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Effective Weed Management, Collective Action, and Landownership Change in Western Montana

Laurie Yung, John Chandler, and Marijka Haverhals*

Rural landscapes are increasingly diverse and heterogeneous, involving a mix of small and large parcels, amenity and agricultural properties, and resident and absentee owners. Managing invasive plants in landscapes with changing ownership requires understanding the views and practices of different landowners. We surveyed landowners in two rural valleys with 26% absentee ownership and a large number of small parcels in Missoula County, Montana. Landowners indicated a high level of awareness and concern about weeds; more than 80% agreed that weeds are a problem in their valley. Seventy-eight percent of landowners managed weeds, but only 63% were effective at weed management. Absentee owners were far less likely to manage weeds on their properties and less likely to utilize herbicides, as compared with resident landowners. Landowners reported that seeds coming from adjacent properties were the most significant barrier to effective weed control. Many landowners manage weeds to be a good neighbor and believe that cooperation between neighbors is critical to weed management.

Key words: Absentee owners, collective action, herbicides, invasive plants, landownership change, private landowners.

Private landownership has been changing throughout the interior West. A growing number of smaller, nonagricultural parcels and absentee owners now intermingle with more traditional agricultural operations. Controlling invasive weeds in landscapes with mixed land ownership requires management of weeds on individual properties and cooperation across property boundaries. As landownership shifts, a greater diversity of landowners need to engage in weed management to ensure effective control at scales beyond individual parcels. Understanding the views and practices of these diverse landowners is critical to formulating effective management strategies (Kelley et al. 2013). In this paper, we present findings from a survey of private landowners in western Montana.

A handful of studies across the United States provide insight into people's perceptions and knowledge of invasive plants. In a survey in West Virginia, 34% of landowners had *heard or read about invasive plants*, with 62% stating that they were *aware of at least one plant species on or near their woodland that they considered undesirable* (Steele et al. 2008). In contrast, 88% of residents in north central Colorado had *heard or read about invasive plants*, a high level of awareness that the authors attribute to the fact that weeds are a high-profile issue in this region (Daab and Flint 2010). Similarly, in Iowa, 87% of key stakeholders agreed that invasive plants are a problem and 88% agreed that we have a responsibility to manage them (Kapler et al. 2012). In Montana, 76% of residents agreed that noxious weeds are a serious or very serious problem, but 67% reported that they knew little or nothing about noxious weeds; however, 80% could identify a specific problem associated with invasive plants (Sheley et al. 1996).

Management of invasive weeds is increasingly characterized as a collective action problem, requiring cooperation across individual private holdings. According to Hersbdofer et al. (2007, p 226):

> Invasive nonnative plants pose a collective action problem because effective prevention and control of weeds requires that a critical mass of landowners in an area participates in weed management in order to control the spread of undesirable plants, but there is little

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Management Implications

Most rural areas have a diversity of landowners with a range of parcel sizes and management goals. Many of these landscapes are experiencing an influx of amenity migrants and absentee landowners, increasing the number of landowners responsible for weed management. Weed managers and extension agents can benefit from a better understanding of the views and practices of these landowners so that they can develop programs to meet landowner needs. Based on a survey of rural landowners in western Montana, we recommend that in landscapes with a diversity of landowners, practitioners emphasize a range of weed management approaches (from herbicides to biocontrols) and benefits (from wildlife habitat to scenic beauty). In particular, landowners who are concerned about the safety of herbicides might need information on alternative methods. Because absentee landowners are less likely to manage weeds, managers need to find ways to engage these landowners in weed management. Effectively engaging absentee landowners might require innovative communication strategies that involve neighbors, emails, and real estate agents. Further, because seeds coming in from neighboring properties are often seen as a major barrier to effective weed management, engaging a broad range of landowners, including absentee landowners, is critical. Weed managers, extension agents, and community groups can organize landowners and small groups of neighbors to share information, resources, and labor, and build social norms about appropriate weed management.

incentive for an individual landowner to control weeds unless all their neighbors also do.

Research to date suggests that private landowners feel some obligation to their neighbors, even as they advocate for strong property rights. In a study of riparian landowners in the eastern United States, landowners simultaneously argued that they had an obligation to consider the downstream impacts of their own management actions, while consistently underestimating their own contributions to downstream water quality (Dutcher et al. 2004). In a study of private landowners in Indiana, Raymond and Olive (2008) found substantial diversity in the ways that landowners viewed rights and responsibilities relative to biodiversity conservation, with half arguing for a landowner's right to fully control private property and other respondents prioritizing rights to privacy, safety, and a say in neighbors' land management. Despite this diversity, many landowners suggested that they had a responsibility to their neighbors. Residents in north central Colorado also agreed that they were *personally responsible for protecting against the spread of invasive plants, even if others are unconcerned* (Daub and Flint 2010).

Ownership changes in rural landscapes can reduce a community's capacity for collective action (Klepeis et al. 2009). According to Klepeis et al. (2009) amenity migration and absentee ownership have the potential to intensify problems with invasive species, largely because they introduce new land uses and management practices. In a study of Australian landowners, Klepeis et al. (2009) found that new landowners were less knowledgeable about invasive plants and that absentee owners were less likely to ''implement weed control measures and participate in neighborhood and community-scale responses.'' In Oregon, absentee and resident landowners demonstrated similar levels of awareness about invasive weeds, but absentee landowners were less likely to engage in weed control actions (Fischer and Charnley 2012). Fischer and Charnley (2012) suggested that lack of awareness is not the barrier for absentee owners, but rather the inconvenience of residing elsewhere. Epanchin-Niell et al. (2010) suggest that areas with high land-use diversity, what they call ''management mosaics,'' might be more susceptible to biological invasions because the large number of small landowners decreases the incentive to control weeds and because those owners who do not control weeds increase the cost of weed management for others. They also argue that coordination is challenging in landscapes with a large number of landowners who hold diverse goals, because local institutions are less able to facilitate collective action. Klepeis et al. (2009) point out that more monolithic agricultural landscapes have also struggled to control invasives and that agricultural owners hold diverse views on weeds, but they argue that the practices and goals of agriculture provide common ground on which agricultural owners can build collective responses. Landowners also gravitate toward management approaches that are acceptable and accessible to them (Kelley et al. 2013). Thus, ranchers might be more likely to use grazing than landowners without livestock.

A diversity of landowners also translates into a range of views on the use of herbicides. In a study of family forest owners in South Carolina, Howle et al. (2010) found that more than half of landowners felt that *herbicides are dangerous to people and the environment*. In rural California, controversy over control of spotted knapweed (*Centaurea stoebe* L.) revolved in large part around different views about the safety of chemical herbicides (Norgaard 2007). Uncertainty about the safety and efficacy of treatment options, along with uncertainty regarding the extent, pace, and impacts of particular invasive plants, compounds the already challenging task of weed management (Liu et al. 2011).

Materials and Methods

To better understand the views and practices of a diversity of landowners, we conducted interviews and a mail survey in the Potomac and Nine Mile valleys, both of which are about 48 km (30 mi) from Missoula, MT. These valleys were identified by the Missoula County Weed District as locations where invasive plants were

increasingly problematic and where established Weed Management Areas had not been particularly effective. In the Potomac and Nine Mile valleys, grants and other resources for private landowners had gone unused. Both valleys are mixed grasslands and forests. Landownership is also mixed, with a few large agricultural landowners and many small parcels. Landowners are predominantly commuters, telecommuters, retirees, or absentee owners.

A Landowner Survey Committee was established at the outset of the project to guide project design and analysis, and ensure that research questions and results were relevant to local landowners and the Missoula Country Weed District. The Landowner Survey Committee met approximately eight times and was composed of community members, landowners from the Potomac and Nine Mile valleys, University of Montana faculty and graduate students, and representatives from the Missoula Country Weed District and Weed Board. Members were recruited by Weed District staff, Weed Management Areas Coordinators, and Weed Board members based on their contacts in the study sites. Participation was voluntary. The Landowner Survey Committee helped formulate research questions and objectives (e.g., brainstorming questions they hoped the survey would help answer), worked with the lead researchers on sampling (e.g., helping the researchers understand complex property ownership data), reviewed survey drafts (e.g., examined questions to ensure they would be meaningful to survey respondents), developed key questions for analysis (e.g., suggested relationships to examine, such as comparisons between resident and nonresident landowners), and developed outreach plans for the distribution of results (e.g., provided ideas for how to effectively disseminate results to landowners).

The research began with semistructured, in-depth interviews with 29 landowners in the Potomac and Nine Mile valleys. These interviews primarily served as an elicitation study; interview results informed the design of the quantitative mail survey. Interviews were conducted to ensure that the key issues landowners faced relative to invasive plant management were covered in the survey. An interview guide was utilized and questions focused on perceptions of weeds, views of invasive plant ecology and impacts, management practices, perceived barriers to effective management, and ideas about responsibility and obligation for control. The interview sample was purposive and participants were selected to represent a diversity of landowners, including agricultural and nonagricultural landowners, smaller and larger landowners, and newcomers and long-term landowners. The sample also included landowners with extensive experience managing invasives and those with very little experience. Interviews were taped and then reviewed to identify key issues to cover in the mail survey.

A 12-page survey booklet was then developed in collaboration with the Landowner Survey Committee. Survey questions covered views of invasive plants, management practices, knowledge of invasives, barriers and needs, and demographic information. Wherever possible, the survey utilized lay language or local terminology (for example, the term ''weeds'' was used as opposed to ''invasive plants''). The survey was pretested with eight landowners in Missoula County. (Landowners residing in the Potomac and Nine Mile valleys who participated in pretests were removed from the sample.) Pretests were conducted one-on-one and participants were encouraged to ask questions while taking the survey and provide feedback on areas of confusion and key issues that were missing.

The research team then assembled a landownership database drawing on the Montana Cadastral Mapping web resource. A stratified sample was utilized whereby landowners with 100 acres or more and out-of-state landowners were censused to ensure adequate representation of these groups, while other categories were sampled. Of the 732 landowners in the study sites, 536 were sent surveys. A modified Salant and Dillman (1994) method was used. Survey recipients received four mailings in a 2-mo period: an advance letter informing them of the survey, a survey with a cover letter and return envelope, a reminder postcard, and, if they still had not responded, a replacement survey. The advance letter and cover letter listed the names of the Landowner Survey Committee members at the bottom, so that survey recipients could identify people in their communities who were involved with the project. The 14 landowners who were deceased or had sold their property were removed from the total, resulting in 522 landowners sampled. The response rate was 73%, with 386 completed surveys returned. Twenty-six landowners were randomly selected from the nonrespondents and called on the telephone for a nonresponse bias test. These 26 landowners were asked key questions about land management practices, acreage, and residency. Across these dimensions a simple paired *t* test showed no significant differences between respondents and nonrespondents ($P > 0.1$). Further, in the sample as a whole, there were no differences in weed control actions or views on weeds based on age, length of residence, education, employment status, or size of community where landowners grew up. Two-sample *t* tests or chi-square tests were used to determine if weed control activity differed across these dimensions.

Unless otherwise indicated, the statistical tests reported below are permutation tests. In a permutation test, the value of the test statistic is first calculated using the collected data. Typically, the test statistic is the difference between means for a given question between the two groups of a secondary, grouping variable, such as weed controllers vs. noncontrollers or resident vs. absentee

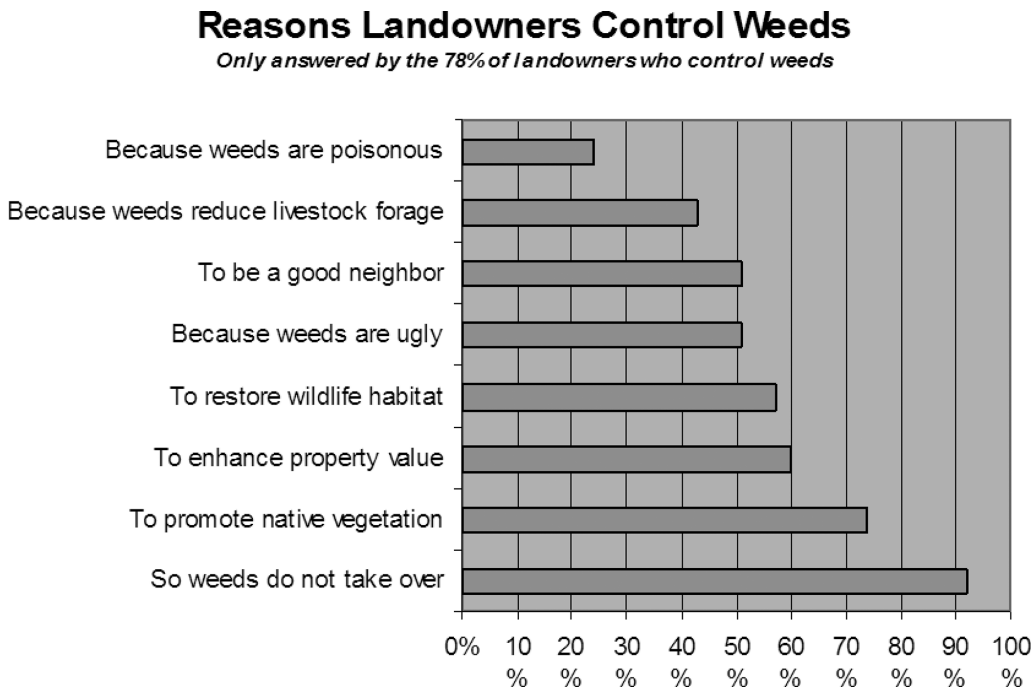

Figure 1. The top two reasons that landowners control weeds are so weeds do not take over and to promote native vegetation.

owners. Then the secondary variable is permutated, while keeping the other variable fixed and the test statistic is recalculated. Repeating this permutation process thousands of times provides a sampling distribution for the test statistic, which can then be analyzed to see if the result in the data is likely to result from chance. The P value is determined by looking at the number of test statistics that are as extreme as or more extreme than the unpermutated value. Permutation tests were utilized because they make minimal assumptions about the distribution of data.

Results and Discussion

Describing the Landowners. Most landowners in this study owned small parcels, with 56% with 0 to 8 ha (0 to 20 ac) and 24% with 9 to 20 ha (21 to 50 ac). Only 17% had parcels over 20 ha (50 ac) in size. More than 70% of landowners indicated that aesthetics/beauty of the land, wildlife habitat, ecological health of the land, and fuel reduction/reducing fire hazard guided their land management, whereas only 18% indicated that economics/making a living guided their land management. A total of 27% raised livestock (including cattle, horses, llamas, sheep, and donkeys), but only 7% indicated that raising livestock was important for their income. For 26% of the landowners, the Potomac Valley or Nine Mile Valley was not their primary place of residence. These absentee owners spent an average of 1.4 mo yr^{-1} on their property. For landowners who described the Potomac Valley or Nine Mile Valley as their primary residence, the average length of residence was 17 yr. In short, these two valleys are comprised of many small properties owned by individuals/families who are not in production agriculture. The vast majority of these landowners were interested in the scenic, wildlife, and ecological values, rather than the economic values of their property. Furthermore, more than a quarter of the properties were owned by absentee owners who lived out-of-state or elsewhere in Montana.

Views on Weeds. Most landowners were concerned about weeds. More than 80% agreed that weeds are a problem in their valley and 66% agreed that weeds are a problem on their property. Spotted knapweed (*Centaurea stoebe* L. CENMA) was considered the most problematic weed (76% ranked this species most problematic), far above all other weeds. The next most problematic was leafy spurge (*Euphorbia esula* L. EPHES) (8% of landowners ranked this species most problematic). Nearly 73% of landowners were concerned about the ecological impacts of weeds. Only 9% believed that weeds do not need to be controlled, and less than 3% felt that weeds are not harmful. Fifteen percent reported that weeds are a low priority for them, and 30% felt that controlling weeds is a losing battle. Almost 60% of landowners considered themselves knowledgeable about weed control, but 18% reported that they did not know which weeds were problematic. Overall, landowners indicated a high level of awareness and concern about weeds.

Weed Control. A total of 78% of landowners conducted weed control. Landowners conducted weed control for

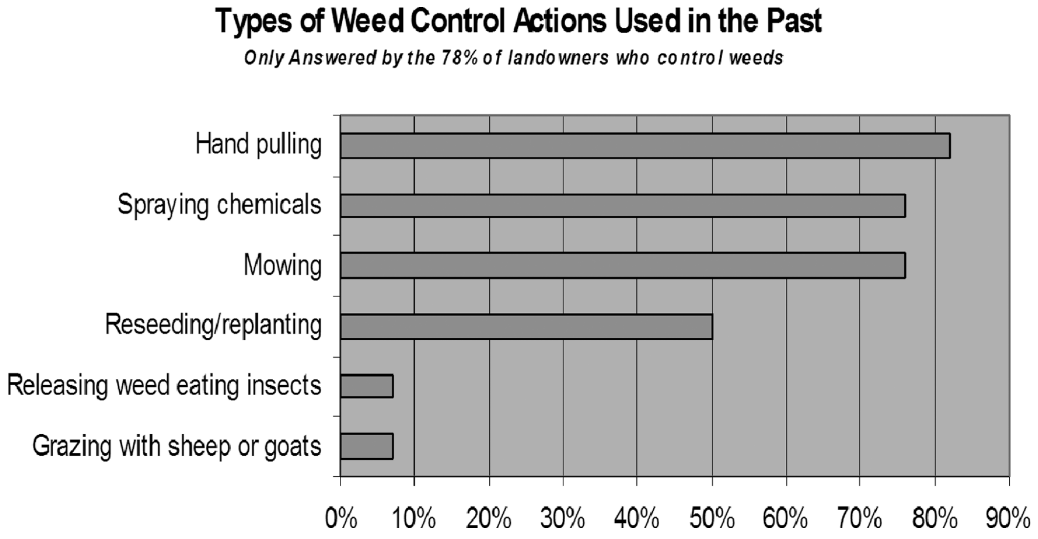

Figure 2. While many landowners had utilized hand pulling, chemicals, and mowing to control weeds, very few had utilized biocontrols or grazing.

a variety of reasons, in particular so that weeds do not take over and to promote native vegetation (see Figure 1). More than half of landowners who control weeds have utilized the following techniques: hand pulling, spraying chemicals, mowing, and reseeding/replanting (see Figure 2). Most landowners who control weeds planned to keep using the same techniques (i.e., insects, chemicals, reseeding) that they have used in the past. Among the most common methods of control (pulling, mowing, chemicals, and reseeding), people who have hand pulled weeds were significantly less likely to reuse the same technique (47% vs. 54%; $P < 0.01$), perhaps because hand pulling is very labor-intensive. Interestingly, landowners were very interested in biocontrols and grazing to control weeds. A total of 45% planned to release weed-eating insects in the future (up from 7% who reported that they previously released weed-eating insects), and 21% planned to graze with goats or sheep in the future (up from 7% who reported that they previously grazed with goats or sheep). Thus, landowners were interested in moving away from handpulling and mowing and toward biocontrols and grazing. Landowners who have used chemicals in the past were the least likely to use other techniques (such as hand pulling, mowing, etc.) and more likely to continue with a spraying program (81% of chemical users were willing to use other techniques vs. 87% of all other respondents; $P < 0.005$).

Landowners reported that seeds coming from adjacent properties were the most significant barrier to effective weed control. Other significant barriers included lack of time, lack of money, lack of equipment, and lack of information/knowledge (see Figure 3). Of the landowners who do not control weeds, more than 40% reported that they do not know what would work best and that they do not have the time to control weeds (see Figure 4 for more reasons why some landowners do not control weeds). These landowners also reported that they would consider conducting weed control if it would benefit wildlife or native plants.

Effective Weed Controllers. To better understand landowners and weed control in the Nine Mile and Potomac valleys, respondents who conducted effective weed control were compared with respondents who did not. For the purposes of this analysis respondents who conduct effective weed control (herein called ''controllers'') were defined as individuals who reported that they conduct weed control activities on their property and answered at least three of the five true/false questions about weeds correctly and reported that they knew which weeds were problematic. Of the five true/false questions, 84% of respondents answered three or more correctly, and 16% of respondents answered two or fewer correctly (see Figure 5 for additional detail on true/false questions and responses). Sixty percent of respondents reported that they knew which weeds were problematic. ''Noncontrollers'' were respondents who reported that they do not conduct weed control activities or answered two or fewer of the five true/false questions correctly or reported that they do not know which weeds are problematic. In other words, respondents who reported that they do conduct weed control, but did not appear to be knowledgeable about weed control were defined as noncontrollers. Accordingly, 63% of respondents were effective weed controllers (note that 78% of respondents reported that they conduct weed control on their property). Controllers and noncontrollers were then compared on a number of key questions, the results of which are summarized in Table 1.

Controllers tend to be landowners whose property is their primary residence (82%), whereas noncontrollers

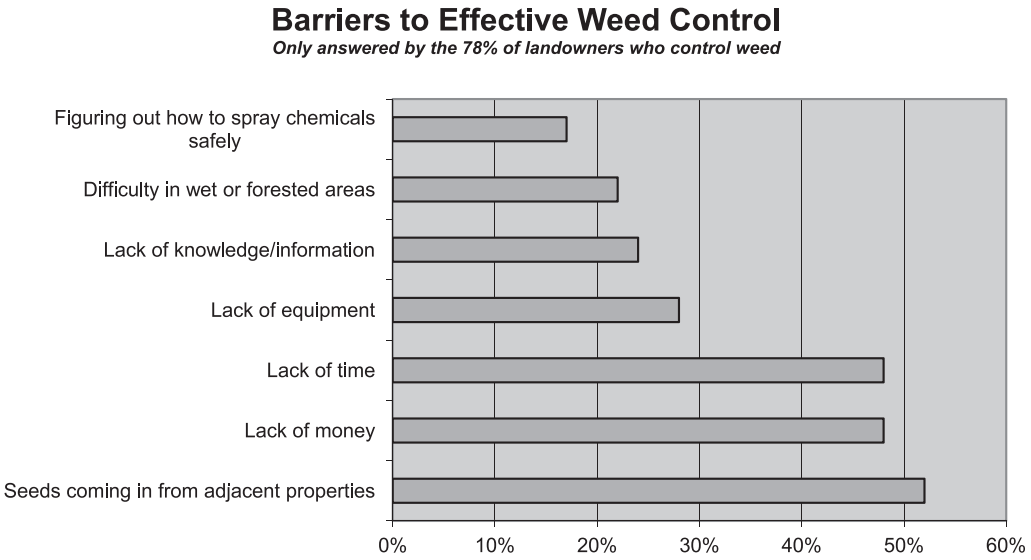

Figure 3. Landowners identified seeds coming in from adjacent properties as the most significant barrier to effective weed control, followed by lack of money and lack of time.

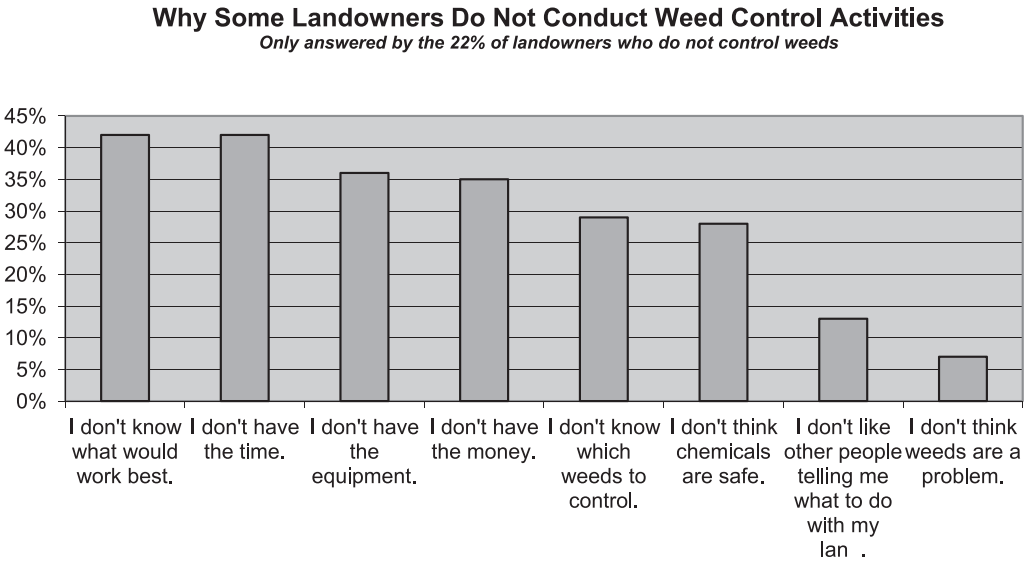

Figure 4. Landowners who do not conduct weed control activities identified lack of knowledge, time, equipment, and money as important barriers.

were about half residents and half absentee owners. Noncontrollers have lived in the Nine Mile or Potomac valleys almost 2 yr longer than controllers. As a group, controllers were more likely to cite each individual landowner as responsible for weed control. Controllers were also somewhat more likely to cite state government, Missoula County, and a valley-wide community group as responsible for weed control. Controllers tended to view most types of weed control actions as more acceptable and more effective compared with noncontrollers (with grazing being an exception; noncontrollers saw grazing as a more acceptable and more effective weed control action as compared with controllers). In particular, controllers rated spraying chemicals as more acceptable and more effective than noncontrollers. Controllers and noncontrollers did not differ on basic demographic characteristics (age, education, occupation). However, we did find a significant difference in the gender of controllers. Although survey respondents were 34% female, 44% of the noncontrollers were female ($P < 0.0001$ using a test of proportions).

In short, effective weed controllers typically were residents who had lived in the area an average of 19 yr.

True/False Statements	Responses	%
Disturbed soil promotes weed invasion.	**True**	82.2
	False	3.1
	Don't Know	12.8
Weeds are only a problem for agricultural landowners.	True	1.3
	False	94.2
	Don't Know	2.4
Most herbicides work best when weeds are not actively growing.	True	4.2
	False	65.4
	Don't Know	28.3
Reseeding desirable plants is an essential tool in long-term weed control.	**True**	75.4
	False	3.4
	Don't Know	19.1
It is better to control small weed infestations before controlling large infestations.	**True**	52.4
	False	15.2
	Don't Know	29.1

Figure 5. Responses to true/false questions. Of the five true/false questions, 84% of respondents answered three or more correctly, and 16% of respondents answered two or fewer correctly.

Controllers were more likely to view herbicides as effective and acceptable, and more likely to view weed control as the responsibility of the individual landowner.

The Impact of Absenteeism. Absentee owners (people who reported that their primary residence was elsewhere in Montana or out of state—26% of the landowners in this study) differed from resident landowners in a number of important ways. Absentee landowners were much less likely to conduct weed control activities (42% of absentee owners conduct weed control, whereas 70% of nonabsentee landowners conduct weed control). Furthermore, although 61% of resident landowners consider themselves knowledgeable about weed control, only 51% of absentee owners reported that they were knowledgeable. Recall that, in the analysis of effective weed controllers described above, 82% of controllers were residents, whereas noncontrollers were about half residents and half absentee owners. Nearly half of absentee owners reported that they did not control weeds because they did not have the time. Absentee owners were particularly interested in controlling weeds if it would benefit wildlife, native plants, and neighbors.

Thus, consistent with previous research (Klepeis et al. 2009; Fischer and Charnley 2012), we found that absentee landowners were less knowledgeable about weeds and less likely to take action to control weeds. As Fischer and Charnley (2012) suggest, the inconvenience of residing elsewhere seemed to be an important barrier, because many absentee owners reported that they did not have the time to control weeds.

Concerns about Chemicals. Most landowners were concerned about the safety of the chemical herbicides used to control weeds. Chemicals were rated as the most effective, but least acceptable type of weed control. Although 68% of landowners were concerned about herbicides, nearly 60% of landowners had previously utilized chemicals to control weeds. The 33% of landowners who were ''very'' concerned about the safety of chemicals used to control weeds were much less likely to have used herbicides (46% vs. 70%, $P < 0.0001$). In a comparison of respondents who were concerned about chemical use and those who were not, respondents who were concerned about chemicals were significantly less likely to use herbicides (57% vs. 76%; $P < 0.0001$), were slightly more in favor of individual landowners' right to decide how to control weeds (5.5/7 vs. 5.2/7; $P < 0.0001$), less likely to identify as controlling weeds

Table 1. Comparison of controllers and noncontrollers.

	Mean responses		
	Controllers	Noncontrollers	P value
Absenteeism and length of residence			
Is your property in the Nine Mile/Potomac Valley your primary residence? (% checking "yes")	82%	52%	< 0.0001
If yes, how long have you lived in the Nine Mile/ Potomac Valley? (yr)	15.4	17.3	< 0.0001
Views on who should be responsible for weed control			
Each individual landowner	87%	77%	< 0.0018
Missoula County	63%	59%	< 0.0685
Neighbors working together	51%	49%	< 0.032
A valley-wide community group	44%	40%	< 0.039
State government	30%	23%	< 0.0783
Acceptability of different weed control actions[a]			
Reseeding/replanting	8.3	7.2	< 0.0001
Mowing	7.8	6.9	< 0.0001
Hand pulling	7.3	6.6	< 0.0001
Grazing	6.5	6.8	< 0.0008
Spraying chemicals	7.0	5.5	< 0.0001
Releasing weed eating insects	7.5	6.0	< 0.0001
Effectiveness of weed control actions			
Reseeding/replanting	6.7	6.0	< 0.0001
Mowing	5.0	4.8	< 0.0001
Hand pulling	5.2	5.0	< 0.0001
Grazing	5.9	6.3	< 0.0004
Spraying chemicals	8.5	7.3	< 0.0001
Releasing weed-eating insects	5.3	5.4	< 0.0005

[a] Scale of 1–10 with 1 as highly unacceptable and 10 as highly acceptable.

(78% vs. 85%; $P < 0.0002$), and less likely to be an effective controller of weeds (60% vs. 72%; $P < 0.0007$).

There were large differences between resident and absentee owners related to the use of herbicides. Although 71% of resident landowners had sprayed herbicides to control weeds on their property, only 36% of absentee owners had done so ($P < 0.0005$). Similarly, 67% of resident landowners reported that they would like to spray chemicals to control weeds in the future, but only 38% of absentee indicated an interested in future chemical control. Residents also viewed chemical control as more acceptable as compared with absentee owners (resident mean response was 6.74 as compared with absentee mean response of 5.82, $P < 0.0005$).

These different perceptions about the safety and acceptability of herbicides were influencing control of invasive plants on individual properties as well as the type of control actions different landowners pursue. Further, because absentee landowners were less likely to use herbicides and less likely to view herbicides as acceptable, as compared with resident landowners, changing landownership in these valleys could be at least partially responsible for different views and practices as they relate to chemical control.

Neighbors and Weed Control. Landowners in the Nine Mile and Potomac valleys appeared to regard neighbors as both a barrier to and opportunity for weed management. The biggest barrier to effective weed control that landowners cited was seeds coming in from adjacent properties (52% of landowners cited this as one of the top three barriers and 28% cited this as the biggest barrier). This finding echoes that of Fischer and Charnley (2012) who also found that landowners saw seeds from neighboring properties as a formidable barrier.

In this study, only 17% of landowners believe that most of their neighbors do a good job of managing weeds. Landowners also expressed a sense of obligation to control weeds for their neighbors' benefit. More than half of landowners who control weeds did so to be a good neighbor. Fischer and Charnley (2012) also found that many landowners believed that being a good neighbor required that they manage their weeds. Of the landowners

Table 2. Absentee and resident landowners and collective action responses using the seven-point Likert scale: 1 strongly disagree, 4 neutral, 7 strongly agree, don't know.

	Mean responses		
	Resident	Absentee	P value
Weeds, cooperation, and private property			
Neighbors need to cooperate more on weed control.	5.61	5.56	< 0.001
I would be willing to help my neighbors pull weeds if they would also help me.	4.24	4.34	< 0.001
Each landowner has a responsibility to the valley as a whole to control weeds.	5.67	5.43	< 0.001
Weeds are a problem for the entire valley and need to be managed collectively and cooperatively.	5.77	5.38	< 0.0005

in this study who do not control weeds, 39% reported that they would consider conducting weed control activities if they believed that their neighbors would benefit.

When asked who should be responsible for weed control, 51% of landowners cited neighbors working together and 43% a valley-wide community group (by comparison, 84% cited individual landowners and 61% cited Missoula County). More than 73% of landowners agreed that neighbors need to cooperate more on weed control. Currently, 28% of landowners who control weeds work with their neighbors or other landowners to do so. Fischer and Charnley (2012) found that 23% of the Oregon landowners in their study had worked with other private landowners on weed control. Similarly, Epanchin-Niell et al. (2010) also found that some landowners cooperated with neighbors by sharing costs or otherwise coordinating control efforts. However, Graham (2013) found that very few landowners engaged in "mutual aid" related to weeds, indicating that different social and ecological contexts might lead to different levels of cooperation.

In this study, although there were statistically significant differences between absentee and resident landowners on questions about the need to cooperate with neighbors on weed control (residents were more likely to agree), willingness to help neighbors pull weeds if they would also help (absentee owners were more likely to agree), that each landowner has a responsibility to the valley as a whole to control weeds (residents were more likely to agree), and that weeds need to be managed cooperatively (residents were more likely to agree), in most cases the differences were very small (see Table 2).

A total of 43% of the landowners want Missoula County to organize weed management areas and cooperative efforts, and 13% want information on how they can organize their neighbors. Although nearly 70% of landowners agreed that individual landowners have the right to decide how to control weeds on their property, only 40% agreed that individual landowners have the right to decide whether or not to control weeds on their property. More than 74% believe that each landowner has a responsibility to the valley as a whole to control weeds.

Thus, whereas the biggest barrier to controlling weeds is by far believed to be seeds coming from neighboring properties, many landowners controlled weeds to be a good neighbor and believed that cooperation between neighbors is critical to weed management. There was a sense that individual landowners have an obligation to their neighbors and a responsibility to the valley as a whole to control weeds, and that individual landowners do not have the right to opt out of weed management (although they have the right to decide how to control weeds on their property).

Models suggest that small amounts of cooperation between landowners could yield large benefits in terms of weed control (Epanchin-Niell and Wilen 2015). Based on interviews with landowners and agency staff, Graham (2013) recommend three pathways for cooperation among landowners: sharing information to increase knowledge, providing support and resources, and applying pressure on neighbors who are not controlling weeds. According to Epanchin-Niell et al. (2010), approaches that draw on government agency resources and expertise and community-level organizing and cooperation (such as weed districts and weed management areas), are needed to facilitate coordinated weed management in landscapes with many small landowners.

Recommendations for Practitioners. Based on these results and the findings of similar studies, we recommend that weed managers, education specialists and extension personnel:

- Focus on a diversity of benefits resulting from effective weed control (from wildlife habitat and native plants to scenic beauty), recognizing that changing landownership is resulting in a larger number of landowners with a broader range of values and interests.
- Develop resources and programs on alternative methods for landowners who are concerned about the safety of chemical herbicides.
- Collaborate with communities to organize neighbors and local landowner groups to share information and

resources, and build social norms about weed control across different types of landowners.
- Develop effective mechanisms to communicate with absentee owners about weed management, through neighbors, email alerts, and welcome packets.

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