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The Management of Insects, Diseases, Fire, and Grazing and Implications for Terrestrial Vertebrates using Riparian Habitats in Eastern Oregon and Washington

Abstract

Riparian habitats in eastern Oregon and Washington compose a small percentage of the landscape, and yet these habitats are essential for many species of vertebrates. Riparian areas are sensitive to disturbance agents, which can pose a formidable challenge to effective management of these habitats. Moreover, few studies have documented the effects of disturbance agents on riparian habitats and associated fauna. In general, disturbances from insects and disease likely have strong effects on cavity nesters and insect feeders, and use of Bt (*Bacillus thuringiensis*) to control insect pests decreases the food supply for insectivores. Most fire effects on terrestrial vertebrates are through changes in habitat, food, and competitors, and responses to fire are variable and species specific. Salvage logging likely has negative effects for species that use dead and dying trees. Livestock grazing in riparian areas can eliminate nesting substrates, alter habitat structure and composition, compact soil, trample banks, encourage cowbird expansion, and increase exotic plants. The magnitude of these effects depends on the timing and intensity of grazing. There are almost no studies on how landscape-level vegetation patterns (including riparian corridors) contribute to the viability of wildlife populations. Managers have usually chosen to buffer riparian areas from harvest, spraying, and prescribed fire, but there are no decision-support tools or guidelines for management of riparian habitat for terrestrial vertebrates.

Introduction

Riparian habitats occupy less than 1% of the landscape of the western United States (Knopf et al. 1988), yet these areas are used disproportionately more by amphibians, birds, and mammals (Thomas et al. 1979). The biological and physical diversity, and availability of water within riparian areas leads to high levels of plant and invertebrate diversity and biomass (grasses, forbs, shrubs, and trees), which provide forage and breeding areas for numerous terrestrial vertebrates. In addition, soils in riparian areas are generally coarse in texture and more friable than in upland areas (Roberts et al. 1977) facilitating burrowing by small mammals, amphibians, and reptiles. Riparian areas may also function as dispersal and migration corridors, as well as refugia for upland species when upland habitat experiences a major disturbance such as fire (Kelsey and West 1998).

Riparian areas, like upland areas, have been altered by many forest management activities and disturbances; timber harvest, grazing, fire suppression, road-building, conversion to agriculture, water diversions, and insect and disease outbreaks have had strong influence on riparian conditions. These activities and disturbances have changed the vegetative structure of the riparian areas and presumably the vertebrate diversity within these areas.

Other articles in this issue provide additional information specific to terrestrial vertebrates of conservation concern (Bull and Wales 2001a, 2001b; Bull et al. 2001). Kie and Lehmkuhl (2001) provide a description of the effects of ungulates on and from forest health issues and practices.

Insects and Disease

Living trees with decay, hollow trees, trees with brooms, dead trees, and down woody material can all derive from processes associated with the activity of insects and wood-decaying fungi. All these structures provide important foraging, denning, roosting, and resting habitat for numerous wildlife species (Bull et al. 1997). Defoliating insects and bark beetles are two major groups of insects that play important ecological and economic roles in the forests of the Northwest. Torgersen (2001) and Hayes and Daterman (2001) describe the ecology and management issues relating to these insects more thoroughly (also see Jaindl and Quigley 1996).

Insectivorous birds play an important ecological role in regulating insect abundance (Crawford et al. 1983, Morrison et al. 1990, Machmer and Steeger 1995). In addition, attempts to control major outbreaks of defoliating insects like the western spruce budworm and Douglas-fir tussock moth have resulted in millions of hectares of aerial treatment with chemical and biological insecticides since 1947 (Dolph 1980, Sheehan 1996). These suppression activities in some cases have been shown to cause negative effects to many non-target species (Miller 1990, Fuxa et al. 1998, Scott 1999). Currently, the most common insecticide being used by the Forest Service is *Bacillus thuringiensis* (Bt), which may negatively affect non-target Lepidoptera, with ensuing effects on insectivorous vertebrates that rely on Lepidoptera as prey (Miller 1990, Fuxa et al. 1998, Scott 1999). Studies show a significant decrease in the richness or abundance of non-target lepidoptera larvae during the year of treatment (using Bt), but with recovery to pretreatment levels in 1 to 2 years for most species (see USDA Forest Service 2000 for a review). A significant decrease in larval populations following treatment does not mean that all lepidopteran larvae are eliminated from the site. It does suggest that there would be fewer larvae available, and that animals, such as birds, feeding on these larvae would either search longer, or switch to other available food sources. Recommendations by Hammond and Miller (1998) and Hall et al. (1999) include options for treating some areas of high lepidopteran populations with virus or leaving some untreated host areas to minimize the effect on non-target lepidopteran populations. Studies on the effects of reduced food levels on birds and bats resulting from applications of Bt are few and show variable effects (Gaddis and Corkran 1986, Gaddis 1987, Rodenhouse and Holmes 1992). Also, riparian areas are generally not treated, owing to a variety of biological and hydrological concerns.

Removal of dead and dying trees has been used both as a tool for suppression of episodic insect and disease events, especially to prevent outbreaks of bark beetles (Gast et al 1991), and for economic benefit post-outbreak. However, little research on the effects of this removal on vertebrates in riparian areas has been conducted, particularly following insect- or disease-induced tree mortality. It is likely that vertebrates that use dead and dying trees for any of their life functions will be negatively affected by the removal of a substantial percentage of these structures.

Fire

Few studies have quantified or qualified differences in the effects of fire between upland and riparian areas. Recently Olson (2000) found that there was little difference in the fire frequencies between riparian and upland areas in similar forest types of the Blue Mountains in Oregon. Smith (2000) presents a thorough overview and description of the effects of wildland fire on fauna at varying landscape scales. Little research exists regarding the effects of prescribed fire on vertebrates, though Tiedemann et al. (1999) describe some potential effects. Consequently, most information presented here refers to effects of wildfire on wildlife species. Effects of fire on terrestrial vertebrates, especially birds, has been reviewed by many authors (Bendell 1974, McMahon and deCalesta 1990, Dobkin 1994, Hejl 1994, James and Hess 1994, Hejl et al. 1995, Hutto 1995, Patton and Gordon 1995, Rotenberry et al. 1995, Ganey et al. 1996, Finch et al. 1997, Russell et al. 1999, Smith 2000; also Fire Effects Information System 1996, Prescribed Fire and Fire Effects Research Work Unit, Rocky Mountain Research Station, www.fs.fed.us/database/feis [1998]). Although direct effects of fire on individuals, including mortality or reduced reproduction (loss of nests), have been documented (Bendell 1974, Singer and Schullery 1989, Patton and Gordon 1995, Rotenberry et al. 1995), more typically the effects of fire are indirect as manifested through habitat modifications, changes in food supply, or changes in abundance of competitors (Rotenberry et al. 1995, Smith 2000).

The response of vertebrates to fire is highly variable and species-specific. The effect depends on the pre-fire condition, the extent and intensity of the fire, and the species' natural history. Species that depend on snags, logs, cavities, or insects typically respond positively in the short term because of the increase in nesting substrates and food (Blackford 1955, Stoddard 1963, Koplin 1969, Bock and Lynch 1970, Kilgore 1971, Lowe et al. 1978, Overturf 1979, Taylor and Barmore 1980, Granholm 1982, Harris 1982, Raphael et al. 1987, Hejl 1994, Hejl et al. 1995, Hutto 1995, Sallabanks 1995, Caton 1996, Hitchcox 1996, Saab and Dudley 1998). By contrast, foliage nesting and foliage-gleaning species decrease initially after a fire (Bock and Lynch 1970, Overturf 1979, Granholm 1982, Wirtz et al. 1988, Sallabanks 1995). However, the grasses, forbs, and shrubs in post-fire areas, stimulated by a flush of nutrients, provide important niches for species associated with early-seral vegetation. Ottmar and

Sandberg (2001) summarize the function and effects of fire on vegetation.

Loss of cover from fire can cause decreased protection from predators for small mammals, which may lead to a reduced density of small mammals in burned areas, at least in the short term (Blankenship 1982, Vacanti and Geluso 1985, Groves and Steenhof 1988). Pearson (1999) provides a review of the natural histories and effects of some disturbance processes on small mammals, including a summary of fire effects. Predators of small mammals may also decline, depending on the intensity of the fire, presumably because of a reduction in prey (Groves and Steenhof 1988, Bevis et al. 1997).

Though little information is available on the response of amphibians and reptiles to fire or post-fire habitats, Russell et al. (1999) describe the current state of knowledge and the implications for management. Reptiles and amphibians may hide in mud, water, under surface objects, or underground during fires (Kahn 1960, Komarek 1969, Lillywhite and North 1974). Post-fire habitats may negatively affect reptiles and amphibians in the short term due to loss of litter and forage (Spellerberg 1975, McLeod and Gates 1998).

Information is scarce on the response of wildlife to fire suppression or alternative silvilcultural treatments involving fire and mechanical/manual "fire surrogates" designed to restore ecological integrity. The recently-initiated national Fire/Fire Surrogate study, and other studies such as a study initiated on the Payette NF with the Rocky Mountain Research Lab and the University of Idaho, Boise, should help provide information on the effects of these alternative treatments on wildlife (Saab et al. 2000, Weatherspoon et al. 2000).

The effect of salvage harvesting in post-wildfire habitats has been summarized in a literature review and annotated bibliography by McIver and Starr (2000). The effects of salvage logging on wildlife will vary significantly, depending on the post-fire conditions and the amount and pattern of salvage logging that occurs. Species that depend on dead and dying trees will be most negatively affected due to removal of some or all of these structures, while species that use more open habitats may benefit from logging. Post-fire habitats, particularly large snags generated from fire or pre-fire legacies that remain, provide essential niches for some wildlife species (Caton 1996, Hitchcox 1996, Hejl and McFadzen 1998, Saab and Dudley 1998).

Grazing

Livestock grazing is the most widespread land management practice and has the most widespread influence on native ecosystems of western North America (Wagner 1978, Crumpacker 1984, Fleishner 1994). Cattle graze disproportionately in and around riparian zones (Ames 1977, Kennedy 1977, Thomas et al. 1979, Samson 1980, Roath and Krueger 1982, Van Vuren 1982, Gillen et al. 1984, Willard 1990, Kauffman et al. 2001). Fleischner (1994) and Belsky et al. (1999) provide a thorough literature review and synthesis of the ecological costs of livestock grazing in western North America. Krausman (1996), though directed more towards rangeland wildlife, provides a useful reference for the interactions of grazing effects on many species of wildlife that use riparian habitats. Livestock grazing can change the composition and quantity of habitat, cause soil compaction and streambank trampling, and facilitate the introduction of exotic plants (Knopf and Cannon 1982, Clifton 1989, Holecheck et al. 1989, Platts and Nelson 1989, Trimble 1994). As with the effects of fire, the influence of livestock grazing on riparian habitats and species is species-specific. Many studies have shown significantly higher density and diversity of birds in ungrazed riparian areas (Mosconi and Hutto 1982, Crouch 1982, Taylor 1986, Szaro and Rinne 1988). However, not all research shows a negative response by species in relation to grazing (e.g., Mosconi and Hutto 1982; Medin and Clary 1990, 1991; Schulz and Leininger 1991; Saab et al 1995; Saab 1998). In general, habitat generalists usually increase with grazing pressure while those species dependant on loose soil, litter, or understory plants for feeding or nesting are negatively affected (Rucks 1978, Schultz and Leininger 1991, Bock et al. 1992, Saab et al. 1995, Finch et al. 1997, Saab 1998). Bird species associated with shrubs and grasses declined in areas of livestock grazing, while canopy- and cavity-nesters remained the same or even increased (Bock et al. 1992, Saab et al. 1995, and Saab 1998).

Small mammals can be negatively affected by soil compaction, loss of herbaceous cover, and reduced forage, especially forb species, as a consequence of grazing by livestock (Johnson 1982, Kauffman et al. 1982, Cornely et al. 1983, Medin and Clary 1989, Schulz and Leininger 1991, Fagerstone and Ramey 1996). In Idaho, Leege et al. (1981) found litter to be an important habitat component for many small mammals, reptiles, and amphibians, with litter biomass twice as high in livestock exclosures as compared with grazed areas. Bull and Hayes (2000) showed no conclusive negative effects caused by grazing on Columbia spotted frogs; however, the timing and intensity of grazing was not differentiated and varied widely.

The timing and intensity of livestock grazing determine the magnitude of effect on riparian vegetation (Milchunas and Lauenroth 1993). Yearlong and growing-season (spring–summer) grazing are particularly damaging to riparian vegetation (Kauffman and Krueger 1984, Platts 1991) and the associated bird communities (Crouch 1982). Short-term spring grazing may be preferable to summer grazing, owing to the presence of succulent upland vegetation during spring that decreases grazing pressure on riparian vegetation (Clary and Webster 1989, Platts 1991). However, soil compaction and direct disturbance to nesting vertebrates from livestock may be most severe during spring (Saab et al. 1995). Most browsing damage to willows (*Salix* spp.) occurs during late summer and fall (Kauffman et al. 1983, Clary and Webster 1989, Sedgwick and Knopf 1991, Kovalchik and Elmore 1992). Light-to-moderate autumn grazing appears to have the least effect on numbers of migratory birds during the breeding season (Kauffman et al. 1982, 1983; Sedgwick and Knopf 1987; Knopf et al. 1988; Medin and Clary 1991). Controlling fall-winter grazing enhances residual plant cover needed to maintain streambanks during spring run-off (Clary and Webster 1989).

In some areas, degraded riparian areas may require complete rest from livestock grazing to initiate the recovery process. The necessary length of rest will vary depending on the extent of damage and growth rate of regenerating plant species (Clary and Webster 1989). Skovlin (1984) recommended a 5-year rest followed by proper livestock management. Use of native plant species to revegetate and rehabilitate riparian areas increases restoration effectiveness for wildlife habitats.

Several studies have quantified the effects of widespread and rapid increase of willow, cottonwood, alder, and other understory herbs and shrubs following cessation of livestock grazing in riparian areas (Marcuson 1977, Busse 1989, Schulz and Leininger 1990, Case 1995, Green and Kauffman 1995, Kauffman et al. 1997). In areas of reduced grazing pressure (light–to-moderately grazed areas; 3 weeks annual grazing late in the season), Green and Kauffman (1995) showed positive trends in willow density and height; recovery rates, however, were significantly less than those in the ungrazed areas. Krueper (1993) showed a dramatic increase in bird species and densities in an area closed to domestic livestock for 4 years in New Mexico. Beschta et al. (1991) and Kauffman et al. (1993) suggest that the cessation of livestock grazing in riparian zones of eastern Oregon was the single most ecologically and economically effective approach for restoring salmonid habitats.

An additional negative effect associated with grazing of non-native ungulates is the potential to increase abundance of brown-headed cowbirds, a prolific nest parasite of numerous bird species. Morrison et al. (1999) and Rothstein (1994) describe the causes and consequences of the range expansion of brown-headed cowbirds over the last century. Cowbirds generally forage in disturbed sites near livestock and breed in forests and riparian areas where passerine densities are high (Robinson et al. 1995). Little information is available on cowbird populations, parasitism rates, host selections, and host nesting success in the Northwest.

We know very little about how landscape-level mosaics and patterns of vegetation (including riparian corridors) contribute to the viability of wildlife populations. Almost no studies have been conducted at large landscape scales on this topic, presumably owing to the inaccuracy of methods used to characterize and monitor fine-scale riparian conditions across large areas. For example, Wisdom et al. (2000) identified 82 non-fish vertebrate species of conservation concern in the Interior Columbia Basin that depend largely on riparian or wetland habitats. However, Wisdom et al. (2000) could not analyze habitat conditions for these species because of lack of methods to accurately estimate fine-scale conditions, like those of riparian habitats, across large landscapes. The need for large-area assessment of riparian conditions for riparian-dependent vertebrates remains an important, unmet need for research and management across the Interior Columbia Basin and most other areas of North America. Furthermore, there are no decision-support tools or management guidelines designed specifically in regards to restoring, or maintaining habitat quality and quantity for terrestrial vertebrates in riparian areas.

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Note

This special issue of *Northwest Science* is a set of papers reviewing the state of knowledge about disturbance processes in eastern Oregon and Washington, related management practices, and effects on key management issues.