Northwest Forest Plan Interagency Regional Monitoring, 15 Year Report
Status and Trend of Marbled Murrelet Populations and Habitat

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Background and New Science

***Objective**:* The primary objective is to address the key question of status and trend of marbled murrelet populations and nesting habitat in the Northwest Forest Plan (Plan) area. This information will help assess if implementing current management direction is contributing to the recovery of this federally-listed species by maintaining and restoring potential murrelet nesting habitat and populations on federal lands.

***Methods**:* Population monitoring is based on estimates of the at-sea murrelet population, for the coastal waters adjacent to the area included in the Plan. A team of cooperating scientists have conducted line transect surveys from boats in those waters during the murrelet breeding season, since 2000. Those data are used to generate annual population estimates for each of five zones and for the five zones combined.

To monitor habitat we applied habitat suitability models to remotely-sensed and field-collected map data on vegetation and physical conditions. These models were used to estimate the amount and distribution of potential murrelet nesting habitat during the 1994-1996 baseline, using 4 habitat suitability classes. We applied the baseline habitat model to the 2006-2007 "bookend" map data to estimate net change as the balance between losses and gains of higher suitability habitat. We then used forest disturbance data provided by LandTrendr to refine the estimates of habitat loss, and to identify likely causes of habitat loss. (See companion report for Status and Trend of Late-Successional and Old Growth Forests for details on "bookend" and LandTrendr methods.)

***New science**:* We used newly-available MaxEnt habitat suitability modeling software to estimate the amount and distribution of potential nesting habitat. Both published literature and tests conducted in collaboration with the northern spotted owl monitoring module indicated that MaxEnt outperformed other modeling approaches, including the Biomapper model used in the 10-year Plan report. Also new were gradient nearest neighbor (GNN) map data on forest composition and structure characteristics, and LandTrendr data on location and causes of habitat loss. New data and MaxEnt models provided more powerful and consistent results across the Plan monitoring area.

Key Results

Population monitoring:

- At the Plan regional scale, the murrelet population declined by an estimated 3.9 percent per year (95% confidence interval = -2.6 to -5.1%) between 2001 and 2009, or about 27% overall (Figure 1).
- At the Conservation Zone scale, a population trend was detected only in Zone 1, with a decline of 7% per year (95% CI = -2.1 to -11.7%). At the zone scale, more years of monitoring will be required to reliably (>80% power) detect annual decline rates of 4 percent or less.

Habitat monitoring:

- Overall, federal lands provided the majority (64% or 2.4 million acres) of higher-suitability potential nesting habitat, mainly in "reserved" land allocations. In California, most coastal forests are in non-federal ownership and little habitat remains (Fig. 2, 3).
- Nesting habitat develops very slowly, and gains are difficult to detect in a short time period. If we focus on LandTrendr-refined loss estimates, federal lands lost about 3% (77,000) acres of higher suitability nesting habitat from the baseline, with two-thirds due to wildland fire loss in Oregon, mostly in the 2002 Biscuit fire. The remaining 1/3 was due mostly to timber harvest in WA and OR.

Losses were much greater on nonfederal lands, where timber harvest accounted for most losses.

- Almost 2 million acres of federal reserve lands are in lower suitability habitat (Class 2). Some of this is likely to eventually develop into higher-suitability nesting habitat (Class 3) and offset losses, although substantial habitat development may take many decades.

Next Steps and Recommendations

Population monitoring has provided initial trend results. While continuing monitoring, a next step is to explore models which relate the distribution and trends of murrelets at-sea to nesting habitat conditions and trends, and to marine conditions. This will help clarify causes for observed declines, and potential remedies. Funding for at-sea monitoring has been adjusted to provide more resources for Pacific Northwest Research Station scientists to pursue this modeling. Other recommendations to improve future monitoring include:

- Identify and develop data sources on prey and other marine conditions that could affect murrelet survival and reproduction, and that could become part of the murrelet monitoring database.
- Further refine the baseline habitat map and vegetation mapping methods with GNN and LandTrendr.
- Explore methods to assess the process and timescale for nesting habitat development in 2nd-growth.
- Continue population monitoring, both to achieve statistical power to test for trends at the zone scale, and to assess whether existing trends continue in the future.
- Consider monitoring murrelet reproductive rates, to improve understanding of factors limiting murrelet populations in the Plan area. This could be added to the at-sea monitoring work.

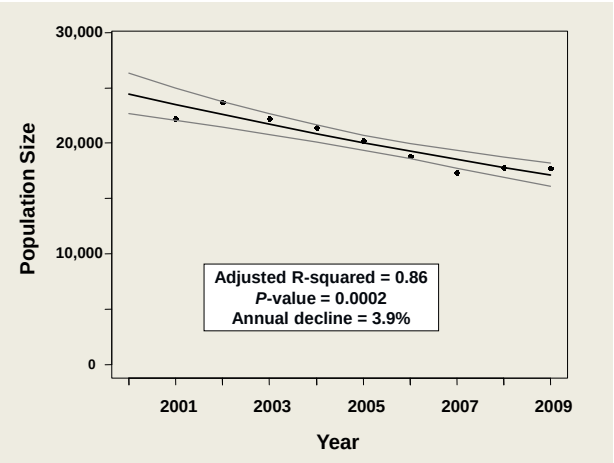

Figure 1. Murrelet population trend for the Plan Area, 2001-2009, with annual estimates and 95% confidence intervals.

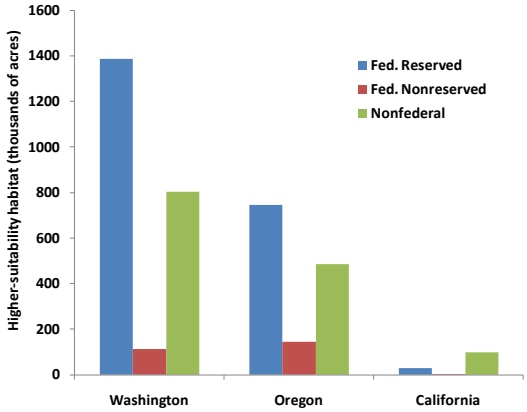

Figure 2. Distribution of higher-suitability murrelet nesting habitat by state and ownership.

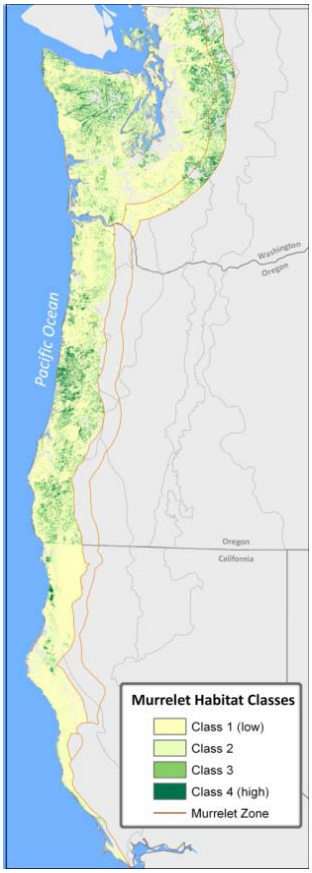

Figure 3. General distribution of murrelet habitat based on suitability classes, for baseline period (1994-96). Classes 3 and 4 are considered higher-suitability habitat.