

# Perceptions of Ranchers About Medusahead (*Taeniatherum caput-medusae* (L.) Nevski) Management on Sagebrush Steppe Rangelands

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**Abstract** Medusahead (*Taeniatherum caput-medusae* (L.) Nevski) is an exotic annual grass invading rangelands in the western United States. Medusahead is a serious management concern because it decreases biodiversity, reduces livestock forage production, and degrades the ecological function of rangelands. Despite the obvious importance of ranchers as partners in preventing and managing medusahead in rangelands, little is known about their perceptions and behaviors concerning medusahead management. We present the results of a survey of ranchers operating on sagebrush steppe rangeland in a three-county area in southeast Oregon encompassing over 7.2 million ha. The primary objective of this research was to determine if the presence of medusahead on a ranch influenced its operator's perceptions and behaviors concerning invasive plant control and prevention. Ranchers operating on medusahead-infested rangeland were more likely to indicate increased awareness and concern about medusahead and the potential for its continued expansion. Ranchers operating on rangeland invaded by

medusahead were also more likely to indicate use of measures to prevent the spread of medusahead and other invasive plants on rangeland, interest in educational opportunities concerning invasive annual grass management, and plans for controlling invasive annual grasses in the future. This study revealed an alarming trend in which individuals are less likely to implement important prevention measures and participate in education opportunities to improve their knowledge of invasive plants until they directly experience the negative consequences of invasion. Information campaigns on invasive plants and their impacts may rectify this problem; however, appropriate delivery methods are critical for success. Web- or computer-based invasive plant information and tools were largely unpopular among ranchers, whereas traditional forms of information delivery including brochures/pamphlets and face-to-face interaction were preferred. However, in the future web- or computer-based information may become more popular as ranchers become more familiar with them.

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## Introduction

Medusahead (*Taeniatherum caput-medusae* (L.) Nevski) is a self-pollinating exotic annual grass native to Eurasia, where it consists of three geographically and morphologically distinct subspecies (Frederiksen 1986; Frederiksen and von Bothmer 1986). The plant invading rangelands in the western United States is *Taeniatherum caput-medusae* ssp. *asperum* (Novak 2004), a subspecies inadvertently introduced into the West in the late 1800s. Subsequently,

medusahead has invaded millions of hectares in the Pacific Northwest, California, Utah, and Nevada. Medusahead is extremely competitive, especially on heavy, clayey soils, and has even displaced cheatgrass in areas of Idaho (Miller and others 1999). Medusahead is a serious management concern (Dahl and Tisdale 1975; Monaco and others 2005) because it decreases biodiversity, reduces livestock and wildlife forage production, and degrades the ecological functions of native plant communities (Davies and Svejcar 2008; Davies 2011). Medusahead can quickly colonize after disturbance and outcompete native species because of the following life-history traits (Evans and Young 1970; Hironaka 1961; Young 1992; Torell and others 1961; Sharp and others 1957): (1) it often occurs in very dense stands with more than 20,000 plants  $m^{-2}$ ; (2) it can germinate in the fall and maintain root growth throughout winter; (3) it produces a large amount of litter that does not readily decompose, elevates fire risk, and can suppress or even exclude other plant species; and (4) it generally produces many seeds, which usually have a high germination rate. These life history traits also substantially contribute to the expense and failure rates of restoration efforts in medusahead-invaded rangeland because seeded native vegetation rarely establishes (Young 1992; Young and others 1999; Monaco and others 2005). In addition, medusahead invasion can greatly reduce the grazing capacity of rangelands (Hironaka 1961; Davies and Svejcar 2008; Davies 2011); making it clear that medusahead can create significant economic losses and management challenges for landowners and ranchers.

A growing number of researchers are recognizing that the issue of managing invasive species is as much a social issue, encompassing political and human factors, as it is a scientific one (e.g., Reaser 2001). In a discussion of the socioecology of biological invasions, Epanchin-Niell and others (2010) concluded that invasion biology must place greater importance on the socioecological processes that shape invasive species spread. Therefore, effective management of invasive species will require understanding the human dimension of invasion (García-Llorente and others 2008). In addition, successful medusahead management efforts cannot be constrained by artificial political boundaries (Davies and Johnson 2008). Thus, to promote more comprehensive and effective medusahead control and prevention programs, both public and private landowners must be engaged. Despite the obvious importance of engaging the ranching community as a partner in effective medusahead management, little is known about ranchers' perceptions, management decisions, and information needs.

The primary objective of this research was to determine whether the presence of medusahead on a ranch influenced the ranch operator's perceptions and behaviors concerning invasive plant management. We employed a survey

questionnaire to accomplish our research goal. Survey questionnaires have been successfully used to determine respondents' perceptions of other exotic species, their management, and risks they pose (e.g., Perrins and others 1992; García-Llorente and others 2008; Andreu and others 2009). We hypothesized that ranchers operating on rangelands invaded by medusahead would have different perceptions and behaviors concerning invasive plant management compared to ranchers operating on noninvaded rangeland.

## Methods

### Study Area

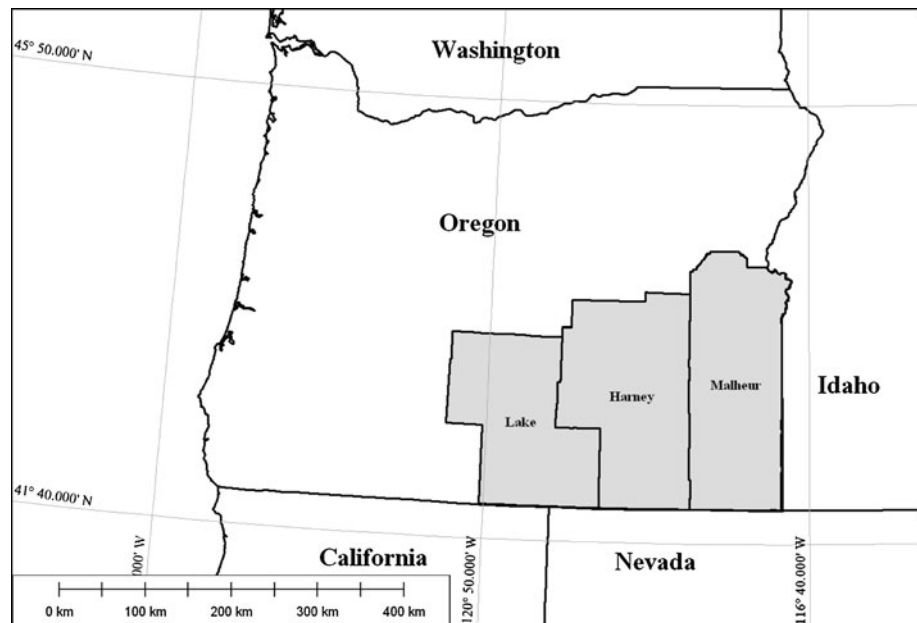
The study was conducted over three large, primarily rural counties in southeast Oregon (Fig. 1) encompassing several million hectares of sagebrush steppe rangeland. The study area is characterized by cold, wet winters and hot, dry summers. Average precipitation is low, with most areas receiving 380 mm or less per year. The summers are warm with temperatures in the 90's and winters are cool with temperatures in the 30's (Taylor and Hannan 1999). The most common sagebrush species are low sagebrush (*Artemisia arbuscula* Nutt.) and big sagebrush (*Artemisia tridentata* Nutt.). Less common yet important sagebrush species in southeast Oregon include stiff sagebrush (*Artemisia rigida* (Nutt.) A. Gray), black sagebrush (*Artemisia nova* A. Nelson), silver sagebrush (*Artemisia cana* Pursh) and three-tip sagebrush (*Artemisia tripartita* Rydb.) (Winward 1980).

Approximately 44,590 people live in the 7.2-million ha study area. The region's economy is primarily based in agriculture (Oregon Blue Book 2011) with livestock and forage crops having contributed 42 and 23% of the 2010 gross farm revenue, respectively (Oregon Agricultural Information Network 2011).

### Sampling Design and Survey Instrument

A written public opinion questionnaire about invasive plant management with particular focus on invasive annual grasses was sent to ranchers operating on sagebrush steppe rangelands in Harney, Malheur, and Lake Counties in southeast Oregon. Mailing addresses of 565 randomly selected ranchers were obtained from databases maintained by each county's respective Cooperative Extension Office. Databases from the Cooperative Extension Offices were selected to define the potential sample population because they provided the most comprehensive option available. These databases were originally compiled by Extension faculty for the primary purpose of information dissemination. The databases were developed by querying tax lot and

**Fig. 1** Study counties in southeast Oregon, USA



land use information to identify holders of land zoned for exclusive farm and ranch use. Ranchers have been added or omitted from these original databases on a request-by-request basis over time. Very little of the latter has occurred, so it is our feeling that the databases used to define the sample population in this study are a reasonable approximation of the general ranching population in the three counties. The sole criterion for subject selection was the rancher must have entirely or partially operated on sagebrush steppe rangeland. The mail survey was administered using the Dillman (2000) multiple contact method that included a pre-survey letter, a survey cover letter, and follow-up reminders conducted via mail and phone. The survey was conducted in 2008, with the first mailing occurring on 15 July. The survey was designed to solicit information about ranching operations and their associated weed management and financial decisions and activities in 2007. After paring our survey instrument to an essential level to address our research objectives, our questionnaire length totaled 2,896 words. Based on the length of our survey, we expected a response rate of less than 16.7%. Jepson and others (2004) reported that questionnaires over 1,000 words experience a marked decrease in response rate and questionnaires over 1,800 words in length yielded a response rate of 16.7%.

An adjusted total survey response rate was calculated as follows (American Association for Public Opinion Research, AAPOR 2000):

$$X = \frac{C + D}{A - B}$$

where X is the adjusted total survey response rate, A is the total surveys mailed, B is the ineligible participants, C is the refusals, and D is the respondents.

Ineligible participants (B) included those whose surveys were returned due to wrong addresses or death, or those who no longer owned or operated rangeland. Respondents (C) were defined as those who returned the questionnaire but refused to complete it citing privacy. Respondents (D) were eligible participants who completed and returned the questionnaire.

The survey included sections addressing ranchers' perceptions of: (1) relative importance of invasive plants as a problem for ranching operations, (2) invasive plant species that are most problematic for grazing operations in their geographic area, (3) factors contributing to the spread of invasive plants, (4) effectiveness and economics of invasive annual grass control alternatives, (5) invasive plant management on rangeland, and (6) the types and delivery methods of information relating to invasive annual grass management.

#### Statistical Analysis

The primary focus of data analyses was to determine whether the presence of medusahead on a ranch influenced its operator's perceptions and behaviors concerning medusahead control and prevention. Individual statements or questions used to solicit ranchers' opinions about prevention measures, control methods, type and form of weed management information, and importance of ranching

issues were clustered and treated as repeated tests of independence between ranchers grouped by their self-reported presence/absence of medusahead. Therefore, the association of medusahead presence, as reported by ranchers, with use of prevention measures, planned future use of control methods, preference for type and delivery method of invasive annual grass management information, and perceived importance of weeds and other ranching issues was evaluated by Cochran–Mantel–Haenszel (C-M-H) Statistics. C-M-H analysis calculates significance by accounting for the number of questions being tested to reduce the likelihood of Type I errors. Because all individual statements or questions of interest were categorical in nature, Fisher's Exact Tests in the C-M-H analyses were used to compare responses between respondents grouped by their self-reported presence/absence of medusahead. All tests were completed as two-sided tests and *P*-values less than 0.05 were considered significant. Statistical analyses were carried out using SAS software, version 9.1 (SAS Institute, Inc., Cary, North Carolina, USA).

## Results

### Response Patterns

After adjusting for surveys that were sent to ineligible participants ( $n = 52$ ), the survey response rate was

approximately 22% (111 completed surveys). Average age of ranchers that responded to the survey was 59 years (Table 1). Average total area operated was 11,493 ha (estimate includes public grazing land). For the 98 respondents (88%) who indicated they grazed cattle on their ranch, the average number of cattle grazed was 592 cow/calf pairs. On average, respondents derived 72% of their gross income from ranching. Approximately 70% of ranchers indicated using public grazing lands. Ranchers that responded to the survey averaged nearly 3 years of post high school education (Table 1). Just over half (53.2%) of ranchers in southeast Oregon indicated medusahead was present on land they managed for grazing. The proportion of rangeland represented by the survey that was infested with medusahead was 7% (as estimated by respondents). Because of a lack of data for comparison, it is unknown whether the self-reported estimates provided by respondents are reflective of actual proportion of rangeland or ranches invaded by medusahead. Ranchers with and without medusahead present on their grazing land did not differ in acreage of grazing land owned/operated ( $P = 0.51$ ), number of cattle ( $P = 0.44$ ), use of public grazing lands ( $P = 0.11$ ), computer ownership ( $P = 0.33$ ), internet access ( $P = 0.37$ ), net income ( $P = 0.32$ ), proportion of total income generated by ranching ( $P = 0.57$ ), age ( $P = 0.1$ ), ranching experience (i.e., years ranching,  $P = 0.14$ ), nor education level ( $P = 0.29$ ) (Table 1).

**Table 1** Characteristics of southeast Oregon ranchers responding to invasive plant management survey, 2007

Characteristic	Have medusahead			<i>t</i> statistic	<i>P</i> -value
	No	Yes (mean ± SE)	Overall		
Proportion of income generated by Ranch	0.69 ± 0.05	0.73 ± 0.05	0.72 ± 0.03	0.57	0.57
Post high school education (years)	2.63 ± 0.23	2.93 ± 0.18	2.8 ± 0.14	1.05	0.29
Respondent age (years)	60.9 ± 1.99	56.8 ± 1.53	58.7 ± 1.2	1.67	0.10
Tenure in county of residence (years)	44.2 ± 3.2	37.4 ± 2.8	40.5 ± 2.1	1.62	0.11
Ranching experience (years)	42.3 ± 3.1	36.9 ± 2.1	39.3 ± 1.8	1.51	0.14
Number of cattle (cow/calf pairs)	534 ± 89	644 ± 110	592 ± 71	0.77	0.22
Net income (\$)	20,407 ± 3,101	24,769 ± 2,983	22,835 ± 2,156	1.00	0.32
Gross income (\$)	175,581 ± 17,421	208,482 ± 15,451	194,191 ± 11,619	1.41	0.16
Grazing land operated (ha)	9,630 ± 2,408	13,061 ± 4,252	11,493 ± 2,552	0.41	0.68
Characteristic	Have medusahead			$\chi^2$ statistic	<i>P</i> -value
	No	Yes %	Overall		
Uses public lands in grazing operation	62.5	76.8	70.2	2.52	0.11
Has computer access	64.6	72.7	68.9	0.79	0.37
Has internet access	62.5	71.4	67.3	0.94	0.33
Has off-ranch job	28.3	26.8	27.5	0.03	0.87

### Relative Importance of Invasive Plants as a Problem for Ranchers

Ranchers tended to perceive feed costs and other operating costs (e.g., fuel, labor, etc.) as being greater concerns than noxious or invasive plants ( $P < 0.05$ , Fisher LSD). However, noxious or invasive plants generated a higher level of concern among ranchers than issues or problems related to grazing land availability, predators, or private land regulations ( $P < 0.05$ , Fisher LSD). Noxious or invasive plants were not perceived as being any more or less problematic than livestock prices, public land regulations, and adverse weather ( $P > 0.05$ , Fisher LSD). Presence of medusahead on a ranch did not influence the relative importance of the issues presented (C-M-H statistic = 0.33,  $P = 0.57$ ). Similarly, presence of medusahead did not affect the general opinion of ranchers concerning whether or not the presented issues had become worse over the last five years (C-M-H statistic = 0.79,  $P = 0.37$ ). However, when asked specifically about noxious or invasive weeds, ranchers operating on medusahead-infested rangeland were 1.5 times more likely to indicate problems with noxious or invasive plants had become more problematic to their operation compared to ranchers grazing livestock on non-invaded rangeland ( $P < 0.001$ , Table 2). Ranchers with medusahead on their property were also more likely to indicate that public land regulations had become more problematic over the past five years compared to ranchers without medusahead ( $P = 0.016$ , Table 2).

### Ranchers' Perceptions of Invasive Plant Species Problematic for Grazing Operations

Plants other than medusahead were perceived by ranchers as creating problems for livestock grazing in southeast Oregon. Species specifically listed in the survey included: cheatgrass (*Bromus tectorum* L.), Dalmatian toadflax (*Linaria dalmatica* (L.) Mill.), knapweeds (*Centaurea* L. spp.), leafy spurge (*Euphorbia esula* L.), perennial pepperweed (*Lepidium latifolium* L.), thistles (*Cirsium* Mill. species), and whitetop (*Cardaria draba* (L.) Desv.). Self-reported presence of weed species other than medusahead on grazing lands operated by ranchers with and without medusahead did not differ for Dalmatian toadflax ( $P = 0.35$ , Fisher's exact test), knapweeds ( $P = 0.11$ , Fisher exact test), leafy spurge ( $P = 0.49$ , Fisher's exact test), perennial pepperweed ( $P = 0.72$ , Fisher exact test), thistles ( $P = 0.08$ , Fisher's exact test), whitetop ( $P = 0.12$ , Fisher exact test), and cheatgrass ( $P = 0.10$ , Fisher exact test). Ranchers perceived medusahead as being more problematic for grazing operations than Dalmatian toadflax, cheatgrass, knapweeds, leafy spurge, and ventenata in

**Table 2** Problems faced by southeast Oregon ranchers in the past five years, 2007

Problems/issues	Have medusahead		P-value
	No (%)	Yes (%)	
	% indicated a major problem		
Other costs	83.3	82.5	0.978
Feed costs	79.2	78.9	0.959
Public land regulations	54.2	61.4	0.391
Noxious or invasive weeds	43.8	56.1	0.119
Adverse weather	52.1	45.6	0.479
Livestock prices	45.8	49.1	0.777
Grazing land availability*	54.2	35.1	0.010
Private land regulations	27.1	26.3	0.899
Predators	25.0	17.5	0.233
	% indicated problem became worse in past 5 years		
Other costs	97.9	91.2	0.058
Feed costs	93.8	91.2	0.593
Public land regulations*	41.7	59.6	0.016
Noxious or invasive weeds*	45.8	70.2	<0.001
Adverse weather	22.9	15.8	0.284
Livestock prices	39.6	49.1	0.255
Grazing land availability*	47.9	28.1	0.006
Private land regulations	27.1	31.6	0.535
Predators	18.8	15.8	0.710

Comparisons in survey responses were between ranchers operating on grazing land with medusahead ( $n = 59$ ) and without medusahead ( $n = 52$ )

\* Statistically different at  $P \leq 0.05$  between those who have medusahead and those who don't for each individual problem (Fisher's Exact Test)

southeast Oregon ( $P < 0.05$ , Fisher LSD), but did not identify medusahead as being anymore problematic for livestock grazing than perennial pepperweed, thistles, or whitetop ( $P > 0.05$ , Fisher LSD). However, ranchers operating on medusahead-invaded rangeland were nearly seven times more likely to indicate medusahead was a major problem for grazing operations in their geographic area compared to respondents operating on noninvaded rangeland ( $P < 0.001$ , Table 3).

### Ranchers' Use of Weed Prevention Practices on Rangeland

When asked to identify the two most important factors that contribute to the spread of invasive plants in rangeland,

**Table 3** Invasive plants perceived to pose the greatest problems to southeast Oregon ranchers within their geographic areas, 2007

Weed species	Have medusahead		<i>P</i> -value
	No (%)	Yes (%)	
	% indicated a major problem		
Juniper	50.0	59.6	0.201
Thistles	52.1	40.4	0.118
Medusahead rye*	12.5	71.9	<0.001
Perennial pepperweed	43.8	42.1	0.887
Whitetop	29.2	35.1	0.449
Knapweeds	16.7	19.3	0.854
Cheatgrass	10.4	17.5	0.153
Dalmatian toadflax*	10.4	0.0	0.002
Ventanata	4.2	5.3	0.715
Leafy spurge	0.0	3.5	0.121

Comparisons in survey responses were between ranchers operating on grazing land with medusahead ( $n = 59$ ) and without medusahead ( $n = 52$ )

\* Statistically different at  $P \leq 0.05$  between those who have medusahead and those who don't for each type of weed considered a major problem (Fisher's Exact Test)

**Table 4** Factors perceived by southeast Oregon ranchers to be the most important contributors to invasive plant spread, 2007

Factor contributing to invasive plant spread	Have medusahead		<i>P</i> -value
	No (%)	Yes (%)	
	% indicated as the most important reason		
Not recognized until too late	45.8	47.4	0.957
Spread from adjoining land	43.8	42.1	0.887
Lack of cost effective controls	33.3	36.8	0.657
Spread by man's actions	35.4	33.3	0.881
Lack of native plant competition	14.6	15.8	0.846
Overgrazing	0.0	5.3	0.059

Comparisons in survey responses were between ranchers operating on grazing land with medusahead ( $n = 59$ ) and without medusahead ( $n = 52$ ); Statistically different at  $P \leq 0.05$  between those who have medusahead and those who don't for each factor perceived as contributing to invasive plant spread (Fisher's Exact Test)

ranchers most often indicated that invasive plants were not recognized as being a problem until it was too late and invasive plants usually spread from adjoining, already infested land (Table 4). Ranchers perceptions of factors contributing to the spread of weeds on rangeland did not vary with medusahead presence (C-M-H statistic = 0.22,  $P = 0.64$ ). Despite ranchers having a common understanding of how weeds spread, ranchers operating on rangeland infested with medusahead were, in general, more likely to indicate that they implement prevention

practices (C-M-H statistic = 20.64,  $P < 0.001$ ). Ranchers with medusahead on their property were more likely to indicate they routinely monitor rangeland for new infestations of invasive plants, spot spray weeds near boundary areas, aggressively destroy small, incipient infestations when found, and insist that invasive plants are controlled along roadways, ditches, and other vectors of invasive plant dispersal ( $P < 0.05$ , Table 5).

#### Ranchers' Perceptions of Effectiveness and Economics of Invasive Annual Grass Control Alternatives

Ranchers' perceptions of the effectiveness and return on investment of various control methods for annual grasses varied depending on the self-reported status of medusahead on their ranch (C-M-H statistic = 8.99,  $P = 0.003$ , C-M-H statistic = 33.22,  $P < 0.001$ ). Ranchers operating on rangeland invaded by medusahead generally ranked the effectiveness and return on investment of annual grass control methods lower than those respondents grazing livestock on rangeland not invaded by medusahead (Table 6). Ranchers with invasive annual grasses other than medusahead on their ranch (i.e., cheatgrass) were nearly 2.5 times as likely to indicate revegetation of annual grass infested rangeland was effective compared to ranchers operating on medusahead-invaded rangeland ( $P < 0.001$ , Table 6). Likewise, those respondents with medusahead on their ranch were less likely to indicate a return on their investment in revegetation, grazing, herbicide, and prescribed fire treatments for controlling invasive annual grasses ( $P < 0.05$ , Table 6). Despite the belief that annual grass control methods provide only marginal effectiveness and return on investment, ranchers operating on rangeland infested with medusahead were more likely to indicate plans to treat their invasive annual grass infestations with herbicides, grazing animals, and revegetation treatments in the future ( $P < 0.05$ , Table 5).

#### Ranchers' Perceptions of Invasive Plant Management on Rangeland

Ranchers were asked to rate their level of agreement to a variety of statements about general rangeland invasive plant management and medusahead management options. The statement that elicited strongest agreement (average score closest to 5, strongly agree) was "I am concerned about controlling invasive plants on rangeland" ( $\bar{x} = 4.5 \pm 0.12$ , Table 7). Ranchers most strongly disagreed with the statement "Invasive plant infestations have no effect on the market value of rangeland" ( $\bar{x} = 1.56 \pm 0.09$ ).

Several statements motivated significantly different responses depending on the self-reported status of

**Table 5** Southeast Oregon ranchers' use of measures to control and prevent infestations of invasive annual grasses, 2007

Preventive/control method	Have medusahead		P-value
	No	Yes	
% indicated use of preventive measure			
Aggressively destroy invasive plants when found*	73.1	91.5	<0.001
Spot spraying near boundary areas*	75	86.4	0.050
Routinely monitor rangeland for invasive plants*	61.5	79.6	0.008
Keep machinery/trucks clean	64.6	64.4	0.995
Insist weeds are controlled along roadways*	32.7	57.6	<0.001
Change grazing system to avoid dispersing seed	32.7	32.2	0.994
Purchase only weed-free hay	22.9	27.1	0.625
% indicated future plans to use method			
Targeted grazing*	50	72.9	0.001
Herbicides*	39.6	64.9	<0.001
Reseeding with competing vegetation*	32.7	52.6	0.007
Mowing	32.7	32.2	0.940
Burning	19.2	28.8	0.136
Disking/tillage	19.2	20.3	0.946

\* Statistically different at  $P \leq 0.05$  between those who have medusahead and those who don't for each preventive/control method (Fisher's Exact Test)

**Table 6** Southeast Oregon ranchers' perceptions of the effectiveness and economics of invasive annual grass control methods, 2007

Control method	Have medusahead		P-value
	No	Yes	
% indicated method was very effective			
Herbicides	31.3	29.8	0.918
Grazing	35.4	24.6	0.165
Reseeding with competing vegetation*	41.7	17.5	<0.001
Prescribed fire	18.8	14	0.446
Mowing	10.4	8.8	0.902
Disking/tillage	4.2	5.3	0.915
% indicated method pays			
Reseeding with competing vegetation*	56.3	36.8	0.011
Targeted grazing*	50	29.8	0.006
Herbicides*	43.8	25.1	0.007
Mechanical	25	15.8	0.161
Prescribed fire*	27.1	11	0.006

Comparisons were limited to those between ranchers with grazing land invaded by medusahead ( $n = 59$ ) and ranchers with grazing land not invaded by medusahead but infested with other invasive annual grasses (primarily cheatgrass) ( $n = 36$ )

\* Statistically different at  $P \leq 0.05$  between those who have medusahead and those who don't for each control method (Fisher exact test)

medusahead on land operated by ranchers. Although respondents generally indicated they were concerned about controlling invasive plants on rangeland, ranchers

operating on medusahead-infested rangeland specified stronger agreement with the statement ( $P < 0.05$ ). Respondents with medusahead present on their ranch also expressed stronger agreement with a need for additional research on controlling invasive plants on rangelands ( $P < 0.05$ ). Ranchers, based on whether or not they operated on medusahead-infested lands, varied considerably in their agreement with the statement "Rangeland invasive plants represent a problem to all ranchers" ( $P < 0.05$ ). Ranchers operating on rangeland infested with medusahead indicated strong agreement with the statement ( $\bar{x} = 4.5 \pm 0.246$ ), whereas ranchers without medusahead present on their ranch were nearly neutral in their opinion ( $\bar{x} = 3.5 \pm 0.115$ ). Ranchers operating medusahead-infested rangeland were also more likely to agree with the statements that "Annual grasses represent a threat to rangeland productivity" and "Governments should pay part of the cost to control annual grasses, even if it means an increase in taxes" ( $P < 0.05$ ).

#### Ranchers' Perceptions of Types and Delivery Methods of Invasive Annual Grass Information

Ranchers' responses to questions pertaining to the types of weed management information they prefer varied depending on the self-reported status of medusahead on their ranch (C-M-H statistic = 68.29,  $P < 0.001$ ). When ranchers were asked about the type of invasive annual grass management information they preferred, regardless of presence or absence of medusahead on their ranch, they

**Table 7** Southeast Oregon ranchers' perceptions of invasive plant management and methods of invasive annual grass control, 2007

Statement	Have medusahead		
	No	Yes mean score <sup>a</sup> ± SE	Overall
I am concerned about controlling invasive plants in rangeland*	4.1 ± 0.23	4.8 ± 0.08	4.5 ± 0.12
State and Federal agencies are not doing enough to help control invasive plants on public grazing land	4.1 ± 0.22	4.4 ± 0.14	4.3 ± 0.12
Herbicides, if used properly, are not harmful to the environment	4.2 ± 0.19	4.1 ± 0.16	4.2 ± 0.12
Annual grasses represent a long term management problem	4.1 ± 0.20	4.3 ± 0.16	4.2 ± 0.13
Restrictions governing use of herbicides on rangeland are too strict	3.9 ± 0.22	4.2 ± 0.16	4.0 ± 0.14
Rangeland invasive plants represent a problem to all ranchers*	3.5 ± 0.25	4.5 ± 0.12	3.9 ± 0.14
There needs to be more research on controlling invasive plants in rangelands*	3.6 ± 0.24	4.2 ± 0.14	3.9 ± 0.14
Annual grasses are a major threat to rangeland productivity*	3.5 ± 0.24	4.3 ± 0.14	3.9 ± 0.14
Local governments are not effective in controlling problem invasive plants	3.5 ± 0.23	3.9 ± 0.13	3.7 ± 0.13
State and Federal agencies are not doing enough to help control invasive plants on private grazing land	3.4 ± 0.22	3.7 ± 0.16	3.6 ± 0.13
Annual grasses can be controlled but it is just too costly to do on an effective scale	3.1 ± 0.24	3.4 ± 0.17	3.2 ± 0.14
It does not pay to control invasive plants on my land when neighbors do not control their invasive plants	3.1 ± 0.23	3.0 ± 0.20	3.1 ± 0.15
Annual grasses are nearly impossible to control with current control methods and techniques	3.0 ± 0.21	3.2 ± 0.18	3.1 ± 0.14
Invasive plant problems in rangelands are generally the result of poor range management	2.9 ± 0.24	3.1 ± 0.18	3.0 ± 0.15
Annual grasses can be controlled but it is too difficult to get reseeded vegetation to grow	3.0 ± 0.21	3.1 ± 0.18	3.0 ± 0.14
Governments should pay part of the cost to control annual grasses, even if it means an increase in taxes*	2.3 ± 0.22	3.1 ± 0.18	2.7 ± 0.15
It's seldom economical to control invasive plants in rangeland*	1.7 ± 0.19	2.2 ± 0.19	2.0 ± 0.14
Public land managers are doing a good job of controlling invasive plants on public land	1.8 ± 0.17	1.8 ± 0.14	1.8 ± 0.11
Invasive plant infestations have no effect on the market value of rangeland	1.6 ± 0.15	1.5 ± 0.11	1.6 ± 0.09

Comparisons in survey responses were between ranchers operating on grazing land with medusahead ( $n = 59$ ) and without medusahead ( $n = 52$ )

\* Statistically different at  $P < 0.05$  between ranchers operating on medusahead-invaded and noninvaded rangeland ( $t$  test)

<sup>a</sup> Based on a score of 1 to 5, where 1 indicates strong disagreement and 5 indicates strong agreement

most often indicated that they would be most interested in information on the effectiveness and economics of herbicide treatments (Table 8). However, without exception, ranchers with medusahead on their property were more likely to indicate greater interest in information on alternative invasive annual grass control methods ( $P < 0.05$ , Table 8). Ranchers did not vary in their preferred invasive plant information delivery methods depending on the presence/absence of medusahead on their ranch (C-M-H statistic = 0.37,  $P = 0.99$ ). However, in general ranchers indicated they preferred information delivered in a pamphlet or bulletin or directly by rangeland/weed management specialists through face-to-face interactions over web-, computer-, and video-based forms of information delivery ( $P < 0.05$ , Fisher LSD). Less than a quarter of respondents indicated they would be interested in computer- or web-based information and videos demonstrating

the effectiveness of annual grass control methods (Table 8).

## Discussion

The response rate (22%) of our study was higher than expected given the survey's length, based on the investigation of the relationship of response rates with questionnaire length by Jepson and others (2004). Furthermore, response rates have been declining for unsolicited surveys on natural resource issues (Connelly and others 2003).

The invasion of medusahead can reduce grazing capacity by 50% to more than 80% (Hironaka 1961; Davies and Svejcar 2008) and often results in near monotypic stands of medusahead (George 1992); making it clear that medusahead can create significant economic losses and



**Table 8** Types and forms of invasive plant management information most requested by southeast Oregon ranchers, 2007

	Have medusahead		<i>P</i> -value
	No % indicated very interested	Yes	
<b>Type of information</b>			
Effectiveness of herbicide treatment programs	68.8	71.9	0.757
Economics of herbicide treatments	62.5	57.9	0.566
Techniques and effectiveness of grazing treatments*	46.1	68.4	0.003
Economics of using grazing treatments*	42.3	63.4	0.005
Effectiveness of revegetation treatment programs*	47.9	64.9	0.022
Economics of revegetation treatments*	47.9	63.4	0.046
Effectiveness of prescribed fire treatment programs*	27.1	57.9	<0.001
Economics of prescribed fire treatments*	31.3	56.1	<0.001
Effectiveness of mechanical treatments*	17.3	43.9	<0.001
Economics of mechanical treatments*	19.2	42.1	<0.001
<b>Form of information</b>			
Pamphlet/bulletin available through the extension service	50	59.6	0.201
Personal visits and on-site help by range specialists	45.8	56.1	0.203
Area demonstration plots of various control methods	37.5	43.9	0.391
Testimonials from fellow ranchers and other land managers	35.4	43.9	0.247
Videos demonstrating the various control methods	20.8	28.1	0.324
Computer/web- based information/decision aids	16.7	21.1	0.589
Other <sup>a</sup>	4.2	7	0.537

Comparisons in survey responses were between ranchers operating on grazing land with medusahead ( $n = 59$ ) and without medusahead ( $n = 52$ )

\* Statistically different at  $P \leq 0.05$  between those who have medusahead and those who don't for each type or form of information (Fisher exact test)

<sup>a</sup> Other forms of information specified included written responses to questions and seminars/workshops

management challenges for ranchers. Thus, it is not all that surprising that the results of our survey suggest the presence of medusahead influenced the perceptions and behaviors of ranchers concerning invasive plant management in southeast Oregon. Ranchers in general demonstrated a relatively high level of awareness and concern about invasive plants in southeast Oregon. However, it is important to note that the ranchers that chose to respond to our survey may have been biased toward individuals with greater interest and awareness of invasive species. The results of this study also suggest that ranchers who were operating on medusahead-invaded rangeland and presumably have directly experienced the negative impacts of invasion on their ranch were more aware and concerned about medusahead and the potential for its continued spread than ranchers operating on non-invaded rangelands. Our survey also indicated that the presence/absence of medusahead on grazing lands was also correlated to different behaviors concerning rangeland invasive plant management.

Ranchers in southeast Oregon, regardless of the self-reported status of medusahead on their ranch, indicated a relatively high level of concern for controlling invasive

plants on rangeland. However, the presence of medusahead prompted divergence in ranchers' opinions relating to general invasive plant and exotic annual grasses management on rangeland. Ranchers operating on medusahead-infested rangeland indicated stronger agreement with statements relating to their concern for controlling invasive plants, the importance of invasive plants as a problem for all ranchers, the threat of exotic annual grasses to the productivity of rangelands, and the need for additional research on invasive annual grasses control options. Stronger agreement with these statements suggests an increased awareness of the potential negative consequences of rangeland invasive plants among ranchers whose operations have been directly impacted by medusahead.

Medusahead represents a serious management problem (Davies and Svejcar 2008) that is becoming increasingly acute for ranchers as medusahead continues expanding (Davies and Johnson 2008). However, regardless of medusahead presence on a ranch, respondents to our survey tended to rank noxious or invasive plants in the middle of issues they were concerned about. The apparent contradiction between the impacts of invasive plants on

rangeland and concern demonstrated by ranchers may be partially related to the reality that land managers frequently have limited resources available to address a wide variety of land management concerns, requiring difficult decisions about the prioritization of issues and management efforts (Westman 1990). Nonetheless, there was a large disparity in the perceived importance of medusahead depending on whether or not ranchers were experiencing the negative impacts of medusahead in their grazing operations. A substantially greater share of ranchers with firsthand experience with medusahead rated it as a major problem in their geographic area; which may be cause for concern for the awareness level of ranchers not currently experiencing the negative impacts of medusahead and, thereby, the potential for its continued spread. Preventing the continued spread of medusahead will in part require that ranchers without medusahead on their grazing lands adopt and implement prevention efforts. That said, a greater awareness of the potential negative impacts of medusahead will be needed to provide motivation for adopting prevention. Prevention efforts are critical to implementing successful invasive plant management programs (Sheley and others 1996; DiTomaso 2000; Davies and Sheley 2007).

When asked to identify the two most important factors that contribute to the spread of medusahead and other rangeland invasive plants, ranchers most often indicated that the invasive plant was not recognized as being a problem until too late and, similar to the findings of Epanchin-Niell and others (2010), it usually spreads from adjoining, already infested land. Respondents to a survey in Spain stated that management of exotic plants was often ineffective because of a lack of awareness, support, and absence of management coordination among different stakeholders (Andreu and others 2009). The awareness level and perceived importance of medusahead as an issue affects invasive plant management behavior as well. Despite ranchers demonstrating a common understanding of how weeds spread, those respondents who had been directly impacted by medusahead were more likely to indicate use of important prevention practices. In addition, ranchers affected by medusahead invasion, without exception, were more likely to indicate an interest in information about invasive annual grass control alternatives, suggesting their heightened awareness of medusahead as a problem has provided greater motivation for learning effective strategies for managing invasive annual grasses. In a study on the importance of bioeconomic feedback in invasive species management Finoff and others (2005) suggested that feedback can exist between society and the environment that are predicated on recognition of ecological change. Often, substantial ecological change

may occur before society is directly affected and recognition of the problem occurs, and may therefore be overlooked or may become too costly or impossible to rectify. When recognition fails, feedbacks may not be perceived, and the trajectory of invasions and damage may differ (Finoff and others 2005). Our results suggest that recognition of the implications associated with the continued spread of medusahead, and perhaps other invasive plants, is lacking, particularly among those not currently experiencing impacts directly.

Ranchers in southeast Oregon understand the inherent challenges of efforts to control and revegetate rangeland infested with invasive annual grasses, particularly those who have attempted to revegetate medusahead-invaded rangeland. Ranchers with such experience generally ranked the effectiveness of annual grass control and revegetation lower than those respondents who were not managing medusahead-invaded rangeland. Likewise, those ranchers with medusahead on their ranch were also less likely to indicate a return on their investment in revegetation, grazing, herbicide, and prescribed fire treatments for controlling invasive annual grasses. These findings are supported by results reported by Young (1992), who reviewed previous research on the ecology and management of medusahead in the Great Basin and reported no inexpensive or successful options for reestablishment of native vegetation on medusahead infested rangelands.

Information on the effectiveness and economics of herbicides, grazing treatments, and revegetation techniques was requested by the majority of ranchers and they stated that they would like to receive the information in a pamphlet/bulletin or via personal visits by range/weed management specialists. Demonstration of invasive plant control techniques and testimonials from fellow ranchers and land managers were also popular information delivery methods. Computer-based decision aids and online information delivery were less popular among southeast Oregon ranchers. In fact, the vast majority of ranchers indicated they would not be interested in internet-provided forms of information. This is somewhat surprising considering that nearly 67% of ranchers in southeast Oregon indicated owning a computer with access to the internet. However, these results parallel those reported by Belton and others (2009) in an assessment of information needs of sage-grouse local working group participants (30–40% being private land owners and ranchers) in nine western states. Participants in their study preferred receiving information through face-to-face contact with knowledgeable people and via fact sheets and short technical guides, whereas internet-based resources were not viewed as very useful information delivery methods.

## Conclusions and Recommendations

Our results suggest ranchers that had directly experienced the negative consequences of medusahead invasion were more likely to indicate increased awareness and knowledge of invasive plants. Thus, invasive plant control and prevention efforts are probably constrained by a lack of awareness and support. Increased awareness, support, and coordination among stakeholders and the general public will be needed for successful management of invasive plants. In this study, ranchers that have not experienced the negative consequences of medusahead invasion indicated less awareness and concern for medusahead. These ranchers were also less inclined to employ efforts to prevent medusahead expansion and would likely be less supportive of coordinated management efforts. There are no obvious solutions for increasing awareness about exotic plants, with the exception of better communication of the negative impacts of invasion. Successful invasive species awareness campaigns have been undertaken (e.g., Bardsley and Edward-Jones 2007) and people are generally more aware of invasive species that have been targeted by information campaigns (García-Llorente and others 2008). However, these endeavors are often constrained by a lack of convincing evidence. Awareness raising campaigns of the actual and perceived costs of invasive species will be required to ensure broader control and prevention efforts (Cronk and Fuller 1995). In addition, until people have direct experience with invasives and a better understanding of the damage caused by invasive species, they will not realize the benefits of control and eradication programs (Fraser 2006). Efforts to raise awareness of exotic annual

grasses and other invasive plants as issues may be bolstered by research that quantifies the economic consequences of their continued expansion and research demonstrating the effectiveness and economics of strategies for preventing their spread. Despite the economic impacts of many invasive species, most published work has concentrated on the biological aspects of invasions (DiTomaso 2000; Grosholz 2002). In addition, campaigns aimed at bolstering awareness of invasive species among ranchers must carefully consider appropriate information delivery methods. Traditional forms of information delivery through face-to-face interaction with knowledgeable experts and short technical guides/bulletins may be more effective than computer, video or web-based delivery methods. However, most of rural southeast Oregon is limited to dial-up internet access over a 56 k modem and largely lacks access to broadband internet services. Thus, web-based information usage may be constrained by relatively unreliable and slow download transfer rates and may in fact grow among ranchers in southeast Oregon with improvements in internet infrastructure. Computer- and internet-based programs may also become more popular as ranchers become more accustomed to them.

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**Appendix A**

A.1. Survey questions (no. 22-36) used to solicit information about responding ranchers and their operations used to generated data shown in Table 1.

22. In 2007, how many acres did you:

	Hay Land/ Cropland	Grazing Land	Total
a. Own	_____	_____	_____
b. Rent or lease from others	_____	_____	_____
c. Rent or lease to others	_____	_____	_____

23. How many head of livestock did you graze in 2007?

	Estimated Number of Head
a. Cattle and calves	_____
b. Sheep and lambs	_____
d. Horses	_____
c. Others (specify _____)	_____

24. Did you use any public (federal and/or state) land for grazing in 2007? Yes / No

If **Yes**, how many acres \_\_\_\_\_ or number of permitted AUMs \_\_\_\_\_?

25. What best describes your ranch/farm organization? (please circle)

- a. single proprietor
- b. partnership
- c. family corporation
- d. other (please clarify \_\_\_\_\_)

26. Do you use a computer to assist you in the operation of your farm or ranch? Yes / No

If **yes**, do you have access to the Internet? Yes / No

27. Which of the following categories best describes your **gross farm income** in 2007?

- a. \$50,000 or less
- b. \$50,001 to \$100,000
- c. \$100,001 to \$150,000
- d. \$150,001 to \$200,000
- e. \$200,001 to \$250,000
- f. \$250,001 to \$300,000
- g. \$300,001 to \$350,000
- h. Over \$350,000

28. Which of the following categories best describes your **net farm income** (gross cash farm income less gross cash farm expenses) in 2007?

- a. negative
- b. \$0 to \$5,000
- c. \$5,001 to \$10,000
- d. \$10,001 to \$20,000
- e. \$20,001 to \$30,000
- f. \$30,001 to \$40,000
- g. \$40,001 to \$50,000
- h. Over \$50,000

29. Approximately what percentage of your gross farm income in 2007 came from grazing livestock?

\_\_\_\_\_ %

30. About what percentage of your total family income in 2007 came from farming/ranching?

\_\_\_\_\_ %

We would now like to ask a few questions about you for statistical purposes. Information will not be disclosed on an individual basis.

31. In what county and state do you live? \_\_\_\_\_ County \_\_\_\_\_ State

32. How long have you lived in this county? \_\_\_\_\_ Years

33. What is your age? \_\_\_\_\_ Years
34. How many years have you been farming/ranching? \_\_\_\_\_ Years
35. Highest level of education received?
- Some high school \_\_\_\_\_
- High School diploma \_\_\_\_\_
- Some college \_\_\_\_\_
- Associate degree \_\_\_\_\_
- Four year university degree \_\_\_\_\_
- Graduate degree \_\_\_\_\_

36. In 2007, did you work an off-ranch job?

\_\_\_\_\_ No

\_\_\_\_\_ Yes, about how many days did you work at least 4 hours per day  
off your ranch? \_\_\_\_\_ Days

A.2. Survey questions (no. 1 & 3) used to gauge perceptions of various problems that ranchers face in southeast Oregon. These results were shown in Table 2.

The following questions pertain to management issues in **your county**.

1. Please rate each of the following problems/issues that may affect livestock grazing operations in your area: (circle the appropriate number)

	Not a Problem	Minor Problem	Major Problem	Don't Know
a. adverse weather conditions	1	2	3	4
b. availability of grazing land	1	2	3	4
c. cost of feed	1	2	3	4
d. other operating costs (fuel, supplies)	1	2	3	4
e. livestock prices	1	2	3	4
f. noxious or invasive weeds	1	2	3	4
g. predators	1	2	3	4
h. regulations affecting use of public lands	1	2	3	4
i. regulations affecting use of private lands	1	2	3	4
j. others (please specify )	1	2	3	4

3. Have these problems/issues in your area improved, remained the same, or become worse over the past five years?

	Improved	Remained the Same	Become Worse	Don't Know
a. adverse weather conditions	1	2	3	4
b. availability of grazing land	1	2	3	4
c. cost of feed and supplies	1	2	3	4
d. other operating costs (fuel, supplies)	1	2	3	4
e. livestock prices	1	2	3	4
f. noxious or invasive weeds	1	2	3	4
g. predators	1	2	3	4
h. regulations affecting use of public lands	1	2	3	4
i. regulations affecting use of private lands	1	2	3	4
j. others (please specify )	1	2	3	4

A.3. Survey question (no. 4) used to determine the invasive plants perceived to pose the greatest problems to southeast Oregon ranchers. These results were shown in Table 3.

4. Which weeds pose problems for livestock grazing operations in your area? (please rate each of following weeds)

	Not a Problem	Minor Problem	Major Problem	Don't Know
a. cheatgrass	1	2	3	4
b. Dalmatian toadflax	1	2	3	4
c. juniper	1	2	3	4
d. knapweeds	1	2	3	4
e. leafy spurge	1	2	3	4
f. medusahead rye	1	2	3	4
g. perennial pepperweed (tall whitetop)	1	2	3	4
h. ventanata	1	2	3	4
i. thistles	1	2	3	4
j. whitetop	1	2	3	4
k. others (please specify _____)	1	2	3	4

A.4. Survey question (no. 6) used to determine the factors perceived by southeast Oregon ranchers to be the most important contributors to invasive plant spread. These results were shown in Table 4.

6. What do you think are the two most important factors contributing to the spread of weeds in your area? (circle the two most important)

- a. infestation spread from adjoining land
- b. not recognized as a problem/threat until it's too late
- c. spread by man's actions (e.g., vehicles, contaminated hay, recreation)
- d. overgrazing of rangeland
- e. lack of competition from native plants/grasses
- f. lack of cost effective controls

A.5. Survey questions (no. 8 and 9) used to determine southeast Oregon ranchers' use of measure to control and prevent infestation of invasive annual grasses. These results were presented in Table 5.

8. What measures have you taken to prevent weeds from establishing and spreading on your farm/ranch?

- |   |     |    |
|---|-----|----|
| a. purchase only weed-free hay  | Yes | No |
| b. keep machinery/trucks clean  | Yes | No |
| c. aggressively destroy weeds when found  | Yes | No |
| d. spot spraying near fringe or boundary areas  | Yes | No |
| e. routinely monitor rangeland for weeds  | Yes | No |
| f. insist that local governments control weeds along road ways                            | Yes | No |
| g. change grazing management to avoid known infestations when weed seeds can be dispersed | Yes | No |
| h. other measures (please specify _____)  | Yes | No |

9. Do you currently have invasive annual grasses (i.e. cheatgrass, medusahead, ventanata) on your farm or ranch?

\_\_\_\_No (if **No**, please go to Question 10)

\_\_\_\_If **Yes**, please indicate if you have used or plan to use any of the following general practices to control annual grasses: (check all that apply)

	Have Used in the Past	Plan to Use
a. herbicides	Yes / No (# of years _____)	Yes / No
b. burning	Yes / No (# of years _____)	Yes / No
c. grazing	Yes / No (# of years _____)	Yes / No
d. mowing	Yes / No (# of years _____)	Yes / No
e. disking/tillage	Yes / No (# of years _____)	Yes / No
f. reseeding with competing vegetation	Yes / No (# of years _____)	Yes / No
g. other controls (please specify _____)	Yes / No (# of years _____)	Yes / No

A.6. Survey questions (no. 14 and 15) use to determine southeast Oregon ranchers' perceptions of the effectiveness and economics of invasive annual grass control methods. These results were presented in Table 6.

14. Even if you currently have no annual grasses, how would you rate the **effectiveness** of the following practices in controlling annual grasses?

	Not Effective	Partially Effective	Very Effective	Don't Know
a. spraying with herbicides	1	2	3	4
b. control with prescribed fire	1	2	3	4
c. control with grazing animals	1	2	3	4
d. control with mowing	1	2	3	4
e. control with disking or tillage	1	2	3	4
f. reseeding with competing vegetation	1	2	3	4
g. other controls (please specify _____)	1	2	3	4

15. Even if you currently have no annual grasses (i.e., cheatgrass, medusahead, ventanata), do you think it pays to use the following annual grass control practices?

	Yes, It Pays	Marginal	Does Not Pay	Don't Know
a. spraying with herbicides	1	2	3	4
b. control with prescribed fire	1	2	3	4
c. control with grazing animals	1	2	3	4
d. mechanical control with mowing, tillage, disking	1	2	3	4
e. reseeding with competing vegetation	1	2	3	4
f. other controls (please specify _____)	1	2	3	4

A.7. Survey question (no. 21) used to determine southeast Oregon ranchers' perceptions of invasive plant management and methods of invasive annual grass control. These results were presented in Table 7.

The next set of questions asks what you think about general weed management issues and concerns dealing with annual grasses.

21. Please indicate whether you agree or disagree with the following statements:

<u>Weed Management Issue</u>	Strongly Disagree (1)	Somewhat Disagree (2)	Neither Agree or Disagree (3)	Somewhat Agree (4)	Strongly Agree (5)
Weed problems on rangelands are generally the result of poor range management	1	2	3	4	5
I am concerned about controlling weeds in rangeland	1	2	3	4	5
State and Federal government agencies are not doing enough to control problem weeds on <u>public</u> grazing land	1	2	3	4	5
State and Federal government agencies are not doing enough to help control problem weeds on <u>private</u> grazing land	1	2	3	4	5
Local governments are not effective in controlling problem weeds	1	2	3	4	5
It seldom makes economic sense to control weeds on rangeland	1	2	3	4	5

Rangeland weeds represent a problem to all ranchers	1	2	3	4	5
It doesn't pay to control weeds on my land when my neighbor doesn't control his weeds	1	2	3	4	5
There needs to be more research on controlling weeds on rangelands	1	2	3	4	5
Restrictions governing the use of herbicides on rangeland are too strict	1	2	3	4	5
Herbicides, if used properly, are not harmful to the environment	1	2	3	4	5
Weeds infestations have no effect on the market (sale) value of rangeland	1	2	3	4	5
Public land managers are doing a good job of controlling weeds on public land	1	2	3	4	5
Annual grasses are nearly impossible to control with current control methods and techniques	1	2	3	4	5
Annual grasses are a threat to rangeland productivity	1	2	3	4	5
Annual grasses can be controlled but it is just too costly to do on an effective scale	1	2	3	4	5
Annual grasses can be controlled but it is too difficult to get reseeded competing vegetation to grow	1	2	3	4	5
Annual grasses are a long-term management problem	1	2	3	4	5
Governments should help pay part of the cost to control annual grasses, even if it means an increase in taxes	1	2	3	4	5

A.8. Survey questions (no. 19 and 20) used to determine the types and forms of information that southeast Oregon ranchers' would like to receive on invasive plant management. These results were presented in Table 8.

19. What type of information would you like to obtain concerning weed management on grazing and hay land?

	Not Interested	Somewhat Interested	Very Interested
a. effectiveness of various herbicide treatment programs	1	2	3
b. economics of herbicide treatments	1	2	3
c. techniques and effectiveness of control with grazing treatments	1	2	3
d. economics of using grazing treatments	1	2	3
e. effectiveness of various prescribe fire treatment programs	1	2	3
f. economics of prescribe fire treatments	1	2	3
g. effectiveness of various mechanical treatment programs	1	2	3
h. economics of mechanical treatments	1	2	3
i. effectiveness of various revegetation treatment programs	1	2	3
j. economics of revegetation treatments	1	2	3
f. others (please specify _____)	1	2	3



## 20. In what form would you like to receive the information?

	Not Interested	Somewhat Interested	Very Interested
a. pamphlet or bulletin available through Extension office or county agent	1	2	3
b. videos (VHS, DVD) demonstrating the various control methods	1	2	3
c. area demonstration plots showing effectiveness of various control methods	1	2	3
d. testimonials from fellow ranchers and other land managers	1	2	3
e. computer based decision aids (programs) that can be used to evaluate the effectiveness or economics of various controls	1	2	3
f. personal visits and on-site help by range management specialists	1	2	3
g. others (please specify _____)	1	2	3

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