Functional Relationships among Songbirds, Arthropods, and Understory Vegetation in Douglas-fir Forests, Western Oregon

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Joan C. Hagar

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Chapter 1

INTRODUCTION

Vegetation structure and composition are among the most important features believed to influence habitat selection by birds (Cody 1985) and the relationships between the distribution and abundance of birds and habitat features have long been a focus of avian ecological research (Holmes 1981, Block and Brennan 1993). While correlations between bird community and vegetation characteristics have been widely established, underlying causal factors rarely have been identified (Holmes 1981). Vegetation structure and composition usually are proximate indicators of the availability of the resources, such as food and nesting sites, which ultimately affect survival and reproduction (Hilden 1965). Relationships between vegetation structure and bird density can be obscure and unpredictable because birds do not usually respond directly to the variables chosen by human observers to quantify habitat (Morse 1985). More direct measurements of resources, such as arthropod biomass available to insectivorous birds, may better predict habitat use than variables that describe vegetation (Brush and Stiles 1986). Even when bird abundance may be well correlated with vegetation structure, management strategies based solely on assumed associations with vegetation may fail to meet all habitat requirements unless functional relationships underlying the observed correlations are understood (Holmes 1981). For example, availability of nesting sites as indicated by habitat structure may not necessarily also reflect suitable foraging habitat (Weikel and Hayes 1999). Therefore, evaluation of habitat on the basis of vegetation structure may be unreliable unless associations between wildlife and vegetation are based on a detailed knowledge of species-specific resource requirements (Van Horne 1983).

Our knowledge of the response of birds to management practices in western forests is based largely on correlations between bird abundance and vegetation structure, suggesting a strong need for more information on functional relationships.

Several studies have addressed the effects of forest management on the potential for nesting success (e.g., Chambers 1996, Hanski et al. 1996, Schmiegelow 1997), but few studies have directly examined how management practices influence food availability for forest birds (Hagar 1992, Weikel and Hayes 1999, Hagar 1960). Food availability is a basic, critical habitat component that often limits the reproductive success and survival of breeding birds (Martin 1987), and is therefore a key factor in habitat selection and use (Block and Brennen 1993). Although most bird species may not be directly associated with particular plant species, they may be linked to certain plant taxa through their insect prey (Recher et al. 1991, Robinson and Holmes 1984) because many forest insects select specific host plant species (Edwards and Wratten 1980). Holmes and Shultz (1988) provided evidence that the structure of forest bird communities is associated with variation in types and abundances of arthropod prey among tree species in eastern hardwood forests. While some studies have examined bird diets in western coniferous systems (Beaver and Baldwin 1975, Otvos and Stark 1985), few have related food resources for birds to vegetation composition. Knowledge of bird diets may allow identification of plant species that are important in supporting food resources, establishing a functional link between vegetation and habitat.

An understanding of functional relationships among organisms also may facilitate the implementation of ecosystem management and help managers achieve goals related to the maintenance of biodiversity. Managers faced with the challenge of managing biodiversity often lack information and a good framework for assessment and monitoring. The mandate to manage for biodiversity may well seem logistically and fiscally overwhelming if each species must be considered independently. Furthermore, no species is independent of its community, but rather is related to other species through a web of interactions. As Noss (1990) points out: "… processes such as interspecific interactions … are crucial to maintaining biodiversity." Besides being logistically and fiscally unfeasible, enhancing diversity one species at a time is unlikely to be successful unless relationships among organisms are understood. Trophic interactions or food webs are one of the important ecosystem processes that link many organisms. Because energy stored by plants is passed through the ecosystem by a series of consumers, changes in vegetation may influence organisms at all trophic levels. In spite of the importance of basic trophic processes in maintaining ecosystem functions, little is known about how forest practices are likely to affect organisms at the lowest trophic levels, and how these effects will move through food chains. A food web approach to understanding functional relationships between birds and habitat could facilitate management for biodiversity because it links the habitat requirements of multiple species.

In recent years, an emphasis on managing for timber production on public forested lands of the Northwest has shifted to the more holistic approach of ecosystem management (Kohm and Franklin 1997). Ecosystem function and performance has been linked to biodiversity (Schulze and Mooney 1993, Tilman and Downing 1994, Naeem et al. 1994), making the maintenance of biodiversity central to ecosystem management (Temple 1997). Information on biodiversity is therefore a high priority need, especially for federal land managers faced with implementing the Northwest Forest Plan (NWFP; Muir et al. 2002). Goals of the NWFP include promoting biodiversity in both designated reserves and in stands managed for timber production (USDA and USDI 1994). Young (<100 years) forests currently occupy much of the land under the jurisdiction of the NWFP. There are two main challenges involved with the management of these young stands to achieve the biodiversity goals of the NWFP. First, managers are concerned with the immediate need to promote and restore biodiversity. Young stands that are the legacy of past clear-cut harvesting often lack the structural heterogeneity of natural stands (Hansen et al. 1991), and are therefore biologically depauperate. One important structural feature that is typically not well developed in dense young stands is understory vegetation. Secondly, managers need tools for accelerating the development of late-successional habitat in reserves that are currently occupied by young forest. Partial harvests such as thinning and group selection are among the practices being developed to simultaneously manage forests for biodiversity and timber production (McComb et al. 1993, Chambers 1996, Carey et al. 1999b). These practices have the potential to increase structural diversity by increasing the availability of light and other resources for vegetation below the forest canopy.

However, partial harvests traditionally have been used for timber production, and their use as tools for managing wildlife habitat needs to be refined. Predicting the response of understory vegetation, and hence forest bird communities, to partial removal of overstory cover is complicated by the interaction of many variables, including harvest intensity, time since harvest, and stand history.

I chose to investigate the relationship of forest understory to food resources for songbirds in order to contribute information on the effects of forest management on biodiversity. My research links three important components of biodiversity in Pacific Northwest forest ecosystems: understory vegetation, arthropods, and songbirds. Understory vegetation represents a large portion of the plant diversity in Pacific Northwest forest (Halpern and Spies 1995). Arthropods contribute hugely to biodiversity on regional and global scales. This contribution comes not only from the overwhelming taxonomic richness of arthropods, but also from the diverse and critically important roles arthropods perform in ecosystem functioning (Kim 1993). However, little is known about arthropod assemblages on understory vegetation in western coniferous forests. Several species of birds are associated with shrubs and understory vegetation (Morrison and Meslow 1983, Marshall et al. 2003). Bird species that primarily nest and forage in the forest understory are among those that respond positively to commercial thinning in western Oregon coniferous forests (Hagar 1992, Hagar and Howlin submitted, Hayes et al. 2003). I hypothesized that forest management may influence food resources for these species via the following pathways. Forest practices that reduce overstory cover can influence cover, density, and frequency of understory shrubs (Bailey et al. 1998, Klinka et al. 1996), which in turn is likely to influence the diversity and biomass of shrub-dwelling arthropods (Humphrey et al. 1999, Jokimaki et al. 1998). Changes in abundance and species composition of arthropod communities in turn may influence the distribution and abundance of avian insectivores (Brush and Stiles 1986).

In this work, I compare the abundance and explore habitat relationships of several species of shrub-associated birds among stands with varied structural characteristics reflecting different silvicultural histories (Chapter 2). In Chapters 3 and 4, I describe the foraging patterns and diets of shrub-associated birds in order to establish which food resources are important and which plant species support them. I focus primarily on food resources for Wilson's warblers and Swainson's thrushes. Both of these species nest and forage in dense thickets of shrubs in forest understories. In Chapter 4, I also describe the patterns of distribution of arthropod prey and other food resources on common understory plant species, and the influences of forest management on these resources. Chapter 5 addresses factors influencing the abundance of aerial prey for Wilson's warblers and other bird species that feed on airborne arthropods.