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The Economic Costs of Delaying Invasive Weed Control: An Illustration based on Nevada's Tall Whitetop Initiative

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1. Introduction

Tall whitetop (*Lepidium latifolium*), also known as perennial pepperweed, is an alien weed that is invading watersheds in Nevada and throughout the West. In Nevada, thousands of acres of tall whitetop infest the lower Truckee River, Lake Tahoe, the West and East Walker Rivers, and much of the riparian lands of the Carson and Humboldt watersheds. Invasions of tall whitetop began along streams and in wet meadows, but now tall whitetop is observed at significant distances away from the riparian areas in upland, dry sites and is spreading to other parts of the state.

Tall whitetop roots do not stabilize stream banks. When they are present, banks erode more easily, polluting streams with silt and debris.

Tall whitetop negatively impacts both the ecology and economy of an area, and eventually the entire state (Young et al., 1995; Donaldson and Johnson, 1999; Olson, 1999; USDA, 1999; Auton et al., 2000).

Tall whitetop out-competes natives, forming monocultures that exclude other plants and animals.

It crowds out desired vegetation and tends to quickly form a monoculture, thereby reducing plant and animal biodiversity. Since it does not provide good habitat for wildlife, it reduces the diversity and numbers of animals such as deer, elk, waterfowl, and other birds. In addition, it does not provide good forage for livestock and imposes costs on farmers who must control its spread in croplands and pastures. Negative economic impacts occur in two distinct ways. First, property owners and land managers who must control tall whitetop are forced to incur out-of-pocket expenditures, for example on labor, herbicides, and revegetation necessary for successful treatment of the weed. Second, until tall whitetop is controlled, its presence yields damages (in the form of foregone benefits) due to lost uses of the land (e.g., grazing, cropping, and outdoor recreation).

The flowers of tall whitetop are deceivingly beautiful. Do not let them go to seed.

This short manuscript illustrates how the costs of tall whitetop control rise as control actions are delayed and infestations grow. Essentially, how much will it cost me if I treat an infestation today compared to the cost if I wait, say, five years to treat it? Will delay be cost effective? These are important questions that deserve scrutiny by landowners, land managers, funding authorities, and other stakeholders faced with competing needs and scarce financial resources.

For our illustration we use cost data collected for one of the tall whitetop control projects recently commenced under Nevada's Tall Whitetop Initiative (Initiative) funded by the 1999 Nevada State Legislature. The Initiative was launched in 2000 by University of Nevada Cooperative Extension with the objective of quickly implementing a suite of tall whitetop management projects throughout the state. We focus on one Initiative project in particular, conducted in Douglas County, Nevada, because complete and detailed cost data were reported to us for that site. Data included labor and supply costs, as well as some limited information on capital equipment costs. However, we focus only on non-equipment costs since we lack good data on the link between infestation size and the need to buy more equipment. Consequently, costs are figured conservatively throughout. Our results are illustrative for a larger set of sites in Nevada and the West that either 1) are currently infested with tall whitetop or 2) may likely become infested in the future.

The next section briefly summarizes out-of-pocket costs in the first year (2000) of the project. To illustrate how costs would have increased if the project had been delayed, we concentrate on costs that vary in proportion to infestation size. Section 3 presents the impacts on costs that would have resulted from a delay in tall whitetop control. Section 4 offers concluding remarks.

2. Year One Project Costs

The control of tall whitetop is not a one-time proposition. Though control expenses may be highest at the outset of the effort, actions over time are necessary (follow-up spraying, revegetation, etc.). For example, the Douglas County project (Project) on which we focus is a planned ten-year effort. Of course, if control of tall whitetop at a particular site is postponed to the future, the infestation will grow and therefore the control costs will rise in every year of a multi-period management effort. *However, we illustrate solely the impacts of a delay on the first year of the Project, since cost data are currently available only for Year 1 (2000).* As well, estimated future costs are not adjusted for future inflation. Consequently, *the results are very conservative and represent an understatement of what may actually occur.*

In this analysis we focus on what are termed variable costs. We define variable costs as those that vary directly according to the size of the infestation. These include expenditures for labor, chemicals, and seed for revegetation. We intentionally exclude capital costs associated with purchase and maintenance of equipment such as trucks and sprayers necessary for chemical application, because these are fixed costs that would not increase in continuous fashion if the infestation were to grow in size. Of course, were the infestation to grow sufficiently, it would be necessary to purchase additional capital equipment at some point. By excluding consideration of capital costs and any amortization associated with them, we simplify the analysis and also deliberately adopt a conservative approach. This underestimates the incremental costs of postponing weed control.

> Tall whitetop invasions negatively impact the economy as 1) costs of control and 2) damages—lost use of land for grazing, cropping, recreation and wildlife habitat.

Variable project costs for Year 1 (2000) are summarized in Table 1. Labor costs, which include costs of labor for both control and revegetation ($7,325), constitute the largest cost category and account for over half the total variable costs ($12,647). Chemical costs ($3,635) are the second largest category and account for almost thirty percent of the total costs. Revegetation (seed) costs ($1,687) are a relatively small proportion of the total, but this can vary widely across different project sites and in some cases seed costs can be much higher.

Table 1. Variable costs for Year 1 (2000) of the Douglas County Tall Whitetop Control Project.

Cost category	Year 1 costs
Labor [a]	$7,325
Chemical costs	$3,635
Revegetation (seed purchase costs)	$1,687
Total Year 1 variable costs	**$12,647**

[a] Includes labor for chemical application, hand pulling, revegetation, mapping, supervision/administration, and volunteer labor. Since volunteer labor (which accounted for an estimated 40 hrs of labor in Year 1) does not impose out-of-pocket costs but nevertheless should be included in an economic accounting framework because it constitutes an opportunity cost, we apply a conservative shadow price of $10/hr (equal to about 25% of typical hourly applicator costs) to yield an estimated $400 in volunteer labor.

3. Cost Impacts of Delaying the Start of the Control Project

In this section we illustrate the impacts on Year 1 project costs that we would see if initiation of the tall whitetop control project were to be delayed for between two to ten years beyond 2000. It is reasonable to expect the Project costs to be affected because we know that tall whitetop infestations rapidly expand when left uncontrolled by humans. At what rate would we expect the infestation at the Project site to grow if control efforts had not been undertaken? While there is some uncertainty on this point and expansion rates vary according to site-specific conditions, the existing literature provides us with good information to characterize a range of likely rates.

As one recent reference point, Smith et al. (1999) examined the growth rates of a variety of different invasive weeds in diverse locations around the western United States. That study found an average expansion rate of approximately 24% per year, with relatively high rates in early years and lower growth rates as an infestation matures. This figure is close to the estimated annual average growth (27%) of spotted knapweed (*Centaurea maculosa*) in Montana since 1920 (Sheley et al., 1996). Smith et al. also note that their projected expansion rates for the early years of small infestations are in the range of the 60% growth rates found in the literature (e.g., Callihan and Evans, 1991; Roche et al., 1994).

Given these data, we estimate impacts on costs assuming three different annual average expansion rates: 10%, 20%, and 30%. These rates bracket the annual average rates found in the literature, but are well below the higher rates for small infestations noted above. Given the relatively small acreage of tall whitetop present at the Douglas County Project site (75 acres), it is reasonable to expect that 10%-30% is a conservative range of assumptions for the expansion rates and, if anything, may understate the rapid growth of which small infestations are capable.

Table 2 shows the impacts on Year 1 Project costs of delaying the Project's commencement by various numbers of years, with start dates ranging from 2000 to 2010. The second column in the table displays Year 1 costs by startup year assuming an annual average expansion rate for tall whitetop equal to 10%. The third and fourth columns display Year 1 costs for the higher expansion rates of 20% and 30%, respectively.

Table 2. Impact of delaying Douglas County Tall Whitetop Project startup on Year 1 variable costs, considering three annual infestation expansion rates. [a]

Project startup year	Year 1 Project costs, considering tall whitetop infestation annual expansion rates[b]		
	10%	20%	30%
2000	$12,647	$12,647	$12,647
2002	$15,303	$18,212	$21,373
2004	$18,516	$26,225	$36,121
2006	$22,405	$37,764	$61,045
2008	$27,110	$54,380	$103,165
2010	$32,803	$78,307	$174,350

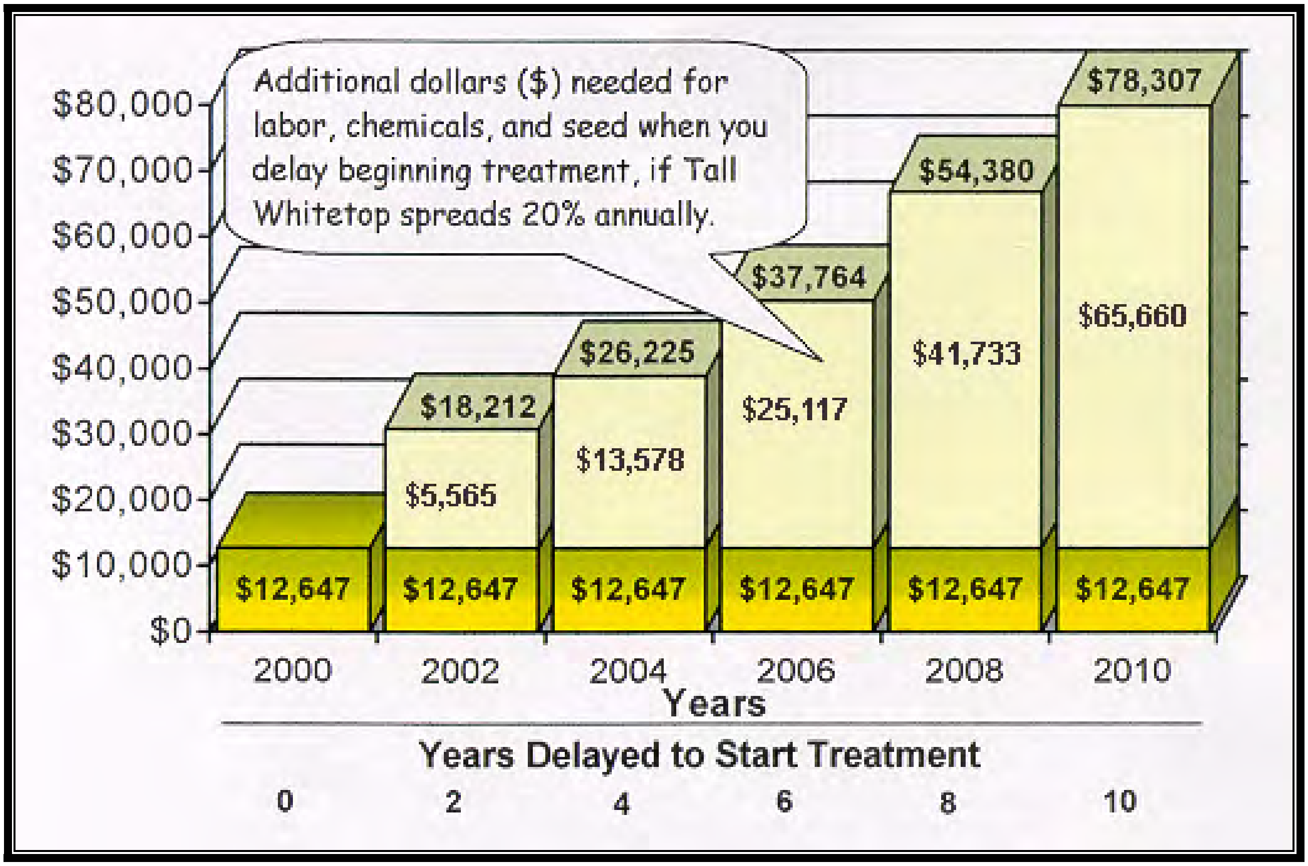
[a] Costs are expressed in current (not present) value dollars (i.e., neither a discount rate nor a rate for anticipated inflation are applied to future costs as these may be offsetting adjustments).

[b] This table illustrates only how Year 1 Project costs would have increased in the event of delay in the Project commencement. Postponing control would also increase costs in each of the other nine years of this ten-year Project, but we do not assess the impacts in those years because the necessary data on costs and tall whitetop bounce back rates are not yet available. For this and other reasons mentioned in the text (conservative expansion rate scenarios, omission of capital costs for weed control and not allowing for inflation), the results shown here tend to underestimate the increase in costs that would result from a delay in the Project startup.

As demonstrated in Table 2, postponing tall whitetop control efforts has a significant impact on how much money is spent on control. Even under a modest expansion rate of 10%, delaying control by 6 years would cause Year 1 costs alone to almost double, rising from $12,647 in 2000 to $22,405 in 2006. If the expansion rate were double this amount (20%), postponing control efforts for six years would cause Year 1 costs to almost triple, rising from $12,647 in 2000 to $37,764 in 2006. An expansion rate of 30% would cause Year 1 costs (six years delayed) to rise to over $60,000. It is important to keep in mind that the highest expansion rate we model (30%) is actually quite close to the average annual rate observed for spotted knapweed in Montana over the last eight decades (27%). Many invasive species, including tall whitetop, have similar or greater expansion rates, particularly in the early years of an infestation. Figure 1 illustrates graphically the estimated rise in costs as tall whitetop control is delayed, assuming our "middle" scenario of a 20% expansion rate.

The cheapest and easiest invasive weed to control is the first one!

Figure 1.Year 1 variable costs for tall whitetop control by project start year at 20 percent annual expansion rate of weeds in Douglas County, NV.



4. Conclusions

Entities faced with demands to spend money on invasive weed control are often besieged by multiple, competing demands to devote resources to a number of other needs as well. This is the case for federal and state agencies and legislative bodies, counties, municipalities, weed districts, irrigation districts, watershed management authorities, and private producers and landowners. Competing demands for scarce funds often result in a delay in expending dollars and efforts on invasive weed management.

The results of our assessment show in a very conservative manner why it is important to adopt a dynamic perspective when deciding how and when to spend money on invasive weed control *instead of* other activities and programs. Because of the peculiar characteristics of the ecological problem posed by tall whitetop and other invaders (i.e., explosive growth), the costs of control multiply rapidly over time. Therefore a failure to devote resources to infestation problems today requires the decision maker to spend appreciably larger sums of money even a small number of years from now. At the highest expansion rate modeled in our assessment (which is well within the range of data observed for invasive weeds in the West), even a four-year delay in beginning a control program would cause the eventual Year 1 control costs to nearly triple. A ten-year delay would cause Year 1 costs to rise by more than a factor of ten.

Do not delay beginning treatment of tall whitetop. Every year you wait adds to the expense of managing this invasive weed.

It is important to bear in mind that our assessment only examines, and very conservatively at that, the impacts on out-of-pocket costs in the first year of the tall whitetop Project. Of course, postponing control would also increase costs in each of the other nine years of this ten-year Project as well. For this and other reasons mentioned above (conservative expansion rate scenarios, omission of capital costs for weed control and not including rates of inflation), our results tend to be "conservative." That is, they underestimate the increase in control costs that would have resulted from a delay in commencement of this Tall Whitetop Initiative Project in Douglas County. In addition, our assessment does not deal with the rapid accumulation of economic damages from invasive weeds (foregone benefits such as grazing and recreation) that occur over time as control is postponed. These lost benefits certainly would escalate rapidly and may in fact constitute a greater economic loss to a community than the out-of-pocket costs demonstrated here.

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