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Economic impacts of leafy spurge on grazing lands in the northern Great Plains

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Leafy spurge (*Euphorbia esula*) is an exotic, noxious perennial weed that has become widely distributed in the northern Great Plains. The plant is found primarily in nontilled agricultural land (pasture, rangeland, hayland, and idle cropland) and also in road ditches, around lakes, and in parks. Because leafy spurge exhibits exceptional ability to spread and thrive in a variety of habitats, is hardy, and resists control, it has become a serious problem for farmers and ranchers.

Heavy infestations of leafy spurge can be found in North Dakota, South Dakota, Montana, Minnesota, Nebraska, Colorado, Idaho, and Wyoming. The prevalence of leafy spurge expansion can be realized by examining the number of acres affected in North Dakota during the last 30 years. North Dakota had an estimated 200,000 acres of leafy spurge in 1962, 423,000 acres in 1973, 862,000 acres in 1982, and approximately 1.1 million acres in 1990 (North Dakota Department of Agriculture 1991).

Numerous studies have been conducted to examine the effectiveness of chemical treatments in restricting the spread of leafy spurge (Messersmith 1989). Herbicide treatments vary in effectiveness depending upon the chemical agent, application rate, timing of application, and age and size of the leafy spurge plant. The effectiveness of chemical treatments in controlling leafy spurge growth, cost of chemical applications, and value of rangeland production indicate that most chemical treatments are not economical (Thompson *et al.* 1990; Messersmith 1989).

Recent research efforts to control leafy spurge have focused on developing, expanding, and improving biological agents (insects and plant diseases); the focus is due in part to growing environmental concern over chemical use and the apparent ineffectiveness of chemical treatments to provide economical long-term control. Leafy spurge has been considered a potentially viable candidate for biological control, since natural forces appear to hold the plant in check in its native European habitat (Carlson and Littlefield 1983). Although considerable resources have been devoted to developing integrated leafy spurge control mechanisms (use and interaction of biological, cultural, and chemical control agents), little effort has been directed at evaluating the economic impacts of leafy spurge.

Several factors have highlighted the concern overestimating the economic impact of leafy spurge on farmers and ranchers and on area economies. The cost and ineffectiveness of chemical treatments and the growing public pressure to restrict chemical use in agriculture may force many producers to re-evaluate chemical control practices. Without chemical use to control leafy spurge, the weed may spread unchecked in many areas. Since biological control may be several years away from being an effective control measure, concern over the weed's continued spread has increased.

The rate of infestation has reached serious levels in many areas of the northern Great Plains, raising concerns from producers and policymakers over the amount of resources that should be used to develop leafy spurge control technologies. Economic information on leafy spurge infestations is required to understand the importance of leafy spurge control and to allocate resources to develop new control technologies.

Objectives

The purpose of this report is to summarize the economic impacts of leafy spurge infestations in Montana, South Dakota, and Wyoming (Bangsund and Leistritz 1991), update the economic impacts of leafy spurge infestations in North Dakota (Thompson *et al.* 1990), and estimate the economic impacts of leafy spurge on the four-state regional economy.

Methods

The procedures and analyses used to estimate the economic impact of leafy spurge in the four states required several steps. The first step was to estimate the number of grazing acres (private, state, and federal) and the animal unit months (AUMs) generated on those acres. The number of AUMs lost because of leafy spurge infestations was estimated using a grazing reduction model. The lost AUMs were assigned a value using grazing land rents. Cow-calf budget analyses were used to estimate the foregone production outlays from cow-calf herds that could have been supported by the lost AUMS. Lost AUMs and production outlays, which represent direct economic impacts, were summed by area and applied to an input-output model to estimate the secondary impacts. A leafy spurge growth model was applied to existing leafy spurge acreage to estimate potential leafy spurge infestations. Future economic impacts were calculated using estimated future leafy spurge acreage, given current AUM values and current beef cow production costs and prices.

Leafy spurge infestation rates

Leafy spurge acreage, as reported by weed inspectors, represented acres of grazing lands that contained some leafy spurge (the actual density or surface amount varied). Leafy spurge infestation rates, as used in this report, differed from leafy spurge acreage. Infestation rates refer to the percent of total grazing acres containing some leafy spurge and were used to estimate lost AUMs. For example, if a county reported 1,000 acres of leafy spurge and has 10,000 acres of grazing land, the leafy spurge infestation rate would be 10 percent.

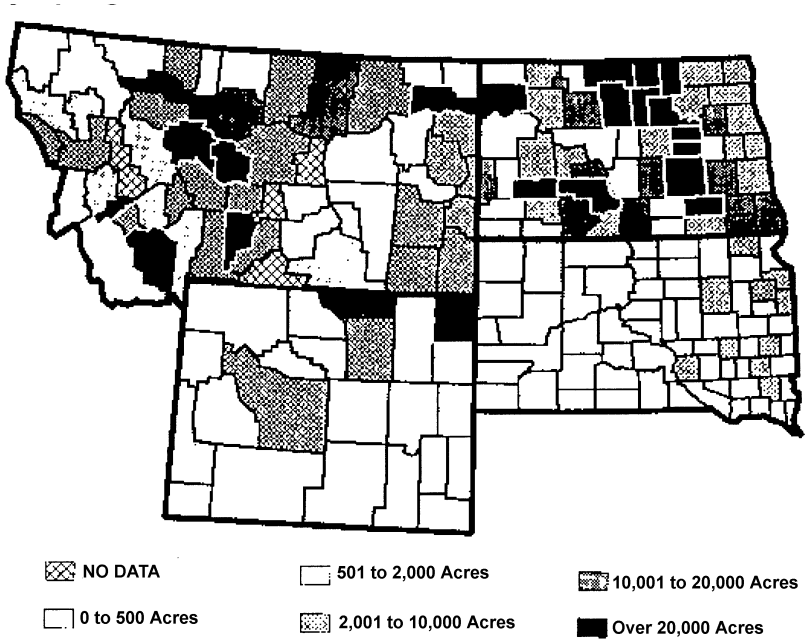

Figure 1. Distribution of leafy spurge on grazing lands in Montana, North Dakota, South Dakota, and Wyoming, 1990.

North Dakota has over 10 times as much leafy spurge acreage as either South Dakota or Wyoming, and about 2.5 times more than Montana; however, only 80 percent of North Dakota's leafy spurge infestations are on grazing lands (Wallace 1991). Leafy spurge appears to be concentrated in central and eastern Montana, north central and east central North Dakota, eastern South Dakota, and northeastern Wyoming (Figure 1).

Carrying capacity reduction

A critical step in estimating the economic impact of any weed is to estimate the amount of lost forage or crop yield reduction due to the infestation. Forage production on grazing lands is usually measured by the number of animals the land can safely support (i.e., its carrying capacity or maximum stocking rate). Carrying capacity was defined as the highest sustainable stocking rate possible.

A carrying capacity reduction model (CCRM), developed by Thompson (1990), was used to estimate the lost forage from leafy spurge infestations. The CCRM estimates the potential AUM reduction for cattle only. Leafy spurge reduces carrying capacity for cattle by (1) inhibiting normal herbage production from direct competition of the spurge plant and (2) reducing available herbage since cattle totally or partially avoid range sites infested with leafy spurge (this effect is accentuated during spring grazing).

The relationship between lost grazing capacity and amount of leafy spurge infestation is approximated by the linear function:

RCC = *CC* * [1 - (1.25 * PI÷100)]

where RCC = reduced carrying

capacity (AUMs/acre)

CC = normal carrying capacity (AUMs/acre)

PI = level of infestation expressed as a percent of land area covered by leafy spurge (%)

A 40 percent leafy spurge infestation would reduce carrying capacity by 50 percent from a practical range management position (Figure 2).

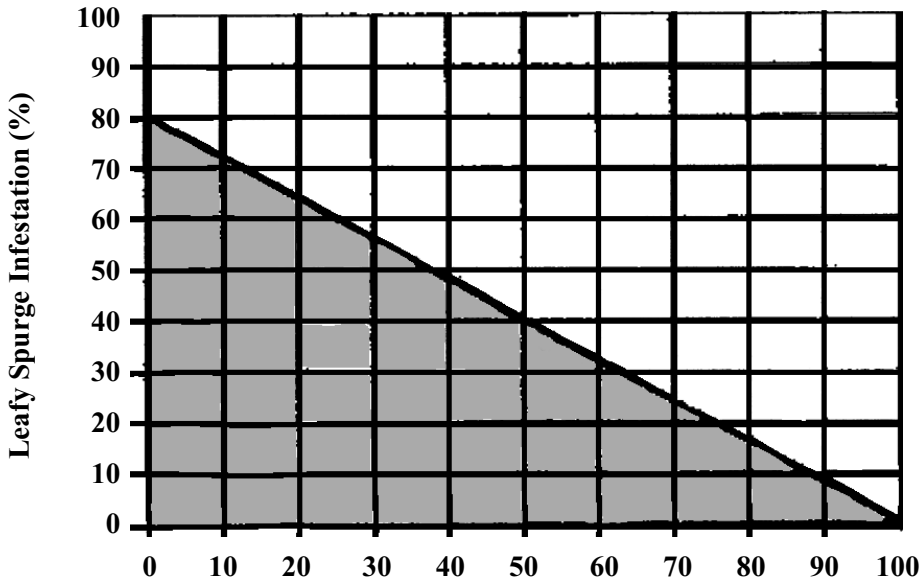

Figure 2. Reduced carrying capacity associated with various levels of leafy spurge infestation.

Grazing lands

The amount of private, state, and federally owned grazing land was estimated for Montana, North Dakota, South Dakota, and Wyoming using data from the Census of Agriculture, state land departments, the United States Bureau of Land Management, and the United States Forest Service. The four states have approximately 144 million grazing acres, with Wyoming and Montana each having about 54 million grazing acres (Table 1).

Grazing capacity

Carrying capacity is generally determined by the number of animal unit months (AUMs) a tract of land can provide. The United States Department of Agriculture Soil Conservation Service in each state provided carrying capacities (AUMs per acre) for private grazing lands or provided information which was used to calculate private carrying capacities. Pasture and rangeland carrying capacities were used with ratios of pasture-to-rangeland to obtain a weighted average carrying capacity that accounts for productivity differences between pasture and rangeland. AUMs produced on private land was estimated at the county level by multiplying private pasture and rangeland acres by the weighted average carrying capacity.

Table 1. Private, state, and federal grazing lands in Montana, North Dakota, South Dakota, and Wyoming, 1990.

State	Grazing Acres by Ownership			Total State
	Private[a]	State[b]	Federal[c]	
Montana	39,970,917	4,153,972	10,276,495	54,401,384
North Dakota	8,541,456	681,858	851,282	10,074,596
South Dakota	22,023,115	795,889	2,156,914	24,975,918
Wyoming	29,013,540	3,638,410	22,098,100	54,750,050
TOTALS	99,549,028	9,270,129	35,382,791	144,201,948

[a] Estimates of private grazing acres were obtained from the U.S. Bureau of the Census. 1987, 1982 & 1978 Census of Agriculture.
[b] Only grazing acres reported by state land departments were included. Grazing acres leased by other state departments or agencies were not included.
[c] Only grazing acres reported by the Bureau of Land Management and the United States Forest Service were included.

AUMs produced on private grazing lands were combined with state and federal AUMs to estimate total AUMs for each state. Assuming no leafy spurge infestation and assuming private rangeland and pasture were grazed at the highest sustainable stocking rates, Montana, North Dakota, South Dakota, and Wyoming produced about 14.2 million, 5.2 million, 14.4 million, and 12.7 million AUMs in 1990, respectively (Table 2).

Valuation of grazing

The value of grazing was estimated to determine the value of the lost AUMs from leafy spurge infestations. Two methods of estimating the value of AUMs were compared: (1) land rental rates and (2) cow-calf enterprise budgeting. The two approaches resulted in similar values for grazing AUMs. The cash rent method of valuing grazing AUMs was adopted for subsequent analyses. Montana and Wyoming had the lowest average rangeland cash rent and also the lowest value per AUM of the four states (Table 3).

Results

Impacts were estimated from two perspectives: (1) losses incurred by landowners and ranchers from leafy spurge infestations on grazing lands and (2) the direct and secondary impacts of leafy spurge infestations on state and regional economies. Impacts on ranchers and landowners included lost AUMs, reduced livestock sales, and decreased land values. All results were calculated at the county or regional level and were presented as state totals.

Economic impacts to ranchers and landowners

The economic impacts of leafy spurge to ranchers and landowners included reduced income from reductions in grazing capacity, foregone livestock sales (from lost grazing

Table 2. Production of private, state, and federal Animal Unit Months in Montana, North Dakota, South Dakota, and Wyoming, 1990.

State	AUMs by Land Ownership			Total State
	Private[a]	State[b]	Federal[c]	
Montana	10,853,878	1,022,263	2,276,634	14,152,974
North Dakota	4,339,134	354,370	561,048	5,254,552
South Dakota	13,558,972	303,545	511,234	14,377,751
Wyoming	8,971,680	941,137	2,827,254	12,740,071
TOTALS	37,723,664	2,621,315	6,176,370	46,525,348

[a] Production of AUMs was based on the assumption that private grazing lands were grazed to capacity. Production of private AUMs was based on carrying capacities that were not adjusted for leafy spurge infestations.

[b] Only AUMs reported by state land departments were included. AUMs leased by other state departments or agencies were not included.

[c] Only AUMs reported by the Bureau of Land Management and the United States Forest Service were included.

Table 3. Average rangeland cash rents, value per Animal Unit Month, number of lost Animal Unit Months, and value of lost Animal Unit Months, for Montana, North Dakota, South Dakota, and Wyoming, 1986-1990.

State	Average Rangeland Cash Rent[a]	Value Per AUM[b]	Number of Lost AUMs	Value of Lost Grazing
	- $/acre -	- dollars -		- dollars -
Montana	3.40	12.52	159,020	2,185,723
North Dakota	8.08	15.90	583,253	8,722,555
South Dakota	7.37	11.98	96,313	1,431,516
Wyoming	3.10	10.04	25,075	221,391
TOTALS	-----	-----	863,661	12,561,185

[a] Average was calculated by weighting cash rent estimates by private grazing acres by county. Cash rent estimates, 1986 through 1990, were adjusted for inflation to represent 1990 dollars using Consumer Price Index Inflators (U.S. Department of Labor, Bureau of Labor Statistics).

[b] Values for AUMs represent private values calculated from private acres and private AUMs. Value per AUM for each state was weighted by the total number of AUMs produced in each country.

capacity), and reduced grazing land values from leafy spurge infestations. The CCRM (Figure 2) was used with the leafy spurge infestation rates to estimate the number of lost AUMs. The value of lost grazing was estimated by applying the value per AUM to the number of lost AUMs. Ranchers and landowners in Montana, North Dakota, South Dakota, and Wyoming lost $2.2 million, $8.7 million, $1.4 million, and $220,000, respectively, in foregone income due to reduced carrying capacity from leafy spurge infestations on grazing lands in 1990 (Table 3).

The value of lost livestock sales was derived from the number of lost AUMs. In 1990, Montana, North Dakota, South Dakota, and Wyoming lost an estimated 159,000, 583,000, 96,000, and 25,000 AUMs, respectively, from leafy spurge infestations. The AUMs lost in Montana, North Dakota, South Dakota, and Wyoming would support beef herds of 17,032, 63,124, 10,424, and 2,685 cows in these states. Those beef herds could have generated $6.9 million in Montana, $28.2 million in North Dakota, $4.6 million in South Dakota, and $1.1 million in Wyoming in livestock sales.

Leafy spurge infestations reduce the productivity of grazing lands, which leads to lower land values in the absence of alternative uses. Potential decreases in land values from leafy spurge infestations were estimated assuming all other determinants of land values remained unchanged.

Potential decreases in land values, which could be expected from current levels of leafy spurge infestations, were estimated using a value-to-rent ratio (1986 to 1990) for private grazing lands. Grazing land values in Montana, North Dakota, South Dakota, and Wyoming were estimated to be reduced by $69.3 million, $123.4 million, $16.4 million, and $5.3 million, respectively.

Direct and secondary impacts on the states' economies

The direct impacts to state economies can be summed from (1) the reduced income to ranchers and landowners from lost grazing capacity and (2) decreases in production outlays associated with ranchers' herd reductions. The total direct economic impacts (value of lost AUMs and expenditure reductions) of leafy spurge infestation on grazing lands in Montana, North Dakota, South Dakota, and Wyoming in 1990 were $5.7 million, $23.2 million, $3.8 million, and $778,000, respectively (Table 4).

The secondary impacts of leafy spurge infestations on grazing lands were estimated using the North Dakota Input-Output Model (Coon *et al.* 1985). The North Dakota Input-Output Model was deemed suitable for measuring impacts in Montana, South Dakota, and Wyoming (Chase *et al.* 1982; Coon *et al.* 1983).

Table 4. Direct and secondary impacts of leafy spurge infestations on the state economies of Montana, North Dakota, South Dakota, and Wyoming, 1990.

State	Direct Impacts: Rancher Incomes	Direct Impacts: Reduced Expenditures	Secondary Impacts	Total Impacts
	dollars (000s)			
Montana	2,186	3,533	12,969	18,688
North Dakota	8,723	14,469	53,130	76,322
South Dakota	1,432	2,389	8,753	12,574
Wyoming	221	556	1,790	2,567
TOTALS	12,562	20,947	76,642	110,151

Total direct impacts of about $33.5 million annually from leafy spurge infestations on grazing lands in Montana, North Dakota, South Dakota, and Wyoming generated about $76.6 million in secondary impacts to the states' economies. Direct and secondary impacts from current levels of leafy spurge in the four states were over $110 million, or $127 per lost AUM in 1990 (Table 4).

Future impacts

Leafy spurge will continue to cause serious problems for ranchers and producers until economical and effective control methods are developed. Since current levels of leafy spurge infestations have substantial economic impacts, ranchers, landowners, and policymakers are concerned about potential future impacts and problems this weed presents.

Leafy spurge infestations in Montana, North Dakota, South Dakota, and Wyoming were assumed to grow unrestricted for five years, using a leafy spurge growth model developed by Stroh *et al.* (1990). Several key assumptions were used to estimate the potential level of leafy spurge infestation in 1995: (1) Current acreage of leafy spurge was broken into quarter acre equivalents to estimate growth. (2) Spread was estimated from existing acreage only; increased acreage from the establishment of new patches was not considered. (3) Current leafy spurge infestations were allowed to spread devoid of restrictions (i.e., no natural and man-made barriers limiting spread and no biological, cultural, or chemical treatments curtailing growth).

Leafy spurge infestations could increase 37 percent by 1995, based on these growth conditions and assumptions. North Dakota could have over 10 percent of its grazing lands infested with leafy spurge by 1995. Direct annual impacts from leafy spurge infestations in

Table 5. Potential impacts of leafy spurge infestations on grazing lands in Montana, North Dakota, South Dakota, and Wyoming in 1995[a].

State	Leafy Spurge Acres		Lost Grazing Capacity	Potential Economic Impacts		
	1990	1995		Direct	Secondary	Total
			- AUMs	---------- dollars (000s) ---------		
Montana	431,162	590,099	217,639	7,800	17,800	25,600
North Dakota[b]	893,239	1,222,509	750,548	29,791	66,259	98,050
South Dakota	79,863	109,302	131,816	5,200	12,800	17,200
Wyoming	61,292	83,886	34,318	1,100	2,400	3,500
TOTALS	1,465,556	2,005,796	1,134,321	43,891	100,459	144,350

[a] Potential expansion of leafy spurge in 1995 was estimated using a leafy spurge grown model developed by Stroh *et al.* (1990). Leafy spurge was assumed to expand without territorial limitations or restrictions from control mechanisms. Acreage from new spurge infestations was not considered. Current prices and costs were used, and no changes in grazing acres and carrying capacities were assumed.

[b] Leafy spurge acres (1.12 million in 1990) were adjusted to reflect only infestations on private and public grazing lands (Wallace 1991).

1995 could reach $7.8 million, $29.8 million, $5.2 million, and $1.1 million in Montana, North Dakota, South Dakota, and Wyoming, respectively. Secondary impacts in 1995 could reach $17.8 million, $68.3 million, $12 million, and $2.4 million in Montana, North Dakota, South Dakota, and Wyoming, respectively. Total economic impacts in the four states could reach over $144 million annually by 1995, a 31 percent increase in just five years (Table 5).

Conclusions

Leafy spurge is a serious problem for ranchers and land managers, businesses dependent upon the grazing industry, and policymakers involved with grazing issues. The effects this weed has on the productivity of grazing lands in the northern Great Plains can readily be seen; however, the scope of the problem is rarely expressed in economic terms. The economic impacts of leafy spurge on grazing lands in Montana, North Dakota, South Dakota, and Wyoming are substantial; with direct and secondary economic impacts in 1990 approaching $34 million and $76.6 million, respectively.

The high levels of foregone income and business activity, which also represent lost tax revenue, reaffirm the need to devote resources to develop viable leafy spurge control technologies. The potential returns from leafy spurge control could be substantial, and continuing efforts to develop economical control methods for leafy spurge remain justified.

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