reduce timber harvest within lands designated as long-term forest cover. The highest reduction in timber harvest is expected under Alternative F and the lowest under Alternative H. Pacific and Wahkiakum counties are projected to be impacted the most (refer to Section 4.11) by reductions in available timber volume under alternatives C through H.

The cumulative economic effects related to regional forest policy decisions, regulatory strategies, and complex economic and social conditions have and will continue to occur at much larger scales than the effects that would occur due to amending the 1997 HCP. Even though up to 143,000 acres of additional long-term forest cover over the no-action alternative may sound like a large amount of land, the incremental effect of this change may not be significant within the context of more than 12 million acres of commercial forestlands in western Washington (Daniels 2004), with the exception of impacts to Pacific and Wahkiakum counties as noted in Section 4.11.

■ Summary of Incremental Impacts

Table 5.1.1 summarizes past, present, and future forest management and land use activities within the analysis area and whether the alternatives incrementally add to those impacts. Refer to sections 4.6 and 4.11 of this FEIS for analysis of impacts on marbled murrelets and social and economic values, respectively.

Table 5.4.1. Incremental Impacts of the Alternatives: Impacts Added to Past Effects and Future Trends Within the Range of the Marbled Murrelet in Washington

Element of the environment	Effects of past actions	Effects of present actions	Effects of future actions and trends	Cumulative impacts
Marbled murrelets	Habitat loss, predation, and threats in the marine environment (for example, oil spills) contributed to population decline. Inland habitat has been reduced to about 12 percent of the historic habitat-capable area in Washington.	Population decline continues in Washington (current rate is estimated at 3.9%). Habitat losses on federal and DNR-managed land have been substantially reduced, while habitat loss on private forestlands continues. Federal reserves provide the primary role for marbled murrelet conservation and recovery, but habitat on DNR-managed lands is essential for the conservation of murrelets in landscapes that have limited federal ownership (for example, southwest Washington).	Conservation of the marbled murrelet will be difficult to achieve if trends in habitat loss continue at the current rate. Habitat loss on private forestlands will continue and habitat will eventually be limited to known occupied marbled murrelet sites, some riparian zones, and some limited deferral areas under Washington forest practices rules. Habitat in federal reserves is expected to increase over the next 50 years as young forests transition to more mature forests and the quality of current habitat increases through a reduction of past habitat fragmentation and edge effects. Depending on the alternative, habitat losses balanced with habitat gains on DNR-managed lands are projected to result in a net increase from the current level of about 15% habitat area to 19% to 23% habitat area over the next 50 years. Because the amount and configuration of habitat is the primary factor associated with murrelet population trends,	All alternatives are projected to result in increased murrelet habitat area on DNR-managed lands over the next 50 years. The increase in murrelet habitat has the potential to slow or reverse the population decline by conserving habitat in long-term forest cover and mitigating the short-term impacts of habitat loss through the growth of new habitat, softening edge effects over time and imposing conservation measures that reduce disturbance and non-harvest impacts. Alternative B has the greatest potential to result in negative cumulative effects due to greater harvest of current habitat and lack of buffers on occupied sites. Alternative F has the highest potential to provide positive cumulative effects by conserving more current habitat and recruiting additional habitat in key landscapes that are essential for conservation and recovery of marbled murrelets.

Element of the environment	Effects of past actions	Effects of present actions	Effects of future actions and trends	Cumulative impacts
			murrelet populations are likely to stabilize and eventually increase as habitat area and quality gradually increase over time on both federal and DNR-managed lands. However, cumulative, ongoing impacts from other stressors in the marine and terrestrial environments that are outside the scope or control of the proposed action also may be contributing to ongoing population declines. Depending on the alternative, murrelet conservation strategies on DNR-managed lands may reduce the impact of other stressors. For example, alternatives that distribute habitat gains throughout the strategic locations may reduce the impact of changes in productive foraging locations resulting from climate change.	Forestland conversions are expected to continue, which can remove habitat or reduce effectiveness of current habitat. Climate change is expected to affect marine and terrestrial habitats.
Forest management	Historic timber harvest, clearing for agriculture and development, and reforestation over the past 100 years have created densely stocked stands with reduced	Ongoing timber harvest has the potential for local adverse effects on soils, water, wildlife habitat, and other elements of the environment. Significant effects are typically avoided or mitigated through the	Ongoing use of thinning will continue to increase timber productivity and wildlife habitat values.	Only Alternative B results in more land available for harvest compared with the no action alternative. Other action alternatives include some local increases in land available for harvest but an overall increase in the amount of long-term forest cover. The existing regulatory framework is sufficient to

Element of the environment	Effects of past actions	Effects of present actions	Effects of future actions and trends	Cumulative impacts
	timber productivity and wildlife habitat values. Wildlife habitat has been significantly reduced due to the loss and fragmentation of structurally complex forest stands.	existing policy and regulatory framework. Active thinning improves timber production and wildlife habitat values. Much thinning is conducted as part of commercial harvest.		address the incremental effects of harvest. Thinning would decrease under some alternatives within some marbled murrelet conservation areas. Thinning may increase where needed to meet habitat objectives. Thinning may also increase due to certainty provided by the long-term conservation strategy (clarity around what land is truly "off-base" for future harvest).
Non-forestland uses	Road building, mineral extraction, and clearing for other types of infrastructure and development occurred. Developed facilities, recreational trails, and off-road vehicles can disturb soils, water quality, and riparian and wildlife habitats and attract predators.	Policies and statewide regulations limit road density and protect soils, streams, and fish habitats. Recreation and non-timber land uses occur throughout public and private forestland. Current demand for communication facilities is high. Interest in energy developments is currently low. High levels of recreational use occur near urban areas, particularly in the South Puget HCP planning unit.	Road densities are expected to remain constant. Future demands for mineral or energy leases on state trust lands may increase based on future market conditions. Effects would be addressed in project-specific planning efforts. Increasing recreation demands on forestland are expected as populations increase.	No additive effects are expected from the alternatives. Conservation measures limit new development in marbled murrelet habitat. Shifting demands for recreational uses can be addressed through forestland plans and project-specific planning. Potential local road reductions are expected within long-term forest cover, which could impact access for other users. Overall, no net change to road density is expected.

Element of the environment	Effects of past actions	Effects of present actions	Effects of future actions and trends	Cumulative impacts
Socio-economic effects (associated with timber volume)	From 1997 to 2017, harvest volumes have fluctuated on land in counties in the analysis area. Harvest in counties in the analysis area have declined slightly on all ownerships but remained more consistent on DNR-managed lands.	DNR-managed forestland produces an average of 17% of total harvest volume for counties in the analysis area. Private forestland produces approximately 81%, and federal lands and other public lands produce an average of 2%.	Private forestlands are expected to continue to provide the majority of timber products to industry into the future, regardless of actions on DNR-managed lands.	Pacific and Wahkiakum counties may be significantly impacted by reductions in available timber volume under alternatives C, D, E, F, or G. Pacific County may be significantly impacted by reductions in available timber volume under Alternative H (refer to Section 4.11).