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Estimating Net Losses in Recreation Use Values from Non-Indigenous Invasive Weeds

Photo by Susan Donaldson

Poor root strength of perennial pepperweed (left) leads to soil erosion, unstable banks, poor water quality and loss of habitat for fish and game.

Photo by Erin Post

Photo by Robert Abbey

Yellow starthistle (above) makes infested lands inaccessible to recreationists and wildlife. Both yellow starthistle and leafy spurge (left) dominate native landscapes. They reduce plant and animal numbers, provide poor forage and decrease native habitats that support game.

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Summary: Economic losses imposed by alien, invasive weeds via impacts on outdoor recreation are not well known. The data to estimate such impacts are not easily measured and are scarce. We apply two analytical approaches to limited data and compare results to estimate ranges in which the true economic losses lie. To reflect underlying uncertainty, we develop a range of estimates using low, medium, and high scenario combinations of parameter and variable values. In a case study of alien, invasive weeds on public lands in Nevada, we estimate lost wildlife-related recreation values from $5 to $17 million per year. Using our most conservative findings for all annual recreation losses, we predict that discounted losses over five years would range from $26 to $34 million, depending on actual future expansion rates of the weeds.

INTRODUCTION

Terrestrial and aquatic, alien weeds spread rapidly in riparian ecosystems (Smith et al., 1999). They impact fishing, hunting, hiking, wildlife viewing, and water-based recreation by affecting soil quality, water quality and quantity, plant diversity, availability of forage and cover, and animal diversity and abundance, including that of fish (Olson, 1999; Madsen, 1997; Newroth, 1985).

Photo by David Spencer, USDA Exotic & Invasive Weeds Research Unit, Davis, CA

Eurasian watermilfoil in watercourses interferes with swimming, boating, fishing and other water-associated activities.

Few estimates of economic losses to recreation due to weeds exist, except analyses that 1) are part of studies on reduced grazing, 2) are focused on weed species that have yielded substantial economic impacts, and 3) are helped by good maps or other data collected for other purposes (e.g., Leistritz et al., 1992; Leitch et al., 1996).

Herein, we deal with the common problem of estimating recreational losses from invasive weeds when data are scarce or of poor quality and estimates are sought by agencies to decide how to spend money on invasive weed detection, prevention, and control. For lack of “bottom up” data, our approach analyzes aggregated state-level data, employs two analytical approaches, compares results and lastly, acknowledges and reflects uncertainty in the available data by estimating a range of potential recreation losses.

MATERIALS AND METHODS

Data: First, we used recreation days per year in Nevada for fishing, hunting, and wildlife-watching (U.S. Fish and Wildlife Service, 1996). Second, we estimated per-day net economic values (NEV), known as consumer surplus, for wildlife-related recreation, drawing on an existing meta-analysis (Walsh et al., 1990). Multiplying the number of recreation days per year by NEV per day produces an estimate of the NEV per year for each category of recreation. Summing across the three activities gives values of wildlife-related recreation at about $163 million per year in Nevada (Year 2000 dollars), Table 1.

Table 1. Estimated annual net recreation use values (consumer surplus) in Nevada.[a]

Recreation activity	Recreation days/yr[b]	Net economic value/day[c]	Estimated net value/yr
Hunting	649,000	$53	$34.4 m
Fishing	1,976,000	$43	$85.0 m
Wildlife viewing	1,394,000	$31	$43.2 m
Totals	4,019,000	NA	$162.6 m

[a] Monetary values denote consumer surplus, or net economic values, from recreation uses. Consumer surplus is the amount that recreators are willing to pay for recreation minus all recreation expenditures (therefore a net value).
[b] U.S. Fish and Wildlife Service, 1996.
[c] Source: median values by recreation use type as reported in the Walsh et al. (1990) meta-analysis, updated to June 2000 dollars.

To estimate infestation rates of alien invasive weeds for this study, we conducted an expert opinion survey of state and federal agency land managers. About 87 percent of Nevada is under federal agency management. The mean response for the percentage of a typical watershed infested was 47 percent. Variability among geographic and management units was significant. To reflect such variability and uncertainty in our estimation techniques, we use “lower” (35 percent) and “higher” (65 percent) estimates for the statewide mean percent infestation rates along with a “middle” estimate of about 50 percent as derived from the survey.

Photo by Wayne S Johnson

Photo by Susan Donaldson

Perennial pepperweed replaces native riparian plant communities. This displaces large and small game dependent upon the native plants for forage and habitat.

Estimation Techniques: We developed “lower,” “middle,” and “higher” estimates of annual losses from alien invasive weeds. This reflects uncertainty in the analyses, yields a “bounding exercise,” and estimates a likely range of potential losses rather than a point estimate.

Approach One: We develop a range of estimates of losses in consumer surplus from wildlife-based recreation.

$$RL = (\theta)\ (\phi)\ (\Delta)\ (CR + RL) \qquad (1)$$

where:

θ = fraction of potential wildlife-related recreation use values lost on recreation lands fully infested (100 percent cover) with alien invasive weeds, $0 < \theta < 1$

ϕ = fraction of potential recreation lands that are currently infested with alien invasive weeds, $0 < \phi < 1$

Δ = average percent weed cover (÷ 100) on those recreation lands that are currently infested, $0 < \Delta < 1$

CR = current wildlife-related recreation use values

RL = wildlife-related recreation use losses

Table 2 summarizes parameter values used herein.

Table 2. Parameter values for the net recreation use value (consumer surplus) loss estimates using only Nevada data (Approach 1).

Variable/ parameter	Scenario estimate		
	Lower	Middle	Higher
θ	0.50	0.70	0.90
ϕ	0.35	0.50	0.65
Δ	0.10	0.30	0.50
CR	$163 m	$163 m	$163 m

Approach Two: We use a partial parameter transfer based on research in the upper Great Plains. This approach is similar to approach one, except that it employs information derived by Leitch et al. (1996) on the linkage between infestation rates and recreation activity. Wildlife-related recreation losses are estimated as:

$$RL = (\eta)\ (\phi)\ (CR + RL) \qquad (2)$$

where η denotes the average percent reduction in recreation expenditures per 1 percent increase in weed infestation (scale = from 0 percent to 100 percent infestation) as calculated based on Leitch et al. For example, if the η = 0.15, then each 1 percent increase in weed infestation is calculated to lead to a 0.15 percent decline in wildlife-related recreation activity, on average, over the range of data. Table 3 summarizes parameter values for this approach.

Table 3. Parameter values for the net recreation use value (consumer surplus) loss estimates using Great Plains partial parameter transfer (Approach 2).

Variable/ parameter	Scenario estimate		
	Lower	Middle	Higher
η	0.12	0.17	0.22
ϕ	0.35	0.50	0.65
CR	$163 m	$163 m	$163 m

RESULTS AND DISCUSSION

Loss Estimates: Table 4 summarizes the annual recreation loss estimates for the two analytical techniques. Lower estimates range from $3 to $7 million per year, middle from $15 to $19 million per year, and higher $27 to $67 million per year. With the exception of the "higher" estimate, which is a product of the higher linkage parameters, specifically between infestation rate and reductions in recreation, the estimates are comparable across the two estimation approaches. The means provide reasoned estimates of net recreational use losses due to invasive weeds in Nevada, except at the "higher" scenario.

Table 4. Summary of annual net recreation use loss estimates by analytical approach.[a]

Approaches	Scenarios (m/yr)		
	Lower	Middle	Higher
Approach #1	$2.9	$19.1	$67.2
Approach #2	$7.1	$15.1	$27.1
Mean (across approaches)	$5.0	$17.1	$47.2

The width of the range of economic losses may be somewhat overstated because the lower (higher) scenarios use all low (high) parameters jointly. Gaps in knowledge lead to these under and over estimations, particularly regarding the true infestation rates of individual species within particular ecological systems and management schemes, if managed.

Table 5 presents estimates of the discounted present value of future flows of net economic losses (foregone benefits) from reduced recreation. We predict losses for four alternative average annual rates of expansion for invasive species (5 percent, 10 percent, 15 percent, and 20 percent) over a time horizon of five years. Conservatively, we use the mean of the lower scenario estimates of annual recreation losses ($5 million per year) from Table 4 to predict foregone net benefits over future periods. If any of the other scenario estimates more accurately describe true losses, then our predictions in Table 5 will understate future losses. Conservative estimates of the present value of the future flow of net recreation use losses range from about $26 million to about $34 million over

Table 5. Future flows of wildlife-related net recreation use losses using the lower scenario annual loss estimate as the starting point, by expansion rate.

Mean annual expansion rate	Present value streams of future recreation losses [a, b]
	T = 5 y
5%	$26 m
10%	$28 m
15%	$31 m
20%	$34 m

[a] Discount rate = 4 percent.
[b] As the starting point for current annual net recreation use losses, we use the approximate mean of the lower scenario estimates in Table 4 ($5 million per year). For this and other reasons, the present value streams in this table likely understate the true net recreation use losses that would accrue over the next five years in the absence of weed management measures.

the next five years. The present value stream of foregone benefits depends upon the future average, annual expansion rate for invasive species, which is uncertain. The longer the future time horizon, the greater the uncertainty regarding future expansion rates will be. Uncertainty in future expansion rates is at least as important as uncertainty in current annual recreation losses.

Smith et al. (1999) examined the growth rates of a variety of invasive weeds in diverse locations around the western United States and found an average expansion rate of 24 percent per year, with relatively high rates in early years and lower growth rates as an infestation matures. Based on this information, it is likely that the expansion rates in Table 5 are lower than the intrinsic growth rates many Western states will experience without control of alien, invasive species. If this is the case, the economic impacts herein will tend to be understated.

Photo Wayne S Johnson

Salt cedar has invaded the Muddy River. The dense stand precludes all recreational uses of the river. Much water is lost to the air from the watershed because salt cedar uses more water than native plants.

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REFERENCES

Leistritz, F.L., F. Thompson, and J.A. Leitch. 1992. Economic impact of leafy spurge in North Dakota. Weed Science 40:275-280.

Leitch, J.A., F.L. Leistritz, and D.A. Bangsund. 1996. Economic effect of leafy spurge in the upper Great Plains: methods, models, and results. Impact Assessment 14:419-433.

Madsen, J.D. 1997. Methods for management of nonindigenous aquatic plants. In: J.O. Luken and J.W. Thieret (eds.). Assessment and management of plant invasions. N Y, Springer-Verlag. pp. 145-171.

Newroth, P.R. 1985. A review of Eurasian watermilfoil impacts and management in British Columbia. In: Proc. First international symposium on watermilfoil (*Myriophyllum spicatum*) and related Haloragaceae species. July 23-24, 1985. Vancouver, BC, Canada. pp. 139-153.

Olson, B.E. 1999. Impacts of noxious weeds on ecologic and economic systems. In: R.L. Sheley and J.K. Petroff, (eds.). Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State Univ. Press. pp. 4-18.

Smith, H.A., W.S. Johnson, J.S. Shonkwiler, and S.R. Swanson. 1999. The implications of variable or constant expansion rates in invasive weed infestations. Weed Science 47:62-66.

U.S. Fish and Wildlife Service. 1996. 1996 national survey of fishing, hunting and wildlife-associated recreation. USFWS, Washington, D.C.

Walsh, R.G., D.M. Johnson, and J.R. McKean. 1990. Nonmarket values from two decades of research on recreation demand. In: V.K. Smith and A.N. Link (eds.). Advances in applied micro-economics, Vol. 5. JAI Press, Inc.

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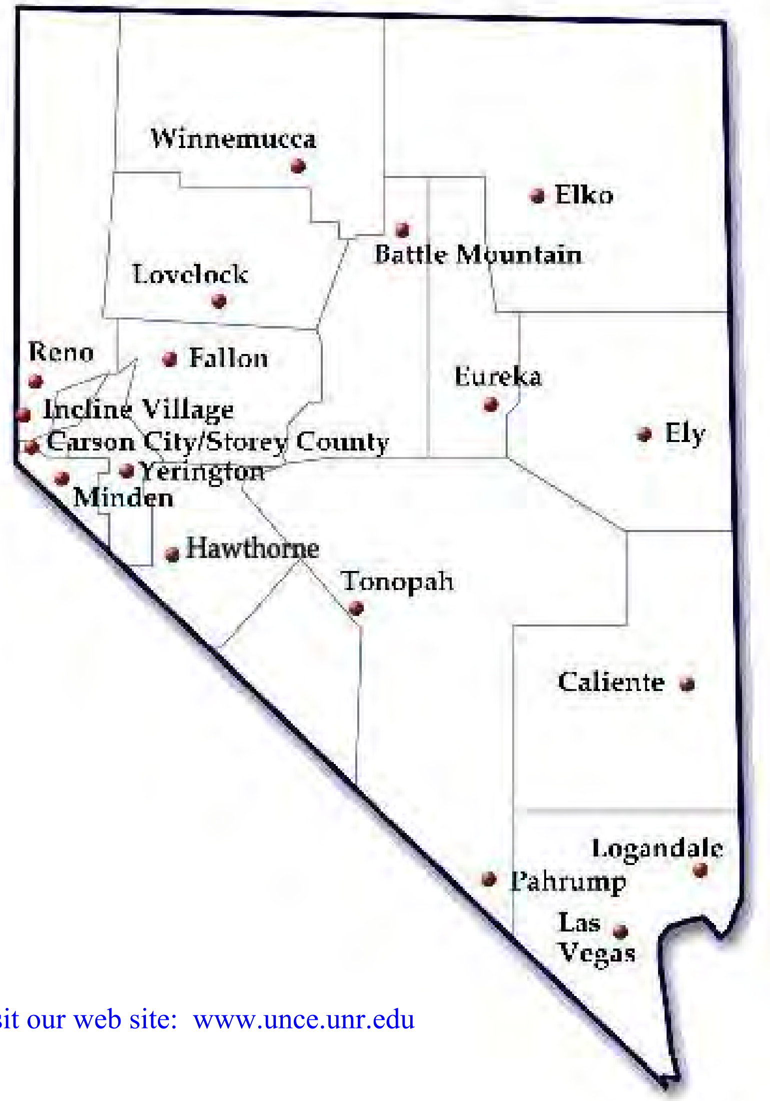

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