Monitoring for Adaptive Management in Coniferous Forests of the Northern Rockies[1]

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Abstract

Monitoring can and should be much more than the effort to track population trends; it can be a proactive effort to understand the effects of human activities on bird populations. It should be an integral part of the adaptive management process. With this in mind, the Northern Region Landbird Monitoring Program has a dual focus: (1) to monitor long-term bird population trends, and (2) to study bird-habitat relationships and management effects. By conducting permanent, long-term monitoring transects every other year, we are free to use the intervening years to study the effects of specific management activities. The coordination and funding is in place to achieve an impressive degree of replication in such studies. These alternate-year monitoring efforts have great potential to get management-oriented results into the hands of managers in the short term, so planning can be improved before long-term trends might reveal a problem. We have conducted several such projects, including the effects of partial-cut logging in coniferous forests, and the effects of grazing on willow-riparian bird communities. We discuss here another such project that we initiated in 2001, on bird responses to dry-forest restoration in the northern Rockies. Ponderosa pine (*Pinus ponderosa*) stands have been greatly altered from historical conditions due to logging and fire suppression. Active treatment of ponderosa pine forests to reverse historical trends is a recent management direction involving well-financed, regionally coordinated restoration efforts. The widespread distribution and abundance of planned treatments provided a unique opportunity for a controlled research design (with high replication), including pre- and post-treatment surveys. We present some preliminary results and discuss their relevance to adaptive management.

Key words: forest, habitat relationships, management, monitoring, restoration

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Introduction

"*Monitoring is thus the cornerstone of adaptive management; without monitoring we cannot learn and cannot adapt*." Noss and Cooperrider (1994, p. 300).

The goal of bird conservation requires at least three major processes that are integral to the Partners in Flight agenda: To increase our knowledge of the ecological requirements of bird species, to use this knowledge to implement appropriate management and restoration activities, and to monitor the effects of those activities. A program that integrates these elements into one collaborative process can be said to be practicing adaptive management (Walters 1986, Lee 1993).

Adaptive management has been defined in many ways and used in many contexts (Gray 2000). It often refers to policy decisions covering multiple resources and balancing the needs of multiple stakeholders over large-scale management areas (e.g., Stankey and Shindler 1997). Here we use the term *adaptive management* on a smaller scale, referring to any process that monitors the effects of management practices and uses that information in future management decisions.

In developing the Forest Service's Northern Region Landbird Monitoring Program (NRLMP), we have felt from the beginning that a monitoring program should involve both the tracking of long-term population trends and the description of habitat associations and land-use effects (Hutto and Young 2002). A program that relies entirely on the monitoring of long-term population trends will always be reactive. The monitoring of long-term trends is useful for discovering whether populations are in decline, but not very useful for discovering the reasons behind such declines. Monitoring can and should be much more than the effort to track population trends; it can be a much more proactive effort to understand the effects of human activities that may persist or increase in intensity or extent over time. Habitat association data can help us move beyond long-term population trend monitoring, which most of us equate with the word "monitoring." Perhaps most importantly, habitat association data can be used to anticipate problems, thereby allowing an agency to modify its activities through a process of adaptive management.

The NRLMP involves breeding-season monitoring of all diurnal (primarily forest) landbird species that can be detected through a single (point-count) methodology. The dual focus of the NRLMP is to produce short-term results on habitat relationships and management effects as well as long-term population trend data. By conducting permanent, long-term monitoring transects on an alternate-year basis, we are free to use the intervening years to study the effects of management activities. The coordination and funding is in place to efficiently survey a large number of sites across the region—a level of replication almost never achieved in published studies (see summary of the usual levels of replication in Sallabanks et al. 2000). These alternate-year monitoring efforts have the potential to be a very powerful way to get management-oriented results into the hands of managers in the short term, so planning can be improved before long-term trends might reveal a problem.

As an example of one of the alternate-year studies of management effects, we discuss here a study we initiated in 2001 on avian species' responses to dry-forest restoration in the northern Rockies. Dry forest habitat types historically and currently represent a major forest cover type in Montana and the American west. Dry forest types are distributed widely throughout the interior west, and are found at lower to middle elevations on both public and private lands. Forest stands dominated by ponderosa pine (*Pinus ponderosa*) represent approximately 35 percent of the commercial forestland in the American west, or about 12 million ha (Barrett 1979). Timbered, dry sites comprise two million out of 10 million total ha in Forest Service Region One.

Prior to European settlement, fire intervals in the dry forest types of Montana ranged from 5 to 45 yrs depending on elevation, local climate, and the extent of fire initiation by Native Americans (Fischer and Bradley 1987, Arno 2000). These frequent fires were usually of low intensity and promoted a forest structure of open, uneven-aged stands dominated by large ponderosa pines by selectively killing the more fire-sensitive young Douglas-fir (*Pseudotsuga menziesii*). Understory development was dominated by grass species with shrub undergrowth generally sparse (Arno et al. 1997). Stands of large ponderosa pine historically dominated most dry forest sites in western Montana. It should be noted, however, that it is still not known how much variation existed in tree densities and fire regimes on these sites (Baker and Ehle 2001).

Human intervention in the form of fire suppression has had a dramatic effect on existing vegetation, allowing forest succession to progress unimpeded toward climax vegetation. The absence of fire has permitted relatively shade-tolerant and fire-vulnerable Douglas-fir and grand fir (*Abies grandis*) to become a significant portion of the species composition of many of these sites (Fischer and Bradley 1987). The major change common to most dry forest types (especially ponderosa pine) in Montana and elsewhere in the American west is a profound alteration in age-class structure, physical structure, tree density, and tree species composition as a result of logging and fire suppression (Arno et al. 1997, Covington and Moore 1994). Stands that were largely dominated by mature and old-growth trees in an open-parkland setting have been changed to abnormally dense stands dominated by younger trees. Douglas-fir regeneration in the understory has created a fire ladder, greatly increasing the potential of stand-replacement crown fires (Fischer and Bradley 1987; Saab and Rich 1997).

Active treatment of ponderosa pine forests to reverse historical trends is a recent phenomenon. From 1997 to 1998, the area treated with logging and understory burning increased in Forest Service Region One from approximately 18,000 to 24,000 ha. Under a tentative two-decade plan (USDA Forest Service 1998), the area to be treated with both logging and understory burning will rise to 70,000 ha annually in Region One, with an additional 30,000 ha to undergo solely mechanical treatment. Under the tentative plan, approximately half of the estimated 1.7 million dry-forest ha on Forest Service land in Montana would be treated to restore historic conditions during a 20-yr cycle. These major restoration activities in Montana and northern Idaho complement similarly well-financed and regionally coordinated efforts in Regions 2, 5, and 6 (Colorado, California, Washington, and Oregon). The extreme forest fire seasons of 2000 and 2002, when millions of acres burned throughout the western United States, have greatly increased the perception that we need active management of dry forests and have virtually assured increased funding for such activities (USDA Forest Service and Department of the Interior 2000, U.S. Office of the President 2002).

The goal of this project is to collect and develop information on avian species' response to guide management of dry forests in Region One and the west. By combining survey efforts across the multiple national forests and other land types in Region One, we can gain important insight into the health of dry forests, identify universal and site-specific features to guide restoration, and identify the most effective techniques for active land management and the conservation of avian habitats. Specific objectives are to

1) compare the effects on bird populations of dry-forest restoration treatments and the naturally-caused low-to-moderate-severity fires they are intended to mimic

2) determine the relationship of vegetation structure and plant species composition to bird populations within and among untreated, treated, and naturally-burned sites

3) compare vegetation structure, components, and plant species composition among treatment types

Methods

We selected study sites in stands of mature forest that contained ponderosa pine mixed with Douglas-fir or grand fir. Habitat types were represented by dry Douglas-fir and grand fir habitat types that contain ponderosa pine as the major seral or climax associate. Western larch (*Larix occidentalis*) is potentially a co-dominant on some sites under consideration. We chose three categories of sites for comparison in this study: 1) 30 control sites, slated for future treatment, containing either significant fire-ladder fuels or encroachment by medium- or smaller-diameter trees; 2) 11 treated sites that had been logged, underburned, or a combination of logging and underburning to reduce fuels and approximate the more open structural conditions that existed historically; and 3) 19 sites that were naturally underburned during the 2000 fire season.

The study design was developed to maximize opportunities for statistical comparison for a single field season or for multiple field seasons. All untreated sites are targeted for treatment within the next few years, and at least half will be treated before the final bird surveys. Statistical analyses will allow us to compare bird responses to 1) different treatment categories within one year, 2) pre- and post-treatment conditions at the same sites in multiple years, and 3) continuous variables within and among treatment types

A controlled experimental design, especially one utilizing pre- and post-treatment testing (BACI), minimizes the potential effect of confounding variables due to differences in environmental conditions among sites and the surrounding landscapes.

The bird survey design we used on this and other impact assessment studies is a little more intensive than the single-visit methods we use for the long-term monitoring. We surveyed multiple points per site (usually five) and visited each site three times per year, a design similar to the habitat-based protocol of Huff et al. (2000). The multiple-visit protocol improves the accuracy of habitat association analyses by increasing the probability of detecting an individual when it is present (Thompson and Schwalbach 1995). We placed most of the survey points away from roads, and we also collected more extensive habitat data.

The bird survey technique followed recommendations established by participants in the national point count workshop (Ralph et al. 1995). A description of the point count method also can be found in Hutto et al. (1986). Field technicians conducted 10-minute point counts at each of the sampling points in a site, recording all birds seen or heard within the count period. We use 10-minute counts to decrease variability due to observer skill levels and bird detectability (Hutto and Young 2002). They surveyed each site three times (occasionally two) during the breeding season from the third week of May through the second week of July, in the first five hours after sunrise, and not when there was continuous rain or high winds.

Results

We surveyed 60 sites: 19 were natural underburns, 11 had received recent restoration treatments, and 30 were untreated dry forest sites that are to be treated in the future. We anticipate that at least 9 or 10 of those sites will be treated before we survey them again in 2003 and 2005.

We detected 75 bird species, with 43 species detected on at least six (10 percent) of the sites (*table 1*). The canopy cover was reduced by about the same amount (relative to the controls) in the restoration treatments as in the natural underburns (*fig. 1a*). The understory cover, especially of deciduous shrubs, was lowest in the natural underburns (*fig.1b*). Species that typically respond negatively to thinning of the tree canopy, such as Townsend's Warbler (*Dendroica townsendi*; *fig. 2a*) and Golden-crowned Kinglet (*Regulus satrapa*), had a negative response to both treatments in this study. Most of the species that differed in abundance between the restoration treatment and the natural underburns were species associated with shrubs, such as Swainson's Thrush (*Catharus ustulatus*; *fig. 2b*), MacGillivray's Warbler (*Oporornis tolmiei*), and Warbling Vireo (*Vireo gilvus*). These were probably responding to the lower shrub cover in the natural burns (*fig. 1b*).

Discussion

Preliminary results showed that the responses of most species were similar to those found in other data on the effects of forest thinning from the NRLMP (Young and Hutto 2002). There was some indication that the restoration treatments provided similar habitat to the natural underburns that they are intended to mimic. This suggests that the restoration treatment may be at least superficially successful as a management practice.

The lower coverage of understory shrubs in the natural underburns may have accounted for most of the differences in bird populations between the treatments. The surveys in the natural underburns were conducted less than a year after the fires occurred, so the understory vegetation had no chance to recover. As the understory recovers, the differences between the treatments (both birds and vegetation) may lessen. On the other hand, the open understory in the first couple of years after a natural underburn may be critical for such ground-foraging species as the Townsend's Solitaire, which was the only species that was significantly more abundant on natural underburns than on restoration treatments.

Table 1— *Relative abundances of birds among dry-forest controls, restoration treatments, and natural underburns in the northern Rockies. This table includes the 43 species (in taxonomic order) that were detected on at least 6 (10 percent) of the sites in 2001.*

	Abundance per 100 points		
Species	**Control**	**Treated**	**Natural**
Ruffed Grouse, *Bonasa umbellus*	3	0	2
Williamson's Sapsucker, *Sphyrapicus thyroideus*	2	3	3
Red-naped Sapsucker, *Sphyrapicus nuchalis*	2	9	1
Hairy Woodpecker, *Picoides villosus*	4	11	7
Northern Flicker, *Colaptes auratus*	7	17	16
Pileated Woodpecker, *Dryocopus pileatus*	6	1	3
Hammond's Flycatcher, *Empidonax hammondii*	14	66	23
Dusky Flycatcher, *Empidonax oberholseri*	7	12	6
Cassin's Vireo, *Vireo cassinii*	36	5	4
Warbling Vireo, *Vireo gilvus*	3	18	10
Gray Jay, *Perisoreus canadensis*	10	3	6
Steller's Jay, *Cyanocitta stelleri*	1	1	3
Clark's Nutcracker, *Nucifraga columbiana*	53	18	7
Common Raven, *Corvus corax*	3	3	1
Black-capped Chickadee, *Poecile atricapillus*	26	48	8
Mountain Chickadee, *Poecile gambeli*	23	48	36
Chestnut-backed Chickadee, *Poecile rufescens*	4	0	0
Red-breasted Nuthatch, *Sitta canadensis*	112	122	59
Brown Creeper, *Certhia Americana*	6	8	2
Winter Wren, *Troglodytes troglodytes*	3	1	3
Golden-crowned Kinglet, *Regulus satrapa*	14	4	5
Ruby-crowned Kinglet, *Regulus calendula*	19	26	23
Townsend's Solitaire, *Myadestes townsendi*	5	13	22
Swainson's Thrush, *Catharus ustulatus*	52	38	17
Hermit Thrush, *Catharus guttatus*	0	0	7
American Robin, *Turdus migratorius*	27	72	39
Cedar Waxwing, *Bombycilla cedrorum*	3	14	0
Orange-crowned Warbler, *Vermivora celata*	13	9	7
Nashville Warbler, *Vermivora ruficapilla*	7	8	1
Yellow-rumped Warbler, *Dendroica coronata*	99	98	87
Townsend's Warbler, *Dendroica townsendi*	50	20	18
MacGillivray's Warbler, *Oporornis tolmiei*	18	7	8
Western Tanager, *Piranga ludoviciana*	75	87	75
Spotted Towhee, *Pipilo maculatus*	4	12	4
Chipping Sparrow, *Spizella passerina*	47	57	59
Dark-eyed Junco, *Junco hyemalis*	54	81	77
Black-headed Grosbeak, *Pheucticus melanocephalus*	6	1	1
Lazuli Bunting, *Passerina amoena*	1	0	9
Brown-headed Cowbird, *Molothrus ater*	11	20	1
Cassin's Finch, *Carpodacus cassinii*	0	1	3
Red Crossbill, *Loxia curvirostra*	23	79	13
Pine Siskin, *Carduelis pinus*	24	80	27
Evening Grosbeak, *Coccothraustes vespertinus*	8	5	0

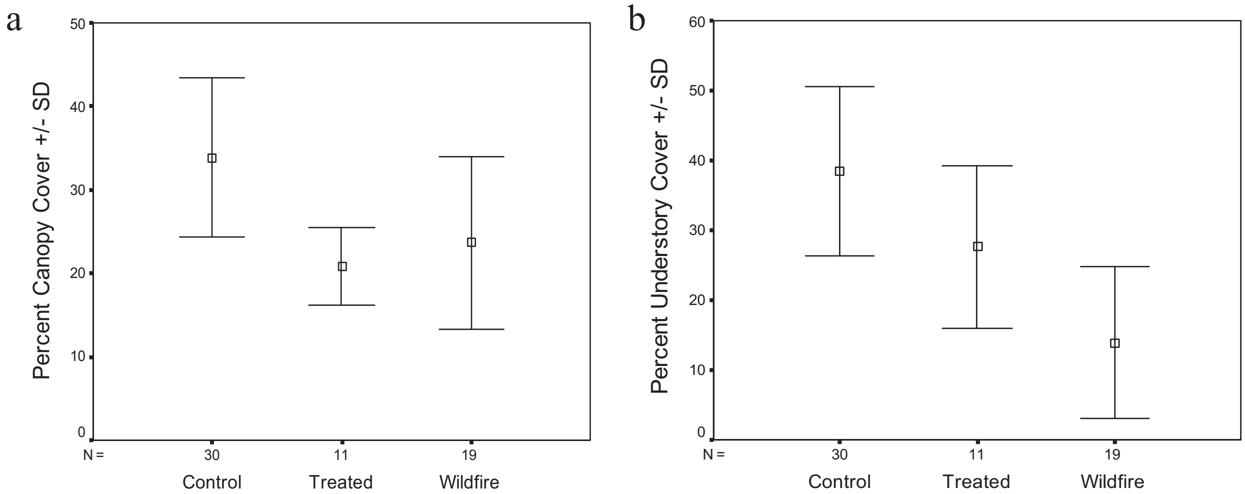

Figure 1— Means and standard deviations of ocular estimates for the percent cover of vegetation in dry-forest controls, restoration treatments, and natural underburns in the northern Rockies in 2001: a) tree canopy cover, b) total shrub and sapling understory cover.

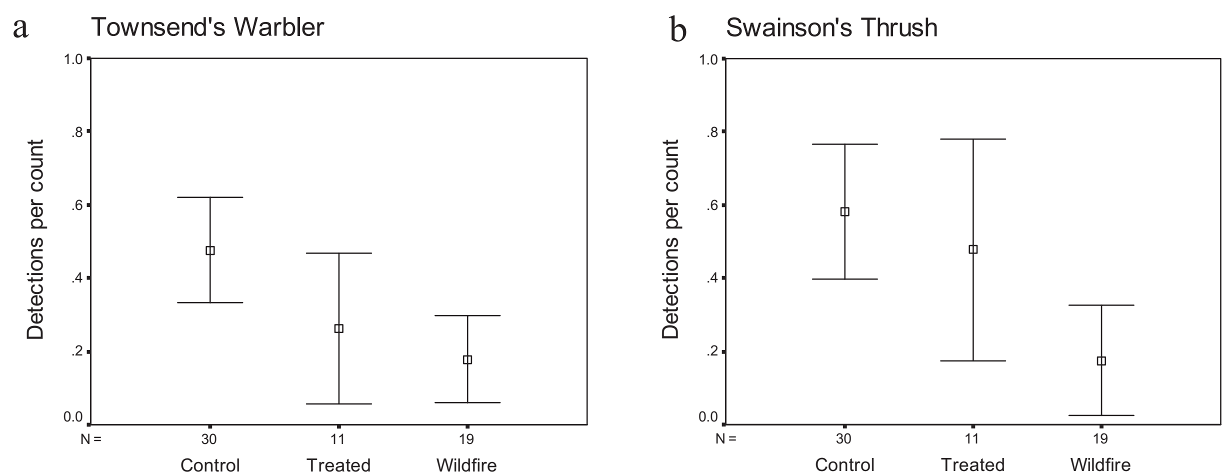

Figure 2— Means and 95 percent Confidence Intervals of the number of detections per count in dry-forest controls, restoration treatments, and natural underburns in the northern Rockies in 2001: a) Townsend's Warbler; b) Swainson's Thrush.

Bird species typically associated with denser, more mesic conifer forests were negatively affected by restoration treatments. However, treatments applied to dry forests should not greatly reduce the overall populations of these species, the bulk of which occur in those mesic forests. On the other hand, if thinning and other fuels-reduction treatments were applied to those more mesic forests as well as to the drier, lower elevation forests, then such activity would begin to negatively affect many bird species that need the denser forests.

Any conclusions should wait for the completion of the study, however. We hope to be able to get before-and-after data on at least 10 sites that are scheduled for treatment in the next couple of years. We will survey all of the sites again in 2003 and probably at a later date as well. Further data collection also will help to clear up immediate post-treatment complications such as site fidelity and vegetation recovery.

We feel that incorporating impact assessment studies into monitoring programs in this way greatly strengthens the scientific worth of, and political support for, the program. It allows anticipation of problems and, therefore, is proactive and fulfills some of the promise of adaptive management (McLain and Lee 1996). Such studies can be done separately, but under our design the coordination and funding are in place to efficiently survey many replicates across the region. It also turns out to be the strongest selling point for the program in many cases, interesting agencies in participating that would be reluctant to sign on to a purely long-term monitoring scheme.

We recognize that we have not yet achieved the full process of adaptive management. We have meetings in which biologists and managers determine management activities in need of evaluation. However, for the most part we are monitoring the effects of management treatments that are already planned. We also are not explicitly comparing different ways of reaching the management goal. Most importantly, however, we do not have a formal process by which the results of the study are applied directly toward planning of future management activities.

If there is one weakness associated with adaptive management in practice, it is the lack of a formal involvement of monitoring participants in the adaptive management loop, where participants have a chance to present results that might bear on future land-use plans. Although "monitoring is at the core of adaptive management and essentially synonymous with effective decision making" (Mulder and Palmer 1999; p. 6), our monitoring results are not yet formally integrated into the decision-making process. Instead, most of our findings that have influenced policy have done so because the information filtered informally into management circles. Even worse, we observe way too often that environmental impact statements and subsequent management decisions are clearly made without all of the available scientific information.

There needs to be a more formalized method for direct communication between the actual decision-makers and reputable biologists with access to the latest research and monitoring data. Ultimately, monitoring should be part of an adaptive management cycle that involves

1) gathering data on long-term population trends and short-term land-use effects

2) informing planners of results

3) discussing whether results merit a change in land-use plans

The last step could be in the form of interdisciplinary team meetings or some other process. We do not know what the best method will turn out to be, but we believe that this issue must be addressed if we are to fulfill the promise of adaptive management and conservation biology.

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