2020 Washington At-Sea Marbled Murrelet Population Monitoring:

Research Progress Report

Monique M. Lance and Scott F. Pearson

Washington Department of Fish and Wildlife
Wildlife Science Division
Olympia, Washington

March 2021

Washington Department of FISH and WILDLIFE

Abstract

In 1992, the marbled murrelet (*Brachyramphus marmoratus*) was listed as a Threatened species by U.S. Fish and Wildlife Service in California, Oregon, and Washington under the Endangered Species Act and as Threatened by Washington State. A federal recovery plan was published in 1997 that outlined recovery strategies including developing and conducting standardized at-sea surveys. In addition to meeting the requirements of the Endangered Species Act, marbled murrelet monitoring was designed to evaluate the effectiveness of the Northwest Forest Plan (Madsen et al. 1999), which is a large-scale ecosystem management plan for federal lands in the Pacific Northwest.

As part of the Effectiveness Monitoring Program of the Northwest Forest Plan, Washington Department of Fish and Wildlife, USDA Forest Service Pacific Northwest Research Station, U.S. Fish and Wildlife Service, Crescent Coastal Research, and other state, federal, and private researchers have participated in a program to estimate marbled murrelet population size and trends during the breeding season between San Francisco Bay and Washington state since 2000. The information derived from this effort is the only information available to assess population size and trends in this geographic area for this species. This monitoring program uses at-sea line transects within 8 km of the Washington, Oregon, and northern California coastline in the area covered by the Northwest Forest Plan. There are five monitoring zones or Conservation Zones throughout this range, two of which are in Washington: (Zone 1) Strait of Juan de Fuca, Puget Sound, Hood Canal, and the San Juan Islands; and (Zone 2) the outer coast of Washington. Both zones are currently monitored by the Washington Department of Fish and Wildlife. The U.S. Forest Service monitored Zone 1 from 2000-2012.

Between 2000 and 2015 we conducted annual surveys of both of Washington's Conservation Zones. Due to funding constraints, in 2016 we implemented a reduced-sampling effort design, where Conservation Zone 1 is sampled in even years and Conservation Zone 2 is sampled in odd years. This report focuses on monitoring results from Conservation Zone 1 during the 2020 monitoring season (15 May - 31 July). We changed some aspects of our survey approach to keep our survey team safe during the COVID-19 pandemic (see Methods). Despite the complications of surveying during the pandemic, we completed all 30 PSUs in Zone 1.

The population estimate for Puget Sound and the Strait of Juan de Fuca in 2020 (Zone 1) was 3,143 birds (95% confidence interval = 2,030 – 4,585 birds) with a -4.96% (95% CI = -7.01 to -2.86%) average annual rate of decline for the 2001-2020 period, assuming a constant rate of decline.

Suggested citation: Lance, M.M., and S.F. Pearson. 2021. Washington 2020 at-sea marbled murrelet population monitoring: Research Progress Report. Washington Department of Fish and Wildlife, Wildlife Science Division.

Table of Contents

Introduction

In 1992, the marbled murrelet (*Brachyramphus marmoratus*) was listed as Threatened in California, Oregon, and Washington under the federal Endangered Species Act. A recovery plan was published in 1997 that outlined recovery strategies including developing and conducting standardized at-sea surveys (U.S. Fish and Wildlife Service 1997). Also, in the 1990s, controversy over harvest of old-growth forest led to sweeping changes in federal forest management and to the implementation of a large-scale ecosystem plan for federal forests, the Northwest Forest Plan (FEMAT 1993). In response to the recovery goal for the murrelet and the requirement for monitoring under the Northwest Forest Plan, the U.S. Fish and Wildlife Service, U.S. Forest Service, and state wildlife agencies initiated a marbled murrelet monitoring strategy in 2000 (Madsen et al. 1999; Raphael et al. 2007; Miller et al. 2012). The goal of this monitoring strategy is to estimate marbled murrelet population size and trends in each of five conservation zones between San Francisco and the Washington – Canada border. Results from this effort are used to evaluate: 1) effectiveness of the Northwest Forest Plan (Madsen et al. 1999); 2) effects of incidental take under the Endangered Species Act, and 3) marbled murrelet recovery. In addition, this research has been used to help us understand the spatial distribution of birds and mammals (e.g., Menza et al. 2016) and to investigate the factors influencing the changes in murrelet abundance and distribution (e.g., Raphael et al. 2015).

Since 2000, Washington Department of Fish and Wildlife along with researchers from Pacific Northwest and Pacific Southwest Research Stations of the U.S. Forest Service, U.S. Fish and Wildlife Service, and Crescent Coastal Research, have been estimating marbled murrelet population size and trends using at-sea line transects within 8 km of the Washington, Oregon, and northern California coastline. Transects cover ~8,800 km^2. The range of the ESA listed population has been subdivided into six marbled murrelet Conservation Zones identified in the marbled murrelet Recovery Plan (Figure 1; U.S. Fish and Wildlife Service 1997). Five of these zones (Zones 1-5) fall within the scope of the Northwest Forest Plan and have been monitored from year 2000 to 2019. This report focuses on the methods and results from Zone 1 during the 2020 monitoring season.

Methods

Sampling Design.
We monitored Zone 1 marbled murrelets from 15 May - 31 July, a time when the birds detected on the water are potentially nesting. Conservation Zone 1 includes the Strait of Juan de Fuca, Puget Sound, Hood Canal, and the San Juan Islands (Figure 2). Within this zone, there are three geographic strata based on murrelet density and ecological factors: Stratum 1: Strait of Juan de Fuca; Stratum 2: San Juan Islands, Whidbey and Camano islands, Port Townsend, Admiralty Inlet, and northern Hood Canal; and Stratum 3: central/south Puget Sound. Each stratum is divided into primary sampling units (PSUs), each of which is a roughly rectangular area along approximately 20 km of coastline. At-sea sampling followed methods described in Raphael et al. (2007).

Observer Training.
The team of biologists had a minimum of 4 months of full-time survey work and as many as 9 years of experience with this monitoring program and conducting year-round monitoring of murrelets. Typically, our team transitions directly from winter surveys to these spring surveys using the same protocols and

methodology and no training or distance testing is needed. We did not conduct protocol training, but boat safety instructions were repeated prior to beginning the field season on 15 May.

Each observer completed 100 distance estimates prior to starting our 2020 sampling season. Distance estimates from the transect line are a critical part of the data collected and substantial time was spent practicing and visually calibrating before surveys began, followed by weekly testing throughout the survey period. Distance trials involve each individual observer's estimate of perpendicular distance being compared to a perpendicular distance recorded with a laser rangefinder. These trials were conducted using stationary buoys and bird decoys as targets, which were selected at a range of distances from the transect line and in locations in front of as well as to the sides of the boat where marbled murrelets would be encountered on real surveys (see Raphael et al. 2007 for details). Each observer was tested weekly throughout the survey season. During weekly tests, each observer estimated five perpendicular distances to floating targets. If all five estimates were within 15% of the actual distance, the trial was complete. If any of the five estimates were not within 15% of actual, the observer continued to conduct estimates in sets of five until all five distances were within 15% of the actual distance.

Audits have been conducted in the past by project leads to evaluate the survey team's overall performance and ability to detect marbled murrelets during the survey season (Raphael et al. 2007, Huff et al. 2003). The results of those audits were shared with the observers after the survey day was completed for feedback and discussion. There were no audits performed this year due to COVID-19 operating procedures which precluded an additional person on the boat. This team is highly experienced and conducts surveys with these strict protocols year-round.

Observer Methods.

In all previous years, the survey team consisted of the boat captain and data recorder inside the cabin and two observers (one responsible for each side of the boat) located on observation platforms outside and aft of the cabin about 3 feet apart. Prior to this year, all team members were on the boat and rotated among these duties at the beginning of each PSU (or as needed) to avoid survey fatigue. This year, we changed our data collection logistics to ensure the health and safety of our team and a minimum physical spacing of six feet. To accomplish this, we reduced the team on the boat from four to three and the data recorder was remote (at home) and communicated with the team via Bluetooth wireless headset connected to a satellite or cellular phone connection. Positions on the boat also changed, with our boat captain always operating the boat from inside the cabin and not rotating with other team members.

For the observers, positions were rotated each week but remained fixed within a week. The port observer remained on the port observation platform aft of the cabin to offset the weight of the boat captain on the starboard side. The starboard observer moved to the center bow hatch to ensure minimum physical spacing of six feet. A custom bulkhead was built to separate the main cabin (where the boat captain resides) from the v-birth. Wireless headsets stayed permanently with each observer and were not shared. Eye-level for the bow observer was slightly (less than 1 foot) lower than the observation platforms used aft of the cabin. Observers felt that murrelet detectability was not compromised by the change in observation locations.

Both observers (one covering each side of the boat) scanned from 0^{o} off the bow to 90^{o} abeam of the vessel. Slightly more effort was spent watching for marbled murrelets forward of the boat and close to the transect line (within 45^{o} of line). Observers scanned continuously, not staring in one direction, with a

complete scan taking about 4-8 seconds. Observers were instructed to scan far ahead of the boat for birds that flush in response to the boat and communicated via wireless headsets between observers to minimize missed detections or double counting. Binoculars were used for species verification, but not for detecting birds.

Consistent with previous years, survey speed was maintained at 8-12 knots, and survey effort was ended if glare obstructed the view of observers, or if Beaufort wind scale was 3 or greater for more than 25% of the survey. Beaufort 3 is described as a gentle breeze, 7-10 knot winds, creating large wavelets, crests beginning to break, and scattered whitecaps. The crew surveyed in short stretches of Beaufort 3 associated with tidal rips, or other bathymetric features common in Puget Sound.

Equipment.
Surveys were conducted from a 26-foot Lee Shore (R/V Fog Lark) with twin-outboard engines. This was our fifth year using this vessel.

As described briefly above, observers relayed data (species, number of birds, estimated perpendicular distance of the bird(s) from the trackline) via wireless headsets to the satellite or cellular phone that was connected to the team member at home. The team member at home entered seabird and marine mammal observation data directly onto a laptop computer using DLOG3 software (developed by R.G. Ford, Inc., Portland, OR.). Time was synched between the land computer and the computer running on the boat (also running DLOG3). The boat laptop was located in the bow and interfaced with a GPS unit that collected real time trackline data. Additional data such as PSU identification, weather and sea conditions, on/off effort, and names of observers were recorded manually into the DLOG3 program by the bow observer. There were three occasions (27 and 29 May and 29 July) when cell and satellite signal were not reliable, and the team used handheld tape recorders for part of a survey in the same manner used by Crescent Coastal Research. Tape recorders were synched each day they were used, time was synched with GPS trackline, and data were transcribed after the survey was complete. For all other dates, both the track line information (from the boat) and detection information (recorded from home) were combined using custom R scripts using time to synch the two datasets into one.

The following data were collected for each murrelet detection: group size (a collection of birds separated by less than or equal to 2 m at first detection and moving together, or if greater than 2 m the birds are exhibiting behavior reflective of birds together), plumage class (Strong 1998), and water depth (from boat depth finder).

Safety equipment was added to each of three work areas (aft of cabin, cabin, and bow) this year rather than one centralized location inside the cabin. Safety equipment included: ditch bag, life vest, survival suit, VHF radio, EPIRB, and horn. In addition, antibacterial wipes, hand sanitizer, and gloves for cleaning and during daily operations were added.

Survey Effort
Zone 1 contains a total of 98 PSUs, of which 30 were randomly selected prior to starting the sampling program in 2000. These same 30 PSUs have been sampled every year since. Consistent with this approach, we sampled 5 PSUs in Stratum 1, 20 PSUs in Stratum 2, and 5 PSUs in Stratum 3. Each PSU was sampled twice during the survey season with replicate one completed by 30 June. A random sampling unit selection approach was used to spread the survey effort in space and time. We

accomplished this by selecting a Stratum randomly (1, 2, or 3) and then randomly selecting PSUs within that Stratum to build a survey week. During each week, the team moved nearly every day and typically started in the south and worked their way north, or the opposite. Within each PSU, a coin flip determined whether to conduct the nearshore or offshore segment of the PSU first. PSUs in Stratum 1 were accessed from Port Angeles and Sekiu, PSUs in Stratum 2 were accessed from Coronet Bay, Port Townsend, or Quilcene, and PSUs in Stratum 3 were accessed from Everett, Manchester, or Tacoma. Busy boat launches were deliberately avoided in 2020 for team safety during the pandemic.

This year, there were no overnight stays due to the risks presented by the COVID-19 and travel recommendations made by WDFW. This added to commute times for team members. In addition, team members had new responsibilities and operating procedures including submitting health attestations each morning via email before leaving for the field, no carpooling, use of face coverings, physical distancing, boat captain solely responsible for launching and retrieving the boat and taking care of all other aspects of the boat and communication, and maintaining sanitized work spaces and vehicles.

Data Analysis

Transect distances, murrelet group size, and perpendicular distances for each marbled murrelet observation were sent to U.S. Forest Service statistician Jim Baldwin for analysis. Jim Baldwin used the programs DISTANCE in the program R to calculate densities and 95% confidence intervals (CI) as described in Miller et al. 2006 and Raphael et al. 2007. For population trends, we used a linear regression to the natural logarithm of annual density estimates to test for declining trends. For our analysis, the natural logarithm best fits and tests existing demographic models (USFWS 1997; McShane et al. 2004) that predict the murrelet population is declining by a constant percentage each year. We tested the null hypothesis that the slope equals zero or greater (no change or increase in murrelet numbers) against the alternative hypothesis of the slope being less than zero (i.e., a one-tailed test for decreasing murrelet densities).

Results

Population Estimates and Trends –Puget Sound and Strait of Juan de Fuca

In 2020, two replicates of all 30 PSUs in Conservation Zone 1 were sampled using accepted protocols. Because of the relatively protected nature and typically favorable summer weather in Conservation Zone 1, cancelled surveys are uncommon and deviations from the randomly chosen survey schedule occurred only when surveys in a given area were switched due to wind or fog on a given day or between two consecutive days, or a Naval installation activity preventing access. Schedule changes were made in 2020 specifically to avoid halibut and salmon fishing openers when boat launches became very busy, most notably, Sekiu and Tacoma.

The population estimate for Puget Sound and the Strait of Juan de Fuca in 2020 was 3,143 birds (95% confidence interval = 2,030 – 4,585 birds) with a -4.96% (95% CI = -7.01 to -2.86%) average annual rate of decline for the 2001-2020 period, assuming a constant rate of decline (Table 1, Figure 5). The results for Zone 1 are the same in this report and in McIver et al. (2020). We observed eight young of the year birds, one on 9 July on the south end of Lopez Island, six on 24 July on the south end of Marrowstone Island, and one on 27 July near Everett. These data are consistent with observations made in previous years.

Table 1. Estimate of average annual rate of population change (linear) for Zone 1, 2001-2020. This same information is reported in McIver et al. (2020).

Zone	Annual Rate (%)	95% Lower CL	95% Upper CL	Adjusted R^2	P-value
1	-4.96	-7.01	-2.86	0.579	0.00015

Acknowledgments

Funding was provided by U.S. Fish and Wildlife Service under contract F19AC00047. We thank Chad Norris, who was our full-time boat captain and who developed and maintained our communication system, and built the bulkhead – without his innovation our survey season would not have happened. We thank Kelly Beach (lead Biologist), and biologists Erin Parsons and Sarah Tanedo who embraced our new operating procedures tirelessly and without complaint and approached our surveys with confidence and optimism each day. We thank Jim Baldwin (USFS, PSW Research Station) who provided statistical analyses, Deanna Lynch who coordinated our contracts with the Service and provided valuable feedback, Marty Raphael (USFS) who provided advice and guidance, Bill McIver who facilitated the overall Northwest Forest Plan murrelet monitoring, and Rich Young (USFWS) who provided survey coordinates and GIS support.

Figure 1. Marbled murrelet Recovery Plan Conservation Zones (from Raphael et al. 2007).

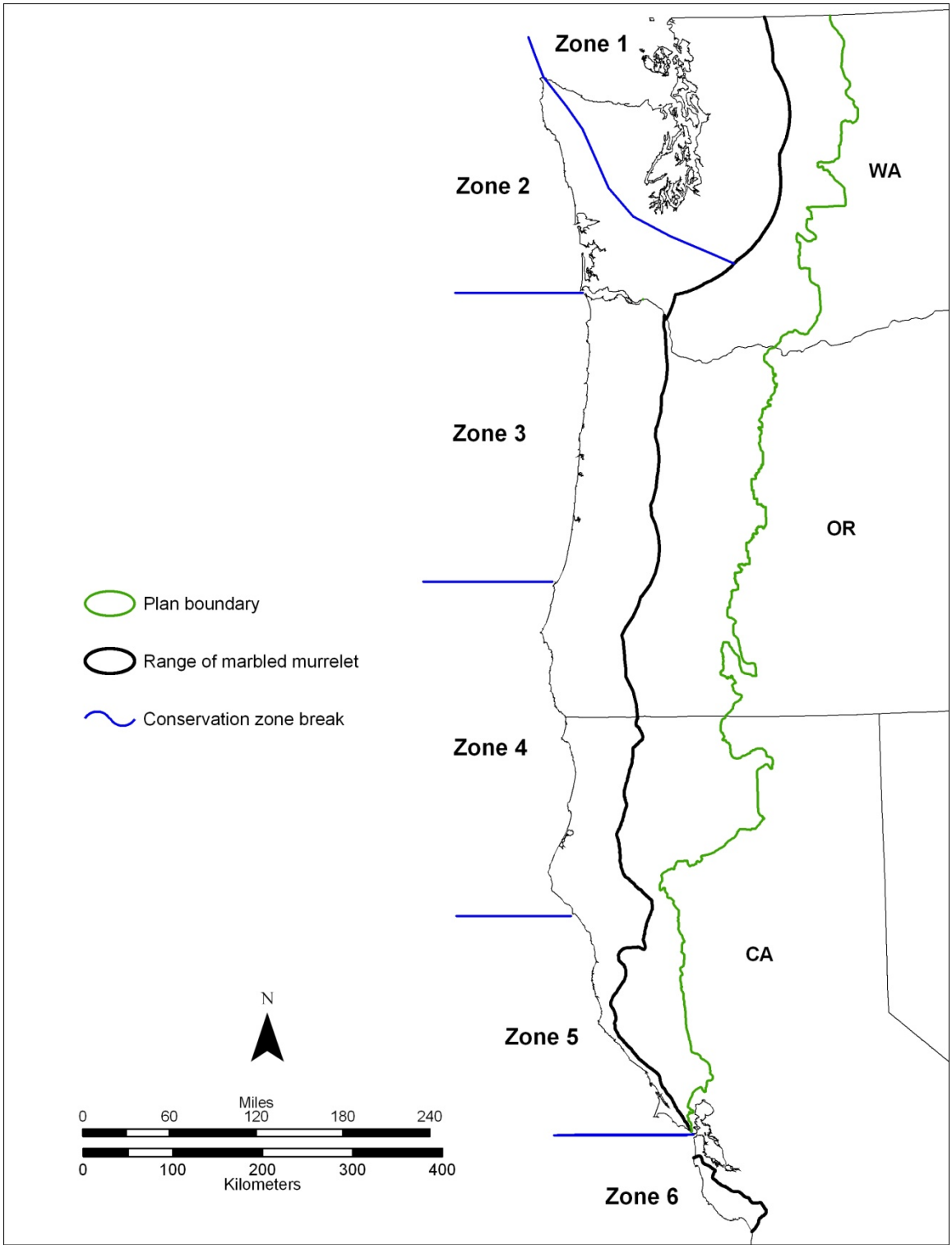
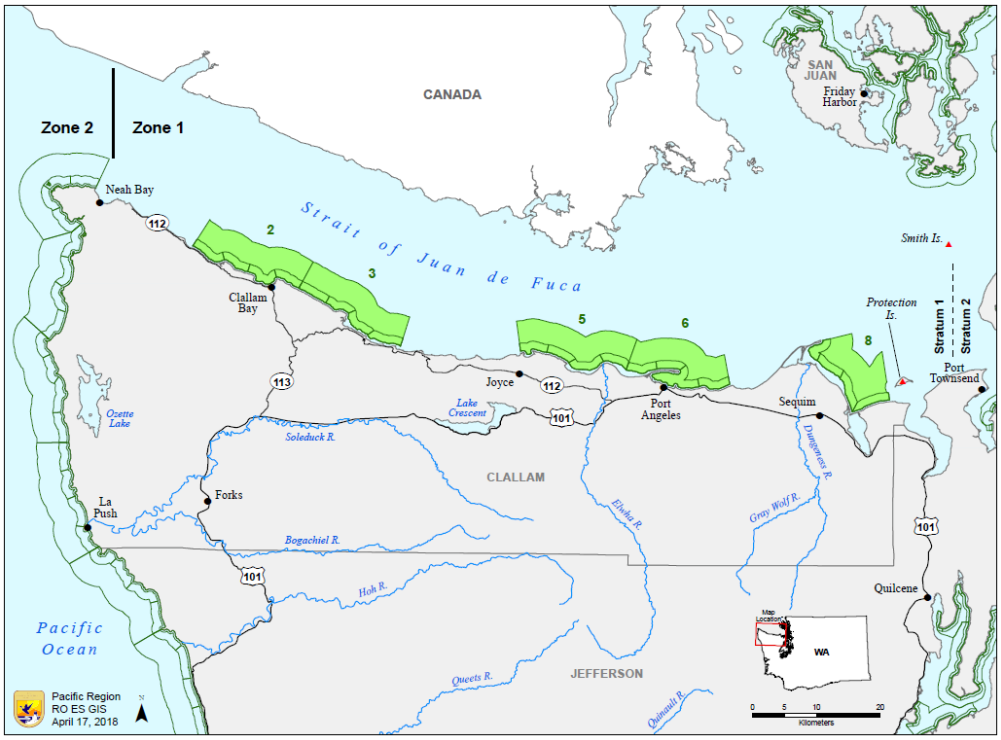
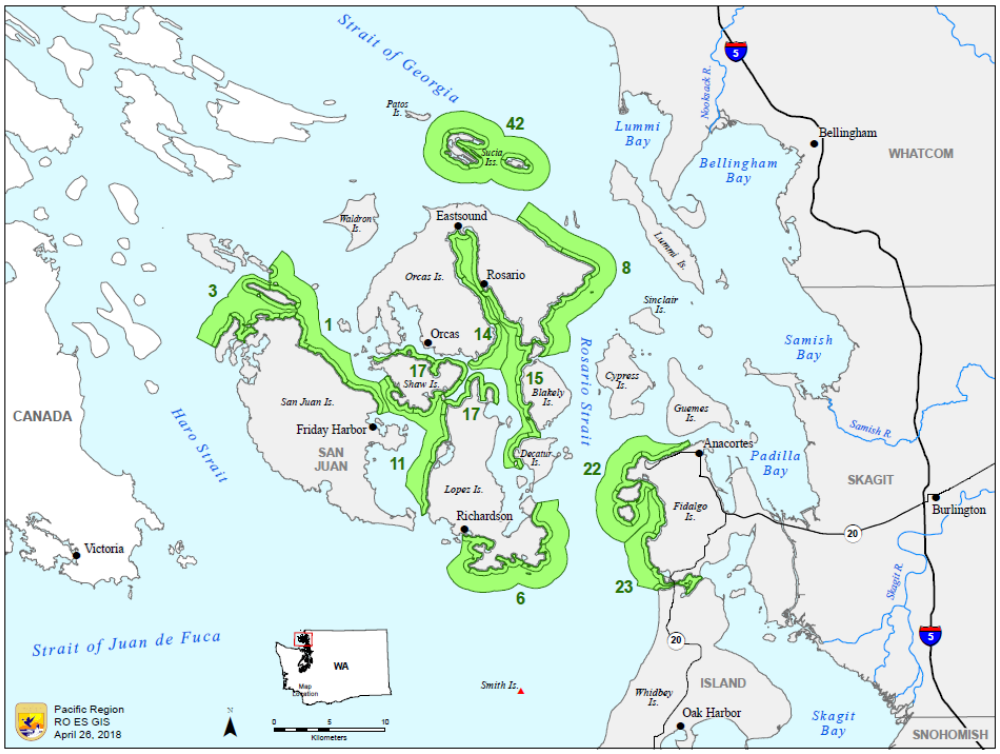


Figure 2. Marbled murrelet Conservation Zone 1: A) PSUs in Strata 1 along the Strait of Juan de Fuca; and B) PSUs in the San Juan Islands (Stratum 2), and C) PSUs in Stratum 2 and Stratum 3 in Puget Sound.

A.



B.



C.

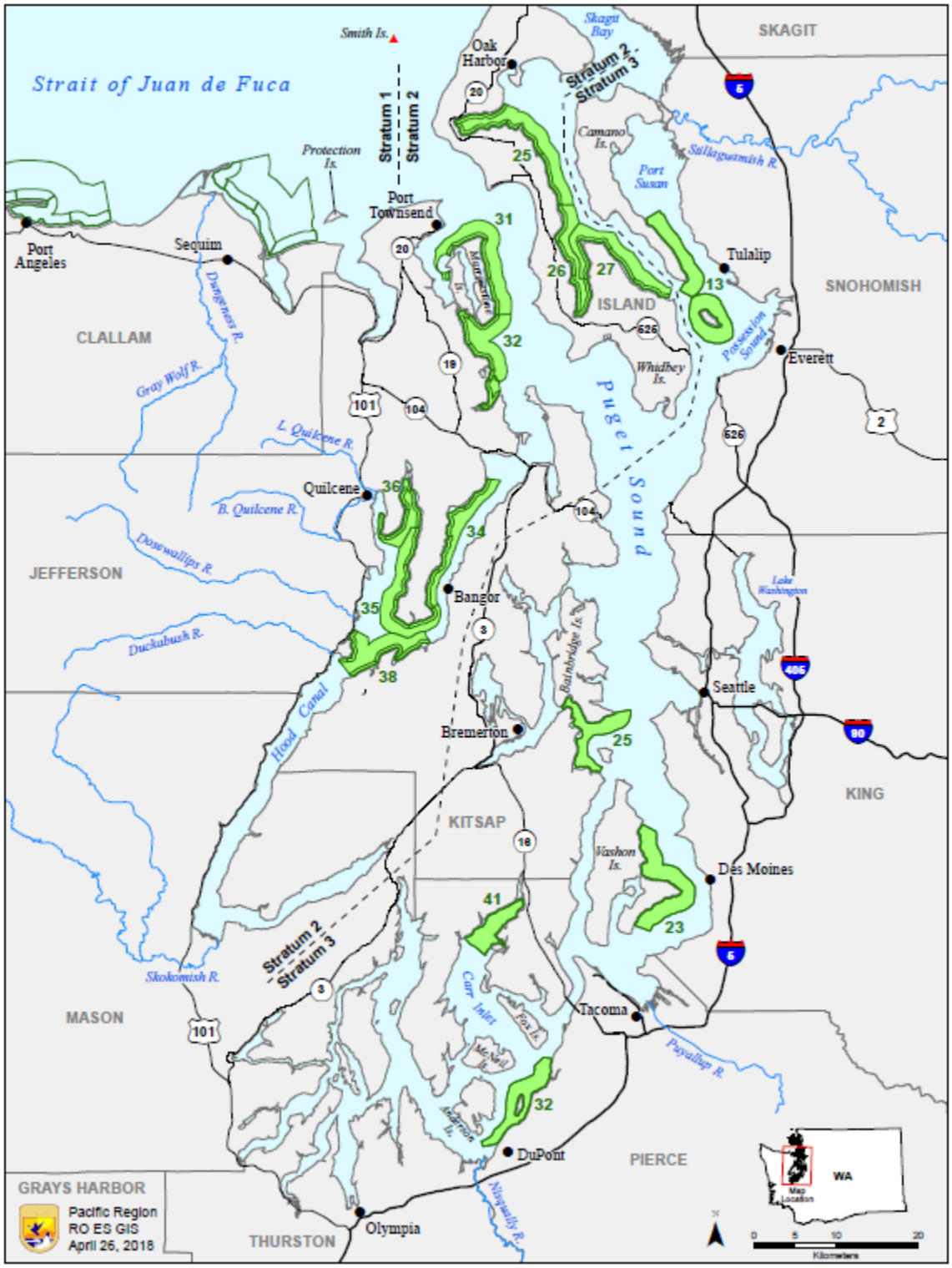

Strait of Juan de Fuca
Smith Is.
Stratum 1
Stratum 2
Stratum 2
Stratum 3
Protection Is.
Port Townsend
Oak Harbor
Skagit Bay
SKAGIT
Camano Is.
Port Susan
Stillaguamish R.
Tulalip
SNOHOMISH
Port Angeles
Sequim
Dungeness R.
CLALLAM
Gray Wolf R.
L. Quilcene R.
B. Quilcene R.
Quilcene
Dosewallips R.
JEFFERSON
Duckabush R.
Hood Canal
Skokomish R.
MASON
GRAYS HARBOR
Pacific Region
RO ES GIS
April 26, 2018
THURSTON
Olympia
Nisqually R.
DuPont
PIERCE
Tacoma
Puyallup R.
Carr Inlet
Fox Is.
McNeil Is.
Harstine Is.
Bangor
Marrowstone Is.
ISLAND
Whidbey Is.
Possession Sound
Everett
Puget Sound
Bainbridge Is.
Bremerton
KITSAP
Vashon Is.
Seattle
Lake Washington
Des Moines
KING
25
31
26
27
13
32
36
34
35
38
25
41
23
32
20
18
101
104
3
5
405
90
2
626
WA
Map Location
0 5 10 20
Kilometers

Figure 3. Marbled murrelet monitoring primary sampling unit (PSU) illustrating nearshore and offshore subunits and 1500 m centerline. The nearshore unit is divided into four equal-length segments (about 5 km each) and four equal-width bins (bands parallel to and at increasing distances from the shore). One bin is selected (without replacement) for each segment of transect (from Raphael et al. 2007).

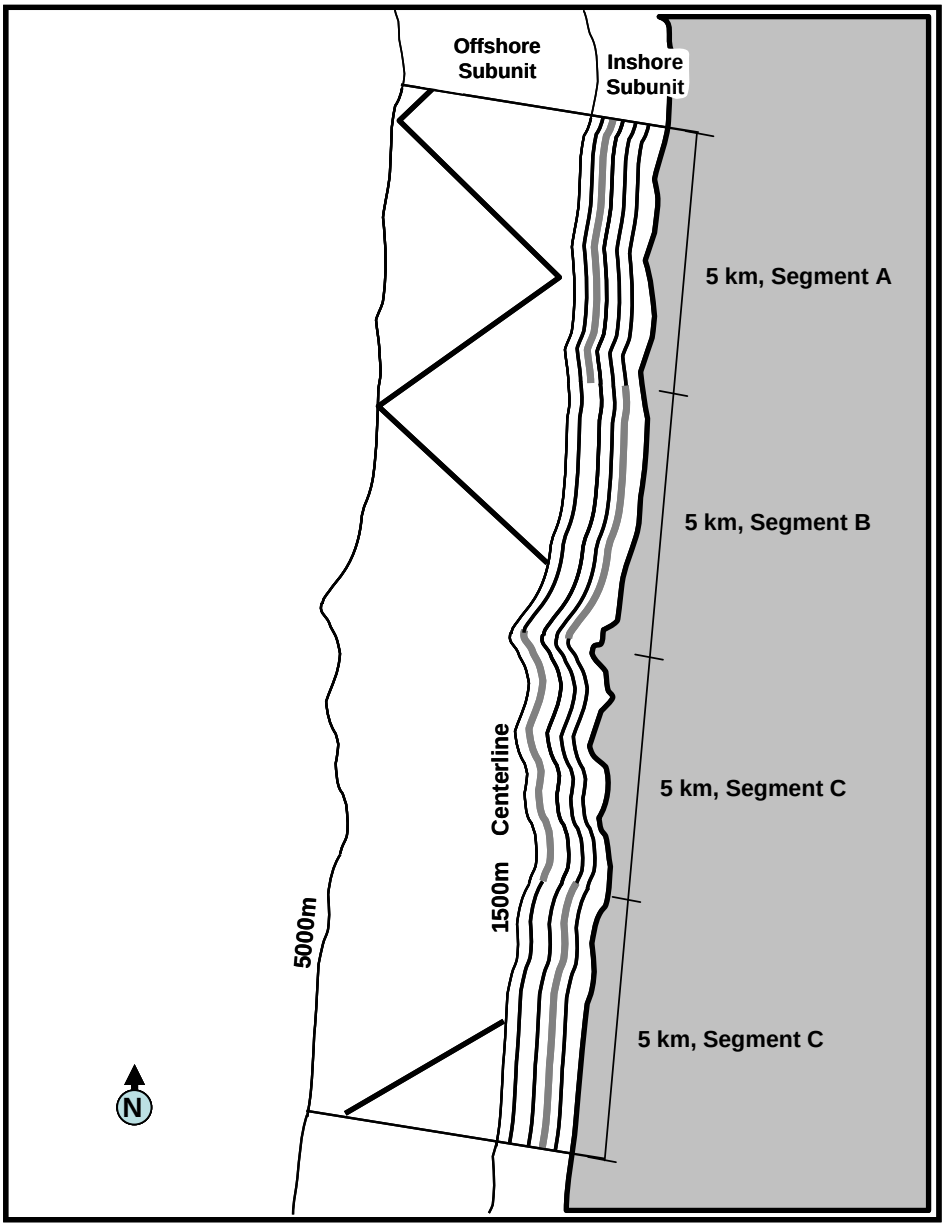


Figure 4. 2001-2020 marbled murrelet population densities (birds/km^2) with 95% confidence intervals for Puget Sound and Strait of Juan de Fuca (Zone 1) and for the three strata within this zone: 1) Strait of Juan de Fuca (Stratum 1), 2) San Juan Islands and northern Hood Canal (Stratum 2) and, 3) southern Puget Sound (Stratum 3). Note the Y axis scale differs among graphs. The information here for this zone is identical to that reported in McIver et al. (2020; Table 3).

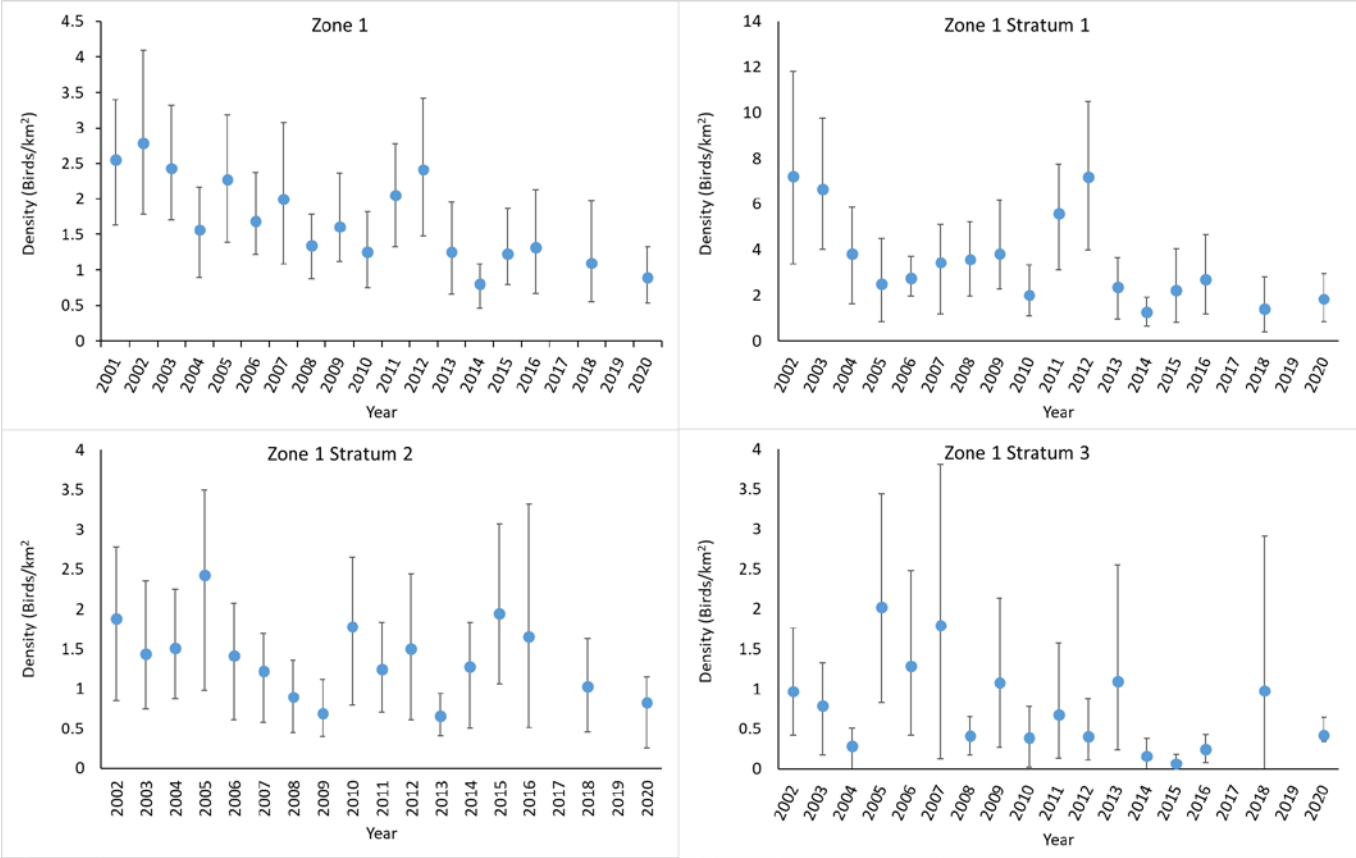
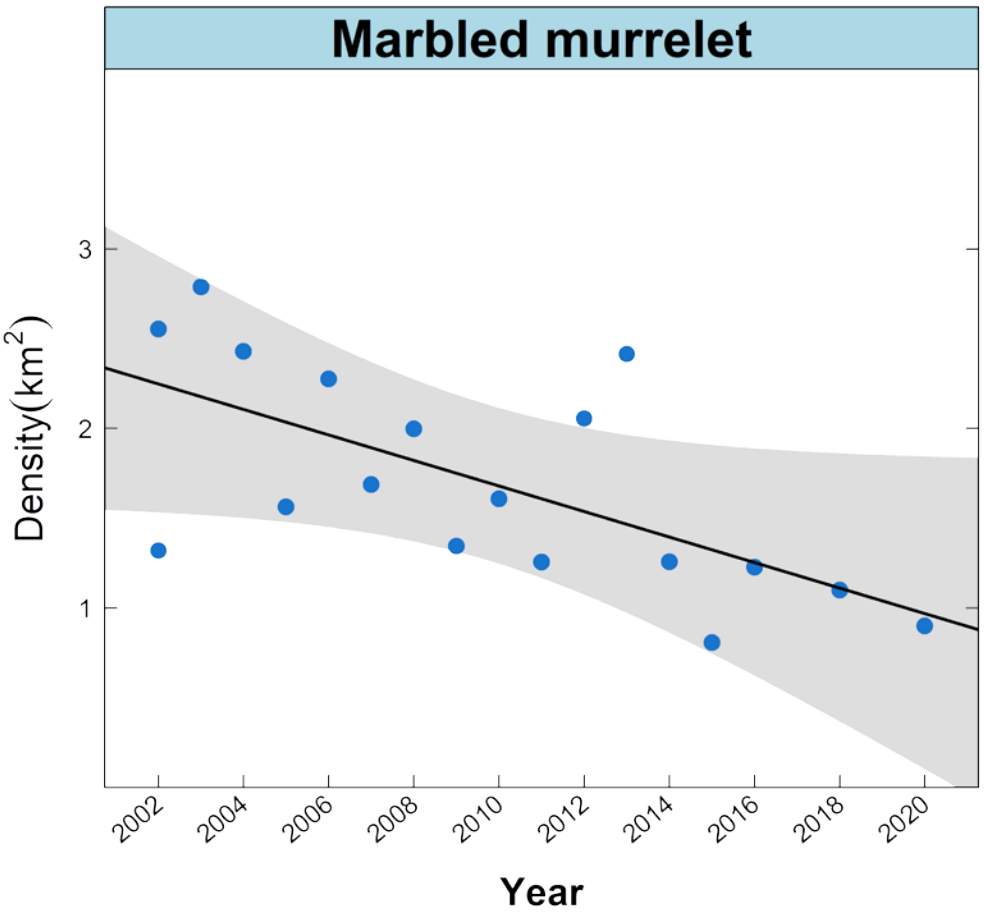


Figure 5. Washington marbled murrelet population density trend for 2001-2020 with 95% confidence band for Zone 1 (Puget Sound and Strait of Juan de Fuca). The trend is for a linear trend in the log of density. We excluded 2000 from this analysis because distances to birds were not recorded and fewer replicates were conducted in that year for Zone 2 and for Zone 1 Stratum 1.



Literature Cited and Referenced

Bloxton, T. D., and M. G. Raphael. 2008. Breeding ecology of the Marbled Murrelet in Washington state, project update 2004–2007. USDA Forest Service Pacific Northwest Research Station, Olympia, WA.

Falxa, G., J. Baldwin, M. Lance, D. Lynch, S.K. Nelson, S.F. Pearson, M.G. Raphael, C. Strong, and R. Young. 2014. Marbled murrelet effectiveness monitoring, Northwest Forest Plan: 2013 summary report. 20 pp.

Huff, M. H. 2006. Introduction to effectiveness monitoring of the Northwest Forest Plan for marbled murrelets. Pages 1-8 in Huff, M.; Raphael, M.G.; Miller, S.L.; Nelson, S.K.; Baldwin, J.; tech. coords. Northwest Forest Plan—the first 10 years (1994-2003): status and trends of populations and nesting habitat for the marbled murrelet. Gen. Tech. Rep. PNW-GTR-650. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: PNW-GTR-650.

Huff, M.H., C.J. Ralph, S. Miller, M. Raphael, C. Thompson, C. Strong, J. Baldwin, T. Max, and R. Young. 2003 *draft*. Quality Assurance Project Plan, marbled murrelet Long-term Population Monitoring, marbled murrelet Module, NWFP Interagency Regional Monitoring.

Mack, D.E., M.G. Raphael, R.J. Wilk. 2003. Protocol for monitoring marbled murrelets from boats in Washington's inland waters. USDA Forest Service Pacific Northwest Research Station, Olympia Forestry Sciences Laboratory, Olympia, WA.

Madsen, S., D. Evans, T. Hamer, P. Henson, S. Miller, S.K. Nelson, D. Roby, and M. Stapanian. 1999. Marbled murrelet Effectiveness Monitoring Plan for the Northwest Forest Plan. USDA Forest Service General Technical Report PNW-GTR-439. Pacific Northwest Research Station, Portland, OR.

McIver, W.R.; Baldwin, J.; Lance, M.M.; Pearson, S.F.; Strong, C.; Lynch, D.; Raphael, M.G.; Young, R.; Johnson, N; Fitzgerald, K.; Duarte, A. 2021. Marbled murrelet effectiveness monitoring, Northwest Forest Plan: At-sea Monitoring - 2020 summary report. 25 p.

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. Unpublished report. EDAW, Inc. Seattle, Washington. Prepared for the U.S. Fish and Wildlife Service, Region 1. Portland, Oregon.

Menza, C., J. Leirness, T. White, A. Winship, B. Kinlan, L. Kracker, J.E. Zamon, L. Ballacne, E. Becker, K.A. Forney, J. Barlow, J. Adams, D. Pereksa, S. Pearson, J. Pierce, S. Jeffries, J. Calambokidis, A. Douglas, B. Hanson, S.R. Benson and L. Antrim. 2016. Predictive mapping of seabirds, pinnipeds and cetaceans off the Pacific coast of Washington. NOAA Technical Memorandum NOS NCCOS 210. Silver Spring, MD. 96 pp. doi:10.7289/V5NV9G7Z.

Miller, S.L.; Ralph, C.J.; Raphael, M.G.; Strong, G.; Thompson, C.; Baldwin, J.; Huff, M.H. 2006. At-sea monitoring of marbled murrelet population status and trend in the Northwest Plan area. Pages 31-60 *in*: Huff, M.; Raphael, M.G.; Miller, S.L.; Nelson, S.K.; Baldwin, J.; tech. coords. Northwest Forest Plan—the first 10 years (1994-2003): status and trends of populations and nesting habitat for the

marbled murrelet. Gen. Tech. Rep. PNW-GTR-650. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: PNW-GTR-650.

Miller, S.L., M.G. Raphael, G.A. Falxa, C. Strong, J. Baldwin, T. Bloxton, B.M. Gallagher, 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.

Raphael, M.G., D. Evans Mack, and R.J. Wilk. 1999. Sampling marbled murrelets at sea: tests of survey methods and designs. Draft Report, February 17, 1999.

Raphael, M.G., J. Baldwin, G.A. Falxa, M.H. Huff, M.M. Lance, S.L. Miller, S.F. Pearson, C.J. Ralph, C. Strong, and C. Thompson. 2007. Regional population monitoring of the marbled murrelet: field and analytical methods. Gen. Tech. Rep. PNW-GTR-716. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 70 p.

Raphael, M.G., A. Shirk, G.A. Falxa, and S.F. Pearson. 2015. Habitat associations of marbled murrelets during the nesting season in nearshore waters along the Washington to California coast. Journal of Marine Systems 146:17-25.

Strong, C. S. 1998. Techniques for marbled murrelet age determination in the field. Pacific Seabirds 25(1): 6-8.

Thompson, C.W. 1999. Distribution and abundance of marbled murrelets and Common Murres on the outer coast of Washington, Summer 1997 through winter 1998-1999. Unpubl. Report for Washington Dept. of Fish and Wildlife, Mill Creek, WA.

U.S. Fish and Wildlife Service. 1997. Recovery Plan for the Threatened marbled murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, Oregon. 203 pp.