“The frying pan or the fire: public attitudes about using herbicides to manage invasive weeds”

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Abstract

How do we balance risks? This paper assesses hypotheses derived from instrumental rationality and risk society theories about the reasoning strategies that people will use to develop views supportive or oppositional to the use of herbicides to manage cheatgrass (*Bromus tectorum*), an invasive weed. Cheatgrass is well-known in the population of the American West to increase wildfire risks substantially and to harm the environment in other ways. But are the cures worse than the disease? One demonstrably effective method of cheatgrass suppression is the use of herbicides, and the paper explores sources of support for and opposition to the use of herbicides for this purpose. The data are from a representative sample of residents of Nevada, one of the states greatly at risk from cheatgrass (N = 532). Attitude and cultural practice clusterings are assessed using factor analysis. Direct and indirect effects of demographic and background variables and cultural practices on support for/opposition to herbicide use are assessed via structural equation models. Results show that there is more support for the instrumental rationality hypothesis, but that the risk society hypothesis is also needed to account for all the findings.

Keywords: natural resources, invasive weeds, public opinion, attitudes, environmental management, general population surveys.
JEL Classification: Q34.

Introduction

The Great Basin – the iconic American West of sagebrush prairie and thrusting mountain ranges – is on the verge of a transition to monoculture cheatgrass (*Bromus tectorum*), an invasive weed with low nutritive value and high fuel potential which threatens both ranching and environmental goals (Bureau of Land Management, 2000; Miller and Tausch, 2001; Pellant, Abbey, and Karl, 2004; Young and Clements, 2009). Similar challenges face steppe ecologies throughout the world. The threat of transition comes about because of a positive feedback loop whereby fire enhances opportunities for cheatgrass and cheatgrass, in turn, increases wildfire risk.

But the alternatives to cheatgrass encroachment are not necessarily attractive. Prior research shows that, in general, even where there is agreement on a vegetation management problem, people's different interests, perceptions, and subcultures may prevent them from coming to prefer the same solution (Norgaard, 2007, p. 452; Wilson, Tucker, Hooker, LeJeune, and Doohan, 2008). One such contested solution seems likely to be the use of herbicides to manage cheatgrass.

At specific stages of cheatgrass infestation, herbicides have been shown to be particularly effective both in terms of ecological outcomes and economic outcomes, relative to other methods of treatment. McIver et al. (2010) describe the different methods available to treat cheatgrass invasions at various stages of infestation over various ecological conditions on sagebrush rangelands. These methods also include the use of fire as a control tool, mechanical methods to reduce overgrown vegetation with machines and hand tools, and targeted grazing with livestock. Herbicides are highly effective at preventing early stage infestations from surging out of control. When used in conjunction with other methods, they can greatly enhance the probability of success for restoring native vegetation. For example, an economic analysis of treatments on Great Basin rangelands found that, due to the low per hectare costs and high success rates, herbicides used in early stages (when lands are relatively healthy) yield higher rates of returns than would other methods (Taylor et al., 2011). Controlled fire can reduce cheatgrass invasion by mimicking natural controls; however, the probability and expected costs of losing control of a prescribed burn and the effects of smoke on downwind communities often makes this option unavailable. Targeted livestock grazing is not practical on the large landscape scales needed, and since livestock prefer perennial native grasses over cheatgrass, targeted grazing is more effective on heavy infestations. The relatively expensive alternative of hand crews using mechanical methods tends to be limited to areas with large buildups of overgrown brush, where herbicides alone would not be effective and prescribed burns have higher expected costs.

Herbicides may be a particularly sensitive issue in the West, because our focus group work suggests that many people do not distinguish between herbicides and pesticides. For some of them, the near-disappearance of the bald eagle caused by the use of DDT, once proclaimed to be safe, is a potent symbol of trust betrayed, an embodiment of loss. Moreover, rural areas have traditionally high rates of military service, so lingering memories and concerns about Agent Orange could affect evaluations of newer herbicides.

Moreover, prior research finds that, throughout the developed world, worry about pesticides is rather high and, at most, weakly related to demographic factors (Chipman and Kendall, 1995; Kelley, 2003; van Tassell, Ferrell, Lang, Legg, and Lloyd, 1999). It seems likely that will be true of herbicides as well. The generalization "chemicals are bad" may influence many specific policy preferences, with some scholars going so far as to posit a generalized distrust of science and industrial technology – especially chemicals and machines – across the most developed countries (Douglas and Wildavsky, 1983), although the empirical evidence is mixed (Rippl, 2002). For whatever reason, social conflict over the use of herbicides has erupted in many places (Norgaard, 2007, p. 451).

Attitudes towards the environment in the Great Basin region have, historically, been strongly influenced by Mormon culture, based in Utah but radiating throughout the area, with the central tenet being that the highest, best use of nature is to feed people and otherwise serve human purposes (Brehm and Eisenhauer, 2006). But migration has drastically changed the social composition of the intermountain West (Albrecht, 2008), bringing in newcomers ranging from those who share traditional values to those who seek to establish alternative goals of the environment as an end in itself to those who moved in for entirely different reasons and are indifferent or even hostile towards the sagebrush heath where they now dwell (Winkler, Field, Luloff, Krannich, and Williams, 2007). Return migration and family unification are common migration motives (Glasgow and Brown, 2006) which could well enhance commonality of attitudes between long-term residents and migrants. On the other hand, long-term residents and migrants may disagree sharply over the desirability and importance of invasives. For example, research elsewhere has found that some migrants have positive attitudes towards invasives that remind them of home (Isern, 2007).

Focusing on Nevada, a substantial portion of the Great Basin, this paper examines the attitudes of a broad array of socioeconomic groups towards the use of herbicides to manage cheatgrass. We build on prior qualitative research about attitudes towards the use of herbicides to manage rangeland vegetation with special reference to invasive weeds (Norgaard, 2007) by incorporating hypotheses and insights from that research into statistical analysis of survey data, with special reference to theories of instrumental rationality and the "risk society".

The paper is organized as follows. The next section sketches the theoretical frameworks that guide this research. Following that, we detail our data, measurement, and methods. Next comes the presentation of the descriptive and analytic statistical results. Finally, our discussion synthesizes the findings with prior research and generates from that a set of working hypotheses for future research.

1. Theories

To the extent that people use *instrumental rationality* (Bratman, 2009; Eastwood, 2005; Kalberg, 1980; Weber, 1947) to think about nature and environmental problems, the methods or tools for solving the problems should be evaluated purely in terms of (1) the priority accorded the goal, i.e. how much the person values solving the environmental problem, (2) the effectiveness of the method in achieving the solution, and (3) the degree to which the method has unintended consequences for other goals. For example, support for the use of foetal tissue from abortions as a stem-cell source for research and treatment is almost entirely driven by these three considerations (Evans, Zanjani, and Kelley, 2002). More generally, the social-psychological cognitive hierarchy model which has been successfully used to model policy preferences concerning wildlife as a consequence of wildlife value orientations (Vaske and Donnelly, 1999; Whittaker, Vaske, and Manfredo, 2006) provides important confirmation of the hypothesis that people think about (at least some) environmental issues in instrumentally rational ways. In addition, people who perceive more dangerous and pervasive effects of climate change are much more likely to support policy measures to mitigate it (Dietz, Dan, and Shwom, 2007).

By contrast, the *risk society perspective* suggests that the presence of large-scale technologically-based risks in modern society generates a kind of generalized low-level anxiety which manifests itself in a generalized social reorientation towards minimizing risks rather than maximizing benefits, with particular anxieties about science and technology (Beck, 1992; Douglas and Wildavsky, 1983). This perspective also suggests that people probably tend to perceive inflated risks – that they are likely to overestimate the negative unintended consequences of methods which involve "heavy technology" or "big technology" – large, loud, indiscriminate machinery, and broadcast use of factory-produced chemicals.

In terms of environmental problems, this risk society perspective suggests that, contrary to the instrumental rationality hypothesis, people will evaluate methods or tools for solving environmental problems partly as ends in themselves, for example, by taking into account their "flavor" or "affinity" with other aspects of people's culture or subcultural preferences (Beck, 1995). For example, attitudes towards cloning exhibit a strong tendency to evaluate the technology as

an end-in-itself, rather than in terms of the goals it serves, particularly when it comes to human cloning (Evans and Kelley, 2004; Evans and Kelley, 2011). Similarly, prior research reveals that the generalized cultural feeling of being a part of nature influences attitudes towards a range of environmental policy options net of environmental goals (Dutcher, Finley, Luloff, and Johnson, 2007). Moreover, the risk society perspective anticipates exaggerated perceived risks of negative unintended consequences for other goals.

2. Hypotheses

We summarize the hypotheses in Table 1, then narratively describe them and the literature leading to them.

2.1. Dimensionality. In terms of invasive weeds, such as cheatgrass, these two theoretical perspectives suggest clearly distinct hypotheses about public opinion on herbicide use. To the extent that herbicides are viewed as means to ends and assessed via instrumental rationality, then they should be evaluated in their own right and attitudes towards them should not be strongly linked to attitudes about other methods of vegetation management (which should each be evaluated separately)[1]. So the instrumental rationality perspective predicts that each vegetation management method should stand alone, in terms of public opinion.

By contrast, the risk society perspective suggests a generalized distrust of "heavy tech" solutions, so it suggests that there should be strong evidence that attitudes towards herbicides and attitudes towards other "heavy tech" solutions, such as using machinery to remove vegetation (Wiedemann, 2007) are really different aspects of a single underlying attitude.

Table 1. Hypotheses: predictions from the instrumental rationality and risk society theories

	Prediction from theory	
Issue	Instrumental rationality	Risk society
1. Dimensionality: Independent assessments, or two measures of one assessment:		
a. Do attitudes towards herbicides and towards mechanical removal of vegetation both reflect a single underlying concept ("heavy tech")?	No (inter-item correlations should be low; no prediction about correlations with criterion variables; factor analysis loadings should be low, scale reliability should be low)	Yes (inter-item correlations should be high; correlations with criterion variables should be similar; factor analysis loadings should be high, scale reliability should be high)
2. Influences of wildlands culture: Vegetation management goals and recreational practices		
a. Do people who value native plants have more positive or more negative attitudes towards "heavy tech"?	More positive (positive, significant parameter in structural equation model)	More negative (negative, significant parameter in structural equation model)
b. Do contemplative recreators have more positive or more negative attitudes towards "heavy tech"?	More positive, but weak compared to 2a (positive, significant, small parameter in SEM)	More negative (negative, significant parameter in SEM)
c. Do interactive recreators have more positive or more negative attitudes towards "heavy tech"?	More positive, but weak compared to 2a (positive, significant, small parameter in structural equation model)	More positive (positive, significant parameter in structural equation model)
3. Direct influences of demographic and socioeconomic conditions of life on attitudes towards "heavy tech":		
a. Age	ns (= effect not statistically significant in structural equation model)	Positive (= effect positive and statistically significant in SEM)
b. Gender	ns	"Female" effect negative and statistically significant in structural equation model
c. Mother with dependent children at home	ns	Very negative
d. Urban residence	ns	Negative
e. Years in Nevada	ns	Positive
f. Education	ns	ns
g. Occupation in ranching or farming	ns	Positive
h. Occupation in recreation	ns	Negative
i. Family income	ns	ns

[1] The hypotheses necessarily focus on the range of vegetation management methods towards which attitudes were solicited in the existing survey data. Others are conceivable, but the list in the survey included a broad range of methods – all those even remotely under serious consideration by ranchers and public lands agencies today. See Swanson, Sherman, Ben Bruce, Rex Cleary, Bill Dragt, Gary Brackley, Gene Fults, James Linebaugh, Gary McCuin, Valerie Metscher, Barry Perryman, Paul Tueller, Diane Weaver, and Duane Wilson (2007). *Nevada Rangeland Monitoring Handbook*, 2nd edition, UNCE Educational Bulletin 06-03, Reno, NV: University of Nevada Cooperative Extension.

To test these hypotheses empirically, we need to assess whether attitudes towards herbicides and towards other "heavy tech" solutions are distinct or whether they really measure the same underlying attitude of opposition to "heavy tech" solutions in general.

$H1_{IR}$: Instrumental rationality implies multidimensionality. Members of the public evaluate each vegetation management method separately, so that attitudes to herbicides will be distinct from attitudes towards mechanical removal (and other "heavy tech" measures, if available). The correlations between the items will be lower than we would expect if they measured the same thing, and there will be signs of distinctiveness in their patterns of correlations with criterion variables. If data are available for a factor analysis, attitudes towards the different vegetation management methods will load on different factors.

$H1_{RS}$: The risk society perspective implies ideological clustering: Members of the public frame vegetation management methods in terms of cultural meanings that group them together. In particular, the generalized trustworthiness of science and machinery is a culturally contested domain, so that attitudes to herbicides will be indistinguishable from attitudes towards mechanical removal (and other heavy tech measures, if available). The correlations between the items will be high enough to support the claim that they measure the same deeper concept, and their patterns of correlations with criterion variables will be closely similar. If data are available for a factor analysis, attitudes towards the different vegetation management methods will load on the same factor.

2.2. Social differentiation. In terms of social differentiation, the instrumental rationality perspective suggests that socially differentiated interests will lead people to hold different goals and hence to adopt different attitudes towards the environment and towards environmental management in order to further those goals. The "risk society" perspective suggests little social differentiation of attitudes towards nature and towards human attempts to manage nature, because all are at risk of unintended consequences, the negative attitudes towards "scientific" and "heavy tech" solutions should be widely diffused throughout society. These two general theories suggest a variety of specific hypotheses, some of which are detailed below. Note that socially differentiated interests are not assumed to be monolithic – the multivariate analysis approach allows for the possibility that one's views may be influenced by diverse, possibly conflicting social network ties (Moore, 2008).

2.3. Age. The effects of age in related research are ambiguous. Older people are more positive towards policies designed to mitigate climate change (Dietz, Dan, and Shwom, 2007). But research on attitudes towards wildlife finds no age effect (Koval and Mertig, 2004; Ryan and Harvey, 2000). In terms of the theories under consideration, the instrumental rationality hypothesis predicts no direct effect of age on attitudes towards "heavy tech" solutions (i.e. there might, or might not be, age differences in the priority allocated to native plants vs cheatgrass, but among people holding any of the range of attitudes about this goal, there will be no age differences in evaluation of the means, the "heavy tech" solutions). By contrast, the risk society hypothesis suggests that succeeding generations in our culture are progressively more oriented towards risk reduction and techno-phobia, so it predicts a strong direct age effect with the young having much more negative attitudes towards heavy tech solutions than their seniors, even for those who accord the same priority to the goal of enhancing conditions for native plants (i.e. even net of indirect effects through possible differences in goal endorsement).

$H.Age._{IR}$: No significant age effect on attitudes towards herbicides and "heavy tech" more generally.

$H.Age._{RS}$: Younger cohorts have grown up in the shadow of the risk society will be less supportive than their seniors of herbicides and other "heavy tech" solutions as vegetation management tools. There will be a strong negative direct effect of age on attitudes towards "heavy tech" solutions.

Duration of residence should have a positive effect on attitudes towards native plants (Isern, 2007), especially where the community identity has strong symbolic links to its natural environment (Brehm, Eisenhauer and Krannich, 2006), possibly exacerbated if the increasing community inequalities induced by the new migration (Hunter, Boardman and Saint Onge, 2005; Saint Onge, Hunter and Boardman, 2007) lead long term locals to shift their local attachments from the community towards the environment.

The instrumental rationality hypothesis would expect that duration of residence in Nevada would have no significant effect on attitudes towards the use of "heavy tech methods" per se, although it could well have indirect effects through goal shifts, with longer term residents coming increasingly to value native plants. The risk society hypothesis here also suggests no direct effect – one of the key claims of the risk society is that technological dread is widely diffused throughout society.

H.Dur.$_{IR}$: No direct duration effect on attitudes towards herbicides and "heavy tech" more generally.

H.Dur.$_{RS}$: No direct duration effect on attitudes towards herbicides and "heavy tech" more generally.

Urban residence is of interest in part because the risk society theory holds that technological dread is stronger in cities (Beck, 1995). In this vein, urban residence is associated with agro-environmental concerns, although that apparent linkage is really a proxy for proximity to agriculture (Sharp and Adua 2009). From the standpoint of instrumental rationality, there should be no direct effect of rurality on attitudes towards "heavy tech" vegetation control, although there could well be indirect effects reflecting differential recreation customs, and possible values on native plants of city dwellers and rural folk. On the other hand, instrumental rationality could lead to a positive effect of urbanicity on attitudes towards "heavy tech" vegetation managment methods: if people perceived the herbicides as risky and were only interested in their own welfare, then rural people, being more exposed, should be more opposed. But this seems less plausible than the "no effect hypothesis".

H.Urb.$_{IR}$: No direct effect of urban residence on attitudes towards herbicides and "heavy tech" more generally.

H.Urb.$_{RS}$: Urban residence will have a negative effect on attitudes towards herbicides and "heavy tech" more generally.

2.4. Gender. A comprehensive review of research through the early 1990s found that the preponderance of evidence in prior literature suggests that women tend to have more pro-environment attitudes than men, especially when the human/environment tradeoff is monetary or involves sacrifice of convenience (Mohai, 1992). More recent research is somewhat mixed. For example, compared to men, women are significantly less inclined to think that animals should be used for human ends such as hunting, animal testing of medicines, etc (Kendall, Lobao, and Sharp, 2006), are more inclined towards the view that nature should be cherished as an end in itself rather than in the service of human goals (Dietz, Kalof, and Stern, 2002), tend to be more fearful of gmos (Kelley, 2003; Siegrist, 2000) and pesticides (Kelley, 2003), and tend to perceive greater risk of high tech industrial disasters (Wester-Herber and Warg, 2002). On the other hand, other research with good measurement has found no evidence of gender differences in attitudes towards climate change mitigation policies (Dietz, Dan, and Shwom, 2007). In terms of the theories under consideration, the instrumental rationality hypothesis would predict that there is no significant direct effect of gender on attitudes towards "heavy tech" vegetation management methods (i.e. that if there is an effect it is all indirect through differences in goals, i.e. attitudes towards cheatgrass). By contrast, the risk society hypothesis would predict a direct effect, with men more supportive of "heavy tech" methods even net of differences in goals, because of the affinity between the heavy tech solutions and masculine identities that valorize mastery and industrial technology, and the corresponding affinity between feminine identities that valorize harmony and pre-industrial technologies (Bord, 1997).

H.Gen.$_{IR}$: No significant gender effect on attitudes towards herbicides and "heavy tech" more generally.

H.Gen.$_{RS}$: Gendered subcultures make women less supportive than men of herbicides and other "heavy tech" solutions as vegetation management tools.

Mothers with dependent children are expected by the risk society theory to be especially opposed to "heavy tech" vegetation management methods because they are thought to be more deeply engaged in a traditional feminine subculture and to be especially susceptible to technological dread because of their special responsibilities for the protection and nurturance of the next generation (Norgaard, 2007).

2.5. Education. The effects of education are mixed in prior research. Much prior research finds little or no linkage between educational attainment and environmental attitudes (e.g. Dietz, Dan, and Shwom, 2007). Nonetheless, other prior research also using state-of-the-art survey and measurement strategies yields conflicting results. On the one hand, some have found that highly educated people are more likely than their less educated peers to value wildlife as an end-in-itself rather than in service of human ends (Manfredo, Teel, and Bright, 2003; Vaske, Donnelly, Williams, and Jonker, 2001). On the other hand, highly educated people are more likely than their less educated peers to think that animals should be used for human ends such as hunting, animal testing of medicines, etc. (Kendall, Lobao, and Sharp 2006). In terms of risk perceptions, compared to their peers with little education, highly educated people perceive gmos and pesticides as less risky (Kelley, 2003).

In terms of predicted effects, neither theory predicts a significant effect of education.

2.6. Occupation. The instrumental rationality perspective would expect ranching/non-ranching differences to be indirect through differences in goals about vegetation management, but the risk society perspective suggests that the "natural" flavor of the rangelands for people further from daily engagement with them (i.e. non-ranchers) will lead them to op-

pose the use of "heavy tech" methods. Culture clashes associated with in-migration are reduced when there are cultural intersections between newcomers and people working in traditional rural occupations (Petrzelka, Krannich, and Brehm, 2006). This could certainly include recreational elements, but the views of people working in recreation could be dominated by a clientele seeking a "natural" experience, so the risk society perspective suggests that working in a recreation-based job will lead people to adopt views opposed to "heavy tech" vegetation management methods.

H.Rnch.$_{IR}$: No direct duration effect on attitudes towards herbicides and "heavy tech" more generally.

H.Rnch.$_{RS}$: Ranching will have a positive effect on attitudes towards herbicides and "heavy tech" more generally.

H.RecOcc.$_{IR}$: No direct duration effect on attitudes towards herbicides and "heavy tech" more generally.

H.RecOcc.$_{RS}$: Ranching will have a positive effect on attitudes towards herbicides and "heavy tech" more generally.

We will also investigate the effects of participation in recreation, since recreational engagement has been shown to have a strong link with agro-environmental concerns in prior research (Sharp and Adua, 2009). For our purposes, there are two key forms of recreation that involve direct contact with the rangelands – an interactive recreation lifestyle and a contemplative recreation lifestyle (described in detail below; these are different dimensions rather than opposite ends of one dimension, with some people doing both). Both of these could have indirect effects on attitudes towards vegetation management by leading people to be more likely to endorse the goal of healthy rangelands. Do they also directly affect attitudes towards vegetation management methods? The instrumental rationality hypothesis would say no, and the risk society hypothesis would say yes.

H.Inter.$_{IR}$: No direct effect of an interactive recreation lifestyle on attitudes towards herbicides and "heavy tech" more generally.

H.Inter.$_{RS}$: Participation in the interactive recreation lifestyle will lead to more approval of herbicides and "heavy tech" more generally.

H.Contem.$_{IR}$: No direct effect of the contemplative recreation lifestyle on attitudes towards herbicides and "heavy tech" more generally.

H.Contem.$_{RS}$: Participation in the contemplative recreation lifestyle will lead to more approval of herbicides and "heavy tech" more generally.

2.7. Data. The data in this article are from a 2005 survey of a representative sample of the general public in Nevada concerning their perceptions, attitudes, and preferences for vegetation management methods, with special reference to cheatgrass.

As part of a research project directed by Kimberly Rollins, these data were collected through a 2005 mail survey sent to residents of Nevada using Dillman's well-known guidelines for survey data collection (Dillman, 2000). The list of potential vegetation management methods presented in the questionnaire includes the range of methods under serious consideration by contemporary land managers (Nader, Henkin, Smith, Ingram, and Narvaez, 2007). Foundational work for the survey was conducted through focus groups, questionnaire development and pretesting proceeded through spring and summer of 2005. Some pretest respondents were individually debriefed to assess comprehension and interpretations; the primary investigators also met with other pretest respondents to critique the questionnaire and elicit suggestions for improvements during group sessions; the primary investigators then analyzed the results statistically to assess reliability and coherence. Question wording was revised in light of pretest results and the revised questionnaire was then used in a pilot survey (Rollins, Castledine, Swanson, Evans, McAdoo, Schultz, Havercamp, and Wilson, 2007). These data have also been used in research on measurement for non-market valuation (Mimako Kobayashi, 2010).

Of 2,125 surveys sent out, 178 were undeliverable (no forwarding addresses available) and 576 completed surveys were returned for a state-wide response rate of 30% (Rollins et al., 2007). Response rates tended to be higher in rural counties, so the county-weighted average (37%) is higher than the state-wide average. County response rates varied from 17% for Clark County to 53% for Lincoln County. Clark County's low response rate may reflect the large proportion of new residents in the area. Washoe County, the other mainly urban county had a 32% response rate. Many of the rangeland issues described in the questionnaire may be seen as not relevant for Clark County residents, who live just beyond the southern border of the Great Basin in a different ecosystem.

2.8. Measurement and methods. The variables used in the analysis are listed in Appendix (Table 1), together with their measurement information. Column 1 lists the concept being measured; column 2 provides the corresponding verbatim item from the questionnaire or details the calculation for calculated variables; and column 3 details the scoring of answer categories and the missing data treatment for the item. Exact quotes from the questionnaire ("verbatims") are in italics.

One understanding of culture is that praxis, or socially patterned lived experience, generates attitudes. Accordingly, we will examine the degree to which there are subcultures of outdoor recreation and whether participation in these influences attitudes towards cheatgrass. In particular, research suggests that in the area under consideration, there are at least two subcultures of outdoor recreation: an interactive subculture and a contemplative subculture. Using the scales developed by Pettis (2009) in light of factor analysis and classic measurement model requirements of similar correlations with criterion variables, we measured interactive outdoor recreation as the number of times the respondent has been hunting, fishing, target shooting, or off-roading on Nevada rangelands in the last twelve months. Contemplative recreation was measured as the number of times respondents has gone wildlife viewing, sightseeing/photographing, or hiking in the last twelve months.

Missing data treatments were (1) on the dependent variables (attitudes towards herbicides and attitudes towards mechanical removal of vegetation) cases with missing data were excluded from the analysis and (2) on the independent variables (all the rest), missing data were replaced with the item mean (or by 0 for checklist items, because many respondents only check "yeses" on checklists and simply skip the "noes"). Substitution of a likely value (the mean for most variables) preserves cases for the multivariate analysis, thereby increasing the precision of the estimates and allows us to take advantage of all the non-missing information each respondent provided. Exploratory analysis showed that the data are essentially missing at random, so each respondent who had missing data on one or two out of the 24 independent variables in the analysis provided information on the other 22 or 23 variables and their relationships. Coding the missing data to the mean allows us to incorporate all that information into the analysis. By contrast, excluding cases with missing data on any item would be much less productive here: with 24 variables in the analysis, losing about 5 to 7% of the cases (that is the typical missing data rate here) independently for each variable (because the data are essentially missing at random) would lead to a rapidly diminishing case base. That in turn would grossly inflate the standard errors of the parameters in the model, thereby inhibiting our ability to test the hypotheses of interest. Accordingly, it was decided to use likely value replacement (usually the mean) of missing data for the independent variables.

3. Findings: descriptive

As one might expect from prior research on related issues, herbicides do not appeal to most members of the public as a vegetation management method, although neither are they the least popular method (Table 2). To set the public view of these methods in context, let us consider them in light of the entire list of vegetation management methods that respondents were asked to consider in the survey. Seeding native species and fire control were substantially the most popular methods, with means, on a points out of 100 basis, of 79 and 71 points respectively. Next come prescribed grazing and prescribed fire at 63 points and 60 points. Then come brush- and tree-cutting by hand (57 points), control with selected insects (53 points), and using machinery to remove vegetation (50 points). A considerable distance behind comes herbicides (39 points), followed by seeding non-native species (34 points) and excluding grazing animals (28 points).

Table 2. Attitudes toward alternative vegetation management methods.
Percentage distribution and means (Nevada, 2005)

How appropriate do you feel each of the following vegetation management methods are for use on Nevada's rangelands?							
	Not at all appropriate	Somewhat appropriate	Appropriate	Very appropriate			
	0	33	67	100	Total	Mean	N
Heavy tech methods:							
Using machinery to remove vegetation	14	35	39	12	100	50	479
Using herbicides	29	36	26	9	100	39	489
Other methods:							
Seeding native species	2	11	38	50	100	79	523
Fire control	3	20	37	39	100	71	532
Prescribed grazing	7	25	41	27	100	63	503
Prescribed fire	7	29	41	23	100	60	497
Brush and tree cutting by hand	8	31	44	17	100	57	487
Control with selected insects	14	31	35	19	100	53	435
Seeding non-native species	34	39	20	7	100	34	467
Excluding grazing animals	48	30	12	11	100	28	481

Source: Rollins, Kimberly, Anita Castledine, Sherman Swanson, Kent McAdoo, Brad Schultz, Michael Havercamp, and Robert Wilson (2007). "Nevada's Rangeland Vegetation: A Public Opinion Questionnaire, 2005. Machine Readable Datafile", University of Nevada, Reno, NV.

Attitudes towards herbicides are not distinct, but rather form part of a general attitude pro-or anti-"heavy tech" vegetation management (Table 3). The inter-item correlation between attitudes towards herbicides and attitudes towards mechanical removal of vegetation is 0.55, and their patterns of correlations with criterion variables are similar. They load well in a factor analysis (0.637 for herbicides and 0.861 for vegetation removal by machine). Moreover, the sizes and signs of their correlations with criterion variables are closely similar. Thus, these three classical indicators of dimensionality all suggest that these two variables measure a single underlying construct – attitudes towards "heavy tech" vegetation management methods. This is consistent with the risk society hypothesis ($H1_{RS}$) and contrary to the instrumental rationality hypothesis ($H1_{IR}$).

These results justify combining the answers to these questions into a two-item scale representing attitudes towards "heavy tech" vegetation management methods. Accordingly, we use this scale as our dependent variable in the rest of the analysis.

Table 3. "Heavy tech" methods of vegetation control: measurement properties

	Machinery	Herbicides
Heavy tech methods: correlations		
Using machinery to remove vegetation	1.00	
Using herbicides	.55	1.00
Correlations with criterion variables		
Years lived in Nevada	.08	.12
Age	.13	.12
Education (years)	.02	.07
Family income	.10	.15
Urban resident	-.09	-.04
Activities: Hunting, fishing, off-roading	.13	.11
Activities: Sightseeing, bird watching, hiking	.03	-.02
Against cheatgrass, for native plants	.18	.12
Confirmatory factor loadings[1]		
First factor	.86	.64

Note: [1] Scale reliability: alpha = .71.
Source: Rollins, Kimberly, Anita Castledine, Sherman Swanson, Kent McAdoo, Brad Schultz, Michael Havercamp, and Robert Wilson (2007). "Nevada's Rangeland Vegetation: A Public Opinion Questionnaire, 2005. Machine Readable Datafile", University of Nevada, Reno, NV.

3.1. Goal endorsement. An important aspect of the instrumental rationality theory is the specification of goals, because the heart of the instrumental rationality argument is that people will judge "means" (in this case, vegetation management methods) in terms of how well those means serve their goals. The survey asked about a variety of potential vegetation management priorities, four of which are strongly related to the importance of managing cheatgrass. They are given verbatim in Table 4. The correlations among these items are high, being in the range .56-.77. Their correlations with criterion variables are of approximately the same sizes and the same signs. Finally, the factor loadings are strong, all being over 0.7. Accordingly, it makes sense to combine these items into a multiple-item scale measuring the subjective importance of fighting cheatgrass.

Table 4. Goals with respect to cheatgrass and native plants: measurement properties

	How important are the following vegetation management priorities to you personally?			
	Weed	Restore	Prevent	Native
Correlations				
Invasive weed control	1.00			
Restoration of cheatgrass dominated areas	.68	1.00		
Prevention of cheatgrass domination	.71	.77	1.00	
Maintenance of native plant communities	.65	.57	.56	1.00
Correlations with criterion variables				
Years lived in Nevada	.15	.13	.16	.10
Age	.24	.21	.21	.13
Education (years)	.06	.09	.05	.08
Family income	.07	.02	.02	-.06
Urban resident	-.09	-.11	-.10	-.05
Activities: hunting, fishing, off-roading	.10	.06	.10	.04
Activities: sghtseeing, bird watching, hiking	.19	.13	.19	.24
Descriptive statistics				
Mean support (0 = not at all important; 33 =somewhat; 67 = important; 100 = very)	68	61	67	58
Standard deviation	31	34	33	31
Confirmatory factor loadings[1]				
First factor	.86	.80	.85	.73

Note: [1]Scale reliability: alpha = .89.

4. Findings: analytic

Which social structural and cultural forces directly affect attitudes towards "heavy tech" vegetation management? From the point of view of the instrumental rationality thesis, a crucial question is to what degree attitudes about the goal affect attitudes about the means. The instrumental rationality hypothesis anticipates a strong connection between goals and means; by contrast the risk society hypothesis expects "means" to be evaluated as ends-in-themselves, in terms of their cultural meanings. In particular technological dread would be expected to erase the connection between the goal – controlling/subduing cheatgrass – and the means to that end.

In Table 5, the columns headed "For "heavy tech" vegetation management" give the structural equation model estimates of the relevant direct effects.

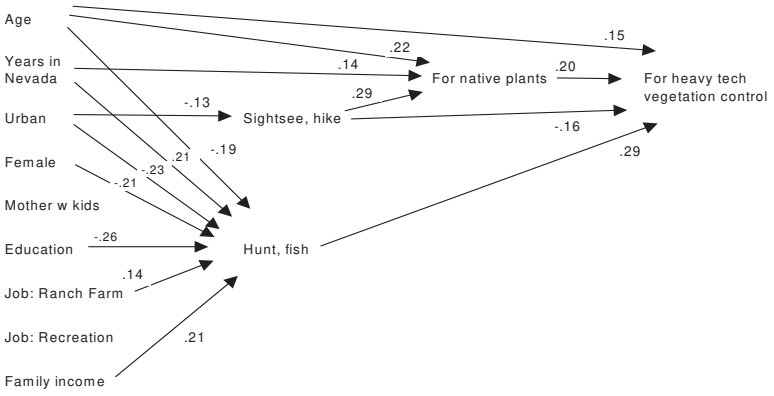
People who strongly endorse fighting cheatgrass as an important goal (see Table 5) are substantially more likely than others to endorse the use of "heavy tech" methods to combat cheatgrass, as shown by the standardized SEM coefficient of 0.2 (Table 5, right panel). That is a moderately important, but not overwhelming effect. This part of the evidence supports the instrumental rationality hypothesis.

Table 5. Standardized structural equation estimates and *t*-statistics (Nevada, 2005)

	Activities: hunting, fishing, off-roading		Activities: sightseeing, bird watching, hiking		Against cheatgrass, for native plants		For "heavy tech" vegetation management	
	Std.	*t*	Std.	*t*	Std.	*t*	Std.	*t*
Years lived in Nevada	.21	4.93	-	-	.14	3.39	-	-
Age	-.19	-4.41	-	-	.22	5.26	.15	2.78
Gender (female = 1)	-.21	-4.69	-	-	-	-	-	-
Mother with young child	-	-	-	-	-	-	-	-
Education (years)	-.26	-4.65	-	-	-	-	-	-
Job: rancher, farmer	.14	3.22	-	-	-	-	-	-
Job: recreation, tourism	-	-	-	-	-	-	-	-
Family income	.21	3.30	-	-	-	-	-	-
Urban resident	-.23	-4.78	-.13	-2.73	-	-	-	-
Activities: hunting, fishing, off-roading	-	-	-	-	-	-	.29	3.94
Activities: sightseeing, bird watch, hiking	-	-	-	-	.26	5.45	-.16	-2.28
Against cheatgrass, for native plants	-	-	-	-	-	-	.20	3.46
R-squared	.31		.02		.15		.12	

Note: Only effects statistically significant at $p < .05$. $N = 576$.

However, there also seem to be elements of cultural affinities that have nothing to do with instrumental rationality. The single most important effect in the model (0.29) shows that people involved in the interactive outdoor recreation subculture have much more positive attitudes towards "heavy tech" vegetation management methods than do their peers outside the interactive outdoor recreation subculture, even net of their goals (Table 5, right panel, and Figure 1). The importance of cultural affinities or cultural styles is also evident in the smaller, but definitely not negligible, direct negative effect of participation in contemplative outdoor recreation on attitudes, as shown by the standardized SEM coefficient of 0.16: people who engage in contemplative outdoor recreation are less supportive of "heavy tech" vegetation management than are their peers.



Source: Table 6.

Fig. 1. Standardized structural equation estimates (Nevada, 2005)

Effects of demography and social structure are few. Support/opposition to "heavy tech" vegetation management has a moderately important link to age (effect of 0.15), with older people being more supportive, all else equal. There are no other significant effects of demographic and social structural variables. Interestingly, the variables representing incidental exposure to the Nevada landscape (duration of residence in Nevada and urban residence) do not have a significant effect on "heavy tech" vegetation management, in contrast to the chosen exposures/avoidances of engagement in interactive and contemplative outdoor recreation.

Discussion and conclusion

Summary of hypothesis tests. All in all, the analysis tested 13 predictions made by the instrumental rationality hypothesis of which 9 were supported

(69% correct) and 12 predictions drawn from the risk society hypothesis (42% correct), as shown in Table 6. Table 6 also provides a set of recommended working hypotheses for use in future research.

Table 6. Hypotheses revisited: original predictions from instrumental rationality (IR) and risk society (RS) theories, findings, and recommended working hypotheses

	Evidence on prediction		Recommended working hypothesis
Issue	IR	RS	
1. Dimensionality: Independent assessments or two measures of one assessment?			
a. Do attitudes towards herbicides and towards mechanical removal of vegetation both reflect a single underlying concept ("heavy tech")?	No	**Yes**	Environmental management techniques and approaches are likely to be evaluated by the public in clusters reflecting cultural affinities as well as on other grounds.
2. Influences of wildlands culture: vegetation management goals and recreational practices	**+**		
a. Do people who value native plants have more positive or more negative attitudes towards "heavy tech"?	**+**	-	The ends have a substantial effect on justifying the means: Embracing a particular environmental goal in raises the chances that people will endorse demonstrably effective environmental management techniques and approaches that could help achieve that goal.
b. Do contemplative recreators have more positive or more negative attitudes towards "heavy tech"?	ns	**-**	Cultural affinities between recreation praxis and environmental management techniques and approaches will influence people towards endorsing or opposing the use of particular techniques, even net of the links between recreation praxis and attachment to environmental goals.
c. Do interactive recreators have more positive or more negative attitudes towards "heavy tech"?	ns	**+**	As above.
3. Direct influences of demographic and socioeconomic conditions of life on attitudes towards "heavy tech"			
a. Age	ns	**+**	Year of birth influences endorsing or opposing the use of particular techniques, even net of the links between recreation praxis and attachment to environmental goals.
b. Gender (female)	**ns**	-	
c. Mother with dependent children at home	**ns**	-	
d. Urban residence	**ns**	-	
e. Years in Nevada	**ns**	+?	
f. Education	**ns**	**ns**	
g. Occupation in ranching or farming	**ns**	+	
h. Occupation in recreation	**ns**	-	

Note: Correct predictions are printed in boldface.

All in all, this paper has shown that attitudes towards herbicides are not distinctive, but instead are one aspect of attitudes towards "heavy technology" – in this dataset also measured by herbicide use and massive machinery solutions to vegetation management in the American Great Basin. If correct, this dimension should also include pesticides and other kinds of large-scale "blanket" applications (airplane based seeding or fertilizer), a clear prediction for future research.

Importantly, an adequate explanation of support for or opposition to the use of herbicides needs to include both instrumental rationality and risk society elements. There are large differences in support according to whether the environmental goal is endorsed or not, and to what degree, in conformity with the instrumental rationality hypothesis, and there are also cultural/lifestyle differences even aside from goal endorsement, as the risk society hypothesis would anticipate. But contrary to the most obvious version of the risk society hypothesis, there are virtually no effects of demographic and background variables.

These findings have implications for community capacity, as well. Prior research shows that task-oriented community-based activities tend to strengthen social bonds, thereby enhancing the community's social capital and its capacity to address future problems (Korsching and Allen, 2004; Stedman, Lee, Brasier, Weigle, and Higdon, 2009). That, together with a long-time horizon could help harness the increased complexity stemming from the new migration streams in the service of sustainability (Tainter, 2001). For example, the combination of concrete goals and specific tasks whereby community members could "do their bit" has led to dramatic results in Missoula, Montana (Marler, Supplee, Wessner and Marks, 2005).

Note that the existence of the direct effects of both outdoor recreation lifestyles on attitudes towards "heavy tech" vegetation management (net of vegetation management goals) is inconsistent with the instrumental rationality theory. They are consistent with risk society theory's claim that means will be evaluated as ends in themselves in terms of their

cultural "flavor", but it is also worth exploring in future research whether these findings are also consistent with other theories of culture. For example, recent work on the complexities of the social and landscape aspects of place attachment (Brehm, 2007) suggests that many affinities of cultural elements cannot be reduced to the risk minimization theme of the risk society. In terms of the problem at hand, the strong direct link of the interactive outdoor recreation lifestyle on attitudes towards using "heavy tech" vegetation management methods does not seem likely to be reflecting a risk minimization outlook. Rather, it might exemplify how having positive experiences oneself through the challenge and thrill of interacting with technology and nature generalizes to the attitude that nature has an underlying logic that people can grasp. That, in turn may lead participants to adopt the view that humans can make beneficial interventions in nature, such as successful vegetation management methods.

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Appendix

Table 1. Measurement: variables, verbatim questions, and scoring

Concept	Verbatim question	Scoring
Attitudes towards vegetation management methods		
Stem question	*"How appropriate do you feel each of the following vegetation management methods are for use on Nevada's rangelands?"*	
	Using herbicides	*Not at all* = 0; *Somewhat* = 33; *Appropriate* = 67; *Very* = 100; cases with "Don't know" and missing are removed from the analysis
	Using machinery to remove vegetation	As above
	Prescribed fire	As above
	Fire control	As above
	Seeding native species	As above
	Seeding non-native species	As above
	Prescribed grazing	As above
	Excluding grazing animals	As above
	Brush and tree cutting by hand	As above
	Control with selected insects	As above
Vegetation management goals		
Stem question	*"How important are the following vegetation management priorities to you personally?"*	Missing data are coded to the mean on these variables
	Maintenance of native plant communities	*Not at all* = 0; *Somewhat* = 33; *Important* = 67; *Very* = 100
	Invasive weed control	As above
	Restoration of cheatgrass dominated areas	As above
	Prevention of cheatgrass domination	As above
Interactive outdoor recreation		
Stem question	*"Please check the boxes that best indicate your use of Nevada's rangelands for the listed activities in the last 12 months..."*	Missing data are coded to "never" on these variables
	Camping	*Never* = 0; 1 *to* 4 *times* = 2; 5+ *times* = 5
	Off-road vehicle use	
	Hunting	As above
	Fishing	As above
	Target shooting	As above
Contemplative outdoor recreation		
Stem question	Please check the boxes that best indicate your use of Nevada's rangelands for the listed activities in the last 12 months...	
	Hiking	Never = 0; 1 to 4 times = 2; 5+ times = 5
	Sightseeing/photography	As above
	Wildlife viewing	As above
Age	What is your age?	Single years; missing to mean
Children present	Not including yourself, how many people in your household are in each of the age groups listed below?	# age 0-17; missing to zero
Duration of residence	*How many years have you lived in Nevada?*	Coded to category midpoints: 1, 3.5, 7.5, 15, 25, 37; missing to mean
Education	*What is the highest level of schooling you have completed?*	Qualifications coded to nearest standard year (e.g. HS grad = 12)
Gender	*What is your gender?*	Male = 0, Female = 1; no missing
Mother with dependent children	Interaction: Gender * Children present	1 = Female with dependent children; 0 = other

Table 1 (cont.). Measurement: variables, verbatim questions, and scoring

Concept	Verbatim question	Scoring
Rancher	*Please choose the field(s) that best describes your line of work. Check all that apply.*	*Ranching, agriculture* = 1; other = 0
Outdoor recreation/tourism job	The same as above.	*Outdoor recreation and tourism* = 1; other = 0
Income	*Please indicate your total household income from all sources, before taxes, in 2004.*	9 categories, coded to midpoints, divided by 1000 to keep coefficients readable; missing to mean
Urban residence	Not asked directly; coded from zip code.	1 = yes, 0 = other

Source: Rollins, Kimberly, Anita Castledine, Sherman Swanson, M.D.R. Evans, Kent McAdoo, Brad Schultz, Michael Havercamp, and Robert Wilson (2007). The 2005 Nevada Rangeland Vegetation Survey: General Public Questionnaire and Summary of Responses. Reno, NV: University of Nevada Cooperative Extension, Special Publication 07-11. Online: http://www.unce.unr.edu/publications/files/nr/2007/sp0711.pdf.
Note: Verbatim items from the questionnaire are in italics.