

The Effect of Invasive and Noxious Plants on Land Management in Eastern Oregon and Washington

Abstract

A key issue for forest and rangeland health and productivity in eastern Oregon and Washington is invasive species. Although some exotic plant introductions were accidental, many were intentional for wildlife habitat improvement, ornamental purposes, wood or fiber production, soil conservation, livestock forage production, or other crop uses. Exotic species, or weeds, can be a significant component of global environmental change because of their potential to alter primary productivity, decomposition, hydrology, nutrient cycling, and natural disturbance regimes. At smaller scales, they alter the structure, composition, and successional pathways of ecosystems. They lower diversity by out-competing native plants. Disturbance caused by forest restoration activities (thinning and prescribed fire) can promote weed spread, but ultimately will improve native plant diversity and productivity, improving ecosystem resistance to weed invasion. Restoration strategies need to include consideration of weed prevention and control and restoration of natives. Prevention includes restoring ecosystem processes; control includes biological, manual, mechanical, herbicidal, and prescribed burning methods; restoration involves returning native plants to a site. Monitoring is important to provide managers with information that will allow them to evaluate restoration activities and modify ineffective restoration approaches.

Introduction

Movement of plant species from one continent to another and within continents has become a common phenomenon (Baker 1986, Karl et al. 1996, Toney et al. 1998). Although many of these "exotic" plants have been introduced accidentally, a large majority were introduced intentionally for wildlife habitat improvement, ornamental purposes, wood or fiber production, soil conservation, livestock forage production, or other crop uses and then escaped into native plant communities. These introduced plants are often referred to as weeds. Whether introduced accidentally or intentionally, weeds often interfere with other land management objectives, and their establishment or spread can be exacerbated by land management activities. This document provides an overview of the effects and management of weeds in relation to current forest restoration practices in eastern Oregon and Washington.

Ecologically, weeds are considered those species that colonize or pioneer open or disturbed habitats, largely resulting from human activities (Baker 1965, Baker 1986, Taylor 1990). In some definitions, a weed does not need to be exotic, but only "a plant growing where it is not desired, or a plant out of place" (Ashton and Monaco 1991) or "a plant that interferes with management objectives for a given area of land at a given point

in time" (Whitson et al. 1992). When a weed has substantial environmental or economic effect, government agencies declare them "noxious weeds." For the purposes of this synthesis, weeds are considered those exotic (non-native) plants that colonize disturbed habitats or invade undisturbed native plant communities and may have deleterious effects on native plants, wildlife, crops, or livestock (Harrod et al. 1996b). It is important to note the distinction between those species that colonize and those that invade. Invaders are exotic species that invade native plant communities even in the absence of intense or frequent disturbance, while colonizers tend to occupy sites with intense or frequent disturbance (Bazzaz 1986).

Invasions of weeds have been numerous during the 20th century throughout the Columbia Basin (Karl et al. 1996, Quigley and Arbelbide 1997) including eastern Oregon and Washington. There are an estimated 862 exotic plant species in the Columbia Basin and these species represent anywhere from 43% (Quigley and Arbelbide 1997) to <20% (Kartesz and Meacham 1999, Pimentel et al. 2000) of all the exotic plants in North America (north of Mexico) (see <http://invader.dbs.umt.edu>, 2001). In the Blue Mountains of eastern Oregon and Washington, Harrod et al. (1996b) list 65 species legally declared by both state and federal agencies as "noxious weeds," which are more than

half those listed for the entire 5-state region of the Columbia Basin (Quigley and Arbelbide 1997). The number of species present, the continued spread of weeds throughout the region, and the potential for new introduction is of great concern for many land managers.

There are many reasons why weeds are of concern to land managers. From a broad perspective, Vitousek et al. (1996) consider the invasion of exotic plants (weeds) a significant component of global environmental change. The authors pose this argument because of the potential for weeds to alter ecosystem processes such as primary productivity, decomposition, hydrology, nutrient cycling, and natural disturbance regimes. Furthermore, weeds can alter the structure, composition, and successional pathways of ecosystems at various smaller scales (Harty 1986, Vitousek 1986, Hobbs and Huenneke 1992, Harrod et al. 1996a, Quigley and Arbelbide 1997). For example, cheatgrass (*Bromus tectorum*) has invaded and become dominant in several locations through eastern Oregon and Washington, changing the potential vegetation at the landscape scale (300,000 to 400,000 ha) to an exotic type rather than a native type (Quigley and Arbelbide 1997). Once established, cheatgrass can dramatically increase fire frequency, which can lower native species diversity (Bunting 1991, Billings 1994). At the scale of a site (up to 400 ha), weed species such as purple loosestrife (*Lythrum salicaria*) can displace whole native wetland communities (Thompson et al. 1987). Such whole community replacements have cascading effects on other components of wetland ecosystems, such as the displacement of migratory and passerine birds, and small mammals (Thompson et al. 1987).

Regardless of scale, one of the most important effects of weeds is decreased biodiversity (Soulé 1990, Asher 1993, Harrod et al. 1996a, Karl et al. 1996), particularly species diversity as cited above. Many weeds out-compete native species by strongly exploiting available resources (e.g. salt-cedar (*Tamarix* spp.) and Russian olive (*Eleagnus angustifolius*) (Vitousek 1986)) or by reducing native species fitness through allelopathy (diffuse knapweed, *Centaurea diffusa*) (Muir and Majak 1983) or other interactions, such as decreasing important mycorrhizal fungi (e.g. cheatgrass) (Goodwin 1992). Many weeds often lack insects or pathogens that keep populations smaller in their native environments (often Euro-

pean or Asian countries); having few native predators or pathogens gives weeds a competitive advantage over many native species. In general, weeds often have a number of life history characteristics that allow them to out-compete native species (Baker 1965), thus lowering species diversity for a given site.

Weeds are spread by the steady advancement of a population or the establishment of satellite populations away from an original center (Baker 1986). Weed seeds are adapted to facilitate one of these two patterns, but many species in eastern Oregon and Washington are efficient dispersers and routinely establish satellite populations (Harrod et al. 1996b). Seeds of weeds in the sunflower family (Asteraceae) are often provided with a feathery parachute allowing seeds to be carried by wind. Some species, such as tumbleweed (*Salsola kali*), become severed at ground level when seeds are mature and the whole plant tumbles in the wind scattering seeds over great distances. Mammals or birds are often important seed vectors. For example, Wallander et al. (1992) found that mule deer (*Odocoileus hemionus*) passed 21% of spotted knapweed (*C. maculosa*) consumed, some as many as 10 days after the initial ingestion. Roché (1992) notes that yellow starthistle (*C. solstitialis*) may be dispersed by birds. However, humans are by far the most efficient dispersers of weeds (Harrod et al. 1996b, Vitousek et al. 1996). Plant parts or seeds are carried by automobiles, machinery, crop seed, or stock feed. Collecting and transporting plants such as baby's breath (*Gypsophila paniculata*) for floral trade can also spread weeds. Sheep and cattle can carry seeds in hair or digestive tracts and deposit them along driveways or in new pastures. Roads, railways, irrigation ditches, trails, and logging skid trails are also common dispersal avenues for weeds (Harrod et al. 1996b).

Weed Management

Weed management can and should be an important aspect of present-day forest management. Currently in eastern Oregon and Washington, restoration efforts are focused on thinning and prescribed burning within dry forests, which have become susceptible to catastrophic wildfires and large-scale insect and disease epidemics because of the dense forest structure that resulted from a century of fire exclusion and past management

practices (Agee 1994, Hessburg et al. 1994, Jensen and Everett 1994, Johnson 1994, Quigley and Arbelbide 1997). The goal of current forest management is to create sustainable ecosystems by restoring the inherent composition, structure, and disturbance regime (USDA 1996, Agee 1998, Harrod et al. 1999). Weeds have changed the composition and often the disturbance regime of many forest ecosystems. Therefore, weed management is an important and integral part of forest restoration (Harrod 1994). A generalized objective of present-day management might be the development of healthy plant communities that are relatively weed-resistant (Sheley et al. 1996).

Current forest restoration strategies can have two primary effects on weeds. First, there is the potential for the continued spread of weeds or the introduction of new satellite populations of weeds. Sites recently disturbed by logging and road building provide suitable habitat for many weed species (Vitousek et al. 1996), and weeds may become established if a seed source is available. However, the outcome of forest restoration can help prevent weed invasion as well. It has been suggested that thinning and burning will increase the diversity and productivity of native species in dry forest ecosystems (Covington et al. 1997). Therefore, the second effect of restoration activities is improved diversity and productivity of native plant communities, which are likely to be more resistant to weed invasion (Elton 1958, MacArthur 1970, Crawley 1986, Case 1990, Law and Morton 1996, Tilman 1997, Levine and D'Antonio 1999, but see Huston 1997, Higgins et al. 1999, and Stohlgren et al. 1999).

A strategy for weed management in eastern Oregon and Washington is needed given both potential positive and negative effects of forest restoration treatments on weeds. A successful weed management program would likely be interagency (Harrod et al. 1996b) and integrate weed management tactics into a long-term strategy for dealing with weeds (Ashton and Monaco 1991, Karl et al. 1996). This approach is referred to as Integrated Weed Management (IWM), which consists of three levels: (1) prevention, (2) control, and (3) restoration.

The most practical and cost-effective aspect of weed management is prevention (Ashton and Monaco 1991, Harrod 1994, Karl et al. 1996). Prevention means reducing or stopping the ex-

pansion of existing weeds or the introduction of a new weed. Prevention includes education, awareness, and training about modes of spreading weeds; developing inventory and monitoring strategies to detect new infestations; and restoring disturbed sites preferably with native plants to prevent weed establishment (Asher 1993). Karl et al. (1996) provide an extensive list of weed prevention measures for a variety of management activities, such as road maintenance, recreation, wildlife habitat improvement, range management, mineral extraction, prescribed fire and fire suppression, and timber management. Although often overlooked, restoration of forest composition and structure through thinning and prescribed burning can be an effective prevention measure in the long term by restoring ecosystem integrity and resiliency. Many weeds thrive in areas with low vegetative cover (Crawley 1986), and the current dense structure of dry forest has led to low cover of native forbs and grasses, which may allow some weeds to invade. In addition, present-day forests are susceptible to high-intensity fire, which may also lead to weed invasion. By restoring ecosystem health in these forest types, native forbs, shrubs, and grasses increase in diversity and productivity (Covington et al. 1997) thereby increasing native plant community resistance to weed invasion.

Control is weed management that decreases weed populations below a level that interferes with native plant communities (Ashton and Monaco 1991). This level of weed suppression balances ecological gains with the cost of the control practices (Karl et al. 1996). Control, rather than eradication, is the goal of most successful weed management programs. A number of weed control practices are described by several authors (e.g. Ashton and Monaco 1991, Asher 1993, Harrod 1994, Harrod et al. 1996b, Karl et al. 1996) and include biological control, prescribed burning, manual control, mechanical control, and herbicidal control. The control method selected should be commensurate with the environmental, cultural, economic, and management factors for specific ownerships and land allocations within eastern Oregon and Washington. For example, Youtie (1997) has successfully used hand-pulling (manual control) to control weeds within northeast Oregon Natural Areas. Although herbicides could be used in these areas, the presence of rare plant species makes hand-pulling a preferred method of control. However, hand-pulling is expensive and may

be impractical for larger infestations. Knecht and Frazee (1999) found that hand-pulling knapweed along several miles of road in northcentral Washington could cost as much as \$1,411 per acre in one year, and the pulling effort could take up to 10 years to achieve control. In addition, stem density was reduced little more than half during the first year. It becomes clear that weed managers need to consider a number of factors before implementing an IWM plan.

Eradication is the complete elimination of a weed from an area (Ashton and Monaco 1991) and differs from control. In this case, both live plants and reproductive parts are eliminated. The long life of many weed seeds make eradication a difficult goal, particularly when attempted over large areas. Eradication of small satellite populations, however, is feasible and is an important aspect of an overall weed control program. For example, Moody and Mack (1988) found that eliminating satellite weed populations was more important than curbing the expansion of the main weed population. In their study, destroying even 30% of satellites greatly improved the effectiveness of overall control measures.

Restoration is the final level of weed management and involves returning native plants to a site. Control and restoration activities often occur simultaneously. Seeding or planting seedlings of native species can accelerate recovery and may be necessary in large areas where native plants are unable to reoccupy the site. Important ecological processes such as fire or flooding may also be introduced (Youtie 1997). Sheley et al. (1996) propose that weed infested communities be directed on successional trajectories that lead to more desirable plant communities. The authors refer to this approach as successional weed management, and it recognizes the dynamic nature of vegetation and uses technology to enhance natural process or mechanisms that regulate vegetation change.

A final and equally important aspect of weed management is monitoring. A first step is to identify clear monitoring objectives. Managers can then specify the population being monitored, what variables will be measured, and how often measurements will be taken (Harrod et al. 1996b, Youtie

1997). Monitoring is important not only for weed control projects, but also for evaluating the potential spread of weeds in forest restoration projects. A comparison of the predicted time and cost to the actual time and cost of a project will assist in planning for future projects (Harrod et al. 1996b). Finally, monitoring results can help managers modify ineffective restoration approaches.

Conclusion

Invasive plant species are numerous in Washington and Oregon and they often interfere with land management objectives. Invasive plants can alter ecosystem processes, modify successional pathways of native plant communities, change disturbance regimes, and decrease biodiversity. It is important to consider these effects in efforts to restore the inherent composition, structure, and disturbance regimes of forest ecosystems. An IWM program provides managers with a long-term strategy for preventing and controlling weed invasions, and restoring altered ecosystems. A well-designed monitoring program can help evaluate long-term weed management strategies and identify topics for further research.

Control and prevention are key components to any IWM program. Control measures are commonly used in agriculture and forestry, but some prevention techniques are less understood. For example, it has been suggested that restoring diversity and productivity of dry forest ecosystems may increase weed resistance (see above), but some authors have concluded the opposite, i.e. high-diversity areas are invadable (Stohlgren et al. 1999). Current forest restoration approaches assume that thinning and prescribed fire will improve both overstory and understory structure and composition, but such assumptions are often untested. Therefore, researchers and forest managers must work together to identify information gaps and design research projects that will address these important issues.

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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.