Joint Fire Science Program

Fire Science Brief

RESEARCH SUPPORTING SOUND DECISIONS

Invasions of noxious weeds such as spotted knapweed and cheatgrass threaten biological diversity, and can alter fire intensity and frequency.

The Tao of Treating Weeds: Reaching for Restoration in the Northern Rocky Mountains

Summary

Noxious weeds are a serious problem that is spreading across the West. Herbicides such as Picloram have proven to be powerful tools in reducing weed invaders, although use of this tool has often produced unintended consequences. Broadleaf herbicides kill forbs, such as the noxious knapweed, but also harm native forbs such as arrowleaf balsamroot. Removing weedy forbs from a landscape creates opportunities for grasses to thrive—native as well as nonnative. Because of herbicide treatment, study sites experienced great increases in cheatgrass, a non-native grass of poor forage that also alters fire intensity and frequency. Managers should consider that efforts to reduce one problem plant may produce other problems.

Key Findings

- Broadleaf herbicides reduce the invasive forb knapweed, but also harm native forbs which are important components of plant communities.
- With competition from forbs lessened, native, as well as nonnative grasses such as cheatgrass, thrive. Cheatgrass provides poor forage, and changes fire intensity and frequency.
- Changes in plant communities affect insects which provide food sources for songbirds. Preliminary data show that herbicide treatments did not necessarily improve conditions for beetles, but analysis of other groups is needed.
- Deer mice, vectors for hantavirus, whose numbers exploded in response to knapweed invasion, fell to natural population levels with herbicide treatment.

Introduction

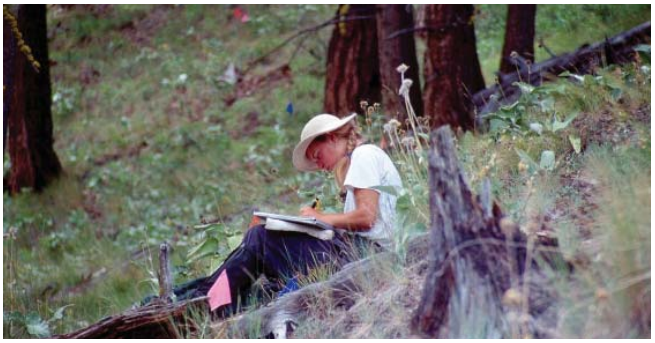
Human beings are endowed with the gift of reflecting on our observations. But what do those observations tell us? Are the judgments we make correct? A Taoist story tells of an old farmer whose horse runs away. His neighbors offer their sympathy—such bad luck, they say. Maybe, the farmer replies. The next morning the horse returns, bringing three other wild horses along. So wonderful, the neighbors offer. Maybe, the farmer replies. The story continues with the farmer's son breaking his leg when he is thrown from one of the horses, but when the army shows up the next day to press him into service, the farmer's son cannot go. Again the neighbors congratulate the farmer. Again he replies maybe. Good outcome? Bad outcome? The farmer's "maybe" indicates his wisdom in recognizing the uncertainty that goes with evaluating situations.

The Chinese word, tao, means path, or way. One of the challenges in planning to take any action is that we cannot see the long-term effect of the path of our decisions. We can only make the best decision we are able to see at any given moment. Restoring weed-invaded landscapes requires managers to act, with often a limited amount of information about the numerous variables and outcomes. Is a restoration outcome good when it eliminates an invasive plant? Maybe. It depends on what else is changed in the process, and ultimately on the management goal. With our ever greater understanding of the linkages between species, and between species and their environment, devising management plans grows ever more complex. Add to that invasive species that alter the already complex world in ways we cannot foretell.

Increasing our knowledge makes decisions easier; using the accumulated observations of science helps us to look down variable paths and see potentials. To assist managers in devising treatment plans that improve natural systems, Yvette Ortega, wildlife biologist with the U.S. Forest Service's Rocky Mountain Research Station, studied the effects of herbicide treatments on native plants, birds, and insects in the Northern Rocky Mountains. Her examinations focused on understanding ecological processes and improving interpretations of the effects of treating weeds in the effort to restore invaded landscapes.

Weeds' deeds—Wrestling with the consequences of a warm welcome

A plant, maybe scooped up and inadvertently sent far from its native lands, appears. Sometimes the exotic grass, or forb, or tree may be purposely planted because it appears to have useful attributes. The introduced plant may be a type that thrives in the new land, as not all plant travelers are made the same. Spreading through vast landscapes, choking out native plants, harming native birds, mammals, and insects, the introduced plant may earn a revised identity based on its behavior in the new land: now we call it an "invasive." With that realization, we can see a wholesale shift occurring in many landscapes, aided by the scientists who reveal the stories. What, Ortega wondered, are the impacts of exotic weeds on native plants? What cascading effects impact animal consumers in the altered landscape? How good are the weed control tools we currently use to lessen those impacts, or are we actually magnifying them? Ortega, with the help of her team, looked for new ways of analyzing the ecological data, to produce practices that land managers can employ.



The researchers tested the effects of using a common management tool for controlling weeds—Picloram, a broadleaf herbicide.

Examining the familiar and revealing the unexpected in the herbicide narrative

"Noxious weed invasions threaten biological diversity," Ortega offers, "and weed control represents one of the greatest challenges facing land managers."

Management plans, including the National Fire Plan, encourage managers to control weeds as well as reduce fuels across large areas. While that might sound straightforward, eliminating weeds could produce unintended consequences. This, the scientists reveal, is because efforts to reduce fuels, whether by prescribed burning or thinning, can make it easier for weeds to spread, so the issues of fuels and weed management go hand in hand. Ortega and her team explored tactics managers have used to reduce weed numbers and to change outcomes for invaded landscapes. In one strategy, managers have used Picloram, a broadleaf herbicide, to reduce the thickness of invasive forbs clogging the landscape in the hope that native plants and animals would be freed from invader impacts, an outcome that would hopefully outweigh any side effects that might occur. To test this management tool, Ortega and her team had planned a burning and herbicide treatment in their study area in Montana's Lolo National Forest. Because of factors beyond their control, the scientists had to postpone the burning treatment they had planned, an alteration Ortega viewed as a boon because it allowed the team to study the independent effects of the herbicide portion of the treatment, which was not possible under the original design.

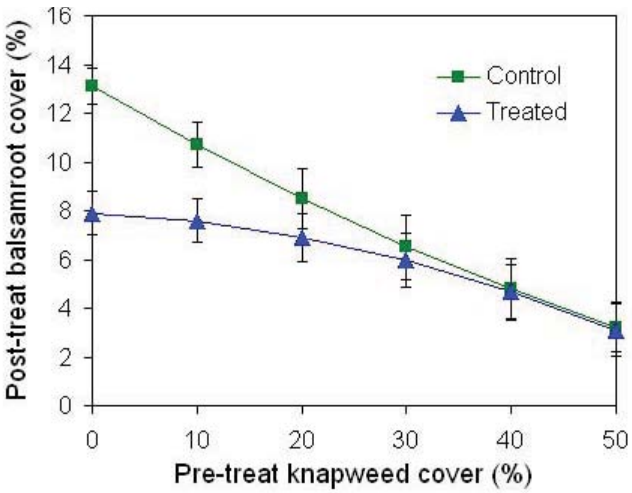
Open forest sites in western Montana dominated by native vegetation (top) provided a measure of pre-invasion conditions for comparison to sites (bottom) invaded by noxious weeds.

The study sites Ortega's team used were steep, open-forest habitats at 4400–5600 feet of elevation—places that were either invaded by spotted knapweed or were still dominated by native vegetation with only small amounts of noxious weeds. Spotted knapweed, an aggressive, nonnative forb, has been spreading in the American West.

The team examined plants and animals at both the knapweed invaded and largely native vegetation sites, and examined the effects two management scenarios would have: no treatment, which would demonstrate what taking no action would do to the plants and animals, and how knapweed spread would affect this landscape; and weed control, which would show what effects using the broadleaf herbicide Picloram to suppress knapweed would have. Picloram was applied through aerial spraying to half the study sites, with the other half serving as controls (no treatment). By focusing on the effect of broadleaf herbicide treatment, which is a primary weed control tool used in managing lands, the scientists were able to deliver information directly relevant to fuels management.

Herbicide treatments favorable? Yes, no, maybe.

Herbicide treatment, Ortega explains, provided temporary suppression of spotted knapweed, the invader this study targeted. Picloram sprayed on the land reduced the noxious forb's canopy cover by 80–90%, with suppression lasting through three years after treatment. The team sprayed in the fall, which killed the knapweed plants and inhibited the plants regenerating from seed before the primary growing season. This timing may be very compatible with spring burning by not allowing knapweed to take advantage of the disturbed landscape. Because Picloram persists in the soil for several years after it is applied, suppression also persists. However, as the Taoist story indicates, while something may appear favorable, seen from a different angle, it might not entirely be so.



Broadleaf herbicide treatment not only kills the target invasive forb, it also harms native forbs such as arrowleaf balsamroot.

Foundering native forbs

"Herbicide treatment had adverse side effects on native perennial forbs," Ortega offers, "which in most cases, were not overcome by positive effects of knapweed suppression."

The scientists reveal that native perennial forbs are particularly sensitive to knapweed invasion, but trying to control knapweed with a broadleaf herbicide in order to give native forbs some space to save them also ends up harming them. The studies revealed that herbicide treatment reduced abundance of some native forbs by more than forty percent in the sampling period after treatment. The relief for native forbs from being crowded out by the invader knapweed only occurred in areas where knapweed was growing in moderate amounts, and relief was only significant in the second year after treatment.

Arrowleaf balsamroot, a yellow-flowered native forb appreciated by hikers, suffered reduced seed production and seed density from herbicide treatment, with no benefit from the release effect that was hoped for by reducing knapweed. Herbicide treatments reduced arrowleaf balsamroot numbers and reproduction in low invasion areas, to levels typically found in areas highly degraded by invasion. And as Picloram residues will decline in the soil, knapweed will recover. Negative impacts from herbicide will be replaced by negative impacts from invaders, unless treatment is repeated.

"If maintenance of native perennial forbs is a management goal," the scientists explain, "broadcast spraying of herbicides like Picloram may not improve the situation, and if applied to areas with only low invasion, may even worsen it."

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Bad for forbs but good for grasses

Herbicide treatments allowed native perennial grasses to increase dramatically. With knapweed and native forbs suppressed and competition reduced, native grasses increased their cover over the land by 40–100 percent, except in areas highly degraded by invasion. The native Bluebunch wheatgrass, for example, in most cases increased even above levels found in habitats that were free from knapweed invasion altogether. And within that dichotomy of good and bad, native grasses weren't the only grasses to thrive. Exotic grasses, particularly the invader cheatgrass, took off, increasing over 100 percent, and in some places as high as 2000 percent, making areas that had low levels of knapweed before treatment even weedier.

Is this a problem? The scientists explain this depends on management goals. Cheatgrass often harms natural systems—it competes with native plants, it provides poor forage for wildlife, and it increases fire intensity and frequency. If managers want to maintain native system functions, the scientists caution, promoting cheatgrass along with native grasses through herbicide treatment may be too big a cost.

Exotic grasses, particularly invasive cheatgrass, exploded as much as 2000 percent in some areas freed from forb competition by herbicides. Cheatgrass provides poor forage for wildlife, and changes fire intensity and frequency.

The composition of plant communities, and the alterations that occur by invading species or by promoting species through management actions, affects more than the plants themselves. "Shifts in plant communities caused by herbicide treatment should affect habitat conditions for wildlife," Ortega explains. Just as knapweed invasion affects plants and the animals that depend on them, so does broadleaf herbicide treatment.

Insects

Insects are a major source of food for consumers like songbirds. They also provide many services to plants, and affect the structure and composition of communities. Different insects were affected by plant community alterations in different ways.

Grasshoppers, tasty to songbirds, and crickets, the scientists found, are very sensitive to knapweed invasion. Herbicide treatments alone didn't restore invaded sites to pre-invasion conditions in beetle communities. The majority of ant communities were more robust in knapweed invaded areas. Knapweed seeds have nutrient-rich nodes that ants like to eat. Ants ignored seeds of two native plants; they collected and dispersed knapweed seed away from the parent plant. This may be increasing the invasiveness of knapweed.

Songbirds

Knapweed invasions caused declines in the foods ground-foraging songbirds like to eat. This led to problems for the birds—

delays in breeding, reduced productivity and commitment of adult birds to their breeding sites.

Songbirds, such as the Chipping Sparrow, may respond positively to herbicide treatments that reduce knapweed and promote native grasses if this shift also promotes the insects that they depend on. However, declines in forbs caused by treatment may reduce certain key resources, and more analysis is needed to determine the total effects on songbirds and their prey.

Mammals

More native grasses mean more forage for grazers like elk and deer. However, herbicide treatment caused native deer mice to decline, which the scientists believe restored the mice populations to levels more typical of habitats that have not been invaded with knapweed.

While most native species are adversely affected by knapweed invasion, the team's studies show that deer mice grow to unnaturally large populations in knapweed-invaded habitats because of the prevalence of gall flies closely linked to knapweed. These flies, introduced as control agents for knapweed in the 1970s, provide mice with a superabundant food source, doubling and sometimes tripling mice populations in knapweed-invaded areas compared to native habitats.

Added to the problem of a population out of balance is the concern that deer mice are the primary vectors, or disease carriers, for the often fatal Sin Nombre hantavirus. The scientists demonstrated that reducing knapweed with herbicide treatment reduced deer mouse populations by removing the exotic food source, and reduced hantavirus risk to humans. This is especially critical, the team explains, in the wildland-urban interface where humans and mice cross each other's paths.

Relinquishing absolute appraisals

Noxious weed invasion is a major issue for land managers, and often sets the stage for other management decisions since exotic plants can dramatically change fire behavior and fire regimes.

While broadleaf herbicides are a powerful tool that can be applied easily over large areas to suppress forb invaders such as knapweed, managers cannot assume that such practices will improve conditions on the land. Suppressing one problem may produce another, and the resulting effects may be worse than the former situation that managers were seeking to cure. Because suppressing noxious forbs by applying broadleaf herbicide is only a temporary remedy, native plants must face return by the invader species, or re-application of the herbicide. Owing to this quandary, scientists recommend that managers use spot-spraying rather than aerial spraying in selected invaded areas, to remove noxious forbs such as knapweed, promote native grasses, and allow native forbs to escape treatment as much as possible.

"The ultimate test of treatment efficacy in ecological terms will be the response of wildlife to associated changes in the vegetation."

How successful any treatment activity is at restoring invaded landscapes becomes more apparent by considering the animals that are closely linked to native plants. Ortega explains, "the ultimate test of treatment efficacy in ecological terms will be the response of wildlife to associated changes in the vegetation." The path of management planning, then, is to begin, as the saying goes, with the end in mind. And the path of using treatments requires the realization that results will be good, bad, or inconsequential to the different species involved.

Management Implications

- Managers cannot assume that applying broadleaf herbicide to suppress forb invaders will improve conditions on the land, and must consider the side effects of applying treatments in order to prevent creating a situation that is worse than the original condition.
- Managers should use spot-spraying rather than broadcast spraying methods in order to focus suppression more directly on forb invaders, minimize impacts on native forbs, and reduce the risk of secondary invasion by exotic grasses.
- Ecological effects of herbicide treatments are complex, with some native resources moving closer to pre-invasion conditions, and others moving farther. Whether or not treatments can be called successful ultimately depends on the nature of management goals and what degree of restoration is desired.

Further Information: Publications and Web Resources

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Scientist Profile

Yvette K. Ortega is a Wildlife Biologist with the Rocky Mountain Research Station (USDA Forest Service) in Missoula, MT. Her research focus is building understanding of interactions among differing levels of natural systems in order to guide their management, with a current emphasis on impacts and control of invasive plant species.

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Manager's Viewpoint
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Effects of Fuels Treatments on Native Flora and Fauna: Restoration in Weed-Invaded Landscapes of the Northern Rocky Mountains

Written By: Paige Houston

Purpose of this opinion piece

Manager's Viewpoint is an opinion piece written by a fire or land manager based on information in a JFSP final report and other supporting documents. This is our way of helping managers interpret science findings. If readers have differing viewpoints, we encourage further dialogue through additional opinions. Please contact Tim Swedberg to submit input (timothy_swedberg@nifc.blm.gov). Our intent is to start conversations about what works and what doesn't.

Problem

This study focuses on several strategies to assist land managers with a relatively unknown variable of how to eliminate weeds—if that is ever possible—through application of fuel treatments and herbicides. Because disturbance from wildland fires across vast landscapes and ecosystems creates much of this weed problem, fire prevention and suppression have become the new challenge. Hence, land managers are now faced with how to best manage weeds when applying fuel treatments and herbicides, as well as the timing of these applications.

Managing noxious weeds through the use of the herbicide "Picloram" was investigated to verify if any positive effects to wildlife and native plant species occur. The investigation further analyzes the consequences when supplementing the herbicide treatment in conjunction with fuel treatments. This is when noxious weeds are likely to occur (Ortega 2006). Although this study was unable to apply prescribed burning to the area of study to determine effects when used with herbicides, it highlights the importance of integrating weed management during all fuel treatment projects.

Application by Land Managers: Weighing the Benefits Versus the Risks

Research showed seeds from knapweed are less apt to survive from herbicide in the fall, thus preventing germination the next growing season (Ortega 2006). To capitalize on the suppression of weeds, the concept of applying a spring burn the season following herbicide application (Ortega 2006) was targeted. However, because prescribed burn applications could not be carried out due to logistical and weather constraints, the study's primary focus centered on the use of herbicides and evaluation of the effects.

Some of the effects determined by this study included impacts to native species and density following treatment compared to the level of how much a site was invaded by noxious weeds.

What was found will force land managers to truly weigh the benefits versus risks when applying Picloram. More than 40 percent of forbs were reduced in areas of minimal invasion as well as areas of high invasion (Ortega 2006). However, this same effect did not impact the native grasses as aggressively.

Does the Benefit Outweigh the Risk?

This study shows how some grasses responded favorably to Picloram while reducing the spotted knapweed. However, cheatgrass also benefited from the application of herbicides. Land managers would value this finding of what *not* to do when trying to eliminate a fire hazard like cheatgrass. But, if a land manager is basically dealing with spotted knapweed, using Picloram should not have negative impacts to the native grasses.

Land managers would value this finding of what not to do when trying to eliminate a fire hazard like cheatgrass.

Other studies also agree with using herbicides as one of the most ideal treatments to eliminate or reduce spotted knapweed. This is largely due to the plant's deep root system and minimal impacts to the soil (Miller 2000). Picloram, that suppresses plant growth, remains in the soil for approximately three years after application (Ortega 2006).

The underlying theme from scientists suggests that management objectives should provide the necessary outline to help determine whether or not using herbicides will meet their objectives. Thus, when considering using herbicides, fire managers need to determine if the benefit outweighs the risk in achieving their management objectives and goals.

The overall consensus seems to rely on the fact that for land managers to be effective in targeting weeds when implementing projects or reducing fire hazards, sometimes you give up one benefit for another—and the ripple effect is still in the early stages.

Ensuring Weed Management Occurs

Ortega and the group of scientists conducting this study have demonstrated the importance of ensuring that weed management, to be most effective, is tagged onto all fuel treatment projects. The fuel treatment projects should be a combination of tactics that evaluate the objectives, scale of the problem, and timing. Two other scientists, Sutherland and Rice, point out that if land managers know the scale of potential impacts, then the process of dealing with the weeds should be integrated into the planning phases (2004, 2000).

Finally, some of the variables not determined from the report include what the major impacts were to big game wildlife and habitat (except that forage was reduced dramatically when herbicides were applied in areas that caused an increase in cheatgrass). In addition, other than fuel reduction activities and those actions taking place within the wildland-urban interface, the types of fuel treatments were not specific.

The study also mentions wildlife species such as songbirds, chipping sparrows, and some insects as being negatively impacted by herbicide application due to the immediate effects on the ground where most of their food source is available. However, deer mice seemed to

benefit through herbicide application by reducing their populations to what is considered “natural.” This also reduces the hantavirus in and around the wildland-urban interface (Ortega 2006). Therefore, both positive and negative benefits to wildlife exist with herbicide application.

Therefore, both positive and negative benefits to wildlife exist with herbicide application.

The underlying message from this study does confirm that getting ahead of the weed situation is critical—especially when implementing fuel treatments. Because activities from fuel treatments can induce weed invasion, the importance of “staying ahead of the power curve” resonates with the group who conducted this study. And, of course, the application of herbicides has both positive and negative impacts that will need to be evaluated *before* making the decision to use these products. Furthermore, prescribed fire is a fuel treatment alternative that has not been fully evaluated regarding weed invasion.

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Manager Profile

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She spent eight years with the Bitterroot and Lolo hotshot crews and worked two seasons with the Alaska Smokejumpers. She has several more years of experience in other primary firefighter and fuel management positions, including a season with the rappellers out of Chelan, WA. She's a graduate of the University of Montana where she received a degree in resource conservation.

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