Expert Reviews of the Draft Marbled Murrelet Technical Report

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Marbled Murrelet Technical Report
Draft

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Photo Credit: Gus van Vliet, USGS

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Executive Summary

In 2016, the Board of Forestry (Board) received a Petition to Initiate Rulemaking for the marbled murrelet under Forest Practices Act (FPA) specified resource site rules. The Board directed the Department to begin work on this rule analysis and received an update and an initial timeline for work to be completed at their meeting in April 2017. The Board's evaluation for possible rule-making is to be based on best available information summarized in a technical review paper. The technical review paper must include information on identification of the resource site(s) used by the species, identification of forest practices that conflict with the resource sites, evaluation of the biological consequences of those conflicts, and include information on protection requirements and exceptions(from OAR 629-680-0100(1)(a)). This technical report was developed to evaluate this required information as well as to provide information on the ecology and habitat use of marbled murrelets. While this report is intended to inform the rule analysis project and the Board's decision making process, additional work and analysis will be needed prior to decisions on possible rule-making.

The marbled murrelet is one of the only seabirds and the only species in the alcid family that nests in forested environments. They spend most of their life at sea, but rely on very old conifer trees for nesting. While most nesting is limited to old growth conifer forests, they are also known to nest in residual old trees within younger stands and in younger hemlock-dominated stands heavily infested with mistletoe in NW Oregon. Nests are typically located on a suitable platform, usually on a large, mossy, horizontal tree branch. Nests are normally in the mid to upper portion of the tree, typically about 100 feet above the ground and with vegetative cover adjacent or above the nest. The presence of suitable platform limbs is considered one of the most important habitat features for this species.

Marbled murrelets have narrow habitat requirements and are secretive in nature when inland. They primarily visit their nest sites at dawn and dusk when they are less likely to be detected by potential predators. They are difficult to detect, and tend to nest high up in the canopy. Thus, nests are extremely difficult to find. Because of this, there are still gaps in our knowledge of habitat use by this species, especially for nesting birds in Oregon.

The relationship between marbled murrelet nest site selection, nest success and landscape characteristics is complicated and available information does not allow us to determine a consistent trend. There is little information available in Oregon. Research from across the entire range of the species has found various patterns for how landscape pattern (i.e., amount and fragmentation of suitable habitat) impacts murrelets. There is some evidence that murrelets may tend to locate nests near forest edges (natural and human-created), but that in some situations they experience lower rates of nest success near edges, especially human-created "hard" edges.

Oregon population surveys conducted in between 2000 and 2016 indicate that the population trend is likely stable. Results for the state-wide population trends for Oregon through 2016

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indicatean increase of +1.8% per year (95% CI from 0.1 to +3.6) between 2000 and 2016. The data indicates a weak upward trend in Oregon, and this trend was statistically significant (P=0.042).

Because additional analysis will need to be considered at a later date, and because identification of the resource site is the first key question that must be decided by the Board before other policy work can occur, this technical report does not include policy recommendations. Rather a range of options is included, where appropriate. Details for protection strategies will be included in a future rule-analysis report.

The technical report includes a range of options for the definition of a resource site for marbled murrelets. Unlike existing birds with rules under the FPA that are highly visible or that have established methods to locate nests, marbled murrelet nests are extremely challenging to locate and there is no efficient and effective method to locate nests. Thus, identification of only the nest tree as the resource site for this species is likely to be insufficient. Another option is to include locations of occupied detections as a proxy for nest sites. The technical report also discusses an option to use designated potential suitable habitat as a resource site. In this context, the habitat would be presumed occupied by the species until additional work is conducted to determine that the area is not actually suitable nesting habitat (e.g. trees with suitable nesting platforms are not present) or not occupied by murrelets (i.e., as determined through surveys).

Because marbled murrelets nest in forested environments, conflicts between forest practices and marbled murrelets are likely to occur. Most conflicts will occur from forest harvesting, with conflicts likely due to loss of nests during logging or due to disturbance to nesting birds or increased risks to nesting birds from increased exposure to the elements or increased risk of depredation of nests by predators.

Because protection strategies for marbled murrelets may vary greatly depending on the Board's decision regarding definition of a resource site, specific strategies are not addressed in this report. Instead, a range of possible protection strategies for this species are discussed. Both prescriptive approaches and programmatic approaches are addressed in the report. Prescriptive approaches would describe best management practices to protect sites and could be codified as regulations or as voluntary measures. Programmatic approaches include use of Safe Harbor Agreements and Stewardship Agreements to encourage voluntary protection and development of suitable habitat for marbled murrelets.

Future policy work is needed to inform this discussion (ODF 2017a). As per OAR 629-680-0100 (1)(b), this technical report must undergo a formal "Expert Review". Feedback from the review will be summarized and included in a subsequent report that will be delivered to the Board.

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Background

In June 2016, the Board received a Petition to Initiate Rulemaking for the marbled murrelet under Forest Practices Act (FPA) specified resource site rules. The Board considered the petition during their meeting on July 20. Acting within its authority under the Administrative Procedures Act, the Board denied the petition. In September, the petitioners submitted a Petition to Review an Agency Order through the Lane County Circuit Court to request the court compel rulemaking. In November, the Board held a public meeting and accepted public comment to reconsider their decision to deny the petition for rulemaking. After consultation with the Oregon Department of Justice, the Board voted to withdraw and reverse its previous decision on the rulemaking petition.

In March 2017, the Board received an update on this rule analysis. A report was presented to the Board that included a review of the petition and a summary of work needed to be conducted as part of any rule-analysis process (ODF 2017a). It was determined the petition did not include adequate information for purposes of a rule analysis. The Board directed ODF Department staff (hereafter Department) to initiate development of a Technical Report on marbled murrelets as per OAR 629-680-0100.

This report was developed to meet the requirement for a Technical Report for purposes of informing the rule analysis process for marbled murrelets. The progress report presented to the Board in March of 2017 (ODF 2017a) outlined additional work to be conducted as part of this rule analysis project. Much of the additional work that needs to be conducted is related to statutes, rules, or measures put into effect after the Specified Resource Site process rules (OAR 629, Division 680) were enacted. Examples include 1) passage of the ORS 527.714 statute that requires additional analysis prior to adoption for some new Forest Practices Act rules, and 2) passage of Ballot Measures 36 and 49 which require compensation or waiving new rules that result in lost real estate value. This technical report is meant to fulfill only the needed information for a Technical Report under OAR 629-680-0100 (1)(a). The Department envisions the rule analysis project, as a whole, will involve multiple steps and decisions by the Board. The decision on protection measures for marbled murrelets is likely to occur at a later date, after the Board has heard all of the pertinent information on this topic and considered input from stakeholders. Thus, specific protection measures for marbled murrelets are not recommended in this report. Instead, a general discussion of a range of possible protection measures is included.

Requirements for Rule Development

When a species is added to either the federal or state Endangered Species Act lists (T&E), protection rules under the FPA may be warranted. However, every listed species does not necessarily warrant development of FPA rules. Instead, the focus is on species that occur in forestland and that may be negatively impacted by forest practices. The process to evaluate T&E listed species for possible rule-making under the FPA is laid out in statute (ORS 527.710) and in administrative rule (OAR 629-680-0100).

For a species to qualify for rules under the FPA, the following criteria must be met:

1) The species must be on state or federal Endangered Species Act lists.
2) One or more forest practices must conflict with the sites used by the species.

Forest Practice in this context can be any kind of operation regulated under the FPA such as timber harvest, road construction, application of chemicals, etc. (see OAR 629-605-0050 (26)). Conflict would occur if the resource site is abandoned, or if productivity (e.g., nesting success) at the site is reduced (OAR 629-600-0050 (14)). In most cases, conflict for a resource site occurs from habitat modification or disturbance during key periods of use.

The Board's evaluation for possible rule-making is to be based on best available information summarized in a technical review paper. The technical review paper is to include the following information (from OAR 629-680-0100(1)(a)):

1) Identify the resource sites used by the species
2) Identify the forest practices that conflict with the resource sites
3) Evaluate the biological consequences of the forest practice conflicts
4) Propose protection requirements and exceptions for the resource sites

This report provides information on the general ecology and habitat use of marbled murrelets, but also addresses the specific criteria that must be included in a Technical Report. The report builds off of the original Petition for Rulemaking (Cascadia Wildlands et al. 2016) and also draws from the ODFW Draft Status Review report (ODFW 2018), the 20-year update on the NW Forest Plan (Falxa et al. 2016), the ODF-sponsored systematic evidence review for marbled murrelets (Plissner et al. 2015), and other available literature as appropriate. This report is not meant to be a complete literature review on marbled murrelets, but a targeted summary of available information pertinent to the rule-analysis project and the specific requirements of a Technical Report under OAR 629-680-0100 rules.

Marbled Murrelet Biology & Habitat Characteristics

General Life History & Characteristics

The marbled murrelet is a small seabird that spends most of its life on the ocean, but in Oregon, nests almost exclusively in trees in coastal forests. They do not build a nest, but instead lay their single egg directly on mossy limbs or other suitable flat platforms in the forest canopy. For this reason, they tend to nest predominantly in very old conifer forests where large-diameter trees with broad, horizontal branches suitable for nesting are most abundant (Raphael et al. 2011). Throughout most of Oregon, nesting habitat is characterized as very old (large-diameter) conifer forests (typically Douglas-fir) or younger forests with a component of residual old conifer trees. In the north coast of Oregon, they are also known to nest in mid-aged (60+ year old) conifer stands, primarily in hemlock stands with a component of mistletoe defect (citation needed). The mistletoe infections cause branch deformity

and creates flattened areas with debris that can function as suitable nesting platforms. See the Nesting Habitat section of this report for additional information.

During most of the year, murrelets have white and black plumage that is typical for many seabirds. During the nesting season, they molt into a light brown, mottled plumage. It is thought that this plumage is an adaptation to camouflage in their forested nesting environment.

Marbled murrelets spend most of their time at sea, where they are typically found foraging nearshore (within 3.1 miles of shore) or in bays and inlets (Nelson 1997, ODFW 2018). During the breeding season, murrelets feed on primarily on small fish, including sandlance (*Ammodytes sp),* northern anchovy (*Engraulus mordax*), smelt (*Osmeridae sp*), and Pacific herring (*Clupea pallassi*) (ODFW 2018). Whereas adult murrelets tend to consume larval or juvenile fish, they tend to deliver larger sized adult fish to chicks. This is likely a mechanism to maximize the nutritional value delivered to chicks while also minimizing energetic costs due to long flights inland as murrelets feed whole prey to their young. Murrelets are considered an opportunistic forager in that they consume a variety of prey species and will switch prey species depending on availability (ODFW 2018). However, there is growing evidence that poor ocean conditions may be having a negative impact on the quality of diet for murrelets, which in turn may be linked to poor reproductive output (ODFW 2018). One study on this topic in British Columbia used isotopic analysis of museum specimens to examine changes in likely diet quality of murrelets over a 107- year period ranging from the 1889 – 1996 (Norris et al. 2007). They found evidence of a reduction in nutrient-rich forage fish and in increase in zooplankton (a lower trophic food item that is less nutrient rich) in the diet of murrelets over this time period. Furthermore, they found evidence that populations of murrelets in this region may have been limited by diet quality over the time period studied.

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When nesting, the female lays a single egg. Adults share incubation duties, switching roughly every 24 hours. The eggs hatch in 28-30 days. Adults typically brood the chick for only one to two days, although some will brood for up to five days but only at night. Both adults then begin to spend much of their time at sea foraging, leaving the chick unattended in the nest. Adults bring one whole fish inland to feed the chick, one to eight times per day. Young birds fledge 27-40 days after hatching. Young fledge on their own and fly to the ocean.

Marbled murrelets have a relatively long and asynchronous nesting season (meaning that individuals do not all nest at the same time). The murrelet nesting season in Oregon is thought to begin in mid-April and extend through mid- to late September (Hamer and Nelson 1995, Hamer et al. 2003, McShane et al. 2004). In Oregon, the incubation phase ranged from mid-April through August 15 and the nestling phase ranged from approximately May 15 to September 15. Approximate time period for fledging of young ranged from mid-June to mid-September (Hamer et al. 2003).

Although murrelets only use inland habitats for nesting, adult murrelets have been documented flying inland during most months of the year except for when they are molting

(spring and fall). The reason for the non-breeding season flights inland are not well understood, but it is thought that birds are possibly establishing pair bonds or prospecting for nesting sites. Most inland activity occurs during the breeding season. The peak period of inland flights is typically in July. Although inland flights can occur at any time of day, most of the inland activity occurs around dawn and dusk.

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Because marbled murrelets are rare, cryptic, and secretive, locating their nests is extremely difficult. The first marbled murrelet nests were not found until the 1970's and as of 2017, only 75 nests have been confirmed in Oregon (ODFW 2018). In Oregon, murrelets have been detected as far inland as 80 miles, but the furthest inland nest known was at 32 miles and the furthest inland observation of an occupied behavior was at 47 miles (Nelson 2003, ODFW 2018, Raphael et al. 2018). Most of the early known nests in Oregon were located by accident or by chance when eggshells or chicks were located on the ground, when nest trees were felled during logging, or when birds were observed landing in trees. More recently, nests have been located by climbing potential nest trees during research projects or as an alternative survey method (Pacific Seabird Group 2013). In other regions, many nests have been located by capturing and placing tracking devices (telemetry receivers) on birds, and then locating them inland when they are at their nest sites (e.g., Zharikov et al. 2007, Burger et al. 2009, Silvergieter and Lank 2011, Lorenz et al. 2017, Wilk et al. 2016). These methods are currently being used for a study in Oregon, but during the first year of the study, no murrelets came inland to nest (Rivers pers. comm. 2017).

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Marbled murrelets are thought to exhibit some level of site-fidelity. Fidelity is the propensity of individuals to use the same area for nesting repeatedly. However, the topic of site fidelity is not well studied using rigorous studies (Plissner et al. 2015). Plissner et al. (2015) provides a comprehensive review of studies that included information on site fidelity and their results are summarized here. They found evidence that murrelets may return to the same watershed, stand, and even the same tree to nest in subsequent nesting seasons (Plissner et al. 2015). This is largely based on studies that have used tree-climbing to find and characterize nests of murrelets, however evidence for fidelity exists across multiple studies across the range of the species. Because of the difficulty in reading bands on marked birds and the lack of telemetry receivers that allow for tracking of individuals over multiple seasons, information on fidelity of specific individuals is lacking. One study in California documented a single marked bird returning to the same nest annually for over a decade (Golightly and Schneider 2011). One marked individual in British Columbia was tracked using telemetry in two years (1999 and 2001) and was found nesting in the same stand; the two nests were approximately 650 feet apart (Burger et al. 2009).

There is evidence that if a nesting attempt fails, particularly if failure occurs during the incubation phase, some proportion of pairs will attempt to renest. In their review of the literature for this topic, Plissner et al. (2015) found only five studies that explicitly discussed renesting attempts. In those studies, it appeared the percentage of pairs that attempted to renest after a failure ranged from roughly 16% to 34%. When nesting attempts fail, there is evidence birds may return to the same stand when renesting (Plissner et al. 2015). Reuse of a

nest tree or stand may be higher in areas where habitat is limited. One study looked at relative

rates of re-use across three regions in British Columbia found greater evidence of multiple nests or reuse of nest sites in all three regions. The authors noted that the two study areas with a greater history of logging had greater evidence of multiple nests and reuse than the study area with little to no logging history and surmised that nest reuse may be more likely in areas where nesting habitat is limited (Burger et al. 2009).

Unlike many other species of seabirds, murrelets do not nest in colonies (multiple nests in very close proximity), but instead are somewhat solitary. However, there are documented occurrences of multiple nests (active or older nests) within the same general area (e.g., within 300 feet of each other) or within the same stand or watershed. One study in Oregon found two active nests located within 98 feet of each other (Nelson and Wilson 2002). Most of the available information of this topic is based on finding nests of various ages (active or older nests). In their review of the literature on this topic, Plissner et al. (2015) found five reported examples of nests being located within 330 feet of each other. They also reported four examples of nests located between 660 feet and 0.6 miles of each other, and five examples of nests located at a greater distance of up to 7.5 miles from each other which may indicate a broad distribution of nests (rather than evidence of a clumped distribution). Plissner et al. (2015) found only one robust study on this topic (Zharikov et al. 2007). Using nests from a large number of radio-tagged murrelets in BC, Zharikov et al. (2007) found the mean nearest nest distance (n = 157 nests) was over 2.5 miles in their two study areas. All of the inter-nest distances reported are considered rough estimates, however, as it is unlikely all of the nests were located in any of the studies.

Population Status and Trends

Overall population trends

In Oregon, as well as California and Washington, murrelet population numbers and trends are evaluated and monitored by counting birds at sea. As a component of the Northwest Forest Management Plan Effectiveness Monitoring Program, a large-scale effort has been conducted to estimate populations annually across Washington, Oregon, and California since the 1990's (see Falxa and Raphael 2016 and Pearson et al. 2018). Surveys are conducted within conservation zones, as established by the Marbled Murrelet Recovery Plan (USFWS 1997). Surveys in Oregon include conservation zone 3 and a portion of conservation zone 4 (Figure 1). The overall population estimate for murrelets in Washington, Oregon and California as of 2016 is 22,600 birds (95% confidence interval [CI] of 18,200 to 27,100). The overall population trend from 2001 – 2016 is a decline of 0.15% per year (95% CI from -1.2 to +1.6), however this trend is inconclusive as the confidence interval overlaps zero and the trend is not statistically significant (P=0.824). Population trends vary by state and conservation zone. There is statistically significant evidence of population declines in Washington (-3.9%/year [CI of -6.1 to -1.7]; P=0.002), evidence of an increasing trends in Oregon (1.8% /yr, CI0.1 to 3.6, p = 0.042), and California (+4.59%/year [CI +2.2 to +6.9]; P=0.001).

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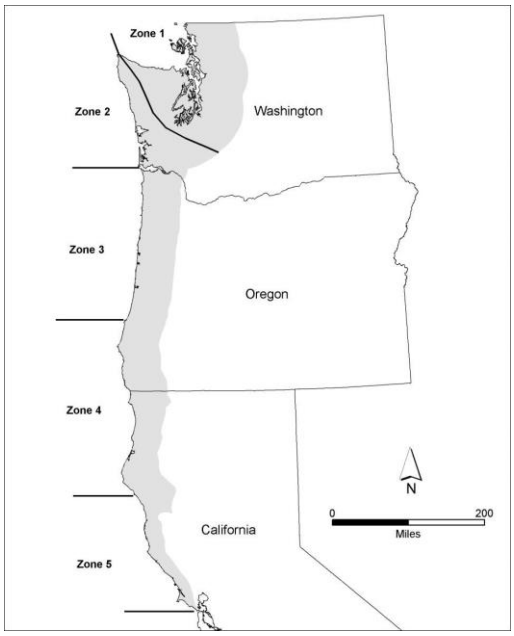

Figure 1: The five at-sea marbled murrelet conservation zones adjacent to the Northwest Forest Plan area (from Lynch et al. 2017).

Oregon-specific population trends

Oregon surveys were conducted in between 2000 and 2016, however, only conservation zone 3 was surveyed in 2016 (see Figure 1). Because of the difference in the time span for results between these two zones, results are reported separately. Results for the state-wide population trends for Oregon through 2015 indicate an increase of +1.7% per year (CI from -0.3 to +3.7) between 2000 and 2015. The data indicates an upward trend in Oregon, however because the confidence interval overlaps zero and this trend was not statistically significant (P=0.088) there is uncertainty about the actual population trend (Figure 2; Lynch 2017).

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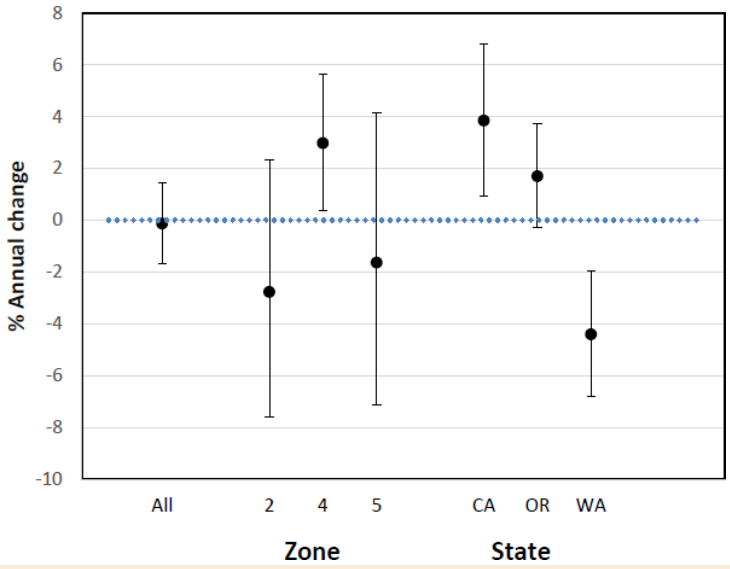

Figure 2: Trend results for units with populations through 2015 only: average rate of change with 95 percent confidence (rom Lynch et al. 2017). Zones 1 and 3 are not displayed because data was available for these zones through 2016; see text for results for zone 3 in Oregon.

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Because conservation zone 3 data extends through 2016, Lynch et al. (2017) reported results for this conservation zone separately from the state-wide results shown in Figure 2. Data for conservation zone 3 indicates that the population trend within only this zone was likely also stable through 2016. The rate of change for this zone through 2016 was +1.1%/ year (95% CI =-0.9 to 3.3%); however because the confidence interval overlaps zero and the trend was not statistically significant (P=0.266), there is uncertainty about the actual population trend (Lynch et al. 2017).

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Listing status

Marbled murrelets are currently listed as a threatened species under the federal Endangered Species Act. They are listed as Endangered under the Washington and California state Endangered Species Acts. The Oregon Fish and Wildlife Commission recently decided to change the status of the marbled murrelet to endangered under the Oregon Endangered Species Act. Rulemaking regarding this change, including development of survival guidelines for the species, is ongoing and is expected to be completed by June 2018.

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Marbled murrelet habitat quantity and trends in Oregon

The recent Marbled Murrelet Status Review for Oregon (ODFW 2018) provides a summary of trends in habitat for marbled murrelets from the time of listing to now. Most the discussion in

the Status Review is from a habitat modelling effort conducted as part of the federal Northwest Forest Plan Effectiveness Monitoring (Raphael et al. 2016a). As with all models, the outputs represent predicted habitat, not actual habitat. The model used in Raphael et al. (2016a) separated potential habitat into four broad categories. Each category reflects a "bin" of habitat with varying scores on their habitat suitability index. The four bins are assigned Classes and names, using the terminology of Class 1--lowest suitability; Class 2--marginal suitability, Class 3--moderate suitability, and Class 4--highest suitability. Raphael et al. (2016a) considers Class 3 and 4 to represent "higher suitability habitat" and uses these two categories for their estimates of predicted habitat where the likelihood of detecting murrelets (presence) or the likelihood of nests or occupied detections is greatest. While there are criticisms with the habitat model used in Raphael et al. (2016a) (see public comments for ODFW 2018), these models represent best available information at this time.

Total amount of suitable marbled murrelet habitat is widely believed to have declined significantly in the last 100 years due primarily to logging and wildfire (see ODFW 2018 for review). Since the time of listing, Raphael et al. (2016a) estimated that amounts of modeled higher suitability habitat (Class 3 and 4)in Oregon declined by 9.2% (78,600 acres) between 1993 and 2012. Although total modeled higher suitability habitat was predicted to be much more abundant on federal ownership classes, relative reductions were greatest on the non-federal ownership class (59,000 acres) as compared to the federal ownership class (19,000 acres). Most of the estimated loss on non-federal ownership class was due to logging whereas most of the estimated loss on the federal ownership class was due to fire.

Because Raphael et al. (2016a) reported amounts of modeled higher suitable habitat only to the ownership classes of federal and non-federal, the amount predicted to occur on private lands was not reported. However, in their species status review, ODFW (2018) used the data available from Raphael et al. (2016a) to further estimate habitat conditions as of the 2012 modeled habitat year by land ownership class in Oregon. Their analysis predicted that as of 2012 (the modeled habitat year), amounts of modeled higher suitable habitat by land ownership or management class is as follows:

- U.S. Forest Service (55%)
- Bureau of Land Management (16%)
- Oregon Department of Forestry (15%)[1]
- Private (12%)
- Other (2%)

Additional work is needed to further examine the distribution of suitable habitat in Oregon. For example, the relative distribution of suitable habitat on private industrial versus private non-industrial lands is not known. In addition, a more detailed analysis of forest conditions and anticipated recruitment of suitable habitat on all forest ownership classes in Oregon is

[1] ODFW estimates do not reflect the recent change of management of the Elliott State Forest to from ODF to Department of State Lands.

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anticipated to be important to the Board's decision-making process. The Department plans to conduct this work during a later phase of this project.

Marbled Murrelet Nesting Habitat Characteristics

Nesting platform/ actual nest site location

ODFW (2018) summarized nests and nest trees for all known nests in Oregon (see Table 1). Plissner et al. (2015) provided a summary of habitat associated with nesting of marbled murrelets, across their range.

Table 1: Selected marbled murrelet nest tree (table 1a) and nest (table 1b) characteristics for Oregon. Data were provided by S.K. Nelson for all 75 nests found in Oregon since 1990. Mean values are shown for variables measured, along with standard deviation (SD), range, and sample size (n, number of nests). Adapted from Table 1 in ODFW (2018); only change is conversion of values from metric to English.

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Table 1a. Nest tree characteristics

	Tree DBH (in)	Tree Height (ft)	No. Platforms in Nest Tree	Distance from Ocean (mi)	Distance to Edge (ft)	Elevation (ft)
Mean	55	184	26	14	167	1083
SD	19	46	19	6	148	492
Range	19 – 110	108 – 279	8 – 92	0.6 - 30	0 - 607	174 - 2024
n	70	70	46	75	75	75

Table 1b. Nest Characteristics

	Nest Limb Height Above Ground (ft)	Nest Limb Diameter at Trunk (in)	Limb Diameter at Nest (in)	Distance from Trunk (ft)	Nest Platform Width (in)	Moss Depth Adjacent to Nest (in)	Duff and Litter Depth in Nest Cup (in)	Percent Horizontal Cover (side)	Percent Vertical Cover (overhead)
Mean	118	9	9	3.6	10	1.7	0.9	53	83
SD	46	4	4	3.8	4	0.9	0.7	19	21
Range	33 – 246	3 – 22	3 – 19	0 - 25	3 - 20	0 – 4.3	0 – 3.3	13 – 85	25 - 100
n	66	67	35	67	65	65	54	53	56

Nests are typically located on a suitable platform, usually on a large, mossy, horizontal tree branch. Nests are normally in the mid to upper portion of the tree, typically 100 feet above the ground (range 33 – 246') and with vegetative cover adjacent or above the nest (Table 1, ODFW 2018, Plissner et al. 2015).

Recorded diameter of limbs (at tree bole) used for nesting ranged from a minimum of four to a maximum of 29 inches (as reported across the entire range of the species); average limb diameter was more than six inches with most studies reporting an average width of more than ten inches (Plissner et al. 2015). Recorded diameter of actual platforms where birds laid their eggs ranged from five to 28 inches (Plissner et al. 2015).

Nest tree and nest patch

A variety of tree species are used for nesting, including Douglas-fir, western hemlock, Sitka spruce, coast redwood, and western red cedar (Nelson 1997). Only conifers are known to be used for nesting in Oregon, Washington, and California, but nests have been documented in red alder in British Columbia (ODFW 2018). One ground nest (on a cliff face) has been documented in Washington (Wilk et al. 2016). Most known nests are in large-diameter trees in old-growth forests (> 200 years old; Nelson 1997, McShane et al. 2004). However, murrelets have also been found to nest in residual mature to old-growth-aged trees that occur within younger forests and in mature hemlock trees (66-150 yrs. old) that have heavy infections of mistletoe (citation needed here). The youngest recorded tree used for nesting was a 66 year old hemlock infected with mistletoe in the north coast range (Nelson and Wilson 2002). Mistletoe infections can create brooms that serve as platforms or cause branch deformity, resulting in fattened limbs. Nests have been found on platforms and limbs of these mistletoe-infected hemlock trees (Nelson and Wilson 2002).

Murrelet nests tend to have canopy gaps or other open areas near the nest location (ODFW 2018). This feature is important to allow murrelets access to the nest platform. Because murrelets are adapted for foraging in water, their wings are relatively long and narrow in relation to their body size (termed high wing loading). Thus, murrelets are not well adapted for flying or maneuvering in forest environments. They have to fly at high rates of speed (often > 44 miles per hour) in order to remain airborne and tend to approach their nest from below and "stall out" as they land. Thus, having an unobstructed area for approaches and take-offs from the nest is important.

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Nesting stand

Because of their reliance on platforms for nesting which occur mostly on large limbs in large trees, suitable nesting habitat occurs primarily in old-growth or mature forests (McShane et al. 2004). Throughout most of Oregon, nesting habitat is characterized by mature to old-growth Douglas-fir stands or younger stands with a component of residual mature or old-growth trees. In the north coast of Oregon, murrelets are known to nest in younger-aged hemlock stands with heavy infestations of mistletoe.

The presence of potential nesting platforms is considered the most important characteristic of marbled murrelet nesting habitat (Nelson 1997). Murrelets select trees for nesting with more potential nesting platforms than what occurs on nearby trees. In addition, there is often a greater density of trees with platforms near nests than elsewhere in the stand (Plissner et al. 2015, Wilk et al. 2016). Density of trees with suitable nesting platforms in stands used for nesting by murrelets ranged from nine to 50 trees per acre; the minimum number reported was two platform trees per acre (Plissner et al. 2015). One study reported that the probability of a murrelet using a stand for nesting increased with increasing density of platform trees up to 40 trees per acre, after which there was no additional change (Silvergieter and Lank 2011). Murrelets tend to select nesting locations with vegetative cover over the nest to provide protection from overhead nest predators, but also near gaps in the canopy to allow for access to and from their nesting platform (Nelson 1997).

Landscape pattern; relationship to nest selection and success

Information on the relationship between landscape pattern and fragmentation and nest site selection and nesting success is limited in Oregon. Most studies on this topic are from British Columbia where the forest type and landscape conditions are arguably different than in Oregon. Available information on this topic is summarized below.

Habitat use and nest site selection

Two studies in southern Oregon looked at the relationship between occupied detections and landscape patterns of old-growth forests. They found that the number of occupied murrelet detections were greater in unfragmented old-growth patches (Meyer et al. 2002) and that occupied areas tended to have less fragmented and isolated old-growth patches than did unoccupied areas (Meyer and Miller 2002). Occupied inland habitat also tended to be close to the coast and river mouths (Meyer and Miller 2002). Similar research has not yet been conducted in other regions of Oregon, or in a broader range of age-classes of forests.

Commented [MGR10]: Note that Raphael et al. 2016 describe landscape patters (amounts of core and edge habitat); also Raphael et al. 2018 review literature on edge effects and fragmentation effects.

Studies examining landscape patterns (e.g., distance from ocean, patch size, core area, and other metrics of fragmentation) using actual murrelet nests are limited in Oregon. Most research on this topic is from British Columbia, where the forest conditions and landscape patterns are arguably different from in Oregon. Of the studies available, there is conflicting information with regards to whether marbled murrelets tend to nest in large interior blocks of habitat, far from forest edges[2] or if they are more general in their nest placement preference. Although murrelets are generally thought of as being negatively impacted by edge effects, a majority of nests have been found near edges, especially natural edges (see review in McShane et al. 2004). In contrast, one recent study in Washington found most nests occur in the interior of forests or in patches with a more interior habitat than at random locations (Wilk et al. 2016). Murrelets may tend to nest closer to edges or gaps as these openings provide ample flying room for adults coming into the nest site or for juveniles when they fledge (McShane et al. 2004). The relationship between murrelet nests and forest edges may vary with the extent of

[2] The term edge refers to the break between a forested area and a non-forested area. The nonforested area may be natural (e.g., river, meadow, natural gap in the canopy) or human-made (e.g., road, clearcut

harvest, development).

habitat available in an area, with murrelets nesting near edges or in isolated fragments more frequently where habitat, particularly interior forest habitat, is limiting (McShane et al. 2004, Plissner et al. 2015).

Nest Success, nest predation & landscape conditions

Marbled murrelets are believed to have low reproductive success, meaning that a large majority of nesting attempts fail to result in successfully fledged young. The primary theory for low rates of success is that nests have high rates of nest depredation, primarily by corvids (jays, ravens, and crows) (ODFW 2018, Plissner et al. 2015). Existing research, primarily using artificial nests, indicates corvid abundance, and predation pressure on nests, is increased in stands near areas that provide additional food resources for corvids such as near human habitation or recreation areas and near regenerating stands with high cover of berry-producing shrubs (Plissner et al. 2015).

The relationship between marbled murrelet nesting success and landscape characteristics is complicated and available information does not allow us to determine any consistent trend. Plissner et al. (2015) provides the most current review of available research on this topic (see Table 13 for additional information). Key information includes the following:

- There were no statistically significant results to indicate that rates of nest success was associated with stand size (Marzluff et al. 1999, Raphael et al. 2002, Zharikov et al. 2006, Zharikov et al. 2007, Nelson and Hamer 1995), platform density (Manley 2003, Silvergieter 2009), tree density (Manley 2003, Golightly et al. 2009, Silvergieter 2009), or canopy height (Silvergieter 2009, Golightly et al. 2009).
- Relationships have been reported between nest success and patch shape (positive association with compact versus linear shapes) (Marzluff et al. 1999), percent canopy cover (negative association) (Malt and Lank 2007 and Waterhouse et al. 2008) and canopy complexity (positive) (Waterhouse et al. 2008). Other studies found no relationship for one or more of these variables (Marzluff et al. 1999, Waterhouse et al. 2008).
- Conflicting results were reported on the relationship between stand age and nest success. Most studies did not report a statistically significant result (Manley 2003, Silvergieter 2009, Waterhouse et al. 2008). Malt and Lank (2007) found increased predation of artificial nests in landscapes with greater percentage of old-growth. In contrast, Zharikov et al. (2007) found that nest success (measured through tracking bird activity with telemetry) was negatively associated with the amount of young forests in the landscape.
- Conflicting results were found for the relationship between nest success and edges. Overall, five of nine studies reviewed by Plissner et al. (2015) reported positive associations between nest success and distance to edge, meaning nest success was higher further from edges.

Commented [MGR11]: See Raphael et al 2018 for a review of this literature

- One study found that murrelets nesting closer to a "hard" edge[3] had lower nest success than murrelets nesting further from edges (Malt and Lank 2007). Another study, however, found murrelets nesting near hard edges had greater nest success (Zharikov et al. 2006) than murrelets further in the interior. At the landscape scale, however, Zharikov et al. (2007) found that nests in landscapes with greater contrast between the nest stand and neighboring units had lower nest success than in landscapes with less contrast (soft edges). See Burger and Page (2007) for critique of this study.
- The type of edge may have implications to nest success, with murrelets having lower nest success if nesting near a hard edge as compared to a soft or natural edge. Zharikov et al. (2007) reported that nests were more successful in landscapes with lower edge contrast (e.g., soft edges). Similarly, Malt and Lank (2007) reported reduced nest success at hard edges and no edge effects at soft and natural edges.

In general, it is documented that marbled murrelets locate their nests near canopy gaps, including forest edges, presumably to aid in the ability of the adult birds to access the nest as they fly in from the ocean. However, information on effects of landscape condition and fragmentation appears to indicate that those murrelets nesting near edges, especially hard edges, may suffer lower nest success than murrelets nesting further in the interior of a stand. Thus, there is a paradox that edges may improve access for murrelets, but sometimes at the cost of reduced nest success.

Landscape condition and off-shore distribution of marbled murrelets

Range-wide, breeding season murrelet abundance off shore has been reported to be associated with the amount and condition (fragmentation level) of older forest condition inland, with higher densities of murrelets occurring offshore from areas with more and less fragmented older forests (Raphael et al. 2015, Raphael et al. 2016b). This is thought to indicate that murrelet populations and distribution patterns offshore are influenced by the amount of potential nesting habitat inland with birds tending to forage in close proximity to their nesting stands (Raphael et al. 2015). However, a recent study in Washington and British Columbia (Lorenz et al. 2017) found that some individuals not only travelled long distances inland, but also travelled long distances across marine environments to reach their foraging areas (mean distance travelled for 20 birds = 17.4 miles—range of 0.3 to 82 miles). This latter study suggests that some individuals may travel long distances across marine environments to reach suitable foraging areas rather than to forage immediately offshore from their nesting stand. In addition, recent preliminary information from a study in Oregon indicate that individuals that are not nesting may move long distances during the nesting season (Rivers personal communication). Thus, density patterns of birds offshore may not be entirely representative of populations of nesting birds. More work is needed on this topic.

[3] The term "hard edge" generally refers to an edge with a large amount of contrast, such as the edge between a meadow or a recent clear-cut and a mature forest stand. The term "soft edge" generally refers to an edge with less contrast. Examples of soft edges include an edge between a mature forest and a mid-aged stand of trees or an edge that has a more variable contrast such as a thinned or feathered boundary between the mature stand and an adjacent open area.

Commented [MGR12]: The need for biological realism in habitat modeling: a reinterpretation of Zharikov et al. (2006)Landscape Ecology November 2007, Volume 22, Issue 9, pp 1273–1281

Commented [MGR13]: See Lorenz, T.J., M.G. Raphael, and T. Bloxton. 2016. Marine Habitat Selection by Marbled Murrelets (*Brachyramphus marmoratus*) During the Breeding Season. PLoS ONE 11(9): e0162670. doi:10.1371/journal.pone.0162670. In this study, proximity of onshore nesting habitat was a major contributor to marine habitat selection.

Existing Marbled Murrelet Survey Methods

The Pacific Seabird Group[4] has developed a survey protocol to determine if murrelets are using a forested area (Evans Mack et al. 2003). The protocol focuses on detecting murrelets and characterizing behaviors observed. A set of behaviors, called occupied behaviors, are key to characterizing use of forested areas. These behaviors include flying below the canopy (subcanopy flight), landing in a tree, stationary vocalization, and jet dives. Circling above the canopy is not considered an occupied behavior, but is considered indicative of potential occupancy and provides the basis for additional survey effort to attempt to observe subcanopy flights. In addition, some research studies include this behavior in their definition of an occupied behavior (Falxa et al. 2016). Research has documented that actively nesting murrelets exhibit these occupied behaviors near their nests (Plissner et al. 2015). Thus, observation of occupied behaviors are thought to indicate the area being surveyed is occupied by marbled murrelets and likely used for nesting. Other types of observations of murrelets such as flying above the canopy and non-stationary vocalizations indicate that murrelets are present, but not necessarily using the area of interest for nesting.

Commented [MGR14]: Technically speaking, this protocol is meant to determine the probability of detecting a murrelet given that a murrelet is present (or occupied). This is different that determining if a murrelet is using an area. Also note that a new protocol is under development, and this protocol may address probability of occupancy per se.

The existing protocol for surveying for murrelets (Evans Mack et al. 2003) is designed to document the occurrence or probable absence of murrelets, and if murrelets are present, to determine if birds are exhibiting occupied behaviors. This protocol was not designed to locate marbled murrelet nest trees. The existing marbled murrelet survey protocol (Evans Mack et al. 2003) is the most frequently used method to survey for murrelets in forested stands.

Surveys conducted using the existing protocol surveys result in three different scales of data[5]:

1) The Survey Station where the occupied behavior was observed,
2) The Survey Site within which one or more Survey Stations had occupied behaviors observed,
3) The larger Survey Area within which one or more Survey Sites had occupied behaviors.

These three scales are based on the design of the survey protocol. The Survey Area typically includes the area of interest (usually a proposed harvest area) and all contiguous suitable habitat within a ¼ mile. The Survey Area is then broken down into Survey Sites, which are smaller areas within which multiple Survey Stations are located. The Survey Station is where the observer looks and listens for murrelets. The survey protocol was designed so that, statistically, if surveys are conducted according to the protocol standards including the required number of visits, one will have a 95% chance of observing occupied behaviors should the Survey

[4] The Pacific Seabird Group is a society of professional seabird researchers and managers dedicated to the study and conservation of seabirds and their environment. https://pacificseabirdgroup.org/

[5] Throughout this document, the terms Survey Area, Survey Site, and Survey Station are capitalized to indicate that these terms relate back to the definitions in the survey protocol (Evans Mack et al. 2003). If not capitalized, the terms area, site, and station are used generically and are not meant to refer to the definitions in the protocol

Site actually be occupied. The analysis that is the basis for the protocol was conducted at the scale of the survey site, thus the statistical probability is appropriately applied to the scale of the Survey Site. The protocol then recommends results be extended to the entire Survey Area, based on an assumption that suitable habitat contiguous with the location where occupied behaviors is observed is important for murrelets for current and future nesting. Applying results to the entire Survey Area may result in additional Survey Sites being designated as "occupied" even when the surveys within that Site indicate that murrelets are likely absent or only "present". In the cases where the Survey Area is large or linear in nature, this can effectively result in habitat that is a long distance (e.g., 1/2 mile or more) from the actual locations of occupied detections being designated as "occupied". Thus, when using information derived from protocol survey, only data at the scale of the Survey Station(s) and the Survey Site(s) would be based on the location(s) where murrelets were observed exhibiting occupied behaviors. Any additional Survey Sites and Stations (with probably absence or presence) within the larger Survey Area would be considered occupied based on extrapolation. However, the recommended approach in the protocol is to conduct the extrapolation and to consider the entire Survey Area occupied of any occupied detections of murrelets are observed.

Information Gaps

Despite the marbled murrelet being one of the more well-studied seabirds in the Pacific Northwest, there are still key gaps in our knowledge about the species. Given the secretive nature and camouflage of marbled murrelets when nesting inland, this is not surprising. Some of the information gaps that have bearing on development of protection measures for this species are discussed below.

Relationship between occupied behaviors and actual nesting

There is consistent evidence that marbled murrelets exhibit occupied behaviors (e.g., subcanopy flights, landings, stationary vocalizations) at locations where active or past-used nests are known to occur (Evans Mack et al. 2003, Plissner et al. 2015). However, there are still key unanswered questions regarding the relationship of these behaviors to active nesting and this topic has not been systematically examined using a rigorous study design. We do not fully understand how often these behaviors occur in suitable habitat that is not actually used for nesting (e.g., by non-nesting birds prospecting for nest sites or by incidental flights below the canopy). To our knowledge, no studies have examined the spatial relationship between observation of the behaviors and the location of active nests using a rigorous study design. For example, one knowledge gap is how far active nests are typically located from the location(s) where occupied behaviors were observed. The temporal relationship between occupied detections and actual nesting has also not been well studied. Although it has been documented that marbled murrelets exhibit occupied behaviors at locations where past nesting has occurred (Plissner et al. 2015) and it is thought they may visit a stand and exhibit occupied behaviors prior to actual nesting (e.g., prospecting), it is not known how often or for how long marbled murrelets may visit a stand and exhibit occupied behaviors prior to actual nesting—or in the case of an abandoned nesting stand, for how long after the last nesting attempt has occurred.

It is also not known how often prospecting occurs, but does not result in use of a stand for nesting.

This information would help inform whether or not occupied detections can be used as a surrogate for a nesting site, when actual nesting or the location of the nest tree is not known. In addition, it would help inform the question of how far from a potential occupied detection a nest might actually occur.

Long term patterns of habitat use

It is well established that murrelet nesting patterns vary, and that poor ocean conditions may result in only a proportion of the population that nests (ODFW 2018). However, short and long term temporal patterns of nesting and use of stands are not well studied. One study in California which looked at relationship between occupied detections and landscape condition found a time lag in response to fragmentation, with birds abandoning fragmented patches a few years after they were isolated (Meyer et al. 2002). To our knowledge, there are no long-term studies that have looked at long-term patterns of habitat use. Specifically, it is not known if stands are used annually or if breaks occur in nesting or occupancy of a stand. Furthermore if breaks in use do occur, how often and how long of a break in use occurs before the area is reused again. Alternately, information is lacking to indicate if an area is unlikely to be used again after birds are absent for a period of time, and if so, how long of a period of no detections of a bird are needed to be relatively certain that the area is actually abandoned (as defined in the FPA). This information would help inform development of criteria to distinguish an abandoned versus an active resource site under the FPA.

Nest site fidelity and spatial distribution

Fidelity is the propensity of individuals to use the same area for nesting repeatedly. For example, bald eagles are considered to have high site fidelity because pairs often return to the same nest year after year. As discussed previously, marbled murrelets are thought to have relatively high site fidelity, but there are key gaps in our knowledge for this topic. In their review of the literature on the topic of site fidelity, (Plissner et al. 2015) found only two studies using marked birds. One study in California documented a single marked bird returning to the same nest multiple times over a decade-long time period (Golightly and Schneider 2011) and the second study in British Columbia documented the same individual returning to the same stand to nest in two non-consecutive years (Burger et al. 2009). Thus evidence of fidelity of specific individuals is poorly known at all scales, but information from at least one marked bird suggests that it can occur.

Additional information is needed on spatial distribution of nests, especially in Oregon. Although rigorous studies using marked birds in British Columbia have provided valuable information, including information on spatial distribution of nests, this type of research has been mostly lacking in Oregon. A new study at Oregon State University may provide additional insight. Key questions are, how many pairs may use a stand in a given year or among years and whether presence of one nest indicates that additional nests are also likely present. There is

also no information on tagged or radio-collared birds between seasons to indicate if marbled murrelets also exhibit plasticity in habitat selection. For example, if a previously used area is no longer suitable nesting habitat (e.g., loss from logging or natural disasters) will murrelets move to a new area or do they cease to nest? Meyer et al. (2002) showed that there was a time lag in response to habitat fragmentation and that murrelets would continue to use an area for some time before abandoning the fragmented parcel (based on patterns of occupied detections—not confirmed nesting). Zharikov et al. (2007) found that nesting murrelets were more abundant in a fragmented area, suggesting that murrelets may have been "packing" into remaining habitat rather than move to a new area to nest. Thus there is some evidence that murrelets may attempt to continue to use their historic nesting areas as habitat is reduced, but this topic has not been specifically addressed. It would likely take a robust study of marked individuals over multiple years to fully address this question. Currently the technology does not exist to efficiently track individuals over multiple seasons.

Commented [MGR15]: Radar studies (Burger 2001, Journal of Wildlife Managemewnt65:696-715) and Raphael et al. 2002, Condor 104:331-342) do not support this idea. In those studies there was no evidence of packing into fragmented habitat.

Also not well understood is whether or not the number of detections is indicative of local abundance or if the observation of a nest (or occupied behavior) is predictive of whether or not other nests occur nearby and how far away they may occur. Information on these topics would help inform development of protection strategies for marbled murrelets as well as development of criteria to distinguish an abandoned versus an active resource site under the FPA.

Technical Report—Required Content for Rule Analysis for a T&E Listed Species--Evaluation of OAR 680 criteria

A key component of a Technical Report for purposes of a rule analysis is evaluation of the criteria listed in the process rules for Specified Resource Sites (OAR 629, division 680). The Division 680 rules were developed by the Department and the Board of Forestry to define the process to be used for reviewing fish or wildlife species for possible rule development under the Forest Practices Act, and in the case of "recovered" species, for possible removal or revision of the species. For species that have been added to state or federal Endangered Species Act lists, the process for review is laid out in OAR 629-680-0100.

The Technical Report for a review under OAR 629-680-0100 must include the following:

1) Identify the resource sites used by the species
2) Identify the forest practices that conflict with the resource sites
3) Evaluate the biological consequences of the forest practice conflicts
4) Propose protection requirements and exceptions for the resource site

The information below includes the Department's review of the information on marbled murrelets in relation to these four components of a technical report.

Identification of the resource site(s) used by the species

The Board of Forestry must determine the resource site to be protected. In the Department's March 2017 assessment of the Petition, it was determined the resource site was not adequately identified (ODF 2017a). This section provides additional information to help inform the Board of options for identification of the resource site for protection.

For all wildlife species currently protected under the FPA, the resource site is defined as the nest tree. For the spotted owl, protection can be centered on an activity center if the nest tree is not known. In the recent past, bald eagle winter roost trees and foraging perch trees were protected under the FPA, but those rules are no longer in effect as of September 1, 2017. Thus, protection for all past and present wildlife sites have focused on individual trees or a fixed point location. To date, resource sites have not yet been defined as patches of habitat (occupied or presumed occupied).

Marbled murrelets only use forested environments for nesting and not for foraging or roosting. Thus it is logical to focus the identification of the resource site on the nest tree. However, because of their cryptic and secretive nature and tendency to nest high in trees, locating nest trees is extremely challenging. Despite efforts, only a small number of nests (75) have been found to date in Oregon (ODFW 2018). Limiting definition of the resource site to only nest trees would likely lead to protection of a small subset of the actual nesting trees on the landscape because there is no protocol or method currently available to effectively and efficiently locate nests of marbled murrelets. Climbing potential nest trees can be used to look for signs of nests after the breeding season is over. However this method is extremely difficult and cost-prohibitive over large areas (Plissner et al. 2015). Tree climbing to find nests is likely only effective in small areas where the approximate area of nesting is known. Even with tree-climbing methods, nests can be missed and this method is not effective for documenting that nesting has not occurred (Pacific Seabird Group 2013). A new research study in Oregon (Rivers personal communication) is exploring the use of drones equipped with infrared cameras to detect nesting murrelets. This technique is being explored within the context of a research study and not as a survey tool. Even if effective, this tool may not be a suitable survey tool due to the potential for drones to pose a disturbance to nesting birds.

As discussed in the Survey Protocol section, surveys using the existing survey protocol for marbled murrelets result in information on occupied detections of marbled murrelets. It is assumed that birds exhibiting occupied behaviors are likely nesting, however as discussed in the Information Gaps section, there are still untested questions about this assumption.

Absent of an effective and efficient method to locate nests of marbled murrelets, occupied behaviors may be the only available information that could be used as a possible proxy for nests. The scales of information from protocol surveys related to "occupancy" are 1) the actual location of the bird(s) exhibiting occupied behaviors, 2) the Survey Station from which the occupied behaviors were observed, and 3) the larger Survey Site or 4) Survey Area within which birds were observed.

ORS 527.710 (3)(a)(A) indicates the Board should develop an inventory for sites of Threatened or Endangered Species without any specifications of the types of sites to be included in the inventory. OAR 629-665-(62)(a)(A) defines a resource site for Threatened and Endangered Species as the "nest tree, roost tree, or foraging perch and key components". For murrelets, this rule definition would seem to limit the definition of a resource site to the actual nest tree (murrelets do not use roost trees or foraging perches). However, current rules for spotted owls allow for identification of an activity center, when the nest tree location is not known, to be used as the center for protection under the FPA rules. It is also within the Board's authority to modify the definition of a resource site through this rule development process.

Because of the difficulty in finding nests, defining the protected resource site for marbled murrelets is not straight forward. In summary, options relating to actual observations of marbled murrelets would be,

1) Known nest trees only, or
2) Known nest trees and locations of occupied detections of marbled murrelets.

The pros and cons of options based on known locations of birds are shown in Table 2.

It can be argued another option for definition of the Resource Site for marbled murrelets might be the larger polygon equivalent to the Survey Site or Survey Area used to design surveys under the existing Survey Protocol. These are not included as possible options in the definition of a resource site because these larger polygons surrounding known locations are more suitable as a protection standard than as the resource site itself. These larger areas are discussed later in the section regarding Protection.

Although resource sites for all species protected under OAR 629-655-000 (Specified Resource Site Rules) have been based on point locations of nests, activity centers, roost trees, and foraging perches, for some species of wildlife, identification of potential, or presumed occupied, habitat may be appropriate. This may be appropriate in cases where a species does not use a single fixed point location as a key component of its life history (e.g. mammals that range over a large area and use multiple forest structures to meet its needs) or species that are especially rare or difficult to detect. These types of species may require something other than a fixed point as a resource site.

Because of their secretive nature and the challenge in locating nests, the marbled murrelet may be a species where focusing protection on only known nest sites may result in many other, undetected nest sites not being protected. Another option would be to define, identify, and map areas of suitable habitat that would be presumed to be occupied by the species. Under this scenario, the habitat would be presumed occupied unless ground-truthing indicated that suitable nesting platforms did not actually occur, or other key components of suitable habitat were lacking. Alternatively, surveys could be conducted to document that murrelets were not occupying the area (e.g., probable absence or presence only from protocol surveys).

Because identification of suitable habitat as a resource site would be an entirely new approach under OAR 629-665-0000, additional work would be needed, should the Board wish to consider this option. Additional work would include, but likely not be limited to, determining characteristics to define suitable habitat, identification of conditions needed for an area to be considered “presumed occupied” habitat, modeling work to map this habitat, defining appropriate survey strategies to determine lack of habitat, determining appropriate survey strategies to confirm lack of nesting of murrelets, determining appropriate protection strategies, and consultation with the Department of Justice on this new approach.

Table 2: Possible definitions of resource sites for marbled murrelets.

Resource Site	Definition	Pro's	Con's
1: Nest Trees	Individual trees confirmed to be used for nesting by marbled murrelets	• Known use for reproduction • Fixed point to center protection around • Similar to existing rules	• Only a small # of nests known • Potential to miss protection of many existing resource sites • Extremely challenging to locate
2: Occupied Detections	Locations where marbled murrelets were observed exhibiting occupied behaviors during protocol surveys (either location of bird or the survey station from which the bird was observed)	• Based on surveys using a standardized protocol • Based on actual observation of marbled murrelets exhibiting behaviors assumed to indicate likely nesting • Fixed point to center protection around • Similar to existing rules	• Not known if nesting actually occurred; may protect some areas not actually used for nesting • Not known where nests located; may center protection away from actual nest location • Bird location data of occupied detections may not be readily available-may have to rely on survey station locations from which the birds were observed (data more likely to be readily available)
3: Presumed occupied habitat	Area of suitable habitat presumed to be occupied by the species	• May identify habitat with murrelet sites not otherwise known to occur	• Not based on actual nests or observation of birds • May identify many areas as occupied by the species that are not actually occupied or not used for nesting • New approach; likely would require significant work to develop and implement

Identify the forest practices that conflict with the resource sites & evaluate the biological consequences of the forest practice conflicts

A technical report for rule development must also include information to identify the forest practices that conflict with the resource site and evaluate the biological consequences of the forest practices conflicts. These two aspects are combined below.

The Petition identified forest practices that conflict with marbled murrelets in a general sense (e.g. habitat loss), but did not identify the specific forest practices that might conflict with resource sites. The Petition provided details on the biological consequences of conflicts, but focused primarily on forest harvest and loss of habitat. This report expands on the information in the Petition and describes the full suite of Forest Practices and potential biological consequences of those forest practices.

Forest Practices are defined in rule (OAR 629-600-0100 (28)) and include forest harvesting, reforestation, road construction and maintenance, application of chemicals, disposal of slash, and removal of woody biomass. Conflict defined in rule: "means a resource site abandonment or reduced productivity" (OAR 629-600-0100 (14)).

Harvesting of forest trees may conflict with marbled murrelet resource sites by causing direct loss (e.g., removal) of nest trees, by increasing risk of windthrow of nest trees, or by increasing exposure of nests to the elements or to predation. In cases where a hard edge is created near actively nesting murrelets, even if murrelets are not directly harmed by nearby harvest operations and continue to nest, there may be risk of negative effects on the young due to thermal stress and dehydration if adults or chicks are exposed to direct sunlight or increased winds (based on professional judgement). This may result in reduced productivity, however this topic has not been researched. Creation of hard edges may also have an indirect impact on marbled murrelets. Changes in microclimate (due to increased sun, exposure to wind, etc.) can have a negative impact on mosses (Van Rooyen et al. 2011). This is pertinent to murrelets because they largely rely on moss for nest substrates. Microclimate effects on moss may extend 150 feet into the forested stand, possibly further in areas with greater wind exposure. Any changes in moss cover would likely occur at longer time scales—not immediately after creation of a new hard edge. Impacts of changes in microclimate on murrelet nest site selection or nesting success have not been studied. There is evidence timber harvest may result in reduced productivity by increasing risk of predation of nests. As discussed previously, predation of nests is thought to be a significant concern and limiting factor for successful marbled murrelet reproduction. Timber harvesting has a potential to pose a conflict indirectly by increasing exposure of nests to predators, especially near hard edges. Timber harvest, especially thinning, has the potential for creating more diverse understory habitat that can attract jay and crows, thus increasing risk of murrelet nest predation.

The topic of disturbance has not been well studied and most available information is anecdotal in nature. However, a literature review of existing information on known and likely impacts of disturbance on nesting murrelets has been compiled by the US Fish and Wildlife Service (USFWS

2006) and is used, in part, as the basis for this section of the report. This review includes information on known impacts of marbled murrelets to disturbance activities, although all

available information on actual murrelets is anecdotal in nature. The review also includes additional analyses from other species as well as information on decibel outputs from various activities (e.g., chainsaws, aircraft, etc.).

Timber harvesting activities can pose a conflict by creating disturbances that may disrupt normal nesting activities. Disturbance may result in reduced productivity by: 1) causing incubating adults to flush and leave the egg unintended, 2) causing adults delivering fish to the nest to flush and not feed the nestling (resulting in longer duration between feedings), 3) by causing chicks to flush off the nest too soon, before they are ready to fledge, 4) by attracting predators to the nesting area (USFWS 2006). All of these could pose a conflict by causing nest failure and thus reduced productivity, or by causing abandonment of the nest.

The US Fish and Wildlife Service developed guidance to evaluate potential for projects to negatively impact nesting activities of murrelets. This guidance is included as a component of various Biological Opinions (e.g., USFWS 2017). The USFWS guidance indicates activities near murrelets may cause a significant disruption of breeding activities such that injury (i.e., harassment) may occur. Activities considered likely to cause a disruption, and hence a conflict, include chainsaw and heavy equipment use, rock crushing, blasting, aircraft use, drone use, tree-climbing, and burning. Distances for disruption effects range from 330 feet for most activities to 1/2 mile for blasting and burning. Because nest sites are not typically known, the disruption distances recommended by the USFWS are typically based on the edge of an occupied habitat patch.

Examples of forest operations and associated activities not likely to pose a conflict would include reforestation, timber cruising and wildlife surveys (that do not involve tree climbing), pre-commercial thinning using non-powered equipment, standard road maintenance (e.g., road grading) and log hauling. In addition, activities that may cause a conflict within close distances during the nesting season would not be expected to pose a conflict if they occur outside of the nesting season or far enough away to not cause a disruption of nesting behavior.

Protection requirements—range of options

As a part of a technical report, under OAR 629-680-0100, protection requirements and exceptions must be proposed. The initial petition (Cascadia Wildlands et al. 2016) included recommended protection requirements including proposed rule language. However, in the Department's review of the petition, it was determined much of the proposed protection was outside the authority of the Board (ODF 2017a).

There are a range of possible protection strategies for marbled murrelets which would vary depending on many factors including how the resource site is defined for this species. The Department believes the Board will need to define the resource site for marbled murrelets prior to addressing specific protection strategies for marbled murrelets. Thus, rather than recommend one specific protection strategy, a range of general protection strategies that the Board might consider are described below.

Prescriptive Approaches to Protection

One method to protection is to have a prescriptive approach where best management practices and recommended standards are described in detail. These approaches are commonly used in development of regulations, but might also be suitable using a voluntary measures approach.

If the resource site is defined as the nest tree, the location of an occupied detection, or some other specific point on the landscape, a strategy where protection is centered around that point (or group of points) might be applied. This would follow a similar method as used for current FPA rules for wildlife (i.e., northern spotted owl, osprey, bald eagle, and great-blue heron). Once the resource site is defined, the Department would need to develop and maintain an inventory of known sites for marbled murrelets. Currently, landowners are not required to conduct surveys for protected species under the FPA. Instead, inventories are developed and maintained using readily available information compiled primarily from other governmental agencies (e.g., ODFW, BLM, USFS). The Department has some data already, but would need to determine availability and request additional information from other entities (e.g., other state and federal agencies, tribal governments, private landowners, etc.) (ODF2017a).

Protection standards for a point-centric approach would include 1) protection of the resource site and its key components (e.g., replacement trees and habitat buffer) around the point or points, and 2) seasonal restrictions for forestry activities within a certain distance of the point location to protect any nesting birds from disturbance during a critical use period.

Key components of a marbled murrelet resource site need to be identified. Key components are the attributes that are essential to maintain the resource site over time (OAR 629-600-0100 (39)). The key components may vary depending on how a resource site is defined. However, they are likely include replacement trees and a buffer of additional habitat to help protect nests from the elements, risk of blowdown, and to help minimize risk of nest predation due to edge-effects. A replacement tree is typically a tree with the suitable features to be used for nesting, either as an alternate nest tree or as a replacement if the original nest tree should fall down.

Possible options for habitat protection might range from a fixed buffer around a known point location to identification of a polygon of habitat. Both would need to include adequate habitat area to protect the site(s) to avoid a conflict (i.e. site abandonment or reduced productivity). The extent of the habitat area to be included in protection might be identified using the survey protocol or a user-identified polygon of suitable habitat of a specific minimum size. The latter approach would be similar to the existing rules for spotted owls, where a core area of suitable habitat is required to be maintained around nest sites or activity centers. A summary of these options, including pros and cons of each approach are included in Table 3.

As previously mentioned, should the Board determine to identify suitable habitat (e.g., presumed occupied habitat) as a resource site under the FPA, significant additional work would need to occur. Included in this additional work would be identification of appropriate protection strategies. Thus, protection strategies for this approach are not described here and not included in Table 3.

Table 3: Possible options for habitat protecting strategies for marbled murrelet resource sites.

Option	Description	Pro's to this approach	Cons to this approach
1: Polygon of habitat associated with protocol surveys	Polygon that identifies an area surveyed within which occupied detections were observed	• Based on surveys using a standardized protocol	• Survey boundaries are somewhat arbitrary and typically based on boundary of a proposed operation (e.g., timber harvest) and associated buffer, thus they are not necessarily biologically based. • May include stations with no detections or only presence detections • Not known if nesting actually occurred; may identify polygons for protection that not actually used for nesting • Not available unless surveys conducted based on protocol standards
2: User-Identified Polygon	A polygon of habitat around known nest site(s) or occupied detection(s) that would be identified by the operator	• Similar to the core area approach used for spotted owls • Approach can be used for data not obtained from protocol surveys • Boundaries can be established based on biological criteria such as extent of suitable habitat, topography, etc.	• Would require additional work to identify the parameters to be used to identify the extent and location of habitat to be protected • Might under or over protect marbled murrelet nesting sites

Prescriptive Approaches—Summary and Additional Work

If the Board determines a prescriptive approach should be used for marbled murrelets, additional work would need to be conducted by the Department and subsequent decisions may be needed by the Board of Forestry. This would include but not necessarily be limited to the following:

- Defining suitable habitat for marbled murrelets
- Identification of key components for marbled murrelet resource sites[6]
- Defining the extent of habitat to be protected, and how it will be identified
- Describing forest activities to be limited or allowed within protected habitat
- Defining the critical use period
- Defining the zone, within which forestry activities would be limited during the critical use period to avoid disturbing nesting birds
- If suitable, or presumed occupied, habitat is used to define a resource site, a significant amount of new work is needed (see text of document)

Programmatic Approaches to Protection

Programs that encourage or incentivize maintenance or development of suitable marbled murrelet habitat on their lands are an option to encourage voluntary actions by landowners. Possible voluntary, programmatic approaches the Department could use include 1) Development of a Programmatic Safe Harbor Agreement (SHA) for marbled murrelets with the USFWS, 2) use of the existing Stewardship Agreement program to encourage voluntary actions to conserve habitat. These voluntary measures are described below.

Programmatic Safe Harbor Agreement

A Safe Harbor Agreement is an option available under the federal Endangered Species Act. This program encourages nonfederal landowners to voluntarily enhance and maintain habitat for a listed species by providing assurances the USFWS will not impose additional restrictions because of their voluntary conservation efforts, as long as the result is a net conservation benefit for the species. This program is available now, however individual landowners would need to enroll individually with the USFWS. Under a programmatic Safe Harbor Agreement, the Department would enter into an agreement with the USFWS and would then work with individual landowners to enroll them into the Programmatic SHA. The programmatic approach to the SHA is an efficient way to implement this program. It also allows landowners to work with the Department rather than directly with the USFWS. This can be beneficial because 1) landowners are already used to working with the Department through implementation of the Forest Practices Act, and 2) some landowners have an inherent fear or mistrust of federal agencies. The Department already has a Programmatic Safe Harbor Agreement with the USFWS for the northern spotted owl (USFWS et al. 2010), thus, there is already a precedent for

[6] Defined in FPA OAR 629-600-0100 (39) as attributes which are essential to maintain the use and productivity of a resource site over time.

using this approach. Currently there are 13 properties and 3,484 acres enrolled in the Programmatic Safe Harbor Agreement for spotted owls.

While SHAs may take many forms, most SHAs involve three elements: 1) a definition of species populations or habitat conditions at the start of the SHA (baseline), 2) commitments from the landowner to conduct, or refrain from, specific actions affecting the species, and 3) a timeframe over which these actions will occur, after which the landowner is permitted to return the lands to the defined baseline condition. Under a programmatic SHA, the Department would hold the permit. If a landowner wished to be included in the terms of the SHA, they would agree to actions described in the programmatic SHA to conserve or develop habitat for marbled murrelets. A baseline for their lands would be established at the time of enrollment, defining the starting conditions at the beginning of the Agreement. The landowner is then issued a certificate of inclusion which authorizes the landowner to return the property to pre-agreement conditions (baseline conditions) at the end of the commitment period. For example, if a landowner creates habitat for marbled murrelets over the term of the agreement, they can remove that habitat at the end of the agreement without being subject to ESA take regulations. Even with a programmatic SHA available, individual landowners could still opt to develop their own SHA with the USFWS.

Stewardship Agreement Program

The Department's Stewardship Agreement Program was developed to 1) provide efficiencies for a landowner for implementation of the Forest Practices Act regulations on their property and 2) to encourage landowners to provide for conservation, restoration, and improvement of fish and wildlife habitat and water quality. This program was also intended to be a mechanism to allow for coordination and implementation of incentive programs. The Stewardship Agreement Program is a required component for implementation of the current Programmatic SHA for spotted owls and would also be required under a SHA for marbled murrelets. However, the Stewardship Agreement Program is also a possible mechanism to encourage voluntary actions for marbled murrelets as a stand-alone program.

The Stewardship Agreement Program allows the Department to provide regulatory certainty to landowners in certain situations (ORS 541.423 (7)). If, in a Stewardship Agreement, a landowner identifies specific voluntary actions that exceed regulatory requirements, the Board may agree to exempt the landowner from future changes to a specific rule under the Forest Practices Act. Because there are no rules in the Forest Practices Act specific to marbled murrelets, the Department cannot currently grant regulatory certainties relating to rules for murrelets. However, if during this process or at a future time the Board does develop rules for marbled murrelets, regulatory certainties may be granted. Stewardship Agreements may also be a tool that can be used to provide regulatory certainties at a state-level for landowners who have a Habitat Conservation Plan with the USFWS that addresses marbled murrelets, assuming that HCP actions exceed what is required by rule under the Forest Practices Act.

Although regulatory certainties cannot be granted at this time for any future rules for marbled murrelets, a landowner may still enroll in this program now to conserve habitat for marbled murrelets. The landowner may still obtain other benefits of this program, such as regulatory efficiencies (exemption from written plan requirements) and regulatory certainty for rules already in place (e.g., stream protection rules). Should the Board develop rules for marbled murrelets after the time an Agreement is already in place, the Agreement can be re-evaluated and amended as needed to obtain certainties for murrelets under the FPA.

Next Steps

A general summary of next steps was presented to the Board of Forestry in April of 2017 (ODF 2017b). However, subsequent work may depend on decisions made by the Board of Forestry during this rule analysis process.

As described to the Board in April 2017, this Technical Report will undergo a review by subject experts. The purpose of the review is to evaluate the literature used and content of the report, to ensure that the "best available information" is presented to the Board for their decision-making process.

Following the Expert Review, the Department will summarize the input received and create an amendment to the Technical Report, if needed. This information will then be presented to the Board at a subsequent meeting. Also, as described in the March 2017 Progress Report to the Board of Forestry, additional work is needed to help inform the decision-making process. This includes consultation with other agencies, additional analysis as required per ORS 527.714, and consideration of impacts from ballot measure 49 and associated statutes (ORS 195.305). ORS 527.714 requires additional review and that certain standards are met before new Forest Practices Act rules can be enacted. ORS 195.305 resulted from ballot measure 49 and allows claims to be made for compensation if new regulations affect the fair market value of a property; alternatively the claimant may request an exemption from the new rule. Thus, additional work will be needed to 1) conduct the required analysis under ORS 527.714 and 2) to understand the implications of ORS 195.305 on any new regulations for marbled murrelets.

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2) Jason Robison
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From: Jason Robison - GO \ Director of Natural Resources [mailto:JRobison@cowcreek.com]
Sent: Tuesday, August 14, 2018 4:26 PM
To: WEIKEL Jennifer * ODF <Jennifer.Weikel@oregon.gov>
Subject: Tribal Comments - Draft Technical Report

Jennifer,

Thank you for the opportunity to review and comment on the Marbled Murrelet Technical Report. I have attached a copy of the report with my comments/suggests in the margin. Please let me know if you have any questions. Thank you once again for allowing a little more time to review and comment on the document.

As stated in my comments back in February, state laws have limited if any application on Tribal lands. It should be noted somewhere in the document that Indian lands must be considered differently under any proposed administrative process. Tribal lands should be omitted from any protection strategies for MAMU. Tribal lands have been found under other listed species analysis to be non-essential to conserve a listed species as the Conservation needs of the listed species can be achieved by limiting protections to other lands. Tribal lands are not essential to conserve MAMU and placing any protection on Tribal lands would result in a disproportionate burden to Tribes and their resources. When it comes to species protection the federal government shall be considered first, followed by states.

Please call me if you have any questions.

Best Regards!

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Marbled Murrelet Technical Report
Draft

April 25, 2018

Photo Credit: Gus van Vliet, USGS

Report developed by Jennifer Weikel, Wildlife Biologist
Private Forest Program, Oregon Department of Forestry

Table of Contents

Executive Summary

In 2016, the Board of Forestry (Board) received a Petition to Initiate Rulemaking for the marbled murrelet under Forest Practices Act (FPA) specified resource site rules. The Board directed the Department to begin work on this rule analysis and received an update and an initial timeline for work to be completed at their meeting in April 2017. The Board's evaluation for possible rule-making is to be based on best available information summarized in a technical review paper. The technical review paper must include information on identification of the resource site(s) used by the species, identification of forest practices that conflict with the resource sites, evaluation of the biological consequences of those conflicts, and include information on protection requirements and exceptions(from OAR 629-680-0100(1)(a)). This technical report was developed to evaluate this required information as well as to provide information on the ecology and habitat use of marbled murrelets. While this report is intended to inform the rule analysis project and the Board's decision making process, additional work and analysis will be needed prior to decisions on possible rule-making.

The marbled murrelet is one of the only seabirds and the only species in the alcid family that nests in forested environments. They spend most of their life at sea, but rely on very old conifer trees for nesting. While most nesting is limited to old growth conifer forests, they are also known to nest in residual old trees within younger stands and in younger hemlock-dominated stands heavily infested with mistletoe in NW Oregon. Nests are typically located on a suitable platform, usually on a large, mossy, horizontal tree branch. Nests are normally in the mid to upper portion of the tree, typically about 100 feet above the ground and with vegetative cover adjacent or above the nest. The presence of suitable platform limbs is considered one of the most important habitat features for this species.

Commented [JR-G\DoNR1]: Strike rely on as the next sentence documents other types of nesting habitat used. Older forests appear to be important due to platforms and canopy structure. Ground nests and nests in hardwoods have also been identified.

Marbled murrelets have narrow habitat requirements and are secretive in nature when inland. They primarily visit their nest sites at dawn and dusk when they are less likely to be detected by potential predators. They are difficult to detect, and tend to nest high up in the canopy. Thus, nests are extremely difficult to find. Because of this, there are still gaps in our knowledge of habitat use by this species, especially for nesting birds in Oregon.

The relationship between marbled murrelet nest site selection, nest success and landscape characteristics is complicated and available information does not allow us to determine a consistent trend. There is little information available in Oregon. Research from across the entire range of the species has found various patterns for how landscape pattern (i.e., amount and fragmentation of suitable habitat) impacts murrelets. There is some evidence that murrelets may tend to locate nests near forest edges (natural and human-created), but that in some situations they experience lower rates of nest success near edges, especially human-created "hard" edges.

Commented [JR-G\DoNR2]: Some situations they experience lower rates; however, what about others where rates of production are not significantly impacted? Should point this out to be clear.

Oregon population surveys conducted in between 2000 and 2016 indicate that the population trend is likely stable. Results for the state-wide population trends for Oregon through 2015

indicate an increase of +1.7% per year (95% CI from -0.3 to +3.7) between 2000 and 2015. The data indicates an upward trend in Oregon, however because the confidence interval overlaps zero and this trend was not statistically significant (P=0.088) there is uncertainty about the actual trend.

Because additional analysis will need to be considered at a later date, and because identification of the resource site is the first key question that must be decided by the Board before other policy work can occur, this technical report does not include policy recommendations. Rather a range of options is included, where appropriate. Details for protection strategies will be included in a future rule-analysis report.

The technical report includes a range of options for the definition of a resource site for marbled murrelets. Unlike existing birds with rules under the FPA that are highly visible or that have established methods to locate nests, marbled murrelet nests are extremely challenging to locate and there is no efficient and effective method to locate nests. Thus, identification of only the nest tree as the resource site for this species is likely to be insufficient. Another option is to include locations of occupied detections as a proxy for nest sites. The technical report also discusses an option to use designated potential suitable habitat as a resource site. In this context, the habitat would be presumed occupied by the species until additional work is conducted to determine that the area is not actually suitable nesting habitat (e.g. trees with suitable nesting platforms are not present) or not occupied by murrelets (i.e., as determined through surveys).

Because marbled murrelets nest in forested environments, conflicts between forest practices and marbled murrelets are likely to occur. Most conflicts will occur from forest harvesting, with conflicts likely due to loss of nests during logging or due to disturbance to nesting birds or increased risks to nesting birds from increased exposure to the elements or increased risk of depredation of nests by predators.

Because protection strategies for marbled murrelets may vary greatly depending on the Board's decision regarding definition of a resource site, specific strategies are not addressed in this report. Instead, a range of possible protection strategies for this species are discussed. Both prescriptive approaches and programmatic approaches are addressed in the report. Prescriptive approaches would describe best management practices to protect sites and could be codified as regulations or as voluntary measures. Programmatic approaches include use of Safe Harbor Agreements and Stewardship Agreements to encourage voluntary protection and development of suitable habitat for marbled murrelets.

Future policy work is needed to inform this discussion (ODF 2017a). As per OAR 629-680-0100 (1)(b), this technical report must undergo a formal "Expert Review". Feedback from the review will be summarized and included in a subsequent report that will be delivered to the Board.

Commented [JR-G\DoNR3]: Important key here is that the population is at least stable and not declining even under current management. This should be pointed out.

Commented [JR-G\DoNR4]: Not as clear in the literature. Exposure of juveniles? Obviously microclimates may have some impact however this impact has not been quantified based on the MAMU data available.

Background

In June 2016, the Board received a Petition to Initiate Rulemaking for the marbled murrelet under Forest Practices Act (FPA) specified resource site rules. The Board considered the petition during their meeting on July 20. Acting within its authority under the Administrative Procedures Act, the Board denied the petition. In September, the petitioners submitted a Petition to Review an Agency Order through the Lane County Circuit Court to request the court compel rulemaking. In November, the Board held a public meeting and accepted public comment to reconsider their decision to deny the petition for rulemaking. After consultation with the Oregon Department of Justice, the Board voted to withdraw and reverse its previous decision on the rulemaking petition.

In March 2017, the Board received an update on this rule analysis. A report was presented to the Board that included a review of the petition and a summary of work needed to be conducted as part of any rule-analysis process (ODF 2017a). It was determined the petition did not include adequate information for purposes of a rule analysis. The Board directed ODF Department staff (hereafter Department) to initiate development of a Technical Report on marbled murrelets as per OAR 629-680-0100.

This report was developed to meet the requirement for a Technical Report for purposes of informing the rule analysis process for marbled murrelets. The progress report presented to the Board in March of 2017 (ODF 2017a) outlined additional work to be conducted as part of this rule analysis project. Much of the additional work that needs to be conducted is related to statutes, rules, or measures put into effect after the Specified Resource Site process rules (OAR 629, Division 680) were enacted. Examples include 1) passage of the ORS 527.714 statute that requires additional analysis prior to adoption for some new Forest Practices Act rules, and 2) passage of Ballot Measures 36 and 49 which require compensation or waiving new rules that result in lost real estate value. This technical report is meant to fulfill only the needed information for a Technical Report under OAR 629-680-0100 (1)(a). The Department envisions the rule analysis project, as a whole, will involve multiple steps and decisions by the Board. The decision on protection measures for marbled murrelets is likely to occur at a later date, after the Board has heard all of the pertinent information on this topic and considered input from stakeholders. Thus, specific protection measures for marbled murrelets are not recommended in this report. Instead, a general discussion of a range of possible protection measures is included.

Requirements for Rule Development

When a species is added to either the federal or state Endangered Species Act lists (T&E), protection rules under the FPA may be warranted. However, every listed species does not necessarily warrant development of FPA rules. Instead, the focus is on species that occur in forestland and that may be negatively impacted by forest practices. The process to evaluate T&E listed species for possible rule-making under the FPA is laid out in statute (ORS 527.710) and in administrative rule (OAR 629-680-0100).

Commented [JR-G\DoNR5]: Might be nice to include a definitions or terms section with consistent definitions.

Commented [JR-G\DoNR6]: Important to point out that this process may take quite some time as the scientific information available is extremely limited especially when looking at Oregon populations.

Commented [JR-G\DoNR7]: First question is whether MAMU require protections? Trend is static or slightly increasing based on current management.

For a species to qualify for rules under the FPA, the following criteria must be met:

1) The species must be on state or federal Endangered Species Act lists.
2) One or more forest practices must conflict with the sites used by the species.

Forest Practice in this context can be any kind of operation regulated under the FPA such as timber harvest, road construction, application of chemicals, etc. (see OAR 629-605-0050 (26)). Conflict would occur if the resource site is abandoned, or if productivity (e.g., nesting success) at the site is reduced (OAR 629-600-0050 (14)). In most cases, conflict for a resource site occurs from habitat modification or disturbance during key periods of use.

The Board's evaluation for possible rule-making is to be based on best available information summarized in a technical review paper. The technical review paper is to include the following information (from OAR 629-680-0100(1)(a)):

1) Identify the resource sites used by the species
2) Identify the forest practices that conflict with the resource sites
3) Evaluate the biological consequences of the forest practice conflicts
4) Propose protection requirements and exceptions for the resource sites

This report provides information on the general ecology and habitat use of marbled murrelets, but also addresses the specific criteria that must be included in a Technical Report. The report builds off of the original Petition for Rulemaking (Cascadia Wildlands et al. 2016) and also draws from the ODFW Draft Status Review report (ODFW 2018), the 20-year update on the NW Forest Plan (Falxa et al. 2016), the ODF-sponsored systematic evidence review for marbled murrelets (Plissner et al. 2015), and other available literature as appropriate. This report is not meant to be a complete literature review on marbled murrelets, but a targeted summary of available information pertinent to the rule-analysis project and the specific requirements of a Technical Report under OAR 629-680-0100 rules.

Marbled Murrelet Biology & Habitat Characteristics

General Life History & Characteristics

The marbled murrelet is a small seabird that spends most of its life on the ocean, but in Oregon, nests almost exclusively in trees in coastal forests. They do not build a nest, but instead lay their egg directly on mossy limbs or other suitable flat platforms in the forest canopy. For this reason, they tend to nest predominantly in very old conifer forests where large-diameter trees with broad, horizontal branches suitable for nesting are most abundant. Throughout most of Oregon, nesting habitat is characterized as very old conifer forests (typically Douglas-fir) or younger forests with a component of residual old conifer trees. In the north coast of Oregon, they are also known to nest in mid-aged (60+ year old) conifer stands, primarily in hemlock stands with a component of mistletoe defect. The mistletoe infections cause branch deformity

Commented [JR-G\DoNR8]: What is very old? – Subjective
Also, important to note where else we have looked. At this time activities occurring in or near older habitats have prompted the most exploration.

Commented [JR-G\DoNR9]: Once again this is subjective.

Commented [JR-G\DoNR10]: Mid aged would suggest significant decline at 120 years. Some would argue that structural complexity doesn't occur until 150 years. Need a valid definition of these types of stands (mid seral versus early and late seral).

and creates flattened areas with debris that can function as suitable nesting platforms. See the Nesting Habitat section of this report for additional information.

During most of the year, murrelets have white and black plumage that is typical for many seabirds. During the nesting season, they molt into a light brown, mottled plumage. It is thought that this plumage is an adaptation to camouflage in their forested nesting environment.

Marbled murrelets spend most of their time at sea, where they are typically found foraging nearshore (within 3.1 miles of shore) or in bays and inlets (Nelson 1997, ODFW 2018). During the breeding season, murrelets feed on primarily on small fish, including northern anchovy (*Engraulus mordax*), smelt (*Osmeridae sp*), and Pacific herring (*Clupea pallassi*) (ODFW 2018). Whereas adult murrelets tend to consume larval or juvenile fish, they tend to deliver larger sized adult fish to chicks. This is likely a mechanism to maximize the nutritional value delivered to chicks while also minimizing energetic costs due to long flights inland as murrelets feed whole prey to their young. Murrelets are considered an opportunistic forager in that they consume a variety of prey species and will switch prey species depending on availability (ODFW 2018). However, there is growing evidence that poor ocean conditions may be having a negative impact on the quality of diet for murrelets, which in turn may be linked to poor reproductive output (ODFW 2018). One study on this topic in British Columbia used isotopic analysis of museum specimens to examine changes in likely diet quality of murrelets over a 107-year period ranging from the 1889 – 1996 (Norris et al. 2007). They found evidence of a reduction in nutrient-rich forage fish and in increase in zooplankton (a lower trophic food item that is less nutrient rich) in the diet of murrelets over this time period. Furthermore, they found evidence that populations of murrelets in this region may have been limited by diet quality over the time period studied.

When nesting, the female lays a single egg. Adults share incubation duties, switching roughly every 24 hours. The eggs hatch in 28-30 days. Adults typically brood the chick for only one to two days, although some will brood for up to five days but only at night. Both adults then begin to spend much of their time at sea foraging, leaving the chick unattended in the nest. Adults bring one whole fish inland to feed the chick, one to eight times per day. Young birds fledge 27-40 days after hatching. Young fledge on their own and fly to the ocean.

Marbled murrelets have a relatively long and asynchronous nesting season (meaning that individuals do not all nest at the same time). The murrelet nesting season in Oregon is thought to begin in mid-April and extend through mid- to late September (Hamer and Nelson 1995, Hamer et al. 2003, McShane et al. 2004). In Oregon, the incubation phase ranged from mid-April through August 15 and the nestling phase ranged from approximately May 15 to September 15. Approximate time period for fledging of young ranged from mid-June to mid-September (Hamer et al. 2003).

Although murrelets only use inland habitats for nesting, adult murrelets have been documented flying inland during most months of the year except for when they are molting

Commented [JR-G\DoNR11]: What is known if anything about the correlation between productivity at sea and nest success. Not much is discussed in this TR. What additional studies are available?

Also, might be good to point back to original research as opposed to ODFW's review of existing research.

Commented [JR-G\DoNR12]: Important to note that murrelets may not nest every year.

Commented [JR-G\DoNR13]: At least this is the hypothesis. Still unknown as to whether or not inlands habitats are used for other reasons.

(spring and fall). The reason for the non-breeding season flights inland are not well understood, but it is thought that birds are possibly establishing pair bonds or prospecting for nesting sites. Most inland activity occurs during the breeding season. The peak period of inland flights is typically in July. Although inland flights can occur at any time of day, most of the inland activity occurs around dawn and dusk.

Because marbled murrelets are rare, cryptic, and secretive, locating their nests is extremely difficult. The first marbled murrelet nests were not found until the 1970's and as of 2017, only 75 nests have been confirmed in Oregon (ODFW 2018). In Oregon, murrelets have been detected as far inland as 80 miles, but the furthest inland nest known was at 31 miles and the furthest inland observation of an occupied behavior was at 40 miles (Nelson 2003, ODFW 2018). Most of the early known nests in Oregon were located by accident or by chance when eggshells or chicks were located on the ground, when nest trees were felled during logging, or when birds were observed landing in trees. More recently, nests have been located by climbing potential nest trees during research projects or as an alternative survey method (Pacific Seabird Group 2013). In other regions, many nests have been located by capturing and placing tracking devices (telemetry receivers) on birds, and then locating them inland when they are at their nest sites (e.g., Zharikov et al. 2007, Burger et al. 2009, Silvergieter and Lank 2011, Lorenz et al. 2017). These methods are currently being used for a study in Oregon, but during the first year of the study, no murrelets came inland to nest (Rivers pers. comm. 2017).

Marbled murrelets are thought to exhibit some level of site-fidelity. Fidelity is the propensity of individuals to use the same area for nesting repeatedly. However, the topic of site fidelity is not well studied using rigorous studies (Plissner et al. 2015). Plissner et al. (2015) provides a comprehensive review of studies that included information on site fidelity and their results are summarized here. They found evidence that murrelets may return to the same watershed, stand, and even the same tree to nest in subsequent nesting seasons (Plissner et al. 2015). This is largely based on studies that have used tree-climbing to find and characterize nests of murrelets, however evidence for fidelity exists across multiple studies across the range of the species. Because of the difficulty in reading bands on marked birds and the lack of telemetry receivers that allow for tracking of individuals over multiple seasons, information on fidelity of specific individuals is lacking. One study in California documented a single marked bird returning to the same nest annually for over a decade (Golightly and Schneider 2011). One marked individual in British Columbia was tracked using telemetry in two years (1999 and 2001) and was found nesting in the same stand; the two nests were approximately 650 feet apart (Burger et al. 2009).

There is evidence that if a nesting attempt fails, particularly if failure occurs during the incubation phase, some proportion of pairs will attempt to renest. In their review of the literature for this topic, Plissner et al. (2015) found only five studies that explicitly discussed renesting attempts. In those studies, it appeared the percentage of pairs that attempted to renest after a failure ranged from roughly 16% to 34%. When nesting attempts fail, there is evidence birds may return to the same stand when renesting (Plissner et al. 2015). Reuse of a nest tree or stand may be higher in areas where habitat is limited. One study looked at relative

Commented [JR-G\DoNR14]: Challenge one for determining an appropriate resource site.

Commented [JR-G\DoNR15]: However, these methods have also failed in identifying nest trees despite tracking.

Commented [JR-G\DoNR16]: Important to note that MAMU may have less fidelity than other Alcids. Although not well documented, nest selection may change within a given area.

Commented [JR-G\DoNR17]: Nesting was not confirmed three consecutive years for that study.

"Based on video and audio recorded at the Davison Tree during the last 10 years, we conclude that it is possible that murrelets do not initiate a nest annually".

Commented [JR-G\DoNR18]: Important to point out that nest tree/location may move.

Commented [JR-G\DoNR19]: Not well documented.

rates of re-use across three regions in British Columbia found greater evidence of multiple nests or reuse of nest sites in all three regions. The authors noted that the two study areas with a greater history of logging had greater evidence of multiple nests and reuse than the study area with little to no logging history and surmised that nest reuse may be more likely in areas where nesting habitat is limited (Burger et al. 2009).

Unlike many other species of seabirds, murrelets do not nest in colonies (multiple nests in very close proximity), but instead are somewhat solitary. However, there are documented occurrences of multiple nests (active or older nests) within the same general area (e.g., within 300 feet of each other) or within the same stand or watershed. One study in Oregon found two active nests located within 98 feet of each other (Nelson and Wilson 2002). Most of the available information of this topic is based on finding nests of various ages (active or older nests). In their review of the literature on this topic, Plissner et al. (2015) found five reported examples of nests being located within 330 feet of each other. They also reported four examples of nests located between 660 feet and 0.6 miles of each other, and five examples of nests located at a greater distance of up to 7.5 miles from each other which may indicate a broad distribution of nests (rather than evidence of a clumped distribution). Plissner et al. (2015) found only one robust study on this topic (Zharikov et al. 2007). Using nests from a large number of radio-tagged murrelets in BC, Zharikov et al. (2007) found the mean nearest nest distance (n = 157 nests) was over 2.5 miles in their two study areas. All of the inter-nest distances reported are considered rough estimates, however, as it is unlikely all of the nests were located in any of the studies.

Commented [JR-G\DoNR20]: Should one read this as protection of the nest tree in highly fragmented landscapes is more important than protection of the nest tree in less fragmented landscapes?

Commented [JR-G\DoNR21]: Pilssner didn't find this study relevant in the scientific review (2015)

Commented [JR-G\DoNR22]: Important to point out that this is based on a very small sample size of located nests.

Population Status and Trends

Overall population trends

In Oregon, as well as California and Washington, murrelet population numbers and trends are evaluated and monitored by counting birds at sea. As a component of the Northwest Forest Management Plan Effectiveness Monitoring Program, a large-scale effort has been conducted to estimate populations annually across Washington, Oregon, and California since the 1990's (see Falxa and Raphael 2016 and Lynch et al. 2017). Surveys are conducted within conservation zones, as established by the Marbled Murrelet Recovery Plan (USFWS 1997). Surveys in Oregon include conservation zone 3 and a portion of conservation zone 4 (Figure 1). The overall population estimate for murrelets in Washington, Oregon and California as of 2015 is 24,100 birds (95% confidence interval [CI] of 19,700 to 28,600). The overall population trend from 2001 – 2015 is a decline of 0.13% per year (95% CI from -1.7 to +1.4), however this trend is inconclusive as the confidence interval overlaps zero and the trend is not statistically significant (P=0.863). Population trends vary by state and conservation zone. There is statistically significant evidence of population declines in Washington (-4.4%/year [CI of -6.8 to -1.9]; P=0.002), no evidence of a trend in Oregon (see below), and statistically significant evidence of a population increase in California (+0.9%/year [CI +0.9 to +6.8]; P=0.013).

Commented [JR-G\DoNR23]: If the trend is static or increasing under existing conditions, will additional protections off of federal lands significantly change this? More information is needed to assess baseline conditions on federal lands. Additionally there is a need to better evaluate the available habitat on non-federal lands based on known use within certain watersheds.

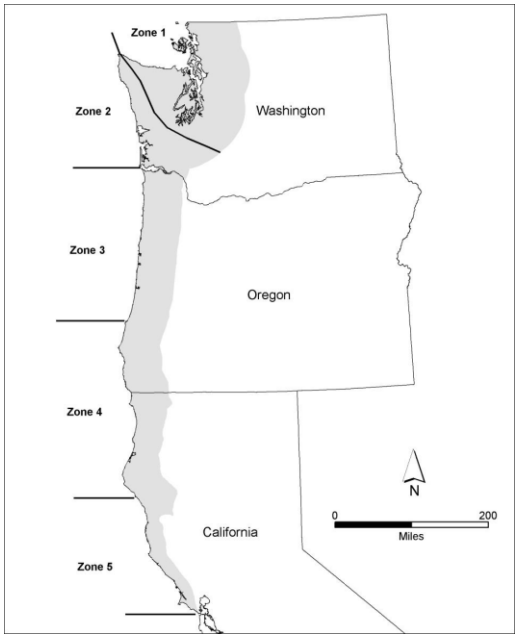

Figure 1: The five at-sea marbled murrelet conservation zones adjacent to the Northwest Forest Plan area (from Lynch et al. 2017).

Oregon-specific population trends

Oregon surveys were conducted in between 2000 and 2016, however, only conservation zone 3 was surveyed in 2016 (see Figure 1). Because of the difference in the time span for results between these two zones, results are reported separately. Results for the state-wide population trends for Oregon through 2015 indicate an increase of +1.7% per year (CI from -0.3 to +3.7) between 2000 and 2015. The data indicates an upward trend in Oregon, however because the confidence interval overlaps zero and this trend was not statistically significant (P=0.088) there is uncertainty about the actual population trend (Figure 2; Lynch 2017).

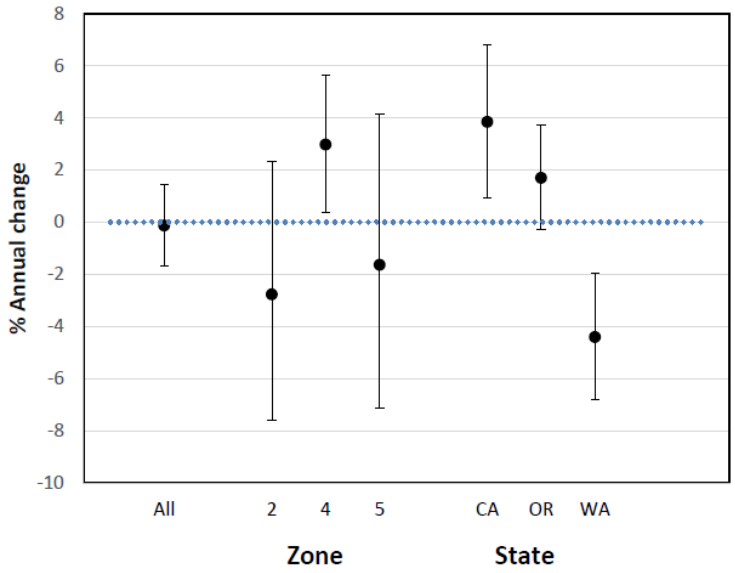

Figure 2: Trend results for units with populations through 2015 only: average rate of change with 95 percent confidence (rom Lynch et al. 2017). Zones 1 and 3 are not displayed because data was available for these zones through 2016; see text for results for zone 3 in Oregon.

Because conservation zone 3 data extends through 2016, Lynch et al. (2017) reported results for this conservation zone separately from the state-wide results shown in Figure 2. Data for conservation zone 3 indicates that the population trend within only this zone was likely also stable through 2016. The rate of change for this zone through 2016 was +1.1%/ year (95% CI = -0.9 to 3.3%); however because the confidence interval overlaps zero and the trend was not statistically significant (P=0.266), there is uncertainty about the actual population trend (Lynch et al. 2017).

Listing status

Marbled murrelets are currently listed as a threatened species under the federal Endangered Species Act. They are listed as Endangered under the Washington and California state Endangered Species Acts. The Oregon Fish and Wildlife Commission recently decided to change the status of the marbled murrelet to endangered under the Oregon Endangered Species Act. Rulemaking regarding this change, including development of survival guidelines for the species, is ongoing and is expected to be completed by June 2018.

Commented [JR-G\DoNR24]: This direction has been changed primarily based on population status and trend data. Update in report.

Marbled murrelet habitat quantity and trends in Oregon

The recent Marbled Murrelet Status Review for Oregon (ODFW 2018) provides a summary of trends in habitat for marbled murrelets from the time of listing to now. Most the discussion in

the Status Review is from a habitat modelling effort conducted as part of the federal Northwest Forest Plan Effectiveness Monitoring (Raphael et al. 2016a). As with all models, the outputs represent predicted habitat, not actual habitat. The model used in Raphael et al. (2016a) separated potential habitat into four broad categories. Each category reflects a "bin" of habitat with varying scores on their habitat suitability index. The four bins are assigned Classes and names, using the terminology of Class 1--lowest suitability; Class 2--marginal suitability, Class 3--moderate suitability, and Class 4--highest suitability. Raphael et al. (2016a) considers Class 3 and 4 to represent "higher suitability habitat" and uses these two categories for their estimates of predicted habitat where the likelihood of detecting murrelets (presence) or the likelihood of nests or occupied detections is greatest. While there are criticisms with the habitat model used in Raphael et al. (2016a) (see public comments for ODFW 2018), these models represent best available information at this time.

Total amount of suitable marbled murrelet habitat is widely believed to have declined significantly in the last 100 years due primarily to logging and wildfire (see ODFW 2018 for review). Since the time of listing, Raphael et al. (2016a) estimated that amounts of modeled higher suitability habitat (Class 3 and 4) declined by 9.2% (78,600 acres) between 1993 and 2012. Although total modeled higher suitability habitat was predicted to be much more abundant on federal ownership classes, relative reductions were greatest on the non-federal ownership class (59,000 acres) as compared to the federal ownership class (19,000 acres). Most of the estimated loss on non-federal ownership class was due to logging whereas most of the estimated loss on the federal ownership class was due to fire.

Because Raphael et al. (2016a) reported amounts of modeled higher suitable habitat only to the ownership classes of federal and non-federal, the amount predicted to occur on private lands was not reported. However, in their species status review, ODFW (2018) used the data available from Raphael et al. (2016a) to further estimate habitat conditions as of the 2012 modeled habitat year by land ownership class in Oregon. Their analysis predicted that as of 2012 (the modeled habitat year), amounts of modeled higher suitable habitat by land ownership or management class is as follows:

- U.S. Forest Service (55%)
- Bureau of Land Management (16%)
- Oregon Department of Forestry (15%)[1]
- Private (12%)
- Other (2%)
- Tribe(s)

Additional work is needed to further examine the distribution of suitable habitat in Oregon. For example, the relative distribution of suitable habitat on private industrial versus private non-

[1] ODFW estimates do not reflect the recent change of management of the Elliott State Forest to from ODF to Department of State Lands.

Commented [JR-G\DoNR25]: This report should describe ways to improve modeling.

Commented [JR-G\DoNR26]: Suitable habitat doesn't mean it was ever fully occupied habitat. It simply means it has certain stand components that are observed in areas where murrelet nesting has been documents. This is an important note to make.

Commented [JR-G\DoNR27]: Raises the argument that management actions may be needed to reduce the risk of fire on federal lands in order to protect murrelets.

Would be good to accurately capture the lack of reduction in federal forests over the past 10 years and the long-term protections in place under current management plans.

Commented [JR-G\DoNR28]: Indian lands must be considered differently under any proposed administrative process. Tribal lands should be omitted from any protection strategies for MAMU. Tribal lands have been found under other listed species analysis to be non-essential to conserve a listed species as the Conservation needs of the listed species can be achieved by limiting protections to other lands. Tribal lands are not essential to conserve MAMU and placing any protection on Tribal lands would result in a disproportionate burden to Tribes and their resources. When it comes to species protection the federal government shall be considered first, followed by states.

Commented [JR-G\DoNR29]: Is 14% significant enough require site-specific protection in order to assure the continuation of the species throughout its natural range? This is the threshold under 629-680-0210.

Commented [JR-G\DoNR30]: Agreed. Model should be refined to take into account areas/watersheds of high use based on current survey data.

industrial lands is not known. In addition, a more detailed analysis of forest conditions and anticipated recruitment of suitable habitat on all forest ownership classes in Oregon is anticipated to be important to the Board's decision-making process. The Department plans to conduct this work during a later phase of this project.

Commented [JR-G\DoNR31]: Before any decisions are made regarding the resource site definition and or protection measures?

Marbled Murrelet Nesting Habitat Characteristics

Nesting platform/ actual nest site location

ODFW (2018) summarized nests and nest trees for all known nests in Oregon (see Table 1). Plissner et al. (2015) provided a summary of habitat associated with nesting of marbled murrelets, across their range.

Table 1: Selected marbled murrelet nest tree (table 1a) and nest (table 1b) characteristics for Oregon. Data were provided by S.K. Nelson for all 75 nests found in Oregon since 1990. Mean values are shown for variables measured, along with standard deviation (SD), range, and sample size (n, number of nests). Adapted from Table 1 in ODFW (2018); only change is conversion of values from metric to English.

Commented [JR-G\DoNR32]: Have more been located since this analysis was conducted? If so update.

Table 1a. Nest tree characteristics

	Tree DBH (in)	Tree Height (ft)	No. Platforms in Nest Tree	Distance from Ocean (mi)	Distance to Edge (ft)	Elevation (ft)
Mean	55	184	26	14	167	1083
SD	19	46	19	6	148	492
Range	19 – 110	108 – 279	8 – 92	0.6 - 30	0 - 607	174 - 2024
n	70	70	46	75	75	75

Table 1b. Nest Characteristics

	Nest Limb Height Above Ground (ft)	Nest Limb Diameter at Trunk (in)	Limb Diameter at Nest (in)	Distance from Trunk (ft)	Nest Platform Width (in)	Moss Depth Adjacent to Nest (in)	Duff and Litter Depth in Nest Cup (in)	Percent Horizontal Cover (side)	Percent Vertical Cover (overhead)
Mean	118	9	9	3.6	10	1.7	0.9	53	83
SD	46	4	4	3.8	4	0.9	0.7	19	21
Range	33 – 246	3 – 22	3 – 19	0 - 25	3 - 20	0 – 4.3	0 – 3.3	13 – 85	25 - 100
n	66	67	35	67	65	65	54	53	56

Nests are typically located on a suitable platform, usually on a large, mossy, horizontal tree branch. Nests are normally in the mid to upper portion of the tree, typically 100 feet above the ground (range 33 – 246') and with vegetative cover adjacent or above the nest (Table 1, ODFW 2018, Plissner et al. 2015).

Recorded diameter of limbs (at tree bole) used for nesting ranged from a minimum of four to a maximum of 29 inches (as reported across the entire range of the species); average limb diameter was more than six inches with most studies reporting an average width of more than ten inches (Plissner et al. 2015). Recorded diameter of actual platforms where birds laid their eggs ranged from five to 28 inches (Plissner et al. 2015).

Nest tree and nest patch

A variety of tree species are used for nesting, including Douglas-fir, western hemlock, Sitka spruce, coast redwood, and western red cedar (Nelson 1997). Only conifers are known to be used for nesting in Oregon, Washington, and California, but nests have been documented in red alder in British Columbia (ODFW 2018). One ground nest has been documented in Washington (Wilk et al. 2016). Most known nests are in large-diameter trees in old-growth forests (> 200 years old; Nelson 1997, McShane et al. 2004). However, murrelets have also been found to nest in residual mature to old-growth-aged trees that occur within younger forests and in mature hemlock trees (66-150 yrs. old) that have heavy infections of mistletoe. The youngest recorded tree used for nesting was a 66 year old hemlock infected with mistletoe in the north coast range (Nelson and Wilson 2002). Mistletoe infections can create brooms that serve as platforms or cause branch deformity, resulting in fattened limbs. Nests have been found on platforms and limbs of these mistletoe-infected hemlock trees (Nelson and Wilson 2002).

Murrelet nests tend to have canopy gaps or other open areas near the nest location (ODFW 2018). This feature is important to allow murrelets access to the nest platform. Because murrelets are adapted for foraging in water, their wings are relatively long and narrow in relation to their body size (termed high wing loading). Thus, murrelets are not well adapted for flying or maneuvering in forest environments. They have to fly at high rates of speed (often > 44 miles per hour) in order to remain airborne and tend to approach their nest from below and "stall out" as they land. Thus, having an unobstructed area for approaches and take-offs from the nest are important.

Nesting stand

Because of their reliance on platforms for nesting which occur mostly on large limbs in large trees, suitable nesting habitat occurs primarily in old-growth or mature forests (McShane et al. 2004). Throughout most of Oregon, nesting habitat is characterized by mature to old-growth Douglas-fir stands or younger stands with a component of residual mature or old-growth trees. In the north coast of Oregon, murrelets are known to nest in younger-aged hemlock stands with heavy infestations of mistletoe.

Commented [JR-G\DoNR33]: There needs to be a consistent definition of the nest sites, seems to vary in the literature. Also addressed by Plissner et al.

Commented [JR-G\DoNR34]: At this time; however, there isn't enough data to rule out the use of other types of trees in Oregon (i.e. hardwoods).

Commented [JR-G\DoNR35]: The terms very old, old growth, mature are all used. Need to identify a consistent terminology.

Is there documentation as to the density and average DBH of trees within these older stands? Important to note as there are many differences between stands along the coast range. Refer to work by Thomas Sensenig , John D. Bailey , and John C. Tappeiner.

Commented [JR-G\DoNR36]: So stands with higher tree densities may be less inviting to murrelets despite the presence of older trees, large limbs, and or platforms. This may be an important factor to review in follow up work.

Commented [JR-G\DoNR37]: Once again need to use consistent terminology.

Commented [JR-G\DoNR38]: Early seral, <60 years of age?

The presence of potential nesting platforms is considered the most important characteristic of marbled murrelet nesting habitat (Nelson 1997). Murrelets select trees for nesting with more potential nesting platforms than what occurs on nearby trees. In addition, there is often a greater density of trees with platforms near nests than elsewhere in the stand (Plissner et al. 2015, Wilk et al. 2016). Density of trees with suitable nesting platforms in stands used for nesting by murrelets ranged from nine to 50 trees per acre; the minimum number reported was two platform trees per acre (Plissner et al. 2015). One study reported that the probability of a murrelet using a stand for nesting increased with increasing density of platform trees up to 40 trees per acre, after which there was no additional change (Silvergieter and Lank 2011). Murrelets tend to select nesting locations with vegetative cover over the nest, but also near gaps in the canopy to allow for access to and from their nesting platform (Nelson 1997).

Commented [JR-G\DoNR39]: Reporting the specific metrics for these trees would be useful (DBH, Age, Height, number of platforms, etc.)

Landscape pattern; relationship to nest selection and success

Information on the relationship between landscape pattern and fragmentation and nest site selection and nesting success is limited in Oregon. Most studies on this topic are from British Columbia where the forest type and landscape conditions are arguably different than in Oregon. Available information on this topic is summarized below.

Habitat use and nest site selection

Two studies in southern Oregon looked at the relationship between occupied detections and landscape patterns of old-growth forests. They found that the number of occupied murrelet detections were greater in unfragmented old-growth patches (Meyer et al. 2002) and that occupied areas tended to have less fragmented and isolated old-growth patches than did unoccupied areas (Meyer and Miller 2002). Occupied inland habitat also tended to be close to the coast and river mouths (Meyer and Miller 2002). Similar research has not yet been conducted in other regions of Oregon, or in a broader range of age-classes of forests.

Commented [JR-G\DoNR40]: Discuss validity of Meyers work. Wasn't heavily cited by Plissner.

Commented [JR-G\DoNR41]: But there is existing MAMU survey data for occupied stands on BLM and Forest Service lands. How can this be used?

Studies examining landscape patterns (e.g., distance from ocean, patch size, core area, and other metrics of fragmentation) using actual murrelet nests are limited in Oregon. Most research on this topic is from British Columbia, where the forest conditions and landscape patterns are arguably different from in Oregon. Of the studies available, there is conflicting information with regards to whether marbled murrelets tend to nest in large interior blocks of habitat, far from forest edges[2] or if they are more general in their nest placement preference. Although murrelets are generally thought of as being negatively impacted by edge effects, a majority of nests have been found near edges, especially natural edges (see review in McShane et al. 2004). In contrast, one recent study in Washington found most nests occur in the interior of forests or in patches with a more interior habitat than at random locations (Wilk et al. 2016). Murrelets may tend to nest closer to edges or gaps as these openings provide ample flying room for adults coming into the nest site or for juveniles when they fledge (McShane et al. 2004). The relationship between murrelet nests and forest edges may vary with the extent of

Commented [JR-G\DoNR42]: In fact some studies argue that this may be a selection criteria for MAMU. Nelson 1997, Manley 1999, Zharikov et al. 2006

[2] The term edge refers to the break between a forested area and a non-forested area. The nonforested area may be natural (e.g., river, meadow, natural gap in the canopy) or human-made (e.g., road, clearcut harvest, development).

habitat available in an area, with murrelets nesting near edges or in isolated fragments more frequently where habitat, particularly interior forest habitat, is limiting (McShane et al. 2004, Plissner et al. 2015).

Nest Success, nest predation & landscape conditions

Marbled murrelets are believed to have low reproductive success, meaning that a large majority of nesting attempts fail to result in successfully fledged young. The primary theory for low rates of success is that nests have high rates of nest depredation, primarily by corvids (jays, ravens, and crows) (ODFW 2018, Plissner et al. 2015). Existing research, primarily using artificial nests, indicates corvid abundance, and predation pressure on nests, is increased in stands near areas that provide additional food resources for corvids such as near human habitation or recreation areas and near regenerating stands with high cover of berry-producing shrubs (Plissner et al. 2015).

The relationship between marbled murrelet nesting success and landscape characteristics is complicated and available information does not allow us to determine any consistent trend. Plissner et al. (2015) provides the most current review of available research on this topic (see Table 13 for additional information). Key information includes the following:

- There were no statistically significant results to indicate that rates of nest success was associated with stand size (Marzluff et al. 1999, Raphael et al. 2002, Zharikov et al. 2006, Zharikov et al. 2007, Nelson and Hamer 1995), platform density (Manley 2003, Silvergieter 2009), tree density (Manley 2003, Golightly et al. 2009, Silvergieter 2009), or canopy height (Silvergieter 2009, Golightly et al. 2009).
- Relationships have been reported between nest success and patch shape (positive association with compact versus linear shapes) (Marzluff et al. 1999), percent canopy cover (negative association) (Malt and Lank 2007 and Waterhouse et al. 2008) and canopy complexity (positive) (Waterhouse et al. 2008). Other studies found no relationship for one or more of these variables (Marzluff et al. 1999, Waterhouse et al. 2008).
- Conflicting results were reported on the relationship between stand age and nest success. Most studies did not report a statistically significant result (Manley 2003, Silvergieter 2009, Waterhouse et al. 2008). Malt and Lank (2007) found increased predation of artificial nests in landscapes with greater percentage of old-growth. In contrast, Zharikov et al. (2007) found that nest success (measured through tracking bird activity with telemetry) was negatively associated with the amount of young forests in the landscape.
- Conflicting results were found for the relationship between nest success and edges. Overall, five of nine studies reviewed by Plissner et al. (2015) reported positive associations between nest success and distance to edge, meaning nest success was higher further from edges.

Commented [JR-G\DoNR43]: Need more comparable research in areas where predation is more natural and less impacted by fragmentation to prove this out.

Commented [JR-G\DoNR44]: Need to discuss changes through time as adjacent stands grow, edge effects, decrease, and food resources for wood be predators decreases. Is predation pressure consistent through time?

Commented [JR-G\DoNR45]: Important finding when considering the size of an area beyond the nest site that may be needed for protection.

Commented [JR-G\DoNR46]: Based on the literature stand age appears to be a less important metric than the location of the stand and level of predation when considering nest success.

Commented [JR-G\DoNR47]: Yes but, murrelets are predisposed to nesting along canopy gaps, preferably along waterways, which facilitate access to their nest-site (Nelson 1997, Manley 1999, Zharikov et al. 2006)

- One study found that murrelets nesting closer to a "hard" edge[3] had lower nest success than murrelets nesting further from edges (Malt and Lank 2007). Another study, however, found murrelets nesting near hard edges had greater nest success (Zharikov et al. 2006) than murrelets further in the interior. At the landscape scale, however, Zharikov et al. (2007) found that nests in landscapes with greater contrast between the nest stand and neighboring units had lower nest success than in landscapes with less contrast (soft edges).
- The type of edge may have implications to nest success, with murrelets having lower nest success if nesting near a hard edge as compared to a soft or natural edge. Zharikov et al. (2007) reported that nests were more successful in landscapes with lower edge contrast (e.g., soft edges). Similarly, Malt and Lank (2007) reported reduced nest success at hard edges and no edge effects at soft and natural edges.

In general, it is documented that marbled murrelets locate their nests near canopy gaps, including forest edges, presumably to aid in the ability of the adult birds to access the nest as they fly in from the ocean. However, information on effects of landscape condition and fragmentation appears to indicate that those murrelets nesting near edges, especially hard edges, may suffer lower nest success than murrelets nesting further in the interior of a stand. Thus, there is a paradox that edges may improve access for murrelets, but sometimes at the cost of reduced nest success.

Landscape condition and off-shore distribution of marbled murrelets

Range-wide, breeding season murrelet abundance off shore has been reported to be associated with the amount and condition (fragmentation level) of older forest condition inland, with higher densities of murrelets occurring offshore from areas with more and less fragmented older forests (Raphael et al. 2015, Raphael et al. 2016b). This is thought to indicate that murrelet populations and distribution patterns offshore are influenced by the amount of potential nesting habitat inland with birds tending to forage in close proximity to their nesting stands (Raphael et al. 2015). However, a recent study in Washington and British Columbia (Lorenz et al. 2017) found that some individuals not only travelled long distances inland, but also travelled long distances across marine environments to reach their foraging areas (mean distance travelled for 20 birds = 17.4 miles—range of 0.3 to 82 miles). This latter study suggests that some individuals may travel long distances across marine environments to reach suitable foraging areas rather than to forage immediately offshore from their nesting stand. In addition, recent preliminary information from a study in Oregon indicate that individuals that are not nesting may move long distances during the nesting season (Rivers personal communication). Thus, density patterns of birds offshore may not be entirely representative of populations of nesting birds. More work is needed on this topic.

[3] The term "hard edge" generally refers to an edge with a large amount of contrast, such as the edge between a meadow or a recent clear-cut and a mature forest stand. The term "soft edge" generally refers to an edge with less contrast. Examples of soft edges include an edge between a mature forest and a mid-aged stand of trees or an edge that has a more variable contrast such as a thinned or feathered boundary between the mature stand and an adjacent open area.

Commented [JR-G\DoNR48]: Is this more to do with the edge or with the increase in predation risk associated with the edge?

Commented [JR-G\DoNR49]: Limited amount of data on this subject.

Commented [JR-G\DoNR50]: So there is no definitive trend. Simply state the obvious here.

Commented [JR-G\DoNR51]: Avoid the use of PC in this document. All statements should be substantiated by rigorous research outputs/primary literature.

Existing Marbled Murrelet Survey Methods

The Pacific Seabird Group[4] has developed a survey protocol to determine if murrelets are using a forested area (Evans Mack et al. 2003). The protocol focuses on detecting murrelets and characterizing behaviors observed. A set of behaviors, called occupied behaviors, are key to characterizing use of forested areas. These behaviors include flying below the canopy (subcanopy flight), landing in a tree, stationary vocalization, and jet dives. Circling above the canopy is not considered an occupied behavior, but is considered indicative of potential occupancy and provides the basis for additional survey effort to attempt to observe subcanopy flights. In addition, some research studies include this behavior in their definition of an occupied behavior (Falxa et al. 2016). Research has documented that actively nesting murrelets exhibit these occupied behaviors near their nests (Plissner et al. 2015). Thus, observation of occupied behaviors are thought to indicate the area being surveyed is occupied by marbled murrelets and likely used for nesting. Other types of observations of murrelets such as flying above the canopy and non-stationary vocalizations indicate that murrelets are present, but not necessarily using the area of interest for nesting.

The existing protocol for surveying for murrelets (Evans Mack et al. 2003) is designed to document the occurrence or probable absence of murrelets, and if murrelets are present, to determine if birds are exhibiting occupied behaviors. This protocol was not designed to locate marbled murrelet nest trees. The existing marbled murrelet survey protocol (Evans Mack et al. 2003) is the most frequently used method to survey for murrelets in forested stands.

Commented [JR-G\DoNR52]: It's important to note that Generally, a high percentage of documented murrelet occurrences remain unseen to the observer, and most behaviors indicating occupancy are derived almost exclusively from visual observations. (Evans et al 2003).

Surveys conducted using the existing protocol surveys result in three different scales of data[5]:

1) The Survey Station where the occupied behavior was observed,
2) The Survey Site within which one or more Survey Stations had occupied behaviors observed,
3) The larger Survey Area within which one or more Survey Sites had occupied behaviors.

These three scales are based on the design of the survey protocol. The Survey Area typically includes the area of interest (usually a proposed harvest area) and all contiguous suitable habitat within a ¼ mile. The Survey Area is then broken down into Survey Sites, which are smaller areas within which multiple Survey Stations are located. The Survey Station is where the observer looks and listens for murrelets. The survey protocol was designed so that, statistically, if surveys are conducted according to the protocol standards including the required number of visits, one will have a 95% chance of observing occupied behaviors should the Survey

[4] The Pacific Seabird Group is a society of professional seabird researchers and managers dedicated to the study and conservation of seabirds and their environment. https://pacificseabirdgroup.org/

[5] Throughout this document, the terms Survey Area, Survey Site, and Survey Station are capitalized to indicate that these terms relate back to the definitions in the survey protocol (Evans Mack et al. 2003). If not capitalized, the terms area, site, and station are used generically and are not meant to refer to the definitions in the protocol

Site actually be occupied. The analysis that is the basis for the protocol was conducted at the scale of the survey site, thus the statistical probability is appropriately applied to the scale of the Survey Site. The protocol then recommends results be extended to the entire Survey Area, based on an assumption that suitable habitat contiguous with the location where occupied behaviors is observed is important for murrelets for current and future nesting. Applying results to the entire Survey Area may result in additional Survey Sites being designated as "occupied" even when the surveys within that Site indicate that murrelets are likely absent or only "present". In the cases where the Survey Area is large or linear in nature, this can effectively result in habitat that is a long distance (e.g., 1/2 mile or more) from the actual locations of occupied detections being designated as "occupied". Thus, when using information derived from protocol survey, only data at the scale of the Survey Station(s) and the Survey Site(s) would be based on the location(s) where murrelets were observed exhibiting occupied behaviors. Any additional Survey Sites and Stations (with probably absence or presence) within the larger Survey Area would be considered occupied based on extrapolation. However, the recommended approach in the protocol is to conduct the extrapolation and to consider the entire Survey Area occupied of any occupied detections of murrelets are observed.

Information Gaps

Despite the marbled murrelet being one of the more well-studied seabirds in the Pacific Northwest, there are still key gaps in our knowledge about the species. Given the secretive nature and camouflage of marbled murrelets when nesting inland, this is not surprising. Some of the information gaps that have bearing on development of protection measures for this species are discussed below.

Commented [JR-G\DoNR53]: Very little has been documented in Oregon. This TR states in many sections that there is a need for more research. Begs the question as to how much data needed to inform the best policy decisions.

Relationship between occupied behaviors and actual nesting

There is consistent evidence that marbled murrelets exhibit occupied behaviors (e.g., subcanopy flights, landings, stationary vocalizations) at locations where active or past-used nests are known to occur (Evans Mack et al. 2003, Plissner et al. 2015). However, there are still key unanswered questions regarding the relationship of these behaviors to active nesting and this topic has not been systematically examined using a rigorous study design. We do not fully understand how often these behaviors occur in suitable habitat that is not actually used for nesting (e.g., by non-nesting birds prospecting for nest sites or by incidental flights below the canopy). To our knowledge, no studies have examined the spatial relationship between observation of the behaviors and the location of active nests using a rigorous study design. For example, one knowledge gap is how far active nests are typically located from the location(s) where occupied behaviors were observed. The temporal relationship between occupied detections and actual nesting has also not been well studied. Although it has been documented that marbled murrelets exhibit occupied behaviors at locations where past nesting has occurred (Plissner et al. 2015) and it is thought they may visit a stand and exhibit occupied behaviors prior to actual nesting (e.g., prospecting), it is not known how often or for how long marbled murrelets may visit a stand and exhibit occupied behaviors prior to actual nesting—or in the case of an abandoned nesting stand, for how long after the last nesting attempt has occurred.

Commented [JR-G\DoNR54]: This is extremely important when determining the resource site for murrelet.

It is also not known how often prospecting occurs, but does not result in use of a stand for nesting.

This information would help inform whether or not occupied detections can be used as a surrogate for a nesting site, when actual nesting or the location of the nest tree is not known. In addition, it would help inform the question of how far from a potential occupied detection a nest might actually occur.

Long term patterns of habitat use

It is well established that murrelet nesting patterns vary, and that poor ocean conditions may result in only a proportion of the population that nests (ODFW 2018). However, short and long term temporal patterns of nesting and use of stands are not well studied. One study in California which looked at relationship between occupied detections and landscape condition found a time lag in response to fragmentation, with birds abandoning fragmented patches a few years after they were isolated (Meyer et al. 2002). To our knowledge, there are no long-term studies that have looked at long-term patterns of habitat use. Specifically, it is not known if stands are used annually or if breaks occur in nesting or occupancy of a stand. Furthermore if breaks in use do occur, how often and how long of a break in use occurs before the area is reused again. Alternately, information is lacking to indicate if an area is unlikely to be used again after birds are absent for a period of time, and if so, how long of a period of no detections of a bird are needed to be relatively certain that the area is actually abandoned (as defined in the FPA). This information would help inform development of criteria to distinguish an abandoned versus an active resource site under the FPA.

Commented [JR-G\DoNR55]: What about Golighly's work? Although limited it could be used in this context to show that there may a combination of prolonged use in addition to breaks in use.

Nest site fidelity and spatial distribution

Fidelity is the propensity of individuals to use the same area for nesting repeatedly. For example, bald eagles are considered to have high site fidelity because pairs often return to the same nest year after year. As discussed previously, marbled murrelets are thought to have relatively high site fidelity, but there are key gaps in our knowledge for this topic. In their review of the literature on the topic of site fidelity, (Plissner et al. 2015) found only two studies using marked birds. One study in California documented a single marked bird returning to the same nest multiple times over a decade-long time period (Golightly and Schneider 2011) and the second study in British Columbia documented the same individual returning to the same stand to nest in two non-consecutive years (Burger et al. 2009). Thus evidence of fidelity of specific individuals is poorly known at all scales, but information from at least one marked bird suggests that it can occur.

Commented [JR-G\DoNR56]: Very low sample size. Definitely need more information on this. Watershed and stand scales may be more appropriate to report out on.

Additional information is needed on spatial distribution of nests, especially in Oregon. Although rigorous studies using marked birds in British Columbia have provided valuable information, including information on spatial distribution of nests, this type of research has been mostly lacking in Oregon. A new study at Oregon State University may provide additional insight. Key questions are, how many pairs may use a stand in a given year or among years and whether presence of one nest indicates that additional nests are also likely present. There is

also no information on tagged or radio-collared birds between seasons to indicate if marbled murrelets also exhibit plasticity in habitat selection. For example, if a previously used area is no longer suitable nesting habitat (e.g., loss from logging or natural disasters) will murrelets move to a new area or do they cease to nest? Meyer et al. (2002) showed that there was a time lag in response to habitat fragmentation and that murrelets would continue to use an area for some time before abandoning the fragmented parcel (based on patterns of occupied detections—not confirmed nesting). Zharikov et al. (2007) found that nesting murrelets were more abundant in a fragmented area, suggesting that murrelets may have been "packing" into remaining habitat rather than move to a new area to nest. Thus there is some evidence that murrelets may attempt to continue to use their historic nesting areas as habitat is reduced, but this topic has not been specifically addressed. It would likely take a robust study of marked individuals over multiple years to fully address this question. Currently the technology does not exist to efficiently track individuals over multiple seasons.

Commented [JR-G\DoNR57]: No support for this concept of packing in the literature. Only speculation and should be omitted from report. Potentially a misinterpretation of Zharikovs work.

Also not well understood is whether or not the number of detections is indicative of local abundance or if the observation of a nest (or occupied behavior) is predictive of whether or not other nests occur nearby and how far away they may occur. Information on these topics would help inform development of protection strategies for marbled murrelets as well as development of criteria to distinguish an abandoned versus an active resource site under the FPA.

Technical Report—Required Content for Rule Analysis for a T&E Listed Species--Evaluation of OAR 680 criteria

A key component of a Technical Report for purposes of a rule analysis is evaluation of the criteria listed in the process rules for Specified Resource Sites (OAR 629, division 680). The Division 680 rules were developed by the Department and the Board of Forestry to define the process to be used for reviewing fish or wildlife species for possible rule development under the Forest Practices Act, and in the case of "recovered" species, for possible removal or revision of the species. For species that have been added to state or federal Endangered Species Act lists, the process for review is laid out in OAR 629-680-0100.

The Technical Report for a review under OAR 629-680-0100 must include the following:

1) Identify the resource sites used by the species
2) Identify the forest practices that conflict with the resource sites
3) Evaluate the biological consequences of the forest practice conflicts
4) Propose protection requirements and exceptions for the resource site

The information below includes the Department's review of the information on marbled murrelets in relation to these four components of a technical report.

Identification of the resource site(s) used by the species

The Board of Forestry must determine the resource site to be protected. In the Department's March 2017 assessment of the Petition, it was determined the resource site was not adequately identified (ODF 2017a). This section provides additional information to help inform the Board of options for identification of the resource site for protection.

For all wildlife species currently protected under the FPA, the resource site is defined as the nest tree. For the spotted owl, protection can be centered on an activity center if the nest tree is not known. In the recent past, bald eagle winter roost trees and foraging perch trees were protected under the FPA, but those rules are no longer in effect as of September 1, 2017. Thus, protection for all past and present wildlife sites have focused on individual trees or a fixed point location. To date, resource sites have not yet been defined as patches of habitat (occupied or presumed occupied).

Marbled murrelets only use forested environments for nesting and not for foraging or roosting. Thus it is logical to focus the identification of the resource site on the nest tree. However, because of their cryptic and secretive nature and tendency to nest high in trees, locating nest trees is extremely challenging. Despite efforts, only a small number of nests (75) have been found to date in Oregon (ODFW 2018). Limiting definition of the resource site to only nest trees would likely lead to protection of a small subset of the actual nesting trees on the landscape because there is no protocol or method currently available to effectively and efficiently locate nests of marbled murrelets. Climbing potential nest trees can be used to look for signs of nests after the breeding season is over. However this method is extremely difficult and cost-prohibitive over large areas (Plissner et al. 2015). Tree climbing to find nests is likely only effective in small areas where the approximate area of nesting is known. Even with tree-climbing methods, nests can be missed and this method is not effective for documenting that nesting has not occurred (Pacific Seabird Group 2013). A new research study in Oregon (Rivers personal communication) is exploring the use of drones equipped with infrared cameras to detect nesting murrelets. This technique is being explored within the context of a research study and not as a survey tool. Even if effective, this tool may not be a suitable survey tool due to the potential for drones to pose a disturbance to nesting birds.

Commented [JR-G\DoNR58]: Note. Even with telemetry, nests have been difficult to locate.

As discussed in the Survey Protocol section, surveys using the existing survey protocol for marbled murrelets result in information on occupied detections of marbled murrelets. It is assumed that birds exhibiting occupied behaviors are likely nesting, however as discussed in the Information Gaps section, there are still untested questions about this assumption.

Absent of an effective and efficient method to locate nests of marbled murrelets, occupied behaviors may be the only available information that could be used as a possible proxy for nests. The scales of information from protocol surveys related to "occupancy" are 1) the actual location of the bird(s) exhibiting occupied behaviors, 2) the Survey Station from which the occupied behaviors were observed, and 3) the larger Survey Site or 4) Survey Area within which birds were observed.

Commented [JR-G\DoNR59]: Yes but using occupied behaviors could under or overestimate the required protections for the site. Occupancy should be followed up with nest identification and confirmation.

ORS 527.710 (3)(a)(A) indicates the Board should develop an inventory for sites of Threatened or Endangered Species without any specifications of the types of sites to be included in the inventory. OAR 629-665-(62)(a)(A) defines a resource site for Threatened and Endangered Species as the "nest tree, roost tree, or foraging perch and key components". For murrelets, this rule definition would seem to limit the definition of a resource site to the actual nest tree (murrelets do not use roost trees or foraging perches). However, current rules for spotted owls allow for identification of an activity center, when the nest tree location is not known, to be used as the center for protection under the FPA rules. It is also within the Board's authority to modify the definition of a resource site through this rule development process.

Because of the difficulty in finding nests, defining the protected resource site for marbled murrelets is not straight forward. In summary, options relating to actual observations of marbled murrelets would be,

1) Known nest trees only, or
2) Known nest trees and locations of occupied detections of marbled murrelets.

The pros and cons of options based on known locations of birds are shown in Table 2.

It can be argued another option for definition of the Resource Site for marbled murrelets might be the larger polygon equivalent to the Survey Site or Survey Area used to design surveys under the existing Survey Protocol. These are not included as possible options in the definition of a resource site because these larger polygons surrounding known locations are more suitable as a protection standard than as the resource site itself. These larger areas are discussed later in the section regarding Protection.

Although resource sites for all species protected under OAR 629-655-000 (Specified Resource Site Rules) have been based on point locations of nests, activity centers, roost trees, and foraging perches, for some species of wildlife, identification of potential, or presumed occupied, habitat may be appropriate. This may be appropriate in cases where a species does not use a single fixed point location as a key component of its life history (e.g. mammals that range over a large area and use multiple forest structures to meet its needs) or species that are especially rare or difficult to detect. These types of species may require something other than a fixed point as a resource site.

Because of their secretive nature and the challenge in locating nests, the marbled murrelet may be a species where focusing protection on only known nest sites may result in many other, undetected nest sites not being protected. Another option would be to define, identify, and map areas of suitable habitat that would be presumed to be occupied by the species. Under this scenario, the habitat would be presumed occupied unless ground-truthing indicated that suitable nesting platforms did not actually occur, or other key components of suitable habitat were lacking. Alternatively, surveys could be conducted to document that murrelets were not occupying the area (e.g., probable absence or presence only from protocol surveys).

Commented [JR-G\DoNR60]: The presence of suitable habitat alone should not be used as the only indicator. Watershed conditions, existing detections with an area, and/or other site specific biological criteria should be used. – These other criteria will help inform the likelihood of MAMU presence.

Because identification of suitable habitat as a resource site would be an entirely new approach under OAR 629-665-0000, additional work would be needed, should the Board wish to consider this option. Additional work would include, but likely not be limited to, determining characteristics to define suitable habitat, identification of conditions needed for an area to be considered "presumed occupied" habitat, modeling work to map this habitat, defining appropriate survey strategies to determine lack of habitat, determining appropriate survey strategies to confirm lack of nesting of murrelets, determining appropriate protection strategies, and consultation with the Department of Justice on this new approach.

Table 2: Possible definitions of resource sites for marbled murrelets.

Resource Site	Definition	Pro's	Con's
1: Nest Trees	Individual trees confirmed to be used for nesting by marbled murrelets	• Known use for reproduction • Fixed point to center protection around • Similar to existing rules	• Only a small # of nests known • Potential to miss protection of many existing resource sites • Extremely challenging to locate
2: Occupied Detections	Locations where marbled murrelets were observed exhibiting occupied behaviors during protocol surveys (either location of bird or the survey station from which the bird was observed)	• Based on surveys using a standardized protocol • Based on actual observation of marbled murrelets exhibiting behaviors assumed to indicate likely nesting • Fixed point to center protection around • Similar to existing rules	• Not known if nesting actually occurred; may protect some areas not actually used for nesting • Not known where nests located; may center protection away from actual nest location • Bird location data of occupied detections may not be readily available-may have to rely on survey station locations from which the birds were observed (data more likely to be readily available)
3: Presumed occupied habitat	Area of suitable habitat presumed to be occupied by the species	• May identify habitat with murrelet sites not otherwise known to occur	• Not based on actual nests or observation of birds • May identify many areas as occupied by the species that are not actually occupied or not used for nesting • New approach; likely would require significant work to develop and implement

Commented [JR-G\DoNR61]: More than likely that a combination of these will be needed; however, there isn't enough current data to adequately decide on a definition for a resource site.

Identify the forest practices that conflict with the resource sites & evaluate the biological consequences of the forest practice conflicts

A technical report for rule development must also include information to identify the forest practices that conflict with the resource site and evaluate the biological consequences of the forest practices conflicts. These two aspects are combined below.

The Petition identified forest practices that conflict with marbled murrelets in a general sense (e.g. habitat loss), but did not identify the specific forest practices that might conflict with resource sites. The Petition provided details on the biological consequences of conflicts, but focused primarily on forest harvest and loss of habitat. This report expands on the information in the Petition and describes the full suite of Forest Practices and potential biological consequences of those forest practices.

Forest Practices are defined in rule (OAR 629-600-0100 (28)) and include forest harvesting, reforestation, road construction and maintenance, application of chemicals, disposal of slash, and removal of woody biomass. Conflict defined in rule: "means a resource site abandonment or reduced productivity" (OAR 629-600-0100 (14)).

Harvesting of forest trees may conflict with marbled murrelet resource sites by causing direct loss (e.g., removal) of nest trees, by increasing risk of windthrow of nest trees, or by increasing exposure of nests to the elements or to predation. In cases where a hard edge is created near actively nesting murrelets, even if murrelets are not directly harmed by nearby harvest operations and continue to nest, there may be risk of negative effects on the young due to thermal stress and dehydration if adults or chicks are exposed to direct sunlight or increased winds (based on professional judgement). This may result in reduced productivity, however this topic has not been researched. Creation of hard edges may also have an indirect impact on marbled murrelets. Changes in microclimate (due to increased sun, exposure to wind, etc.) can have a negative impact on mosses (Van Rooyen et al. 2011). This is pertinent to murrelets because they largely rely on moss for nest substrates. Microclimate effects on moss may extend 150 feet into the forested stand, possibly further in areas with greater wind exposure. Any changes in moss cover would likely occur at longer time scales—not immediately after creation of a new hard edge. Impacts of changes in microclimate on murrelet nest site selection or nesting success have not been studied. There is evidence timber harvest may result in reduced productivity by increasing risk of predation of nests. As discussed previously, predation of nests is thought to be a significant concern and limiting factor for successful marbled murrelet reproduction. Timber harvesting has a potential to pose a conflict indirectly by increasing exposure of nests to predators, especially near hard edges.

The topic of disturbance has not been well studied and most available information is anecdotal in nature. However, a literature review of existing information on known and likely impacts of disturbance on nesting murrelets has been compiled by the US Fish and Wildlife Service (USFWS 2006) and is used, in part, as the basis for this section of the report. This review includes information on known impacts of marbled murrelets to disturbance activities, although all

Commented [JR-G\DoNR62]: The TR has discussed exposure to the elements as a primary factor in MAMU nesting success. Need more inform to support.

Commented [JR-G\DoNR63]: Un supported statement. Consider omitting.

Commented [JR-G\DoNR64]: Need cite to support also this risk decreases over time as adjacent stands age and less forage is available for predatory species.

Commented [JR-G\DoNR65]: Good point.

available information on actual murrelets is anecdotal in nature. The review also includes additional analyses from other species as well as information on decibel outputs from various activities (e.g., chainsaws, aircraft, etc.).

Timber harvesting activities can pose a conflict by creating disturbances that may disrupt normal nesting activities. Disturbance may result in reduced productivity by: 1) causing incubating adults to flush and leave the egg unintended, 2) causing adults delivering fish to the nest to flush and not feed the nestling (resulting in longer duration between feedings), 3) by causing chicks to flush off the nest too soon, before they are ready to fledge, 4) by attracting predators to the nesting area (USFWS 2006). All of these could pose a conflict by causing nest failure and thus reduced productivity, or by causing abandonment of the nest.

The US Fish and Wildlife Service developed guidance to evaluate potential for projects to negatively impact nesting activities of murrelets. This guidance is included as a component of various Biological Opinions (e.g., USFWS 2017). The USFWS guidance indicates activities near murrelets may cause a significant disruption of breeding activities such that injury (i.e., harassment) may occur. Activities considered likely to cause a disruption, and hence a conflict, include chainsaw and heavy equipment use, rock crushing, blasting, aircraft use, drone use, tree-climbing, and burning. Distances for disruption effects range from 330 feet for most activities to 1/2 mile for blasting and burning. Because nest sites are not typically known, the disruption distances recommended by the USFWS are typically based on the edge of an occupied habitat patch.

Examples of forest operations and associated activities not likely to pose a conflict would include reforestation, timber cruising and wildlife surveys (that do not involve tree climbing), pre-commercial thinning using non-powered equipment, standard road maintenance (e.g., road grading) and log hauling. In addition, activities that may cause a conflict within close distances during the nesting season would not be expected to pose a conflict if they occur outside of the nesting season or far enough away to not cause a disruption of nesting behavior.

Protection requirements—range of options

As a part of a technical report, under OAR 629-680-0100, protection requirements and exceptions must be proposed. The initial petition (Cascadia Wildlands et al. 2016) included recommended protection requirements including proposed rule language. However, in the Department's review of the petition, it was determined much of the proposed protection was outside the authority of the Board (ODF 2017a).

There are a range of possible protection strategies for marbled murrelets which would vary depending on many factors including how the resource site is defined for this species. The Department believes the Board will need to define the resource site for marbled murrelets prior to addressing specific protection strategies for marbled murrelets. Thus, rather than recommend one specific protection strategy, a range of general protection strategies that the Board might consider are described below.

Commented [JR-G\DoNR66]: The review has little basis in science. Should be cautions developing assumptions based on anecdotal information. Stick to research based information. Recommend omitting disturbance references.

Commented [JR-G\DoNR67]: Not substantiated.

Prescriptive Approaches to Protection

One method to protection is to have a prescriptive approach where best management practices and recommended standards are described in detail. These approaches are commonly used in development of regulations, but might also be suitable using a voluntary measures approach.

If the resource site is defined as the nest tree, the location of an occupied detection, or some other specific point on the landscape, a strategy where protection is centered around that point (or group of points) might be applied. This would follow a similar method as used for current FPA rules for wildlife (i.e., northern spotted owl, osprey, bald eagle, and great-blue heron). Once the resource site is defined, the Department would need to develop and maintain an inventory of known sites for marbled murrelets. Currently, landowners are not required to conduct surveys for protected species under the FPA. Instead, inventories are developed and maintained using readily available information compiled primarily from other governmental agencies (e.g., ODFW, BLM, USFS). The Department has some data already, but would need to determine availability and request additional information from other entities (e.g., other state and federal agencies, tribal governments, private landowners, etc.) (ODF2017a).

Protection standards for a point-centric approach would include 1) protection of the resource site and its key components (e.g., replacement trees and habitat buffer) around the point or points, and 2) seasonal restrictions for forestry activities within a certain distance of the point location to protect any nesting birds from disturbance during a critical use period.

Key components of a marbled murrelet resource site need to be identified. Key components are the attributes that are essential to maintain the resource site over time (OAR 629-600-0100 (39)). The key components may vary depending on how a resource site is defined. However, they are likely include replacement trees and a buffer of additional habitat to help protect nests from the elements, risk of blowdown, and to help minimize risk of nest predation due to edge-effects. A replacement tree is typically a tree with the suitable features to be used for nesting, either as an alternate nest tree or as a replacement if the original nest tree should fall down.

Possible options for habitat protection might range from a fixed buffer around a known point location to identification of a polygon of habitat. Both would need to include adequate habitat area to protect the site(s) to avoid a conflict (i.e. site abandonment or reduced productivity). The extent of the habitat area to be included in protection might be identified using the survey protocol or a user-identified polygon of suitable habitat of a specific minimum size. The latter approach would be similar to the existing rules for spotted owls, where a core area of suitable habitat is required to be maintained around nest sites or activity centers. A summary of these options, including pros and cons of each approach are included in Table 3.

As previously mentioned, should the Board determine to identify suitable habitat (e.g., presumed occupied habitat) as a resource site under the FPA, significant additional work would need to occur. Included in this additional work would be identification of appropriate protection strategies. Thus, protection strategies for this approach are not described here and not included in Table 3.

Commented [JR-G\DoNR68]: Based on the literature review, there isn't enough data support any of these options at this time. Furthermore based on status and trend data the need for protection measures is difficult to justify.

Table 3: Possible options for habitat protecting strategies for marbled murrelet resource sites.

Option	Description	Pro's to this approach	Cons to this approach
1: Polygon of habitat associated with protocol surveys	Polygon that identifies an area surveyed within which occupied detections were observed	• Based on surveys using a standardized protocol	• Survey boundaries are somewhat arbitrary and typically based on boundary of a proposed operation (e.g., timber harvest) and associated buffer, thus they are not necessarily biologically based. • May include stations with no detections or only presence detections • Not known if nesting actually occurred; may identify polygons for protection that not actually used for nesting • Not available unless surveys conducted based on protocol standards
2: User-Identified Polygon	A polygon of habitat around known nest site(s) or occupied detection(s) that would be identified by the operator	• Similar to the core area approach used for spotted owls • Approach can be used for data not obtained from protocol surveys • Boundaries can be established based on biological criteria such as extent of suitable habitat, topography, etc.	• Would require additional work to identify the parameters to be used to identify the extent and location of habitat to be protected • Might under or over protect marbled murrelet nesting sites

Commented [JR-G\DoNR69]: Not ripe for discussion at this time. There is still a lot of research needed to validate the need and definition of a resource site for MAMU.

Prescriptive Approaches—Summary and Additional Work

If the Board determines a prescriptive approach should be used for marbled murrelets, additional work would need to be conducted by the Department and subsequent decisions may be needed by the Board of Forestry. This would include but not necessarily be limited to the following:

- Defining suitable habitat for marbled murrelets
- Identification of key components for marbled murrelet resource sites[6]
- Defining the extent of habitat to be protected, and how it will be identified
- Describing forest activities to be limited or allowed within protected habitat
- Defining the critical use period
- Defining the zone, within which forestry activities would be limited during the critical use period to avoid disturbing nesting birds
- If suitable, or presumed occupied, habitat is used to define a resource site, a significant amount of new work is needed (see text of document)

Programmatic Approaches to Protection

Programs that encourage or incentivize maintenance or development of suitable marbled murrelet habitat on their lands are an option to encourage voluntary actions by landowners. Possible voluntary, programmatic approaches the Department could use include 1) Development of a Programmatic Safe Harbor Agreement (SHA) for marbled murrelets with the USFWS, 2) use of the existing Stewardship Agreement program to encourage voluntary actions to conserve habitat. These voluntary measures are described below.

Programmatic Safe Harbor Agreement

A Safe Harbor Agreement is an option available under the federal Endangered Species Act. This program encourages nonfederal landowners to voluntarily enhance and maintain habitat for a listed species by providing assurances the USFWS will not impose additional restrictions because of their voluntary conservation efforts, as long as the result is a net conservation benefit for the species. This program is available now, however individual landowners would need to enroll individually with the USFWS. Under a programmatic Safe Harbor Agreement, the Department would enter into an agreement with the USFWS and would then work with individual landowners to enroll them into the Programmatic SHA. The programmatic approach to the SHA is an efficient way to implement this program. It also allows landowners to work with the Department rather than directly with the USFWS. This can be beneficial because 1) landowners are already used to working with the Department through implementation of the Forest Practices Act, and 2) some landowners have an inherent fear or mistrust of federal agencies. The Department already has a Programmatic Safe Harbor Agreement with the USFWS for the northern spotted owl (USFWS et al. 2010), thus, there is already a precedent for

[6] Defined in FPA OAR 629-600-0100 (39) as attributes which are essential to maintain the use and productivity of a resource site over time.

using this approach. Currently there are 13 properties and 3,484 acres enrolled in the Programmatic Safe Harbor Agreement for spotted owls.

While SHAs may take many forms, most SHAs involve three elements: 1) a definition of species populations or habitat conditions at the start of the SHA (baseline), 2) commitments from the landowner to conduct, or refrain from, specific actions affecting the species, and 3) a timeframe over which these actions will occur, after which the landowner is permitted to return the lands to the defined baseline condition. Under a programmatic SHA, the Department would hold the permit. If a landowner wished to be included in the terms of the SHA, they would agree to actions described in the programmatic SHA to conserve or develop habitat for marbled murrelets. A baseline for their lands would be established at the time of enrollment, defining the starting conditions at the beginning of the Agreement. The landowner is then issued a certificate of inclusion which authorizes the landowner to return the property to pre-agreement conditions (baseline conditions) at the end of the commitment period. For example, if a landowner creates habitat for marbled murrelets over the term of the agreement, they can remove that habitat at the end of the agreement without being subject to ESA take regulations. Even with a programmatic SHA available, individual landowners could still opt to develop their own SHA with the USFWS.

Stewardship Agreement Program

The Department's Stewardship Agreement Program was developed to 1) provide efficiencies for a landowner for implementation of the Forest Practices Act regulations on their property and 2) to encourage landowners to provide for conservation, restoration, and improvement of fish and wildlife habitat and water quality. This program was also intended to be a mechanism to allow for coordination and implementation of incentive programs. The Stewardship Agreement Program is a required component for implementation of the current Programmatic SHA for spotted owls and would also be required under a SHA for marbled murrelets. However, the Stewardship Agreement Program is also a possible mechanism to encourage voluntary actions for marbled murrelets as a stand-alone program.

The Stewardship Agreement Program allows the Department to provide regulatory certainty to landowners in certain situations (ORS 541.423 (7)). If, in a Stewardship Agreement, a landowner identifies specific voluntary actions that exceed regulatory requirements, the Board may agree to exempt the landowner from future changes to a specific rule under the Forest Practices Act. Because there are no rules in the Forest Practices Act specific to marbled murrelets, the Department cannot currently grant regulatory certainties relating to rules for murrelets. However, if during this process or at a future time the Board does develop rules for marbled murrelets, regulatory certainties may be granted. Stewardship Agreements may also be a tool that can be used to provide regulatory certainties at a state-level for landowners who have a Habitat Conservation Plan with the USFWS that addresses marbled murrelets, assuming that HCP actions exceed what is required by rule under the Forest Practices Act.

Although regulatory certainties cannot be granted at this time for any future rules for marbled murrelets, a landowner may still enroll in this program now to conserve habitat for marbled murrelets. The landowner may still obtain other benefits of this program, such as regulatory efficiencies (exemption from written plan requirements) and regulatory certainty for rules already in place (e.g., stream protection rules). Should the Board develop rules for marbled murrelets after the time an Agreement is already in place, the Agreement can be re-evaluated and amended as needed to obtain certainties for murrelets under the FPA.

Next Steps

A general summary of next steps was presented to the Board of Forestry in April of 2017 (ODF 2017b). However, subsequent work may depend on decisions made by the Board of Forestry during this rule analysis process.

As described to the Board in April 2017, this Technical Report will undergo a review by subject experts. The purpose of the review is to evaluate the literature used and content of the report, to ensure that the "best available information" is presented to the Board for their decision-making process.

Following the Expert Review, the Department will summarize the input received and create an amendment to the Technical Report, if needed. This information will then be presented to the Board at a subsequent meeting. Also, as described in the March 2017 Progress Report to the Board of Forestry, additional work is needed to help inform the decision-making process. This includes consultation with other agencies, additional analysis as required per ORS 527.714, and consideration of impacts from ballot measure 49 and associated statutes (ORS 195.305). ORS 527.714 requires additional review and that certain standards are met before new Forest Practices Act rules can be enacted. ORS 195.305 resulted from ballot measure 49 and allows claims to be made for compensation if new regulations affect the fair market value of a property; alternatively the claimant may request an exemption from the new rule. Thus, additional work will be needed to 1) conduct the required analysis under ORS 527.714 and 2) to understand the implications of ORS 195.305 on any new regulations for marbled murrelets.

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3) Michael Rochelle
Wildlife Biologist with Weyerhaeuser Company

From: Rochelle, Mike [mailto:Mike.Rochelle@weyerhaeuser.com]
Sent: Tuesday, August 14, 2018 3:47 PM
To: WEIKEL Jennifer * ODF <Jennifer.Weikel@oregon.gov>
Subject: Draft Marbled Murrelet Technical Report Review

Hey there,

My red-line version of the MAMU Tech Report is attached. First of all, thanks for the opportunity to participate and for allowing broad representation from the various interested stakeholder groups. The inclusiveness and transparency with which your agency is conducting this process is appreciated.

As I'm sure you assumed would happen, I was offered input and edits from a slightly larger group: OFIC, Hancock, & Cafferata Consulting all participated. I appreciate your willingness to allow a wider range of voices to be heard; as the stakeholder rep for Private Forest Landowners I felt it was important that I solicit broader input beyond just my/Weyerhaeuser's point of view.

As requested (and as specified in the Charter), all comments and edits are incorporated into this single document. And while I did make reference to the Pearson et al 2018 document, I did not include it. Figured you've been provided a copy multiple times at this point.

Regards,
MR

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Marbled Murrelet Technical Report
Draft

April 25, 2018

Photo Credit: Gus van Vliet, USGS

Report developed by Jennifer Weikel, Wildlife Biologist
Private Forest Program, Oregon Department of Forestry

Table of Contents

Executive Summary

In 2016, the Board of Forestry (Board) received a Petition to Initiate Rulemaking for the marbled murrelet under Forest Practices Act (FPA) specified resource site rules. The Board directed the Department to begin work on this rule analysis and received an update and an initial timeline for work to be completed at their meeting in April 2017. The Board's evaluation for possible rule-making is to be based on best available information summarized in a technical review paper. The technical review paper must include information on identification of the resource site(s) used by the species, identification of forest practices that conflict with the resource sites, evaluation of the biological consequences of those conflicts, and include information on protection requirements and exceptions(from OAR 629-680-0100(1)(a)). This technical report was developed to evaluate this required information as well as to provide information on the ecology and habitat use of marbled murrelets. While this report is intended to inform the rule analysis project and the Board's decision making process, additional work and analysis will be needed prior to decisions on possible rule-making.

The marbled murrelet is one of the only seabirds and the only species in the alcid family that nests in forested environments. They spend most of their life at sea, rely primarily on very old conifer stands for nesting but are also known to nest in residual old trees within younger stands and in younger hemlock-dominated stands heavily infested with mistletoe in NW Oregon. Nests are typically located on a suitable platform, usually on a large, mossy, horizontal tree branch. Nests are normally in the mid to upper portion of the tree, typically about 100 feet above the ground and with vegetative cover adjacent or above the nest. The presence of suitable platform limbs is considered one of the most important nesting habitat features for this species.

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Marbled murrelets have narrow habitat requirements and are secretive in nature when inland. They primarily visit their nest sites at dawn and dusk when they are less likely to be detected by potential predators. They are difficult to detect, and tend to nest high up in the canopy. Thus, nests are extremely difficult to find. Because of this, there are still gaps in our knowledge of habitat use by this species, especially for nesting birds in Oregon.

The relationship between marbled murrelet nest site selection, nest success and landscape characteristics is complicated and available information does not allow us to determine a consistent trend. There is little information available in Oregon. Research from across the entire range of the species has found various patterns for how landscape pattern (i.e., amount and fragmentation of suitable habitat) impacts murrelets. There is some evidence that murrelets may tend to locate nests near forest edges (natural and human-created), but that in some situations they experience lower rates of nest success near edges, especially human-created "hard" edges.

Since 2000 a team of researchers from several state and federal agencies have collaborated to monitor murrelet populations across Washington, Oregon, and California. The monitoring

strategy was designed to estimate population size and trends in these areas. The latest report affirmed that "these are the only data available for assessing murrelet recovery" (Pearson et. al 2018). In this report, Oregon population surveys conducted between 2000 and 2016 indicate that the population is trending positive at a statistically significant rate. Results for the state-wide population trends for Oregon through 2016 indicate an increase of +1.8% per year (95% CI from 0.1 to +3.6) between 2000 and 2016.

Because additional analysis will need to be considered at a later date, and because identification of the resource site is the first key question that must be decided by the Board before other policy work can occur, this technical report does not include policy recommendations. Rather a range of options is included, where appropriate. Details for protection strategies will be included in a future rule-analysis report.

Unlike existing birds species with rules under the FPA that are highly visible or that have established methods to locate nests, marbled murrelet nests are extremely challenging to locate and there is no efficient and effective method to locate nests. Thus, identification of only the nest tree as the resource site for this species is likely to be insufficient. Another option for identifying the resource site is to include locations of occupied detections as a proxy for nest sites. A third option would be to use designated potential suitable habitat as a resource site. In this context, the habitat would be presumed occupied by the species until additional work is conducted to determine that the area is not actually suitable nesting habitat (e.g. trees with suitable nesting platforms are not present) or not occupied by murrelets (i.e., as determined through surveys).

Because marbled murrelets nest in forested environments, conflicts between forest practices and marbled murrelets are likely to occur. Most conflicts will occur from forest harvesting, with conflicts likely due to loss of nests during logging, disturbance to nesting birds or increased risks to nesting birds from increased exposure to the elements or increased risk of depredation of nests by predators.

Because protection strategies for marbled murrelets may vary greatly depending on the Board's decision regarding definition of a resource site, specific strategies are not addressed in this report. Instead, a range of possible protection strategies for this species are discussed. Both prescriptive approaches and programmatic approaches are addressed in the report. Prescriptive approaches would describe best management practices to protect sites and could be codified as regulations or as voluntary measures. Programmatic approaches include use of Safe Harbor Agreements and Stewardship Agreements to encourage voluntary protection and development of suitable habitat for marbled murrelets.

Future policy work is needed to inform this discussion (ODF 2017a). As per OAR 629-680-0100 (1)(b), this technical report must undergo a formal "Expert Review". Feedback from the review will be summarized and included in a subsequent report that will be delivered to the Board.

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Background

In June 2016, the Board received a Petition to Initiate Rulemaking for the marbled murrelet under Forest Practices Act (FPA) specified resource site rules. The Board considered the petition during their meeting on July 20. Acting within its authority under the Administrative Procedures Act, the Board denied the petition. In September, the petitioners submitted a Petition to Review an Agency Order through the Lane County Circuit Court to request the court compel rulemaking. In November, the Board held a public meeting and accepted public comment to reconsider their decision to deny the petition for rulemaking. After consultation with the Oregon Department of Justice, the Board voted to withdraw and reverse its previous decision on the rulemaking petition.

In March 2017, the Board received an update on this rule analysis. A report was presented to the Board that included a review of the petition and a summary of work needed to be conducted as part of any rule-analysis process (ODF 2017a). It was determined the petition did not include adequate information for purposes of a rule analysis. The Board directed ODF Department staff (hereafter Department) to initiate development of a Technical Report on marbled murrelets as per OAR 629-680-0100.

This report was developed to meet the requirement for a Technical Report for purposes of informing the rule analysis process for marbled murrelets. The progress report presented to the Board in March of 2017 (ODF 2017a) outlined additional work to be conducted as part of this rule analysis project. Much of the additional work that needs to be conducted is related to statutes, rules, or measures put into effect after the Specified Resource Site process rules (OAR 629, Division 680) were enacted. Examples include 1) passage of the ORS 527.714 statute that requires additional analysis prior to adoption for some new Forest Practices Act rules, and 2) passage of Ballot Measures 36 and 49 which require compensation or waiving new rules that result in lost real estate value. This technical report is meant to fulfill only the needed information for a Technical Report under OAR 629-680-0100 (1)(a). The Department envisions the rule analysis project, as a whole, will involve multiple steps and decisions by the Board. The decision on protection measures for marbled murrelets is likely to occur at a later date, after the Board has heard all of the pertinent information on this topic and considered input from stakeholders. Thus, specific protection measures for marbled murrelets are not recommended in this report. Instead, a general discussion of a range of possible protection measures is included.

Requirements for Rule Development

When a species is added to either the federal or state Endangered Species Act lists (T&E), protection rules under the FPA may be warranted. However, every listed species does not necessarily warrant development of FPA rules. Instead, the focus is on species that occur in forestland and that may be negatively impacted by forest practices. The process to evaluate T&E listed species for possible rule-making under the FPA is laid out in statute (ORS 527.710) and in administrative rule (OAR 629-680-0100).

For a species to qualify for rules under the FPA, the following criteria must be met:

1) The species must be on state or federal Endangered Species Act lists.
2) One or more forest practices must conflict with the sites used by the species.

Forest Practice in this context can be any kind of operation regulated under the FPA such as timber harvest, road construction, application of chemicals, etc. (see OAR 629-605-0050 (26)). Conflict would occur if the resource site is abandoned, or if productivity (e.g., nesting success) at the site is reduced (OAR 629-600-0050 (14)). In most cases, conflict for a resource site occurs from habitat modification or disturbance during key periods of use.

The Board's evaluation for possible rule-making is to be based on best available information summarized in a technical review paper. The technical review paper is to include the following information (from OAR 629-680-0100(1)(a)):

1) Identify the resource sites used by the species
2) Identify the forest practices that conflict with the resource sites
3) Evaluate the biological consequences of the forest practice conflicts
4) Propose protection requirements and exceptions for the resource sites

This report provides information on the general ecology and habitat use of marbled murrelets, but also addresses the specific criteria that must be included in a Technical Report. The report builds off of the original Petition for Rulemaking (Cascadia Wildlands et al. 2016) and also draws from the ODFW Draft Status Review report (ODFW 2018), the 20-year update on the NW Forest Plan (Falxa et al. 2016), the ODF-sponsored systematic evidence review for marbled murrelets (Plissner et al. 2015), and other available literature as appropriate. This report is not meant to be a complete literature review on marbled murrelets, but a targeted summary of available information pertinent to the rule-analysis project and the specific requirements of a Technical Report under OAR 629-680-0100 rules.

Marbled Murrelet Biology & Habitat Characteristics

General Life History & Characteristics

The marbled murrelet is a small seabird that spends most of its life on the ocean, but in Oregon, nests almost exclusively in trees in coastal forests. They do not build a nest, but instead lay their egg directly on mossy limbs or other suitable flat platforms in the forest canopy. For this reason, they tend to nest predominantly in very old conifer forests where large-diameter trees with broad, horizontal branches suitable for nesting are most abundant. Throughout most of Oregon, nesting habitat is characterized as very old conifer forests (typically Douglas-fir) or younger forests with a component of residual old conifer trees. In the north coast of Oregon, they are also known to nest in mid-aged (60+ year old) conifer stands, primarily in hemlock stands with a component of mistletoe defect. The mistletoe infections cause branch deformity

and create flattened areas with debris that can function as suitable nesting platforms. See the Nesting Habitat section of this report for additional information.

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During most of the year, murrelets have white and black plumage that is typical for many seabirds. During the nesting season, they molt into a light brown, mottled plumage. It is thought that this plumage is an adaptation to camouflage in their forested nesting environment.

Marbled murrelets spend most of their time at sea, where they are typically found foraging nearshore (within 3.1 miles of shore) or in bays and inlets (Nelson 1997, ODFW 2018). During the breeding season, murrelets feed on primarily on small fish, including northern anchovy (*Engraulus mordax*), smelt (*Osmeridae sp*), and Pacific herring (*Clupea pallassi*) (ODFW 2018). Whereas adult murrelets tend to consume larval or juvenile fish, they tend to deliver larger sized adult fish to chicks. This is likely a mechanism to maximize the nutritional value delivered to chicks while also minimizing energetic costs due to long flights inland as murrelets feed whole prey to their young. Murrelets are considered an opportunistic forager in that they consume a variety of prey species and will switch prey species depending on availability (ODFW 2018). However, there is growing evidence that poor ocean conditions may be having a negative impact on the quality of diet for murrelets, which in turn may be linked to poor reproductive output (ODFW 2018). One study on this topic in British Columbia used isotopic analysis of museum specimens to examine changes in likely diet quality of murrelets over a 107-year period ranging from the 1889 – 1996 (Norris et al. 2007). They found evidence of a reduction in nutrient-rich forage fish and in increase in zooplankton (a lower trophic food item that is less nutrient rich) in the diet of murrelets over this time period. Furthermore, they found evidence that populations of murrelets in this region may have been limited by diet quality over the time period studied.

When nesting, the female lays a single egg. Adults share incubation duties, switching roughly every 24 hours. The eggs hatch in 28-30 days. Adults typically brood the chick for only one to two days, although some will brood for up to five days but only at night. Both adults then begin to spend much of their time at sea foraging, leaving the chick unattended in the nest. Adults bring one whole fish inland to feed the chick, one to eight times per day. Young birds fledge 27-40 days after hatching. Young fledge on their own and fly to the ocean.

Marbled murrelets have a relatively long and asynchronous nesting season (meaning that individuals do not all nest at the same time). The murrelet nesting season in Oregon is thought to begin in mid-April and extend through mid- to late September (Hamer and Nelson 1995, Hamer et al. 2003, McShane et al. 2004). In Oregon, the incubation phase ranged from mid-April through August 15 and the nestling phase ranged from approximately May 15 to September 15. Approximate time period for fledging of young ranged from mid-June to mid-September (Hamer et al. 2003).

Although murrelets only use inland habitats for nesting, adult murrelets have been documented flying inland during most months of the year except for when they are molting

(spring and fall). The reason for the non-breeding season flights inland are not well understood, but it is thought that birds are possibly establishing pair bonds or prospecting for nesting sites. Most inland activity occurs during the breeding season. The peak period of inland flights is typically in July. Although inland flights can occur at any time of day, most of the inland activity occurs around dawn and dusk.

Because marbled murrelets are rare, cryptic, and secretive, locating their nests is extremely difficult. The first marbled murrelet nests were not found until the 1970's and as of 2017, only 75 nests have been confirmed in Oregon (ODFW 2018). In Oregon, murrelets have been detected as far inland as 80 miles, but the furthest inland nest known was at 31 miles and the furthest inland observation of an occupied behavior was at 40 miles (Nelson 2003, ODFW 2018). Most of the early known nests in Oregon were located incidentally when eggshells or chicks were located on the ground, nest trees were inadvertently felled during logging, or when birds were observed landing in trees. Nests have also been located by climbing potential nest trees during research projects or as an alternative survey method (Pacific Seabird Group 2013). In other regions, nests have been located by capturing and placing tracking devices (telemetry receivers) on birds, and then locating them inland when they are at their nest sites (e.g., Zharikov et al. 2007, Burger et al. 2009, Silvergieter and Lank 2011, Lorenz et al. 2017). This method is currently being used for a study in Oregon; during the first year of the study, no murrelets came inland to nest (J. Rivers pers. comm. 2017) but as of July 30 2108 there are 7 confirmed nests in year 2 (2018) of the study (J. Rivers pers. comm. 2018).

Fidelity is the propensity of individuals to use the same area for nesting repeatedly. However, the topic of site fidelity by marbled murrelets is not well studied using rigorous studies (Plissner et al. 2015). Plissner et al. (2015) provides a comprehensive review of studies that included information on site fidelity and their results are summarized here. They found evidence that murrelets may return to the same watershed, stand, and even the same tree to nest in subsequent nesting seasons (Plissner et al. 2015). This is largely based on studies that have used tree-climbing to find and characterize nests of murrelets. Because of the difficulty in reading bands on marked birds and the lack of telemetry receivers that allow for tracking of individuals over multiple seasons, information on fidelity of specific individuals is lacking. One study in California documented a single marked bird returning to the same nest annually for over a decade (Golightly and Schneider 2011). One marked individual in British Columbia was tracked using telemetry in two years (1999 and 2001) and was found nesting in the same stand; the two nests were approximately 650 feet apart (Burger et al. 2009).

There is evidence that if a nesting attempt fails, particularly if failure occurs during the incubation phase, some proportion of pairs will attempt to renest. In their review of the literature for this topic, Plissner et al. (2015) found five studies that explicitly discussed renesting attempts. In those studies, it appeared the percentage of pairs that attempted to renest after a failure ranged from roughly 16% to 34%. When nesting attempts fail, there is evidence birds may return to the same stand when renesting (Plissner et al. 2015). Reuse of a nest tree or stand may be higher in areas where habitat is limited. One study that looked at relative rates of re-use across three regions in British Columbia found greater evidence of

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multiple nests or reuse of nest sites in all three regions. The authors noted that the two study areas with a greater history of logging had greater evidence of multiple nests and reuse than the study area with little to no logging history and surmised that nest reuse may be more likely in areas where nesting habitat is limited (Burger et al. 2009). It should be noted however that there is no research in Oregon on this subject.

Unlike many other species of seabirds, murrelets may not nest in colonies (multiple nests in very close proximity), but instead may be somewhat solitary. However, there are documented occurrences of multiple nests (active or older nests) within the same general area (e.g., within 300 feet of each other) or within the same stand or watershed. One study in Oregon found two active nests located within 98 feet of each other (Nelson and Wilson 2002). Most of the available information of this topic is based on finding nests of various ages (active or older nests). In their review of the literature on this topic, Plissner et al. (2015) found five reported examples of nests being located within 330 feet of each other. They also reported four examples of nests located between 660 feet and 0.6 miles of each other, and five examples of nests located at a greater distance of up to 7.5 miles from each other which may indicate a broad distribution of nests (rather than evidence of a clumped distribution). Plissner et al. (2015) found only one robust study on this topic (Zharikov et al. 2007). Using nests from a large number of radio-tagged murrelets in BC, Zharikov et al. (2007) found the mean nearest nest distance (n = 157 nests) was over 2.5 miles in their two study areas. All of the inter-nest distances reported are considered rough estimates, however, as it is unlikely all of the nests were located in any of the studies.

Population Status and Trends

Overall population trends

In Oregon, as well as California and Washington, murrelet population numbers and trends are evaluated and monitored by counting birds at sea. As a component of the Northwest Forest Management Plan Effectiveness Monitoring Program, a large-scale effort has been conducted to estimate populations annually across Washington, Oregon, and California since the 1990's (see Falxa and Raphael 2016 and Lynch et al. 2017). Surveys are conducted within conservation zones, as established by the Marbled Murrelet Recovery Plan (USFWS 1997). Surveys in Oregon include conservation zone 3 and a portion of conservation zone 4 (Figure 1). The overall population estimate for murrelets in Washington, Oregon and California as of 2015 is 24,100 birds (95% confidence interval [CI] of 19,700 to 28,600). The overall population trend from 2001 – 2017 shows an increase of 0.15% per year (95% CI from -1.2 to +1.5), however this trend is inconclusive as the confidence interval overlaps zero and the trend is not statistically significant (P=0.824). Population trends vary by state and conservation zone. There is statistically significant evidence of population declines in Washington (-3.9%/year [CI of -6.1 to -1.7]; P=0.002), statistically significant evidence of a population increase in Oregon (see below), and statistically significant evidence of a population increase in California (+4.5%/year [CI +2.2 to +6.9]; P=0.001).

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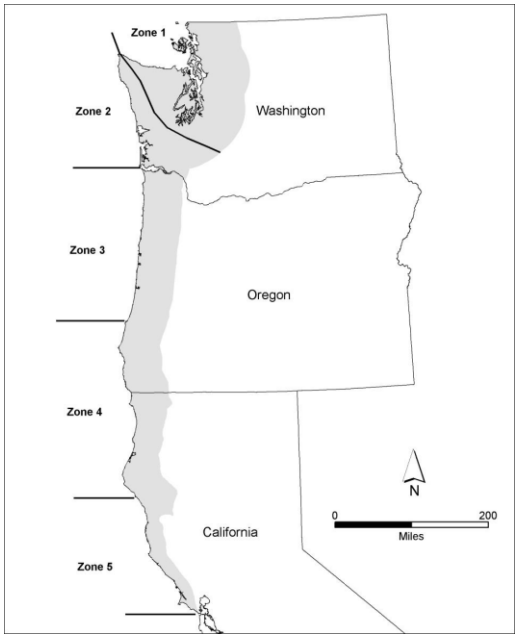

Figure 1: The five at-sea marbled murrelet conservation zones adjacent to the Northwest Forest Plan area (from Lynch et al. 2017).

Oregon-specific population trends

Oregon surveys were conducted between 2000 and 2017, however, only conservation zone 4 was surveyed in 2017 (see Figure 1). Results for the state-wide population trends for Oregon through 2016 indicate an increase of +1.8% per year (CI from 0.1 to +3.6) between 2000 and 2016. The data indicates a statistically significant increasing population trend in Oregon (P=0.042).

Listing status

Marbled murrelets are currently listed as a threatened species under both the federal Endangered Species Act and Oregon's State Endangered Species Act. They are listed as Endangered under the Washington and California state Endangered Species Acts. The Oregon Fish and Wildlife Commission recently declined a petition to uplist the species to Endangered in Oregon after weighing all of the pertinent and available information on the subject. They did, however, elect to craft Advisory Survival Guidelines which equate to suggested voluntary actions for land managers to consider on stateowned lands.

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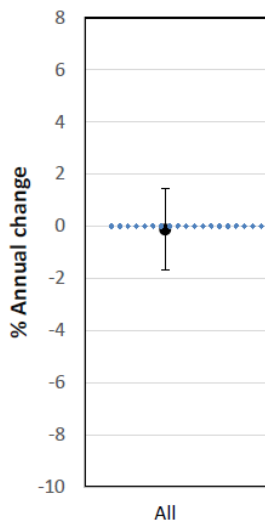

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Marbled murrelet habitat quantity and trends in Oregon

The recent Marbled Murrelet Status Review for Oregon (ODFW 2018) provides a summary of trends in habitat for marbled murrelets from the time of listing to now. Most of the discussion in the Status Review is from a habitat modelling effort conducted as part of the federal Northwest Forest Plan Effectiveness Monitoring (Raphael et al. 2016a). As with all models, the outputs represent predicted habitat, not actual habitat. The model used in Raphael et al. (2016a) separated potential habitat into four broad categories. Each category reflects a "bin" of habitat with varying scores on their habitat suitability index. The four bins are assigned Classes and names, using the terminology of Class 1--lowest suitability; Class 2--marginal suitability, Class 3--moderate suitability, and Class 4--highest suitability. Raphael et al. (2016a) considers Class 3 and 4 to represent "higher suitability habitat" and uses these two categories for their estimates of predicted habitat where the likelihood of detecting murrelets (presence) or the likelihood of nests or occupied detections is greatest. While there are criticisms with the habitat model used in Raphael et al. (2016a) (see public comments for ODFW 2018), these models represent best available information at this time.

Total amount of suitable marbled murrelet habitat is widely believed to have declined significantly in the last 100 years due primarily to logging and wildfire (see ODFW 2018 for review). Since the time of listing, Raphael et al. (2016a) estimated that amounts of modeled higher suitability habitat (Class 3 and 4) declined by 9.2% (78,600 acres) between 1993 and 2012. Although total modeled higher suitability habitat was predicted to be much more abundant on federal ownership classes, relative reductions were greatest on the non-federal ownership class (59,000 acres) as compared to the federal ownership class (19,000 acres). Most of the estimated loss on non-federal ownership class was due to logging whereas most of the estimated loss on the federal ownership class was due to fire.

Because Raphael et al. (2016a) reported amounts of modeled higher suitable habitat only to the ownership classes of federal and non-federal, the amount predicted to occur on private lands was not reported. However, in their species status review, ODFW (2018) used the data available from Raphael et al. (2016a) to further estimate habitat conditions as of the 2012 modeled habitat year by land ownership class in Oregon. Their analysis predicted that as of 2012 (the modeled habitat year), amounts of modeled higher suitable habitat by land ownership or management class are as follows:

- U.S. Forest Service (55%)
- Bureau of Land Management (16%)
- Oregon Department of Forestry (15%)[1]
- Private (12%)
- Other (2%)

[1] ODFW estimates do not reflect the recent change of management of the Elliott State Forest to from ODF to Department of State Lands.

Commented [RM2]: Available USFS FIA data could be analyzed to estimate acres within the range of the murrelet in Oregon in varying categories, such as age classes, and offer an alternative to the modeled data provided in the Raphael report. Verschuyl and Prisley conducted such an analysis as part of the ODFW status review process, and while unpublished, their findings could be used as an example of how an analysis could be completed. In their white paper, the analysis suggested that much of the forest area along the Pacific is entering in to age classes which may provide murrelet nesting habitat, and that the trend in available habitat would appear to be increasing over time.

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Additional work is needed to further examine the distribution of suitable habitat in Oregon. For example, the relative distribution of suitable habitat on private industrial versus private non-industrial lands is not known. In addition, a more detailed analysis of forest conditions and anticipated recruitment of suitable habitat on all forest ownership classes in Oregon is anticipated to be important to the Board's decision-making process. The Department plans to conduct this work during a later phase of this project.

Marbled Murrelet Nesting Habitat Characteristics

Nesting platform/ actual nest site location

ODFW (2018) summarized nests and nest trees for all known nests in Oregon (see Table 1). Plissner et al. (2015) provided a summary of habitat associated with nesting of marbled murrelets, across their range.

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Table 1: Selected marbled murrelet nest tree (table 1a) and nest (table 1b) characteristics for Oregon. Data were provided by S.K. Nelson for all 75 nests found in Oregon since 1990. Mean values are shown for variables measured, along with standard deviation (SD), range, and sample size (n, number of nests). Adapted from Table 1 in ODFW (2018); only change is conversion of values from metric to English.

Table 1a. Nest tree characteristics

	Tree DBH (in)	Tree Height (ft)	No. Platforms in Nest Tree	Distance from Ocean (mi)	Distance to Edge (ft)	Elevation (ft)
Mean	55	184	26	14	167	1083
SD	19	46	19	6	148	492
Range	19 – 110	108 – 279	8 – 92	0.6 - 30	0 - 607	174 - 2024
n	70	70	46	75	75	75

Table 1b. Nest Characteristics

	Nest Limb Height Above Ground (ft)	Nest Limb Diameter at Trunk (in)	Limb Diameter at Nest (in)	Distance from Trunk (ft)	Nest Platform Width (in)	Moss Depth Adjacent to Nest (in)	Duff and Litter Depth in Nest Cup (in)	Percent Horizontal Cover (side)	Percent Vertical Cover (overhead)
Mean	118	9	9	3.6	10	1.7	0.9	53	83
SD	46	4	4	3.8	4	0.9	0.7	19	21
Range	33 – 246	3 – 22	3 – 19	0 - 25	3 - 20	0 – 4.3	0 – 3.3	13 – 85	25 - 100
n	66	67	35	67	65	65	54	53	56

Nests are typically located on a suitable platform, usually on a large, mossy, horizontal tree branch. Nests are normally in the mid to upper portion of the tree, typically 100 feet above the ground (range 33 – 246') and with vegetative cover adjacent or above the nest (Table 1, ODFW 2018, Plissner et al. 2015).

Recorded diameter of limbs (at tree bole) used for nesting ranged from a minimum of four to a maximum of 29 inches (as reported across the entire range of the species); average limb diameter was more than six inches with most studies reporting an average width of more than ten inches (Plissner et al. 2015). Recorded diameter of actual platforms where birds laid their eggs ranged from five to 28 inches (Plissner et al. 2015).

Nest tree and nest patch

A variety of tree species are used for nesting, including Douglas-fir, western hemlock, Sitka spruce, coast redwood, and western red cedar (Nelson 1997). Conifers are known to be used almost exclusively for nesting in Oregon, Washington, and California, but a nest was located in a big-leaf maple in 2018 (K. Nelson, pers. comm. 2018) and nests have been documented in red alder in British Columbia (ODFW 2018). One ground nest has been documented in Washington (Wilk et al. 2016). Most known nests are in large-diameter trees in old-growth forests (> 200 years old; Nelson 1997, McShane et al. 2004). However, murrelets have also been found to nest in residual mature to old-growth-aged trees that occur within younger forests and in mature hemlock trees (66-150 yrs. old) that have heavy infections of mistletoe. The youngest recorded tree used for nesting was a 66 year old hemlock infected with mistletoe in the north coast range (Nelson and Wilson 2002). Mistletoe infections can create brooms, or cause branch deformity, resulting in fattened limbs, both of which can serve as platforms. Nests have been found on platforms and limbs of these mistletoe-infected hemlock trees (Nelson and Wilson 2002).

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Murrelet nests tend to have canopy gaps or other open areas near the nest location (ODFW 2018). This feature is important to allow murrelets access to the nest platform. Because murrelets are adapted for foraging in water, their wings are relatively long and narrow in relation to their body size (termed high wing loading). Thus, murrelets are not well adapted for flying or maneuvering in forest environments. They have to fly at high rates of speed (often > 44 miles per hour) in order to remain airborne and tend to approach their nest from below and "stall out" as they land. Thus, having an unobstructed area for approaches and take-offs from the nest are important.

Nesting stand

Because of their reliance on platforms for nesting which occur mostly on large limbs in large trees, suitable nesting habitat occurs primarily in old-growth or mature forests (McShane et al. 2004). Throughout most of Oregon, nesting habitat is characterized by mature to old-growth Douglas-fir stands or younger stands with a component of residual mature or old-growth trees. In the north coast of Oregon, murrelets are known to nest in younger-aged hemlock stands with heavy infestations of mistletoe.

The presence of potential nesting platforms is considered the most important characteristic of marbled murrelet nesting habitat (Nelson 1997). Murrelets select trees for nesting with more potential nesting platforms than what occurs on nearby trees. In addition, there is often a greater density of trees with platforms near nests than elsewhere in the stand (Plissner et al. 2015, Wilk et al. 2016). Density of trees with suitable nesting platforms in stands used for nesting by murrelets ranged from nine to 50 trees per acre; the minimum number reported was two platform trees per acre (Plissner et al. 2015). One study reported that the probability of a murrelet using a stand for nesting increased with increasing density of platform trees up to 40 trees per acre, after which there was no additional change (Silvergieter and Lank 2011). Murrelets tend to select nesting locations with vegetative cover over the nest, but also near gaps in the canopy to allow for access to and from their nesting platform (Nelson 1997).

Landscape pattern; relationship to nest selection and success

Information on the relationship between landscape pattern and fragmentation and nest site selection and nesting success is limited in Oregon. Most studies on this topic are from British Columbia where the forest type and landscape conditions are arguably different than in Oregon. Available information on this topic is summarized below.

Habitat use and nest site selection

Two studies in southern Oregon looked at the relationship between occupied detections and landscape patterns of old-growth forests. They found that the number of occupied murrelet detections were greater in unfragmented old-growth patches (Meyer et al. 2002) and that occupied areas tended to have less fragmented and isolated old-growth patches than did unoccupied areas (Meyer and Miller 2002). Occupied inland habitat also tended to be close to the coast and river mouths (Meyer and Miller 2002). Similar research has not yet been conducted in other regions of Oregon, or in a broader range of age-classes of forests.

Studies examining landscape patterns (e.g., distance from ocean, patch size, core area, and other metrics of fragmentation) using actual murrelet nests are limited in Oregon. Most research on this topic is from British Columbia, where the forest conditions and landscape patterns are arguably different from those in Oregon. Of the studies available, there is conflicting information with regards to whether marbled murrelets tend to nest in large interior blocks of habitat, far from forest edges[2] or if they are more general in their nest placement preference. Although murrelets are generally thought of as being negatively impacted by edge effects, a majority of nests have been found near edges, especially natural edges (see review in McShane et al. 2004). In contrast, one recent study in Washington found most nests occur in the interior of forests or in patches with a more interior habitat than at random locations (Wilk et al. 2016). Murrelets may tend to nest closer to edges or gaps as these openings provide ample flying room for adults coming into the nest site or for juveniles when they fledge

[2] The term edge refers to the break between a forested area and a non-forested area. The nonforested area may be natural (e.g., river, meadow, natural gap in the canopy) or human-made (e.g., road, clearcut harvest, development).

(McShane et al. 2004). The relationship between murrelet nests and forest edges may vary with the extent of habitat available in an area, with murrelets nesting near edges or in isolated fragments more frequently where habitat, particularly interior forest habitat, is limiting (McShane et al. 2004, Plissner et al. 2015).

Nest Success, nest predation & landscape conditions

Marbled murrelets are believed to have low reproductive success, meaning that a large majority of nesting attempts fail to result in successfully fledged young. The primary theory for low rates of success is that nests have high rates of nest depredation, primarily by corvids (jays, ravens, and crows) (ODFW 2018, Plissner et al. 2015). Existing research, primarily using artificial nests, indicates corvid abundance, and predation pressure on nests, is increased in stands near areas that provide additional food resources for corvids such as near human habitation or recreation areas and near stands with high cover of berry-producing shrubs (Plissner et al. 2015).

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The relationship between marbled murrelet nesting success and landscape characteristics is complicated and available information does not allow us to determine any consistent trend. Plissner et al. (2015) provides the most current review of available research on this topic (see Table 13 for additional information). Key information includes the following:

- There were no statistically significant results to indicate that rates of nest success was associated with stand size (Marzluff et al. 1999, Raphael et al. 2002, Zharikov et al. 2006, Zharikov et al. 2007, Nelson and Hamer 1995), platform density (Manley 2003, Silvergieter 2009), tree density (Manley 2003, Golightly et al. 2009, Silvergieter 2009), or canopy height (Silvergieter 2009, Golightly et al. 2009).
- Relationships have been reported between nest success and patch shape (positive association with compact versus linear shapes) (Marzluff et al. 1999), percent canopy cover (negative association) (Malt and Lank 2007 and Waterhouse et al. 2008) and canopy complexity (positive) (Waterhouse et al. 2008). Other studies found no relationship for one or more of these variables (Marzluff et al. 1999, Waterhouse et al. 2008).
- Conflicting results were reported on the relationship between stand age and nest success. Most studies did not report a statistically significant result (Manley 2003, Silvergieter 2009, Waterhouse et al. 2008). Malt and Lank (2007) found increased predation of artificial nests in landscapes with greater percentage of old-growth. In contrast, Zharikov et al. (2007) found that nest success (measured through tracking bird activity with telemetry) was negatively associated with the amount of young forests in the landscape.
- Conflicting results were found for the relationship between nest success and edges. Overall, five of nine studies reviewed by Plissner et al. (2015) reported positive associations between nest success and distance to edge, meaning nest success was higher further from edges.

- One study found that murrelets nesting closer to a "hard" edge[3] had lower nest success than murrelets nesting further from edges (Malt and Lank 2007). Another study, however, found murrelets nesting near hard edges had greater nest success (Zharikov et al. 2006) than murrelets further in the interior. At the landscape scale, however, Zharikov et al. (2007) found that nests in landscapes with greater contrast between the nest stand and neighboring units had lower nest success than in landscapes with less contrast (soft edges).
- The type of edge may have implications to nest success, with murrelets having lower nest success if nesting near a hard edge as compared to a soft or natural edge. Zharikov et al. (2007) reported that nests were more successful in landscapes with lower edge contrast (e.g., soft edges). Similarly, Malt and Lank (2007) reported reduced nest success at hard edges and no edge effects at soft and natural edges.

In general, it is documented that marbled murrelets locate their nests near canopy gaps, including forest edges, presumably to aid in the ability of the adult birds to access the nest as they fly in from the ocean. However, information on effects of landscape condition and fragmentation appears to indicate that those murrelets nesting near edges, especially hard edges, may suffer lower nest success than murrelets nesting further in the interior of a stand. Thus, there is a paradox that edges may improve access for murrelets, but sometimes at the cost of reduced nest success.

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Landscape condition and off-shore distribution of marbled murrelets

Range-wide, breeding season murrelet abundance off shore has been reported to be associated with the amount and condition (fragmentation level) of older forest condition inland, with higher densities of murrelets occurring offshore from areas with more and less fragmented older forests (Raphael et al. 2015, Raphael et al. 2016b). This is thought to indicate that murrelet populations and distribution patterns offshore are influenced by the amount of potential nesting habitat inland with birds tending to forage in close proximity to their nesting stands (Raphael et al. 2015). However, a recent study in Washington and British Columbia (Lorenz et al. 2017) found that some individuals not only travelled long distances inland, but also travelled long distances across marine environments to reach their foraging areas (mean distance travelled for 20 birds = 17.4 miles—range of 0.3 to 82 miles). This latter study suggests that some individuals may travel long distances across marine environments to reach suitable foraging areas rather than to forage immediately offshore from their nesting stand. In addition, recent preliminary information from a study in Oregon indicate that individuals that are not nesting may move long distances during the nesting season (Rivers personal communication). Thus, density patterns of birds offshore may not be entirely representative of populations of nesting birds. More work is needed on this topic.

[3] The term "hard edge" generally refers to an edge with a large amount of contrast, such as the edge between a meadow or a recent clear-cut and a mature forest stand. The term "soft edge" generally refers to an edge with less contrast. Examples of soft edges include an edge between a mature forest and a mid-aged stand of trees or an edge that has a more variable contrast such as a thinned or feathered boundary between the mature stand and an adjacent open area.

Existing Marbled Murrelet Survey Methods

The Pacific Seabird Group[4] has developed a survey protocol to determine if murrelets are using a forested area (Evans Mack et al. 2003). The protocol focuses on detecting murrelets and characterizing behaviors observed. A set of behaviors, called occupied behaviors, are key to characterizing use of forested areas. These behaviors include flying below the canopy (subcanopy flight), landing in a tree, stationary vocalization, and jet dives. Circling above the canopy is not considered an occupied behavior, but is considered indicative of potential occupancy and provides the basis for additional survey effort to attempt to observe subcanopy flights. In addition, some research studies include this behavior in their definition of an occupied behavior (Falxa et al. 2016). Research has documented that actively nesting murrelets exhibit these occupied behaviors near their nests (Plissner et al. 2015). Thus, observation of occupied behaviors are thought to indicate the area being surveyed is occupied by marbled murrelets and may be being used for nesting. Other types of observations of murrelets such as flying above the canopy and non-stationary vocalizations indicate that murrelets are present, but not necessarily using the area of interest for nesting.

The existing protocol for surveying for murrelets (Evans Mack et al. 2003) is designed to document the occurrence or probable absence of murrelets, and if murrelets are present, to determine if birds are exhibiting occupied behaviors. This protocol was not designed to locate marbled murrelet nest trees. The existing marbled murrelet survey protocol (Evans Mack et al. 2003) is the most frequently used method to survey for murrelets in forested stands.

Surveys conducted using the existing protocol survey result in three different scales of data[5]:

1) The Survey Station
2) The Survey Site within which one or more Survey Stations are located
3) The larger Survey Area within which one or more Survey Sites are located

These three scales are based on the design of the survey protocol. The Survey Area typically includes the area of interest (usually a proposed harvest area) and all contiguous suitable habitat within a ¼ mile. The Survey Area is then broken down into Survey Sites, which are smaller areas within which multiple Survey Stations are located. The Survey Station is where the observer looks and listens for murrelets. The survey protocol was designed so that, statistically, if surveys are conducted according to the protocol standards including the required number of visits, one will have a 95% chance of observing occupied behaviors should the Survey Site actually be occupied. The analysis that is the basis for the protocol was conducted at the

[4] The Pacific Seabird Group is a society of professional seabird researchers and managers dedicated to the study and conservation of seabirds and their environment. https://pacificseabirdgroup.org/

[5] Throughout this document, the terms Survey Area, Survey Site, and Survey Station are capitalized to indicate that these terms relate back to the definitions in the survey protocol (Evans Mack et al. 2003). If not capitalized, the terms area, site, and station are used generically and are not meant to refer to the definitions in the protocol

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scale of the survey site, thus the statistical probability is appropriately applied to the scale of the Survey Site. The protocol then recommends results be extended to the entire Survey Area, based on an assumption that suitable habitat contiguous with the location where occupied behaviors is observed is important for murrelets for current and future nesting. Applying results to the entire Survey Area may result in additional Survey Sites being designated as "occupied" even when the surveys within that Site indicate that murrelets are likely absent or only "present". In the cases where the Survey Area is large or linear in nature, this can effectively result in habitat that is a long distance (e.g., 1/2 mile or more) from the actual locations of occupied detections being designated as "occupied". Thus, when using information derived from the Pacific Seabird Group protocol survey, only data at the scale of the Survey Station(s) and the Survey Site(s) would be based on the location(s) where murrelets were observed exhibiting occupied behaviors. Any additional Survey Sites and Stations (with probably absence or presence) within the larger Survey Area would be considered occupied based on extrapolation. However, the recommended approach in the Pacific Seabird Group protocol is to conduct the extrapolation and to consider the entire Survey Area occupied of any occupied detections of murrelets are observed.

Information Gaps

Despite the marbled murrelet being one of the more well-studied seabirds in the Pacific Northwest, there are still key gaps in our knowledge about the species. Some of the information gaps that have bearing on development of protection measures for this species are discussed below.

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Relationship between occupied behaviors and actual nesting

There is consistent evidence that marbled murrelets exhibit occupied behaviors (e.g., subcanopy flights, landings, stationary vocalizations) at locations where active or past-used nests are known to occur (Evans Mack et al. 2003, Plissner et al. 2015). However, there are still key unanswered questions regarding the relationship of these behaviors to active nesting and this topic has not been systematically examined using a rigorous study design. We do not fully understand how often these behaviors occur in suitable habitat that is not actually used for nesting (e.g., by non-nesting birds prospecting for nest sites or by incidental flights below the canopy). To our knowledge, no studies have examined the spatial relationship between observation of the behaviors and the location of active nests using a rigorous study design. For example, one knowledge gap is how far active nests are typically located from the location(s) where occupied behaviors were observed. The temporal relationship between occupied detections and actual nesting has also not been well studied. Although it has been documented that marbled murrelets exhibit occupied behaviors at locations where past nesting has occurred (Plissner et al. 2015) and it is thought they may visit a stand and exhibit occupied behaviors prior to actual nesting (e.g., prospecting), it is not known how often or for how long marbled murrelets may visit a stand and exhibit occupied behaviors prior to actual nesting—or in the case of an abandoned nesting stand, for how long after the last nesting attempt has occurred. It is also not known how often prospecting occurs but does not result in use of a stand for nesting.

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Research that could provide this information would help inform whether or not occupied detections can be used as a surrogate for a nesting site, when actual nesting or the location of the nest tree is not known. In addition, it would help inform the question of how far from a potential occupied detection a nest might actually occur.

Long term patterns of habitat use

It is well established that murrelet nesting patterns vary, and that poor ocean conditions may result in only a proportion of the population that nests (ODFW 2018). However, short and long term temporal patterns of nesting and use of stands are not well studied. One study in California which looked at relationship between occupied detections and landscape condition found a time lag in response to fragmentation, with birds abandoning fragmented patches a few years after they were isolated (Meyer et al. 2002). To our knowledge, there are no long-term studies that have looked at long-term patterns of habitat use. Specifically, it is not known if stands are used annually or if breaks occur in nesting or occupancy of a stand, and if breaks in use do occur, how often and how long of a break in use occurs before the area is reused again. Alternately, information is lacking to indicate if an area is unlikely to be used again after birds are absent for a period of time, and if so, how long of a period of no detections of a bird are needed to be relatively certain that the area is actually abandoned (as defined in the FPA). Having this information would help inform development of criteria to distinguish an abandoned versus an active resource site under the FPA.

Nest site fidelity and spatial distribution

Fidelity is the propensity of individuals to use the same area for nesting repeatedly. For example, bald eagles are considered to have high site fidelity because pairs often return to the same nest year after year. As discussed previously, marbled murrelets are thought to have relatively high site fidelity, but there are key gaps in our knowledge for this topic. In their review of the literature on the topic of site fidelity, (Plissner et al. 2015) found only two studies using marked birds. One study in California documented a single marked bird returning to the same nest multiple times over a decade-long time period (Golightly and Schneider 2011) and the second study in British Columbia documented the same individual returning to the same stand to nest in two non-consecutive years (Burger et al. 2009). Thus evidence of fidelity of specific individuals is poorly known at all scales, but information from at least one marked bird suggests that it can occur.

Additional information is needed on spatial distribution of nests, especially in Oregon. Although rigorous studies using marked birds in British Columbia have provided valuable information, including information on spatial distribution of nests, this type of research has been mostly lacking in Oregon. A new study at Oregon State University may provide additional insight. Key questions include how many pairs may use a stand in a given year or among years and whether presence of one nest indicates that additional nests are also likely present. There is also no information on tagged or radio-collared birds to indicate if marbled murrelets also exhibit plasticity in habitat selection from one breeding season to the next. For example, if a

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previously used area is no longer suitable nesting habitat (e.g., loss from logging or natural disaster) will murrelets move to a new area or do they cease to nest? Meyer et al. (2002) showed that there was a time lag in response to habitat fragmentation and that murrelets would continue to use an area for some time before abandoning the fragmented parcel (based on patterns of occupied detections—not confirmed nesting). Zharikov et al. (2007) found that nesting murrelets were more abundant in a fragmented area, suggesting that murrelets may have been "packing" into remaining habitat rather than move to a new area to nest. Thus there is some evidence that murrelets may attempt to continue to use their historic nesting areas as habitat is reduced, but this topic has not been specifically addressed. It would likely take a robust study of marked individuals over multiple years to fully address this question. Currently the technology does not exist to efficiently track individuals over multiple seasons.

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Also not well understood is whether or not the number of detections is indicative of local abundance or if the observation of a nest (or occupied behavior) is predictive of whether or not other nests occur nearby and how far away they may occur. Information on these topics would help inform development of protection strategies for marbled murrelets as well as development of criteria to distinguish an abandoned versus an active resource site under the FPA.

Technical Report—Required Content for Rule Analysis for a T&E Listed Species--Evaluation of OAR 680 criteria

A key component of a Technical Report for purposes of a rule analysis is evaluation of the criteria listed in the process rules for Specified Resource Sites (OAR 629, division 680). The Division 680 rules were developed by the Department and the Board of Forestry to define the process to be used for reviewing fish or wildlife species for possible rule development under the Forest Practices Act, and in the case of "recovered" species, for possible removal or revision of the species. For species that have been added to state or federal Endangered Species Act lists, the process for review is laid out in OAR 629-680-0100.

The Technical Report for a review under OAR 629-680-0100 must include the following:

1) Identify the resource sites used by the species
2) Identify the forest practices that conflict with the resource sites
3) Evaluate the biological consequences of the forest practice conflicts
4) Propose protection requirements and exceptions for the resource site

The information below includes the Department's review of the information on marbled murrelets in relation to these four components of a technical report.

Identification of the resource site(s) used by the species

The Board of Forestry must determine the resource site to be protected. In the Department's March 2017 assessment of the Petition, it was determined the resource site was not adequately identified (ODF 2017a). This section provides additional information to help inform the Board of options for identification of the resource site for protection.

For all wildlife species currently protected under the FPA, the resource site is defined as the nest tree. For the spotted owl, protection can be centered on an activity center if the nest tree is not known. In the recent past, bald eagle winter roost trees and foraging perch trees were protected under the FPA, but those rules are no longer in effect as of September 1, 2017. Thus, protection for all past and present wildlife sites have focused on individual trees or a fixed point location. To date, resource sites have not yet been defined as patches of habitat (occupied or presumed occupied).

Marbled murrelets only use forested environments for nesting and not for foraging or roosting. Thus it is logical to focus the identification of the resource site on the nest tree. However, because of their cryptic and secretive nature and tendency to nest high in trees, locating nest trees is extremely challenging. Despite extensive efforts, only a small number of nests (75) have been found to date in Oregon (ODFW 2018). Because there is no protocol or method currently available to effectively and efficiently locate nests of marbled murrelets, limiting the definition of the resource site to only nest trees would likely lead to protection of a small subset of actual nest trees on the landscape. Current research being conducted at Oregon State University has documented several new nest sites in 2018, and researchers are exploring new methods of locating nests, including). the use of drones equipped with infrared cameras. Data from this study may offer new insight into murrelet ecology as well as current and future survey methods. Alternatively, climbing potential nest trees can be used to look for signs of nests after the breeding season is over. This method is extremely difficult and cost-prohibitive over large areas (Plissner et al. 2015). Tree climbing to find nests is likely only effective in small areas where the approximate area of nesting is known. Because of the difficult nature of this method, currently only a small subset of the actual nesting trees on the landscape have been identified and documented.

As discussed in the Survey Protocol section, surveys using the existing survey protocol for marbled murrelets result in information on occupied detections of marbled murrelets. It is assumed that birds exhibiting occupied behaviors are likely nesting, however as discussed in the Information Gaps section, there are still untested questions about this assumption.

Absent of an effective and efficient method to locate nests of marbled murrelets, occupied behaviors may be the only available information that could be used as a possible proxy for nests. The scales of information from protocol surveys related to "occupancy" are 1) the actual location of the bird(s) exhibiting occupied behaviors, 2) the Survey Station from which the occupied behaviors were observed, and 3) the larger Survey Site or 4) Survey Area within which birds were observed.

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ORS 527.710 (3)(a)(A) indicates the Board should develop an inventory for sites of Threatened or Endangered Species without any specifications of the types of sites to be included in the inventory. OAR 629-665-(62)(a)(A) defines a resource site for Threatened and Endangered Species as the "nest tree, roost tree, or foraging perch and key components". For murrelets, this rule definition would seem to limit the definition of a resource site to the actual nest tree (murrelets do not use roost trees or foraging perches). However, current rules for spotted owls allow for identification of an activity center, when the nest tree location is not known, to be used as the center for protection under the FPA rules. It is also within the Board's authority to modify the definition of a resource site through this rule development process.

Because of the difficulty in finding nests, defining the protected resource site for marbled murrelets is not straight forward. In summary, options relating to actual observations of marbled murrelets would be,

1) Known nest trees only, or
2) Known nest trees and locations of occupied detections of marbled murrelets.

The pros and cons of options based on known locations of birds are shown in Table 2.

It can be argued another option for definition of the Resource Site for marbled murrelets might be the larger polygon equivalent to the Survey Site or Survey Area used to design surveys under the existing Survey Protocol. These are not included as possible options in the definition of a resource site because these larger polygons surrounding known locations are more suitable as a protection standard than as the resource site itself. These larger areas are discussed later in the section regarding Protection.

Although resource sites for all species protected under OAR 629-655-000 (Specified Resource Site Rules) have been based on point locations of nests, activity centers, roost trees, and foraging perches, for some species of wildlife, identification of potential, or presumed occupied, habitat may be appropriate. This may be appropriate in cases where a species does not use a single fixed point location as a key component of its life history (e.g. mammals that range over a large area and use multiple forest structures to meet its needs) or species that are especially rare or difficult to detect. These types of species may require something other than a fixed point as a resource site.

Because of their secretive nature and the challenge in locating nests, the marbled murrelet may be a species where focusing protection on only known nest sites may result in many undetected nest sites not being protected. Another option would be to define, identify, and map areas of suitable habitat that would be presumed to be occupied by the species. Under this scenario, the habitat would be presumed occupied unless ground-truthing indicated that suitable nesting platforms did not actually occur, or other key components of suitable habitat were lacking. Alternatively, surveys could be conducted to document that murrelets were not occupying the area (e.g., probable absence or presence only from protocol surveys).

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Because identification of suitable habitat as a resource site would be an entirely new approach under OAR 629-665-0000, additional work would be needed, should the Board wish to consider this option. Additional work would include, but likely not be limited to, determining characteristics to define suitable habitat, identification of conditions needed for an area to be considered "presumed occupied" habitat, modeling work to map this habitat, defining appropriate survey strategies to determine lack of habitat, determining appropriate survey strategies to confirm lack of nesting of murrelets, determining appropriate protection strategies, and consultation with the Department of Justice on this new approach.

Table 2: Possible definitions of resource sites for marbled murrelets.

Resource Site	Definition	Pro's	Con's
1: Nest Trees	Individual trees confirmed to be used for nesting by marbled murrelets	• Known use for reproduction • Fixed point to center protection around • Similar to existing rules	• Only a small # of nests known • Potential to miss protection of many existing resource sites • Extremely challenging to locate
2: Occupied Detections	Locations where marbled murrelets were observed exhibiting occupied behaviors during protocol surveys (either location of bird or the survey station from which the bird was observed)	• Based on surveys using a standardized protocol • Based on actual observation of marbled murrelets exhibiting behaviors assumed to indicate likely nesting • Fixed point to center protection around • Similar to existing rules	• Not known if nesting actually occurred; may protect some areas not actually used for nesting • Not known where nests located; may center protection away from actual nest location • Bird location data of occupied detections may not be readily available-may have to rely on survey station locations from which the birds were observed (data more likely to be readily available)
3: Presumed occupied habitat	Area of suitable habitat presumed to be occupied by the species	• May identify habitat with murrelet sites not otherwise known to occur	• Not based on actual nests or observation of birds • May identify many areas as occupied by the species that are not actually occupied or not used for nesting • New approach; likely would require significant work to develop and implement

Identify the forest practices that conflict with the resource sites & evaluate the biological consequences of the forest practice conflicts

A technical report for rule development must also include information to identify the forest practices that conflict with the resource site and evaluate the biological consequences of the forest practices conflicts. These two aspects are combined below.

The Petition identified forest practices that conflict with marbled murrelets in a general sense (e.g. habitat loss), but did not identify the specific forest practices that might conflict with resource sites. The Petition provided details on the biological consequences of conflicts, but focused primarily on forest harvest and loss of habitat. This report expands on the information in the Petition and describes the full suite of Forest Practices and potential biological consequences of those forest practices.

Forest Practices are defined in rule (OAR 629-600-0100 (28)) and include forest harvesting, reforestation, road construction and maintenance, application of chemicals, disposal of slash, and removal of woody biomass. Conflict defined in rule: "means a resource site abandonment or reduced productivity" (OAR 629-600-0100 (14)).

Harvesting of forest trees may conflict with marbled murrelet resource sites by causing direct loss (e.g., removal) of nest trees, by increasing risk of windthrow of nest trees, or by increasing exposure of nests to the elements or to predation. Creation of hard edges may have an indirect impact on marbled murrelets aschanges in microclimate (due to increased sun, exposure to wind, etc.) can have a negative impact on mosses (Van Rooyen et al. 2011). This is pertinent to murrelets because they largely rely on moss for nest substrates. Microclimate effects on moss may extend 150 feet into the forested stand, possibly further in areas with greater wind exposure. Any changes in moss cover would likely occur at longer time scales—not immediately after creation of a new hard edge. However, to date impacts of changes in microclimate on murrelet nest site selection or nesting success have not been studied. There is evidence timber harvest may result in reduced productivity by increasing risk of predation of nests. As discussed previously, predation of nests is thought to be a significant concern and limiting factor for successful marbled murrelet reproduction.

The topic of disturbance has not been well studied and most available information is anecdotal in nature. However, a literature review of existing information on known and likely impacts of disturbance on nesting murrelets has been compiled by the US Fish and Wildlife Service (USFWS 2006) and is used, in part, as the basis for this section of the report. This review includes information on known impacts of marbled murrelets to disturbance activities, although all available information on actual murrelets is anecdotal in nature. The review also includes additional analyses from other species as well as information on decibel outputs from various activities (e.g., chainsaws, aircraft, etc.).

Timber harvesting activities can pose a conflict by creating disturbances that may disrupt normal nesting activities. Disturbance may result in reduced productivity by: 1) causing

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incubating adults to flush and leave the egg unintended, 2) causing adults delivering fish to the nest to flush and not feed the nestling (resulting in longer duration between feedings), 3) causing chicks to flush off the nest too soon, before they are ready to fledge, 4) attracting predators to the nesting area (USFWS 2006). All of these could pose a conflict by causing nest failure and/or abandonment and thus reduced productivity.

The US Fish and Wildlife Service developed guidance to evaluate potential for projects to negatively impact nesting activities of murrelets. This guidance is included as a component of various Biological Opinions (e.g., USFWS 2017). The USFWS guidance indicates activities near murrelets may cause a significant disruption of breeding activities such that injury (i.e., harassment) may occur. Activities considered likely to cause a disruption, and hence a conflict, include chainsaw and heavy equipment use, rock crushing, blasting, aircraft use, drone use, tree-climbing, and burning. Distances for disruption effects range from 330 feet for most activities to 1/2 mile for blasting and burning. Because nest sites are not typically known, the disruption distances recommended by the USFWS are typically based on the edge of an occupied habitat patch.

Examples of forest operations and associated activities not likely to pose a conflict would include reforestation, timber cruising and wildlife surveys (that do not involve tree climbing), pre-commercial thinning using non-powered equipment, standard road maintenance (e.g., road grading) and log hauling. In addition, activities that may cause a conflict during the nesting season would not be expected to pose a conflict if they occur outside of the nesting season.

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Protection requirements—range of options

As a part of a technical report, under OAR 629-680-0100, protection requirements and exceptions must be proposed. The initial petition (Cascadia Wildlands et al. 2016) included recommended protection requirements including proposed rule language. However, in the Department's review of the petition, it was determined much of the proposed protection was outside the authority of the Board (ODF 2017a).

There are a range of possible protection strategies for marbled murrelets which would vary depending on many factors including how the resource site is defined for this species. The Department believes the Board will need to define the resource site for marbled murrelets prior to addressing specific protection strategies for marbled murrelets. Thus, rather than recommend one specific protection strategy, a range of general protection strategies that the Board might consider are described below.

Prescriptive Approaches to Protection

One method to protection is to have a prescriptive approach where best management practices and recommended standards are described in detail. These approaches are commonly used in development of regulations, but might also be suitable using a voluntary measures approach.

If the resource site is defined as the nest tree, the location of an occupied detection, or some other specific point on the landscape, a strategy where protection is centered around that point (or group of points) might be applied. This would follow a similar method as used for current FPA rules for wildlife (i.e., northern spotted owl, osprey, bald eagle, and great-blue heron). Once the resource site is defined, the Department would need to develop and maintain an inventory of known sites for marbled murrelets. Currently, landowners are not required to conduct surveys for protected species under the FPA. Instead, inventories are developed and maintained using readily available information compiled primarily from other governmental agencies (e.g., ODFW, BLM, USFS). The Department has some data already, but would need to determine availability and request additional information from other entities (e.g., other state and federal agencies, tribal governments, private landowners, etc.) (ODF2017a).

Protection standards for a point-centric approach would include 1) protection of the resource site and its key components (e.g., replacement trees and habitat buffer) around the point or points, and 2) seasonal restrictions for forestry activities within a certain distance of the point location to protect any nesting birds from disturbance during a critical use period.

Key components of a marbled murrelet resource site need to be identified. Key components are the attributes that are essential to maintain the resource site over time (OAR 629-600-0100 (39)). The key components may vary depending on how a resource site is defined. However, they are likely to include replacement trees and a buffer of additional habitat to help protect nests from the elements, risk of blowdown, and risk of nest predation due to edge-effects. A replacement tree is typically a tree with the suitable features to be used for nesting, either as an alternate nest tree or as a replacement if the original nest tree should fall down.

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Possible options for habitat protection might range from a fixed buffer around a known point location to identification of a polygon of habitat. Both would need to include adequate habitat area to protect the site(s) to avoid a conflict (i.e. site abandonment or reduced productivity). The extent of the habitat area to be included in protection might be identified using the survey protocol or a user-identified polygon of suitable habitat of a specific minimum size. The latter approach would be similar to the existing rules for spotted owls, where a core area of suitable habitat is required to be maintained around nest sites or activity centers. A summary of these options, including pros and cons of each approach are included in Table 3.

As previously mentioned, should the Board determine to identify suitable habitat (e.g., presumed occupied habitat) as a resource site under the FPA, significant additional work would need to occur. Included in this additional work would be identification of appropriate protection strategies. Thus, protection strategies for this approach are not described here and not included in Table 3.

Table 3: Possible options for habitat protecting strategies for marbled murrelet resource sites.

Option	Description	Pro's to this approach	Cons to this approach
1: Polygon of habitat associated with protocol surveys	Polygon that identifies an area surveyed within which occupied detections were observed	• Based on surveys using a standardized protocol	• Survey boundaries are somewhat arbitrary and typically based on boundary of a proposed operation (e.g., timber harvest) and associated buffer, thus they are not necessarily biologically based. • May include stations with no detections or only presence detections • Not known if nesting actually occurred; may identify polygons for protection that not actually used for nesting • Not available unless surveys conducted based on protocol standards
2: User-Identified Polygon	A polygon of habitat around known nest site(s) or occupied detection(s) that would be identified by the operator	• Similar to the core area approach used for spotted owls • Approach can be used for data not obtained from protocol surveys • Boundaries can be established based on biological criteria such as extent of suitable habitat, topography, etc.	• Would require additional work to identify the parameters to be used to identify the extent and location of habitat to be protected • Might under or over protect marbled murrelet nesting sites

Prescriptive Approaches—Summary and Additional Work

If the Board determines a prescriptive approach should be used for marbled murrelets, additional work would need to be conducted by the Department and subsequent decisions may be needed by the Board of Forestry. This would include but not necessarily be limited to the following:

- Defining suitable habitat for marbled murrelets
- Identification of key components for marbled murrelet resource sites[6]
- Defining the extent of habitat to be protected, and how it will be identified
- Describing forest activities to be limited or allowed within protected habitat
- Defining the critical use period
- Defining the zone, within which forestry activities would be limited during the critical use period to avoid disturbing nesting birds
- If suitable, or presumed occupied, habitat is used to define a resource site, a significant amount of new work is needed (see text of document)

Programmatic Approaches to Protection

Programs that encourage or incentivize maintenance or development of suitable marbled murrelet habitat on their lands are an option to encourage voluntary actions by landowners. Possible voluntary, programmatic approaches the Department could use include 1) Development of a Programmatic Safe Harbor Agreement (SHA) for marbled murrelets with the USFWS, 2) use of the existing Stewardship Agreement program to encourage voluntary actions to conserve habitat. These voluntary measures are described below.

Programmatic Safe Harbor Agreement

A Safe Harbor Agreement is an option available under the federal Endangered Species Act. This program encourages nonfederal landowners to voluntarily enhance and maintain habitat for a listed species by providing assurances the USFWS will not impose additional restrictions because of their voluntary conservation efforts, as long as the result is a net conservation benefit for the species. This program is available now, however individual landowners would need to enroll individually with the USFWS. Under a programmatic Safe Harbor Agreement, the Department would enter into an agreement with the USFWS and would then work with individual landowners to enroll them into the Programmatic SHA. The programmatic approach to the SHA is an efficient way to implement this program. It also allows landowners to work with the Department rather than directly with the USFWS. This can be beneficial because 1) landowners are already used to working with the Department through implementation of the Forest Practices Act, and 2) some landowners have an inherent fear or mistrust of federal agencies. The Department already has a Programmatic Safe Harbor Agreement with the USFWS for the northern spotted owl (USFWS et al. 2010), thus, there is already a precedent for

[6] Defined in FPA OAR 629-600-0100 (39) as attributes which are essential to maintain the use and productivity of a resource site over time.

using this approach. Currently there are 13 properties and 3,484 acres enrolled in the Programmatic Safe Harbor Agreement for spotted owls.

While SHAs may take many forms, most SHAs involve three elements: 1) a definition of species populations or habitat conditions at the start of the SHA (baseline), 2) commitments from the landowner to conduct, or refrain from, specific actions affecting the species, and 3) a timeframe over which these actions will occur, after which the landowner is permitted to return the lands to the defined baseline condition. Under a programmatic SHA, the Department would hold the permit. If a landowner wished to be included in the terms of the SHA, they would agree to actions described in the programmatic SHA to conserve or develop habitat for marbled murrelets. A baseline for their lands would be established at the time of enrollment, defining the starting conditions at the beginning of the Agreement. The landowner is then issued a certificate of inclusion which authorizes the landowner to return the property to pre-agreement conditions (baseline conditions) at the end of the commitment period. For example, if a landowner creates habitat for marbled murrelets over the term of the agreement, they can remove that habitat at the end of the agreement without being subject to ESA take regulations. Even with a programmatic SHA available, individual landowners could still opt to develop their own SHA with the USFWS.

Stewardship Agreement Program

The Department's Stewardship Agreement Program was developed to 1) provide efficiencies for a landowner for implementation of the Forest Practices Act regulations on their property and 2) to encourage landowners to provide for conservation, restoration, and improvement of fish and wildlife habitat and water quality. This program was also intended to be a mechanism to allow for coordination and implementation of incentive programs. The Stewardship Agreement Program is a required component for implementation of the current Programmatic SHA for spotted owls and would also be required under a SHA for marbled murrelets. However, the Stewardship Agreement Program is also a possible mechanism to encourage voluntary actions for marbled murrelets as a stand-alone program.

The Stewardship Agreement Program allows the Department to provide regulatory certainty to landowners in certain situations (ORS 541.423 (7)). If, in a Stewardship Agreement, a landowner identifies specific voluntary actions that exceed regulatory requirements, the Board may agree to exempt the landowner from future changes to a specific rule under the Forest Practices Act. Because there are no rules in the Forest Practices Act specific to marbled murrelets, the Department cannot currently grant regulatory certainties relating to rules for murrelets. However, if during this process or at a future time the Board does develop rules for marbled murrelets, regulatory certainties may be granted. Stewardship Agreements may also be a tool that can be used to provide regulatory certainties at a state-level for landowners who have a Habitat Conservation Plan with the USFWS that addresses marbled murrelets, assuming that HCP actions exceed what is required by rule under the Forest Practices Act.

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Although regulatory certainties cannot be granted at this time for any future rules for marbled murrelets, a landowner may still enroll in this program now to conserve habitat for marbled murrelets. The landowner may still obtain other benefits of this program, such as regulatory efficiencies (exemption from written plan requirements) and regulatory certainty for rules already in place (e.g., stream protection rules). Should the Board develop rules for marbled murrelets after the time an Agreement is already in place, the Agreement can be re-evaluated and amended as needed to obtain certainties for murrelets under the FPA.

Next Steps

A general summary of next steps was presented to the Board of Forestry in April of 2017 (ODF 2017b). However, subsequent work may depend on decisions made by the Board of Forestry during this rule analysis process.

As described to the Board in April 2017, this Technical Report will undergo a review by subject experts. The purpose of the review is to evaluate the literature used and content of the report, to ensure that the "best available information" is presented to the Board for their decision-making process.

Following the Expert Review, the Department will summarize the input received and create an amendment to the Technical Report, if needed. This information will then be presented to the Board at a subsequent meeting. Also, as described in the March 2017 Progress Report to the Board of Forestry, additional work is needed to help inform the decision-making process. This includes consultation with other agencies, additional analysis as required per ORS 527.714, and consideration of impacts from ballot measure 49 and associated statutes (ORS 195.305). ORS 527.714 requires additional review and that certain standards are met before new Forest Practices Act rules can be enacted. ORS 195.305 resulted from ballot measure 49 and allows claims to be made for compensation if new regulations affect the fair market value of a property; alternatively the claimant may request an exemption from the new rule. Thus, additional work will be needed to 1) conduct the required analysis under ORS 527.714 and 2) to understand the implications of ORS 195.305 on any new regulations for marbled murrelets.

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4) Bob Sallinger
Conservation Director of the Audubon Society of Portland

Date: August 17, 2018
Re: Marbled Murrelet Status Report Comments
From: Bob Sallinger
To: Oregon Department of Forestry

Dear Oregon Department of Forestry,

Thank you for the opportunity to submit comments on the April 25, 2018 Draft Marbled Murrelet Technical Report ("Report") that is being developed, as required under OAR 629-680-0100, by Oregon Department of Forestry (ODF) to inform rulemaking related to marbled murrelets on lands governed under the Oregon Forest Practices Act (OFPA).

Audubon Society of Portland has been engaged in efforts to protect and recover marbled murrelet populations since the 1980s. In 1988, Audubon Society of Portland commissioned the status review written by David B. Marshall that provided the basis for listing the marbled murrelet under the Federal Endangered Species Act. Audubon Society of Portland petitioned and sued the US Fish and Wildlife Service resulting in the listing of the marbled murrelet as threatened under the Federal Endangered Species Act in 1992. The species was subsequently listed as threatened under the Oregon Endangered Species Act in 1995. We remain deeply concerned that, despite these protections, marbled murrelet populations in Oregon continue to move closer to extinction, in large part due to inadequate protections on lands owned and regulated by the State of Oregon. Portland Audubon, along with Cascadia Wildlands, Center for Biological Diversity, Coast Range Forest Watch, Oregon Wild and the Oregon Chapter of the Sierra Club initiated the petition for rulemaking by Oregon Department of Forestry to protect marbled murrelet resources sites as required under the Oregon Forest Practices Act.

Under Oregon's laws pertaining to the Board of Forestry (Board) and forest regulations, the Board is required to promulgate rules to provide for the maintenance of fish and wildlife resources. ORS 527.710(2)(d). Specifically, the Board is required to "collect and analyze the best available information and establish inventories of resources sites of either federally listed or state listed endangered or threatened wildlife species." ORS 527.710(3)(A). The marbled

murrelet was listed as threatened under the federal Endangered Species Act (ESA) in 1992 and under the Oregon Endangered Species Act in 1995. Therefore, the Board is required to collect and analyze the best available information on marbled murrelets, and conduct a resource site inventory. If the Board determines that forest practices would conflict with resource sites in the inventory, the Board shall adopt rules to protect resources sites after considering the consequences and appropriate levels of protection. ORS 527.710(3)(b), (c). The Board of Forestry is more than two decades overdue on developing rules to adequately protect marbled murrelets on lands governed by the Oregon Forest Practices Act.

The Charter for the expert review identified three areas for focus:

1) Identify any missing, pertinent literature that would lend merit to the Board's rule review process.
2) Review the report for interpretation of the science and identify any areas of concern.
3) Review and provide input on the scientific merit of options for resource site and protection strategies

We have consulted with other conservation groups in developing these comments although the final product is the responsibility of Audubon Society of Portland alone. We have also provided an annotated version of the technical report.

Identify any missing, pertinent literature that would lend merit to the Board's rule review process.

<u>Expand the literature Review related to the marbled murrelet's population status in Oregon</u>

The most significant omission in the report is the exclusive focus on at-sea surveys in terms of characterizing marbled murrelet population status since the species was listed under the Oregon Endangered Species Act. First, the at-sea data needs to be updated to include the most recent Northwest Forest Plan Interagency Regional Monitoring Program Summary Report that includes 2017 data from at-sea Marbled Murrelet surveys published in May 2018[1]. Second, ODF should ensure that this data is accurately portrayed and its limitations are clearly articulated. The limitations of this data were clearly described by the Pacific Seabird Working Group in a letter to the ODFW Commission dated July 1, 2018. The PSG wrote the following:

> *…at-sea surveys only take place every other year in Conservation Zones 3 and 4 (most of Oregon is included in Zone 3, Southern Oregon in Zone 4); as a result the Oregon 2016 trend estimate actually relies on data interpolation for Zone 4 based on datasets from multiple years since there was no 2016 data for Zone 4. The* ***2016 Oregon population estimate in Table 2 relies on data only from Zone 3 from 2016. The Zone 4 data used in***

[1] Pearson, S.F., B. McIver, D. Lynch, N. Johnson, J. Baldwin, M.M. Lance, M.G. Raphael, C. Strong, R. Young, T. Lorenz, and K. Nelson. 2018. Marbled murrelet effectiveness monitoring, Northwest Forest Plan: 2017 summary report. 19pp.

the Oregon estimate is an interpolation of data collected in 2015 and 2017. *This is evident in Table 3 of the Pearson et al. report. In addition, Zone 4 data from the last 2 years surveyed (2015 and 2017) showed unusually high density estimates of murrelets outside the range of confidence intervals (see Pearson et al. report – Figure 3, Zone 4 graph). There was no data gathered for Zone 3 in 2017, yet the years 2016 and 2017 have strong leverage on the overall trend estimate reported. The monitoring report was clear about these data limitations…. Given that the Marbled Murrelet is a long-lived species with low reproductive rate, it is not possible to conclude that this sudden increase in density is the result of local reproduction and high survival rates. It is entirely possible that murrelets foregoing breeding in recent years due to historically poor oceanic conditions in the North Pacific[2] are spending more time at sea and thus inflating the population estimate. There is also a strong likelihood that immigration from outside populations could result in more birds counted in Oregon's nearshore waters.[3]*

Third, the at-sea survey data only tells a limited part of the story regarding the population status of murrelets in Oregon. The ODFW Marbled Murrelet Status Review Report[4] developed by ODFW staff does a good job summarizing a variety of research that should also be cited in the ODF Technical Report in order to provide a complete picture of the marbled murrelet's status in Oregon. In particular, we would direct ODF to McShane et al. (2004)[5], who found "using what may be optimistic population parameters (e.g., survival = 83-92%, breeding propensity = 90% in most years, nest success = 23-46%), extinction probability is high in Oregon (over 80% by 2060 for Conservation Zone 4: Siskiyou Coast Range, over 80% by 2100 for Conservation Zone 3: Oregon Coast Range)."[6]

Fourth, it is important to explicitly note that to the degree that Oregon murrelet populations are stable, "it appears that the Oregon population may now be fluctuating around a new, lower baseline."[7] As currently written, the ODF Report fails to acknowledge the substantial

[2] https://phys.org/news/2017-02-pacific-vast-seabird-die-off.html

[3] Pacific Seabird Group Letter to ODFW Commission. July 1, 2018 https://pacificseabirdgroup.org/wp-content/uploads/2018/07/PSG-Reverse-MAMU-downlisting_FINAL.pdf

[4] 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. 134pp.

[5] McShane, C., T. Hamer., H. Carter, G. Swartzman, V. Friesen, D. Ainley, R. Tressler, K. Nelson, A. Burger, L. Spear, T. Mohagen, R. Martin, L. Henkel, K. Prindle, C. Strong, and J. Keany. 2004. Evaluation report for the 5-year status review of the Marbled Murrelet in Washington, Oregon, and California. Report prepared for the U.S. Fish and Wildlife Service, Region 1, Portland, Oregon. EDAW, Inc., Seattle, Washington.

[6] 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. 134pp, at Page iv.

[7] 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. 134pp.

population decreases that have occurred since the murrelet was listed under the State ESA[8,9] and also fails to provide adequate background on the historic (past 100+ years) decimation of prime murrelet nesting habitat (i.e. old-growth)[10,11,12].

The Report should clearly articulate the inadequacy of current protections for marbled murrelets on lands owned or regulated by the State of Oregon.

The ODFW Status Report (2018) does a good job summarizing the continued threat from logging particularly on lands owned and regulated by the State of Oregon. This information should be included in the ODF Report to provide context for why it is important for ODF to adopt a more aggressive approach to protecting marbled murrelet nesting habitat regulated under the Oregon Forest Practices Act. Specifically the ODFW Status Report cites Raphael et al. 2016 in stating that it is "estimated that higher-suitability habitat declined in Oregon from an estimated 853,400 ac in 1993 to 774,800 ac in 2012, a net loss of 78,600 ac (-9.2% change); on nonfederal lands, 21.1% of higher-suitability habitat was lost during this period compared to 3.4% on federal lands."[13] The ODFW report concludes:

> The threat posed by inadequate state and federal programs and regulations has decreased since state listing of the Marbled Murrelet in 1995 and federal listing in 1992. For example, implementation of the Northwest Forest Plan greatly reduced the rate of habitat loss due to timber harvest on federal lands. Nonetheless, existing state and federal programs and regulations have failed to prevent continued high rates of habitat loss on nonfederal lands in Oregon. (emphasis added).[14]

We would also point ODF to the recently published Synthesis of Science to Inform Land Management within the Northwest Forest Plan Area. (2018)[15] Chapter 5, Marbled Murrelets by

[8] Miller, S. L., M. G. Raphael, G. A. Falxa, C. Strong, J. Baldwin, T. Bloxton, B. M. Galleher, M. Lance, D. Lynch, S. F. Pearson, C. J. Ralph, and R. D. Young. 2012. Recent population decline of the Marbled Murrelet in the Pacific Northwest. Condor 114: 771-781.

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[10] Strittholt, J. R., D. A. Dellasala, and H. Jiang. 2006. Status of mature and old-growth forests in the Pacific Northwest. Conservation Biology 20: 363-374.

[11] Wimberly, M. C. and J. L. Ohmann. 2004. A multi-scale assessment of human and environmental constraints on forest land cover change on the Oregon (USA) Coast Range. Landscape Ecology 19: 631-646.

[12] Spies, T. A. and J. F. Franklin. 1988. Old-growth and forest dynamics in the Douglas-fir region of western Oregon and Washington. Natural Areas Journal 8: 190-201.

[13] Raphael, M. G., G. A. Falxa, D. Lynch, S. K. Nelson, S. F. Pearson, A. J. Shirk, and R. D. Young. 2016. Status and trend of nesting habitat for the Marbled Murrelet under the Northwest Forest Plan. Pages *Marbled Murrelet Status Review* 116 37-94 *in* Northwest Forest Plan – the first 20 years (1994-2013): status and trend of Marbled Murrelet populations and nesting habitat, General Technical Report PNW-GTR-933 (G. A. Falxa and M. G. Raphael, Tech. Coords.). U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon.

[14] 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. 134pp, at Page v.

[15] https://www.fs.fed.us/pnw/publications/gtr966/

Raphael et al. provides a good synopsis of the loss of marbled murrelet habitat on non-federal lands in Oregon (see pages 310-315).

We urge ODF to provide a section on the inadequacy of existing regulations to protect marbled murrelets from logging on lands owned and regulated by the State of Oregon. This would provide essential context for the Board of Forestry to consider as they move through this process.

Review the report for interpretation of the science and identify any areas of concern.

PSG Protocol:

The report devotes a good deal of text to the issue of the scale at which to define occupied nesting habitat when utilizing the Pacific Seabird Group Protocol (station, survey site or survey area). The Pacific Seabird Group Protocol is clear and explicit on this issue and states that if any sites within a survey area yields behaviors indicating occupancy, the occupancy designation should apply to the entire survey site. We see no credible scientific basis for deviating from the PSG Protocol and a decision to apply the occupied status at a smaller scale than the survey area would be explicitly contrary to the design and purpose of the protocol. The Protocol states the following:

> *Because the survey area, by definition, is continuous potential habitat, the highest classification of probable absence, presence, or occupancy among the sites within the survey area applies to the survey area. When one survey site encompasses the entire survey area, the outcome of surveys at that site applies to the survey area interchangeably. In contrast, when a survey area is divided into more than one site, the outcomes at the sites, collectively, determine the status of the survey area. For example, if a block of continuous potential habitat is divided into three contiguous survey sites, and one of those three sites yields subcanopy detections, the entire survey area is considered occupied, not just that one site, because all the sites form one large piece of continuous habitat.* [16]

Further, the Report indicates that applying the occupied status to survey sites and stations within a survey area (with probably absence or presence) is based on "extrapolation." This statement is not accurate. The PSG protocol explains the basis for applying the occupied designation to the entire survey area as follows:

> *The hypothesis that continuous habitat is important is based on the following observations on the nesting behavior of murrelets and alcids in general:*

[16] Pacific Seabird Group Methods for Surveying Marbled Murrelets in Forests: A revised Protocol for Land Management and Research (2003) Page 23.

> *(1) Although Marbled Murrelets nest solitarily, more than one pair of birds are usually found in a single, continuous forest (Nelson and Peck 1995). The interaction of murrelets in a single stand seems important for social and breeding purposes.*
> *(2) As two or more pairs of murrelets might nest asynchronously in a stand (or perhaps even renest), murrelets could be nesting at different times - and therefore different places - in the same stand in the same year.*
> *(3) Over several years, murrelets might use more than one nest tree or use different parts of a stand for nesting (Nelson 1997). Murrelets exhibit high nest site fidelity, with some stands supporting 20+ years of murrelet use (Divoky and Horton 1995). A few nest trees have been used in consecutive years (Singer et al. 1995, Nelson 1997, Manley 1999); however, most are not, suggesting that breeding birds may move elsewhere within a stand in successive years or may not nest every year.*[17]

If occupancy behaviors are observed using the PSG Protocol, we can see no valid scientific basis for applying this information at a smaller scale that for which the survey was designed.

<u>Add information regarding blowdown of trees to the Conflicts Section (Report at Page 27)</u>
The report correctly identifies multiple risks to murrelets associated with man-made edge habitat. However, it fails to adequate identify and address the risk of tree blow-down to murrelets which can result in decreased stand size, loss of nest trees, increased penetration of predators, and exacerbation and amplification of all the other negative outcomes identified in the technical report. It is important that the technical report recognize that creation of edge habitat is not a static situation but rather one which can result in increasing peril to nesting marbled murrelets over time due to the increased risk of blow-down.

<u>Include mature throughout document as potential marbled murrelet nesting habitat</u>
In several locations the Report describes marbled murrelet nesting habitat as “very old forests” and “old growth forests.” An example occurs on page 15 of the Report where the Report described murrelets nesting in old growth forests and mature to old growth trees occurring in younger forests. This leaves out the entire classification of mature forests (80-200 years old) in which murrrlets are also found nesting in Oregon. The Report should specify that murrelets are found nesting in mature and old growth forests in Oregon.[18]

[17] Pacific Seabird Group Methods for Surveying Marbled Murrelets in Forests: A revised Protocol for Land Management and Research (2003) Page 6.
[18] Nelson, S. K. and A. K. Wilson. 2002. Marbled Murrelet habitat characteristics on state lands in western Oregon. Final report, Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Corvallis, Oregon.

Natural Gaps versus Hard Edges Created by Logging

In several places, the Report appears to conflate natural gaps with edges created by logging. In doing so the Report suggests that both may be beneficial to murrelets. The Report also appears to suggest that marbled murrelets may even have a preference for edges created through logging. We are not aware of any sound science that indicates that gaps created by logging, especially large gaps created by clear cuts represent a beneficial feature for marbled murrelets. In fact, studies examining "hard" edges (recent clear cuts) found that hard edges tend to produce detrimental effects whereas "soft" edges (regenerating forest) or "natural" (e.g. riparian) edges appear to have lessened or minimal edge effects[19,20,21]. Absent supporting scientific literature, the Report needs to clarify that edges created by logging, and particularly clear cut logging are detrimental to the species.

Use of Forests by Murrelets

The Report indicates that murrelets use forests only for nesting. In fact, the literature shows that they use the forest for a variety of activities in addition to nesting including roosting, courtship, fledging, and investigation of nests sites[22], in addition to nesting. Please clarify this statement.

Review and provide input on the scientific merit of options for resource site and protection strategies

Resource Sites: The Technical Report devotes significant verbiage to discussing how to define a resource site for marbled murrelets. The Report notes that OAR 629-655-(62)(a)(A) defines a resource site for Threatened and Endangered Species as the "nest tree, roost tree, or foraging perch and key components." The Report also notes that "because of their cryptic and secretive nature and tendency to nest high in trees, locating (marbled murrelet) nest trees is extremely challenging." (Report at Page 23) Due to the difficulty in identifying nest trees, the Report accurately recognizes that "focusing protection on only known nest sites "may result in many other undetected nest not being protected." (Technical Report at 24). The Report offers four alternatives for identifying the resource site:

1) Identified nest trees
2) Occupied detections (either the location of the bird or the survey station)
3) Polygons based upon the survey site or survey area (ODF rejects this option based on the assertion that this approach is more suitable as a protection standard)

[19] Bradley, R. W. 2002. Breeding ecology of radio-marked Marbled Murrelets (*Brachyramphus marmoratus*) in Desolation Sound, British Columbia. M.Sc. Thesis, Simon Fraser University, Burnaby, British Columbia.

[20] Malt, J. and D. Lank. 2007. Temporal dynamics of edge effects on nest predation risk for the Marbled Murrelet. Biological Conservation 140: 160–173.

[21] van Rooyen, J. C., J. M. Malt, and D. B. Lank. 2011. Relating microclimate to epiphyte availability: edge effects on nesting habitat availability for the Marbled Murrelet. Northwest Science 85: 549-56.

[22] Nelson, S. K. 1997. Marbled Murrelet (*Brachyramphus marmoratus*), version 2.0. *In* The Birds of North America (P. G. Rodewald, Ed.). Cornell Lab of Ornithology, Ithaca, New York.

4) Presumed occupied habitat (based upon mapped areas of suitable habitat that would be presumed to be occupied until either protocol surveys document probable absence or presence (but no nesting) or until ground-truthing determines that the habitat is not suitable for nesting.

Alternatives 1, 2 and 3 all suffer from the same fatal flaw, which is that currently under the Forest Practices Act, landowners are not required to conduct surveys for threatened and endangered species. Instead, ODF relies upon "readily available information compiled primarily from other governmental organizations." (Report at page 29). Given the dearth of public information regarding murrelet nests on private lands, failure to remedy this fundamental issue would relegate Options 1, 2 and 3 to the realm of meaningless paper exercises. In short, in the vast majority of cases, if surveys are not conducted, nesting murrelets will not be found, resource sites will not be designated and protection will not be provided. ODFW should only consider alternatives that have a realistic potential to actually result in meaningful protection for nesting murrelets on lands governed by the OFPA. To this end, if Alternatives 1, 2 or 3 are considered, ODF should devote a section of the Report to elucidating what would need to occur to make surveys mandatory in potential murrelet habitat located on private lands prior to any disturbance-causing activities being initiated. If mandating surveys is considered, ODF should require that those surveys are conducted by experienced professionals and following methodology outlined in the PSG protocol.

We do not believe that Alternatives 1 or 2 are scientifically valid or would meet the requirements of OAR 629-655-000. Option 1 fails because, as the report accurately notes, identification of nest trees is extremely challenging and basing the designation of the resource site exclusively on the identification of nest trees would result in a situation where the vast majority of marbled murrelet nests would go undetected and unprotected. Option 2 fails because neither the survey station nor the point where the bird is observed are necessarily the same as the location where the bird is actually nesting; nor does it take into account the likelihood that other murrelets are nesting in the same vicinity and that murrelets may switch trees within a stand from year to year. The only way to make this option adequately protective would be to also adopt a protection standard that adequately protects the entire survey area (as defined by the PSG Protocol) in which observations of occupied behaviors occur.

We do not fully understand the rational for presenting and then rejecting Alternative 3 (designation of polygons of the survey site or survey area as the resource site.) For reasons outlined above, we believe that the survey area (as defined in the PSG Protocol is the appropriate scale for protection when occupied behaviors are identified. We do not see a legal or scientific rational for not designating the entire survey area in which occupied behaviors are observed as the resource site. First, we believe the entire survey area could qualify as "key components" under the definition of OAR 629-655-(62)(a)(A). There is a strong case that can be made that given the probability of multiple murrelets utilizing the survey area for nesting, the

potential for murrelets to utilize different trees within a survey area from year to year, and the risks outlined in the section of the Report focused on forest practices that conflict with Resource Sites (Report at 27-28), that the entire survey area should qualify as a resource site. As the report notes, there is already precedent in the Administrative Rules for designating "activity centers" as resource sites for northern spotted owls in situations where specific nest trees have not been identified. We do not see why the same approach could not be extended to marbled murrelets utilizing the survey area as the resource site. We would urge ODF to add back this alternative for consideration by the Board of Forestry provided that 1) landowners are actually required to do PSG Protocol Surveys before conducting potentially detrimental activities in potentially occupied habitat; 2) the survey area (and not the survey site) is used as the resource site.

We view Alternative 4, Presumed Occupied Habitat, as the most viable alternative of those listed and encourage ODF to make this the preferred alternative. This alternative is the only alternative, given that landowners are not currently required to conduct surveys under the OFPA, which would offer any sort of meaningful protection for marbled murrelets. Under this alternative, potentially occupied habitat would be mapped and adverse activities would be prohibited unless ground-truthing reveals that the habitat is actually not suitable for nesting murrelets or protocol surveys do not identify murrelet nesting behaviors.

<u>Protection Strategies:</u>
The Report considers both prescriptive and programmatic approaches to protecting marbled murrelets. While the programmatic approaches outlined (safe harbor agreements and stewardship agreements) are certainly useful tools and are worthy programs for further development related to marbled murrelets, we do not see how these voluntary programs meet ODF's statutory obligation to adopt rules to protect resources sites where forest practices are in conflict. ORS 527.710(3)(b).(c).

We encourage ODF to adopt regulatory prescriptive protections, which would provide baseline protection for nesting marbled murrelets in conjunction with voluntary programmatic approaches that could offer landowners additional flexibility. The key, however, in meeting the obligations of the OFPA would be to provide a strong baseline of regulatory protections.
In the Draft Report, prescriptive approaches are poorly sketched out due to uncertainty surrounded how ODF will ultimately define a resource site. We would offer the following suggestions:

1) If protection areas are based on protocol surveys (Alternative 1 in Table 3), the appropriate scale of protection is the survey area. The basis for utilizing the survey area rather than the survey site or survey station is outlined previously in these comments.
2) Table 3 should include a third option, Presumed Occupied Habitat. This alternative is discussed in the preceding narrative but is left off the table based on the fact that significant additional work would need to occur (Report at page 29). While it is true that

significant additional work would need to occur, it would certainly be possible to provide a thumbnail sketch consistent with the other alternatives described in Table 3. Leaving this alternative off the table suggests (perhaps inadvertently) that staff are prematurely discouraging this approach which would provide the greatest protection to nesting murrelets.

3) The Report notes that a protection strategy proposed by petitioners was determined by ODF to be largely outside the authority of the Board of Forestry. (Report at page 26) We do not concur with this assessment. The Report should provide greater detail of why this strategy is not viable.

Data Gaps:
The Report spends a significant amount of time discussing data gaps. Where possible, we have tried to address these in our comment in the margin notes. While more research about marbled murrelets would be welcome, it is important to note that where data is lacking a precautionary approach is warranted. Lack of data should not be viewed as license to continue the status quo. Currently lands governed under the Forest Practices Act provide minimal protection for marbled murrelets. We do know that despite more than two decades listed under the state and federal Endangered Species Acts, marbled murrelets have moved significantly closer to extinction in Oregon, that continued loss of nesting habitat remains a primary threat, and that, while habitat loss on federal lands has to a large degree stabilized, the highest losses continue to occur on lands owned and regulated by the State of Oregon.

We appreciate the opportunity to comment on the Draft Technical Report, which will inform the rulemaking process by the Board of Forestry regarding marbled murrelets.

Thank you for your consideration of these comments.

Respectfully,

Bob Sallinger
Conservation Director
Audubon Society of Portland

Marbled Murrelet Technical Report
Draft

April 25, 2018

Photo Credit: Gus van Vliet, USGS

Report developed by Jennifer Weikel, Wildlife Biologist
Private Forest Program, Oregon Department of Forestry

Table of Contents

Executive Summary

In 2016, the Board of Forestry (Board) received a Petition to Initiate Rulemaking for the marbled murrelet under Forest Practices Act (FPA) specified resource site rules. The Board directed the Department to begin work on this rule analysis and received an update and an initial timeline for work to be completed at their meeting in April 2017. The Board's evaluation for possible rule-making is to be based on best available information summarized in a technical review paper. The technical review paper must include information on identification of the resource site(s) used by the species, identification of forest practices that conflict with the resource sites, evaluation of the biological consequences of those conflicts, and include information on protection requirements and exceptions(from OAR 629-680-0100(1)(a)). This technical report was developed to evaluate this required information as well as to provide information on the ecology and habitat use of marbled murrelets. While this report is intended to inform the rule analysis project and the Board's decision making process, additional work and analysis will be needed prior to decisions on possible rule-making.

The marbled murrelet is one of the only seabirds and the only species in the alcid family that nests in forested environments. They spend most of their life at sea, but rely on very old conifer trees for nesting. While most nesting is limited to old growth conifer forests, they are also known to nest in residual old trees within younger stands and in younger hemlock-dominated stands heavily infested with mistletoe in NW Oregon. Nests are typically located on a suitable platform, usually on a large, mossy, horizontal tree branch. Nests are normally in the mid to upper portion of the tree, typically about 100 feet above the ground and with vegetative cover adjacent or above the nest. The presence of suitable platform limbs is considered one of the most important habitat features for this species.

Marbled murrelets have narrow habitat requirements and are secretive in nature when inland. They primarily visit their nest sites at dawn and dusk when they are less likely to be detected by potential predators. They are difficult to detect, and tend to nest high up in the canopy. Thus, nests are extremely difficult to find. Because of this, there are still gaps in our knowledge of habitat use by this species, especially for nesting birds in Oregon.

The relationship between marbled murrelet nest site selection, nest success and landscape characteristics is complicated and available information does not allow us to determine a consistent trend. There is little information available in Oregon. Research from across the entire range of the species has found various patterns for how landscape pattern (i.e., amount and fragmentation of suitable habitat) impacts murrelets. There is some evidence that murrelets may tend to locate nests near forest edges (natural and human-created), but that in some situations they experience lower rates of nest success near edges, especially human-created "hard" edges.

Oregon population surveys conducted in between 2000 and 2016 indicate that the population trend is likely stable. Results for the state-wide population trends for Oregon through 2015

Commented [BS1]: Long-billed murrelets (Russia and Japan) nest in trees in forests. Ancient murrelets nest in forests but on the ground.

Commented [BS2]: Include the estimated percentage nesting in old-growth here.

Commented [BS3]: This should be dwarf mistletoe. This needs to be clarified throughout the report.

Commented [BS4]: Delete "typically." They always need nest platforms.

Commented [BS5]: Define nest platform as greater than 30 feet in heights and greater than 4 inches in diameter

Commented [BS6]: However, worth noting that prior to 2018, 70 nest trees had been identified in Oregon and more were found in 2018, so there is data on a large number of conditions that murrelets use for nesting.

Commented [BS7]: Why especially for birds nesting in Oregon?

Commented [BS8]: We question the use of the word "tend." It would be more accurate to say that "Murrelets sometimes locate their nests near forest edges, and in some situations…."

Commented [BS9]: This is not accurate. The trend is not significant for Zone 3. The results of the most recent forest plan report show that the Zone 4 population may have increased and that this is what is affecting the overall Oregon trend. There is no evidence of a trend in Zone 3 which is most of Oregon. It is important that the population surveys be explained clearly so that the "likely stable trend" is not overstated or misinterpreted. These surveys were limited an drepsetended a high level of variability. They also were not indicative of whether or not the birds counted were nesting, much less nesting successfully.

indicate an increase of +1.7% per year (95% CI from -0.3 to +3.7) between 2000 and 2015. The data indicates an upward trend in Oregon, however because the confidence interval overlaps zero and this trend was not statistically significant (P=0.088) there is uncertainty about the actual trend.

Because additional analysis will need to be considered at a later date, and because identification of the resource site is the first key question that must be decided by the Board before other policy work can occur, this technical report does not include policy recommendations. Rather a range of options is included, where appropriate. Details for protection strategies will be included in a future rule-analysis report.

The technical report includes a range of options for the definition of a resource site for marbled murrelets. Unlike existing birds with rules under the FPA that are highly visible or that have established methods to locate nests, marbled murrelet nests are extremely challenging to locate and there is no efficient and effective method to locate nests. Thus, identification of only the nest tree as the resource site for this species is likely to be insufficient. Another option is to include locations of occupied detections as a proxy for nest sites. The technical report also discusses an option to use designated potential suitable habitat as a resource site. In this context, the habitat would be presumed occupied by the species until additional work is conducted to determine that the area is not actually suitable nesting habitat (e.g. trees with suitable nesting platforms are not present) or not occupied by murrelets (i.e., as determined through surveys).

Because marbled murrelets nest in forested environments, conflicts between forest practices and marbled murrelets are likely to occur. Most conflicts will occur from forest harvesting, with conflicts likely due to loss of nests during logging or due to disturbance to nesting birds or increased risks to nesting birds from increased exposure to the elements or increased risk of depredation of nests by predators.

Because protection strategies for marbled murrelets may vary greatly depending on the Board's decision regarding definition of a resource site, specific strategies are not addressed in this report. Instead, a range of possible protection strategies for this species are discussed. Both prescriptive approaches and programmatic approaches are addressed in the report. Prescriptive approaches would describe best management practices to protect sites and could be codified as regulations or as voluntary measures. Programmatic approaches include use of Safe Harbor Agreements and Stewardship Agreements to encourage voluntary protection and development of suitable habitat for marbled murrelets.

Future policy work is needed to inform this discussion (ODF 2017a). As per OAR 629-680-0100 (1)(b), this technical report must undergo a formal "Expert Review". Feedback from the review will be summarized and included in a subsequent report that will be delivered to the Board.

Commented [BS10]: This statement is not accurate. There is no evidence of a trend because the confidence interval overlaps zero. This statement also needs to be placed in context of the longer-term historic decline to a lower baselines since murrelets were listed in Oregon. ODFW status review (2018)

Commented [BS11]: "Existing" appears to be in the wrong place. Should come before "rules" rather than "birds."

Commented [BS12]: Cite to the PSG Protocol here which discusses protecting occupied areas because nest trees are difficult to locate.

Commented [BS13]: Delete word "would"

Commented [BS14]: It is important to include a specific list of future policy work, analyses, etc. as well as timelines to complete this work, so that everyone understands what elements are currently missing from this process.

Background

In June 2016, the Board received a Petition to Initiate Rulemaking for the marbled murrelet under Forest Practices Act (FPA) specified resource site rules. The Board considered the petition during their meeting on July 20. Acting within its authority under the Administrative Procedures Act, the Board denied the petition. In September, the petitioners submitted a Petition to Review an Agency Order through the Lane County Circuit Court to request the court compel rulemaking. In November, the Board held a public meeting and accepted public comment to reconsider their decision to deny the petition for rulemaking. After consultation with the Oregon Department of Justice, the Board voted to withdraw and reverse its previous decision on the rulemaking petition.

In March 2017, the Board received an update on this rule analysis. A report was presented to the Board that included a review of the petition and a summary of work needed to be conducted as part of any rule-analysis process (ODF 2017a). It was determined the petition did not include adequate information for purposes of a rule analysis. The Board directed ODF Department staff (hereafter Department) to initiate development of a Technical Report on marbled murrelets as per OAR 629-680-0100.

This report was developed to meet the requirement for a Technical Report for purposes of informing the rule analysis process for marbled murrelets. The progress report presented to the Board in March of 2017 (ODF 2017a) outlined additional work to be conducted as part of this rule analysis project. Much of the additional work that needs to be conducted is related to statutes, rules, or measures put into effect after the Specified Resource Site process rules (OAR 629, Division 680) were enacted. Examples include 1) passage of the ORS 527.714 statute that requires additional analysis prior to adoption for some new Forest Practices Act rules, and 2) passage of Ballot Measures 36 and 49 which require compensation or waiving new rules that result in lost real estate value. This technical report is meant to fulfill only the needed information for a Technical Report under OAR 629-680-0100 (1)(a). The Department envisions the rule analysis project, as a whole, will involve multiple steps and decisions by the Board. The decision on protection measures for marbled murrelets is likely to occur at a later date, after the Board has heard all of the pertinent information on this topic and considered input from stakeholders. Thus, specific protection measures for marbled murrelets are not recommended in this report. Instead, a general discussion of a range of possible protection measures is included.

Commented [BS15]: Please clarify projected timeline

Requirements for Rule Development

When a species is added to either the federal or state Endangered Species Act lists (T&E), protection rules under the FPA may be warranted. However, every listed species does not necessarily warrant development of FPA rules. Instead, the focus is on species that occur in forestland and that may be negatively impacted by forest practices. The process to evaluate T&E listed species for possible rule-making under the FPA is laid out in statute (ORS 527.710) and in administrative rule (OAR 629-680-0100).

For a species to qualify for rules under the FPA, the following criteria must be met:

1) The species must be on state or federal Endangered Species Act lists.
2) One or more forest practices must conflict with the sites used by the species.

Forest Practice in this context can be any kind of operation regulated under the FPA such as timber harvest, road construction, application of chemicals, etc. (see OAR 629-605-0050 (26)). Conflict would occur if the resource site is abandoned, or if productivity (e.g., nesting success) at the site is reduced (OAR 629-600-0050 (14)). In most cases, conflict for a resource site occurs from habitat modification or disturbance during key periods of use.

Commented [BS16]: This implies that the concern is primarily during nesting season. Marbled murrelets have high fidelity to the same site year after year, so logging a site in winter has the same impacts are doing it during the summer (ie loss of nesting habitat).

The Board's evaluation for possible rule-making is to be based on best available information summarized in a technical review paper. The technical review paper is to include the following information (from OAR 629-680-0100(1)(a)):

1) Identify the resource sites used by the species
2) Identify the forest practices that conflict with the resource sites
3) Evaluate the biological consequences of the forest practice conflicts
4) Propose protection requirements and exceptions for the resource sites

This report provides information on the general ecology and habitat use of marbled murrelets, but also addresses the specific criteria that must be included in a Technical Report. The report builds off of the original Petition for Rulemaking (Cascadia Wildlands et al. 2016) and also draws from the ODFW Draft Status Review report (ODFW 2018), the 20-year update on the NW Forest Plan (Falxa et al. 2016), the ODF-sponsored systematic evidence review for marbled murrelets (Plissner et al. 2015), and other available literature as appropriate. This report is not meant to be a complete literature review on marbled murrelets, but a targeted summary of available information pertinent to the rule-analysis project and the specific requirements of a Technical Report under OAR 629-680-0100 rules.

Marbled Murrelet Biology & Habitat Characteristics

General Life History & Characteristics

The marbled murrelet is a small seabird that spends most of its life on the ocean, but in Oregon, nests almost exclusively in trees in coastal forests. They do not build a nest, but instead lay their egg directly on mossy limbs or other suitable flat platforms in the forest canopy. For this reason, they tend to nest predominantly in very old conifer forests where large-diameter trees with broad, horizontal branches suitable for nesting are most abundant. Throughout most of Oregon, nesting habitat is characterized as very old conifer forests (typically Douglas-fir) or younger forests with a component of residual old conifer trees. In the north coast of Oregon, they are also known to nest in mid-aged (60+ year old) conifer stands, primarily in hemlock stands with a component of mistletoe defect. The mistletoe infections cause branch deformity

Commented [BS17]: Remove "almost." They nest exclusively in trees in Oregon.

Commented [BS18]: Remove "very" and change to "in older aged conifer forests (mature and old-growth) in addition to younger forests with platform trees.

Commented [BS19]: Remove "very" and change to "in older aged conifer forests (mature and old-growth) in addition to younger forests with platform trees.

Commented [BS20]: Important to include relative percentages of know nesting in 1) very old conifer 2)younger forests with residual older trees. Mid-age forests with mistletoe

Commented [BS21]: Also known to have nested in bigleaf maples. See Ryder et al. Earliest Well-described Nest of the Marbled Murrelet: Elk Creek, British Columbia *Wildlife Afield* 9(1):49-58, 2012

Commented [BS22]: Add "dwarf"

and creates flattened areas with debris that can function as suitable nesting platforms. See the Nesting Habitat section of this report for additional information.

During most of the year, murrelets have white and black plumage that is typical for many seabirds. During the nesting season, they molt into a light brown, mottled plumage. It is thought that this plumage is an adaptation to camouflage in their forested nesting environment.

Marbled murrelets spend most of their time at sea, where they are typically found foraging nearshore (within 3.1 miles of shore) or in bays and inlets (Nelson 1997, ODFW 2018). During the breeding season, murrelets feed on primarily on small fish, including northern anchovy (*Engraulus mordax*), smelt (*Osmeridae sp*), and Pacific herring (*Clupea pallassi*) (ODFW 2018). Whereas adult murrelets tend to consume larval or juvenile fish, they tend to deliver larger sized adult fish to chicks. This is likely a mechanism to maximize the nutritional value delivered to chicks while also minimizing energetic costs due to long flights inland as murrelets feed whole prey to their young. Murrelets are considered an opportunistic forager in that they consume a variety of prey species and will switch prey species depending on availability (ODFW 2018). However, there is growing evidence that poor ocean conditions may be having a negative impact on the quality of diet for murrelets, which in turn may be linked to poor reproductive output (ODFW 2018). One study on this topic in British Columbia used isotopic analysis of museum specimens to examine changes in likely diet quality of murrelets over a 107-year period ranging from the 1889 – 1996 (Norris et al. 2007). They found evidence of a reduction in nutrient-rich forage fish and in increase in zooplankton (a lower trophic food item that is less nutrient rich) in the diet of murrelets over this time period. Furthermore, they found evidence that populations of murrelets in this region may have been limited by diet quality over the time period studied.

When nesting, the female lays a single egg. Adults share incubation duties, switching roughly every 24 hours. The eggs hatch in 28-30 days. Adults typically brood the chick for only one to two days, although some will brood for up to five days but only at night. Both adults then begin to spend much of their time at sea foraging, leaving the chick unattended in the nest. Adults bring one whole fish inland to feed the chick, one to eight times per day. Young birds fledge 27-40 days after hatching. Young fledge on their own and fly to the ocean.

Marbled murrelets have a relatively long and asynchronous nesting season (meaning that individuals do not all nest at the same time). The murrelet nesting season in Oregon is thought to begin in mid-April and extend through mid- to late September (Hamer and Nelson 1995, Hamer et al. 2003, McShane et al. 2004). In Oregon, the incubation phase ranged from mid-April through August 15 and the nestling phase ranged from approximately May 15 to September 15. Approximate time period for fledging of young ranged from mid-June to mid-September (Hamer et al. 2003).

Although murrelets only use inland habitats for nesting, adult murrelets have been documented flying inland during most months of the year except for when they are molting

Commented [BS23]: Mistletoe does not create the debris

Commented [BS24]: It is really about half and half…

Commented [BS25]: In Oregon, WA and CA is it is primarily open ocean. Bays and inlets are more typical of behavior on AK and BC.

Commented [BS26]: Not in literature cited section. Please add

Commented [BS27]: Should this be "nesting success" rather than polulations?

Commented [BS28]: Need citation on these life history characteristics. Probably ok to cite to Birds of North America account.

(spring and fall). The reason for the non-breeding season flights inland are not well understood, but it is thought that birds are possibly establishing pair bonds or prospecting for nesting sites. Most inland activity occurs during the breeding season. The peak period of inland flights is typically in July. Although inland flights can occur at any time of day, most of the inland activity occurs around dawn and dusk.

Because marbled murrelets are rare, cryptic, and secretive, locating their nests is extremely difficult. The first marbled murrelet nests were not found until the 1970's and as of 2017, only 75 nests have been confirmed in Oregon (ODFW 2018). In Oregon, murrelets have been detected as far inland as 80 miles, but the furthest inland nest known was at 31 miles and the furthest inland observation of an occupied behavior was at 40 miles (Nelson 2003, ODFW 2018). Most of the early known nests in Oregon were located by accident or by chance when eggshells or chicks were located on the ground, when nest trees were felled during logging, or when birds were observed landing in trees. More recently, nests have been located by climbing potential nest trees during research projects or as an alternative survey method (Pacific Seabird Group 2013). In other regions, many nests have been located by capturing and placing tracking devices (telemetry receivers) on birds, and then locating them inland when they are at their nest sites (e.g., Zharikov et al. 2007, Burger et al. 2009, Silvergieter and Lank 2011, Lorenz et al. 2017). These methods are currently being used for a study in Oregon, but during the first year of the study, no murrelets came inland to nest (Rivers pers. comm. 2017).

Marbled murrelets are thought to exhibit some level of site-fidelity. Fidelity is the propensity of individuals to use the same area for nesting repeatedly. However, the topic of site fidelity is not well studied using rigorous studies (Plissner et al. 2015). Plissner et al. (2015) provides a comprehensive review of studies that included information on site fidelity and their results are summarized here. They found evidence that murrelets may return to the same watershed, stand, and even the same tree to nest in subsequent nesting seasons (Plissner et al. 2015). This is largely based on studies that have used tree-climbing to find and characterize nests of murrelets, however evidence for fidelity exists across multiple studies across the range of the species. Because of the difficulty in reading bands on marked birds and the lack of telemetry receivers that allow for tracking of individuals over multiple seasons, information on fidelity of specific individuals is lacking. One study in California documented a single marked bird returning to the same nest annually for over a decade (Golightly and Schneider 2011). One marked individual in British Columbia was tracked using telemetry in two years (1999 and 2001) and was found nesting in the same stand; the two nests were approximately 650 feet apart (Burger et al. 2009).

There is evidence that if a nesting attempt fails, particularly if failure occurs during the incubation phase, some proportion of pairs will attempt to renest. In their review of the literature for this topic, Plissner et al. (2015) found only five studies that explicitly discussed renesting attempts. In those studies, it appeared the percentage of pairs that attempted to renest after a failure ranged from roughly 16% to 34%. When nesting attempts fail, there is evidence birds may return to the same stand when renesting (Plissner et al. 2015). Reuse of a nest tree or stand may be higher in areas where habitat is limited. One study looked at relative

Commented [BS29]: They are only flightless during the fall molt

Commented [BS30]: Murrelets have also been observed copulating in the forest. See Nesting Biology and Behavior (Nelson 95)

Commented [BS31]: New far inland site at 47 miles in 2016 on Roseburg BLM lands

Commented [BS32]: Is this accurate? Citation? Our understanding is that most nests in Oregon have been found by conducting specific surveys to locate the nests. We do not know of any sites in Oregon that were identified either by felling of trees or chick being found on the ground (chicks were found on ground in 1930s and 40s but nests were not identified…)

Commented [BS33]: Should cite to Nelson and Wilson 2002. The PSG protocol does not discuss how nests were found in each state.

Commented [BS34]: Add Nelson et al. 2009 and Barbaree et al. 2014

Commented [BS35]: Important to mention the number of birds that were equipped with tracking devices in Rivers study.

Commented [BS36]: Would be more accurate to say "noe of the tracked murrelets came inland to nest."

Commented [BS37]: Should be "are known…"Plissner et al summary says that there is evidence of site fidelity. The Oregon MAMU database shows clearly that MAMU have high site fidelity and MAMU return year after year to the same stands. We don't know if they are the same individuals but based on other alcids biology, it is extremely likely.

Commented [BS38]: This sentence: "However the topic of site fidelity is not well studied using rigorous studies" does not accurately reflect Plissner et al 2015. In …

Commented [BS39]: Should be "surveys and tree-climbing"

Commented [BS40]: Two marked individuals in SE Alaska were found to return to the exact …

rates of re-use across three regions in British Columbia found greater evidence of multiple nests or reuse of nest sites in all three regions. The authors noted that the two study areas with a greater history of logging had greater evidence of multiple nests and reuse than the study area with little to no logging history and surmised that nest reuse may be more likely in areas where nesting habitat is limited (Burger et al. 2009).

Unlike many other species of seabirds, murrelets do not nest in colonies (multiple nests in very close proximity), but instead are somewhat solitary. However, there are documented occurrences of multiple nests (active or older nests) within the same general area (e.g., within 300 feet of each other) or within the same stand or watershed. One study in Oregon found two active nests located within 98 feet of each other (Nelson and Wilson 2002). Most of the available information of this topic is based on finding nests of various ages (active or older nests). In their review of the literature on this topic, Plissner et al. (2015) found five reported examples of nests being located within 330 feet of each other. They also reported four examples of nests located between 660 feet and 0.6 miles of each other, and five examples of nests located at a greater distance of up to 7.5 miles from each other which may indicate a broad distribution of nests (rather than evidence of a clumped distribution). Plissner et al. (2015) found only one robust study on this topic (Zharikov et al. 2007). Using nests from a large number of radio-tagged murrelets in BC, Zharikov et al. (2007) found the mean nearest nest distance (n = 157 nests) was over 2.5 miles in their two study areas. All of the inter-nest distances reported are considered rough estimates, however, as it is unlikely all of the nests were located in any of the studies.

Commented [BS41]: Reuse of the same nests lots of areas within and between years. This is not clear in this paragraph.

Commented [BS42]: Important to point out that the chance of nest predation increases when nest sites are reused because predators can learn historic nest locations (See Plissner et al. 2015 – pg 27 –cites Burger et al. 2009)

Commented [BS43]: This sentence is worded wrong. The inter-nest distances in these studies were known, but it is also known that they did not find all the nests in the study areas. No study has marked all the birds in an area to find all the nests. The evidence available shows co-occurrence. Plissner et al did not look at raw data. There are a bunch more nests active at the same time in small areas/same stands.

Population Status and Trends

Overall population trends

In Oregon, as well as California and Washington, murrelet population numbers and trends are evaluated and monitored by counting birds at sea. As a component of the Northwest Forest Management Plan Effectiveness Monitoring Program, a large-scale effort has been conducted to estimate populations annually across Washington, Oregon, and California since the 1990's (see Falxa and Raphael 2016 and Lynch et al. 2017). Surveys are conducted within conservation zones, as established by the Marbled Murrelet Recovery Plan (USFWS 1997). Surveys in Oregon include conservation zone 3 and a portion of conservation zone 4 (Figure 1). The overall population estimate for murrelets in Washington, Oregon and California as of 2015 is 24,100 birds (95% confidence interval [CI] of 19,700 to 28,600). The overall population trend from 2001 – 2015 is a decline of 0.13% per year (95% CI from -1.7 to +1.4), however this trend is inconclusive as the confidence interval overlaps zero and the trend is not statistically significant (P=0.863). Population trends vary by state and conservation zone. There is statistically significant evidence of population declines in Washington (-4.4%/year [CI of -6.8 to -1.9]; P=0.002), no evidence of a trend in Oregon (see below), and statistically significant evidence of a population increase in California (+0.9%/year [CI +0.9 to +6.8]; P=0.013).

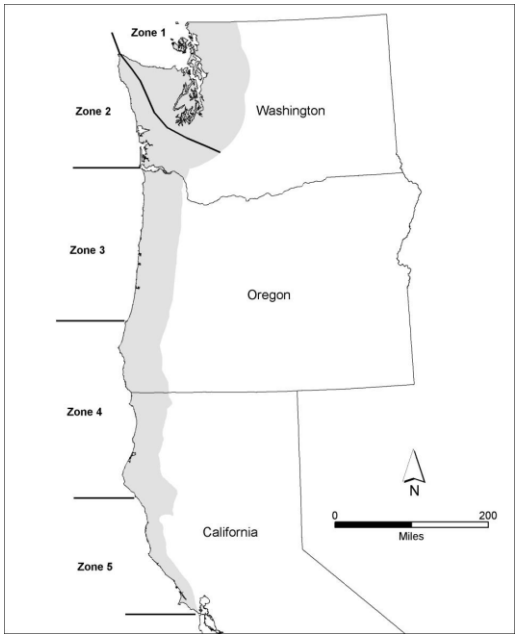

Figure 1: The five at-sea marbled murrelet conservation zones adjacent to the Northwest Forest Plan area (from Lynch et al. 2017).

Oregon-specific population trends

Oregon surveys were conducted in between 2000 and 2016, however, only conservation zone 3 was surveyed in 2016 (see Figure 1). Because of the difference in the time span for results between these two zones, results are reported separately. Results for the state-wide population trends for Oregon through 2015 indicate an increase of +1.7% per year (CI from -0.3 to +3.7) between 2000 and 2015. The data indicates an upward trend in Oregon, however because the confidence interval overlaps zero and this trend was not statistically significant (P=0.088) there is uncertainty about the actual population trend (Figure 2; Lynch 2017).

Commented [BS44]: These results are from Zone 4, not Zone 3 (which covers most of Oregon). As per the prior paragraph, there is "no evidence of a trend in Oregon."

Commented [BS45]: Important to include in the section information about longer-term trend in Oregon which indicate marbled murrelet decline in Oregon leading to a lower baseline.

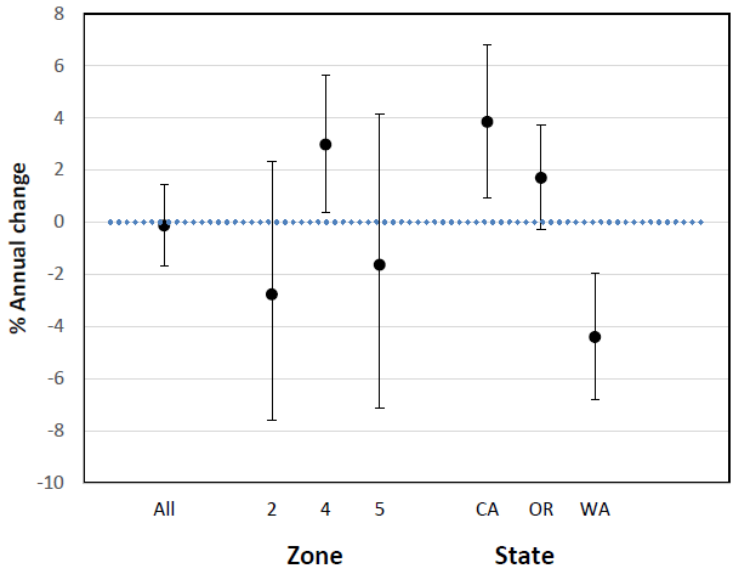

Figure 2: Trend results for units with populations through 2015 only: average rate of change with 95 percent confidence (rom Lynch et al. 2017). Zones 1 and 3 are not displayed because data was available for these zones through 2016; see text for results for zone 3 in Oregon.

Because conservation zone 3 data extends through 2016, Lynch et al. (2017) reported results for this conservation zone separately from the state-wide results shown in Figure 2. Data for conservation zone 3 indicates that the population trend within only this zone was likely also stable through 2016. The rate of change for this zone through 2016 was +1.1%/ year (95% CI = -0.9 to 3.3%); however because the confidence interval overlaps zero and the trend was not statistically significant (P=0.266), there is uncertainty about the actual population trend (Lynch et al. 2017).

Commented [BS46]: This statement is not supported by the data that follows. Because the confidence level overlaps zero, there is no statistically significant trend. It would be more accurate to simply focus on the fact that there is no statistically significant trend than to include unsupported statements that the population trend was likely stable.

Commented [BS47R46]:

Listing status

Marbled murrelets are currently listed as a threatened species under the federal Endangered Species Act. They are listed as Endangered under the Washington and California state Endangered Species Acts. The Oregon Fish and Wildlife Commission recently decided to change the status of the marbled murrelet to endangered under the Oregon Endangered Species Act. Rulemaking regarding this change, including development of survival guidelines for the species, is ongoing and is expected to be completed by June 2018.

Commented [BS48]: This section needs to be updated to reflect June 2018 Commission decision to reject petition to uplist. Also needs to assess implications of survival guidelines adopted by ODFW Commission at August meeting.

Marbled murrelet habitat quantity and trends in Oregon

The recent Marbled Murrelet Status Review for Oregon (ODFW 2018) provides a summary of trends in habitat for marbled murrelets from the time of listing to now. Most the discussion in

Commented [BS49]: Add "of"

the Status Review is from a habitat modelling effort conducted as part of the federal Northwest Forest Plan Effectiveness Monitoring (Raphael et al. 2016a). As with all models, the outputs represent predicted habitat, not actual habitat. The model used in Raphael et al. (2016a) separated potential habitat into four broad categories. Each category reflects a "bin" of habitat with varying scores on their habitat suitability index. The four bins are assigned Classes and names, using the terminology of Class 1--lowest suitability; Class 2--marginal suitability, Class 3--moderate suitability, and Class 4--highest suitability. Raphael et al. (2016a) considers Class 3 and 4 to represent "higher suitability habitat" and uses these two categories for their estimates of predicted habitat where the likelihood of detecting murrelets (presence) or the likelihood of nests or occupied detections is greatest. While there are criticisms with the habitat model used in Raphael et al. (2016a) (see public comments for ODFW 2018), these models represent best available information at this time.

Total amount of suitable marbled murrelet habitat is widely believed to have declined significantly in the last 100 years due primarily to logging and wildfire (see ODFW 2018 for review). Since the time of listing, Raphael et al. (2016a) estimated that amounts of modeled higher suitability habitat (Class 3 and 4) declined by 9.2% (78,600 acres) between 1993 and 2012. Although total modeled higher suitability habitat was predicted to be much more abundant on federal ownership classes, relative reductions were greatest on the non-federal ownership class (59,000 acres) as compared to the federal ownership class (19,000 acres). Most of the estimated loss on non-federal ownership class was due to logging whereas most of the estimated loss on the federal ownership class was due to fire.

Commented [BS50]: Include the percentage of estimated loss of higher suitability habitat on non-federal land (21.1%)

Because Raphael et al. (2016a) reported amounts of modeled higher suitable habitat only to the ownership classes of federal and non-federal, the amount predicted to occur on private lands was not reported. However, in their species status review, ODFW (2018) used the data available from Raphael et al. (2016a) to further estimate habitat conditions as of the 2012 modeled habitat year by land ownership class in Oregon. Their analysis predicted that as of 2012 (the modeled habitat year), amounts of modeled higher suitable habitat by land ownership or management class is as follows:

- U.S. Forest Service (55%)
- Bureau of Land Management (16%)
- Oregon Department of Forestry (15%)[1]
- Private (12%)
- Other (2%)

Additional work is needed to further examine the distribution of suitable habitat in Oregon. For example, the relative distribution of suitable habitat on private industrial versus private non-industrial lands is not known. In addition, a more detailed analysis of forest conditions and anticipated recruitment of suitable habitat on all forest ownership classes in Oregon is

[1] ODFW estimates do not reflect the recent change of management of the Elliott State Forest to from ODF to Department of State Lands.

anticipated to be important to the Board's decision-making process. The Department plans to conduct this work during a later phase of this project.

Marbled Murrelet Nesting Habitat Characteristics

Nesting platform/ actual nest site location

ODFW (2018) summarized nests and nest trees for all known nests in Oregon (see Table 1). Plissner et al. (2015) provided a summary of habitat associated with nesting of marbled murrelets, across their range.

Table 1: Selected marbled murrelet nest tree (table 1a) and nest (table 1b) characteristics for Oregon. Data were provided by S.K. Nelson for all 75 nests found in Oregon since 1990. Mean values are shown for variables measured, along with standard deviation (SD), range, and sample size (n, number of nests). Adapted from Table 1 in ODFW (2018); only change is conversion of values from metric to English.

Table 1a. Nest tree characteristics

	Tree DBH (in)	Tree Height (ft)	No. Platforms in Nest Tree	Distance from Ocean (mi)	Distance to Edge (ft)	Elevation (ft)
Mean	55	184	26	14	167	1083
SD	19	46	19	6	148	492
Range	19 – 110	108 – 279	8 – 92	0.6 - 30	0 - 607	174 - 2024
n	70	70	46	75	75	75

Table 1b. Nest Characteristics

	Nest Limb Height Above Ground (ft)	Nest Limb Diameter at Trunk (in)	Limb Diameter at Nest (in)	Distance from Trunk (ft)	Nest Platform Width (in)	Moss Depth Adjacent to Nest (in)	Duff and Litter Depth in Nest Cup (in)	Percent Horizontal Cover (side)	Percent Vertical Cover (overhead)
Mean	118	9	9	3.6	10	1.7	0.9	53	83
SD	46	4	4	3.8	4	0.9	0.7	19	21
Range	33 – 246	3 – 22	3 – 19	0 - 25	3 - 20	0 – 4.3	0 – 3.3	13 – 85	25 - 100
n	66	67	35	67	65	65	54	53	56

Nests are typically located on a suitable platform, usually on a large, mossy, horizontal tree branch. Nests are normally in the mid to upper portion of the tree, typically 100 feet above the ground (range 33 – 246') and with vegetative cover adjacent or above the nest (Table 1, ODFW 2018, Plissner et al. 2015).

Recorded diameter of limbs (at tree bole) used for nesting ranged from a minimum of four to a maximum of 29 inches (as reported across the entire range of the species); average limb diameter was more than six inches with most studies reporting an average width of more than ten inches (Plissner et al. 2015). Recorded diameter of actual platforms where birds laid their eggs ranged from five to 28 inches (Plissner et al. 2015).

Nest tree and nest patch

A variety of tree species are used for nesting, including Douglas-fir, western hemlock, Sitka spruce, coast redwood, and western red cedar (Nelson 1997). Only conifers are known to be used for nesting in Oregon, Washington, and California, but nests have been documented in red alder in British Columbia (ODFW 2018). One ground nest has been documented in Washington (Wilk et al. 2016). Most known nests are in large-diameter trees in old-growth forests (> 200 years old; Nelson 1997, McShane et al. 2004). However, murrelets have also been found to nest in residual mature to old-growth-aged trees that occur within younger forests and in mature hemlock trees (66-150 yrs. old) that have heavy infections of mistletoe. The youngest recorded tree used for nesting was a 66 year old hemlock infected with mistletoe in the north coast range (Nelson and Wilson 2002). Mistletoe infections can create brooms that serve as platforms or cause branch deformity, resulting in fattened limbs. Nests have been found on platforms and limbs of these mistletoe-infected hemlock trees (Nelson and Wilson 2002).

Murrelet nests tend to have canopy gaps or other open areas near the nest location (ODFW 2018). This feature is important to allow murrelets access to the nest platform. Because murrelets are adapted for foraging in water, their wings are relatively long and narrow in relation to their body size (termed high wing loading). Thus, murrelets are not well adapted for flying or maneuvering in forest environments. They have to fly at high rates of speed (often > 44 miles per hour) in order to remain airborne and tend to approach their nest from below and "stall out" as they land. Thus, having an unobstructed area for approaches and take-offs from the nest are important.

Nesting stand

Because of their reliance on platforms for nesting which occur mostly on large limbs in large trees, suitable nesting habitat occurs primarily in old-growth or mature forests (McShane et al. 2004). Throughout most of Oregon, nesting habitat is characterized by mature to old-growth Douglas-fir stands or younger stands with a component of residual mature or old-growth trees. In the north coast of Oregon, murrelets are known to nest in younger-aged hemlock stands with heavy infestations of mistletoe.

Commented [BS51]: Remove "or". All nests have high overhead cover and some have adjacent cover.

Commented [BS52]: Should be four, not five.

Commented [BS53]: And big leaf maple—see earlier note.

Commented [BS54]: Would be helpful to include the exact percentage (and sample size) that nest in large-diameter trees in old-growth forests.

Commented [BS55]: Add "and mature." There are nests in Oregon in trees < 200 years old.

Commented [BS56]: This section leaves out mature forests (80-200 years old) and appears to focus only on old growth (>200 years old) and young forests (<80 years old)

Commented [BS57]: Add "Dwarf". How many nests have been found in dwarf mistletoe infected hemlock. Important include especially if it is a limited number.

Commented [BS58]: Is this accurate. Our understanding is that they need gaps primarily for taking off rather than landing.

Commented [BS59]: Change to "at sea"

Commented [BS60]: This paragraph needs citations for the information presented.

Commented [BS61]: More accurate to say Sitka Spruce stands with Hemlock

The presence of potential nesting platforms is considered the most important characteristic of marbled murrelet nesting habitat (Nelson 1997). Murrelets select trees for nesting with more potential nesting platforms than what occurs on nearby trees. In addition, there is often a greater density of trees with platforms near nests than elsewhere in the stand (Plissner et al. 2015, Wilk et al. 2016). Density of trees with suitable nesting platforms in stands used for nesting by murrelets ranged from nine to 50 trees per acre; the minimum number reported was two platform trees per acre (Plissner et al. 2015). One study reported that the probability of a murrelet using a stand for nesting increased with increasing density of platform trees up to 40 trees per acre, after which there was no additional change (Silvergieter and Lank 2011). Murrelets tend to select nesting locations with vegetative cover over the nest, but also near gaps in the canopy to allow for access to and from their nesting platform (Nelson 1997).

Landscape pattern; relationship to nest selection and success

Information on the relationship between landscape pattern and fragmentation and nest site selection and nesting success is limited in Oregon. Most studies on this topic are from British Columbia where the forest type and landscape conditions are arguably different than in Oregon. Available information on this topic is summarized below.

Habitat use and nest site selection

Two studies in southern Oregon looked at the relationship between occupied detections and landscape patterns of old-growth forests. They found that the number of occupied murrelet detections were greater in unfragmented old-growth patches (Meyer et al. 2002) and that occupied areas tended to have less fragmented and isolated old-growth patches than did unoccupied areas (Meyer and Miller 2002). Occupied inland habitat also tended to be close to the coast and river mouths (Meyer and Miller 2002). Similar research has not yet been conducted in other regions of Oregon, or in a broader range of age-classes of forests.

Studies examining landscape patterns (e.g., distance from ocean, patch size, core area, and other metrics of fragmentation) using actual murrelet nests are limited in Oregon. Most research on this topic is from British Columbia, where the forest conditions and landscape patterns are arguably different from in Oregon. Of the studies available, there is conflicting information with regards to whether marbled murrelets tend to nest in large interior blocks of habitat, far from forest edges[2] or if they are more general in their nest placement preference. Although murrelets are generally thought of as being negatively impacted by edge effects, a majority of nests have been found near edges, especially natural edges (see review in McShane et al. 2004). In contrast, one recent study in Washington found most nests occur in the interior of forests or in patches with a more interior habitat than at random locations (Wilk et al. 2016). Murrelets may tend to nest closer to edges or gaps as these openings provide ample flying room for adults coming into the nest site or for juveniles when they fledge (McShane et al. 2004). The relationship between murrelet nests and forest edges may vary with the extent of

[2] The term edge refers to the break between a forested area and a non-forested area. The nonforested area may be natural (e.g., river, meadow, natural gap in the canopy) or human-made (e.g., road, clearcut harvest, development).

Commented [BS62]: Remove “to and”

Commented [BS63]: Add predation et al. 2003

Commented [BS64]: Not accurate. See Ripple et al. 2003

Commented [BS65]: Important to note that a murrelet nesting in the vicinity of a man-made gap is not showing a “preference.” They have strong site fidelity. As the forest is cut around them, they return and try to nest successful. This is not a question of preference. The issue of manmade edges and fragmentation relates primarily to nest success rather than nest preference.

Commented [BS66]: The 3rd sentence of this paragraph is unclear and leading: "conflicting information whether murrelets tend to select large interior blocks vs. "more general in their nest placement"? How many Oregon studies is this statement based on? What exactly does "more general in nest preference" mean? This section needs to be re-written and clarify what "more general in nest preference" means and also frame this within the context of the number and rigor of studies in Oregon that support this apparent conflict in information.

In the following sentences, the way it is written, it seems to suggest that murrelets may prefer to nest near natural edges. While it may be true that a majority of nests have been found near edges, this is likely more related to easier access / opportunistic discovery by researchers than actual murrelet nesting preference. A sentence needs to be ...

Commented [BS67]: Gaps and edges may be important but there is a point at where these lead to problems with corvid and predator penetration. There needs to be a statement here that there currently is little/no information in the literature that gets at what threshold in gap sizes allows corvids access ...

habitat available in an area, with murrelets nesting near edges or in isolated fragments more frequently where habitat, particularly interior forest habitat, is limiting (McShane et al. 2004, Plissner et al. 2015).

Nest Success, nest predation & landscape conditions

Marbled murrelets are believed to have low reproductive success, meaning that a large majority of nesting attempts fail to result in successfully fledged young. The primary theory for low rates of success is that nests have high rates of nest depredation, primarily by corvids (jays, ravens, and crows) (ODFW 2018, Plissner et al. 2015). Existing research, primarily using artificial nests, indicates corvid abundance, and predation pressure on nests, is increased in stands near areas that provide additional food resources for corvids such as near human habitation or recreation areas and near regenerating stands with high cover of berry-producing shrubs (Plissner et al. 2015).

The relationship between marbled murrelet nesting success and landscape characteristics is complicated and available information does not allow us to determine any consistent trend. Plissner et al. (2015) provides the most current review of available research on this topic (see Table 13 for additional information). Key information includes the following:

- There were no statistically significant results to indicate that rates of nest success was associated with stand size (Marzluff et al. 1999, Raphael et al. 2002, Zharikov et al. 2006, Zharikov et al. 2007, Nelson and Hamer 1995), platform density (Manley 2003, Silvergieter 2009), tree density (Manley 2003, Golightly et al. 2009, Silvergieter 2009), or canopy height (Silvergieter 2009, Golightly et al. 2009).
- Relationships have been reported between nest success and patch shape (positive association with compact versus linear shapes) (Marzluff et al. 1999), percent canopy cover (negative association) (Malt and Lank 2007 and Waterhouse et al. 2008) and canopy complexity (positive) (Waterhouse et al. 2008). Other studies found no relationship for one or more of these variables (Marzluff et al. 1999, Waterhouse et al. 2008).
- Conflicting results were reported on the relationship between stand age and nest success. Most studies did not report a statistically significant result (Manley 2003, Silvergieter 2009, Waterhouse et al. 2008). Malt and Lank (2007) found increased predation of artificial nests in landscapes with greater percentage of old-growth. In contrast, Zharikov et al. (2007) found that nest success (measured through tracking bird activity with telemetry) was negatively associated with the amount of young forests in the landscape.
- Conflicting results were found for the relationship between nest success and edges. Overall, five of nine studies reviewed by Plissner et al. (2015) reported positive associations between nest success and distance to edge, meaning nest success was higher further from edges.

Commented [BS68]: Change to "known"

Commented [BS69]: Is it accurate to call this a "theory." There is strong data about nest predation particularly by corvids. See McShane et al. 2004, Hébert and Golightly (2006, 2007),

Commented [BS70]: Need to include here that high rates of forest fragmentation (via clear cut) or intensive forest thinning practices also create an edge effect that can lead to higher nest predation.

Current research and expert opinion indicates that forest thinning at high levels will allow increased nest predation - see pg. 50 of ODFW Marbled Murrelet Status Review 2018

Commented [BS71]: More accurate to say that there is a dearth of information on this topic than that it is "complicated."

- One study found that murrelets nesting closer to a "hard" edge[3] had lower nest success than murrelets nesting further from edges (Malt and Lank 2007). Another study, however, found murrelets nesting near hard edges had greater nest success (Zharikov et al. 2006) than murrelets further in the interior. At the landscape scale, however, Zharikov et al. (2007) found that nests in landscapes with greater contrast between the nest stand and neighboring units had lower nest success than in landscapes with less contrast (soft edges).
- The type of edge may have implications to nest success, with murrelets having lower nest success if nesting near a hard edge as compared to a soft or natural edge. Zharikov et al. (2007) reported that nests were more successful in landscapes with lower edge contrast (e.g., soft edges). Similarly, Malt and Lank (2007) reported reduced nest success at hard edges and no edge effects at soft and natural edges.

In general, it is documented that marbled murrelets locate their nests near canopy gaps, including forest edges, presumably to aid in the ability of the adult birds to access the nest as they fly in from the ocean. However, information on effects of landscape condition and fragmentation appears to indicate that those murrelets nesting near edges, especially hard edges, may suffer lower nest success than murrelets nesting further in the interior of a stand. Thus, there is a paradox that edges may improve access for murrelets, but sometimes at the cost of reduced nest success.

Landscape condition and off-shore distribution of marbled murrelets

Range-wide, breeding season murrelet abundance off shore has been reported to be associated with the amount and condition (fragmentation level) of older forest condition inland, with higher densities of murrelets occurring offshore from areas with more and less fragmented older forests (Raphael et al. 2015, Raphael et al. 2016b). This is thought to indicate that murrelet populations and distribution patterns offshore are influenced by the amount of potential nesting habitat inland with birds tending to forage in close proximity to their nesting stands (Raphael et al. 2015). However, a recent study in Washington and British Columbia (Lorenz et al. 2017) found that some individuals not only travelled long distances inland, but also travelled long distances across marine environments to reach their foraging areas (mean distance travelled for 20 birds = 17.4 miles—range of 0.3 to 82 miles). This latter study suggests that some individuals may travel long distances across marine environments to reach suitable foraging areas rather than to forage immediately offshore from their nesting stand. In addition, recent preliminary information from a study in Oregon indicate that individuals that are not nesting may move long distances during the nesting season (Rivers personal communication). Thus, density patterns of birds offshore may not be entirely representative of populations of nesting birds. More work is needed on this topic.

[3] The term "hard edge" generally refers to an edge with a large amount of contrast, such as the edge between a meadow or a recent clear-cut and a mature forest stand. The term "soft edge" generally refers to an edge with less contrast. Examples of soft edges include an edge between a mature forest and a mid-aged stand of trees or an edge that has a more variable contrast such as a thinned or feathered boundary between the mature stand and an adjacent open area.

Commented [BS72]: Should mention here that Zharikov et al. 2006 study has been scrutinized and put into question by the scientific community. See Burger and Page 2007, Landscape Ecology 22: 1273-1281.

Commented [BS73]: need to include a bullet in this section that describes relationship between corvids and forest fragmentation: 3 artificial nest studies and 1 real nest study documented increased corvid numbers were associated with lower murrelet nest success (Marzluff et al. 1999, Luginbuhl et al. 2001, Marzluff and Netherlin 2006, Raphael et al. 2002).

Commented [BS74]: It is important to note here that the birds are not purposely locating nests near clearcuts. The may nest near natural openings, but in the case of manmade clearcuts, the birds had nests before the clearcuts were established.

Commented [BS75]: yes, but there are no studies (that we are aware of) that quantify how large a gap is before you have an edge effect. Murrelets may sometimes need a gap to fly from their nests but it is not clear at what gap size threshold an edge effect ...

Commented [BS76]: Delete "more and." Densities are higher offshore in areas with less fragmented forests.

Commented [BS77]: We question the comparison of Puget Sound to the outer coast of OR. In places with convoluted shorelines (Puget Sound and north) birds will fly over water to get to other water. From th ...

Commented [BS78]: Describe here that these long traveling distances may also put into question reliability of the at-sea population estimates.

Existing Marbled Murrelet Survey Methods

The Pacific Seabird Group[4] has developed a survey protocol to determine if murrelets are using a forested area (Evans Mack et al. 2003). The protocol focuses on detecting murrelets and characterizing behaviors observed. A set of behaviors, called occupied behaviors, are key to characterizing use of forested areas. These behaviors include flying below the canopy (subcanopy flight), landing in a tree, stationary vocalization, and jet dives. Circling above the canopy is not considered an occupied behavior, but is considered indicative of potential occupancy and provides the basis for additional survey effort to attempt to observe subcanopy flights. In addition, some research studies include this behavior in their definition of an occupied behavior (Falxa et al. 2016). Research has documented that actively nesting murrelets exhibit these occupied behaviors near their nests (Plissner et al. 2015). Thus, observation of occupied behaviors are thought to indicate the area being surveyed is occupied by marbled murrelets and likely used for nesting. Other types of observations of murrelets such as flying above the canopy and non-stationary vocalizations indicate that murrelets are present, but not necessarily using the area of interest for nesting.

Commented [BS79]: Our understanding is that this may change in the revised protocol.

The existing protocol for surveying for murrelets (Evans Mack et al. 2003) is designed to document the occurrence or probable absence of murrelets, and if murrelets are present, to determine if birds are exhibiting occupied behaviors. This protocol was not designed to locate marbled murrelet nest trees. The existing marbled murrelet survey protocol (Evans Mack et al. 2003) is the most frequently used method to survey for murrelets in forested stands.

Surveys conducted using the existing protocol surveys result in three different scales of data[5]:

1) The Survey Station where the occupied behavior was observed,
2) The Survey Site within which one or more Survey Stations had occupied behaviors observed,
3) The larger Survey Area within which one or more Survey Sites had occupied behaviors.

These three scales are based on the design of the survey protocol. The Survey Area typically includes the area of interest (usually a proposed harvest area) and all contiguous suitable habitat within a ¼ mile. The Survey Area is then broken down into Survey Sites, which are smaller areas within which multiple Survey Stations are located. The Survey Station is where the observer looks and listens for murrelets. The survey protocol was designed so that, statistically, if surveys are conducted according to the protocol standards including the required number of visits, one will have a 95% chance of observing occupied behaviors should the Survey

Commented [BS80]: It is arbitrarily broken down

[4] The Pacific Seabird Group is a society of professional seabird researchers and managers dedicated to the study and conservation of seabirds and their environment. https://pacificseabirdgroup.org/

[5] Throughout this document, the terms Survey Area, Survey Site, and Survey Station are capitalized to indicate that these terms relate back to the definitions in the survey protocol (Evans Mack et al. 2003). If not capitalized, the terms area, site, and station are used generically and are not meant to refer to the definitions in the protocol

Site actually be occupied. The analysis that is the basis for the protocol was conducted at the scale of the survey site, thus the statistical probability is appropriately applied to the scale of the Survey Site. The protocol then recommends results be extended to the entire Survey Area, based on an assumption that suitable habitat contiguous with the location where occupied behaviors is observed is important for murrelets for current and future nesting. Applying results to the entire Survey Area may result in additional Survey Sites being designated as "occupied" even when the surveys within that Site indicate that murrelets are likely absent or only "present". In the cases where the Survey Area is large or linear in nature, this can effectively result in habitat that is a long distance (e.g., 1/2 mile or more) from the actual locations of occupied detections being designated as "occupied". Thus, when using information derived from protocol survey, only data at the scale of the Survey Station(s) and the Survey Site(s) would be based on the location(s) where murrelets were observed exhibiting occupied behaviors. Any additional Survey Sites and Stations (with probably absence or presence) within the larger Survey Area would be considered occupied based on extrapolation. However, the recommended approach in the protocol is to conduct the extrapolation and to consider the entire Survey Area occupied of any occupied detections of murrelets are observed.

Commented [BS81]: This is not actually what the protocol says. Rather the basis for including the entire survey area is based on the hypothesis that continuous habitat is important (See PSG Protocol at Page 6)

Commented [BS82]: This paragraph leads the reader to believe that you can only draw an accurate estimate of occupancy at the scale of the site or station. However, the study design includes a random sample of sites within the study area so that adequate coverage of the study Area is achieved so you cannot separate these two as described within the context of a study design. Having multiple sites sampled within the area allows you to reliably cover the area of interest. Thus, if you have a detection at 1 site, then it is entirely appropriate to extrapolate the estimate to the larger survey Area based on the study design. The PSG Protocol designates the entire survey area occupied if one site within the area is occupied. (See PSG Protocol at page 26)

Information Gaps

Despite the marbled murrelet being one of the more well-studied seabirds in the Pacific Northwest, there are still key gaps in our knowledge about the species. Given the secretive nature and camouflage of marbled murrelets when nesting inland, this is not surprising. Some of the information gaps that have bearing on development of protection measures for this species are discussed below.

Relationship between occupied behaviors and actual nesting

There is consistent evidence that marbled murrelets exhibit occupied behaviors (e.g., subcanopy flights, landings, stationary vocalizations) at locations where active or past-used nests are known to occur (Evans Mack et al. 2003, Plissner et al. 2015). However, there are still key unanswered questions regarding the relationship of these behaviors to active nesting and this topic has not been systematically examined using a rigorous study design. We do not fully understand how often these behaviors occur in suitable habitat that is not actually used for nesting (e.g., by non-nesting birds prospecting for nest sites or by incidental flights below the canopy). To our knowledge, no studies have examined the spatial relationship between observation of the behaviors and the location of active nests using a rigorous study design. For example, one knowledge gap is how far active nests are typically located from the location(s) where occupied behaviors were observed. The temporal relationship between occupied detections and actual nesting has also not been well studied. Although it has been documented that marbled murrelets exhibit occupied behaviors at locations where past nesting has occurred (Plissner et al. 2015) and it is thought they may visit a stand and exhibit occupied behaviors prior to actual nesting (e.g., prospecting), it is not known how often or for how long marbled murrelets may visit a stand and exhibit occupied behaviors prior to actual nesting—or in the case of an abandoned nesting stand, for how long after the last nesting attempt has occurred.

It is also not known how often prospecting occurs, but does not result in use of a stand for nesting.

This information would help inform whether or not occupied detections can be used as a surrogate for a nesting site, when actual nesting or the location of the nest tree is not known. In addition, it would help inform the question of how far from a potential occupied detection a nest might actually occur.

Long term patterns of habitat use

It is well established that murrelet nesting patterns vary, and that poor ocean conditions may result in only a proportion of the population that nests (ODFW 2018). However, short and long term temporal patterns of nesting and use of stands are not well studied. One study in California which looked at relationship between occupied detections and landscape condition found a time lag in response to fragmentation, with birds abandoning fragmented patches a few years after they were isolated (Meyer et al. 2002). To our knowledge, there are no long-term studies that have looked at long-term patterns of habitat use. Specifically, it is not known if stands are used annually or if breaks occur in nesting or occupancy of a stand. Furthermore if breaks in use do occur, how often and how long of a break in use occurs before the area is reused again. Alternately, information is lacking to indicate if an area is unlikely to be used again after birds are absent for a period of time, and if so, how long of a period of no detections of a bird are needed to be relatively certain that the area is actually abandoned (as defined in the FPA). This information would help inform development of criteria to distinguish an abandoned versus an active resource site under the FPA.

Nest site fidelity and spatial distribution

Fidelity is the propensity of individuals to use the same area for nesting repeatedly. For example, bald eagles are considered to have high site fidelity because pairs often return to the same nest year after year. As discussed previously, marbled murrelets are thought to have relatively high site fidelity, but there are key gaps in our knowledge for this topic. In their review of the literature on the topic of site fidelity, (Plissner et al. 2015) found only two studies using marked birds. One study in California documented a single marked bird returning to the same nest multiple times over a decade-long time period (Golightly and Schneider 2011) and the second study in British Columbia documented the same individual returning to the same stand to nest in two non-consecutive years (Burger et al. 2009). Thus evidence of fidelity of specific individuals is poorly known at all scales, but information from at least one marked bird suggests that it can occur.

Additional information is needed on spatial distribution of nests, especially in Oregon. Although rigorous studies using marked birds in British Columbia have provided valuable information, including information on spatial distribution of nests, this type of research has been mostly lacking in Oregon. A new study at Oregon State University may provide additional insight. Key questions are, how many pairs may use a stand in a given year or among years and whether presence of one nest indicates that additional nests are also likely present. There is

Commented [BS83]: While further research would certainly be welcome, the PSG Protocol is the best available, science-based protocol for surveying and designating marbled murrelet nesting habitat. The protocol answers this question in the affirmative---occupied detections can and are used as a surrogate for a nesting site. The PSG Protocol provides the rational on Page 20. (also see Plissner et al. 2014) This sentence should be rewritten as "More intensive studies and/ or monitoring would help provide more confidence in estimating occupied detections as a surrogate for active murrelet nesting sites."

Also, it is our understanding that the PSG Marbled Murrelet Technical committee that is working on the next version of the PSG murrelet protocol is considering recommending increasing rigor of pre-timber harvest monitoring (more monitor stations and more monitoring replicates) so that problems of incorrectly counting prospecting murrelets as nesting murrelets and false negative detections (not counting birds that are actually present) can be minimized. You should mention this on-going work and fact that increased rigor of surveys (both temporally and spatially) will help rectify some of these issues.

Commented [BS84]: The PSG Protocol provides the rational for maintaining the occupied designation on an indefinite basis (pages 23-24)

Commented [BS85]: The last sentence of this paragraph needs to be tempered with additional text that indicates there is strong evidence of site fidelity at the watershed and stand scales (see Plissner's review indicates over 20 studies that indicate high site fidelity at watershed and stand scales) for breeding murrelets as a whole (though not well-documented for specific individuals)).

also no information on tagged or radio-collared birds between seasons to indicate if marbled murrelets also exhibit plasticity in habitat selection. For example, if a previously used area is no longer suitable nesting habitat (e.g., loss from logging or natural disasters) will murrelets move to a new area or do they cease to nest? Meyer et al. (2002) showed that there was a time lag in response to habitat fragmentation and that murrelets would continue to use an area for some time before abandoning the fragmented parcel (based on patterns of occupied detections—not confirmed nesting). Zharikov et al. (2007) found that nesting murrelets were more abundant in a fragmented area, suggesting that murrelets may have been "packing" into remaining habitat rather than move to a new area to nest. Thus there is some evidence that murrelets may attempt to continue to use their historic nesting areas as habitat is reduced, but this topic has not been specifically addressed. It would likely take a robust study of marked individuals over multiple years to fully address this question. Currently the technology does not exist to efficiently track individuals over multiple seasons.

Also not well understood is whether or not the number of detections is indicative of local abundance or if the observation of a nest (or occupied behavior) is predictive of whether or not other nests occur nearby and how far away they may occur. Information on these topics would help inform development of protection strategies for marbled murrelets as well as development of criteria to distinguish an abandoned versus an active resource site under the FPA.

Commented [BS86]: Abundance is not determined through inland observations. Populations are determined at sea.

Commented [BS87]: We would recommend including two take home messages at the end of the data gaps section: 1) there are obviously data gaps that need to be studied through targeted research and monitoring that will help inform subsequent management; 2) in the absence of rigorous information a precautionary approach is appropriate for providing the best protection for listed species until new information comes to light.

Technical Report—Required Content for Rule Analysis for a T&E Listed Species--Evaluation of OAR 680 criteria

A key component of a Technical Report for purposes of a rule analysis is evaluation of the criteria listed in the process rules for Specified Resource Sites (OAR 629, division 680). The Division 680 rules were developed by the Department and the Board of Forestry to define the process to be used for reviewing fish or wildlife species for possible rule development under the Forest Practices Act, and in the case of "recovered" species, for possible removal or revision of the species. For species that have been added to state or federal Endangered Species Act lists, the process for review is laid out in OAR 629-680-0100.

The Technical Report for a review under OAR 629-680-0100 must include the following:

1) Identify the resource sites used by the species
2) Identify the forest practices that conflict with the resource sites
3) Evaluate the biological consequences of the forest practice conflicts
4) Propose protection requirements and exceptions for the resource site

The information below includes the Department's review of the information on marbled murrelets in relation to these four components of a technical report.

Identification of the resource site(s) used by the species

The Board of Forestry must determine the resource site to be protected. In the Department's March 2017 assessment of the Petition, it was determined the resource site was not adequately identified (ODF 2017a). This section provides additional information to help inform the Board of options for identification of the resource site for protection.

For all wildlife species currently protected under the FPA, the resource site is defined as the nest tree. For the spotted owl, protection can be centered on an activity center if the nest tree is not known. In the recent past, bald eagle winter roost trees and foraging perch trees were protected under the FPA, but those rules are no longer in effect as of September 1, 2017. Thus, protection for all past and present wildlife sites have focused on individual trees or a fixed point location. To date, resource sites have not yet been defined as patches of habitat (occupied or presumed occupied).

Marbled murrelets only use forested environments for nesting and not for foraging or roosting. Thus it is logical to focus the identification of the resource site on the nest tree. However, because of their cryptic and secretive nature and tendency to nest high in trees, locating nest trees is extremely challenging. Despite efforts, only a small number of nests (75) have been found to date in Oregon (ODFW 2018). Limiting definition of the resource site to only nest trees would likely lead to protection of a small subset of the actual nesting trees on the landscape because there is no protocol or method currently available to effectively and efficiently locate nests of marbled murrelets. Climbing potential nest trees can be used to look for signs of nests after the breeding season is over. However this method is extremely difficult and cost-prohibitive over large areas (Plissner et al. 2015). Tree climbing to find nests is likely only effective in small areas where the approximate area of nesting is known. Even with tree-climbing methods, nests can be missed and this method is not effective for documenting that nesting has not occurred (Pacific Seabird Group 2013). A new research study in Oregon (Rivers personal communication) is exploring the use of drones equipped with infrared cameras to detect nesting murrelets. This technique is being explored within the context of a research study and not as a survey tool. Even if effective, this tool may not be a suitable survey tool due to the potential for drones to pose a disturbance to nesting birds.

As discussed in the Survey Protocol section, surveys using the existing survey protocol for marbled murrelets result in information on occupied detections of marbled murrelets. It is assumed that birds exhibiting occupied behaviors are likely nesting, however as discussed in the Information Gaps section, there are still untested questions about this assumption.

Absent of an effective and efficient method to locate nests of marbled murrelets, occupied behaviors may be the only available information that could be used as a possible proxy for nests. The scales of information from protocol surveys related to "occupancy" are 1) the actual location of the bird(s) exhibiting occupied behaviors, 2) the Survey Station from which the occupied behaviors were observed, and 3) the larger Survey Site or 4) Survey Area within which birds were observed.

Commented [BS88]:
There is an extensive body of scientific research that has been built on for decades that supports the need for buffer areas or zone of habitat complexity surrounding a fixed point to ameliorate a wide variety of threats to the targeted wildlife species (e.g. edge effects). We realize that the resource site is currently defined separately from protection measures. We recommend a shift in paradigm to define a resource site in a more biologically relevant manner - i.e. include patch of habitat that provides protection from disturbance and affords successful reproduction. It is surprising that ODF hasn't adopted such basic wildlife management principles in defining resource sites.

ORS 527.710 (3)(a)(A) indicates the Board should develop an inventory for sites of Threatened or Endangered Species without any specifications of the types of sites to be included in the inventory. OAR 629-665-(62)(a)(A) defines a resource site for Threatened and Endangered Species as the "nest tree, roost tree, or foraging perch and key components". For murrelets, this rule definition would seem to limit the definition of a resource site to the actual nest tree (murrelets do not use roost trees or foraging perches). However, current rules for spotted owls allow for identification of an activity center, when the nest tree location is not known, to be used as the center for protection under the FPA rules. It is also within the Board's authority to modify the definition of a resource site through this rule development process.

Because of the difficulty in finding nests, defining the protected resource site for marbled murrelets is not straight forward. In summary, options relating to actual observations of marbled murrelets would be,

1) Known nest trees only, or
2) Known nest trees and locations of occupied detections of marbled murrelets.

The pros and cons of options based on known locations of birds are shown in Table 2.

It can be argued another option for definition of the Resource Site for marbled murrelets might be the larger polygon equivalent to the Survey Site or Survey Area used to design surveys under the existing Survey Protocol. These are not included as possible options in the definition of a resource site because these larger polygons surrounding known locations are more suitable as a protection standard than as the resource site itself. These larger areas are discussed later in the section regarding Protection.

Although resource sites for all species protected under OAR 629-655-000 (Specified Resource Site Rules) have been based on point locations of nests, activity centers, roost trees, and foraging perches, for some species of wildlife, identification of potential, or presumed occupied, habitat may be appropriate. This may be appropriate in cases where a species does not use a single fixed point location as a key component of its life history (e.g. mammals that range over a large area and use multiple forest structures to meet its needs) or species that are especially rare or difficult to detect. These types of species may require something other than a fixed point as a resource site.

Because of their secretive nature and the challenge in locating nests, the marbled murrelet may be a species where focusing protection on only known nest sites may result in many other, undetected nest sites not being protected. Another option would be to define, identify, and map areas of suitable habitat that would be presumed to be occupied by the species. Under this scenario, the habitat would be presumed occupied unless ground-truthing indicated that suitable nesting platforms did not actually occur, or other key components of suitable habitat were lacking. Alternatively, surveys could be conducted to document that murrelets were not occupying the area (e.g., probable absence or presence only from protocol surveys).

Commented [BS89]: Our interpretation of "key components" would allow for designation of the survey area as the "resource site. The Pacific Seabird Group Protocol provides ample basis for why a survey area should qualify as "key components." Further, if the administrative rules allow for designation of "activity centers" for spotted owls when nest trees cannot be identified, we can see no basis for also not allowing designation of an "activity center" for marbled murrelets. Again the PSG Protocol provides the scientific basis for why a survey area area should qualify as the "activity center." Finally. Of neither the above listed options proves feasible, we would recommend amending the OFPA rules to allow for the definition of resource sites to include survey areas for marbled murrelets.

Commented [BS90]: Add a third option: Potential or Presumed Occupied Habitat. This is already included in Table 2. It should be included here as well.

Commented [BS91]: We do not find this argument against designating an entire survey area as a resource site compelling. We find the logic in the next paragraph to make much more sense in terms of designating resource sites for marbled murrlets. The limitation to a fixed point appears arbitrary and necessarily limiting for a species where it is difficult to identify specific nest trees, where the best available science indicates that protection of the entire survey area is warranted and where the science indicates likelihood of lowered survivorship if a larger area surrounding the nest tree is not protected.

Commented [BS92]: We strongly support this option. A precautionary approach would indicate that suitable habitat should be presumed to be occupied until surveys indicate otherwise.

Because identification of suitable habitat as a resource site would be an entirely new approach under OAR 629-665-0000, additional work would be needed, should the Board wish to consider this option. Additional work would include, but likely not be limited to, determining characteristics to define suitable habitat, identification of conditions needed for an area to be considered "presumed occupied" habitat, modeling work to map this habitat, defining appropriate survey strategies to determine lack of habitat, determining appropriate survey strategies to confirm lack of nesting of murrelets, determining appropriate protection strategies, and consultation with the Department of Justice on this new approach.

Commented [BS93]: The PSG Protocol would be the appropriate basis for survey strategies. It is not necessary start from scratch here.

Table 2: Possible definitions of resource sites for marbled murrelets.

Resource Site	Definition	Pro's	Con's
1: Nest Trees	Individual trees confirmed to be used for nesting by marbled murrelets	• Known use for reproduction • Fixed point to center protection around • Similar to existing rules	• Only a small # of nests known • Potential to miss protection of many existing resource sites • Extremely challenging to locate
2: Occupied Detections	Locations where marbled murrelets were observed exhibiting occupied behaviors during protocol surveys (either location of bird or the survey station from which the bird was observed)	• Based on surveys using a standardized protocol • Based on actual observation of marbled murrelets exhibiting behaviors assumed to indicate likely nesting • Fixed point to center protection around • Similar to existing rules	• Not known if nesting actually occurred; may protect some areas not actually used for nesting • Not known where nests located; may center protection away from actual nest location • Bird location data of occupied detections may not be readily available-may have to rely on survey station locations from which the birds were observed (data more likely to be readily available)
3: Presumed occupied habitat	Area of suitable habitat presumed to be occupied by the species	• May identify habitat with murrelet sites not otherwise known to occur	• Not based on actual nests or observation of birds • May identify many areas as occupied by the species that are not actually occupied or not used for nesting • New approach; likely would require significant work to develop and implement

Commented [BS94]: For reasons delineated previously, the survey area is the appropriate scale.

Commented [BS95]: To be consistent with narrative, "add "unless determined by on the ground observation determines that essential nesting components are not present or surveys determine that the site is not occupied. "

Identify the forest practices that conflict with the resource sites & evaluate the biological consequences of the forest practice conflicts

A technical report for rule development must also include information to identify the forest practices that conflict with the resource site and evaluate the biological consequences of the forest practices conflicts. These two aspects are combined below.

The Petition identified forest practices that conflict with marbled murrelets in a general sense (e.g. habitat loss), but did not identify the specific forest practices that might conflict with resource sites. The Petition provided details on the biological consequences of conflicts, but focused primarily on forest harvest and loss of habitat. This report expands on the information in the Petition and describes the full suite of Forest Practices and potential biological consequences of those forest practices.

Forest Practices are defined in rule (OAR 629-600-0100 (28)) and include forest harvesting, reforestation, road construction and maintenance, application of chemicals, disposal of slash, and removal of woody biomass. Conflict defined in rule: "means a resource site abandonment or reduced productivity" (OAR 629-600-0100 (14)).

Harvesting of forest trees may conflict with marbled murrelet resource sites by causing direct loss (e.g., removal) of nest trees, by increasing risk of windthrow of nest trees, or by increasing exposure of nests to the elements or to predation. In cases where a hard edge is created near actively nesting murrelets, even if murrelets are not directly harmed by nearby harvest operations and continue to nest, there may be risk of negative effects on the young due to thermal stress and dehydration if adults or chicks are exposed to direct sunlight or increased winds (based on professional judgement). This may result in reduced productivity, however this topic has not been researched. Creation of hard edges may also have an indirect impact on marbled murrelets. Changes in microclimate (due to increased sun, exposure to wind, etc.) can have a negative impact on mosses (Van Rooyen et al. 2011). This is pertinent to murrelets because they largely rely on moss for nest substrates. Microclimate effects on moss may extend 150 feet into the forested stand, possibly further in areas with greater wind exposure. Any changes in moss cover would likely occur at longer time scales—not immediately after creation of a new hard edge. Impacts of changes in microclimate on murrelet nest site selection or nesting success have not been studied. There is evidence timber harvest may result in reduced productivity by increasing risk of predation of nests. As discussed previously, predation of nests is thought to be a significant concern and limiting factor for successful marbled murrelet reproduction. Timber harvesting has a potential to pose a conflict indirectly by increasing exposure of nests to predators, especially near hard edges.

The topic of disturbance has not been well studied and most available information is anecdotal in nature. However, a literature review of existing information on known and likely impacts of disturbance on nesting murrelets has been compiled by the US Fish and Wildlife Service (USFWS 2006) and is used, in part, as the basis for this section of the report. This review includes information on known impacts of marbled murrelets to disturbance activities, although all

Commented [BS96]: Important to define: Should include both clearcutting and thinning adjacent to and within occupied stands.

Commented [BS97]: Add citation to justify 150 feet. Other studies suggest up to 300 feet. See Chen et al. 1993, 1995, 1999

Commented [BS98]: Include citations: Marzluff et al. 1999, Luginbuhl et al. 2001, Marzluff and Netherlin 2006, Raphael et al. 2002.

Commented [BS99]: Add information regarding increased risk of blowdown associated with hard edges to increase edge effects over time including reduction in size of occupied stand, increased exposure to predators, potential loss of nest trees and other detrimental impacts outlined in this paragraph.

available information on actual murrelets is anecdotal in nature. The review also includes additional analyses from other species as well as information on decibel outputs from various activities (e.g., chainsaws, aircraft, etc.).

Timber harvesting activities can pose a conflict by creating disturbances that may disrupt normal nesting activities. Disturbance may result in reduced productivity by: 1) causing incubating adults to flush and leave the egg unintended, 2) causing adults delivering fish to the nest to flush and not feed the nestling (resulting in longer duration between feedings), 3) by causing chicks to flush off the nest too soon, before they are ready to fledge, 4) by attracting predators to the nesting area (USFWS 2006). All of these could pose a conflict by causing nest failure and thus reduced productivity, or by causing abandonment of the nest.

The US Fish and Wildlife Service developed guidance to evaluate potential for projects to negatively impact nesting activities of murrelets. This guidance is included as a component of various Biological Opinions (e.g., USFWS 2017). The USFWS guidance indicates activities near murrelets may cause a significant disruption of breeding activities such that injury (i.e., harassment) may occur. Activities considered likely to cause a disruption, and hence a conflict, include chainsaw and heavy equipment use, rock crushing, blasting, aircraft use, drone use, tree-climbing, and burning. Distances for disruption effects range from 330 feet for most activities to 1/2 mile for blasting and burning. Because nest sites are not typically known, the disruption distances recommended by the USFWS are typically based on the edge of an occupied habitat patch.

Examples of forest operations and associated activities not likely to pose a conflict would include reforestation, timber cruising and wildlife surveys (that do not involve tree climbing), pre-commercial thinning using non-powered equipment, standard road maintenance (e.g., road grading) and log hauling. In addition, activities that may cause a conflict within close distances during the nesting season would not be expected to pose a conflict if they occur outside of the nesting season or far enough away to not cause a disruption of nesting behavior.

Protection requirements—range of options

As a part of a technical report, under OAR 629-680-0100, protection requirements and exceptions must be proposed. The initial petition (Cascadia Wildlands et al. 2016) included recommended protection requirements including proposed rule language. However, in the Department's review of the petition, it was determined much of the proposed protection was outside the authority of the Board (ODF 2017a).

There are a range of possible protection strategies for marbled murrelets which would vary depending on many factors including how the resource site is defined for this species. The Department believes the Board will need to define the resource site for marbled murrelets prior to addressing specific protection strategies for marbled murrelets. Thus, rather than recommend one specific protection strategy, a range of general protection strategies that the Board might consider are described below.

Commented [BS100]: This section requires further explanation. ODF states that it does not have authority to compel landowners to conduct surveys. If this is in fact the case, can this be changed by rule? If in fact there is no way for ODF to require surveys on private lands, it will be essential that ODF adopt an approach such as the "presumed occupied" alternative which de facto protects potential occupied habitat until it is determined that either murrelets are not occupying the habitat or the ground-truthing determines that the habitat is not adequate to support nesting. We would urge ODF to include a more robust discussion in this report regarding the limitations on requiring surveys on private lands.

Prescriptive Approaches to Protection

One method to protection is to have a prescriptive approach where best management practices and recommended standards are described in detail. These approaches are commonly used in development of regulations, but might also be suitable using a voluntary measures approach.

If the resource site is defined as the nest tree, the location of an occupied detection, or some other specific point on the landscape, a strategy where protection is centered around that point (or group of points) might be applied. This would follow a similar method as used for current FPA rules for wildlife (i.e., northern spotted owl, osprey, bald eagle, and great-blue heron). Once the resource site is defined, the Department would need to develop and maintain an inventory of known sites for marbled murrelets. 70 primarily from other governmental agencies (e.g., ODFW, BLM, USFS). The Department has some data already, but would need to determine availability and request additional information from other entities (e.g., other state and federal agencies, tribal governments, private landowners, etc.) (ODF2017a).

Protection standards for a point-centric approach would include 1) protection of the resource site and its key components (e.g., replacement trees and habitat buffer) around the point or points, and 2) seasonal restrictions for forestry activities within a certain distance of the point location to protect any nesting birds from disturbance during a critical use period.

Key components of a marbled murrelet resource site need to be identified. Key components are the attributes that are essential to maintain the resource site over time (OAR 629-600-0100 (39)). The key components may vary depending on how a resource site is defined. However, they are likely include replacement trees and a buffer of additional habitat to help protect nests from the elements, risk of blowdown, and to help minimize risk of nest predation due to edge-effects. A replacement tree is typically a tree with the suitable features to be used for nesting, either as an alternate nest tree or as a replacement if the original nest tree should fall down.

Possible options for habitat protection might range from a fixed buffer around a known point location to identification of a polygon of habitat. Both would need to include adequate habitat area to protect the site(s) to avoid a conflict (i.e. site abandonment or reduced productivity). The extent of the habitat area to be included in protection might be identified using the survey protocol or a user-identified polygon of suitable habitat of a specific minimum size. The latter approach would be similar to the existing rules for spotted owls, where a core area of suitable habitat is required to be maintained around nest sites or activity centers. A summary of these options, including pros and cons of each approach are included in Table 3.

As previously mentioned, should the Board determine to identify suitable habitat (e.g., presumed occupied habitat) as a resource site under the FPA, significant additional work would need to occur. Included in this additional work would be identification of appropriate protection strategies. Thus, protection strategies for this approach are not described here and not included in Table 3.

Commented [BS101]: This is inadequate to protect nesting murrelets. As discussed elsewhere in this report, the secretive nature of murrelets makes it extremely difficult to identify nest sites. Depending on data sets possessed by governmental agencies to identify murrelet nest sites on private lands is unlikely to identify the vast majority of these sites. It would be helpful to include information on how many nest sites public agencies can currently identify on lands governed by the OFPA.

Commented [BS102]: We do not see why this issue is not resolved in this document.

Commented [BS103]: All of the approaches described in this section will require additional work. We see no reason not to include this approach in the table with a list of preliminary pros and cons. The Report seems to be unnecessarily undermining this approach as a viable option. The Report should also include in this section (and in the table) a discussion of utilizing the survey area as the designated Resource Site. The decision to limit this section to fixed points such as nest trees inaccurately indicates that prescriptive approaches can only be applied to fixed points rather than defined areas.

Table 3: Possible options for habitat protecting strategies for marbled murrelet resource sites.

Option	Description	Pro's to this approach	Cons to this approach
1: Polygon of habitat associated with protocol surveys	Polygon that identifies an area surveyed within which occupied detections were observed	• Based on surveys using a standardized protocol	• Survey boundaries are somewhat arbitrary and typically based on boundary of a proposed operation (e.g., timber harvest) and associated buffer, thus they are not necessarily biologically based. • May include stations with no detections or only presence detections • Not known if nesting actually occurred; may identify polygons for protection that not actually used for nesting • Not available unless surveys conducted based on protocol standards
2: User-Identified Polygon	A polygon of habitat around known nest site(s) or occupied detection(s) that would be identified by the operator	• Similar to the core area approach used for spotted owls • Approach can be used for data not obtained from protocol surveys • Boundaries can be established based on biological criteria such as extent of suitable habitat, topography, etc.	• Would require additional work to identify the parameters to be used to identify the extent and location of habitat to be protected • Might under or over protect marbled murrelet nesting sites

Commented [BS104]: This is a huge problem that needs to be better articulated in the report. Since these is no requirement to conduct surveys, the vast majority of sites will go undetected rendering this approach basically a paper exercise.

Commented [BS106]: Table should include an additional option: Presumed suitable habitat. There is no reason that this approach could not be fleshed out to the same levels as the other two options already outlined in this table.

Commented [BS105]: Seems like a conflict of interest to allow the operator to define the polygon

Prescriptive Approaches—Summary and Additional Work

If the Board determines a prescriptive approach should be used for marbled murrelets, additional work would need to be conducted by the Department and subsequent decisions may be needed by the Board of Forestry. This would include but not necessarily be limited to the following:

- Defining suitable habitat for marbled murrelets
- Identification of key components for marbled murrelet resource sites[6]
- Defining the extent of habitat to be protected, and how it will be identified
- Describing forest activities to be limited or allowed within protected habitat
- Defining the critical use period
- Defining the zone, within which forestry activities would be limited during the critical use period to avoid disturbing nesting birds
- If suitable, or presumed occupied, habitat is used to define a resource site, a significant amount of new work is needed (see text of document)

Programmatic Approaches to Protection

Programs that encourage or incentivize maintenance or development of suitable marbled murrelet habitat on their lands are an option to encourage voluntary actions by landowners. Possible voluntary, programmatic approaches the Department could use include 1) Development of a Programmatic Safe Harbor Agreement (SHA) for marbled murrelets with the USFWS, 2) use of the existing Stewardship Agreement program to encourage voluntary actions to conserve habitat. These voluntary measures are described below.

Programmatic Safe Harbor Agreement

A Safe Harbor Agreement is an option available under the federal Endangered Species Act. This program encourages nonfederal landowners to voluntarily enhance and maintain habitat for a listed species by providing assurances the USFWS will not impose additional restrictions because of their voluntary conservation efforts, as long as the result is a net conservation benefit for the species. This program is available now, however individual landowners would need to enroll individually with the USFWS. Under a programmatic Safe Harbor Agreement, the Department would enter into an agreement with the USFWS and would then work with individual landowners to enroll them into the Programmatic SHA. The programmatic approach to the SHA is an efficient way to implement this program. It also allows landowners to work with the Department rather than directly with the USFWS. This can be beneficial because 1) landowners are already used to working with the Department through implementation of the Forest Practices Act, and 2) some landowners have an inherent fear or mistrust of federal agencies. The Department already has a Programmatic Safe Harbor Agreement with the USFWS for the northern spotted owl (USFWS et al. 2010), thus, there is already a precedent for

[6] Defined in FPA OAR 629-600-0100 (39) as attributes which are essential to maintain the use and productivity of a resource site over time.

using this approach. Currently there are 13 properties and 3,484 acres enrolled in the Programmatic Safe Harbor Agreement for spotted owls.

While SHAs may take many forms, most SHAs involve three elements: 1) a definition of species populations or habitat conditions at the start of the SHA (baseline), 2) commitments from the landowner to conduct, or refrain from, specific actions affecting the species, and 3) a timeframe over which these actions will occur, after which the landowner is permitted to return the lands to the defined baseline condition. Under a programmatic SHA, the Department would hold the permit. If a landowner wished to be included in the terms of the SHA, they would agree to actions described in the programmatic SHA to conserve or develop habitat for marbled murrelets. A baseline for their lands would be established at the time of enrollment, defining the starting conditions at the beginning of the Agreement. The landowner is then issued a certificate of inclusion which authorizes the landowner to return the property to pre-agreement conditions (baseline conditions) at the end of the commitment period. For example, if a landowner creates habitat for marbled murrelets over the term of the agreement, they can remove that habitat at the end of the agreement without being subject to ESA take regulations. Even with a programmatic SHA available, individual landowners could still opt to develop their own SHA with the USFWS.

Commented [BS107]: This needs further discussion. How realistic is it that a landowner would "create" habitat for a marbled murrelet during the term of an agreement given that murrelets require mature and old-growth trees?

Stewardship Agreement Program

The Department's Stewardship Agreement Program was developed to 1) provide efficiencies for a landowner for implementation of the Forest Practices Act regulations on their property and 2) to encourage landowners to provide for conservation, restoration, and improvement of fish and wildlife habitat and water quality. This program was also intended to be a mechanism to allow for coordination and implementation of incentive programs. The Stewardship Agreement Program is a required component for implementation of the current Programmatic SHA for spotted owls and would also be required under a SHA for marbled murrelets. However, the Stewardship Agreement Program is also a possible mechanism to encourage voluntary actions for marbled murrelets as a stand-alone program.

The Stewardship Agreement Program allows the Department to provide regulatory certainty to landowners in certain situations (ORS 541.423 (7)). If, in a Stewardship Agreement, a landowner identifies specific voluntary actions that exceed regulatory requirements, the Board may agree to exempt the landowner from future changes to a specific rule under the Forest Practices Act. Because there are no rules in the Forest Practices Act specific to marbled murrelets, the Department cannot currently grant regulatory certainties relating to rules for murrelets. However, if during this process or at a future time the Board does develop rules for marbled murrelets, regulatory certainties may be granted. Stewardship Agreements may also be a tool that can be used to provide regulatory certainties at a state-level for landowners who have a Habitat Conservation Plan with the USFWS that addresses marbled murrelets, assuming that HCP actions exceed what is required by rule under the Forest Practices Act.

Although regulatory certainties cannot be granted at this time for any future rules for marbled murrelets, a landowner may still enroll in this program now to conserve habitat for marbled murrelets. The landowner may still obtain other benefits of this program, such as regulatory efficiencies (exemption from written plan requirements) and regulatory certainty for rules already in place (e.g., stream protection rules). Should the Board develop rules for marbled murrelets after the time an Agreement is already in place, the Agreement can be re-evaluated and amended as needed to obtain certainties for murrelets under the FPA.

Next Steps

A general summary of next steps was presented to the Board of Forestry in April of 2017 (ODF 2017b). However, subsequent work may depend on decisions made by the Board of Forestry during this rule analysis process.

As described to the Board in April 2017, this Technical Report will undergo a review by subject experts. The purpose of the review is to evaluate the literature used and content of the report, to ensure that the "best available information" is presented to the Board for their decision-making process.

Following the Expert Review, the Department will summarize the input received and create an amendment to the Technical Report, if needed. This information will then be presented to the Board at a subsequent meeting. Also, as described in the March 2017 Progress Report to the Board of Forestry, additional work is needed to help inform the decision-making process. This includes consultation with other agencies, additional analysis as required per ORS 527.714, and consideration of impacts from ballot measure 49 and associated statutes (ORS 195.305). ORS 527.714 requires additional review and that certain standards are met before new Forest Practices Act rules can be enacted. ORS 195.305 resulted from ballot measure 49 and allows claims to be made for compensation if new regulations affect the fair market value of a property; alternatively the claimant may request an exemption from the new rule. Thus, additional work will be needed to 1) conduct the required analysis under ORS 527.714 and 2) to understand the implications of ORS 195.305 on any new regulations for marbled murrelets.

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FOREST LANDSCAPE PATTERNS AROUND MARBLED MURRELET NEST SITES IN THE OREGON COAST RANGE

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ABSTRACT—We analyzed forest composition and landscape preferences of marbled murrelets (*Brachyramphus marmoratus*). Using dawn surveys and tree climbing, we found 41 murrelet nest sites on state and federal lands in the Oregon Coast Range Province in western Oregon between 1990 and 1998. Landscapes in 0.5- and 1.0-km-radius plots at these nest sites were compared to patterns in similar plots around a set of points randomly selected from stands of mature or old-growth trees on public lands in the same province. We found less open-sapling and hardwood forests in the plots at nest sites than at random sites for both plot sizes. Conversely, the proportion of pole-young conifer habitat was greater at nest sites than at random sites for both plot sizes. Landscape pattern analysis showed that the amount of edge-perimeter density, nest-patch perimeter, and high-contrast edge of nest patches was lower in the 1.0-km-radius plots at nest sites than at random sites. Our best multivariate logistic regression model indicated that greater amounts of pole-young and mature-old-growth forests, less edge (perimeter density and high-contrast edge at nest patches), and more cohesive nest-patch shape best distinguished murrelet nest sites from random sites. We hypothesize that murrelet nest-site selection at the landscape scale may be the result of an antipredator strategy to reduce predation risks on eggs and juvenile murrelets. Young (simple-structure) conifer stands adjacent to nesting areas may decrease predation rates at murrelet nests. Land managers should consider limiting clearcut harvest units both adjacent to murrelet nest patches and within at least 1 km of murrelet nests, as clearcuts increase high-contrast edge in addition to increasing fragmentation levels.

Key words: marbled murrelet, *Brachyramphus marmoratus*, aerial photography, GIS, landscape patterns, Oregon Coast Range

Marbled murrelets are forest-nesting seabirds that inhabit the Pacific Coast of North America from Alaska to central California. We know that these small alcids nest primarily in older-aged trees in mature and old-growth coniferous forests with multilayered canopies (for example, Hamer and Nelson 1995; Nelson and Sealy 1995; SKN and others, unpubl. data). They also nest solitarily on large moss-covered platforms with ample cover from surrounding tree branches. Despite their apparent selection of concealed nesting locations, predation rates at nest sites are high (Nelson and Hamer 1995; Manley 1999). Murrelet populations are suspected to be declining at a rate of 4 to 7% per year, based on demographic simulations (Beissinger 1995), due to predation, habitat loss, habitat fragmentation, over-fishing and gill nets in their foraging habitat, and fluctuating ocean conditions (USFWS 1997). In addition, the amount and spatial pattern of suitable nesting habitat might be an important determinant of long-term murrelet population trends (Ralph and others 1995; Raphael and others 1995, 2002b; Burger 2001). This species was federally listed as threatened in 1992 (USFWS 1992).

Understanding the patterns of resource selection by wildlife at multiple scales is central to appropriate habitat management. Researchers have recently described landscape use by murrelets at multiple scales using occupied sites where birds were believed to be nesting (Meyer and others 2002). However, little is known about habitat patterns that are associ-

ated with actual murrelet nest sites at the landscape scale. Landscape patterns may affect reproductive success through the mechanism of predation risk because Nelson and Hamer (1995) found that successful murrelet nests were farther from edges, were better concealed, and had greater canopy closure than unsuccessful nests.

The overall goal of this study was to measure forest composition and landscape patterns associated with marbled murrelet nest sites and random sites using aerial photography and a Geographic Information System (GIS). GIS can be used to calculate forest composition and measures of landscape pattern that have occurred as the result of forest harvesting practices, natural disturbances, and succession (Ripple and others 1991, 1997). This characterization of landscapes around murrelet nests can be used as an aid for managing landscapes suitable for maintaining murrelet populations. Our specific objectives were to characterize forest landscape composition and patterns in the vicinity of marbled murrelet nest sites in the Coast Range of Oregon and to compare forest composition and landscape patterns at nest sites with the composition and patterns at random locations. We believe our research represents the 1st study of landscape patterns around actual marbled murrelet nest sites. Other researchers of landscape pattern have used occupied sites where the birds were believed to be nesting rather than actual nest sites (Raphael and others 1995; Meyer 1999; Meyer and Miller 2002; Meyer and others 2002; Miller and others 2002).

METHODS AND STUDY AREA

Nest sites and random points were located in the Coast Range Province in western Oregon (Fig. 1). These areas are primarily forested; however, timber harvest has been extensive since the early 1900s and most stands are <100 y old. Prior to logging, high intensity and low frequency (>200 y) wildfire was the primary disturbance in the area (Ripple 1994). Due to extensive timber harvesting, the current amount of late seral habitat is lower than prior to logging (Ripple and others 2000) and is lower than the range of historical variability (Wimberly and others 2000). Mature and old-growth conifer trees remain in relatively small, isolated patches. Douglas-fir (*Pseudotsuga menziesii*) is the dominant tree species in the north, and mixed-evergreen species, including Douglas-fir and tanoak (*Lithocarpus densiflorus*), are dominant in the south.

The area is comprised of rugged, mountainous terrain with steep slopes and deep river and creek drainages. The climate is characterized by warm, dry summers and cool, wet winters. Mean temperatures range from 0°C in the winter to 24°C in summer. Annual precipitation ranges from 150 to 300 cm (Franklin and Dyrness 1973). Elevations range from 50 m along the coast to 1200 m in the central Coast Range mountains.

Nest Sites

We located 41 marbled murrelet nest sites on state and federal lands in the Oregon Coast Range between 1990 and 1998 using dawn surveys and tree climbing (SKN, unpubl. data). These nest sites represent all of the nest sites found in Oregon between 1990 and 1998. Surveys and tree climbing were located in areas with previous sightings of murrelet activity. Over the 8 y, nest searches were focused in 3 areas; therefore, most nest trees (n = 22) were clustered in 3 groups with all nest trees within each group <4 km from each other, while the remainder (n = 19) were scattered throughout the rest of our study area (Fig. 1). We note that our set of nest locations may be biased due to our choice of search locations. Because some of our nest sites were clustered, we compared the habitat composition in 1.0-km-radius plots around clustered nests (<1 km to nearest nest) with dispersed nest sites (>1 km to nearest nest).

Landscape Selection

We compared landscapes around nest trees (n = 41) to landscapes around a set of randomly located points (n = 41) at 2 spatial scales. We selected random sampling points from a set of aerial photos to represent the area available to marbled murrelets for nesting. The random points were distributed throughout the Coast Range within 52 km of the coast (the known inland range of murrelets in Oregon). Random points were limited to public lands and stands of mature and old-growth trees (as defined below in the classification scheme) to match our sample of nest sites because all of our murrelet

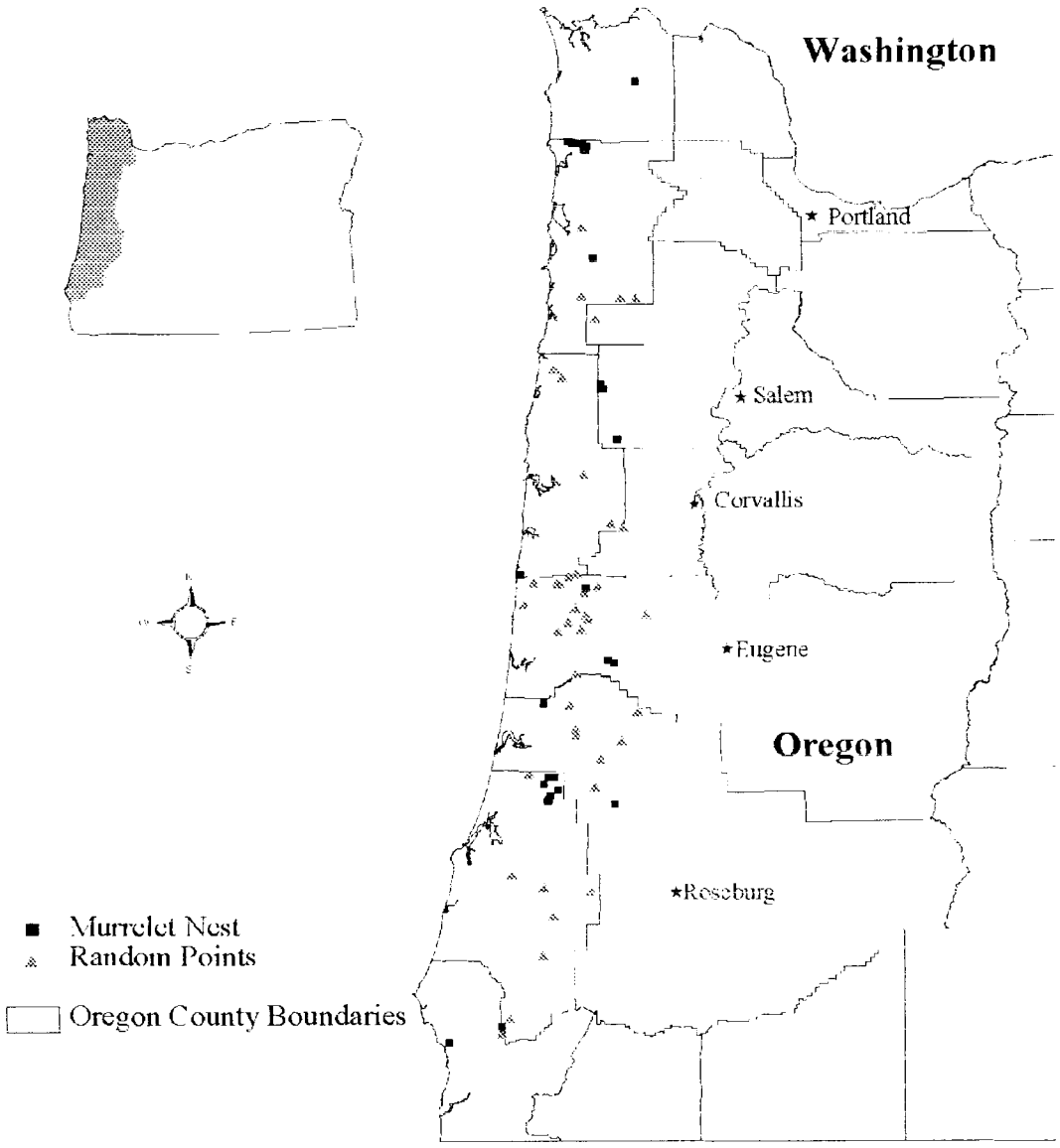

FIGURE 1. Locations of marbled murrelet nests and random point sites in the Coast Range, Oregon.

nests were located in mature and old-growth stands.

We used 2 aerial photo flight projects (scale 1:31,000 and 1:24,000) because no single flight project covered all of the study area. Photos in the 2 flight projects were labeled with a random number, ordered by this random label, and then selected in that sequence. If a photo did not fall over public land, it was excluded from the 1st selection criterion. The 2nd selection criterion consisted of determining which systematically located dots on a template fell within a mature or old-growth stand. Dots that fell on a suitable stand type were then available to the 3rd selection criterion, which was to randomly select a dot, from the dots available on any one photo, to be the center of a 1.0-km-radius plot.

Landscape Classification and Spatial Analysis

Landscapes were classified in a 1.0-km-radius circle drawn around each nest tree and random point. Using a scanning stereoscope,

we classified vegetation within each circle into 1 of 6 habitat classes: open-sapling—dominated by conifers with average DBH ≤ 13 cm; pole-young conifer—dominated by conifers with average DBH between 13 and 50 cm; mature-old-growth conifer—dominated by conifers with average DBH ≥ 50 cm and having an understory of hardwood or conifer; hardwood—dominated by large-stem hardwoods; non-forest—areas not in tree production including rock outcrops, pastures, hay fields, water, and wetlands; and developed—areas with frequent human presence including residences, public parks, and farmsteads. The initial photo interpretation was field checked and adjustments were made to ensure accurate habitat maps. Mature conifer stands were grouped with old-growth conifers because it was not possible to separate these 2 cover types accurately with the small-scale imagery. The minimum mapping unit was 0.5 ha and the minimum width of a mapping polygon was 20 m. Classifications were drawn onto mylar sheets overlaid on the aerial photos. These were then transferred to US Geological Survey orthophoto quadrangle maps using a zoom transfer scope and digitized into GIS layers.

We determined the composition of habitat around nest and random points using 1.0- and 0.5-km-radius plots. A grid-based GIS system (ERDAS Imagine*) was used to determine habitat composition in each circular plot and to calculate values for variables relating to landscape patterns in the 1.0-km-radius plots.

Mature-old growth patch density (number of patches/km^2), core habitat, and perimeter (edge) density (km/km^2) were determined for each nest and random point. Core habitat was defined as the area of mature-old-growth patches remaining after a 100-m band was subtracted from the edge of each patch (Ripple and others 1997). The 100-m distance captures most of the depth of edge influence on air temperature and other edge effects (Paton 1994; Chen and others 1995). Perimeter was defined as the boundary between mature-old growth habitat and any other habitat type. In addition to these landscape pattern variables, 5 patch variables, including nest-patch area (ha), nest-patch perimeter (km), nest-patch shape (nest-patch perimeter/nest-patch area), the proportion of the nest-patch perimeter that was high-contrast edge, and the percent of sites with no high-contrast edge around the nest patch, were determined for each nest patch and the corresponding mature-old-growth patches around the random points. High-contrast edge was defined as a boundary between mature-old-growth and open-sapling, nonforest, or development.

Statistical Analysis

We compared the proportion of the 6 habitat types in both the 0.5- and 1.0-km-radius plots around nest and random sites using univariate logistic comparison models. Statistical tests were not conducted on the non-forest and developed-land cover classes because of the low occurrence of these habitat types in both the nest and random plots.

We conducted a multivariate logistic regression analysis (Proc LOGISTIC) to identify models that best distinguished between murrelet nest sites and random sites for the 1.0-km-radius plots (SAS 1997). Because this was the 1st study of landscape patterns around actual murrelet nests, we examined combinations of variables that best distinguished marbled murrelet nest sites from random sites instead of developing and testing *a priori* hypotheses about the relation of murrelet nest sites and habitat variables. We considered 11 variables (open-sapling, pole-young, mature-old-growth, hardwoods, patch density, core habitat, perimeter density, nest-patch area, nest-patch perimeter, nest-patch shape, and the proportion of nest-patch perimeter in high-contrast edge) measured in the 1-km-radius plot around nest and random points in model development. Highly correlated variables ($r > 0.70$) were eliminated from the multivariate analysis. We did not include >5 variables in any given model because our sample size was low ($n = 41$). The logistic regression model [Logit (β)] described the probability of a cell being a nest site as a function of a set of explanatory variables, where β is the maximum likelihood estimate of the probability that, in a specific cell, a murrelet nest was located during the sampling process. The adequacy of the models was determined by comparing a series of reduced models to the full model using the AIC score (Akaike information criterion) to select the most parsimonious model that adequately fit the data (Burnham and Anderson 1992). AIC is an adjusted drop-in-deviance score based on the number of explanatory variables in the model and the

TABLE 1. Univariate comparison (logistic regression) of percentage area in 6 cover types near 41 marbled murrelet nests and 41 random sites for 2 plot sizes in the Oregon Coast Range. Values for $\bar{x}$, s, Min, and Max, as shown in this table, represent the percent of the total area in the plot. P-values are from testing the null hypothesis of no difference between murrelet nest sites and random sites.

	Nest sites				Random sites				
Cover type	$\bar{x}$	s	Min	Max	$\bar{x}$	s	Min	Max	P
1.0 km-radius plots									
Open-sapling	7.9	7.5	0.0	22.3	15.8	9.7	0.0	34.0	0.001
Pole-young conifer	50.1	14.6	15.7	71.7	34.1	14.8	2.9	71.4	0.001
Mature-old-growth conifer	29.6	14.4	5.2	76.7	33.0	13.8	9.3	68.4	0.719
Hardwood	12.4	10.4	0.0	53.0	15.5	11.7	0.0	54.1	0.051
Non-forest[a]	0.1	0.4	0.0	2.1	1.3	4.0	0.0	21.9	—
Developed[a]	0.0	0.1	0.0	0.5	0.4	1.5	0.0	9.0	—
0.5 km-radius plots									
Open-sapling	6.6	8.9	0.0	29.2	11.6	10.4	0.0	30.6	0.027
Pole-young conifer	42.5	19.7	10.8	477.6	29.1	16.2	1.7	74.2	0.003
Mature-old-growth conifer	43.5	23.9	10.0	82.8	45.1	17.6	9.2	89.0	0.775
Hardwood	7.2	7.7	0.0	31.4	13.6	12.3	0.0	54.1	0.009
Non-forest[a]	0.2	0.6	0.0	2.8	0.6	3.4	0.0	21.6	—
Developed[a]	0.0	0.0	0.0	0.0	0.1	0.8	0.0	4.9	—

[a] Logistic regression was not conducted for non-forest or developed cover types because few sites contained these habitat types.

number of observations used. It is a goodness-of-fit measure for comparing one model to another, with lower values indicating a better model (SAS 1997). We considered the best models to be those with the lowest AIC. Models within 2 AIC units of the best model were considered to be competing models.

Results

The proportions of both open-sapling and hardwood forests were less at nest sites than random sites for both the 0.5- and 1.0-km-radius plot sizes ($P \leq 0.051$, Table 1). Conversely, the proportions of pole-young conifer were significantly greater at nest sites than at random sites for both plot sizes ($P \leq 0.003$). In addition, no significant differences were found in the proportions of mature-old-growth conifer forests between nest sites and random sites ($P \geq 0.719$). In the subpopulation of nest sites with low proportions of pole-young forest, the murrelets were more likely to have nest sites in locations with relatively high proportions of mature-old-growth forests (Fig. 2). In addition, Fig. 2 shows that at any given level of mature-old-growth habitat, more pole-young habitat was present at nest sites than random sites.

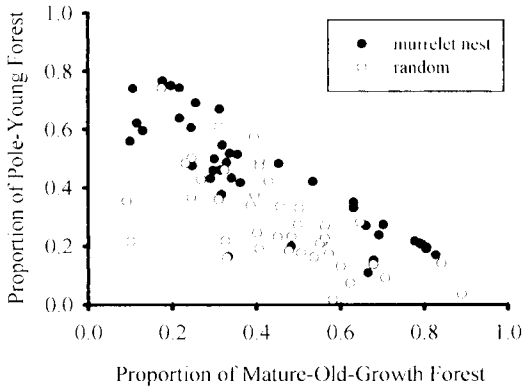

FIGURE 2. Scatter plot of mature- and old-growth forest vs. pole-young forest in 1.0-km-radius circles around marbled murrelet nest sites and random point sites in the Coast Range, Oregon.

Murrelets nested in landscapes with a wide range of habitat types with relatively high standard deviations and ranges of forest type proportions (Fig. 2). We found no significant differences for each of the forest habitat types in the clustered vs. the dispersed nest sites ($P \geq 0.325$). Random landscapes also exhibited high variability in landscape composition.

Results of the landscape pattern analysis for the 1-km-radius circle showed that the amount of mature-old-growth edge (perimeter density) was significantly lower for nest sites than random plots ($P = 0.003$, Table 2). However, we found no differences in the amount of core habitat and patch density between nest sites and random sites ($P \geq 0.119$).

We compared the spatial patterns of the

TABLE 2. Univariate comparisons (logistic regression) of patch and landscape pattern characteristics within 1 km of 41 marbled murrelet nest sites and 41 random points in the Oregon Coast Range. *P*-values are from testing the null hypothesis of no difference between murrelet nest sites and random points.

Variable	Nest sites				Random points				
	$\bar{x}$	s	Min	Max	$\bar{x}$	s	Min	Max	P
Patch density (mature-old-growth patches/km^2)	2.1	1.4	0.3	5.4	2.5	1.2	0.6	5.4	0.119
Core habitat (>100 m from edge; ha)	23.7	31.8	0.0	164.4	17.6	19.5	0.0	87.8	0.307
Perimeter density in 1.0-km-radius plot (km/km^2)	5.0	2.0	1.9	9.7	6.6	2.3	3.0	13.7	0.003
Nest-patch area (ha)	61.2	52.0	2.3	181.0	62.4	43.3	1.0	176.5	0.907
Nest-patch perimeter (km)	6.7	5.0	0.7	21.5	9.6	6.1	0.4	24.8	0.027
Nest-patch shape (nest-patch perimeter [m]/nest-patch area [ha])	156.6	74.9	35.4	403.3	180.8	64.5	77.0	380.0	0.126
Percentage of nest patch perimeter that was high-contrast edge (%)	7.5	11.7	0.0	48.7	16.4	15.6	0.0	56.3	0.008
Percentage of sites with no high-contrast edge around nest patch[a] (%)	53.7	—	—	—	17.1	—	—	—	—

[a] High-contrast edge includes edges between the mature-old-growth cover type and open-sapling, non-forest, and developed cover types. Logistic regression analysis was not conducted on this variable.

murrelet nest patches to the corresponding conifer patches around the random points (Table 2). Mean nest-patch area containing mature-old-growth conifer forest was not different than the area of mature-old-conifer forest around random points ($P = 0.907$). However, nest-patch perimeter was significantly lower than the amount of edge on the corresponding random patches ($P = 0.027$). In addition, the proportion of the total nest patch edge that was high-contrast (open-sapling, non-forest, development) was lower than the proportion of high-contrast edge around the random patches ($P = 0.008$). Most nest patches (54%) had no high-contrast edge compared to 17% with no high-contrast edge around the corresponding mature-old-conifer patches at random points.

We eliminated the variables of core habitat and nest-patch area from the multivariate analysis due to high correlations with other variables. Ten multivariate models including 3 competing models with the lowest AIC values were constructed (Table 3). All our models showed classification accuracies between 63% and 77% at the 0.50 probability level. The best model (lowest AIC) indicated that the combination of greater amounts of pole-young and mature-old-growth forests, less edge (perimeter density in 1.0-km-radius plots and high-contrast edge at nest patches), and more cohesive nest-patch shape best distinguished murrelet nest sites from random sites (Table 4, model 5a). The 2nd and 3rd best models (5b and 4a) were similar to the top model with the exception that they did not include mature-old-growth, and model 5b had less hardwood forests associated with nest sites than random sites (Table 4).

DISCUSSION

In our study, all murrelet nests were located in mature-old-growth conifer forests (as defined by dominant overstory trees >50 cm DBH). Because we made comparisons between nest sites and random sites only located in mature-old-growth forests on public lands, we were able to characterize specific features within older forest landscapes that were associated with marbled murrelet nests. Landscapes at murrelet nests had less early seral (open-sapling) and hardwoods and more pole-young forest than random sites. Hardwoods are typically not used for nesting and may account for the

TABLE 3. Most significant logistic regression models differentiating 41 marbled murrelet nests and 41 random sites in the Coast Range, Oregon.

Model	Significance of coefficients: Akaike information criterion	Classification accuracy: Percentage of sites correctly classified at 0.50 probability level
1a. pole-young	107.07	63.4
1b. perimeter density	106.91	68.3
2a. pole-young, nest-patch shape	97.39	67.1
2b. pole-young, mature-old-growth	97.37	74.4
3a. pole-young, % high-contrast edge, nest-patch shape	90.45	74.4
3b. pole-young, mature-old-growth, nest-patch shape, perimeter density	91.66	74.4
4a. pole-young, nest-patch shape, % high-contrast edge, perimeter density	88.04	76.8
4b. pole-young, mature-old-growth, nest-patch shape, perimeter density	90.45	75.6
5a. pole-young, nest-patch shape, mature-old-growth, perimeter density, % high-contrast edge	87.64	76.8
5b. pole-young, nest-patch shape, hardwood, perimeter density, % high-contrast edge	87.85	74.4

low amount of hardwood forests around nest sites. However, in our univariate results, the proportion of mature-old-growth forest was similar between the 2 sets. This lack of difference in mature-old-growth forests may have been due to our criteria for selecting random sites, which limited variability and required that random points fall only in mature-old-growth patches and on public lands. Conversely, in our multivariate results, which are more

TABLE 4. Logistic regression models that best discriminate between marbled murrelet nests and random sites. χ^2 and P-values based on Wald's χ^2 probability test. Wald's χ^2 probability is a maximum likelihood estimate of the logistic regression coefficients. Its value indicates the probability that an outcome will occur; thus, higher values of this statistic can give an indication of which variables in the model may be significant.

Variable	Parameter estimate	s_A	χ^2	P
Model 5a				
Intercept	−0.41	2.24	0.03	0.855
Pole-young	8.95	2.71	10.94	0.001
Nest-patch shape	−0.012	0.005	4.79	0.023
Mature-old-growth	3.58	2.39	2.25	0.133
Perimeter density	0.30	0.14	4.46	0.035
High-contrast edge (%)	−4.87	2.35	4.28	0.039
Model 5b				
Intercept	3.01	1.30	5.38	0.020
Pole-young	5.79	2.00	8.37	0.004
Nest-patch shape	−0.01	0.01	6.89	0.009
Hardwood	4.37	3.01	2.11	0.147
Perimeter density	−0.27	0.14	3.79	0.052
High-contrast edge (%)	−5.70	2.28	6.23	0.013
Model 4a				
Intercept	2.44	1.15	4.48	0.030
Pole-young	6.38	1.99	10.24	0.001
Nest-patch shape	−0.01	0.01	7.25	0.007
High-contrast edge (%)	−5.99	2.27	6.98	0.008
Perimeter density	−0.28	0.14	3.95	0.047

reliable than the univariate, we found that the proportion of mature-old-growth was an important predictor of murrelet nest sites, once pole-young forest was accounted for. Thus, when the proportion of pole-young forest was low around nest sites, the proportion of mature-old-growth forests was typically high (Fig. 2).

We hypothesize that murrelet nest-site selection at the landscape scale may be the result of an antipredator strategy to minimize predation risks on eggs and juvenile murrelets. The low proportion of early seral stands near nest sites may represent situations with lower predator densities and possibly landscapes that provide the cover needed for murrelets to successfully avoid predators, including jays and ravens. Clearcuts may increase corvid densities because of increased foraging opportunities on berry-producing plants thereby creating the potential for an increase in murrelet nest predation near these clearcuts (Marzluff and Restani 1999). Murrelets appear to be selecting landscapes with patches of mature and old-growth conifers in a matrix of pole-young forests (simple structure) or a matrix of mature-old-growth with patches of pole-young conifers; the presence of the young conifers may provide cover for murrelet nests along older forest edges (Fig. 2).

Our observation that murrelets select landscapes with relatively high amounts of pole-young conifers is consistent with our antipredator hypothesis, because Marzluff and others (2000) reported low densities of corvids in mature-old-growth conifer forests that were simple in structure. At the subregional scale, Meyer and Miller (2002) and Meyer and others (2002) found that offshore densities of murrelets in southern Oregon and northern California were highest in areas with large blocks of old-growth forest within a matrix of medium-sized 2nd-growth forests. At the landscape scale, the highest-quality nesting habitat, as determined by inland murrelet detections, contained large blocks (>50 ha) of unfragmented old-growth forest (Meyer and Miller 2002; Meyer and others 2002).

Our univariate results showed landscapes around murrelet nest sites had less edge than random landscapes. While murrelet nest patches were not different in area than the corresponding random patches, nest patches had significantly less perimeter (edge) than the random patches, and nest-patch perimeters showed much less high-contrast edge than the corresponding random patches. Our best multivariate model also included 2 edge variables. In a sample of 77 nests with known outcomes from Alaska to California, Manley and Nelson (1999) found a survival rate of 38% when murrelet nests were located ≤50 m from edges vs. a 62% survival rate for nests >50 m from edges. Bradley (2002) found no evidence that nesting near natural forest edges reduced reproductive success in marbled murrelets, although corvid densities may have been low around his high elevation sites containing natural forest edges. In another study, lower nest success was documented at artificial murrelet nests located <50 m from edges, but only when the matrix around the nests contained human settlements, recreation areas, or clearcuts (Raphael and others 2002a). There was no difference in nest success when the nest stand was adjacent to regenerating forest.

One limitation of this study of nest sites was that some of our nest-site plots were clustered and not spatially independent. This problem of spatial autocorrelation may have inflated the significance levels of our statistical analysis, although the basic relationships that we found should be valid. Another potential complicating factor in our hypotheses is that murrelets appear to have high site fidelity (Nelson 1997). We know that birds return year after year to the same stand (suspected to be the same individual adults), but we are uncertain whether juveniles disperse across the landscape (generally uncommon in other alcids; Hudson 1985). If there is no dispersal from natal areas, then our results may not reflect selection at the landscape scale, but instead they may be a consequence of recent timber management with recent clearcuts placed away from existing murrelet nesting areas. While we believe that selection occurs at both the stand and within-stand scales, additional research should be conducted to determine how landscape pattern affects murrelet habitat selection. Because of high site fidelity, murrelets may continue to use remaining small fragments of habitat after an area is clearcut. Over time, these birds may disappear due to high predation rates (Meyer and others 2002).

Management Recommendations

Until more is known on selection at the landscape scale and predation risk effects, managers should consider landscapes dominated by a mixture of old (complex structure) and young to medium-aged (simple structure) coniferous forests as potentially important murrelet habitat. The old complex structure provides nesting habitat, while the simple-structure conifers may limit corvid densities (Raphael and others 2002a). Historically, the simple-structure conifers were probably less important for murrelet nesting success; however, recent increases in corvid populations (Marzluff and others 1994), especially in open or disturbed areas, could be affecting murrelet populations.

Landscape configuration and pattern may be important in murrelet nest-site selection because we found variables related to fragmentation levels and forest openings (edge and open-sapling) to be lower in murrelet nest sites when compared to random landscapes. We recommend that fragmentation by early seral stages and the amount of high-contrast edge be primary variables used by researchers and managers when analyzing murrelet landscapes. Land managers should consider limiting clearcut harvest units both adjacent to murrelet nest patches and within at least 1 km of murrelet nests because clearcuts increase high-contrast edge, increase fragmentation levels, and probably increase predation risk.

Acknowledgements

We offer special thanks to J Foster for beginning the aerial photo interpretation and helping select the random locations. This study was funded by the US Fish and Wildlife Service; thanks to N Bentivoglio, N Lee, and G Miller for making this project possible. The murrelet nest sites used in this study were located through grants to SK Nelson from the Bureau of Land Management, National Council of the Paper Industry, Oregon Department of Fish and Wildlife, Oregon Department of Forestry, US Fish and Wildlife Service, and US Forest Service. Daniel W. Schafer provided statistical advice. We thank C Meyer and M Raphael for reviewing on this paper.

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AUGUST 13, 2018

TO: Ms. Jennifer Weikel, Oregon Department of Forestry

CC:

FROM: Jake Verschuyl, Director of Forestry Research – Western U.S. and B.C., NCASI

SUBJECT: Verschuyl Peer Review of the Draft Marbled Murrelet Technical Report, developed by Ms. Jennifer Weikel, Oregon Department of Forestry

Ms. Weikel,

Thank you for the opportunity to serve as a peer reviewer for the Oregon Department of Forestry Draft Marbled Murrelet Technical Report. My peer-review comments are presented in bulleted form below referencing page, paragraph and line numbers from the primary document titled "6b_Draft Marbled Murrelet Technical Report.pdf". Please let me know if you have any questions on the attached review, or if you need additional information.

- Page 3, paragraph 2, line 8-9: The presence of suitable platform limbs is considered one of the most important ***nesting*** habitat features for this species. (I suggest you add the word "nesting").

- Page 3, Paragraph 5: Please revise the trend information reported here and on pages 9-11 to reflect the latest information in the NWFP monitoring report:

Pearson, S.F., B. McIver, D. Lynch, N. Johnson, J. Baldwin, M.M. Lance, M.G. Raphael, C. Strong, and R. Young, T. Lorenz, and K Nelson. 2018. Marbled murrelet effectiveness monitoring, Northwest Forest Plan: 2017 summary report. 19 pp.
Found here:
https://www.fs.fed.us/r6/reo/monitoring/murrelet/NwfpAnnualMonitoringReportMurrelet2018.pdf

Related comment: When reporting trends, in the summary and in the main document, it is very important to report them consistently. If the confidence intervals overlap 0, it seems prudent to report that the trend is "inconclusive". In the text of the draft technical report, trends are labeled

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as increases or declines and then further qualified as inconclusive or not significant. It would be less confusing to use an approach like this (example following uses data from Pearson et al. 2018): "Throughout the NWFP area, the trend in marbled murrelet at-sea abundance through 2016 was inconclusive (0.15% increase per year; 95% CI: -1.2 to 1.5%)", where the statistics are included in a parenthetical statement at the end.

The trend for CA is incorrectly reported on page 9 as 0.9% (it appears from Figure 2 that it should be 3.9%), but this will likely be resolved when all trend numbers are updated to the Pearson et al. 2018 document referenced above. Figure 2 will need to be replaced or modified as well.

- Page 8, Paragraph 2, line 2-3 and line 13-14: It would be worthwhile to have a conversation with Dr. Jim Rivers at Oregon State University to update these numbers before the final draft. I am aware they have found an additional 7 nests (at least) as part of the Oregon Marbled Murrelet Project this year.

- Page 9, Paragraph 1, line 2-5: The Burger et al. (2009) conclusion that nest re-use is more likely in areas where habitat has been reduced by logging is just one of many possible reasons for their findings. The biophysical conditions, and more importantly the off-shore marine environments of Eastern Vancouver Island and the Sunshine Coast of mainland BC differ from those found in the rainforests of Northern and Western Vancouver Island. The comparison is made by Burger et al. (2009) as though logging is the only thing that differs between those zones. I believe a more plausible mechanism for the pattern of nest re-use is that conditions that create appropriate moss depth for nest cups differ in the drier forests of Eastern Vancouver Island and the Sunshine Coast (Table 1; Van Rooyen et al. 2011). Thus, appropriate nesting locations, which may be fewer, get more use. I recognize that reasoning also may not offer a full description of why murrelets behave the way they do in each of these zones, but it sheds light on another unassessed complexity of comparing murrelet behaviors across different geographies.

  For this Technical Report, reporting the published science fairly involves adding additional qualification that authors may have omitted. As an example of a minor modification, I propose the following text for the Draft Technical Report: "The authors noted that the two study areas with a greater history of logging had greater evidence of multiple nests and reuse than the study area with little to no logging history and surmised that nest reuse may be more likely in areas where nesting habitat is limited (Burger et al. 2009). However, many unquantified factors differ between the comparison study areas as well, notably the biophysical setting and prey resources of each."

- Page 9, Paragraph 2, line 1-2: It would be helpful to qualify this statement given that data is lacking to address this fully. E.g.: "In contrast to other seabird species, forest nesting marbled murrelets may not nest in colonies and are generally expected to be somewhat solitary." The Oregon Marbled Murrelet Project is addressing this partially with a con-specific attraction experiment, where I believe they may have had some positive results, highlighting how much is left to learn. It would be good to use language that leaves the topic open regarding whether marbled murrelets are colonial nesters.

- Page 11, Paragraph 2, Listing Status: Please update the language to reflect the Oregon Fish and Wildlife Commission's recent reversal of the decision to up-list the marbled murrelet in Oregon.

- Page 12, Paragraphs 1 - 3: As it relates to murrelet habitat loss/recruitment: Davis et al. 2014 (citation below) reports the following for federal forests related to old-growth trends since the passing of the Northwest Forest Plan:

  > *"The Plan anticipated a continued decline in older forests for the first few decades until the rate of forest succession exceeds the rate of gross losses. Decadal gross losses of about 5 percent per decade as a result of timber harvesting and wildfire were expected. Observed losses from wildfire were about what was expected, but losses from timber harvesting were about one quarter of what was anticipated."*

  Raphael et al. (2016a), in contrast, leaves the reader to believe that terrestrial habitat declines due to logging are the primary continued concern for long-term population viability of the marbled murrelet. I disagree. Federal harvests were 25% of what was projected over the first 20 years of the NWFP, and wildfire acreage was near projected values. Declines in old-growth were expected after passing the NWFP, but federal lands in the Plan area are near (or past) the tipping point where succession will exceed the rate of loss. Given that 55% of the highly suitable habitat for marbled murrelets is on USFS land in Oregon, the greatest potential for loss or gain of murrelet habitat is from federal forests. The in-progress analysis (referenced at the bottom of page 12) will hopefully provide a more detailed understanding of habitat recruitment, critical to completing our understanding of the implications for the marbled murrelet. I am hopeful that the Board of Forestry will have access to the results of that analysis at the time they review this report.

  Citation: *Davis, Raymond J.; Ohmann, Janet L.; Kennedy, Robert E.; Cohen, Warren B.; Gregory, Matthew J.; Yang, Zhiqiang; Roberts, Heather M.; Gray, Andrew N.; Spies, Thomas A. 2015. Northwest Forest Plan–the first 20 years (1994-2013): status and trends of late-successional and old-growth forests. Gen. Tech. Rep. PNW-GTR-911. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 112 p.*
  Found here:
  https://www.fs.fed.us/pnw/pubs/pnw_gtr911.pdf

  I also re-submit the memo (originally submitted during public comment period to ODFW) by Prisley and Verschuyl describing the results of FIA analyses documenting trends (since 1995) in acreage recruited to 50+ year old forest age classes in coastal Oregon forests (attached at the end of these comments). Although mature forests being recruited would not initially be considered "highly suitable" habitat, it is reasonable to expect their quality to increase over time.

- Page 14, Table 1a and 1b: It would be useful to add to this table the new nests found by the Oregon Marbled Murrelet Project this year. I think doing so may be especially important because the nests in the Nelson et al. database were found non-randomly. The nests found by Rivers et al. (OMMP) were found by following telemetered birds to "random" nest locations.

- Page 14, Paragraph 3, Line 4 (and other places throughout the document): It would be helpful to include the original citable work rather than ODFW (2018), to give greater transparency to the sources of information.

- Page 17, Paragraph 6, lines 4-6: Similar to Burger et al. (2009), Zharikov et al. (2007) compared nest success (successful nests vs. failed nests) in two very different landscapes without accounting for the effect of factors other than forest management history on marbled murrelet nest success. It is clear in Figure 2 of the Zharikov et al. (2007) paper that the nest success of Clayoquot Sound and Desolation Sound differed by an order of magnitude during the study. Desolation sound has more fragmented habitat than Clayoquot Sound, but biophysical setting and marine conditions differ drastically between the two zones (outer coast and inland waterway with a warm current), and prey availability would be thought to differ as well. The conclusions drawn by several researchers relating murrelet activities to habitat pattern in British Columbia are confounded by covarying factors that are not accounted for (see earlier critique of Burger et al. 2009). I think the BOF would benefit from these nuances being described.

- Page 22, Paragraph 1, line 7-8: The effect of covarying factors in the Zharikov et al. (2007) paper is not to be underestimated, as described in the prior comment. Most (possibly all) of the papers comparing results from Clayoquot Sound and Desolation Sound during this study were focused on describing variation in murrelet use of forest stands using landscape pattern information alone. A highly plausible alternative scenario is that there was ample terrestrial habitat in both locations, but foraging resources differed between locations during the years sampled. Following the available foraging resources, murrelets nested in higher density in Desolation Sound. If there was less available mature forest habitat in Desolation Sound at that time, then it looks like birds "pack-in" when habitat is "limited". However, this result is likely not related to site fidelity as much as it is an indicator that terrestrial habitat quantity was/is not the limiting factor for murrelet breeding success. These complexities should get further description in the Draft Technical Report.

- Page 27, Paragraph 4, line 5-10: Van Rooyen et al. (2011) found mean temp differences 0f 0.4 degrees C for hard edge vs. interior and 0.6 degrees C for soft edge vs. interior. Neither were statistically significant (Page 557 of Van Rooyen et al. 2011). Many of the conclusions of the Van Rooyen et al. (2011) paper are supported by insignificant tests and very small effect sizes. Although it seems several have tried to prove thermal stress is a factor for nesting murrelets near edges, the data does not support their conclusions. I think it would be fair to include a statement in the Draft Technical Report if it was kept in general terms, e.g.: "Changes in microclimate or surrounding vegetation resulting from timber harvest during the nesting season may influence nest productivity."

- Page 27, Paragraph 4, line 13: I am having a hard time locating any reference information to support the 150 ft microclimate effects. Edge and interior plots in Van Rooyen et al. (2011) were 25m radius plots; the interior plots were at least 150 m from the edge. Therefore, it seems little is known about canopy epiphytes and microclimate between 25m and 125m from the edge. Also, hard edges in high productivity areas have a more abrupt biophysical gradient between open and interior conditions, narrowing the horizontal distance of edge effect (McWethy et al. 2009).

  McWethy, D. B., A. J. Hansen, J. P. Verschuyl. 2009. Edge effects for songbirds vary with forest productivity. Forest Ecology and Management 257: 665-678.
  Found here:
  https://www.researchgate.net/publication/222519217_Edge_effects_for_songbirds_vary_with_forest_productivity

- Page 28, Paragraph 3: Although the USFWS developed the Biological Opinion, there is no data to support noise disruption.

DATE: February 1, 2018

TO: Oregon Department of Fish and Wildlife

FROM: Steve Prisley and Jake Verschuyl

SUBJECT: NCASI Technical Analysis of Recent Trends in Forest Growth and Harvest within 50 Miles of the Pacific Ocean, Oregon.

Forest Inventory and Analysis (FIA) data are collected annually by the US Forest Service. These data include information about forest stand conditions, tree volume and biomass, as well as approximate plot coordinates. The FIA data can be used with statistical approaches to estimate acres of forest nationally or in certain geographic regions that meet specified criteria related to forest stand conditions, age, or other attributes. Plots are remeasured every 5 to 10 years with the measurement cycle being longer in the western U.S. than in the East.

The purpose of this analysis was to assess growth and harvest of forests that are potentially used by the marbled murrelet. For this analysis, we were interested in how many forest acres have been recruited into the 50+ year age class since 1995, within 50 miles of the Pacific coast. This can be restated as how many acres of forest reached age 50 (and were thus recruited into the 50+ age class) each year since 1995. This is determined using the stand age variable (STDAGE) in the FIA database (O'Connell et al. 2015). Stand age can be updated to a single point in time by adding the years elapsed since the plot was last inventoried (e.g., a plot recorded as 60 years old when inventoried in 2011 would be considered 67 years old in 2018).

Since 1995, an average of 64,710 acres have been added annually to the 50-year age class (Figure 1). The trend has been increasing: 226,400 acres were added from 1995-1999, and about double that amount (460,864) were added from 2012-2016.

Because the data used for this age analysis may be up to 10 years old, it is important to understand how many acres in the 50+ year age classes may have been harvested since the last plot measurement. Therefore, we examined the age class distribution of plots harvested during the last measurement cycle. In the coastal region, 170 plots with a previous measurement had a harvest recorded; 84 of these were clearcut harvests[1]. These 84 plots represent an estimated annual harvest level of 45,821 acres,

[1] When subsequent stand age was less than previous stand age, it indicated sufficient canopy removal to alter the stand age, and we classified the harvest as a clearcut.

with distribution of stand age at harvest as shown in Figure 2. An average of 28,011 acres are harvested annually from the 50+ age class.

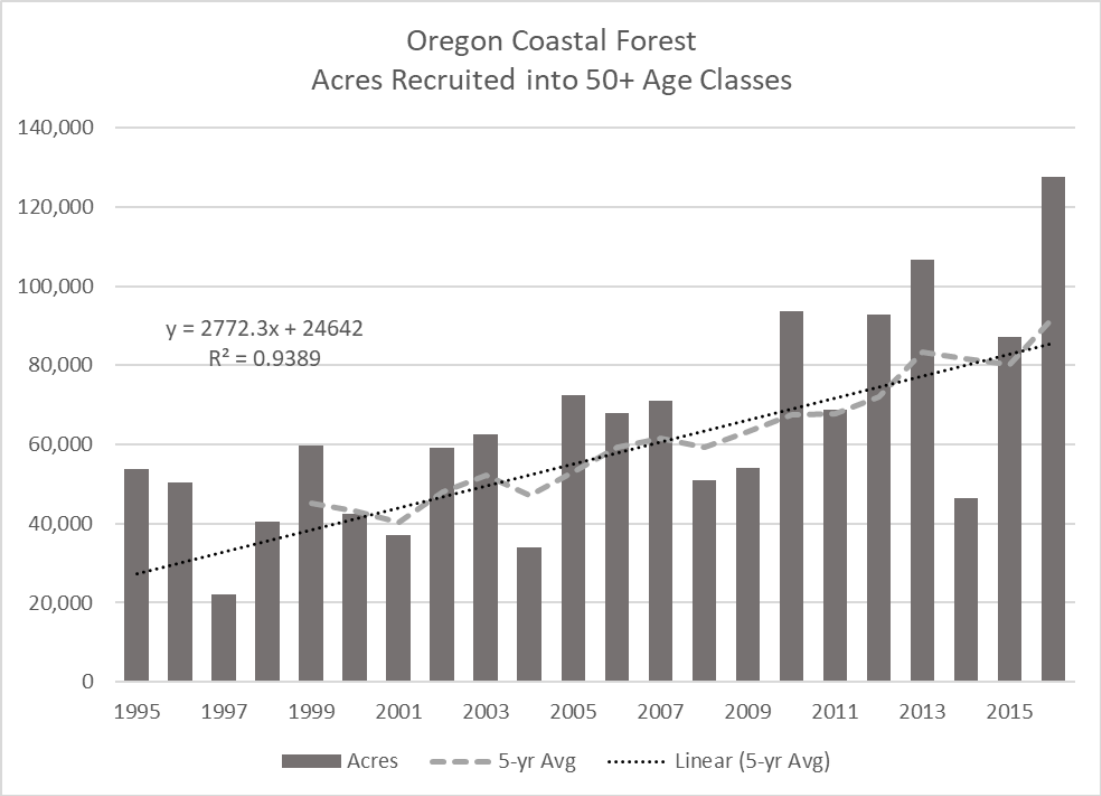

Figure 1. Acres recruited into 50+ year-old forest within 50 miles of the Oregon coast, 1995-2016.

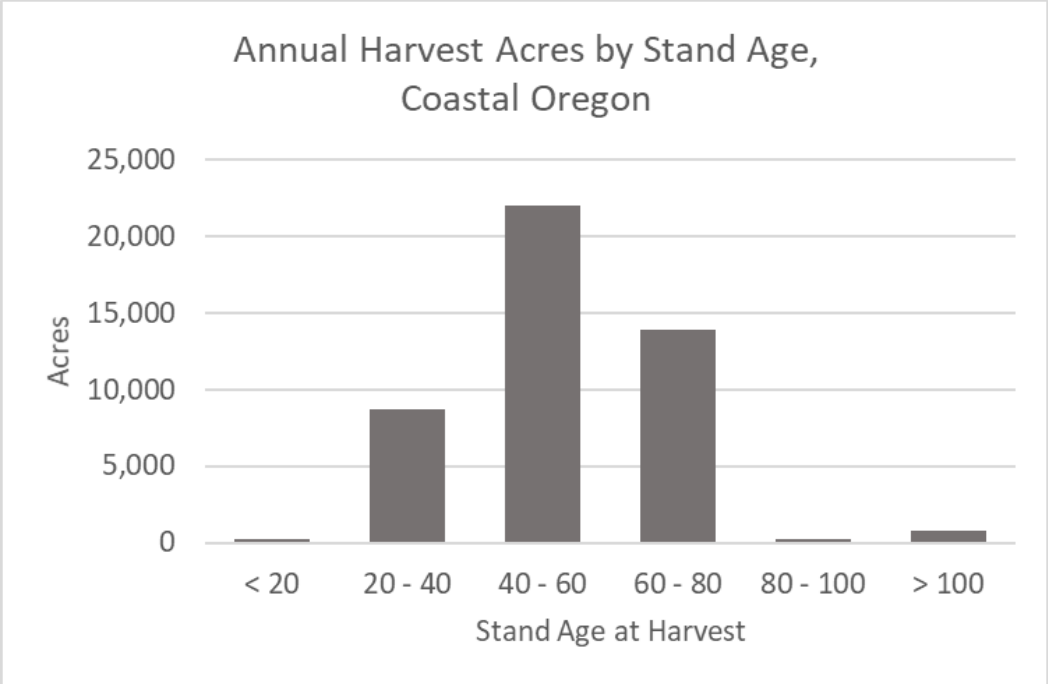

Figure 2. Distribution of annual clearcut harvest acres by stand age at time of harvest, coastal Oregon 2006-2016.

Therefore, according to the most recent inventory data from Oregon, during 2012-2016, an average of 92,173 acres have been recruited annually into the 50+ age class, while an average of 28,011 acres in that age class have been harvested, yielding a net recruitment of over 64,000 acres annually.

Details regarding FIA data in Oregon

In Oregon, FIA collects data from approximately 1,480 plots annually in a ten-year cycle, for a total of about 14,800 plots. Of these, about 9,500 plots are forested, representing 29.65 million acres. For estimating current forest conditions, the most recent measurement for each plot is used. Therefore, to assess current forest status with the most recent Oregon data[2], plots from 2007 to 2016 are included (as well as a few plots measured prior 2007).

When information from previous measurements is required, we must use the subset of those plots that have a prior measurement in the current plot design. In Oregon, there are now six years of remeasurements (2011-2016), so it is possible to examine changes occurring on 5,580 plots that were forested at either the first or second measurement.

For this analysis, estimates of forest acres by stand age come from current conditions, and is therefore based on the 9,500 forested plots measured during 2007-2016. For estimates of acres by harvest age, we look at the subset of plots for which a harvest was recorded in the most recent inventory. Then, we examine the prior plot measurement (if there is one), to determine the age of the stand when it was harvested. Therefore, we must use the six years of remeasurement data for which we can obtain information about previous stand conditions. Estimates of annual area represented by an activity recorded on a plot (e.g., harvest) is obtained by dividing the acres represented by the plot by the remeasurement period (years between plot measurements).
For analysis of a geographic subset, we use the approximate latitude/longitude coordinates published in the FIA database. For security and landowner privacy reasons, FIA cannot publish precise coordinates of FIA plots, so a random error or offset of about 0.5 mile is added to plot coordinates.

According to FIA Database documentation (O'Connell et al. 2015), "for annual inventory data, most plots are within +/- ½ mile" or reported coordinates. For this analysis, we selected all FIA plots with reported coordinates within 49.5 miles of the Pacific Coast (because due to the random error, we cannot be certain about plots within a half mile of the 50-mile threshold). The number of plots by proximity to the coast and forest condition are shown in Table 1.

Table 1. Number of FIA plots by forest condition (forested or not) and proximity to coast, current inventory (plots collected 2007-2016). Coastal indicates reported plot coordinate is within 49.5 miles of the Pacific Coast; Uncertain indicates plots within a 0.5 mile uncertainty zone (49.5 to 50.5 miles from coast); Non-Coastal plots have reported coordinates >- 50.5 miles from coast.

	Coastal	Uncertain	Non-Coastal	Total
Forested	1,450	16	8,022	9,488
Not Forested	230	10	5,086	5,326
Total	1,680	26	13108	14,814

[2] As of 1/20/2018 the most recent posted data are from 2016.

Summary: Increasing forest area within 50 miles of the Pacific Ocean in Oregon is entering age classes which may provide murrelet nesting habitat. In this same region, less than 1 percent of forest area harvested annually is from age classes greater than 80 years old. The trend in available murrelet habitat in Coastal Oregon forests is likely to increase over time.

References Cited

O'Connell, Barbara M.; LaPoint, Elizabeth B.; Turner, Jeffery A.; Ridley, Ted; Pugh, Scott A.; Wilson, Andrea M.; Waddell, Karen L.; Conkling, Barbara L. 2015. The Forest Inventory and Analysis Database: Database description and user guide version 6.0.2 for Phase 2. U.S. Department of Agriculture, Forest Service. 748 p. [Online]. Available at web address: http://www.fia.fs.fed.us/library/database-documentation/.

6) Tim Vredenburg
Managing Partner of Northwest Resource Solutions, LLC – contracted by the Association of Oregon Counties to conduct this review

AOC | Association of Oregon Counties

A Review of the Oregon Department of Forestry's draft marbled murrelet technical report.

Prepared for:
The Association of Oregon Counties
8/17/18

Provided to:

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1 Contents

2 Background and History

The marbled murrelet (*Brachyramphus marmoratus*) is a small seabird that nests in large coniferous trees of coastal forests throughout most of its range in North America. In 1992, the Washington, Oregon, and California population of the marbled murrelet was federally listed as a Threatened Species (USFWS 1992, 1997), requiring that landowners take measures to "avoid take" of the species or develop programmatic approaches to listed species management that may include application for "incidental take" permits. Murrelets are present in some Oregon State Forests, Tribal Forests, County and privately-owned forests where they presently are managed under a "take avoidance approach." Populations in Oregon, Washington, and California was estimated to be around 24,100 birds in 2015 based on ocean counts.

In June 2016, the Oregon Board of Forestry (Board) received a Petition to Initiate Rulemaking for the marbled murrelet under Forest Practices Act (FPA) specified resource site rules. The Board denied the petition in July 2016. In September 2016, the petitioners submitted a Petition to Review an Agency Order through the Lane County Circuit Court to request the court compel rulemaking. In November, the Board held a public meeting and accepted public comment to reconsider their decision to deny the petition for rulemaking. After consultation with the Oregon Department of Justice, the Board voted to withdraw and reverse its previous decision on the rulemaking petition.

In March 2017, the Board received an update on this rule analysis. A report was presented to the Board that included a review of the petition and a summary of work needed to be conducted as part of any rule-analysis process (ODF 2017a). It was determined the petition did not include adequate information for purposes of a rule analysis. The Board directed Oregon Department of Forestry (ODF) staff to initiate development of a Technical Report on marbled murrelets as per OAR 629-680-0100.

The Marbled Murrelet Technical Review Draft report (TR) was developed by ODF staff to meet the requirement for a Technical Report for purposes of informing the rule analysis process for marbled murrelets (Weikel, 2018). The TR is currently undergoing review by an expert review panel. The purpose of the review is to evaluate the literature used and content of the report, to

ensure that the "best available information" is presented to the Board for their decision-making process.

2.1 Technical Report Paper General Overview

Oregon's Forest Practices Act (FPA) statutes and administrative rules indicate that the Board must review the marbled murrelet for possible consideration for rules under the Forest Practices Act. The TR was developed by the ODF to provide the basis of information for this review. In general, the TR summarizes current data on murrelet populations and habitat and suggests that a range of options exist for the definition of a resource site. The TR calls out three options for defining a marbled murrelet resource site. These are: the nest site, occupied detections, and presumed occupied habitat. The TR also identifies two possible options for habitat protection strategies for marbled murrelet resource sites. Additionally, the TR addresses existing programmatic approaches to protecting sensitive species which include Safe Harbor Agreements and Stewardship Agreements.

2.2 Project Scope and Objectives

Northwest Resource Solutions LLC (NWRS) has contracted with the Association of Oregon Counties (AOC) to conduct a review of the ODF Marbled Murrelet Technical Report draft and meet the following objectives:

1. Review current Scientific Literature relating to Marbled Murrelet biology, habitat needs, recovery and management.
2. Perform a validation review of the ODF Systematic Review document/Technical Report to evaluate the effective use of literature and identify studies that may not be represented in the report.
3. Develop comments that can be shared with ODF that offer findings from the review of the literature and the validation review of the document.
4. Review ODF developed options for designating Protected Resource Sites subject to the Oregon Forest Practices Act and provide feedback via comments based on the literature review.

3 Review Methodologies

3.1 Scientific Literature Validation Review

NWRS conducted an extensive review of the TR in the format provided by the ODF (see appendix A). All sources cited and references were gathered using coordination meetings with agencies, journal databases, library catalogues, subject specific professional websites, agencies' websites, and other databases. References were sought out using the author's names, date of publication and title of publication. All references cited in the TR were reviewed and a complete list of available references has been provided to AOC with this report.

A consistency review was conducted to determine if references and discussion in the TR were consistent with the results documented in the literature. For purposes of analysis, the referenced literature was divided into four categories including primary, secondary, tertiary and grey literature. Data limits and vulnerabilities for cited literature was also assessed. The following criteria were used to assess the applicability of the data included in the referenced literature:

- Was the referenced study peer reviewed?
- Were the studies accurately reflected in the TR?
- How old was the study?
- What was the study design?
- Where was the study conducted (geography)?

Results of the Scientific Literature Validation Review are presented in the section 4.1 of this report.

3.2 ODF Development Options Review

NWRS reviewed the Oregon Administrative Rules (OAR 629-665) associated with marbled murrelet resource sites and compared the proposed definitions for marbled murrelet resource sites within the TR to the requirements in the Rules. The options included the nest site, occupied detections, and presumed occupied habitat. NWRS also evaluated the possible options for habitat protecting strategies for marbled murrelet resource sites. Information gathered from the literature review was used to assess each option and develop a list of findings and recommendations associated with each option. Findings and recommendations are presented in section 4.2 of this document.

4 Results

4.1 Scientific Literature Validation Review

Overall, the TR does a good job of capturing relevant literature. There is a shortage of scientific literature related Marbled Murrelets. Only 40 different pieces of scientific literature were relied upon in the development of the TR. Generally, the literature falls into one of four categories, normally referred to as primary, secondary, tertiary and grey literature. It is important to note that of the 40 different pieces of literature cited in the report, only 13 of those qualify as primary references that have benefited from the peer-review process. The remaining 27 references, some of which constitute primary but not peer-reviewed, should not be disqualified because they are not considered primary peer reviewed literature; however, they should be used more cautiously. Generally, there is an overreliance on secondary, tertiary or grey sources that synthesize primary research. When it is available the TR should rely on the primary source research rather than summary or synthesis literature.

The primary peer-reviewed literature used reflects the small number of research studies on Marbled Murrelets that are published in peer-reviewed scientific journals. The peer review process is important in the publication of primary literature, and journals normally require a paper to include a title, abstract, keywords, introduction, material & methods, results, discussion, acknowledgements and references. Each of these standard components of scientific literature provide the reader with important information to evaluate the study.

Secondary literature consists of publications that rely on primary sources for information. Typically, secondary literature synthesizes knowledge from a number of primary sources.

The tertiary literature used consists of published works that are based on primary or secondary sources and that are aimed at scientists who work in different areas from the subject matter of the publication, or towards an interested policy audience. Examples of the tertiary literature include science magazines, newsletters, introductory textbooks, guide books and encyclopedias.

Grey literature refers to sources of scientific information that are not published and distributed in the usual manner and may be difficult to obtain. Grey literature includes theses and dissertations, technical reports, journals published by special interest groups that have a limited distribution, abstracts of conference papers and conference proceedings, some types of

government documents, and working papers. Note that being classified as 'grey literature' in no way implies that the publication has little scientific merit, since some types of grey literature are rigorously peer reviewed and count as primary literature. 'Grey' refers more to the limited distribution and difficulty of accessing the publication than to its content.

The distinctions in literature categories are based on our understanding of common approach to literature review. Additional category definitions are discussed below.

Primary Literature

Primary sources consist of original studies, based on direct observation, use of statistical records, interviews, or experimental methods. They are authored by researchers, contains original research data, and are usually published in a peer-reviewed journal.

Secondary Literature

Secondary literature consists of interpretations and evaluations that are derived from or refer to the primary source literature. Examples include review articles (such as meta-analysis and systematic reviews) and reference works. Professionals within each discipline take the primary literature and synthesize, generalize, and integrate new research.

Tertiary Literature

Tertiary literature consists of a distillation and collection of primary and secondary sources providing an encyclopedic coverage of material. The purpose of tertiary literature is to provide an overview of key research findings and an introduction to principles and practices within the discipline.

Grey Literature

"That which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers." (Fourth International conference on Grey Literature, Washington D.C., October 1999).

The lack of available primary literature haunts the report throughout and places limits on the ability to support policy decisions with "good science." Table 1. Provides an overview of the literature referenced in the TR based on the literature category.

Table 1 – Categories of literatures cited in the Technical Report (continued on next page).

Literature Citation	Grey Literature	Tertiary Literature	Secondary Literature	Primary Literature (Peer Reviewed)
Burger et al. 2009				x
Cascadia Wildlands 2016	x			
Evans et al. 2003	x			
Falxa and Raphael 2016	x			
Golightly and Schneider 2009	x			
Hamer and Nelson 1995	x			
Hamer et al. 2003	x			
Lorenz et al. 2017				x
Lynch et al. 2017	x			
Malt and Lank 2007				x
Manley 2003	x			
Marzluff et al. 1999	x			
McShane et al. 2004	x			
Meyer and Miller 2002				x
Meyer et al. 2002				x
Nelson 1997		x		
Nelson 2003		x		
Nelson and Hamer 1995	x			
Nelson and Wilson 2002	x			
ODFW 2018	x			
ODF 2017a	x			
ODF 2017b	x			
Pacific Seabird Group, 2013		x		
Plissner et al. 2015			x	
Raphael et al. 2016a	x			
Raphael et al. 2016b	x			
Raphael et al. 2015				x
Raphael et al. 2002				x
Rivers 2017	x			
Silvergieter 2009	x			
Silvergieter and Lank 2011				x
USFWS 2016	x			
USFWS 2010	x			
USFWS 2006	x			
USFWS 1997	x			
Rooney et al. 2011				x
Waterhouse et al. 2008				x
Wilk et al. 2016				x
Zharikov et al. 2007				x
Zharikov et al. 2006				x

4.1.1 Valid Scientific Rationale

In general, the TR suitably applies a valid scientific rationale in capturing the literature and including appropriate qualifications that support the proper application of studies using valid scientific rationale. This section includes some observations that should be addressed to further strengthen the appropriate inclusion of the literature.

In regard to Table 1 on page 14 of the TR, some questions related to the data remain unanswered. When was the nest data collected? Also, was the data that summarizes habitat features collected at the same time that the nest was located or was the habitat data collected later? If the data that summarizes habitat features was not collected at the same time the nests were discovered and the nests were active, could historic aerial photos be used to validate the corresponding habitat features?

Also, "edge" is a very important habitat feature discussed throughout the TR. However, there does not appear to be a common definition of "edge" that is stated and relied upon. Some may measure edge from the hard boundary of a stand while some may define the edge boundary as the zone where the microclimate is dominated by the effects of the edge.

On page 20 of the TR in the discussion of survey methods, the report accurately states that "The protocol then recommends results be extended to the entire Survey Area, based on an assumption that suitable habitat contiguous with the location where occupied behavior is observed is important for murrelets for current and future nesting." While it is true that the Pacific Seabird Group has relied upon the assumption that contiguous suitable habitat is important for current and existing nesting, it again must be noted that, to date, no primary peer reviewed literature exists to support the assumption. Regardless of whether or not the assumption is valid, it is important to include the caveat that currently there is not concrete scientific research that directly supports the assumption.

The question of site fidelity is an area that the TR handles well. It is important however, to disclose within the discussion that, while the two studies cited did observe a few birds returning to the same nest (and only one in consecutive years), there were more birds observed not

returning to the same nest site. Taken as a whole, the studies cause doubt that actual single nest fidelity is a common occurrence.

The report accurately identifies the need for additional information related to spatial distribution of nests, especially in Oregon. The best available science was conducted in British Columbia. Although it is recognized that there may be differences between regions the importance of those differences is not well understood. Consequently, the findings derived from the study in British Colombia should not be dismissed.

Finally, within the section discussing nest fidelity on page 22 the report references: "Zharikov et al. (2007) found that nesting murrelets were more abundant in a fragmented area." However, Zharikov's work did not infer that murrelets may have been "packing" into remaining habitat rather than moving to a new area to nest as suggested in the TR. The first half of the statement is well supported by the study. However, there does not appear to be evidence to support the suggestion that "packing" may explain higher abundance.

4.1.2 Areas of Conflict or Insistencies in the Literature

The importance of edge is also discussed in terms of nest success. On page 18 of the TR, the statement is made that "…information on effects of landscape conditions and fragmentation appears to indicate that those murrelets nesting near edges, especially hard edges, may suffer lower nest success than murrelets nesting further in the interior of a stand."

It should be noted that the science is not settled on this issue and that there appears to be conflicts between the literature presented in the TR (Nelson and Hamer 1995, USFWS 1997, 2009, Raphael 2002 and Zharikov et al. 2007). Zharikov et al. (2006), who did the major studies of actual nest sites (n=157), actually appears to present results that are in direct conflict with the above statement made on page 18 of the TR.

With respect to the edge "paradox" and the studies cited in the TR, some of those studies also show that some hard artificial edges caused by forest harvest eventually grow into dense second-growth stands that reduce predation and thus provide a buffer to nest stands. It is clear that more studies are required in order to better understand the interaction of different habitat variables and the associated impacts to nesting.

On page 16 of the TR, the finding is discussed "that occupied areas tended to have less fragmented and isolated old-growth patches than did unoccupied areas (Meyer and Miller 2002)." It should be noted that the findings of this study and its use should be limited because the results from Meyer and Miller 2002 are based on detection data as opposed to actual nests. It should also be noted that the study was not included in Plissner 2015.

4.2 ODF Resource Site Definitions Review

4.2.1 Review of Proposed Options Summary

Oregon Administrative Rule 629-665-(62)(a)(A) defines a resource site for Threatened and Endangered Species as the "*nest tree, roost tree, or foraging perch and key components*". The TR considers three options for defining resource sites for marbled murrelets: option one focuses on the nest tree; option two focuses on occupied detections (i.e. locations where murrelets are observed); and option three focuses on presumed occupied habitat (i.e. habitat with characteristics suitable for marbled murrelets nesting and reproduction). Table 2 within the TR provides a brief description of the possible definitions of a resource site and identifies the pros and cons of each definition (See Table 2 in appendix A). Under all options, the TR provides the assumption that additional work would be required to identify the exact parameters to be used to identify the extent and location of habitat to be protected under any resource site protection measure. This is presumably because of the limited amount of information available regarding the selection and use of murrelet nest trees and the need to identify the key components or stand attributes that are essential to maintain the resource site over time.

4.2.1.1 Definition Option 1 – Nest Tree

If the resource site is defined as the nest tree, the location of an occupied detection, or some other specific point on the landscape, a protection approach centered on that nest location might be applied (Weikel, 2018). This approach would be similar to the protections for osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucocephalus*), and great-blue heron (*Ardea Herodias*) where the resource site includes the active nest tree and any identified key components (OAR 629-665-0110). In contrast, the resource site for the Northern Spotted Owl (*Strix occidentalis caurina*) is identified as a 70-acre area of suitable spotted owl habitat encompassing the nest site, to be maintained as suitable spotted owl habitat under this definition, the core area provides for nesting, roosting and foraging opportunities.

Identification of the Nest Site - Although defining the resource site as the nest site for marbled murrelets seems intuitive, there are many questions and uncertainties that should be addressed. For example, unlike the northern spotted owl, osprey, bald eagle and great-blue heron, marbled murrelets utilize their nest trees for nesting and rearing only. The majority of other activities occur at sea (Nelson 1997, ODFW 2018). Furthermore, identification of nest sites is extremely challenging. Very few studies of murrelets have occurred at their nest site due to the difficulty of locating and observing active nests (Golightly, 2011). Between 1990 and 2017, only 75 nests have been documented in Oregon (ODFW 2018), and only 39 murrelet nests have been precisely located in California since discovering that murrelets nest in trees in 1961 (Golighlty 2011, Kuzyakin 1963, Binford et al. 1975). In addition, there is a significant amount of variation in the definition of the nest site, some authors clearly used "nest-cup" and others used "nest site", "nest branch", or "nest platform". Others used what we suspect meant a nest-tree (Plisnerr 2018). There is also some debate as to whether or not marbled murrelets use other types of sites for nesting. Ground nests and nests in hardwoods have been documented in other locations (California, Alaska, and British Columbia). This discussion should be included in the TR.

According to the literature, active nests are often located by observing murrelets land in trees, finding eggshells on the ground and subsequently locating the nest, using radio telemetry, climbing of trees with potential platforms, or by incidental observations (Nelson and Hamer, 1995). All of these methodologies are time consuming and are not cost effective at larger spatial scales. Furthermore, variation in nesting locations could make it difficult to develop adequate search methodologies for locating murrelet resource sites (i.e. nest trees). Although many nest sites have been found in mature forest stands with larger trees and platforms, some nests have been observed in younger stands with some component of older legacy trees. Additionally, some nests have been observed in large contiguous blocks of structurally complex habitats while other have been observed in significantly fragmented landscapes, and areas with high human activity. Furthermore, the TR asserts that studies examining landscape patterns using actual murrelet nests are limited in Oregon (Weikel 2018).

Use of the Nest Site - The identification and timing of use of a nest site may also pose a challenge as there are very few studies available regarding murrelet nest use. Evans et. al. (2003) noted that it is likely that two or more pairs of murrelets might nest asynchronously in a stand (or

perhaps even re-nest), murrelets could be nesting at different times - and therefore different places - in the same stand in the same year. It is also possible that murrelets do not initiate a nest annually (Golightly, 2011). If one nest tree is identified and protected based on the timing of protocol surveys and corresponding use by murrelets, it is likely that other nest sites will be missed.

Nest Success - Nest success is also called into question under this definition of a resources site. The goal of resource site protection is to ensure that forest practices do not lead to resource site destruction, abandonment or reduced productivity. One study found that murrelets nesting closer to a "hard" edge had lower nest success than murrelets nesting further from edges (Malt and Lank 2009). Another study, however, found murrelets nesting near hard edges had greater nest success (Zharikov et al. 2006). According to Golighlty (2011), it is possible that murrelets do not initiate a nest annually. This inconsistency in the literature creates some uncertainty as to how a resource site (nest) can be adequately protected and or if protection is required.

Furthermore, murrelets are predisposed to nesting along canopy gaps, preferably along waterways which facilitate access to their nest-site (Nelson 1997, Manley 1999, Zharikov et al. 2006). Murrelet nests also tend to have canopy gaps or other open areas near the nest location (ODFW 2018). Therefore, murrelet nest sites are naturally vulnerable to predation and other risks. More information is needed to be able to adequately qualify nest success if the resource site is defined as the nest.

Site Fidelity - In order to manage and protect a resource site there must be some assurances that that site will be used over a long period of time. Although there is some evidence of fidelity to murrelets at the level of the nest, several studies that have attempted to correlate high site fidelity with nest trees have not established co-occurrence of active nests in the same tree over time and evidence of nest fidelity of individuals is poorly known for all scales of fidelity (i.e. Nest, stand, and watershed) (Plissner 2015). Golightly (2011) asserts that nest-site fidelity remains unknown for murrelets, and despite long-term monitoring at nest sites the long-term use of the site cannot be directly measured.

Studies that have identified nest site fidelity like Hébert and Golightly (2006), found that some nest are used over time while others are not. Statistically, nest fidelity has not been proven within the literature and effective study designs have not been developed to adequately test the nest site

fidelity hypothesis. Only five trees in Oregon have been found to contain multiple nests, indicating fidelity at a tree scale, with up to three nests in a tree (Nelson and Wilson 2002[1]). Some authors have also suggested that nest clusters may represent multiple nesting attempts within the same stand by a breeding pair and, hence, indicate fidelity to a nest-patch instead of a nest-tree or a nest-platform. Other studies suggest patterns of fidelity vary geographically (Burger et al. 2009). Multi-year radar and telemetry studies have provided evidence suggestive of reuse of watersheds and specific forest stands across years (Plissner 2015). In general, there is consistent evidence of fidelity at the scale of a watershed, as indicated by each of the 23 studies reviewed by Plissner (2015). Furthermore, it's very likely that habitat differences among areas may have some effect on patterns of fidelity to specific nest areas. The TA correctly asserts that additional information is needed on spatial distribution of nests, especially in Oregon. This new information should include study designs that look for nests sites in areas where conditions are more natural. Additionally, it may be important to consider rocky outcroppings, and ground nesting areas as probable alternatives to tree nests.

Identification of Key Components - Key components are the attributes that are essential to maintain the resource site over time. If the resource site was defined by the nest site, the user would have to identify all the key components necessary for the site. This would be extremely difficult due to all the unknowns associated with nest tree selection and use by murrelets as mentioned previously in this section. It does appear that the presence of potential nesting platforms is considered the most important characteristic of marbled murrelet nesting habitat (Nelson 1997), in addition to some watershed specific attributes. Plissner et al. (2015), and Wilk et al. (2016) noted that there is often a greater density of trees with platforms near nests than elsewhere in a stand.

[1] Note –Meyer and Miller is not cited in Plissner (2015) because it is based on detection data as opposed to real nests.

4.2.1.2 Definition Option 2 – Occupied detections

Under this option, locations would be identified where marbled murrelets were observed exhibiting occupied behaviors during protocol surveys (either location of bird or the survey station from which the bird was observed).

Presence or absence of murrelets - The current PSG protocol is designed to document the occurrence or probable absence of murrelets, and if murrelets are present, to determine if birds are exhibiting occupied behaviors (Evans et. al. 2003). Generally, a high percentage of documented murrelet occurrences remain unseen to the observer, and most behaviors indicating occupancy are derived almost exclusively from visual observations. (Evans et al 2003). Research has documented that actively nesting murrelets exhibit occupied behaviors near their nests; however, these behaviors must be confirmed by visual observations (Plissner et al. 2015). Thus, observation of occupied behaviors is thought to indicate the area being surveyed is occupied by marbled murrelets and likely used for nesting.

Although auditory detections may be used to identify birds within the area, confirmation of occupancy is extremely difficult from auditory detections alone. The TR correctly asserts that using occupied detections and/or survey location as the resource site could result in significant inaccuracies regarding the actual location of the nesting murrelet and may identify occupied areas that are not actually occupied.

Correlation between occupied behaviors and nesting – There does not appear to be any studies that have examined the spatial relationship between observation of occupied behaviors and the location of active nests. The TA correctly assert that there are significant data gaps between documented occupied behaviors and actual nesting. Under this definition, resource protection measures may capture the location where occupied behaviors were observed; however, the nest itself may fall outside of that area. Based on previous discussion, information regarding murrelet site fidelity, nest success, and annual nesting is limited.

4.2.1.3 Option 3 – Presumed occupied habitat

Under this option, an area of suitable habitat presumed to be occupied by the species would be delineated as the resource site until additional work is conducted to determine that the area is not actually suitable nesting habitat (e.g. trees with suitable nesting platforms are not present) or not occupied by murrelets (i.e., as determined through surveys). This definition assumes that all

suitable habitat is occupied unless demonstrated to be otherwise. It is very likely that presumed occupied habitat would provide far more protection of marbled murrelet sites than needed to meet the intent of the statute. Current survey methodologies look for occupied behavior to determine presence and/or absence of murrelets in a given survey area.

Studies have identified some of the key components required for nesting (i.e. moss, platforms, large limbs, older forest, etc.); however, the presence of these components does not mean that a murrelet will use the tree or stand for nesting. There are many variables that must be taken into consideration including watershed specific indicators. It is still not understood why some stands with suitable habitat might be preferred over others. Additional biological criteria would need to be developed to capture variations in nest site selection by murrelets. Since it's not likely that every acre of habitat is of equal value to the murrelet, it is important that more site specific information be gathered in areas where murrelets occur in both natural and fragmented landscapes in order to better understand variations in nest site selection and use by murrelets.

4.2.2 Review of Possible options for habitat protecting strategies for marbled murrelet resource sites.

As a part of a technical report, under OAR 629-680-0100, protection requirements and exceptions must be proposed. The TR considers two options for protecting strategies for marbled murrelet resource sites. These include: identifying a polygon of habitat associated with protocol surveys, and identifying a polygon of habitat around known nest site(s) or occupied detection(s) that would be identified by the operator. Table 3 within the TR provides a brief description of the possible options for habitat protection strategies for marbled murrelet resource sites and identifies the pros and cons of each approach (See Table 3 in appendix A).

4.2.2.1 Polygon of habitat associated with protocol surveys

The polygon of habitat associated with protocol surveys is described as a polygon that identifies an area surveyed within which occupied detections were observed. This option is primary based on surveys using a standardized protocol like the PSG protocol.

Even under the current PSG protocol it is difficult to truly determine the location of murrelet nests. Therefore, unless new methodologies are developed that provide more certainty around occupancy and nesting, this method may result in identifying many areas as occupied by the species that are not actually occupied or not used for nesting at all.

4.2.2.2 User Identified Polygon

The user identified polygon has been defined as a polygon of habitat around known nest site(s) or occupied detection(s) that would be identified by the operator. This approach is similar to the core area approach for the Northern Spotted Owl. This option allows the user to select a polygon based on biological criteria and site specific information.

Although this approach would likely lead to a more realistic level of protection for the resource site by taking into account site specific/biological criteria, it would require an arduous process for identifying nest trees and establishing some biological criteria that would assure long-term use and success of the nest tree. As mentioned previously, identification of nest trees is extremely challenging and potentially cost prohibitive at larger scales. In addition, given some of the inconsistencies within the literature surrounding nest selection, use, and success, it may be challenging to determine the exact conditions needed to adequately protect the resource site. Furthermore, this option could be used to expand protections of murrelets from established sites in federal lands to adjacent private, state, or county lands with little rationale or justification for why the additional protections are needed.

4.2.3 Discussion

Murrelet nesting ecology and biology remain poorly described throughout their range. In particular, site-specific data is lacking for murrelet populations located in zone 3 and the Oregon portions of zone 4. Although the location and quality of the nest trees appears to be very important in determining nesting success by murrelets, more scientific information is needed to appropriately define the resource site for marbled murrelets and any associated protection measures. Specifically, we concur with the author of the TR that more work is needed in the

following areas prior to any formal adoption of a resource site definition and/or associated protection measures:

- Defining suitable habitat for marbled murrelets
- Identification of key components for marbled murrelet resource sites
- Defining the extent of habitat to be protected, and how it will be identified
- Defining the critical use period
- Defining the zone, within which forestry activities would be limited during the critical use period to avoid disturbing nesting birds

In addition, there is very little scientific information pertaining to the use of habitats on contiguous blocks of mature stands on federal lands in Oregon and/or areas where presumed edge effects and anthropocentric disturbance are less of a concern (i.e. Alaska). This sort of information would be valuable in assessing the selection, use, and success of murrelet nests in a less altered environment. Furthermore, similar to what has been studied with regard to the impacts of the Barred Owl on the Northern Spotted owl, are there other types of protection methods (i.e. predation reduction measures) that could be employed to reduce one of the most significant impacts on marbled murrelet (i.e. predation)? Also, if a component of nesting success is driven by food availability and ocean conditions, more work should be done to determine how much, if any, impact this might have on nest success and fitness. Identifying a resource site for nesting may, in fact, be fruitless if there isn't enough information to determine all of the factors that contribute to nesting success.

Overall, the TR did a fairly good job of summarizing the Biology and Habitat Characteristics defined in the literature. However, the lack of available primary literature haunts the report throughout and places limits on the ability to support policy decisions. Additionally, the TR fails to generally assess outliers in the literature and/or inconsistencies that may better inform management practices on fragmented landscapes. Although many of the more reputable studies are cited, the TR relies more heavily on technical review documents rather than the actual science from the studies. Even the reputable science that is available leaves many questions unanswered.

The TR also fails to discuss the current level of protections for murrelets on federal lands which make up more than 71 percent of the total available habitat for murrelets (ODF = 15%, Private = 12%, and Other = 2%). The TR also limits the validity of the current status of murrelets in Oregon (slightly increasing and/or static).

In many cases the TR correctly asserts the need for more scientific research and examination. This prompts the question as to the validity of the timing of the current administrative process. Furthermore, some assessment should be made as to the projected impacts to murrelet populations if resource sites aren't established and/or protected. At this point in time, population appear to be trending positive at a statistically significant rate under current management.

4.2.4 Recommendations

(1) It's very clear that additional work is needed to further refine the definition of a resource site for marbled murrelet and to develop protection measures that adequately meet the intent of the administrative statute. As pointed out in the discussion section, there are still many questions that need to be answered using a rigorous study design. We recommend that this additional work be completed and provided as part of a subsequent scientific review process prior to formalizing the administrative process for defining a resource site for murrelets and/or identifying protection measures.

(2) Since much of the identified suitable habitat occurs on state and/or federal lands, it is likely that, in the absence of resource protection measures, ongoing operations on County or private lands would not result in insignificant impacts to murrelet when considering the broader landscape. Since 2000, a team of researchers from several state and federal agencies have collaborated to monitor murrelet populations across Washington, Oregon, and California. The monitoring strategy was designed to estimate population size and trends in these areas. The latest report affirmed that "these are the only data available for assessing murrelet recovery" (Pearson et. al 2018). In this report, Oregon population surveys conducted between 2000 and 2016 indicate that the population is trending positive at a statistically significant rate. Results for the state-wide population trends for Oregon through 2016 indicate an increase of +1.8% per year (95% CI from 0.1 to +3.6) between 2000 and 2016.

(3) Much of the documentation cited in the TR is from non-primary sources of data. In addition, much of the information comes from geographies outside of Oregon. It may be important to conduct a more specific validation of primary data collected within Oregon to identify/describe the significant data gaps in the literature prior to completing the administrative process.

(4) The resource site definition should include an accurate and consistent description of the nest site in addition to specific biological criteria on or around the nest site that is required to ensure protection of the site. Using the occupied detections definition and/or the presumed occupied definition could grossly overestimate the required protection and/or fail to capture the actual nest tree with the resource site. We would recommend that this additional work be completed and provided as part of a subsequent scientific review process prior to formalizing the administrative process.

(5) User defined criteria similar to protections for Northern Spotted Owls could be appropriate in areas where occupancy currently exists in non-fragmented contiguous stands; however, this approach would be challenging and not recommended in more fragmented areas as the likelihood of successful protection based on current science is limited; therefore, this option would not fit the administrative requirements for long-term production and success.

(6) A more detailed assessment of existing protections for marbled murrelets is recommended to determine if a need truly exists for describing and protecting resource sites beyond what is already provided on federal ownerships. Although the State Forester is required to assess protections for listed species under the FPA, the State is not obligated to provide protections if the site-specific protection does not assure the continuation of the species throughout its natural range.

(7) The author of the TR makes several unqualified statements in the document that do not seem to be supported by the literature either because the data is lacking to address the issue fully or because there are conflicting data in the literature. We would recommend that these statements be omitted, clarified, and/or substantiated by the results of studies. If something is truly unknown, it should be stated as so.

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