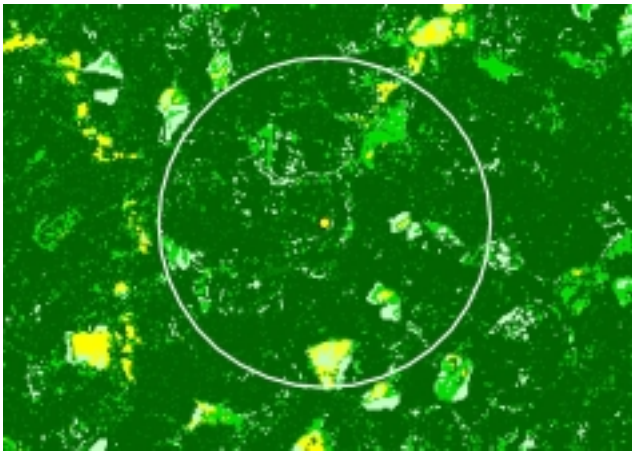
MANAGING LANDBIRD POPULATIONS IN FORESTS OF THE PACIFIC NORTHWEST REGION

EXECUTIVE SUMMARY

The USDA Forest Service Pacific Northwest Region manages 19 National Forests that provide timber, forage for cattle and wildlife, and numerous recreational opportunities. These and similar activities on lands surrounding national forests affect avian communities through alteration or removal of their preferred habitats.



Location of a single Suislaw N.F. MAPS station and 2-km radius superimposed upon a portion of USFS canopy cover dataset depicting a landscape dominated by high canopy cover forest (dark green). Historical logging has left successional stands of medium canopy cover forest (mid-green), and low canopy cover (light green). More recent activity has created patches of shrubland (light blue) and grassland (yellow).

In 1993, the Pacific Northwest Forest Plan emerged for coordinating forest management actions with federal agencies and state, local, and tribal governments across Oregon, Washington, and California. The plan includes strategies for adaptive forest management, conservation and restoration of riparian habitat, and the protection of sensitive species on nonfederal forestlands.

In addition, avian conservation plans have emerged at the federal, regional, and state levels that focus on declining or range-limited species and the critical habitats that they require. These plans, formulated by Partners in Flight, call for adaptive management guidelines to maintain or improve habitats for species of conservation concern, and set specific goals for population recovery.

Ecological models that quantify the effects of landscape pattern and structure on avian population dynamics can help foresters meet these challenges. Foresters require decision-making tools that will enable them to predict the effects of proposed forest management plans on avian demographics, including population densities, reproductive success, and the direction of population trajectories.

The Institute for Bird Populations, through its Monitoring Avian Productivity and Survivorship (MAPS) program (1992-2001), effectively monitored 21 landbird species in six forests. Of these 21 species, we identified 13 species of conservation concern that could be modeled and were listed in federal, regional, and state conservation plans.

We combined MAPS banding data for these 13 species with five regional spatial datasets: USGS National Land Cover Dataset (NLCD 1992), USFS Region Six canopy cover, USGS National Elevation Dataset (NED), Streamnet, and USFS Forest Health Protection Aerial Survey. From these we constructed landscape-scale (1000's of hectares) management models for reversing population declines in landbirds of regional conservation concern.

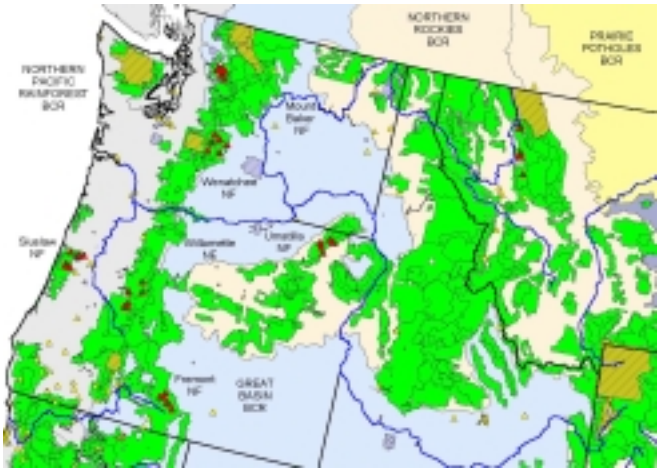
Avian demographic monitoring requires accurate estimation of age. Here the molt limits of Swainson's thrush wing are inspected, identifying it as a second-year (one-year-old) bird.

Table of direction and significance in adult population trends for 13 species of regional conservation concern on six US Forest Service National Forests in Washington (*), and Oregon for which species-landscape models were constructed. The direction of the trend is indicated as decreasing (-) or increasing (+), and significance is indicated by multiple plus or minus characters (e.g. + non-significant, ++ 0.05≤P<0.10, +++ 0.01≤P<0.05, and ++++ P<0.01). The total numbers of effectively monitored species and the numbers of declining trends (and statistically significant trends) are given for each national forest and migration category with the overall totals of declining and increasing trends. The species of forest-specific management concern are shown shaded.

Species of regional conservation concern	**Specific Name**	**MOUNT BAKER***	**WENATCHEE***	**UMATILLA**	**WILLAMETTE**	**SUISLAW**	**FREMONT**
Neotropical migrants							
Hammond's flycatcher	*Empidonax hammondii*	-	+	---	+++		++
"Western" flycatcher	*E. difficilis / occidentalis*	-			-	---	+
Warbling vireo	*Vireo gilvus*	+	-	----	+		-
Swainson's thrush	*Catharus ustulatus*	++	+	---	+	+	
MacGillivray's warbler	*Oporornis tolmiei*	-	-	---	-		+
Wilson's warbler	*Wilsonia pusilla*	+	+	-	+++	+	-
Chipping sparrow	*Spizella passerina*		-	---			
Lincoln's sparrow	*Melospiza lincolnii*		---	-	-		-
Short-distance migrants							
Chestnut-backed chickadee	*Poecile rufescens*	-	+++		-	-	
Winter wren	*Troglodytes troglodytes*	-		+++	++	-	
Song sparrow	*Melospiza melodia*	+	--		+++	+	
Dark-eyed junco	*Junco hyemalis*	-	++	---	-		++
Pine siskin	*Carduelis pinus.*		+	-	---		-
Number of species of management concern		3	4	8	4	3	2
Total declining		6	5	9	6	3	4
Total increasing		4	6	1	6	3	4

Species of management concern were identified for six national forests in Washington (2 forests) and Oregon (4 forests). Each species of regional conservation concern is identified as a species of management concern on one or more national forests. Overall, the ratio of declining to increasing populations of management concern is near unity except for Umatilla N.F. where 9 out of 10 species experienced declines. The proximal cause of these declines may be linked to recent extensive pest outbreaks but requires further investigation.

Using a state-of-the-art statistical approach, we combined multiple regression analyses with model selection by an information complexity criterion (Bozdogan's ICOMP). From these analyses we constructed 78 demographic-landscape models relating to numbers and trends of adults and young, and reproductive success. We interpreted these models to formulate management guidelines designed to help foresters reverse population declines in species of management concern.



Map of locations of MAPS stations on 7 national forests in Washington (2), Oregon (4), and Montana(1) where landbird species of conservation concern were monitored between 1992 and 2001.

Species-landscape models revealed important predictors of avian demographics among the 13 species of management concern. Overall, selected models for forest-dwelling species suggest that management plans should aim to conserve large areas of contiguous forest (upwards of 900 ha) in a 1256 hectare, 2-kilometer radius area. Clearly, within those forested areas, canopy cover, as well as the density of undergrowth and ground cover, should be managed in a manner consistent with published microhabitat management procedures for each target species. Riparian, deciduous, and edge habitat also emerged as important components of several species' habitat requirements.

Hammond's flycatcher. Management for this species should be directed at maintaining high reproductive success. To maintain healthy and productive Hammond's flycatcher populations, land managers should create a shifting mosaic of successional or low canopy cover habitat (covering 10-20%) within extensive uniformly shaped coniferous forest or woodland covering 80-90% of each 1000 hectares. Because reproductive success responds negatively to stream density such management would be best applied to the drier high elevation coniferous stands.

"Western" flycatcher. Our results strongly suggest that "western" flycatcher is sensitive to proximal edges (and/or patch size dependency) of coniferous habitat. It may be sensitive to increased risks of nest predation and parasitism. The numbers of young and reproductive success (young per adult) are higher at those stations associated with a high total core area of coniferous forest habitat totaling some 900 of 1250 hectares (72%). Large tracts of old-growth forests (large core areas of evergreen forest) and dry-upland and riparian sites (thinner canopy and some mixed habitats) are beneficial to the reproductive success of "western" flycatchers.

Warbling vireo. Healthy vireo populations are associated with large tracts of coniferous forest, with forest-successional and forest-grassland edge components. This suggests that creation of regeneration gaps could create productive habitat. However, the pattern of the logging may be important. Our results suggest that at high elevations, large tracts of open coniferous forest interspersed with larger patches of successional habitat create good vireo breeding habitat.

Chestnut-backed chickadee. Our results suggest that chestnut-backed chickadee populations are best managed through the creation or maintenance of open (thin-canopied) forest and forest-successional habitat edge, especially at higher elevations where pest damage was high. However, extensive riparian habitat, as reflected in stream density, was associated with increasing trends in the numbers of young and with reproductive success.

Other research suggests that a) pest infestation is a natural process that later improves overall forest health and timber quality, and b) the increased magnitude and extent of bark beetle damage at higher elevations is likely a result of recent climate change and reduces the core area of forests and canopy cover. Our results show strong positive correlations between mean elevation, the extent of successional habitat ($P<0.05$), and cumulative bark beetle damage ($P<0.005$). The effects of pest outbreaks on forested habitat may be another factor in the observed patterns of chickadee demographics.

Winter wren. Whereas higher populations and greater reproductive success of winter wrens are associated with large areas of evergreen forests, population sizes and reproductive success seem to be increasing over time in areas that were classified approximately ten years ago as thinner

forest with successional habitat and a deciduous component. These results suggest that the best way to manage for winter wrens would be to maintain large uniformly shaped patches of thinner-canopy evergreen forests in stream-dense areas. In addition, smaller patches of mixed or deciduous forests (associated with riparian areas and covering greater than 10% of the area) should be maintained.

A Lincoln's sparrow being carefully handled at a Pacific Northwest training session held prior to the MAPS season.

Swainson's thrush. Our models clearly indicate that within coniferous forests large patches (representing 10% or more of the landscape) of dense, low-elevation, deciduous and mixed-deciduous forests, with high canopy cover (i.e. mature lowland forests), are required to maintain healthy adult populations of Swainson's thrushes. However, young and reproductive success benefit from large patches (>200 hectares or 16%) of more open deciduous and mixed habitat forests. The selection of strongly correlating total core area variables in these models supports previous findings of "edge sensitivity" for this species. This emphasizes the need to conserve large tracts of contiguous forest in lowland areas where moister forests and riparian areas occur. However, the presence of grassland and successional habitat is deleterious to population dynamics. These results suggest that the riparian buffer zone management, currently being implemented across the region, should lead to increases in Swainson's thrush populations.

MacGillivray's warbler. Our results suggest that MacGillivray's warbler is best managed at higher elevations by maintaining large patches of successional habitat interspersed among low to medium canopy cover coniferous forest. Such a coarsely grained habitat should feature extensive successional habitat-forest edge. Although no strong correlations were found between stream density (indicative of the extent of riparian or meadow habitat) and demographic variables, stream density was generally high among the stations used in this study.

Wilson's warbler. Our results suggest that the important habitat components for adult Wilson's Warbler abundance are most closely associated with deciduous habitats with lots of successional habitat edge. However, our models also suggest that reproductive success was higher in successional habitats where the adults were less common. Therefore, riparian management zones do not appear to be as important to Wilson's Warblers as extensive high canopy cover deciduous forests. However, if the riparian management zone includes areas of deciduous forest we predict that it will be beneficial to this species. Overall, we recommend the maintenance of high canopy cover deciduous or mixed forest cover in excess of 60% and narrow successional habitat cover in excess of 4%.

Chipping sparrow. Overall, chipping sparrow models were weak but suggested that the maintenance of a coarse grained, heterogeneous forested landscape featuring larger patches of successional habitat and grassland should benefit chipping sparrow populations.

Song sparrow. Song sparrows appear to be edge-sensitive, thus maintaining or creating large patches of low canopy cover evergreen forest in stream-dense areas should benefit adult and young populations and lead to high reproductive success. The results also suggest that defoliation events may help create suitable habitat for song sparrows by thinning the canopy. The extent of successional habitat should be kept at less than 3%. It is possible that mechanical canopy thinning may also benefit song sparrow populations. Grazing exclusion and creek restoration will help restore higher elevation song sparrow habitat.

Lincoln's sparrow. Maintaining coarse grained habitat heterogeneity (meadow and successional) among high elevation moist coniferous forests is beneficial to this species. At these elevations, frequent natural disturbances such as defoliation events may be responsible for the development of dense scrubby patches and edge habitats where Lincoln's sparrow prefers to breed. Adults responded negatively to grassland area but young responded positively. Larger patches appear to represent better quality habitat in which individuals produce more offspring, whereas smaller patches are available to non-breeders or less fit individuals. This situation results from an ideal despotic distribution which is commonly associated with population dynamics of many sparrow species.

Dark-eyed junco. Maintaining coarse grained heterogeneity among drier, high elevation coniferous forests is beneficial to this species. At these elevations, frequent natural disturbances such as defoliation events may be responsible for the development of dense scrubby patches and edge habitats where junco populations appear to thrive. However, some populations thrived in managed areas where a mosaic of larger regeneration cuts had been created.

Pine siskin. , Maintaining large contiguous (low levels of fragmentation) tracts of drier, high-elevation, coniferous forests is beneficial to this species. At these elevations, recent frequent natural disturbances such as pest infestation may have been responsible for the development of dense scrubby patches and edge habitats where siskin populations appear not to thrive as well as they do in "healthy" forests. In fact, cumulative pest damage was significantly ($P<0.05$) higher, by a factor of approximately 2.4, among the stations used in the siskin study than they were at the other 23 stations.

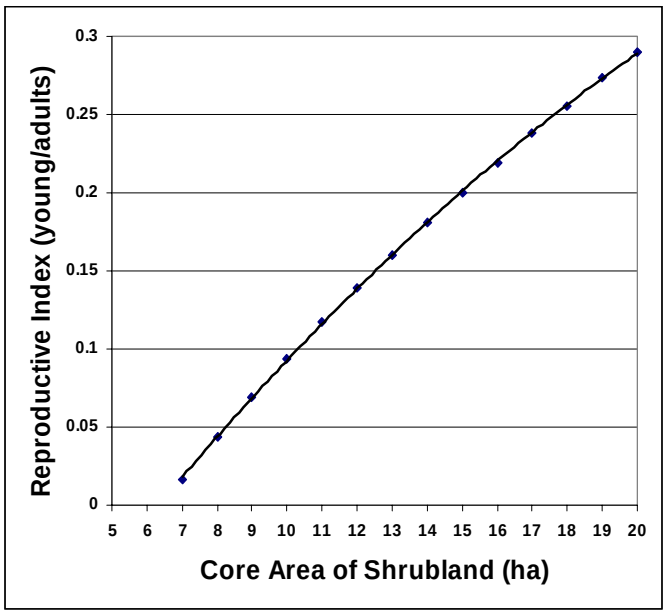
In summary, healthy populations of these 13 species of management concern depend upon differing landscape-scale factors. Some species, like Hammond's flycatcher, depend upon the presence of contiguous coniferous forest with varying degrees of canopy cover. Other species, such as "western" flycatcher and winter wren, depend upon the sensitive forested riparian habitats. At higher elevations moist forest-meadow complexes are critical to species like MacGillivray's warbler and song sparrow. Also, at higher elevations, forests affected by defoliating insects and beetles appear to benefit chestnut-backed chickadee, song sparrow and dark-eyed junco reproductive success.

At higher elevations, a coarse-grained, habitat heterogeneity of forest, successional-shrubland, and grassland-meadow naturally occurs. This provides quality breeding habitat for several species including chipping sparrow and pine siskin. Habitat edges in these and other managed landscapes are ecologically important components in the population dynamics of several species. More importantly, specific pairs of habitats that make an edge may be a preferred habitat component. For example, warbling vireo reproductive success responded positively to forest-successional and forest-grassland edges. Other species, including Swainson's thrush and chestnut-backed chickadee, responded negatively to forest-grassland edge.

A dense and diverse understory of broadleaf shrubs, ferns, and forbs typifies the structure of a late-successional Douglas fir forest monitored by MAPS in Siuslaw National Forest and provides foraging and nesting habitat for many species of concern.

In this study, demographic monitoring and species-landscape modeling have revealed important ecological relationships for 13 species of conservation concern. From these models we can predict the effects of proposed forest management on populations of multiple breeding species. Furthermore, it is possible to spatially extend these models to map potential habitat for a particular species across an entire national forest.

Applying species-landscape models to landbird conservation efforts on national forests can theoretically be a relatively simple process. In the following hypothetical example we consider how to increase "western flycatcher" reproductive success at a Siuslaw MAPS station (Crab Creek) where the adult population is in decline and reproductive success is low.



One component of a three-parameter species-landscape model for "western" flycatcher showing that reproductive success increases as a function of the core area of shrubland (as classified in USFS canopy cover dataset) habitat). The values of the two other parameters remained constant.

The species-landscape model chosen for "western" flycatcher reproductive success (shown above) features three parameters and corresponding regression coefficients: NLCD coniferous forest core area (0.167), USFS shrubland core area (0.150), and shrubland-grassland edge (-0.192).

In this model reproductive success increases as a function of increasing shrubland core area while all other parameter values remain unchanged. Currently, the mean reproductive index at Crab Creek is 0.083, compared to a studywide mean of 0.21, and the landscape features some 10 hectares of shrubland habitat. In order to increase reproductive success to the level of the studywide mean we need to increase the shrubland core area by approximately five hectares to 15 hectares to attain a reproductive index of 0.24.

A forest manager would apply these models in the following manner:

- identify a target species of management concern in an area of the forest.
- using GIS, spatially analyze the existing 2-kilometer radius to obtain estimates of spatial parameters relevant to the target species.
- estimate the expected mean and trajectory of reproductive success, numbers of adults, and numbers of young.
- using GIS, simulate the proposed management actions (e.g. deforestation) within the existing 2-kilometer radius landscape.
- repeat steps two and three to obtain "new" estimates of demographic parameters.
- Evaluate the demographic predictions relative to management goals.

This process allows managers to assess the likely effects of alternative proposed management actions on the species of management concern.

Five regional spatial datasets were used in this study and all have proved useful in quantifying ecological relationships for avian demographics among 13 species of regional conservation concern. In addition, our novel GIS based Unique Combination Edge Model (UCEM), has revealed important ecological relationships among a few species.

Riparian habitat within the boundaries of a MAPS station in Siuslaw national forest. Floodplain grassland and shrubs form edges with coniferous woodland. A number of diseased and dead trees (center and rear) provide food, nest sites, and perches for breeding birds.

The UCEM model was applied to the USFS canopy cover dataset to quantify the amount of edge between forest, shrubland or successional, and grassland or meadow habitats. These proved to be useful predictive variables. For example, MacGillivray's warbler and Wilson's warbler demographics both responded to a specific type of edge habitat.

Sustainable forest management in the Pacific Northwest is crucial to preserving quality breeding habitat for many songbirds, including Neotropical migrants. The models constructed in this research can act as guidelines to the potential effects of spatially extensive forest management on songbird populations. These include "area" effects on forest birds such as "western" flycatcher, for which a reduction of the size of forested patches can cause a reduction in the population size. For other species, such as warbling vireo and Swainson's thrush, these models emphasize the importance of the type of habitat edge as predictors of reproductive success.

Trees killed by western spruce budworm in Cedar Creek, Okanogan National Forest. Defoliating insects provide ample food (and nest sites) for breeding songbirds. Photo courtesy of David McComb, USDA Forest Service.

Future landbird monitoring efforts on Pacific Northwest national forests should focus on the effects of land management on species of conservation concern that are declining across individual forests or ranger districts. Ideally, the network of MAPS stations should be extended to embrace other species of concern for which insufficient data exists (e.g. dusky flycatcher). However, a number of existing stations will be maintained to provide long-term background data.

In future years we plan to implement an adaptive management approach whereby we move existing stations to recently (or soon to be) managed areas unless management in the vicinity of existing stations is already approved and imminent. The new stations will monitor the "effectiveness" of the management in improving the health of the local population of a species of management concern.

To assess the effectiveness of the management we will compare observed demographic changes with the predictions of our models. Furthermore, to obtain information more quickly we should adopt a space-for-time substitution whereby new stations will be located in areas of different post-treatment age (e.g. one year post clearcut, three years post clearcut, etc.).

Future research could be directed at a number of ecological issues in Pacific Northwest national forests. For instance, our results suggest that grazing activity suppresses reproductive success. Further investigations of the effects of grazing exclusion on demographics of species that nest in riparian shrub habitat should be conducted. Furthermore, existing data may allow us to document avian community changes following pest outbreaks around many stations.

Although the research reported here has revealed important species-landscape relationships, it is essential to map temporal changes in land use, vegetation health, and a suite of environmental variables in order to explain the remaining variation in the species-landscape models.

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