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

Leonardo Frid[1], David Hanna[2], Nathan Korb[2], Brad Bauer[2],
Katy Bryan[1], Brian Martin[2], and Brett Holzer[3]
1. ESSA Technologies Ltd., 2. The Nature Conservancy in Montana, 3. Private

Rocky Mountain Front Summary

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 time periods. Range managers are often faced with dilemmas in applying limited resources to the control of invasive plants across a complex landscape, and there are few tools available to guide real-world decision making across large landscapes. In order to develop the best strategies to maintain landscape values and prevent the spread of invaders, quantitative tools are needed to compare the effectiveness of various management strategies over several decades.

Computer models have been used by managers to evaluate alternative strategies of invasive species management while accounting for uncertainties related to the 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. We compared several management strategies under a variety of budget constraints to evaluate the long-term benefits of different approaches, identify appropriate resource allocation levels, and assess costs and benefits of strategies within an economic analysis framework.

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

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 vegetation type, current weed distribution, spatial restrictions on management actions, and features influencing the probability of new invasions. All inputs for the model were based on published literature, data from the landscape, and/or input from managers and experts on the RMF. We used a 30-year time series of weed management and spread data from Pine Butte Swamp Preserve on the RMF to help calibrate the model.

To evaluate varying levels of weed management budgets, we ran simulations over a range of treatment levels with a management strategy that prioritized treatment of small patches over large patches. The simulations ranged from no management (zero budget) to unlimited management (unlimited budget), with 4 additional intermediate budget levels.

To compare the effect of alternative management strategies, we ran simulations at the mid-level budget ceiling with several alternative management scenarios: improving control success rates, treating new infestations when they first appear, prioritizing large infestations instead of small infestations, treating only a portion of the landscape each year, and delaying the onset of management.

We compared total area invaded at the end of the simulations to assess the impact of various management strategies on weed spread and cover on the landscape. We also evaluated the economic costs and benefits

of the strategies by accounting for the damages caused by weeds to grazing forage and the costs associated with implementing management.

Results

40-year simulations for the RMF showed the following:

- With no management, knapweed and spurge increased 11-18 fold
- With unlimited management, total area invaded can be maintained at less than 1% of the landscape; with treatment levels at half of unlimited management, total area invaded can be maintained at 2-3% of the landscape
- At high initial treatment levels, annual area treated declines over time as existing established infestations are brought under control
- Strategies that prioritize small patches over large patches minimize weed spread and result in net economic gain
- Strategies that prioritize large, established patches result in weed spread similar to no-management, while incurring significant treatment costs
- Maximizing treatment success is important in already invaded areas
- Weed spread will overwhelm sporadic management efforts
- Highly susceptible areas with limited treatment options (such as gravel riparian habitats) are likely to become invaded regardless of management strategy
- Areas with relatively few infestations and can be maintained with a reasonable investment of resources and application of effective management.

Management implications for the RMF

- Prevention is important to reduce spread rates
- Prioritizing treatment of small patches (early detection-rapid response) is more effective than focusing on large patches
- Efforts to increase treatment success (applicator education, GPS use, etc.) should be a priority
- Effective management has net positive economic outcome, even when only accounting for grazing revenue
- Biocontrol is important for treating unmanageable infestations and reducing overall costs
- Detecting new infestations early and tracking existing weed locations, including previously treated patches, is important for consistent and effective control efforts
- Regularly managing only a portion of weed infestations or waiting to manage until patches become a noticeable problem is costly in the long-run and results in significantly higher levels of future invasion, which will be more difficult to manage
- At a broad scale, relatively un-invaded areas should be prioritized over heavily invaded areas

Overall, the model results suggest that long term success on the RMF is within reach. With consistent, strategic effort and modest increases in current capacity, we should be able to keep most of the landscape weed free. In addition, strategic management creates economic value on the landscape that is greater than the cost of management, more than paying for itself in the long run.

References

Frid, L., D. Hanna, N. Korb, B. Bauer, K. Bryan, B. Martin, and B. Holzer. 2011. Evaluating the Costs and Benefits of Alternative Weed Management Strategies for Three Montana Landscapes. Prepared by The Nature Conservancy of Montana, Helena, MT and ESSA Technologies Ltd., Vancouver, B.C., 56 pp. + appendices. Available at http://conserveonline.org/library/evaluating-the-costs-and-benefits-of-alternative