PNW
Pacific Northwest
Research Station

Science
FINDINGS

INSIDE

issue thirty-nine / november 2001

"Science affects the way we think together."
Lewis Thomas

UNDER THE RADAR: ADVANCES IN MURRELET MONITORING

Photo credit: University of Washington

Corvids, including gray jays, were the primary predators of simulated murrelet egg nests in Washington forests.

Photo credit: Martin Raphael

A standardized population monitoring protocol, based on line transect surveys at sea, was implemented throughout the Northwest Forest Plan area in 2000.

IN SUMMARY

Future choices in managing federal and private forest lands in the Pacific Northwest, particularly for commodity production, are partly dependent on how the threatened marbled murrelet responds to the Northwest Forest Plan. Is the plan functioning for this elusive species, and are populations stabilized or increasing?

Because the murrelet forages at sea but nests on land in older forests, its condition is affected by many factors: its status at sea, its nesting habitat on land, and the link between the two. Several tools are available to monitor long-term population trends, and studies in nesting habitat have illuminated habitat requirements. The stage is set for correlating habitat trends with population trends.

But what is becoming increasingly clear is that ecosystem interactions in the murrelet's world are even more complicated than was previously understood.

"Where observation is concerned, chance favors only the prepared mind."

Louis Pasteur 1822-1895

With every high-speed flight from its foraging grounds on the ocean to its nesting grounds in the forest, the little marbled murrelet carries a heavy weight on its back. Along with that of the northern spotted owl and many species of anadromous fish, the response of the murrelet to the Northwest Forest Plan is a fulcrum on which the future of the plan itself may balance.

The loss of nesting habitat over time has always been an issue for the murrelet, with windthrow and fire disturbance causing the bird to adapt and recover. But habitat loss due to logging has far exceeded that of any historical disturbance, and now the challenge is to rectify a lost balance. Can the Northwest Forest Plan achieve this feat?

"There has been an assumed link between habitat condition inland and murrelet occurrence offshore," says Martin Raphael, chief research wildlife biologist with the PNW Research Station in Olympia, Washington. "But it is not enough to provide habitat as the plan requires without knowing if murrelets are responding positively to that habitat. If they were, we would see it in reproductive output and growing populations."

Raphael explains that monitoring long-term population trends is the best way to

assess how well current forest management plans and their impacts on nesting habitat are affecting murrelet populations.

"Therefore, not only are reliable estimates of marbled murrelet population trends needed, but given the effort and resources that will be expended under the long-term monitoring program, effective and efficient monitoring techniques must be developed," he says.

If only it were so simple.

KEY FINDINGS

- A complex combination of stand structure, edge, and proximity to human activity on the landscape influences habitat suitability for nesting. Vulnerability to predation is a key factor in nest success.
- Long-term population trends from at-sea counts can be derived from a line transect-based protocol designed to account for the distribution of murrelets on the water through time.
- Radar can be used effectively at inland sites to provide an index of abundance, which then becomes an independent assessment of population trend. Also radar can be applied at several scales, providing a link between habitat condition inland and murrelet occurrence offshore.

A VERY TRICKY BIRD

The marbled murrelet has been variously described as stealthy, elusive, cryptic, and extremely difficult to locate and observe. Thus it is an uneasy monitoring subject, particularly when the monitoring numbers will potentially affect land management decisions on a broad scale.

The marbled murrelet is a small seabird whose summer distribution along the Pacific coast extends from the Aleutian Islands of Alaska to Santa Cruz, California. It forages primarily on small fish in the near-shore area, mostly within about 2 miles of the coast. Unlike other seabirds, Raphael points out, it does not usually nest on the ground and nowhere in dense colonies.

During the breeding season, marbled murrelets fly from foraging and resting sites on the ocean to inland nests each day, with some one-way flights exceeding 50 miles. At sea, their small size (10 inches long), and nondescript mottled brown breeding plumage present challenges for at-sea surveys. They dive to feed, so at any given moment, some proportion of birds will be underwater and thus out of view.

The birds do not build a nest but use a natural platform on limbs of larger coniferous trees, primarily in older forest patches. The severe reduction of older forest because of logging, along with low nest success and mortality at sea, are what have led to the marbled murrelet being listed as threatened in Washington, Oregon, and California in 1992.

On the nesting platform, a single egg is laid, then both adults share equally in incubation, exchanging once every 24 hours. A few days after hatching, the chick is left mostly alone for the rest of the 30- to 40-day nesting period, with adults visiting to feed primarily at dawn and dusk.

Raphael explains that the adult's high flight speed, infrequent and direct flight patterns, mottled brown breeding plumage, and quiet behavior on the nest, combined with the chick's unusual but characteristic silence and stillness in the nest, contribute to the difficulty of observing the bird. "All these features, so frustrating to researchers, are clearly designed to evade predation, which has a huge effect on their nesting success," he says.

Most of the typical demographic indices used for wildlife species, such as reproductive success, juvenile and adult survival, and longevity, are difficult to obtain, he points out. The secretive bird has remained one of the least known birds of North America; the first nest was not discovered on this continent until 1974. Many aspects of the ecology of the species, both at sea and inland, remain unclear.

Photo credit: Tom Hamer

Marbled murrelets nest mostly on platforms in older forests. Its preference for heavy cover in this setting creates a monitoring challenge.

Purpose of PNW Science Findings

To provide scientific information to people who make and influence decisions about managing land.

PNW Science Findings is published monthly by:

Pacific Northwest Research Station
USDA Forest Service
P.O. Box 3890
Portland, Oregon 97208
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Forest Service

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ESTABLISHING ASSOCIATIONS

But the last 10 years have yielded some relatively consistent information on which to base monitoring efforts. Marbled murrelets clearly associate with older coniferous forests: across the range, sites with the highest likelihood of nesting murrelets have larger trees, more potential nest platforms, and sometimes greater moss cover on tree limbs than other sites, Raphael says.

"Nest trees are larger on average than adjacent trees, often the largest within a 25- to 50-yard radius, and contain more platforms with better cover than surrounding trees," he says. Large limbs, deformities from mistletoe and other disease, damage, and moss cover create suitable nesting platforms, and these features are most often found in older forests. This does not mean that murrelets are never found in younger forests, but when they are, they usually associate with residual older trees, or heavy mistletoe infestations.

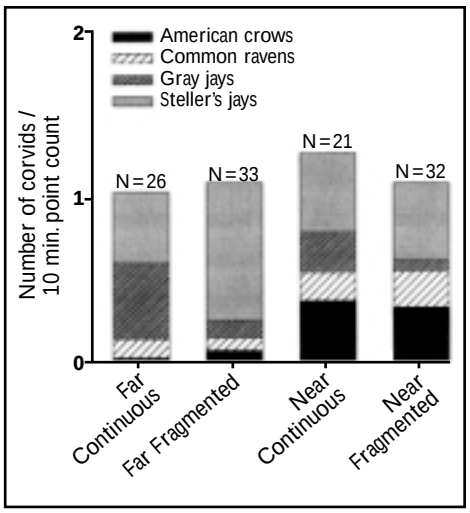
The nesting habitat associations of the murrelet presumably evolved under a regime of large expanses of old conifer forests on the landscape, with infrequent, high-intensity wildfire the primary disturbance agent before the 1800s.

"Loss of conifer forest within the inland limits of the bird's range has been extensive due to logging over the past century," Raphael says, "but actual percentages of potential nesting habitat loss based on area are difficult to extract from the literature."

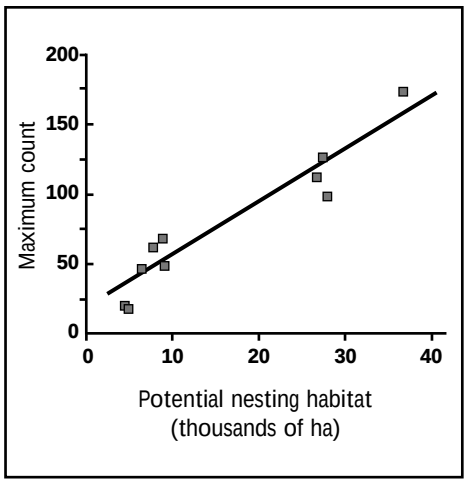
So how can researchers be sure that loss of nesting habitat is truly the problem?

LAND MANAGEMENT IMPLICATIONS

- Complex relations among forest structure, forest edge, and nesting success suggest there may be opportunities for timber management that combine old growth with other age classes.
- Long-term population trends provide the basis for assessing how current forest management policies affect murrelet populations. Only by tracking population change and linking change to habitat can the efficacy of the Northwest Forest Plan be assessed.
- Radar is an efficient, cost-effective, and reliable tool for detecting murrelets at inland sites under many scenarios and at several scales. It could be used to assess population trends independently.



A diversity of corvid nest predators occurs in both continuous nesting habitat and habitat fragmented by younger forest, as well as stands located near or far from human activity. Proximity to human activity confounds our ability to attribute predation risk solely to a fragmentation effect.



Numbers of murrelets detected with radar entering large river drainages on the Olympic Peninsula, Washington, in 1999 were strongly correlated with the amount of suitable nesting habitat within those drainages. Results were similar for 1998 and 2000.

TRACKING POPULATION TRENDS

At this point in our understanding of marbled murrelet ecology, there is general consensus that populations are best assessed at sea, because of the cryptic nature of the species in its nesting habitat high in forest canopies throughout much of its range," Raphael explains. "The ultimate goal of our current monitoring efforts is to show a strong correlation between population trends and nesting habitat so that nesting habitat can be monitored as a surrogate to monitoring the species over the long term."

The monitoring effort costs about $1.3 million per year, including both at-sea and inland components.

Long-term population trends from at-sea counts can be derived from a line transect-based protocol, which has been developed collaboratively with researchers in Washington, Oregon, and northern California, he says. The new, standardized approach takes into account different distributions of the murrelet over the water and through time, and it is the first survey protocol to be applied consistently throughout the Northwest Forest Plan region.

WRITER'S PROFILE

Sally Duncan is a science communications planner and writer specializing in forest resource issues. She lives in Corvallis, Oregon.

The target population to count occurs within 5 miles of shore and is observed mid-May through mid- to late-July, when breeding birds at sea are likely to be associated with inland nesting habitat. The line transect method estimates murrelet density, or number of murrelets per unit area, to establish population size.

The method assumes that objects near the line are not missed, or have not moved away from the line, and that distance of objects from the transect is accurately estimated. Before implementation of the sampling protocol, the at-sea monitoring team tested alternative sampling approaches and refined the sampling protocols. For example, Raphael and his team conducted experiments to evaluate the results of murrelet counts for one- versus two-observer methods and established that two-observer teams collect more accurate information. They also tested and compared two methods for obtaining distance from the transect line.

The new sampling design was implemented during the 2000 field season, and the results represent the first year and baseline of population information for the Northwest Forest Plan area. This area is the nearshore lands extending from San Francisco Bay north to the Canadian border. The total population of 17,000 murrelets is estimated to be in that area. Raphael notes that because these methods have not been used in the same way in the past, comparison with past population estimates is not valid.

An old technology with a new use shows perhaps the best hope of untangling the correlation between populations at sea and nesting habitat inland.

BLIPS ON THE SCREEN

Radar has been demonstrated as an effective tool for detecting the murrelets: it is not subject to variation in visual and auditory abilities of observers, it can be deployed over a large area, and it is effective over many weather and light conditions, unlike a human-based system.

"But what is so important in using radar is that it can be used effectively at inland sites to provide an index of abundance, which serves as an independent assessment of population trend," Raphael says. "In addition, radar sampling can be applied at several scales, providing the all-important link between habitat condition inland and murrelet occurrence offshore."

Raphael and Diane Evans Mack, a wildlife biologist also at the Research Station in Olympia, and Brian Cooper, a scientist with ABR, Inc., recently completed a study of murrelet abundance and nesting habitat that was centered on the use of radar. Its objectives were to identify potential nesting habitat at a broad scale by using a consistent classification, compare numbers of murrelets using drainages of different sizes and with differing amounts of potential habitat, and evaluate annual variation in bird counts as an indicator of nesting activity.

"We hypothesized that the number of murrelets flying into drainages, as detected by radar, would be directly related to the amounts and spatial configurations of nesting habitat within those drainages," Cooper explains. Further, they theorized that annual variations in numbers of the birds entering drainages would reflect the annual variations in numbers of breeding birds. The latter could be cross-checked by supplemental evidence of breeding success, such as at-sea densities.

Although there are still some factors to be corrected by human observation—for example, does one radar blip equal one bird only?—radar has proven to be vastly more accurate.

"With the right topography of steep-sided valleys, you can be confident you are capturing all the birds," he says. "Previous counts might have been missing as many as 90 percent of the fast-flying murrelets."

Although results to date have been inconclusive, Raphael believes radar can be used to investigate the correlation between where murrelets forage on the ocean and where they find nesting habitat. Previously, it was assumed they simply found the nearest available location, but marine conditions vary seasonally, and these birds do not seem as constrained by travel distance as researchers used to believe.

BRINGING SCALE TO MANAGEMENT

"Our finding that numbers of murrelets are strongly correlated with the amount of nesting habitat supports the claim of a decline in murrelet populations due to loss of nesting habitat," Raphael says. "However, some caution needs to be exercised in using our data to estimate potential rates of decline in murrelet populations."

Specifically, as researchers test the efficacy of radar as a monitoring device, what they are classifying as suitable habitat may not actually be suitable, or other factors such as conditions at sea, may be limiting the number of birds. Thus they may have overestimated the extent of nesting habitat.

"Although we do not think it is appropriate to use our data to estimate the quantity of habitat needed to support a pair of nesting murrelets, we believe the relations we observed do support the idea that overall quantity of suitable habitat predicts relative abundance of breeding birds," he says.

Besides providing that elusive link, radar can offer a more realistic count of birds at the scale of individual drainages. Raphael and others do not believe that the murrelet recovery zones used in the monitoring plan—large areas that each cover most of a state—are small enough to permit useful comparisons of at-sea populations and onshore habitat.

Managers, he points out, could get specific in examining changes over time in murrelet counts in direct relation to changes in amounts and patterns of habitat on federally managed land. For example, a matrix area that has been selectively logged for forest health, or a drainage containing clearcuts, could be observed after these disturbances to correlate any changes in murrelet numbers.

Of course, the more researchers learn about murrelets, the more they appreciate the complexity of the task at hand. For example, almost any management intervention is going to result in forest fragmentation, with marked consequences for the vulnerability of the bird to predators.

PREDATORS AND THEIR PREFERENCES

Evidence from Eastern forests suggests an increased risk of predation in fragmented forests, Raphael says, with more edge effects, such as changes in microclimates at open edges compared with interior sites, changes in vegetation, and changes in predator-prey dynamics. But the effects of fragmentation on Western forests, which have had a shorter history of human-induced change and settlement, are more complicated.

The interaction of murrelet populations with edge effects and forest fragmentation in Western forests defy generalization.

"At the regional scale, abundance of murrelets, estimated from offshore surveys, was found to be correlated with amount of nesting habitat in some areas but to a lesser extent with fragmentation of that habitat," Raphael says. "We found a similar pattern at the watershed scale, but at the scale of nest sites and the surrounding landscape, fragmentation may have a greater effect on likelihood of nesting and nest success."

Other studies have shown that high failure rates of nests are mostly due to predation, with birds such as crows and jays the primary predators. And the relation between fragmentation and predation contains many confounding factors, Raphael says.

Over the past 5 years, he has tested assumptions with John Marzluff from the University of Washington about effects of fragmentation using artificial nests located in stands of varying structural complexity, different levels of fragmentation, and unequal proximity to human activity.

"Our artificial nest experiments showed similar rates of predation in fragmented and continuous stands," he explains. "The lack of an obvious fragmentation effect appeared to be due to the diversity of nest predators, the influence of forest structures surrounding nesting stands, and proximity to human activity."

Although the murrelet is most associated with older forest, Raphael notes that old-growth forest is more likely to produce higher numbers of predators. Predation rates thus increased with abundance of predators in continuous stands, but the same relation did not hold in fragmented stands. The simple structure of young forests does not attract many predators, although human refuse does.

A delicate balance therefore remains: "Understanding tradeoffs between predation risk and quality of nesting habitat will require further investigation into how much simple-structured forest in a landscape is enough to reduce predator populations without reducing use of the remaining complex forest for nesting by murrelets," he explains.

NORTHWEST FOREST PLAN AS MURRELET SAVIOR: TOO EARLY TO TELL?

Basic inventory of potential murrelet nesting habitat is being compiled by using vegetation data collected under the Interagency Vegetation Mapping Project. These data will provide a coarse-grain baseline for assessment. They will be linked with other data to build models predicting how proximity to human habitation, forest type, and forest fragmentation will affect murrelet nest density, likelihood of success, and productivity of the population in larger landscapes.

The one huge factor not yet mappable is oceanic conditions. El Niño and La Niña, Pacific decadal oscillations, are aquatic conditions that naturally affect the foraging grounds of the murrelet. Their effects on murrelet population dynamics are as yet poorly understood. Murrelet monitoring activities are confined to what is currently knowable.

"Productivity of murrelet populations remains a big question, as we are only in the first few years of using these consistent protocols and bridging the gap between available habitat and populations at sea," Raphael says. "And even after 5 years of data gathering, it will probably still be unclear whether enough time will have passed to assess the absolute success of the Northwest Forest Plan in restoring murrelets to a more secure status. Because trees mature slowly, and it takes a long time for them to develop suitable nesting structures for murrelets, it may take 30 years or more before we really know whether the forest plan is working."

Raphael does feel confident that if the Northwest Forest Plan stays in place, it cannot but help populations of murrelets recover. In the meantime, the complexity of relations between forest structures and their patterns, forest edge, and nest success suggest that there may be opportunities for timber management that combine old growth with other age classes in a way that does not further threaten murrelet productivity.

FOR FURTHER READING

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