Background and Basis for the Commission's Decision to Reclassify the Marbled Murrelet as Endangered under the Oregon Endangered Species Act

Petition and Procedural Background

In June 2016, Cascadia Wildlands, the Center for Biological Diversity, Coast Range Forest Watch, Oregon Wild, the Audubon Society of Portland, and the Oregon Chapter of the Sierra Club (Petitioners) petitioned the Oregon Fish and Wildlife Commission (Commission) to reclassify, or "uplist", the Marbled Murrelet (*Brachyramphus marmoratus*) from threatened to endangered under the Oregon Endangered Species Act (OESA).

In September 2016, the Commission found that the petition presented substantial scientific information to justify proceeding with the requested action and accepted the petition for further evaluation. This decision initiated the rulemaking process, which includes 1) consultation with affected agencies, tribes, local governments, other states, various organizations, and the public; 2) a review of the biological status of the Marbled Murrelet in Oregon to determine if circumstances meet legal criteria for reclassification; and 3) peer review of the Oregon Department of Fish and Wildlife's (Department) biological status review report.

Following the Commission's acceptance of the petition, the Department notified interested and affected parties and solicited scientific information and other data relevant to staff review. The Department subsequently began its biological status review of the species. In September 2017, the Department released its draft "Status Review of the Marbled Murrelet (*Brachyramphus marmoratus*) in Oregon and Evaluation of Criteria to Reclassify the Species from Threatened to Endangered under the Oregon Endangered Species Act" for invited peer review and for public comment. Following the close of the 42-day comment period, staff revised the draft and prepared a final status review report. All comments received were considered in the development of the final report. In January 2018, the Department released its final "Status Review of the Marbled Murrelet (*Brachyramphus marmoratus*) in Oregon and Evaluation of Criteria to Reclassify the Species from Threatened to Endangered under the Oregon Endangered Species Act" (ODFW 2018, hereafter 'Status Review').

At the February 2018 Commission meeting in Portland, staff presented the Department's Status Review, and the Commission received written comments and oral testimony from the public. The Commission voted to accept the Petitioners' recommendation to reclassify the Marbled Murrelet as endangered under the OESA, and directed staff to develop survival guidelines for adoption at the time of reclassification at the June 2018 Commission meeting.

Current Legal Status in Oregon

The Washington, Oregon, and California distinct population segment of the Marbled Murrelet was listed as threatened under the federal Endangered Species Act (federal ESA) in 1992 (57 FR 45328). The U.S. Fish and Wildlife Service (USFWS) determined that the species was threatened by loss and modification of older forest nesting habitat, mainly due to timber harvest, as well as mortality from gillnet fishing operations in Washington State and the effects of oil spills (57 FR 45328). Federal critical habitat for the Marbled Murrelet was first designated in 1996 (61 FR 26256), revised in 2011 (76 FR 61599), and reaffirmed in 2016 (81 FR 51348). The USFWS completed a recovery plan for the Marbled Murrelet in 1997 (USFWS 1997).

The Marbled Murrelet was listed as threatened under the OESA in 1995 (OAR 635-100-0125), also owing mainly to habitat loss (ODFW 1995).

Legal Framework

The Commission has exclusive statutory authority to designate threatened and endangered wildlife species under the OESA (ORS 496.176(2)). This includes establishing, publishing, and periodically revising, by rule, a list of wildlife species that are threatened or endangered (ORS 496.172(2)).

The OESA defines threatened and endangered species as follows:

> Threatened Species: Any native wildlife species the Commission determines is likely to become an endangered species within the foreseeable future throughout any significant portion of its range within this state (ORS 496.004(17)(a)).
>
> Endangered Species: Any native wildlife species determined by the Commission to be in danger of extinction throughout any significant portion of its range within this state (ORS 496.004(6)(a)).

The OESA requires the Commission to base any reclassification decision on documented and verifiable scientific information (ORS 496.176(3), OAR 635-100-0105(1)). The Department's peer-reviewed Status Review focused on information relevant to the species' biological and legal status, and was designed to help inform the Commission's decision. The peer review process was intended to ensure that the Department incorporated the best available scientific and other information into the Status Review, and characterized the information accurately and objectively. The Department solicited independent peer reviews from four individuals with scientific subject matter expertise: Gary Falxa, Fish and Wildlife Biologist (Retired), USFWS; Deanna Lynch, Fish and Wildlife Biologist, USFWS; S. Kim Nelson, Research Wildlife Biologist, Oregon State University; and John Piatt, Research Wildlife Biologist, U.S. Geological Survey.

The OESA (ORS 496.171-496.192) and its implementing rules (OAR Chapter 635 Division 100) set out criteria and procedural requirements which must be met if the Commission is to reclassify a species from threatened to endangered. Specifically, the Commission must determine that the likelihood of survival of the species has diminished such that the species is in danger of extinction throughout any significant portion of its range within Oregon (ORS 496.176(3), OAR 635-100-0111(1)). In addition, the Commission must determine that at least one of the following factors exists: 1) that most populations are undergoing imminent or active deterioration of their range or primary habitat; 2) that overutilization of the species or its habitat for commercial, recreational, scientific, or educational purposes is occurring or is likely to occur; or 3) that existing state or federal programs or regulations are inadequate to protect the species or its habitat (ORS 496.176(3), OAR 635-100-0105(6)).

Basis for the Commission's Decision

The basis for the Commission's decision to reclassify the Marbled Murrelet as endangered under the OESA is summarized below and also reflected in the Commission's record of proceedings. That record

includes, but is not limited to, the petition, the Department's evaluation of the petition, scientific and other evidence provided to the Department by external parties, the Department's Status Review, the Department's responses to peer reviewer and public comments, and written and oral comments received from conservation organizations, science or research institutions, industry, state and local governments, elected officials, and individuals.

The Commission determined that, based upon the best available information, the likelihood of survival of the Marbled Murrelet has diminished such that the species is in danger of extinction throughout any significant portion of its range within Oregon (ORS 496.176(3), OAR 635-100-0111(1)) and that one or more of the three factors from ORS 496.176(3) and OAR 635-100-0105(6) exist:

1) that most populations are undergoing imminent or active deterioration of their range or primary habitat;
2) that overutilization of the species or its habitat for commercial, recreational, scientific, or educational purposes is occurring or is likely to occur; and
3) that existing state or federal programs or regulations are inadequate to protect the species or its habitat.

The Commission based its decision most heavily on the combination of threats and risk factors affecting the continued existence of the Marbled Murrelet in Oregon. These threats and risk factors include, but are not limited to, specialized habitat requirements, past and ongoing loss and degradation of older forest nesting habitat, low reproductive potential and poor contemporary breeding success, uncertainties associated with recent population trends derived from at-sea surveys due to bird movement, high extinction probabilities inferred from demographic models, increasing threats and stressors in both the marine and terrestrial environments, and inadequacies of current programs and regulations for retaining and recruiting suitable nesting habitat on nonfederal lands. A brief synopsis of these factors is provided below. These items represent only a fraction of the many, complex issues discussed and considered by the Commission since receiving the petition.

Habitat Requirements

Marbled Murrelets are unique among North American alcids in that they nest primarily in coastal old-growth and late-successional forests. They do not construct a nest, per se, but rather lay their single egg on a large or deformed tree branch high in the canopy. Large platforms with moss, lichen, or other nesting substrate, foliage cover above and around the nest, high densities of large trees, multiple canopy layers, and proximity to openings in the canopy that provide flight access are among important habitat features (Nelson et al. 2006). Occupied stands in Oregon are mostly old-growth or fire-regenerated, naturally-planted stands dominated by Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), or Sitka spruce (*Picea sitchensis*) (Grenier and Nelson 1995, Nelson and Wilson 2002). Most nests have been found in trees 80 years or older in Oregon (Hamer and Nelson 1995b, Nelson and Wilson 2002), though nesting has been documented in some younger and mature trees within the Sitka spruce/western hemlock forest type; these younger and mature trees had structural elements (deformities or dwarf mistletoe infestations) characteristic of older trees (Nelson and Wilson 2002).

Marbled Murrelets use nearshore marine waters for resting and feeding on small schooling fish and marine invertebrates (Burkett 1995, Piatt et al. 2007, Nelson et al. 2006). They depend upon productive marine waters in close proximity to suitable forest nesting habitat for successful reproduction, and must commute from nest-sea when provisioning their chick. During the breeding season in Oregon (April through September), murrelets are typically concentrated within 2 km [1.2 miles] of the shore when at sea (Strong et al. 1995, Falxa et al. 2016). Highest murrelet densities during the breeding season have been observed offshore of large blocks of potential nesting habitat (Raphael et al. 2015, Raphael et al. 2016b).

Nesting Habitat Loss and Degradation

There is strong evidence of large-scale loss of older forests since European settlement within the Marbled Murrelet range in the Pacific Northwest and northwestern California (e.g., Booth 1991, Teensma et al. 1991, Bolsinger and Waddell 1993, Ripple 1994, Perry 1995, USFWS 1997, Wimberly et al. 2000, McShane et al. 2004, Strittholt et al. 2006, Ohmann et al. 2007, Davis et al. 2015). In the Oregon Coast Range, Wimberly and Ohmann (2004) estimated that large-conifer forests declined by 58% between 1936 and 1996, with corresponding increases in small-conifer forests during this period. Habitat loss and degradation were primary factors in the initial federal and state listings of the Marbled Murrelet in the 1990s (CDFG 1994, ODFW 1995, Desimone 2016, USFWS 1997, 57 FR 45328).

Since the 1990s, further habitat losses have occurred, mainly due to timber harvest on nonfederal lands and wildfire on federal lands (Raphael et al. 2016a). Based on Northwest Forest Plan (NWFP) estimates, higher-suitability nesting habitat declined in Oregon from approximately 853,400 acres in 1993 to 774,800 acres in 2012, a net loss of 78,600 acres (-9.2% change) (Raphael et al. 2016a). Losses were greatest on nonfederal lands during this period; 59,200 acres (21.1%) of higher-suitability habitat were lost on nonfederal lands compared to 19,400 acres (3.4%) on federal lands (Raphael et al. 2016a).

Past habitat removal has created large gaps that fragment population distribution within the core of the Marbled Murrelet range (Ralph et al. 1995a, USFWS 1997, RIT 2012); in Oregon, large habitat gaps occur in the northwest portion of the state as well as the coastal strip between Reedsport and the Siskiyou Mountains (RIT 2012; Fig. 2 in ODFW 2018). Most remaining nesting habitat persists on public lands in Oregon, including the Siuslaw and Rogue River-Siskiyou National Forests, forests owned by the Bureau of Land Management, and the state-owned and managed Tillamook, Clatsop, and Elliott State Forests (Raphael et al. 2016a; Fig. 2 in ODFW 2018). The full extent of occupied habitat on private lands is unknown since state regulations for forest practices do not require pre-project wildlife surveys by private landowners (Tucker and Weikel 2017a); it is generally assumed to be low given available forest stand inventory and harvest data (Greber et al. 1990, Ohmann et al. 2007) and the Department's examination of the 2012 habitat suitability data produced by Raphael et al. (2016a) for Oregon (see ODFW 2018 for details).

Reproductive Potential and Measures of Breeding Success

Marbled Murrelets are relatively long-lived and have delayed sexual maturity and low fecundity (Nelson 1997). They lay only one egg per clutch and re-nesting rates are low, so nest success (number of

fledglings produced per pair of adults that attempt breeding in a given year) has substantial influence on the demographic measure of fecundity (number of female offspring fledged per adult female per year) (Burger 2002, Peery and Henry 2010).

Across the federally-listed range, nearly all available estimates indicate poor contemporary breeding success (e.g., McShane et al. 2004; Peery et al. 2004; Beissinger and Peery 2007; Crescent Coastal Research 2008, 2013; Lorenz et al. 2017). Data for Oregon are sparse, but nest success has been estimated at roughly 36% (n = 22 nests, S. K. Nelson, pers. comm.). Ratios of juveniles to adult birds counted at sea provide recent productivity indices of 0.025-0.060 for Oregon (Crescent Coastal Research 2008); while these juvenile:adult ratios have known limitations, they are an order of magnitude lower than what population models indicate is necessary to maintain stable populations (0.18-0.28) (Beissinger and Nur 1997). In the first year of an Oregon telemetry study by Oregon State University, none of the 61 murrelets monitored from May to July were known to have nested or attempted nesting in 2017, presumably due to poor ocean conditions that limited prey availability (Rivers 2018).

Population Size and Trend

There is widespread agreement that Marbled Murrelet populations in Washington, Oregon, and California have undergone considerable declines since European settlement (Ralph 1994, McShane et al. 2004). Declines from historical levels have been largely inferred from anecdotal information (e.g., Nelson et al. 1992) and loss of older forest nesting habitat over the last 150-200 years (e.g., Bolsinger and Waddell 1993, Wimberly et al. 2000, Wimberly and Ohmann 2004, Strittholt et al. 2006, Ohmann et al. 2007, Davis et al. 2015). Compared to Alaska and British Columbia, Oregon's Marbled Murrelet population is small (see COSEWIC 2012, Environment Canada 2014).

There are no available surveys that provide a continuous assessment of Marbled Murrelet population trends in Oregon from 1995 to the present. A significant decline (>50%) on Oregon's central coast was first detected in 1996 through at-sea surveys conducted from 1992-1999 (Strong 2003). The NWFP's Marbled Murrelet Effectiveness Monitoring Program monitored murrelets at sea in Oregon nearly annually from 2000-2015, and did not find evidence of a population decline during that period for Oregon (Lynch et al. 2017). It appears that the Oregon population may now be fluctuating around a new, lower baseline. Based on this monitoring program, the Oregon population was estimated at 10,975 birds in 2015 and was likely somewhere between a range of 8,188 and 13,762 birds. The fairly wide confidence limits for these population estimates reflect the challenges of monitoring a highly mobile seabird that is sparsely and patchily distributed, as well as constraints on survey effort.

While the most recent at-sea surveys (2000-2015) did not detect a population decline in Oregon during that period (Lynch et al. 2017), a growing body of evidence indicates that Marbled Murrelet distribution and trend are most closely tied to the amount and trend of suitable nesting habitat, for which the habitat trend is downward in Oregon (see Raphael et al. 2016b). Raphael et al. (2016c) summarized key sources of uncertainty associated with trend estimates. In addition, there may be a time lag before population response due to habitat change is detected by current at-sea monitoring methods since murrelets are long-lived, have high breeding site fidelity, and may survive at sea for many years (Ralph et al. 1995a, Miller et al. 2012, Raphael et al. 2016b).

Dispersing birds may be confounding resident population size and trend estimates. For example, Oregon State University researchers found that many murrelets captured and radio-tagged in Oregon in 2017 subsequently moved into Washington and California waters, likely due to poor ocean conditions that reduced prey availability off Oregon (Rivers 2018). These birds were failed breeders or non-breeders that will presumably return to nest in Oregon in future years, but many would have been counted in at-sea surveys elsewhere (S. K. Nelson, pers. comm.). These results suggest that extensive bird movement could complicate conclusions about population size or trend from at-sea surveys, particularly at the state scale. These findings are so far consistent with those of Peery et al. (2010) in central California, who concluded that most birds moving into Conservation Zone 6 (Santa Cruz Mountains) from the north were not true immigrants but rather "visitors" as few nested or contributed offspring to the resident population.

Demographic Models and Extinction Probabilities

In the most recent demographic modeling for the federally-listed range, McShane et al. (2004) projected population size by Conservation Zone over 40 years; Conservation Zone 3 (Oregon Coast Range) and the northern part of Conservation Zone 4 (Siskiyou Coast Range) occur in Oregon. Among their assumptions were that annual adult survivorship was 83-92%, nest success was 0.324-0.460 for Zone 3 and 0.230-0.324 in Zone 4, juvenile:adult ratios were 0.080 for Zone 3 and 0.084 for Zone 4, and that 90% of adults breed in most years (the latter was reduced to 50% in "severe El Niños", modeled to occur in 3 of every 25 years). They forecasted mean annual rates of decline of 2-6% across all zones initially. Earlier modeling efforts produced similar rates of decline of 4-7% per year for the federally-listed range (Beissinger 1995, Beissinger and Nur 1997).

McShane et al. (2004) also reported extinction probabilities by zone over 100 years. For the entire federally-listed population, the probability of extinction within 100 years was 16%, with a mean 3-state population size of 45 birds at the end of 100 years (all within Zone 1 in Washington State). For Oregon specifically (Zones 3-4), the probability of extinction exceeded 80% by 2060 for Zone 4 and exceeded 80% by 2100 for Zone 3. Projections were especially sensitive to immigration rates and fecundity. Under the model inputs and assumptions, these results suggest high extinction risk for Marbled Murrelets in Oregon within the century.

Key Threats, Stressors, and Climate Change Effects

Forest Habitat Alteration

As discussed above, Marbled Murrelets have experienced both past and contemporary habitat loss. However, it is also the distribution and quality (how far inland, how isolated, how fragmented, etc.) of remaining habitat that is important. Remaining habitat is highly fragmented in Oregon, and most of it persists on public lands. Raphael et al. (2016a) classified nearly 90% of potential habitat on nonfederal lands as "edge", whereas federal lands had lower (>70-80%) but still high proportions of edge. Edge effects can degrade otherwise suitable forest remnants through changes in abiotic or biotic conditions. Lack of buffers and heavy thinning adjacent to murrelet habitat can also contribute to habitat loss and degradation (Raphael et al. 2016b). Examples of adverse edge effects that could result from recent

clearcuts (and logging/thinning adjacent to occupied sites) include elevated predator densities and predation levels, greater windthrow damage, and reduced epiphyte abundance needed for nesting substrate relative to forest interiors (Nelson and Hamer 1995b, McShane et al. 2004, van Rooyen et al. 2011). Fidelity to breeding areas (Divoky and Horton 1995) as well as the time it takes for nesting habitat to develop (decades to centuries) (Falxa et al. 2016) may limit the ability for murrelets to colonize new sites, at least in the short-term.

Adverse Oceanic Conditions

Variability in ocean conditions (winds, temperatures, upwelling patterns) can affect marine productivity, and ultimately, the distribution, abundance, timing, and quality of prey available to murrelets. Marbled Murrelets consume a diverse group of prey, suggesting some degree of flexibility in prey choice and the capacity to switch when necessary (Burkett 1995, Nelson 1997). This makes sense from an adaptive standpoint because prey populations are naturally dynamic. Nevertheless, the evidence indicates that the flexibility to switch prey and alter their activity budget are not adequate to ensure reproductive success during years when ocean productivity is extremely poor (Ronconi and Burger 2008). Because murrelets are long-lived, short-term phenomena such as typical El Niño events or a year with poor ocean productivity would not be expected to adversely affect murrelet populations over the long-term. However, murrelets may not be able to compensate for long periods of unfavorable conditions or increased variability in prey resources (for example, during regime shifts associated with the Pacific Decadal Oscillation), especially in combination with other anthropogenic threats and stressors. Climate change is expected to exacerbate these impacts.

A growing body of evidence indicates that low recruitment in the murrelet is linked, in part, to changes in the marine environment (Peery et al. 2004, Becker and Beissinger 2006, Becker et al. 2007, Norris et al. 2007, Gutowsky et al. 2009, USFWS 2009, Lorenz et al. 2017). During the breeding season, reductions in prey quality or quantity may lead to nest abandonment or failure. During the pre-breeding season, murrelets may fail to initiate nesting altogether without sufficient food resources. Centennial shifts toward lower quality prey types have been documented in both central California and the Salish Sea (Becker and Beissinger 2006, Norris et al. 2007, Gutowsky et al. 2009). Murrelet breeding success appears to be positively associated with an abundance of mid-trophic level prey and cooler ocean temperatures (Becker et al. 2007). Oregon's coastal surface waters have warmed an average of 0.5°F per decade over the latter half of the 20th century and are expected to increase by approximately an additional 2.2°F by the mid-21st century (Mote et al. 2010). The waters off Oregon are also becoming more stratified. The thermocline is 10-20 m [33-66 ft] deeper off Oregon in the early 21st century than it was in the middle of the 20th century (Huyer et al. 2007). Stronger stratification will make ocean mixing due to wind patterns less effective at bringing nutrients to the surface, thereby reducing primary productivity (Osgood 2008, Hoegh-Guldberg and Bruno 2010).

Harmful algal blooms and biotoxins, low-oxygen "dead zones" in the ocean, contaminants in prey, and fishing pressures also have potential to affect murrelets in the marine environment (USFWS 2009), though the magnitude of their effects is uncertain.

Large-scale Disturbances

Disturbances have always played a role in shaping forests. Because current habitat is now limited and disconnected, severe disturbances have the potential to remove key patches that cannot be replaced in the near-term. For example, the 2002 Biscuit Fire in southern Oregon removed over 14,000 acres of suitable habitat (McShane et al. 2004, Raphael et al. 2016a), and the 2017 Chetco Bar Fire impacted over 20,000 acres of federally-designated Marbled Murrelet critical habitat with high to moderate severity burns (Vaughn 2017, p. 14, Table 12). While multiple factors (e.g., climate, weather, topography, vegetation structure/composition/fuels, fire suppression) affect the duration and intensity of fire across the landscape, many studies have concluded that fires are becoming larger and more frequent in the West (e.g., Stephens 2005, Westerling et al. 2006, Kitzberger et al. 2007, Littell et al. 2009, Miller et al. 2009, Westerling 2016).

Predation

Many known or potential murrelet nest predators have seen significant increases in abundance in recent decades (see Burger 2002, Piatt et al. 2007, Halbert and Singer 2017). Evidence throughout the range from both real and artificial murrelet nests indicates that predation is a leading cause of nest failure (Nelson and Hamer 1995b, USFWS 1997, McShane et al. 2004, USFWS 2009) and that corvids (jays, crows, ravens) have the greatest impact (USFWS 2009). Forest fragmentation may contribute to elevated predation rates by increasing predator densities or activity along forest edges (Nelson and Hamer 1995b). Anthropogenic food sources from campgrounds, trails, picnic areas, or other human settlements tend to support elevated levels of corvids, which can lead to higher nest depredation for nearby murrelets (Marzluff and Neatherlin 2006, Bensen 2017, Goldenberg et al. 2016), and perhaps for murrelets nesting further away (West and Peery 2017).

Recovering raptor (e.g., Bald Eagles *Haliaeetus leucocephalus*, Peregrine Falcons *Falco peregrinus*) populations pose a new potential threat to adult and juvenile murrelet survival (Piatt et al. 2007, RIT 2012). This is of particular concern given that murrelet population growth is thought to be influenced most by adult and subadult survival (McShane et al. 2004). Depredation of adult murrelets by Peregrine Falcons, Sharp-shinned Hawks (*Accipiter striatus*), Common Ravens (*Corvus corax*), Northern Goshawks (*A. gentilis*), and Bald Eagles has been documented, but there is no information on mortality rates (McShane et al. 2004).

Oil Spills

Marbled Murrelets are especially vulnerable to oil spills because they feed in local concentrations close to shore and spend most of their time swimming on the sea surface (King and Sanger 1979, Wahl et al. 1981). Exposure to oil (e.g., ingestion during preening, fouling of plumage) can impair thermoregulation, flight ability, reproductive behavior, and/or physiological functions, with lethal or sub-lethal effects (USFWS 2005). A spill could also cause indirect mortality or effects (i.e., if prey base is negatively impacted) (Carter and Kuletz 1995, Peterson et al. 2003). For example, even low levels of oil can result in developmental defects and mortality in Pacific herring (*Clupea pallasii*) embryos (Incardona et al. 2007, 2015).

In 1999, the New Carissa cargo vessel that ran aground and split apart on the southern Oregon coast released over 70,000 gallons of fuel, killing or injuring an estimated 2,465 seabirds, including 262 Marbled Murrelets (USFWS 2009). This spill has had the greatest documented murrelet mortality in Oregon (USFWS 2009). Large oil spills remain a serious threat given the volume of shipping traffic along the West Coast and Columbia River as well as ports, oil facilities, and oil trains operating in Oregon.

Climate Change Effects

There are currently few indications that Marbled Murrelets south of Canada will see benefits from a warming climate (USFWS 2009). Given their low reproductive potential, specialized habitat requirements in both terrestrial and marine environments, breeding site fidelity, and restricted distribution, Marbled Murrelets may not be as resilient as some other species to changing conditions. A recent assessment by Case (2014) described the Marbled Murrelet as highly sensitive to climate change; of the 114 Pacific Northwest bird species analyzed, the Marbled Murrelet had the highest climate-sensitivity score.

There is already strong evidence that climate change is affecting ecosystems in the Pacific Northwest and globally (IPCC 2014, Blunden and Arndt 2016, Dalton et al. 2017). Under even the most optimistic scenarios, Oregon's climate is expected to warm at least 2-5°F by the 2050s and 2-7°F by the 2080s. In the Coast Range specifically, Dalton et al. (2017) noted that warmer, drier conditions may lead to conifer forests shifting to more drought-tolerant mixed forests and increasing impacts from wildfire and the fungal disease Swiss needle cast, which stunts Douglas-fir growth. Climate change effects that reduce growth of moss or other canopy epiphytes that provide nesting substrate for Marbled Murrelets could also impact the species (COSEWIC 2012).

Climate change effects in the marine environment that affect murrelet prey resources are of particular concern (USFWS 2009). Climate models indicate that ocean warming is accelerating and will continue in the future, though changes in upwelling patterns that help to drive marine productivity are less certain (Dalton et al. 2017). There is also evidence that the timing of the annual upwelling cycle may change with changes in climate, and that such changes can affect breeding success of the Marbled Murrelet. For example, reproductive failures for the Cassin's Auklet (*Ptychoramphus aleuticus*) and extremely poor reproductive success for the Marbled Murrelet in 2005 were attributed to the change in timing of the wind-driven upwelling, which resulted in low prey resources at a critical time of their reproductive cycle (Sydeman et al. 2006, Ronconi and Burger 2008).

Unusually warm ocean conditions from 2014-2016 provide additional insights into the ecological effects that a warmer future ocean along the Oregon coast might have. An anomalously warm water mass known as "The Blob" (Bond et al. 2015) formed in the Gulf of Alaska in fall 2013 and spread across the entire North Pacific by 2014. These warm waters combined with a strong El Niño the following year, keeping sea surface temperatures elevated off the Oregon coast through 2016. During "The Blob", the zooplankton community off of the Oregon coast was dominated by small, lipid-poor tropical and subtropical copepods and gelatinous zooplankton, including new species not previously detected off Newport since sampling began in 1969, krill biomass was the lowest on record, and marine reptile and fish species were observed thousands of kilometers outside of their usual ranges (Peterson et al. 2015).

A number of forage fish species declined in abundance in 2013-2016, and a mass starvation of Common Murres (*Uria aalge*) was observed from southern California to the Aleutian Islands. Murre breeding success was also diminished off California and Oregon, and murres failed altogether in Alaska at many colonies in 2015 and 2016. Several other species of seabirds and marine mammals suffered starvation or breeding failures from southern California to the Bering Sea of Alaska during this period (J. F. Piatt et al., in prep.).

State and Federal Programs and Regulations

The Department's status review examined a wide range of state and federal programs and regulations pertinent to the status of the Marbled Murrelet and/or its habitat in Oregon. In the terrestrial environment, federal forest lands have largely been managed under the NWFP since 1994, though the Bureau of Land Management adopted a new Western Oregon Resource Management Plan for their lands in 2016. On nonfederal lands, commercial timber harvest is regulated under the Oregon Forest Practices Act. The Oregon Forest Practices Act (in and of itself) currently provides limited protection of Marbled Murrelet habitat. The Oregon Department of Forestry is undertaking a rulemaking process pertaining to Marbled Murrelet resource sites, but the outcome of that process will not be known for about 18 months (L. Tucker, pers. comm.). Management of state forest lands is additionally guided by applicable forest plans, agency mandates, and operational policies that include protective measures for Marbled Murrelet habitat.

Overall, the Department's review found that the threat posed by inadequate state and federal programs and regulations has decreased since state listing. For example, implementation of the NWFP reduced the rate of habitat loss due to timber harvest on federal lands. However, loss of higher-suitability potential habitat on nonfederal forest lands in Oregon was substantial (21%) from 1993 to 2012, and most of this loss was attributed to timber harvest (Raphael et al. 2016a); this suggests that a mechanism is still needed to reduce continued habitat loss and fragmentation. Fisheries management is another example of state and federal programs and regulations that have been strengthened since the 1990s, improving protections for murrelet prey resources in Oregon. Several marine reserves and marine protected areas have been established, and there is now greater oversight of forage fish management at state and federal levels.

Literature Cited

References identified in this document are provided in the Literature Cited section of the Department's Status Review (ODFW. 2018. Status review of the Marbled Murrelet (*Brachyramphus marmoratus*) in Oregon and evaluation of criteria to reclassify the species from threatened to endangered under the Oregon Endangered Species Act. Oregon Department of Fish and Wildlife, Salem, Oregon.), with the exception listed in full below:

Rivers, J. 2018. The Oregon Marbled Murrelet Project: science to inform conservation and management of Oregon's coastal forests. Oregon State University presentation to the Oregon Fish and Wildlife Commission, February 9, 2018, Portland, Oregon.