Evaluating the Costs and Benefits of Alternative Weed Management Strategies for Three Montana Landscapes

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Centennial Valley Summary

This summary provides highlights of results for the Centennial Valley (CV) from our full report (Frid et al. 2011), which can be consulted for further details and explanation. The report and additional resources are available at http://conserveonline.org/workspaces/montanaweedmodel.

Invasive plant species management at the landscape scale in the Western U.S. is generally based on fine-scale experience and arbitrary decisions ("rules of thumb") with limited understanding of long-term outcomes across broad areas or over long periods. Range managers are often faced with dilemmas in applying limited resources to the control of invasive plants across complex landscapes, and there are few tools available to guide real-world decision-making. In order to develop the best strategies for maintaining intact, native plant communities for biodiversity and local economies, quantitative tools are needed to compare the effectiveness of proposed management strategies over several decades.

Computer models have been used by managers to evaluate alternative strategies of invasive species management while explicitly accounting for uncertainties related to actual landscapes, weed ecology, and management strategies. We used spatially explicit computer simulations to model the spread of leafy spurge and spotted knapweed and the effects of management actions for three Montana landscapes, including the 400,000-acre Centennial Valley (CV) in southwest Montana. We compared several management strategies under a variety of budget constraints to evaluate the long-term benefits of different approaches, identify appropriate funding levels, and assess economic costs and benefits of strategies.

Methods

The computer model simulates the change in weed infestations over a 40-year period, starting with current conditions and applying various management strategies. Spatial data inputs for the simulations included maps of vegetation, current weed distribution, and features influencing the probability of new invasions, such as roads, gravel pits, and trailheads. All inputs for the model were based on published literature, data from the landscape, and/or input from local managers and experts. We evaluated the long-term economic costs and benefits of the strategies by accounting for weed impacts to livestock forage and the costs of treating weeds.

Results

- With no management, knapweed and leafy spurge increased 260-600 fold (Table 1)
- With unlimited management, total area invaded can be maintained at less than 0.02% of the landscape; treatment level at half of unlimited budget maintained total area invaded at 0.75 – 1.25% of the landscape
- Treatment levels at half of unlimited budget are higher than current management for the CV, suggesting preferred outcomes will likely require an increases in control effort over time
- Annual area treated increased over time as new invasions became established from seed sources outside the CV
- Strategies prioritizing Early Detection and Rapid Response (EDRR) minimize weed spread and result in significantly greater net economic gain compared to large-patch priority (Figure 1)
- Strategies delaying treatment result in weed spread similar to no management, while incurring significant economic costs of management (Figure 1)

Table 1: Area invaded, treated, and net present value for spotted knapweed and leafy spurge after 40 years, under high spread rate scenarios. Area invaded at the beginning of the simulations was 25 acres.

Strategy	Area Invaded (acres)	Area Treated (acres)	Net Present Value (2008 $)
No Management	14,700	n/a	n/a
Unlimited Management	50	1,700	$140,200
300-acre Management Budget	2,500	1,100	$144,000
150-acre Management Budget	6,200	600	$106,500
High Control Success*	2,100	1,000	$147,400
Large Patch Edges*	7,000	2,500	$76,500
EDRR*	**200**	**400**	**$196,500**
Delay 10 Years*	10,600	700	-$21,500
Delay 20 Years*	13,300	1,100	-$35,100
Delay 30 Years*	14,300	1,400	-$23,800

* 300 acre Ceiling

Management Implications

Overall, the model results suggest that long-term success in the CV is attainable for limiting invaders and maintaining intact, native plant communities; but success will depend on consistent, strategic effort and modest increases in capacity over time. Strategic management creates economic benefits to the local ranching community that exceed the costs of management. The project supports several priorities for weed management programs:

- Improve detection through education, GPS use, plant ID classes, and careful monitoring
- Prioritize treatment of small patches (EDRR) over large patches when resources are limited
- Delaying treatment is costly in the long run and limits options for long-term success
- Effective management has strong net positive economic outcome

Based on results from other landscapes in Montana, early detection and prioritizing small patches remain valuable strategies in areas with higher levels of infestations, such as the Red Rock Watershed. Despite the high visibility and local impacts of established infestations around towns and highway corridors, we expect greater success, in terms of return on the investment of limited resources and area invaded, if less invaded parts of the watershed are prioritized. Ultimately, our decisions today have significant ramifications for the next generation of weed managers and landowners, and tools such as this model provide one approach to improving our legacy.

Figure 1: Maps of Centennial Valley after 40 years under best (EDDR) and worst (30-year delay) scenarios