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Wildlife species associated with non-coniferous vegetation in Pacific Northwest conifer forests: A review

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Abstract

Non-coniferous vegetation, including herbs, shrubs, and broad-leaved trees, makes a vital contribution to ecosystem function and diversity in Pacific Northwest conifer forests. However, forest management has largely been indifferent or detrimental to shrubs and trees that have low commercial value, in spite of a paradigm shift towards more holistic management in recent decades. Forest management practices that are detrimental to broad-leaved trees and shrubs are likely to decrease habitat diversity for wildlife, but the number of species that may be affected has not previously been enumerated. I reviewed life history accounts for forest-dwelling vertebrate wildlife species and derived a list of 78 species in Oregon and Washington that are associated with non-coniferous vegetation. The diversity of direct and indirect food resources provided was the primary functional basis for associations of most species with non-coniferous vegetation. Thus, a diversity of herbs and broad-leaved trees and shrubs provides the foundation for food webs that contribute to diversity at multiple trophic levels in Pacific Northwest conifer forests. Given the number of species associated with non-coniferous vegetation in conifer-dominated forests, maintaining habitats that support diverse plant communities, particularly broad-leaved trees and shrubs, will be an important component of management strategies intended to foster biodiversity. Silvicultural practices such as modified planting densities, and pre-commercial and commercial thinning, can be used to control stand density in order to favor the development of understory herbs, shrubs, and a diversity of tree species within managed stands. Allowing shrubs and hardwood trees to develop and persist in early seral stands by curtailing vegetation control also would benefit many species associated with non-coniferous vegetation.
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1. Introduction

Management and research of forest ecosystems has been mainly preoccupied with overstory trees, particularly conifers, since they are dominant structures and represent a major portion of the economic value of forests. Consequently, past forest management practices in the Pacific Northwest have emphasized conifer establishment and dominance, often to the detriment of other vegetation. Early, shrub-dominated stages of forest succession, which typically support higher animal diversity than other stages (Harris, 1984; Hall et al., 1985), have been truncated by management practices that promote early establishment of conifers on forestlands managed for timber production (Hansen et al., 1991). Vegetation management and narrow spacing of conifer seedlings serve to reduce competition from other species (Walstad and Kuch, 1987), producing young, closed-canopy second-growth across thousands of hectares in the Pacific Northwest. This forest condition is productive from a timber management perspective, but the homogeneous structure supports low diversity of wildlife (Hayes et al., 1997).

In the past decade, management objectives for public forests in the Pacific Northwest have expanded beyond simply achieving commercial goals, to encompass a broad suite of resources and ecosystem functions, including native biodiversity. Along with this paradigm shift, recognition of the contribution of non-coniferous vegetation to biodiversity and ecosystem function has been increasing. Herbs, shrubs, and broad-leaved trees not only represent a large portion of the plant diversity in Pacific Northwest forests (Halpern and Spies, 1995), but also have important ecosystem functions, including nutrient cycling, carbon sequestration, and contributions to soil fertility (Nilsson and Wardle, 2005; Chastain et al., 2006). Broad-leaved tree species, such as red alder (*Alnus rubra*) and bigleaf maple (*Acer macrophyllum*), also function in nutrient cycling, and influence soil fertility, aquatic food webs, and

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wildlife habitat (McComb, 1994; Bunnell et al., 1999; Compton et al., 2003; CFER, 2005). Furthermore, non-coniferous vegetation is a source of structural complexity at multiple spatial scales. Structural complexity contributes to the maintenance of biodiversity by providing a diversity of habitat niches for organisms (Carey, 2003; Lindenmayer et al., 2006). At the scale of forest stands, the presence of non-coniferous habitat elements such as broad-leaved trees and shrubs has been associated with richness and/or abundance of bird (Huff and Raley, 1991; Hagar et al., 1996; Willson and Comet, 1996a, 1996b), herpetofaunal (Gomez, 1992), and mammal communities (Carey and Johnson, 1995; Gomez and Anthony, 1996) in northwest forests. Patches of non-coniferous vegetation on the landscape, such as seral stands of shrubs, alder, cottonwood, or aspen, provide unique resources that contribute to beta diversity. Non-coniferous vegetation makes significant contributions to structural and compositional diversity throughout all stages of forest development.

In spite of a paradigm shift to more holistic ecosystem management of forests, current policies and practices still tend to overlook the importance of non-coniferous vegetation in meeting goals related to sustainability and biodiversity. State and federal reforestation standards continue to promote conifer dominance by specifying minimum stocking densities of commercially valuable tree species and limited time frames within which seedlings must be "free to grow" (out-competing other vegetation; Adams, 1996; Washington DNR, 2005). These standards apply to forests burned by wildfire as well as to harvest units. In addition, a current focus of management on federal (USDA and USDI, 1994) and state lands (McAllister et al., 1999) is the restoration of old forest structure, primarily emphasizing the large-tree component of these forests. This approach is in danger of neglecting both early seral stages dominated by shrubs or deciduous trees (Kennedy and Spies, 2004), and the non-conifer understory components of mature forests. Although much of the concern in recent decades over threats to biodiversity has centered on loss of old-growth forest habitat, floristically diverse early seral stages, which can support a very high diversity of plant and animal species (Harris, 1984; Hall et al., 1985), also are jeopardized by forest practices that promote rapid conifer dominance after disturbance (Hansen et al., 1991). Finally, conversion of hardwood-dominated riparian areas to conifers may have negative consequences for some hardwood-associated species, and for biodiversity in general, but these effects have not been well studied (CFER, 2005). As a result of these and other management practices, shrub and hardwood tree cover, in at least some parts of the Pacific Northwest, has declined over the past five decades (Kennedy and Spies, 2004). Loss of non-coniferous vegetation from coniferous systems poses a threat to biodiversity (Bunnell et al., 1999; Koivula et al., 1999; Hanley, 2005).

Although there is general recognition that achieving diversity goals for wildlife requires managing for a diversity of habitats, there seems to be a lack of clarity regarding interpretations of "structural complexity" and "understory vegetation". Terms such as "vertical and horizontal heterogeneity", "structural complexity," and "biocomplexity" have been used to describe conditions of forest stands that are desirable for fostering faunal diversity (Carey, 2003; Lindenmayer et al., 2006). But definitions for these concepts that would allow managers to translate them into on-the-ground practices at appropriate spatial scales are needed. Foresters often use the term "understory" to describe regenerating conifers, whereas other vegetation is referred to as "brush" (as demonstrated by a search for the term "brush" on the Society of American Foresters webpage). Thus, silviculturists may encourage the development of understory conifer seedlings and saplings when implementing plans to increase stand structural diversity (e.g., Newton and Cole, 2006). But few studies have addressed whether a forest stand that has multiple layers of coniferous foliage would support as diverse a wildlife assemblage as one with non-coniferous vegetation occupying mid- and understory layers. More explicit information on the elements of stand compositional and structural complexity that are important in meeting the habitat requirements of forest-dwelling species would help managers draft prescriptions for promoting biodiversity.

In this paper, I provide a review of habitat associations of terrestrial vertebrates with non-coniferous vegetation in Pacific Northwest conifer forests. Although habitat associations vary regionally, the contribution of a diverse flora in supporting a diversity of wildlife has been recognized for various forest types throughout the Pacific Northwest (Bunnell et al., 1999). I primarily focus on moist and montane forests in Oregon and Washington as examples of regions where forest management effects on non-coniferous vegetation are likely to have an important influence on wildlife diversity. Information on wildlife associations with habitat that is specific to a region can assist managers in refining strategies for maintaining biodiversity. While many studies have documented associations of individual species with broad-leaved trees, understory shrubs, ferns, herbs, or other vegetation, a compilation of the existing data is needed to emphasize the importance of these habitat elements based on the diversity of wildlife species they support. Bunnell et al. (1997) provided a brief overview and extensive list of terrestrial vertebrate species that use broad-leaved tree and shrub habitats in Oregon, including species that are not closely associated with conifer forest habitats. My emphasis in this paper is different because I wanted to provide information on habitat associations with non-conifer vegetation in both Oregon and Washington, and to highlight the species most likely to be affected by forest management. Therefore, the information I compiled in this paper focuses on species for which conifer forests provide primary habitat. Another goal of this review was to explore the functional bases underlying species associations with particular types of vegetation.

2. Methods

To derive a comprehensive list of species associated with non-coniferous vegetation, I queried the database compiled by Johnson and O'Neil (2001) for species associated with shrub