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Economic impact of leafy spurge on wildland in Montana, South Dakota, and Wyoming

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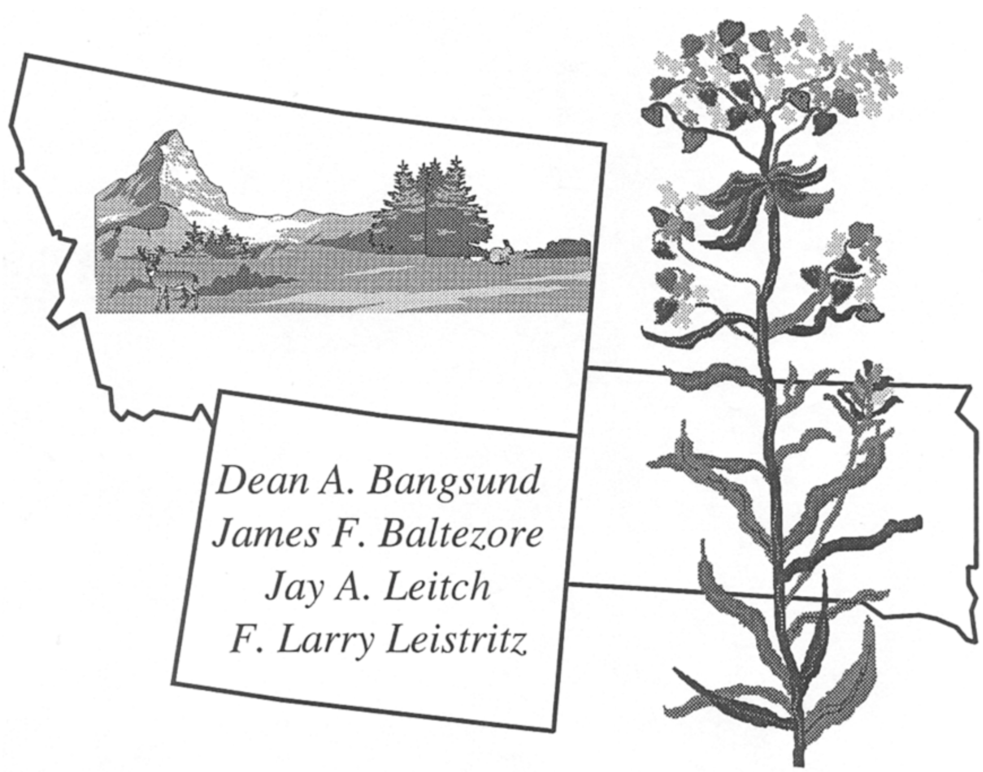

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ECONOMIC IMPACT OF LEAFY SPURGE ON WILDLAND IN MONTANA, SOUTH DAKOTA, AND WYOMING

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HIGHLIGHTS

Leafy spurge is an exotic, noxious perennial weed that has become widely established in the Upper Great Plains. Leafy spurge exhibits exceptional ability to spread and thrive in a variety of habitats. This weed has primarily been thought of as a range management problem; however, it also invades most other untilled land (e.g., wildlife management areas, parks, river banks, road ditches, shelterbelts, and meadows). Once established, leafy spurge displaces native vegetation, which reduces the beneficial outputs from those lands.

Information was gathered on the number of acres of wildland, acres of leafy spurge, value of wildlife-associated recreation, and value of wildland off-site soil and water conservation benefits in Montana, South Dakota, and Wyoming. Montana, South Dakota, and Wyoming had an estimated 30.7, 7.7, and 25.1 million acres of wildland and an estimated 134,000, 68,400, and 15,500 acres of leafy spurge on wildland in 1992, respectively. Wildland was defined as all land except nonfederal agricultural, urban and built-up, and surface water acreage. Tangible outputs from wildland included wildlife-associated recreation and off-site soil and water conservation benefits.

Several conceptional relationships between leafy spurge infestations and wildland outputs were used to estimate the biophysical impacts. Direct annual economic impacts of reduced wildland wildlife-associated recreation expenditures and reduced off-site soil and water conservation benefits were estimated at $465,000, $267,000, and $71,000 in Montana, South Dakota, and Wyoming, respectively. Using an input-output model, secondary economic impacts were estimated at $576,000, $461,000, and $105,000 in Montana, South Dakota, and Wyoming, respectively. Total annual economic impact from leafy spurge infestations on wildland in the three states was estimated at $1.95 million.

The economic impact that leafy spurge caused demonstrate the need to develop economical long-term control methods. However, compared to the impacts leafy spurge caused in North Dakota, impacts of infestations on wildland in Montana, South Dakota, and Wyoming are not staggering. However, leafy spurge infestations on wildland have the potential to cause substantial economic problems in these states as well, and when combined with rangeland impacts, should represent a serious concern for policymakers, landowners, and natural resource managers.

Considering the historic and potential future expansion of leafy spurge, further economic losses are inevitable. Efforts to prevent the weed from spreading to unaffected areas and to control the expansion of established areas should be made, providing the cost of control does not exceed the benefits.

Economic Impact of Leafy Spurge on Wildland in Montana, South Dakota, and Wyoming

Dean A. Bangsund, James F. Baltezore, Jay A. Leitch, and F. Larry Leistritz*

INTRODUCTION

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 on nontilled agricultural land (pasture, rangeland, hay land, and idle cropland) and on other nontilled land (road ditches, shelterbelts, wildlife areas, 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, ranchers, and public land managers.

Leafy spurge was established in Minnesota, North Dakota, Montana, and several eastern states in 1933 (Hanson and Rudd 1933); since then it has spread to several midwestern states. Heavy infestations of leafy spurge can be found in Colorado, Idaho, Minnesota, Montana, Nebraska, North Dakota, South Dakota, and Wyoming. The speed of leafy spurge expansion can be seen by examining the number of acres affected in North Dakota during the past 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 on 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, cost of chemical applications, and value of rangeland production indicate that most chemical treatments on grazing land are not economical (Thompson et al. 1990; Messersmith 1989).

Research to control leafy spurge has focused on developing, expanding, and improving biological agents (insects and plant diseases), 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), only recently have efforts been directed at evaluating the economic impacts of leafy spurge.

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Thompson (1990) estimated the loss of Animal Unit Months (AUMs) of grazing attributable to leafy spurge infestations using a carrying capacity reduction model to determine the economic impacts of leafy spurge infestations on North Dakota rangeland. Thompson (1990) estimated that 577,000 AUMs, valued at $8.6 million, were lost because of leafy spurge infestations on grazing lands in North Dakota. Ranchers and producers did not spend an additional $14.4 million on input costs, which represented reduced revenue for businesses. Thompson (1990) estimated total impacts (direct and secondary) from leafy spurge in North Dakota to be $75 million annually.

Bangsund and Leistritz (1991b) estimated the economic impact of leafy spurge on rangeland in Montana, South Dakota, and Wyoming and updated the estimates for North Dakota. The economic impacts were based on methods Thompson (1990) developed. Direct economic impacts resulting from reductions in AUMs and reduced production outlays ranged from $0.8 million to $23.2 million. Total annual impacts ranged from $2.6 million in Wyoming to $76.3 million in North Dakota.

As early as 1933, leafy spurge was recognized as a serious threat to grazing lands (Hanson and Rudd 1933). The "leafy spurge problem" has continued to be thought of as a range management concern, since impacts from the weed have been predominately measured in terms of grazing losses. The attitude that leafy spurge is essentially a grazing land problem is due primarily to three reasons: (1) tillage operations effectively control the weed in most cropping systems, (2) large acreages of grazing land have focused attention on that resource, and (3) the economic effects of leafy spurge infestations on grazing land are more tangible and recognizable than other economic losses.

However, the "leafy spurge problem" is much broader than just a grazing land problem. In addition to rangeland, leafy spurge invades most other untilled land (e.g., wildlife management areas, parks, riverbanks, road and drainage ditches, shelterbelts, meadows, and forest lands). Once established on these lands, the weed spreads quickly, displacing native vegetation and reducing the value of the land's output (Wallace 1991). Although "wildland" outputs are not directly reflected in the marketplace, they possess value and are important contributors to outdoor recreation, erosion control, and aesthetic beauty.

Wallace (1991) estimated the economic impact of leafy spurge on wildland in North Dakota. Wallace (1991) defined wildland as all land not agricultural, urban and built-up, industrial, or surface water. Wildland outputs were grouped into market goods (mineral and forest products) and nonmarket goods (outdoor recreation, wildlife production and habitat, erosion control, watershed benefits, and intangibles). Two models were developed to estimate the loss of wildland wildlife habitat values and losses of soil and water conservation benefits. Direct annual reductions in wildlife-associated recreation from leafy spurge infestations on North Dakota wildland were $2.9 million and impacts of reduced soil and water conservation benefits were $0.7 million. Total economic impacts were $11 million.

Difficulty in controlling leafy spurge on wildland, expanding infestations of leafy spurge on wildland, increasing awareness of wildland benefits, and the realization that leafy spurge can decrease the outputs of wildland have heightened the concern over determining the economic impacts of leafy spurge. Economic information on leafy spurge infestations is also important for policymakers and land managers when allocating resources used to develop viable leafy spurge control technologies and implementing weed management strategies.

OBJECTIVES

The purpose of this report is to estimate the economic impacts (direct and secondary) of leafy spurge infestations on wildland in Montana, South Dakota, and Wyoming. Specific objectives include

1) estimating total acres of wildland and acres of wildland infested with leafy spurge in Montana, South Dakota, and Wyoming,

2) estimating the economic impact of leafy spurge on the outputs of Montana, South Dakota, and Wyoming wildland,

3) estimating the economic impact of leafy spurge infestations on wildland to the state economies of Montana, South Dakota, and Wyoming, and

4) estimating the economic impact of leafy spurge infestations on wildland on the multistate regional economy.

PROCEDURES

The methods and analyses used in this report parallel those of Wallace et al. (1992). Wildland acreage was estimated using published data. Acres of leafy spurge on wildland were estimated using a survey of county weed board representatives (Appendix A). Wildland benefits/outputs defined by Wallace (1991) were adopted for this study and include wildlife-associated recreation, soil and water conservation, and intangibles.

The value of wildlife-associated benefits was based on expenditures of individuals participating in wildlife-associated activities. Benefits of soil and water conservation were based on changes in water users' expenditures made to mitigate off-site water quality damages.

Wallace (1991) identified the biophysical impacts of leafy spurge on wildland from published literature and input from wildlife and soil science specialists. The biophysical impacts included reduced wildlife habitat and loss of soil and water erosion benefits. The impacts were applied to the value of wildland benefits to estimate the direct economic impacts, which were applied to the North Dakota Input-Output (I-O) Model to estimate secondary economic impacts to the states' economies. This I-O model was deemed appropriate for measuring impacts in Montana, South Dakota, and Wyoming because (1) the economic structure of these three states is similar to that of North Dakota and (2) empirical testing has indicated that the North Dakota I-O coefficients are accurate in estimating changes in levels of economic activity for Montana and Wyoming (Chase et al. 1982; Coon et al. 1983).

WILDLAND DEFINITION

Randall and Peterson (1984) defined wildland as land *not* used for industrial, urban, or agricultural purposes and included forests, recreation areas, and wilderness. Wallace (1991) estimated acreage of wildland in North Dakota by excluding only nonfederal agricultural, urban and built-up, and surface water acreage from the state's total land area. Published literature did not contain estimates of wildland acreage in Montana, South Dakota, and Wyoming using this definition or other measures. Wildland acreage in these states was estimated by excluding nonfederal agricultural land, urban and built-up, and surface water from each state's total land area (Table 1).

TABLE 1. ACREAGE OF WILDLAND IN MONTANA, SOUTH DAKOTA, AND WYOMING, 1987

Land Use/Cover	Montana	South Dakota	Wyoming
	----------	acres	----------
Total land area:	93,952,500	49,354,000	60,649,800
Less:			
Cropland	17,880,700	17,819,000	2,361,800
Pasture and rangeland[a]	44,124,900	22,819,000	32,651,900
Urban and built-up land	205,400	239,600	157,700
Surface water	1,055,200	767,800	375,100
Wildland estimate	**30,686,300**	**7,708,600**	**25,103,300**

[a] Only private and state rangeland are included in the category. Thus, federal rangeland is included in the wildland estimate.

SOURCES: U.S. Soil Conservation Service 1989abc, 1984abc; U.S Bureau of the Census 1989abc, 1984abc, 1981abc.

Federal lands used for grazing were included in the wildland definition. Federal lands were assumed to be managed for multiple uses/products. Leafy spurge on federal lands impacts grazing activity, soil conservation, and wildlife populations. The impacts of leafy spurge on the grazing capacity of these lands have been estimated (Bangsund and Leistritz 1991a); however, other leafy spurge impacts (i.e., soil conservation, wildlife populations) on these lands have not been estimated. State and private rangeland were assumed to be managed for grazing and were excluded from the wildland definition, even though these lands may also support wildlife.

A survey of county weed board representatives was used to estimate leafy spurge infestations on private and public land (Appendix A). Private land was divided into rangeland, cropland, and other private land (i.e., shelterbelts, drainage ditches, wetlands,); and public land was divided into road ditches, rangeland, public recreation and wildlife production areas, military, and other public land. Survey results were applied to each state's current county estimate of leafy spurge infestations to determine the amount of leafy spurge on wildland (Appendix B).

Montana, South Dakota, and Wyoming had about 134,000, 68,400, and 15,500 acres of wildland infested with leafy spurge in 1992, respectively (Table 2). The questionnaire did not separately list leafy spurge infestations on state and federal grazing lands. Leafy spurge infestations on these lands were assumed proportionate to the number of acres in each class of grazing land (i.e., federal land had the same percentage of land infested with leafy spurge as state grazing land).

TABLE 2. ESTIMATED LEAFY SPURGE ACREAGE ON WILDLAND IN MONTANA, SOUTH DAKOTA, AND WYOMING, 1992

Land Use/Cover	Montana	South Dakota	Wyoming
	------------------------------ acres ------------------------------		
Private other	36,765	22,745	2,157
Road ditches	24,042	21,128	854
Federal rangeland	53,403	1,613	5,335
Recreation and wildlife production areas	16,150	16,612	6,806
Military and other areas	3,546	6,284	335
Totals	**133,906**	**68,382**	**15,487**

SOURCES: Survey of county weed board representatives; Montana Department of Agriculture 1992; South Dakota Department of Agriculture 1992; Wyoming Department of Agriculture 1992.

WILDLAND BENEFITS

Wildland provides a variety of outputs, such as grazing, forest products, and mineral resources (market goods); and recreation, wildlife production and habitat, erosion control, and watershed benefits (nonmarket goods) (Randall and Peterson 1984). Wildland may have additional benefits, such as aesthetics, education, or natural products, which may have direct or indirect economic impacts; however, the physical science and the valuation techniques to identify and quantify them are inadequate (Wallace 1991). This study will focus on the value and effect leafy spurge has on nonmarket wildland outputs. Nonmarket goods from wildland were divided into three categories: 1) wildlife-associated recreation, 2) soil and water conservation benefits, and 3) intangible benefits.

Wildlife-associated Recreation

Wildland, like other types of land, provides habitat for wildlife. The existence of wildlife (i.e., wildlife habitat and its outputs) is an important part of many outdoor recreation activities. Money people spend to participate in consumptive (e.g., hunting) or nonconsumptive (e.g., wildlife photography) wildlife recreation impacts local and state economies. Wildlife-associated expenditures can include purchases of ammunition, guns, licenses, gas, lodging, and other goods and services. Total wildlife-associated recreation expenditures in 1992, excluding fishing activities, were $134.7 million, $114.1 million, and $207.2 million in Montana, South Dakota, and Wyoming, respectively (Table 3).

Soil and Water Conservation

Soil and water conservation benefits on wildland include preserving topsoil and plant nutrients and reducing water runoff. Benefits from reduced water runoff include lower water treatment costs, lower sediment removal costs, decreased flood damage, and increased recreational fishing (Ribaudo 1989).

Ribaudo (1989) estimated the benefits of placing highly erodible cropland into the Conservation Reserve Program (CRP). The CRP was designed to take highly erodible cropland out of production and place it into permanent cover. Runoff and soil erosion are reduced when tilled land is converted to permanent cover, reducing off-site water quality damages. Benefits of the reduced runoff are equal to the reduction in expenditures formerly necessary to mitigate damages from nonpoint source pollution (Ribaudo 1986).

The off-site benefits of placing cropland in the CRP for Montana, South Dakota, and Wyoming were previously estimated (Ribaudo 1989). The present value of those benefits was calculated by adjusting past values for inflation. The off-site benefits were estimated at $79.80 per acre for Montana and Wyoming and $48.80 per acre for South Dakota. Discounting the stream of benefits at a 4 percent discount rate (Ribaudo 1989) over the 10-year life of the CRP contract resulted in annual benefits of $9.80 per acre in Montana and Wyoming and $6.02 per acre in South Dakota. Wildland and CRP have similar soil and water conservation benefits (Wallace et al. 1992) allowing the off-site water conservation benefits of pre-leafy spurge wildland to be estimated. By multiplying the off-site water conservation benefits of CRP by acres of wildland, wildland soil and water conservation benefits were estimated at $300.7 million, $46.4 million, and $246 million in Montana, South Dakota, and Wyoming, respectively.

TABLE 3. WILDLIFE-ASSOCIATED RECREATION EXPENDITURES
AND PARTICIPANTS IN MONTANA, SOUTH DAKOTA, AND WYOMING, 1992

Recreation Category	Expenditures[a]	Participants[c]
	--$1,000--	--1,000--
Montana		
Consumptive wildlife-associated recreation		
Resident	34,094.7[b]	143.3
Nonresident	44,478.8[b]	51.3
Total 78,573.5	194.6	
Nonconsumptive wildlife-associated recreation		
Resident	16,185.9[a]	138.9
Nonresident	39,928.8[a]	296.0
Total 56,114.7	434.9	
Total wildlife-associated recreation	**134,688.2**	**629.5**
South Dakota		
Consumptive wildlife-associated recreation		
Resident	32,382.0[a]	106.5
Nonresident	21,540.3[a]	48.5
Total 53,922.4	155.0	
Nonconsumptive wildlife-associated recreation		
Resident	36,791.0[a]	157.3
Nonresident	23,395.0[a]	135.1
Total 60,186.0	292.4	
Total wildlife-associated recreation	**114,108.4**	**447.4**
Wyoming		
Consumptive wildlife-associated recreation		
Resident	32,808.8[a]	102.3
Nonresident	39,163.6[a]	66.3
Total 71,972.3	168.6	
Nonconsumptive wildlife-associated recreation		
Resident	27,109.4[a]	136.4
Nonresident	108,139.9[a]	414.4
Total 135,249.3	550.8	
Total wildlife-associated recreation	**207,221.6**	**719.4**

[a]Expenditures reported in 1985 were inflated to 1992 dollars, using the GNP implicit price deflator. Consumptive wildlife-associated recreation expenditures represent in-state trip-related expenditures and exclude expenditures for special and auxiliary equipment. Nonconsumptive wildlife- associated recreation expenditures represent primary nonresidential expenditures and exclude primary residential and secondary residential and nonresidential expenditures.
[b]Expenditures were obtained from various reports from the Montana Department of Fish, Wildlife, and Parks, Helena, Montana. Expenditures were inflated to 1992 dollars, using the GNP implicit price deflator.
[c]Participants in nonconsumptive wildlife-associated recreation either observed, photographed, or fed wildlife.
SOURCE: U.S. Fish and Wildlife Service 1989.

Intangibles

Existence and option values are two nonmarket benefits of wildlands. Existence value is the value an individual places on a resource from simply "knowing" that it exists, without ever intending to use the resource. Option values are similar to existence values, except option values include the possibility of future use. These two types of values are generally thought to apply only to unique and irreplaceable resources. At the margin, wildland may be neither unique nor irreplaceable. In addition, intangible benefits, such as existence and option values, are nonmarket benefits that accrue to individuals as consumer surplus and, as such, do not monetarily impact the economy (Wallace 1991). Although intangibles are recognized as wildland benefits, they have no direct or indirect monetary impact on state economies and were not included in the economic impacts.

BIOPHYSICAL IMPACTS

Leafy spurge possesses the ability to literally choke out most existing native vegetation (Watson 1985; Belcher and Wilson 1989; Messersmith et al. 1985). The establishment of leafy spurge can be directly related to a decline in native vegetation, threatening native and existing wildland vegetation (Belcher and Wilson 1989). A substantial change in plant diversity that can result from leafy spurge infestations may not provide the necessary habitat to support indigenous wildlife and may negatively impact wildland soil and water conservation.

Wildlife-associated Recreation

Any plant that can change a diverse plant community into a monoculture is a potential threat to wildlife habitat. Floral monocultures can reduce the interspersion of cover types, which reduces habitat (U.S. Department of Agriculture 1989). Wallace (1991) suggested a relationship between leafy spurge and wildland habitat value, assuming changes in plant diversity of wildlife habitat affect wildlife carrying capacities (i.e., the ability of the land to support wildlife populations) (Figure 1). Estimates of reduced wildland habitat value from leafy spurge infestations were used to estimate the economic impact of leafy spurge on wildland wildlife-associated recreation.

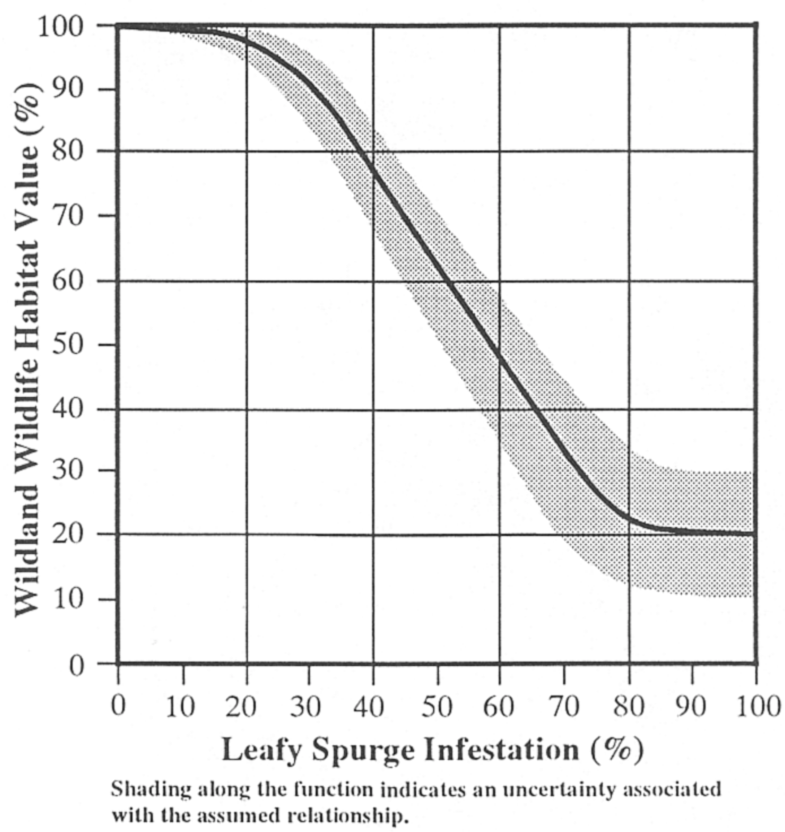

Figure 1. Assumed Relationship Between Wildland Wildlife Habitat Value and Leafy Spurge Infestation Rates

<u>Soil and Water Conservation</u>

Displacing native and existing vegetation on wildland affects the character and composition of wildland vegetative cover. Vegetative cover directly affects runoff and soil erosion. More diverse plant cover is generally preferable to less diverse cover for reducing soil erosion. As leafy spurge displaces diverse plant cultures with monocultures, the erodibility of the land is increased, thereby affecting the on-site and off-site erosion damages. On-site soil erosion damages primarily consist of reduced soil productivity from a loss of soil structure and plant nutrients. Degradation of surface water from runoff carrying sediment, nutrients, and pesticides is off-site soil erosion damages (Rodgers et al. 1990; Ribaudo 1986, 1989). Off-site soil erosion damages include increased flood damage, damage to aquatic ecosystems, reduced water-based recreation opportunities, increased municipal and industrial water treatment cost, accelerated loss of water storage capacity, and aggradation and siltation of navigation and water conveyance channels (Ribaudo 1986, 1989).

The Conservation Reserve Program (CRP), through the enrollment of highly erodible cropland, has increased off-site water quality benefits (Ribaudo 1989). By placing highly erodible cropland into the CRP, less diverse vegetative cover (crop monoculture) was converted to more diverse vegetative cover (trees and grassland). The change from monoculture to diverse vegetative cover on the highly erodible cropland has improved off-site water quality.

A converse scenario can be drawn from leafy spurge infestations on wildland. As vegetative cover changes from more to less diverse, runoff and soil erosion may increase, degrading off-site water quality. Wallace (1991) suggested a relationship between leafy spurge infestations on wildland and changes in off-site water quality benefits, based on two key assumptions: (1) wildland without leafy spurge provides on- and off-site soil and water conservation benefits analogous to CRP land and (2) wildland with leafy spurge provides fewer on- and off-site soil and water conservation benefits than wildland without leafy spurge. A 100 percent leafy spurge infestation was assumed to reduce wildland off-site water conservation benefits by one-fourth (Figure 2).

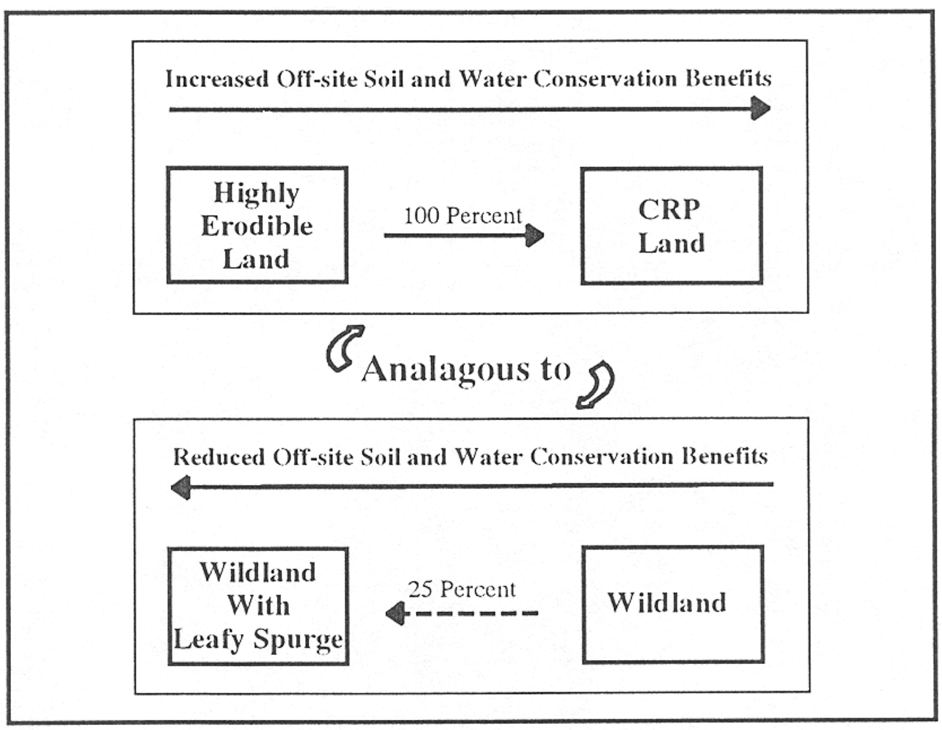

Figure 2. Relationship Between Highly Erodible Land, Conservation Reserve Program, and Wildland

ECONOMIC IMPACTS

Economic impacts of a project, program, or policy can be categorized into direct and secondary impacts. The direct impacts are those changes in output, employment, or income that represent the initial (or direct) effects of the project or program. The secondary impacts (sometimes further categorized into indirect and induced effects) result from subsequent rounds of spending and respending within the economy. This process of spending and respending is sometimes termed the multiplier process, and the resultant secondary effects are sometimes referred to as multiplier effects (Leistritz and Murdock 1981).

Direct Impacts

Direct economic impacts from leafy spurge infestation of wildland include (1) changes in wildlife-associated recreationist expenditures that impact local suppliers of related goods and services and (2) changes in user expenditures to mitigate damages from runoff and soil erosion. The following sections describe these impacts.

Wildlife-associated Recreation

Wallace (1991) developed the following equation to estimate the reduction in wildlife-associated expenditures:

$$R = (E * C)(H * W)(S)$$

where
- R = Change in wildlife-associated recreation expenditures from leafy spurge infestation on wildland
- E = Total wildlife-associated recreation expenditures
- C = Species/land use coefficient
- H = Percentage reduction in wildlife habitat value
- W = Percentage of leafy spurge-infested wildland
- S = Percentage of expenditures lost to state economy

Assessing the impacts of leafy spurge infestations on wildland begins with the relationship of leafy spurge and wildland wildlife habitat value. The area of leafy spurge-infested wildland is assumed to be 100 percent infested, thus reducing wildland wildlife habitat value (H) 80 percent (see Figure 1). The percentage of wildland infested with leafy spurge (W) was 0.44 percent, 0.89 percent, and 0.06 percent in Montana, South Dakota, and Wyoming, respectively. Leafy spurge infestations on wildland were estimated to reduce the overall value of wildlife habitat (H * W) by 0.35 percent, 0.71 percent, and 0.05 percent in Montana, South Dakota, and Wyoming, respectively.

The species/land use coefficient (C) represents the relative importance of different land uses in supporting current wildlife populations. Wallace (1991) used a coefficient for wildland of 0.4, or 40 percent, in North Dakota. The coefficient for North Dakota suggests that the state's wildland, which comprises 10 percent of the state's total land area, supports 40 percent of the state's wildlife.

This figure was appropriate for North Dakota, considering the mix of wildlife in the state and the amount of wildland in the state. However, because of differences in the mix of wildlife, wildland characteristics, and the amount of wildland in Montana, South Dakota, and Wyoming, the coefficient that Wallace (1991) developed was not considered applicable for this analysis.

A species/land use coefficient curve was developed, based on the work of Wallace (1991) and Leitch (1978). The curve can be used to estimate species/land use coefficients for situations with varying amounts of wildland (Figure 3). The species/land use coefficients (C) for Montana, South Dakota, and Wyoming were estimated to be 0.69, 0.48, and 0.77, respectively. The species/land use coefficient multiplied by total wildlife-associated expenditures provides an estimate of wildlife-associated expenditures attributable to wildland. Multiplying the reduction in wildland wildlife habitat value (H * W) by wildland wildlife-associated recreation expenditures (E * C) estimates the reduction in wildlife-associated recreation expenditures from leafy spurge infestations on wildland.

Individuals will partake in other in-state recreational activities in the absence of an opportunity to participate in wildlife-associated recreation. However, some expenditures previously spent in-state will be spent on recreational activities in other states (S), representing a loss to the state economy. Baltezore and Leitch (1992) reported 42 percent of recreationists would pursue their favorite recreation activities out of state if they were not available in North Dakota. The characteristics of recreationists in Montana, South Dakota, and Wyoming were assumed to be similar to those in North Dakota.

Direct economic impacts (reduced expenditures) from wildlife-associated recreation due to leafy spurge infestations on wildland were $137,395, $163,790, and $33,079 in Montana, South Dakota, and Wyoming, respectively (Figure 4).

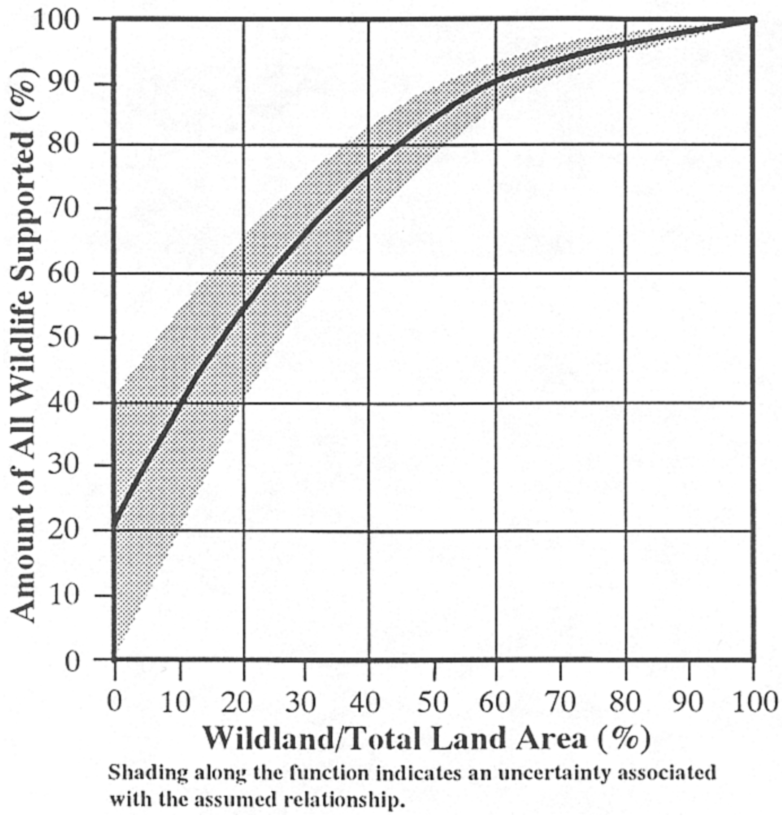

Figure 3. Relationship Between the Amount of Wildland and the Amount of Wildlife Supported by Wildland

MONTANA	SOUTH DAKOTA	WYOMING		
$134,688,200	$114,108,400	$207,221,600	(E)	Wildlife-associated recreation expenditures
0.69	0.48	0.77	(C)	Species/land use coefficient
80%	80%	80%	(H)	Percentage reduction in wildlife habitat value
0.4400%	0.8900%	0.0617%	(W)	Percentage of leafy spurge-infested wildland
42%	42%	42%	(S)	Percentage of expenditures lost to state economy
R = (E x C) (H x W) (S)				Model
$137,395	$163,790	$33,079	(R)	Change in wildlife-associated recreation expenditures

Figure 4. Calculations for Reduced Wildlife-associated Recreation Expenditures From Leafy Spurge Infestations on Wildland in Montana, South Dakota, and Wyoming, 1992

Soil and Water Conservation

Direct economic impacts from soil and water conservation represent changes in expenditures to prevent or counteract damage from pollutants. Water for industrial and municipal use generally requires treatment. Changes in treatment costs represent potential benefits (costs) of increased (decreased) water quality. Increased (decreased) water quality represents direct economic benefits (damages) to water users.

Reductions in soil and water conservation benefits from leafy spurge-infested wildland can be estimated by applying the assumed 25 percent reduction in wildland soil and water conservation benefits (erosion control) to the value per acre of off-site water and conservation benefits from CRP land. Multiplying the per acre reduction in soil and water conservation benefits from wildland by the number of leafy spurge-infested wildland acres results in total off-site soil and water conservation damages. Reductions in soil and water conservation benefits from leafy spurge-infested wildland were about $328,000 (0.25 * $9.80 * 133,906), $103,000 (0.25 * $6.02 * 68,382), and $38,000 (0.25 * $9.80 * 15,487) in Montana, South Dakota, and Wyoming, respectively.

Secondary Impacts

The secondary impacts of leafy spurge infestations were estimated using the North Dakota Input-Output Model (Coon et al. 1990). Input-Output (I-O) analysis is a mathematical tool that traces linkages among sectors of an economy and calculates the total business activity resulting from a direct impact in a basic sector. The I-O model has 18 sectors and was developed from primary (survey) data from firms and households in North Dakota.

The first step in calculating the secondary impacts was to allocate the direct impacts into the appropriate economic sectors. Four of the 18 sectors of the North Dakota Input-Output Model were used to allocate the direct impacts. Direct economic impacts from reduced wildlife-associated recreation were allocated to the **Tourism and Recreation** sector. Expenditures in this sector include auto transportation (e.g., gasoline service stations), lodging (e.g., motels and hotels), food service (e.g., restaurants), entertainment/recreation (e.g., theaters), and general retail trade (Coon et al. 1990).

Direct economic impacts from reduced soil and water conservation benefits were allocated to the **Government**, **Agriculture-Crops**, and **Electricity Generation** sectors. The **Government** sector includes expenditures by executive, legislative, judicial, administrative, and regulatory activities for federal, state, local, and international governments (Coon et al. 1985). Direct impacts allocated to the **Government** sector represent the additional cost of water treatment for municipal and commercial use, damage to water storage facilities, and navigation impacts. The **Agriculture-Crops** sector represents crop production, and the direct impacts allocated to this sector represent flood damages and siltation of irrigation ditches. The **Electricity Generation** sector represents expenditures for electricity generation. The direct impacts allocated to the **Electricity Generation** sector represent additional steam power cooling expenses for hydroelectric activities.

Total direct impacts of $465,000 from leafy spurge infestations on wildland in Montana generated $576,000 in secondary economic impacts to the state's economy, which included $185,000 in lost income in the **Households** sector, $137,000 in lost retail activity in the **Retail Trade** sector, and $85,000 in the **Agricultural Processing and Miscellaneous Manufacturing** sector (Table 4). Total direct impacts of $267,000 from leafy spurge infestations on wildland in South Dakota generated $461,000 in secondary economic impacts to the state's economy, which included $140,000 in lost income in the **Households** sector, $95,000 in lost retail activity in the **Retail Trade** sector, and $88,000 in the **Agricultural Processing and Miscellaneous Manufacturing** sector (Table 5). Total direct impacts of $71,000 from leafy spurge infestations on wildland in Wyoming generated $105,000 in secondary economic impacts to the state's economy, which included $33,000 in lost income in the **Households** sector, $23,000 in lost retail activity in the **Retail Trade** sector, and $18,000 in the **Agricultural Processing and Miscellaneous Manufacturing** sector (Table 6).

The North Dakota I-O Model also estimates secondary employment. Employment estimates represent the number of jobs previously supported by the amount of business activity that was lost. Leafy spurge infestations on wildland represent a reduction in business activity that would support 27, 11, and 2 jobs in Montana, South Dakota, and Wyoming, respectively, in 1992.

TABLE 4. DIRECT, SECONDARY, AND TOTAL ECONOMIC IMPACTS OF LEAFY SPURGE INFESTATIONS ON WILDLAND IN MONTANA, 1992

Economic Sector		Economic Impacts of Leafy Spurge Infestation		
		Direct	Secondary	Totals
		---------------- dollars (000s) ----------------		
Agriculture-livestock		0	18	18
Agriculture-crops		95	35	130
Nonmetal mining		0	1	1
Construction	0	15	15	
Transportation		0	3	3
Communication and public utilities		0	20	20
Agricultural processing and miscellaneous manufacturing		0	85	85
Retail trade		0	137	137
Finance, insurance, and real estate		0	31	31
Business and personal service		0	14	14
Professional and social service		0	13	13
Households		0	185	185
Government		230	19	249
Coal mining		0	0	0
Electricity generation		3	0	3
Petroleum exploration and extraction		0	0	0
Petroleum refining		0	0	0
Tourism and recreation		137	0	137
TOTALS	465	576	1,041	
Number of jobs lost				27

TABLE 5. DIRECT, SECONDARY, AND TOTAL ECONOMIC IMPACTS OF LEAFY SPURGE INFESTATIONS ON WILDLAND IN SOUTH DAKOTA, 1992

Economic Sector		Economic Impacts of Leafy Spurge Infestation		
		Direct	Secondary	Totals
		---------------- dollars (000s) ----------------		
Agriculture-livestock		0	15	15
Agriculture-crops		30	34	64
Nonmetal mining		0	1	1
Construction	0	11	11	
Transportation		0	2	2
Communication and public utilities		0	17	17
Agricultural processing and miscellaneous manufacturing		0	88	88
Retail trade		0	95	95
Finance, insurance, and real estate		0	22	22
Business and personal service		0	11	11
Professional and social service		0	10	10
Households		0	140	140
Government		72	15	87
Coal mining		0	0	0
Electricity generation		1	0	1
Petroleum exploration and extraction		0	0	0
Petroleum refining		0	0	0
Tourism and recreation		164	0	164
TOTALS	267	461	728	
Number of jobs lost				11

TABLE 6. DIRECT, SECONDARY, AND TOTAL ECONOMIC IMPACTS OF LEAFY SPURGE INFESTATIONS ON WILDLAND IN WYOMING, 1992

Economic Sector		Economic Impacts of Leafy Spurge Infestation		
		Direct	Secondary	Totals
		---------------- dollars (000s) ----------------		
Agriculture-livestock		0	3	3
Agriculture-crops		11	7	18
Nonmetal mining		0	0	0
Construction	0	3	3	
Transportation		0	1	1
Communication and public utilities		0	4	4
Agricultural processing and miscellaneous manufacturing		0	18	18
Retail trade		0	23	23
Finance, insurance, and real estate		0	5	5
Business and personal service		0	3	3
Professional and social service		0	2	2
Households		0	33	33
Government		27	3	30
Coal mining		0	0	0
Electricity generation		0	0	0
Petroleum exploration and extraction		0	0	0
Petroleum refining		0	0	0
Tourism and recreation		33	0	33
TOTALS	71	105	176	
Number of jobs lost				2

Multistate Impacts

Total direct impacts of about $803,000 annually from leafy spurge infestations on wildland in Montana, South Dakota, and Wyoming generated about $1.14 million in secondary impacts to the states' economies. Direct and secondary impacts from leafy spurge infestations on wildland in Montana, South Dakota, and Wyoming in 1992 approached $2 million. **Government** ($366,000), **Households** ($358,000), **Tourism and Recreation** ($334,000), **Retail Trade** ($255,000) and **Agriculture-Crops** ($212,000) sectors of the states' economies were most affected by leafy spurge infestations on wildland. Water treatment costs, personal income, wildlife-associated recreation, retail activity, and crop sales were the economic areas (activities) with the greatest direct and secondary impacts. In addition, approximately 40 jobs could be lost as a result of leafy spurge infestations on wildland in the three states.

Wallace (1991) estimated the direct annual reductions in wildlife-associated recreation from relatively greater leafy spurge infestations on North Dakota wildland were $2.9 million and the impacts of reduced soil and water conservation benefits were $0.7 million. Total impacts were estimated at $11 million. The total impacts in North Dakota were about five times greater than the combined effects in Montana, South Dakota, and Wyoming. Although the magnitude of the impacts between North Dakota and Montana, South Dakota, and Wyoming are not comparable, most of the sectors within each state's economy were affected proportionately, with the exception of the **Tourism and Recreation** sector. The Tourism and Recreation sector represented nearly 90 percent of the total impacts in North Dakota, compared to about 40 percent of the impacts in Montana, South Dakota, and Wyoming. The loss of jobs in North Dakota from leafy spurge on wildland was about four times greater than the combined loss of jobs in Montana, South Dakota, and Wyoming.

CONCLUSIONS

Leafy spurge is a serious concern for land managers and operators of non-tilled agricultural land and other non-tilled land (e.g., parks, watersheds, lake shores, road ditches). The weed thrives in non-tilled land, especially in native rangeland, where it crowds out vegetation and restricts cattle from grazing grasses and forages. Leafy spurge is prolific, adapts to a variety of growing conditions, and withstands most economical levels of chemical treatment.

This plant's persistent and aggressive nature, combined with current infestation rates in many areas of the Northern Great Plains, has prompted producers and policymakers to express concerns about the amount of resources that should be devoted to developing viable leafy spurge control technologies. Economic information on leafy spurge infestations should help to quantify the importance of leafy spurge control and should provide useful information about allocating resources among control technologies.

The purpose of this report was to estimate the economic impacts (direct and secondary effects) of leafy spurge infestations on wildlands in Montana, South Dakota, and Wyoming. Information was gathered on the number of acres of wildland, acres of leafy spurge, value of wildlife-associated recreation, and value of wildland off-site soil and water conservation benefits in Montana, South Dakota, and Wyoming. Direct impacts included reduced wildlife-associated recreation and reduced off-site wildland soil and water conservation. Secondary impacts were estimated using an input-output model.

Montana, South Dakota, and Wyoming had about 134,000, 68,400, and 15,500 acres of leafy spurge on wildland in 1992, respectively. Current impacts (direct and secondary) from leafy spurge infestations on wildland were $1,041,000, $728,000, and $176,000 in Montana, South Dakota, and Wyoming, respectively. Also, 27, 11, and 2 jobs were potentially lost as a result of the impacts from leafy spurge infestations on wildland in Montana, South Dakota, and Wyoming, respectively.

The impacts from leafy spurge on wildland in Montana, South Dakota, and Wyoming are not yet serious, considering the combined impacts are about one-fifth of the wildland impacts in North Dakota. However, three issues should be considered. First, considering the potential for leafy spurge to spread, its ability to adapt to different environments, and its resistance to current control methods, Montana, South Dakota, and Wyoming could quickly face the widespread economic losses leafy spurge has caused in North Dakota. Second, leafy spurge has the potential to cause widespread damage in Montana, South Dakota, and Wyoming, since the three states have similar land types and growing conditions and each has well established leafy spurge infestations. Third, wildland impacts should be combined with grazing land impacts. Currently, leafy spurge on wildland represents a smaller economic problem than on grazing land. When wildland and rangeland impacts are combined, the economic losses caused by leafy spurge should concern landowners, policymakers, and natural resource managers.

IMPLICATIONS

This study used the methods and procedures of Wallace (1991), who identified several gaps in natural and physical science data. The data problems that persist include

- a more complete and accurate assessment of leafy spurge infestations; for example, the difference between a complete invasion (i.e., solid leafy spurge) and a slight infestation (i.e., occasional plants or small, isolated patches),

- expansion of the annual estimation of leafy spurge infestation per county to include the land use/cover on which the infestation occurs (e.g., rangeland or road ditches), and

- identification of land ownership (e.g., public or private, federal or state).

Biophysical research needs include

- a more precise description of the physical relationship between leafy spurge, wildland, and wildlife populations (e.g., Figure 1), and

- research to describe the impact of leafy spurge on runoff and soil erosion.

This information would allow for a more confident assessment of the impacts of leafy spurge on different types of land as well as identify and estimate who is impacted.

Considering the historic and potential future expansion and the economic damages leafy spurge has caused in North Dakota, continued research to refine the estimate of the biophysical and economic impacts of leafy spurge on wildland is warranted. Reliable methods are available to refine the estimate of economic impacts of leafy spurge on wildland, provided the physical relationship between leafy spurge and wildland outputs can be better described.

Other areas of concern include potential overestimates or underestimates in wildland and rangeland impacts because of

- the inclusion of federal land in both rangeland and wildland impact estimates, even though including federal land that is managed for multiple uses/products may overestimate the economic impacts,

- the exclusion of wildlife-associated benefits from rangeland impacts; rangeland does provide some wildlife habitat, which, when excluded, may underestimate the economic impacts, and

- unidentified impacts of leafy spurge on rangeland soil and water conservation benefits; leafy spurge may provide greater soil and water conservation benefits than overgrazed rangeland, thus providing a benefit, or it may represent a reduction in benefits as on wildland.

Even though the dollar amount of leafy spurge infestations on wildland in Montana, South Dakota, and Wyoming is an approximation, the near term continued expansion of leafy spurge is almost certain, leading to further reductions in personal income and business activity. The estimates of the economic impacts of leafy spurge on wildland and rangeland in North Dakota suggest that leafy spurge is a major problem. Leafy spurge could cause similar problems in Montana, South Dakota, and Wyoming. Considering the expansion of leafy spurge, further economic losses are inevitable. Serious consideration should be given to preventing the weed from spreading to unaffected areas and to controlling the expansion of established areas. As economic losses from leafy spurge increase, so will the need for cost-effective control methods. However, ongoing analyses of control solutions are necessary until it is clear that the costs of control do not exceed the benefits of control.

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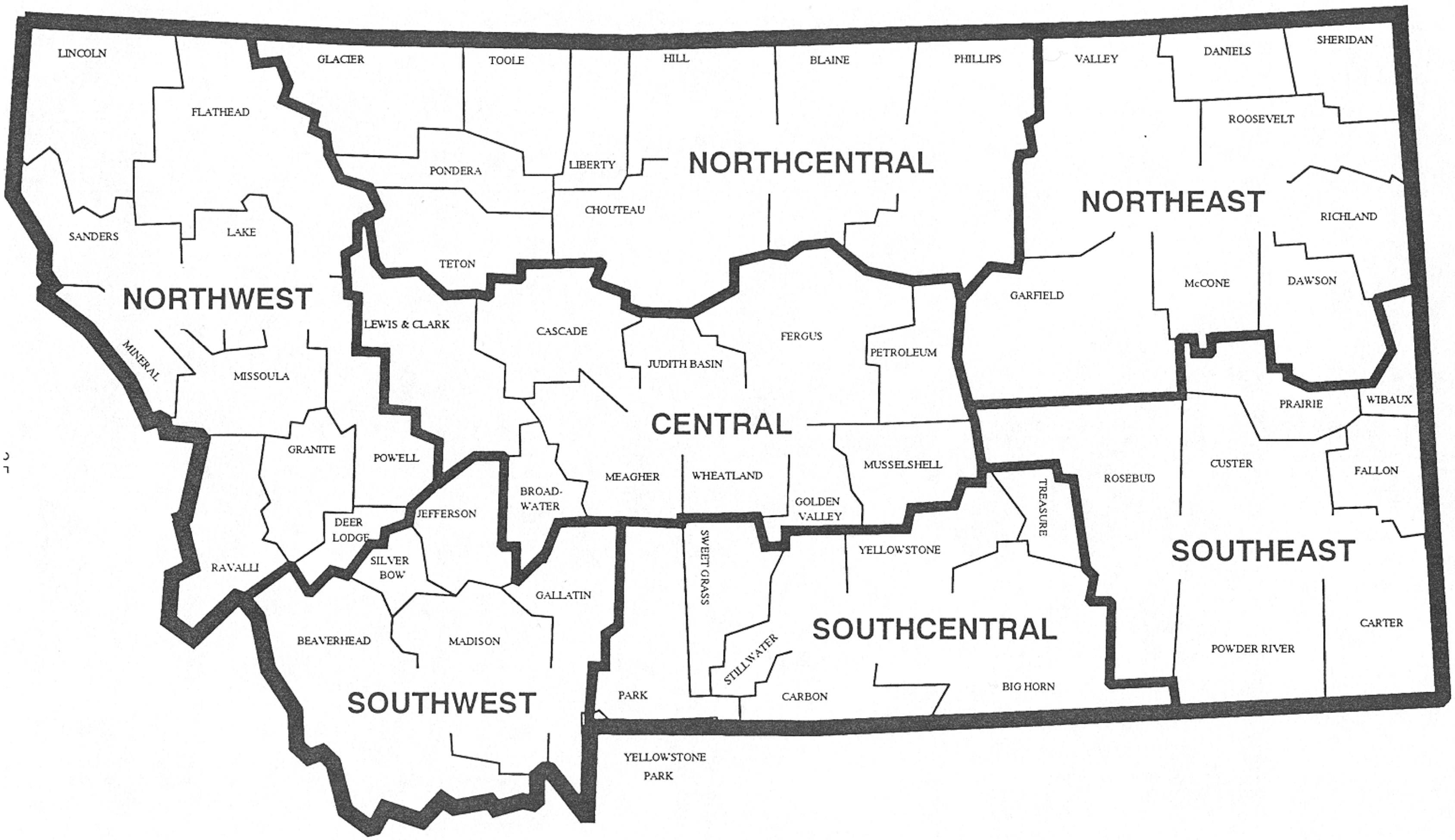
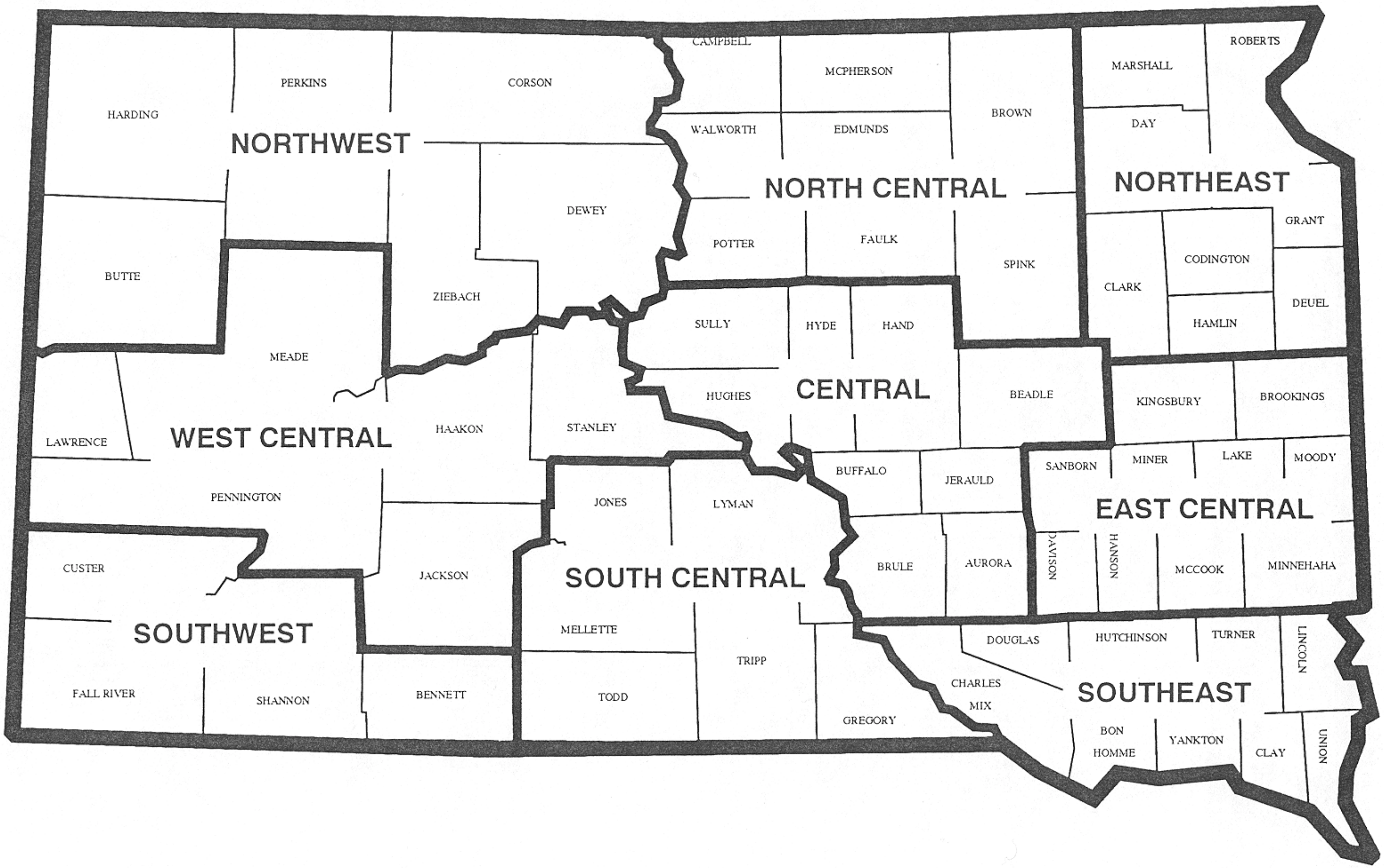
APPENDICES A and B Unavailable

Included here are maps with counties designated for MT, SD, and WY.



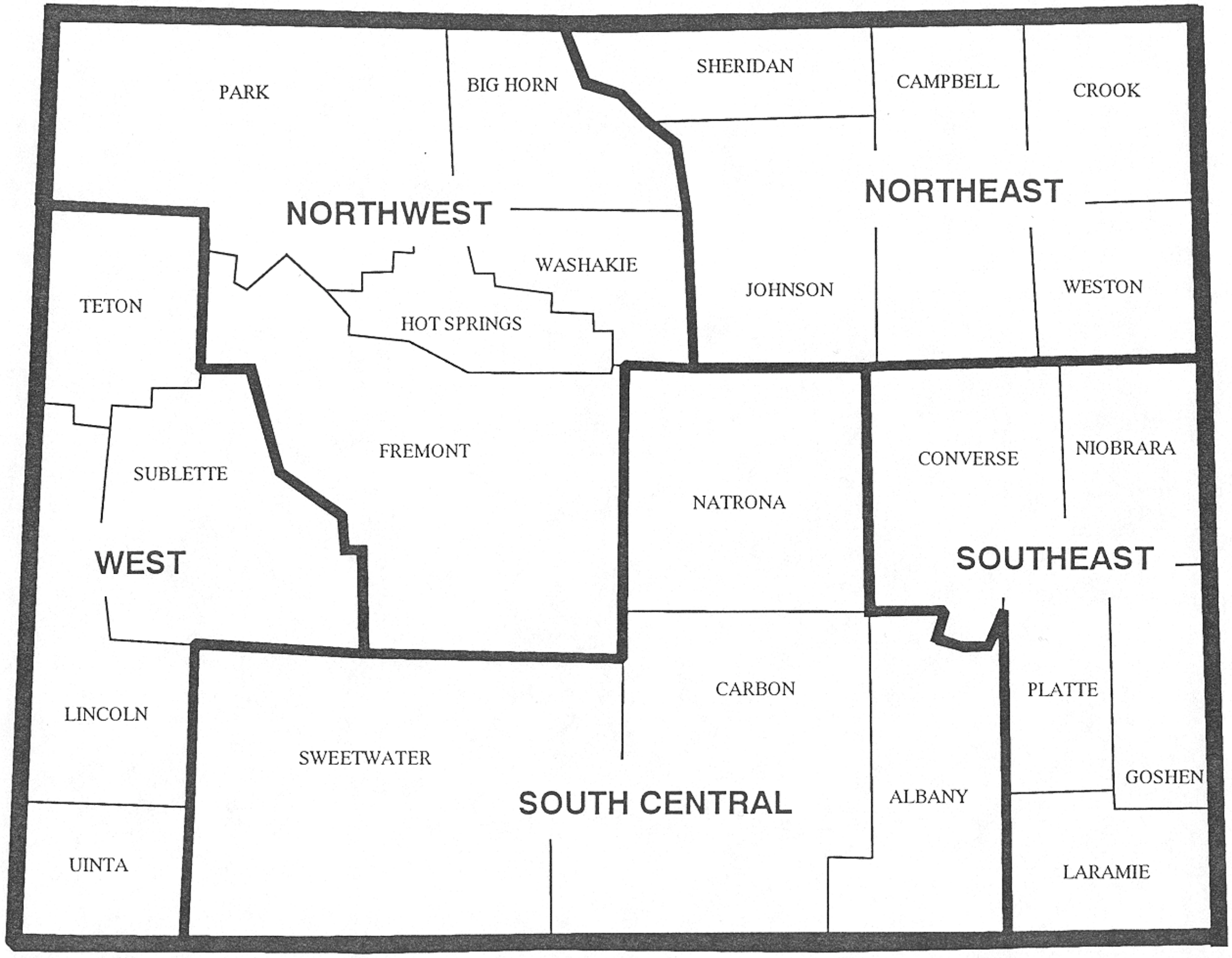
Appendix Figure B1. Montana Agricultural Statistics Regions

SOURCE: Montana Agricultural Statistics Service, Helena.



Appendix Figure B2. South Dakota Agricultural Statistics Regions

SOURCE: South Dakota Agricultural Statistics Service, Sioux Falls.



Appendix Figure B3. Wyoming Agricultural Statistics Regions

SOURCE: Wyoming Agricultural Statistics Service, Cheyenne.