

# Stakeholder knowledge and perceptions of free-roaming equids and their management at a western U.S. land-grant university

**HOLLEE S. WOOD**, Jack H. Berryman Institute, Department of Wildland Resources, Utah State University, 5230 Old Main Hill, Logan, UT 84322, USA [Thompson.hollee@gmail.com](mailto:Thompson.hollee@gmail.com)

**S. NICOLE FREY**, Jack H. Berryman Institute, Department of Wildland Resources, Utah State University, 5230 Old Main Hill, Logan, UT 84322, USA

**TERRY A. MESSMER**, Jack H. Berryman Institute (retired), Department of Wildland Resources, Utah State University, 5230 Old Main Hill, Logan, UT 84322, USA

**Abstract:** The horse (*Equus ferus caballus*), originally native to North America, became extinct on the continent approximately 10,000 years ago. Horses that migrated from North America to Eurasia across the Bering Strait continued to evolve and were domesticated along with burros (*E. asinus*). Both species were then transported to the Americas where they were intentionally released or escaped into the wild, forming feral herds. The Wild Free-Roaming Horses and Burros Act of 1971 (WFRHBA) provided federal oversight and protection for feral horses and burros (hereafter, free-roaming equids) that inhabited designated areas on public lands in the western United States. The Bureau of Land Management (BLM) estimated in 2019 that >90,000 free-roaming equids inhabited 29 million ha on 177 designated herd management areas (HMAs). This population estimate exceeds the designated appropriate management level (AML) of 26,785. To provide BLM managers with insights regarding stakeholder knowledge and perceptions about the management of free-roaming equids in a western U.S. state where HMAs exceed AML, in 2020 we surveyed faculty, staff, and students at the state land-grant university (i.e., Utah State University [USU]). We hypothesized that, because the WFRHBA was passed in 1971, older respondents and those with natural resources education would be more informed and supportive of active free-roaming equid management, such as herd reduction. We received 959 responses (response rate of 12.5%) to our survey (i.e., 14% faculty, 14% staff, and 72% students). Most respondents (60%) were unaware of the WFRHBA, and >50% were unaware that free-roaming equids were protected. Over 45% of our respondents were unsure of HMA AML status or population growth rates. Furthermore, most respondents (65%) did not know that free-roaming equids are ecologically considered feral. Older respondents and those with rural backgrounds and natural resources education were more informed. Our results highlight the need for improved outreach and communication efforts regarding the issues and consequences of free-roaming equid management approaches.

**Key words:** Bureau of Land Management, *Equus asinus*, *Equus ferus caballus*, feral burros, feral horses, land-grant university, public perceptions, survey, Utah, western rangelands

**THE HORSE** (*Equus ferus caballus*; Figure 1), once native to North America, became extinct on this continent between 6,000 and 10,000 years ago (Murchie et al. 2021). Horses that migrated to Eurasia across the Bering Strait continued to evolve in Europe and Asia (Olsen 2016). Approximately 5,000 years ago, wild horses were domesticated by humans, creating breeds specialized to various uses (Warmuth et al. 2012). Burros (*E. asinus*; Figure 2) are native to Africa and were similarly domesticated by humans approximately 5,000 years ago (Mcknight 1958).

European explorers, colonists, and missionaries first transported horses and burros to North

America in 1493 (Garrott 2018). During European exploration and colonization, some horses and burros either escaped or were intentionally released to the wild. Thus, all free-roaming “wild” horses and burros (WHBs; free-roaming equids) in North America are ecologically considered feral descendants of domesticated animals from Eurasia and Africa, respectively (The Wildlife Society 2016).

The domestication of free-roaming equids and their subsequent relationship with humans has created a unique bond between the two (Scasta et al. 2018). This bond has fostered a unique level of respect, high values, and care for the horse. The culture and history of west-



**Figure 1.** An emaciated feral horse (*Equus ferus caballus*) near Vernal, Utah, USA. Photograph was taken on June 23, 2021, amid a severe drought. Although feral horses inhabit several herd management areas in Utah, study respondents knew little about their ecology and management (photo courtesy of H. Wood).



**Figure 2.** Feral burros (*Equus asinus*) on a Bureau of Land Management designated wild burro range in Nevada, USA (photo courtesy of Marrieta Wild Burro Range).

ern North America is rich with references to and images of the horse, in particular. The relationship between horses and Native Americans, and cowboys and their mustangs, are identifying themes of western North America and may have contributed to creating a perception that free-roaming equids were a “wild,” natural part of the American West (Levine 1999).

Kellert and Berry (1980) asked Americans who responded to a national survey to rate 33 different animals based on their value. The horse was second only to the domestic dog (*Canis lupus familiaris*). The high value placed on horses and concern for their humane treatment was reinforced in the 1950s, when public concerns regarding the status and treatment of free-roaming equids led to the creation of the Wild Horse Annie Act, which was passed in 1959 (Smith et al. 2016). This legislation prohibited the use of

motorized vehicles to hunt, harass, or capture WHBs on public lands but did not create a program to protect, manage, or control wild horses and burros (Danvir 2018).

In 1934, the U.S. Congress passed the Taylor Grazing Act (TGA) to better regulate domestic livestock grazing on U.S. public lands (Public Law 73-482 1934). The TGA established and regulated federal grazing allotments, but these regulations did not apply to free-roaming equids. However, horses were seen as competition for grazing livestock, and removing them was an integral part of managing public rangelands (Danvir 2018).

In response to public opinion regarding the humane treatment and management of free-roaming equids, Congress passed the Wild Free-Roaming Horses and Burros Act (WFRHBA) in 1971 (Public Law 92-195 1971). The WFRHBA protected free-roaming horses and burros (defined therein as “WHBs”) from being captured, exploited, or killed by private citizens (Norris 2018). The WFRHBA also gave the Bureau of Land Management (BLM) and the U.S. Forest Service the statutory authority to manage and protect WHBs in designated herd management areas (HMAs) or herd management territories (hereafter included as HMAs). The intent of the WFRHBA was to ensure sustainable populations of free-roaming equids on certain federal lands, in ecological balance with other uses such as mineral extraction, grazing, wilderness, and recreation (Public Law 92-195 1971).

The WFRHBA, as amended by the Public Rangelands Improvement Act (PRIA) of 1978 (Public Law 95-514 1978), required the BLM to “determine appropriate management levels (AMLs) for WHBs on HMAs while balancing multiple uses” (Norris 2018). The rangewide AML set by the BLM is currently 26,785 WHBs inhabiting 29.4 million ha in HMAs across 10 western U.S. states (BLM 2020). As of March 1, 2021, the BLM estimated that there were 86,189 WHBs inhabiting designated HMAs and adjacent private and public lands (BLM 2021a). Schoenecker et al. (2021) estimated that there are >300,000 free-roaming equids in the United States.

When herds are above AML, or when animals are starving or dehydrated due to drought, animals may be herded, removed, and held in off-range holding facilities (BLM 2018, Garrott 2018). Currently, there are approximately 50,000 horses held in long-term facilities, where unless

adopted, they live out the rest of their lives. The current cost of long-term holding facilities exceeds \$50 million annually (BLM 2018).

Current federal WHB management practices include adoption, immunocontraception, and holding of animals in long-term facilities (BLM 2020). From 2016 to 2020, an average of 3,000 horses and 913 burros were adopted annually. However, at the current growth rate of >2,500 free-roaming equids born per year, the adoption programs alone cannot reduce or manage populations (National Research Council [NRC] 2013, Garrott 2018, BLM 2020). Immunocontraception, predominantly porcine zona pellucida-based injections, have been tested and proven effective in reducing growth rates. However, they must be administered annually and thus are not logistically feasible on most HMAs (Hendrickson 2018, Kane 2018). Furthermore, because administration of the contraceptives requires multiple captures and injections, their use becomes increasingly difficult and costly with each capture. Porcine zona pellucida costs about \$500 per dose, lasts about 1 year, and has variable effectiveness of about 30–70% (Killian et al. 2008). Thus, immunocontraception alone will not be effective at returning the on-range free-roaming equid populations to AML in the near future (NRC 2013, Kane 2018).

Without active management to reduce growth rates on public rangelands, the WHB population could exceed 160,000 in just under 5 years (Garrott 2018). Given the 2021 rangewide drought condition on western rangelands, it is expected that many more free-roaming equids will die from dehydration and starvation due to lack of available resources (Garrott 2018). Furthermore, without more active management, the impact of overabundant free-roaming equids on native wildlife, western watersheds, and rangelands will likely become irreversible (Davies and Boyd 2019).

The BLM (2020), in a report to the U.S. Congress, outlined 4 management options, costs, and potential timelines to sustainably manage WHBs. The only tool used broadly enough to make systemic population reductions in WHB populations has been the capture and removal of animals from western rangelands (BLM 2018, Hendrickson 2018). All of the BLM management options identified in the 2018 report to Congress will require the increased and wide-

spread gathering and handling of WHBs to implement the proposed population reduction strategies. Implementing any of the options will require different levels of funding, time, agency persistence, and congressional and stakeholder support. Most options will require dramatically increased expenditures of public tax dollars (BLM 2020). The options outlined by the BLM report to Congress did not address some important underlying sociological questions regarding public support.

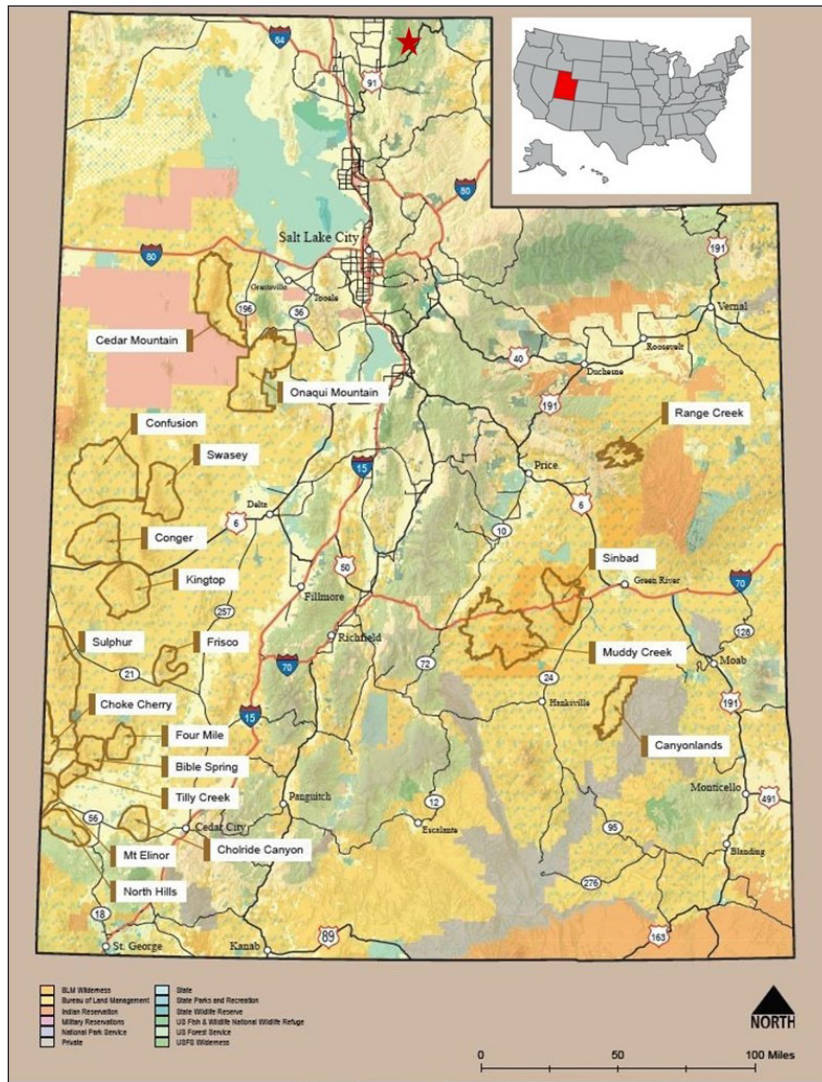
Changing demographics in the United States also suggests that public perceptions regarding WHB management may have changed since the WFRHBA was enacted (Rodriguez 2020, Messmer et al. 2021, Frey et al. 2022). Shifts in demographics, way of life, and priorities among U.S. citizens suggest that American society today may prefer different management practices than have historically been implemented (Manfredo et al. 2018).

There is a knowledge gap regarding public perceptions of free-roaming equids and their actual management options (Messmer et al. 2021). Rodriguez (2020) examined the influence of messaging and wildlife value orientations on the public's acceptance of proposed wild horse management actions within the western United States. Respondents were more accepting of various management actions when the messaging they were shown included an emotional appeal (i.e., photographs of emaciated horses) or a rational appeal, such as including information on limitations to current management practices, as well as negative effects of wild horses (Rodriguez 2020).

Drijfhout et al. (2020) studied Australian's public perceptions regarding the conservation and management of native marsupials (koalas [*Phascolarcto cinereus*] and kangaroos [Macropodidae]) relative to introduced horses (i.e., brumbies). They found that public acceptance of various management actions was highly dependent on the specific species, with lethal management options being preferred to reduce the impacts of brumbies on native wildlife (Drijfhout et al. 2020).

The state of Utah, USA, has several HMAs that exceed AML. The topic of WHBs and their management was further highlighted in a 2017 Wild Horse Summit (<http://www.wildhorserange.org/>), which was sponsored by Utah State University, and by a major news outlet in 2019





**Figure 3.** Wild horse (*Equus ferus caballus*) and burro (*E. asinus*) herd management areas within the state of Utah, USA. The red star indicates Logan, Utah, where Utah State University is located (Bureau of Land Management 2021b).

(O’Donoghue 2019). Because USU Extension and the S. J. and Jessie E. Quinney College of Natural Resources (QCNR) had organized the 2017 summit and hosted numerous workshops and seminars on the topic, we hypothesized that respondents within natural resources, biology, or agricultural programs would be more knowledgeable about the issues regarding wild horses and burros and would be more supportive of active management than other respondents. We also hypothesized that because the WFRHBA was enacted in 1971, older respondents would be more knowledgeable of the issues than

younger respondents. To test these hypotheses, we surveyed USU faculty, staff, and students to determine if their knowledge and perceptions of WHBs and their management differed based on demographic and academic backgrounds.

### Study area

The study population consisted of faculty, staff, and students working and/or enrolled at USU in 2020. Utah State University is the only land-grant university in Utah. As a land-grant university, it administers internationally recognized education, research, and extension

programs that serve all Utah residents (<http://www.usu.edu/>).

The BLM manages 19 WHB HMAs within the state of Utah (Figure 3). These 19 HMAs encompass nearly 2.5 million ha of land and occur throughout the state. The greatest concentration of HMAs (11 of the 19) occur in the southwestern corner of Utah (Figure 3). Utah's HMAs exist in a variety of ecosystems, ranging from desert shrubland to sagebrush (*Artemisia tridentata*) to pinyon-juniper (*Pinus* spp. and *Juniperus* spp.) woodland. As such, there is a range of both climatic conditions and land uses depending on the location of each HMA. The combined AML for all Utah HMAs combined is 1,956 animals. As of March 2021, there was an estimated 4,121 WHBs inhabiting Utah's 19 HMAs (BLM 2021a).

## Methods

### Survey instrument

Our survey consisted of 3 sections that included unique questions to assess respondent demographics, their knowledge of WHBs, and current management practices. The knowledge section of the survey contained 17 questions, and respondents could select a response of either yes, no, or uncertain (Appendix 1). For our analysis, we focused on 9 questions regarding the federal status and ecology of free-roaming horses. These questions were multiple choice, whereby a respondent could select 1 answer from a given set of responses. We assessed the association of the knowledge of these questions to the following demographics: age (<21, 22–37, 38–53, 54–72, and >73); childhood community (rural, suburban, urban); college affiliation (Caine College of the Arts, College of Agriculture and Applied Sciences (CAAS), College of Engineering, College of Humanities and Social Sciences, College of Science, Emma Eccles Jones College of Education & Human Services, Jon M. Huntsman School of Business, QCNR); gender (female, male, non-binary, prefer not to respond); U.S. citizenship (citizen, international); U.S. region (eastern, western); and USU role (faculty, graduate student, staff, undergraduate student).

### Questionnaire distribution

We distributed the survey via email through Qualtrics, a web-based survey tool to conduct survey research, evaluations, and other such

data collection. We emailed an invitation to participate in the survey, which also contained a link to the online survey, to a random sample of 5,000 USU student email addresses (both undergraduate and graduate students) provided by the USU Registrar's Office and 2,681 USU faculty and staff email addresses, obtained from USU colleges and departments. The survey was open from January 22, 2020, to May 11, 2020. We emailed respondents periodic reminders on February 6, March 9, and April 1, 2020. The research protocols and questionnaire were reviewed and approved by the USU Institutional Review Board Office (Protocol #10878).

### Data analysis

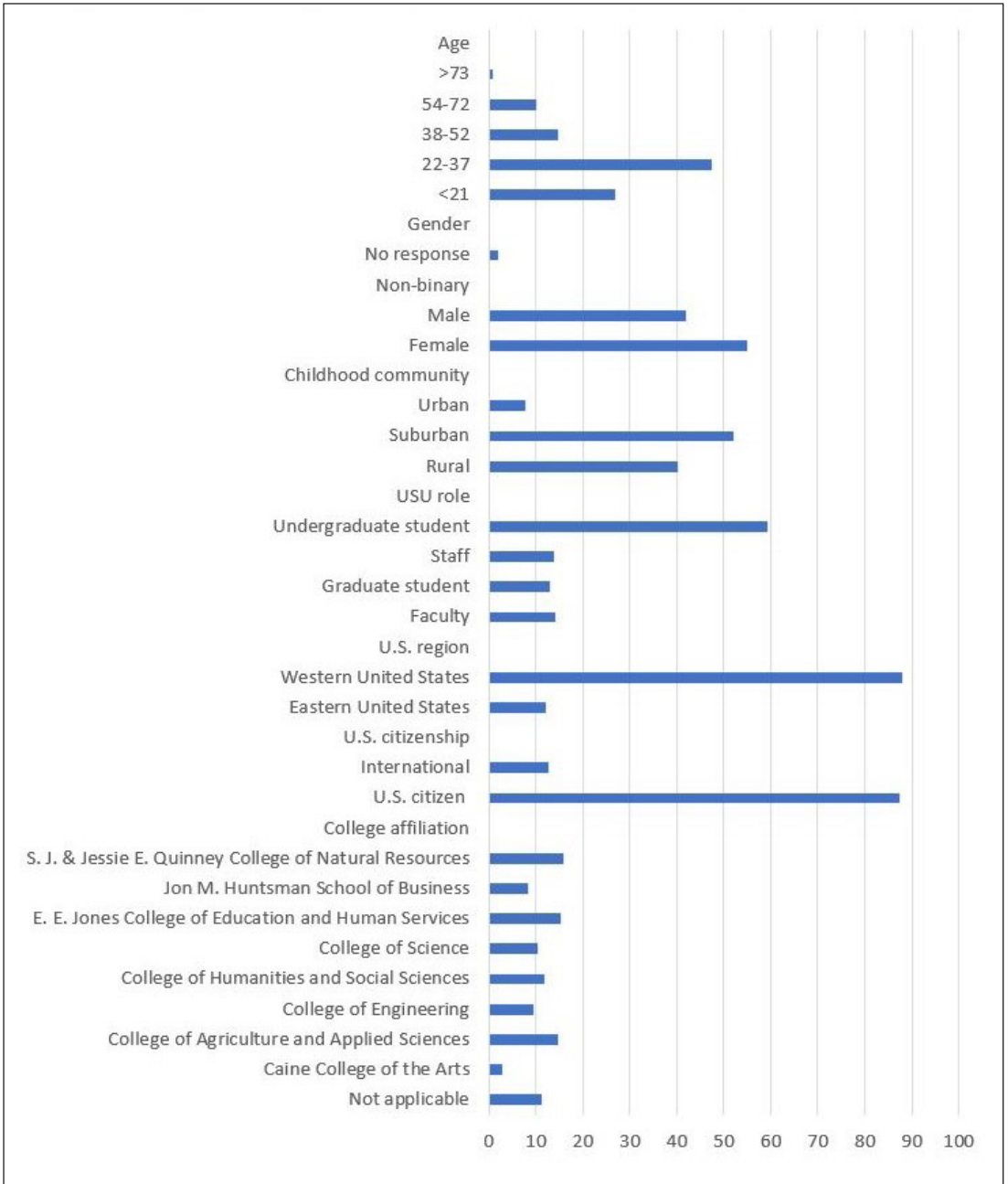
Using the Statistics Package for Social Science (SPSS; IBM 2020), we conducted Crosstabs descriptive statistics to calculate the portion of responses within each interaction. Within Crosstabs, we conducted a chi-square ( $\chi^2$ ) likelihood ratio test for associations, with  $P < 0.05$  considered statistically significant. Post-hoc Bonferroni tests were used to identify statistical differences among categories of pairwise comparisons. Additionally, we evaluated lambda ( $\lambda$ ) for each dependent by independent variable comparison (Frey et al. 2022).

## Results

Of the 7,681 emails that were sent out, we received 959 responses (12.5%). Because responses were anonymous, we were not able to conduct a follow-up investigation of non-response bias. Most of our respondents were 22–37 years of age (47.5%) and undergraduate students (59.2%). Additionally, most of our respondents were U.S. citizens (87%) from the western United States (88%). College affiliation varied widely among respondents, as did childhood residence, while binary gender was relatively evenly distributed (Figure 4). Because non-binary and “no response” respondents represented only 3% of the survey population, we continued our presentation of gender by exploring the results of only male and female respondents to eliminate any spurious conclusions based on gender (hereafter referred to as “sex”).

### Awareness of WFRHBA

Most respondents (59%) were unaware of the WFRHBA. There was no influence of sex on the



**Figure 4.** Demographics of Utah State University faculty, staff, and students responding to a Utah State University community survey to assess their awareness, knowledge and support of free-roaming equids and their management, 2020. It is important to note that respondents were only asked what part of the United States they were from if they indicated that they were not international. Approximately 87% of respondents were from the United States, so the demographics of east/west only reflects that 87% of the sample.

respondent’s awareness of the legislation ( $\chi^2 = 5.269$ ,  $df = 6$ ,  $n = 758$ ,  $P = 0.51$ ; Table 1); however, all other independent variables had significant associations with this question. Awareness of the WFRHBA declined with age ( $\chi^2 = 104.857$ ,

$df = 10$ ,  $n = 758$ ,  $P < 0.00$ ,  $\lambda = 0.16$ ; Table 1). A larger proportion of rural respondents were aware of the legislation than suburban and urban respondents ( $\chi^2 = 27.353$ ,  $df = 4$ ,  $n = 757$ ,  $P < 0.00$ ,  $\lambda = 0.0$ ; Table 1).

Additionally, respondents' awareness of the WFRHBA was associated with their affiliated college ( $\chi^2 = 27.353$ ,  $df = 4$ ,  $n = 758$ ,  $P < 0.00$ ,  $\lambda = 0.0$ ; Table 1). Respondents from the QCNR were more aware of the legislation (69.2%) than any other college, with the exception of CAAS (50.0%). Fewer undergraduates indicated that they were aware of the WFRHBA than graduate students, faculty, and staff ( $\chi^2 = 97.395$ ,  $df = 6$ ,  $n = 757$ ,  $P < 0.00$ ,  $\lambda = 0.137$ ; Table 1).

More international respondents indicated that they were aware of the legislation than U.S. citizens ( $\chi^2 = 6.093$ ,  $df = 2$ ,  $n = 757$ ,  $P < 0.048$ ,  $\lambda = 0.0$ ; Table 1). Similarly, the region of the U.S. where a respondent was raised influenced their knowledge of the WFRHBA ( $\chi^2 = 7.086$ ,  $df = 2$ ,  $n = 659$ ,  $P < 0.029$ ,  $\lambda = 0.0$ ; Table 1), with more eastern U.S. respondents indicating that they were aware of the legislation than western U.S. respondents. Based on  $\lambda$  values, however, no demographic characteristic exhibited predictive power for explaining a respondent's awareness of the WFRHBA.

Most respondents (52%) were unaware that WHBs are protected on public lands in the western United States. Sex ( $\chi^2 = 6.605$ ,  $df = 8$ ,  $n = 755$ ,  $P = 0.58$ ; Table 1) and U.S. region ( $\chi^2 = 2.633$ ,  $df = 2$ ,  $n = 660$ ,  $P = 0.268$ ; Table 1) had no association with the respondents' answer to this question; all other independent variables had significant associations with the question (Table 1). Respondents aged  $>38$  were more aware than younger respondents ( $\chi^2 = 43.534$ ,  $df = 8$ ,  $n = 759$ ,  $P < 0.000$ ,  $\lambda = 0.127$ ; Table 1). Rural respondents were more aware that WHBs were protected than suburban and urban respondents ( $\chi^2 = 41.266$ ,  $df = 4$ ,  $n = 759$ ,  $P < 0.00$ ,  $\lambda = 0.139$ ; Table 1). More international respondents were aware than U.S. citizens ( $\chi^2 = 9.732$ ,  $df = 2$ ,  $n = 759$ ,  $P < 0.008$ ,  $\lambda = 0.036$ ; Table 1).

A respondents' college association and role influenced their awareness of protections for WHBs. Respondents from the QCNR were more aware of protection than any other college except CAAS ( $\chi^2 = 112.77$ ,  $df = 16$ ,  $n = 731$ ,  $P < 0.00$ ,  $\lambda = 0.251$ ; Table 1). Fewer undergraduates indicated that they were aware of WHBs' protected status than graduates, faculty, and staff ( $\chi^2 = 43.94$ ,  $df = 6$ ,  $n = 755$ ,  $P < 0.00$ ,  $\lambda = 0.137$ ; Table 1). Based on  $\lambda$  values, age, childhood community, and USU role had a weak ability to predict the response to this question; however,

while still weak, college affiliation had a higher predictive ability, and all other independent variables had no predictive ability.

### Taylor Grazing Act of 1934

More than 80% of the respondents were unaware of the TGA. The U.S. region ( $\chi^2 = 2.368$ ,  $df = 2$ ,  $n = 659$ ,  $P = 0.306$ ; Table 1) and U.S. citizenship ( $\chi^2 = 3.936$ ,  $df = 2$ ,  $n = 758$ ,  $P = 0.14$ ; Table 1) did not influence a respondent's awareness of the TGA; however, all other variables had an association. Female respondents were less aware of the TGA than male respondents ( $\chi^2 = 26.015$ ,  $df = 8$ ,  $n = 754$ ,  $P < 0.001$ ,  $\lambda = 0.000$ ; Table 1). Knowledge of the TGA increased with age, with respondents aged  $<21$  less knowledgeable than any other age group ( $\chi^2 = 39.221$ ,  $df = 10$ ,  $n = 758$ ,  $P < 0.000$ ,  $\lambda = 0.000$ ; Table 1). A larger proportion of rural respondents were aware of the TGA than suburban respondents, though neither of these were different from urban residents ( $\chi^2 = 18.128$ ,  $df = 4$ ,  $n = 758$ ,  $P < 0.001$ ,  $\lambda = 0.000$ ; Table 1).

Respondents from the QCNR were the most aware of the TGA (40%), while those from the business school were the least knowledgeable (1%;  $\chi^2 = 115.559$ ,  $df = 4$ ,  $n = 730$ ,  $P < 0.000$ ,  $\lambda = 0.000$ ; Table 1). Staff and undergraduates were less knowledgeable of the TGA than faculty and graduate students ( $\chi^2 = 46.48$ ,  $df = 6$ ,  $n = 754$ ,  $P = 0.000$ ,  $\lambda = 0.000$ ; Table 1). Based on  $\lambda$  values, no independent variables had any predictive ability toward this question.

### BLM adoption policy

Most respondents (70%) were unaware that the BLM will pay \$1,000 toward a WHB adoption. Sex ( $\chi^2 = 4.608$ ,  $df = 6$ ,  $n = 760$ ,  $P = 0.595$ ) and U.S. region ( $\chi^2 = 2.144$ ,  $df = 2$ ,  $n = 660$ ,  $P = 0.342$ ) did not have an association with the awareness of respondents regarding the BLM's adoption policy (Table 1). Respondents aged 54–72 were more aware of the adoption program (55%) than any other age group ( $\chi^2 = 73.453$ ,  $df = 8$ ,  $n = 760$ ,  $P < 0.001$ ,  $\lambda = 0.07$ ; Table 1). Rural respondents were more aware of the program than suburban respondents ( $\chi^2 = 19.603$ ,  $df = 4$ ,  $n = 759$ ,  $P < 0.001$ ,  $\lambda = 0.00$ ; Table 1).

Respondents from the QCNR were the most aware of this policy, while respondents from the College of Education were the least aware of this policy ( $\chi^2 = 118.173$ ,  $df = 16$ ,  $n = 731$ ,  $P$



**Table 1.** Respondents' awareness of U.S. wild horse (*Equus ferus caballus*) and burro (*E. asinus*) management policy and the proportion of the respondents within each demographic that selected that they were aware of the policy. Superscripts represent differences based on Bonferroni post-hoc tests at the significance level of  $P < 0.05$ . Utah State University (USU) stakeholder survey regarding free-roaming equids and their management, 2020. WFRHBA = Wild Free-roaming Horses and Burros Act. TGA = Taylor Grazing Act.

Demographic	Aware of WFRHBA	Aware horses are protected	Aware of TGA	Aware of adoption policy
<b>Sex</b>				
Female	31.3	43.3	8.6 <sup>a</sup>	26.3
Male	36.7	41.8	19.2 <sup>b</sup>	30.2
<b>Age</b>				
<21	15.5 <sup>a</sup>	32.4 <sup>a</sup>	4.8 <sup>c</sup>	16.4 <sup>c</sup>
22–37	31.8 <sup>b</sup>	40.6 <sup>b</sup>	13.3 <sup>a</sup>	28.6 <sup>a</sup>
38–53	50.5 <sup>b</sup>	56.3 <sup>b</sup>	19.8 <sup>a,b</sup>	30.4 <sup>a</sup>
54–72	68.8 <sup>a,b</sup>	59.7 <sup>a,b</sup>	26.3 <sup>b</sup>	54.5 <sup>b</sup>
>73	75.0 <sup>c</sup>	25 <sup>a</sup>	50.0 <sup>a,b</sup>	25.0 <sup>a,b,c</sup>
<b>Childhood community</b>				
Rural	44.4 <sup>a</sup>	55.9 <sup>a</sup>	19.5 <sup>a</sup>	36.8 <sup>a</sup>
Suburban	27.5 <sup>b</sup>	33.1 <sup>b</sup>	9.3 <sup>b</sup>	21.7 <sup>b</sup>
Urban	23.7 <sup>b</sup>	35.6 <sup>b</sup>	10.2 <sup>a,b</sup>	25.4 <sup>a,b</sup>
<b>U.S. citizenship</b>				
U.S. citizen	32.8 <sup>a</sup>	41.2 <sup>a</sup>	12.8	27.3
International	43.2 <sup>b</sup>	52.1 <sup>b</sup>	17.7	34.4
<b>U.S. region</b>				
Eastern United States	43.9 <sup>a</sup>	47.6	18.3	34.1
Western United States	31 <sup>b</sup>	40	12	26.3
<b>College affiliation</b>				
Not applicable	40.2 <sup>a,c</sup>	47.6 <sup>a,c</sup>	13.6 <sup>b</sup>	34.1 <sup>b,e</sup>
Caine College of the Arts	23.8 <sup>a,b,c</sup>	33.3 <sup>a,b,c</sup>	9.5 <sup>a,b</sup>	33.3 <sup>a,b,c,d,e</sup>
College of Agriculture and Applied Sciences	50.0 <sup>c,d</sup>	63.0 <sup>c,d</sup>	16.7 <sup>b</sup>	43.5 <sup>d,e</sup>
College of Engineering	17.9 <sup>a,b</sup>	24.6 <sup>a,b</sup>	4.3 <sup>b</sup>	11.6 <sup>c</sup>
College of Humanities and Social Sciences	20.9 <sup>a,b</sup>	31.4 <sup>a,b</sup>	8.1 <sup>b</sup>	17.4 <sup>b,c</sup>
College of Science	16.0 <sup>b</sup>	25.3 <sup>a,b</sup>	4.0 <sup>b</sup>	18.7 <sup>b,c</sup>
Eccles Jones College of Education & Human Services	19.6 <sup>a,b</sup>	35.7 <sup>a,b</sup>	5.4 <sup>b</sup>	9.8 <sup>c</sup>
Jon M. Huntsman School of Business	14.8 <sup>b</sup>	21.3 <sup>b</sup>	1.6 <sup>b</sup>	14.8 <sup>b,c</sup>
S. J. & Jessie E. Quinney College of Natural Resources	69.2 <sup>d</sup>	71.8 <sup>d</sup>	40.2 <sup>a</sup>	59.0 <sup>a,d</sup>
<b>USU role</b>				
Faculty	61	51.9 <sup>b</sup>	32.1 <sup>a</sup>	42.5 <sup>a</sup>
Graduate student	46.9	59.2 <sup>b</sup>	22.4 <sup>a</sup>	42.9 <sup>a</sup>
Staff	50	52.9 <sup>b</sup>	8.7 <sup>b</sup>	35.6 <sup>a</sup>
Undergraduate student	20.9 <sup>a</sup>	33.8 <sup>a</sup>	8.3 <sup>b</sup>	19.7 <sup>b</sup>



= 0.000,  $\lambda = 0.000$ ; Table 1). Undergraduate respondents were less aware of BLM's adoption policy than faculty, graduate students, and staff ( $\chi^2 = 58.815$ ,  $df = 6$ ,  $n = 755$ ,  $P < 0.001$ ,  $\lambda = 0.000$ ; Table 1). College affiliation had a weak predictive ability to the response of this question; no other independent variables had any predictive ability (Table 1).

### Knowledge of WHB ecology and management

Only 2.1% of the respondents correctly identified the AML for WHBs on federal lands as being between 25,000–30,000; >45% of the respondents were unsure of the AML. Gender ( $\chi^2 = 14.882$ ,  $df = 12$ ,  $n = 758$ ,  $P = 0.248$ ), nationality ( $\chi^2 = 9.251$ ,  $df = 4$ ,  $n = 757$ ,  $P = 0.055$ ), and U.S. region ( $\chi^2 = 7.804$ ,  $df = 4$ ,  $n = 659$ ,  $P = 0.099$ ) did not influence the respondents' knowledge of AML (Table 2). While there may have been an association between a respondent's answer to the question and age ( $\chi^2 = 36.679$ ,  $df = 16$ ,  $n = 758$ ,  $P = 0.002$ ,  $\lambda = 0$ ), childhood community ( $\chi^2 = 24.916$ ,  $df = 8$ ,  $n = 757$ ,  $P = 0.002$ ,  $\lambda = 0.00$ ), college affiliation ( $\chi^2 = 88.394$ ,  $df = 36$ ,  $n = 758$ ,  $P < 0.001$ ,  $\lambda = 0.052$ ) and USU role ( $\chi^2 = 27.142$ ,  $df = 12$ ,  $n = 753$ ,  $P = 0.007$ ,  $\lambda = 0.00$ ), there was no difference in the percentage of respondents that indicated the correct response of 25,000–30,000 (Table 2). Based on  $\lambda$  values, no independent variables had any predictive ability for this question.

Respondents (45%) were unsure of the current status of free-roaming equid populations (>90,000). Age ( $\chi^2 = 36.679$ ,  $df = 16$ ,  $n = 757$ ,  $P = 0.128$ ) and U.S. citizenship ( $\chi^2 = 0.847$ ,  $df = 4$ ,  $n = 756$ ,  $P = 0.934$ ) had no association with respondent's knowledge of the current population status (Table 2). While childhood community ( $\chi^2 = 29.768$ ,  $df = 8$ ,  $n = 756$ ,  $P < 0.001$ ,  $\lambda = 0.00$ ), U.S. region ( $\chi^2 = 9.727$ ,  $df = 4$ ,  $n = 658$ ,  $P = 0.045$ ,  $\lambda = 0.00$ ), and college affiliation had associations with respondent's selection, there was no difference in the percentage of respondents that selected the correct population size (Table 2). There was a difference in knowledge of WHB populations between the sexes ( $\chi^2 = 29.163$ ,  $df = 12$ ,  $n = 757$ ,  $P < 0.004$ ,  $\lambda = 0.00$ ); males selected the correct response more than females (Table 2). Additionally, there was an association between a respondent's college role and their knowledge of WHB population size ( $\chi^2 = 36.024$ ,  $df = 12$ ,  $n = 752$ ,  $P < 0.001$ ,  $\lambda = 0.00$ ).

Undergraduate students selected the correct response less than faculty and graduate students (Table 2). Similarly, there was an association between a respondent's associated college and their knowledge of WHB population size ( $\chi^2 = 143.66$ ,  $df = 32$ ,  $n = 757$ ,  $P < 0.001$ ,  $\lambda = 0.031$ ; Table 2). Respondents from the College of Education selected the correct response the least (1%; Table 2). Based on  $\lambda$  values, no independent variables had any predictive ability for this question.

Respondents were uncertain of free-roaming equid annual growth rates. Only 24% of respondents correctly selected an annual growth rate of 10–20% (Table 2). There were no associations between the responses to this question of annual growth rate and age ( $\chi^2 = 20.334$ ,  $df = 16$ ,  $n = 756$ ,  $P = 0.206$ ), sex ( $\chi^2 = 9.803$ ,  $df = 12$ ,  $n = 756$ ,  $P = 0.633$ ), U.S. citizenship ( $\chi^2 = 3.799$ ,  $df = 4$ ,  $n = 755$ ,  $P = 0.434$ ), U.S. region ( $\chi^2 = 7.147$ ,  $df = 4$ ,  $n = 657$ ,  $P = 0.128$ ), or the role of the respondents at USU ( $\chi^2 = 11.326$ ,  $df = 12$ ,  $n = 752$ ,  $P = 0.501$ ; Table 2). There was an association with childhood community ( $\chi^2 = 19.061$ ,  $df = 8$ ,  $n = 755$ ,  $P = 0.015$ ,  $\lambda = 0.00$ ) and college affiliation ( $\chi^2 = 60.07$ ,  $df = 36$ ,  $n = 756$ ,  $P = 0.007$ ,  $\lambda = 0.00$ ); however, there were no differences among these demographic categories for the percentage of respondents that selected the correct response (Table 2). Based on the  $\lambda$  values, no independent variables had any predictive ability for this question.

Most respondents (56%) identified mountain lions ("cougar"; *Puma concolor*) as a good example of a native predator to free-roaming equids, although cougars are usually infrequent predators in a few areas of the western United States. Only 30% of respondents indicated that cougars, bears (*Ursus* spp.), and wolves (*C. lupus*) were not good examples of native predators, which is more common throughout western rangelands. Childhood community ( $\chi^2 = 8.024$ ,  $df = 6$ ,  $n = 754$ ,  $P = 0.236$ ) and U.S. citizenship ( $\chi^2 = 1.297$ ,  $df = 3$ ,  $n = 754$ ,  $P = 0.730$ ) were not associated with the respondent's answer to this question (Table 2).

There was an association with the respondents' knowledge of predators and their age ( $\chi^2 = 34.49$ ,  $df = 12$ ,  $n = 755$ ,  $P < 0.001$ ,  $\lambda = 0.00$ ). Respondents aged <21 selected "none" less than all other age groups, excepting those >73 (Table 2). Respondents aged <21 also selected "cougar" more than respondents aged 22–37 (Table 2). There was also an association between gender and this question

**Table 2.** Respondents' knowledge of U.S. wild horse (*Equus ferus caballus*) and burro (*E. asinus*) ecology and management and the proportion of the respondents within each demographic that selected the most appropriate answer. Superscripts represent differences based on Bonferroni post-hoc tests at the significance level of  $P < 0.05$ . Utah State University (USU) stakeholder survey regarding free-roaming equids and their management, 2020. AML = appropriate management level.

Demographic	Current AML	Current population	Annual growth rate	Native predator (none) <sup>1</sup>	Native predator (mountain lion)	Ecological classification
<b>Sex</b>						
Female	23	5.7 <sup>a</sup>	22.1	23.5 <sup>a</sup>	64.3 <sup>a</sup>	33.3
Male	18.3	14.9 <sup>b</sup>	26.3	38.0 <sup>b</sup>	47.2 <sup>b</sup>	41.3
<b>Age</b>						
<21	25.1	7.2	20.4	18.4 <sup>b</sup>	68.1 <sup>b</sup>	27.5 <sup>a</sup>
22–37	20.8	9.7	23.1	34.0 <sup>a</sup>	49.6 <sup>a</sup>	37.5 <sup>a,b</sup>
38–53	13.4	10.8	30.6	36.9 <sup>a</sup>	54.1 <sup>a,b</sup>	48.2 <sup>b</sup>
54–72	17.3	18.7	23.7	36.5 <sup>a</sup>	56.8 <sup>a,b</sup>	46.1 <sup>b</sup>
>73	50	25	25	25.0 <sup>a,b</sup>	75.0 <sup>a,b</sup>	50.0 <sup>a,b</sup>
<b>Childhood community</b>						
Rural	19.1	13.9	26.3	32.2	54.3	46.7 <sup>a</sup>
Suburban	22.5	8.4	22.1	29.6	57.7	31.4 <sup>b</sup>
Urban	16.9	3.4	19.3	25.9	55.2	27.1 <sup>b</sup>
<b>U.S. citizenship</b>						
U.S. citizen	20.1	10	23.3	30.5	55.5	37
International	25.3	11.6	25.3	29.2	60.4	39.6
<b>U.S. region</b>						
Eastern United States	14.6	14.6	14.8	41.3 <sup>a</sup>	41.3 <sup>a</sup>	43.9
Western United States	21	9.2	24.5	28.9 <sup>b</sup>	57.6 <sup>b</sup>	35.9
<b>College affiliation</b>						
Not applicable	18.5	11.3 <sup>a,b,c,d</sup>	25.6	22.3 <sup>a,b</sup>	62.2 <sup>a,b</sup>	32.9 <sup>a,c</sup>
Caine College of the Arts	23.8	9.5 <sup>a,b,c,d</sup>	9.5	19 <sup>a,b</sup>	71.4 <sup>a,b</sup>	14.3 <sup>a</sup>
College of Agriculture and Applied Sciences	27.9	15.7 <sup>a,b,c</sup>	27.8	38 <sup>b</sup>	48.1 <sup>b,c</sup>	54.6 <sup>b,c</sup>
College of Engineering	20.3	4.3 <sup>a,c,d</sup>	27.5	31.9 <sup>a,b</sup>	52.2 <sup>a,b,c</sup>	29.0 <sup>a</sup>
College of Humanities and Social Sciences	19.8	3.5 <sup>a,c,d</sup>	15.1	22.1 <sup>a,b</sup>	66.3 <sup>a,b</sup>	22.1 <sup>a</sup>
College of Science	13.3	8 <sup>a,b,c,d</sup>	21.6	22.7 <sup>a,b</sup>	58.7 <sup>a,b</sup>	32.0 <sup>a,c</sup>
Emma Eccles Jones College of Education & Human Services	20.5	0.9 <sup>d</sup>	16.2	17.3 <sup>a</sup>	69.6 <sup>a</sup>	26.8 <sup>a</sup>
Jon M. Huntsman School of Business	27.9	3.3 <sup>c,d</sup>	26.2	14.8 <sup>a,b</sup>	59.0 <sup>a,b</sup>	21.3
S. J. & Jessie E. Quinney College of Natural Resources	30.8	25.6 <sup>b</sup>	32.8	62.4 <sup>c</sup>	32.5 <sup>c</sup>	65.8 <sup>b</sup>

Table continued on next page...

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USU role						
Faculty	15.2	21.9 <sup>a</sup>	22.9	39.8 <sup>a,b</sup>	48.5 <sup>a,b</sup>	53.3 <sup>a</sup>
Graduate student	22.4	14.3 <sup>a</sup>	24.5	56.1 <sup>b</sup>	35.7 <sup>b</sup>	56.1 <sup>a</sup>
Staff	14.6	10.8 <sup>a,b</sup>	31.1	25.2 <sup>a,c</sup>	62.1 <sup>a</sup>	32.7 <sup>b</sup>
Undergraduate student	22.8	6.3 <sup>b</sup>	22	23.7 <sup>c</sup>	61.1 <sup>a</sup>	30.0 <sup>b</sup>

<sup>1</sup> The majority of respondents selected “cougar” as an example of a “good” predator to wild horses and burros (WHBs), rather than the expected selection of “none.” Cougars can depredate WHBs but are not considered common predators at this time. Therefore, we present the frequency of both responses for transparency.

( $\chi^2 = 31.423$ ,  $df = 9$ ,  $n = 755$ ,  $P < 0.001$ ,  $\lambda = 0.012$ ). Male respondents selected “none” more than females, while the reverse was true for “cougars” (Table 2). The U.S. region had a slight association with a respondent’s knowledge of predators ( $\chi^2 = 7.790$ ,  $df = 3$ ,  $n = 655$ ,  $P = 0.051$ ); western U.S. respondents selected “cougar” more than eastern respondents, while eastern respondents selected “none” more than western respondents (Table 2).

The role of a respondent at USU ( $\chi^2 = 44.878$ ,  $df = 9$ ,  $n = 751$ ,  $P < 0.001$ ,  $\lambda = 0.061$ ) and their college affiliation ( $\chi^2 = 105.205$ ,  $df = 27$ ,  $n = 755$ ,  $P < 0.001$ ,  $\lambda = 0.106$ ) influenced their selection (Table 2). In general, staff selected “none” the least, and graduate students selected “cougar” the least (Table 2). Respondents from the QCNR selected “none” more than any other college (62.4%), while the science-related colleges tended to select “cougar” less than the other colleges (Table 2). Based on the  $\lambda$  value, college affiliation was a weak predictor of the response to this question; all other independent variables did not exhibit predictive ability.

More respondents knew that free-roaming equids are considered “feral” (35%) rather than wildlife (26%); however, many were uncertain of the ecological classification (Table 2). Gender ( $\chi^2 = 20.319$ ,  $df = 12$ ,  $n = 759$ ,  $P = 0.061$ ), U.S. citizenship ( $\chi^2 = 2.302$ ,  $df = 4$ ,  $n = 758$ ,  $P = 0.67$ ), and U.S. region ( $\chi^2 = 4.805$ ,  $df = 4$ ,  $n = 659$ ,  $P = 0.308$ ) were not associated with a respondent’s selection. There was an association between the knowledge of ecological classification and age ( $\chi^2 = 35.129$ ,  $df = 16$ ,  $n = 759$ ,  $P = 0.004$ ,  $\lambda = 0.034$ ), where there was a trend for more respondents to indicate WHB as “feral” with each older age class (Table 2). Childhood community also influenced respondents’ knowledge of this subject ( $\chi^2$

$= 24.02$ ,  $df = 8$ ,  $n = 758$ ,  $P < 0.002$ ,  $\lambda = 0.011$ ); rural respondents selected “feral” more often than suburban or urban respondents (Table 2).

College affiliation ( $\chi^2 = 126.16$ ,  $df = 36$ ,  $n = 759$ ,  $P < 0.01$ ,  $\lambda = 0.061$ ), and role at USU ( $\chi^2 = 52.218$ ,  $df = 12$ ,  $n = 754$ ,  $P < 0.001$ ,  $\lambda = 0.021$ ) influenced a respondent’s knowledge of WHB ecological classification. Respondents from the QCNR selected “feral” more often than all colleges except the College of Agriculture and Applied Sciences (Table 2). Faculty and graduates selected “feral” more often than staff and undergraduate students (Table 2). Based on the  $\lambda$  values, no independent variables had any predictive ability for this question.

### Discussion

We hypothesized that older respondents would be more informed and supportive of active management. We also hypothesized that those with a background in natural resources would be more informed of the issues and supportive of active management. In general, older survey respondents and those with a background in natural resources were more aware of the WFRHBA, that free-roaming equids are protected on federal lands, and of the BLM’s adoption program compared to younger respondents.

Our results suggest that although free-roaming equids may inhabit HMAs in a given state, and the issues regarding their status and management may be featured in the popular media and in academic environments, the BLM and other management agencies should not expect stakeholders that share these attributes to be well-informed of the facts (such as federal legislation, native status, population size, etc.). Most of our respondents were largely unaware of the current management, laws, and policies re-

garding western federal land management and WHBs (Smith et al. 2016, Norris 2018). Our results also highlighted the need for more comprehensive communication and outreach strategy that more fully engages diverse stakeholders in active management of free-roaming equids.

Recent studies show that 2% of the U.S. public qualifies as ecologically literate (Jacobson and McDuff 2009). Our study population may have higher ecological literacy than the general U.S. public, but even given that most of our respondents were from the western United States (where most WHBs reside), many were still not aware of the legislation that governs the management of free-roaming equids and public lands. The TGA, the WFRHBA, and the PRIA are 3 federal laws that form the basis governing the BLM's management on western public rangelands within the United States (NRC 2013, Danvir 2018, Norris 2018). Although rural residents and those associated with the QCNR were more knowledgeable than others, they were in the minority of our respondents.

While increased knowledge of a contentious management issue does not always lead to increased support, it can lead to increased understanding, which influences the ability of disparate groups to achieve consensus and make informed decisions (Riley and Gregory 2012). For example, Frey et al. (2022) reported that once respondents knew that permanent fertility control was legal for WHBs, they were more likely to support this method of direct management. Managers should identify and implement educational and communication strategies that facilitate early and frequent access to clearly understandable information. This information may increase stakeholder ownership and engagement if it also identifies the consequences of inaction (Messmer et al. 1999, Garrott 2018, Davies and Boyd 2019.).

Most of our respondents were not able to identify AML, current population numbers, or the annual growth rate of free-roaming equids on public lands. Human dimensions research indicates that public support for a species and its management changes with the perception of its abundance (Enck and Bath 2012). If the public perceives that free-roaming equids are rare, as is the case with most protected species, they will generally support more protective actions. Thus, better messaging regarding the status of

equid populations, growth rates, and individual herd population by HMA may facilitate a better understanding of and support for current population objectives and management strategies (Messmer et al. 2021, Frey et al. 2022).

### **Ecological classification and predators**

Most of our respondents did not consider free-roaming equids to be feral and mountain lions as a good example of a native predator. Past studies suggest that in areas where WHB and mountain lion populations overlap, mountain lions may depredate horses. However, few mountain lion populations are large enough to impact horse populations, and the frequency of depredation across WHB distribution is very low (Turner et al. 1992, Greger and Romney 1999, Andreasen et al. 2021). Our use of the phrase "good example" may have been confusing; a better term may have been "common predator." Frey et al. (2022) also reported that most respondents of a national survey believed that mountain lions were common native predators of wild horses in the western United States.

Drijfhout et al. (2020) reported that the public's support of management actions to control animal populations depends on the classification of the animals. They reported that their respondents were more likely to support population control of non-native species to benefit native species. Given a choice between contraceptives, sterilization, or no reproductive control, 25% of respondents preferred that there be no reproductive control in free-roaming horse populations (Frey et al. 2022), while 50% supported the idea that horse populations regulate naturally. Perhaps these responses were correlated in that those that believed WHBs are commonly depredated by mountain lions could be more inclined to support natural regulation.

### **Demographics**

Respondent demographics influenced our respondent responses. As expected, where a person spent their childhood influenced their knowledge of western land management and general horse and burro ecology. Rural respondents reported greater knowledge of western land management and WHBs than suburban and urban respondents. We therefore cannot expect urban and suburban residents—where most of the U.S. population resides—to make



informed decisions about horses and burros. Scientists and managers frequently contend that people may make judgments based on sensational media coverage of horses and burros, when in fact, they may be making judgments in the absence of factual information (Rodriguez 2020, Messmer et al. 2021).

In our survey, age of respondent influenced knowledge; older respondents were more aware of free-roaming equids and management issues. This may reflect the duration of the management policies. The TGA, WFRH-BA, and PRIA were enacted several decades ago. Most of the U.S. public may learn about free-roaming equids when they are in distress, thus reinforcing the impression that they are rare and endangered rather than above recommended population sizes (Norris 2018).

### Stakeholder education and outreach

Messmer et al. (1999) provided some insights into how information can affect public opinions about a controversial management issue such as predator control (Decker and Brown 1987, Messmer et al. 2001). Predator control to benefit wildlife has historically been a common practice that has enjoyed wide-scale support among traditional constituents of wildlife management agencies (Minnis 1997, Messmer et al. 2001). The predator control controversy surfaced in the political arena as stakeholders have sought to define the acceptable range of predation management options through voter ballot initiatives, legislative lobbying, and judicial actions (Messmer et al. 2001). Similar to the feral equid issue, the social targets for political action regarding predator management were considered “neutral” or uninformed on the issues (Gentile 1987, Kirkpatrick and Turner 1997).

Messmer et al. (1999) employed a scenario-based information approach to present wildlife management decisions regarding predation management in a contemporary context. Their scenarios presented information about specific predation management problems and consequences so that respondents could more fully evaluate their support or opposition to predator control. Messmer et al. (1999) reported a moderately knowledgeable, interested public who were able to see shades of gray in the relationship between people, predators, and their management. As a result, they may be less sus-

ceptible to public information campaigns than less knowledgeable individuals. Messmer et al. (1999) respondents also believed that lethal predator control should be considered when examining options for population management that are based on sound scientific evidence.

However, social scientists have long argued that general attitudes of an uninformed or misinformed public are not good predictors of specific behaviors (Dollard 1949, Wicker 1969, Heberlein and Black 1975). Surveys conducted to assess general public attitudes toward direct management approaches such as predator control or the management of feral equids that do not provide competing information are weak predictors of political action in support of or opposition to a particular agency response to a management problem (Messmer et al. 1999). Thus, managers and policymakers should be cautious when extrapolating public attitudes to specific free-roaming equid management options based on well-organized social media or signature petition campaigns.

Respondent demographics, particularly age, influenced respondent awareness and knowledge of free-roaming equids. Nafziger et al. (1951) reported similar results regarding influence of age relative to the role of mass media, particularly written media, in informing stakeholders. The Pew Institute reported that >86% of the American public now gets their news from their smartphones (Shearer 2021) via social media platforms (Hutchinson 2021). Our results suggest that if government agencies and other groups desire to create a more informed and educated public about free-roaming equids and their management, they will need to broaden their use of alternative mass media platforms to include more use of social media.

Our results suggest that sustainable management of free-roaming equids will only be achieved if managers work to balance the needs of the WHBs with other societal needs and desires. To accomplish this, program managers, governments, and informed stakeholders need to actively engage all stakeholders in the decision-making process (Hewitt and Messmer 1997, NRC 2013). An example of this is a new coalition-building effort facilitated by the Free-roaming Equid and Ecosystem Sustainability Network (FREES 2021). The FREES network re-engages diverse stakeholders in seeking solutions to free-roaming

equid management issues by facilitating open dialogue and building positive relationships to promote the health of free-roaming equids, western rangeland ecosystem health and sustainability, and the principles of multiple-use.

### Management implications

Our research suggests that although stakeholders may live where free-roaming equids reside and have received regular publicity, it cannot be assumed that these stakeholders are also well-informed about free-roaming equids and their management. This is especially true for younger generations and those who grew up in urban and suburban settings. However, with targeted educational campaigns, the public can be more informed and engaged in management. A better informed public, with greater understanding of the ecological classification and bounds of free-roaming equids, is more likely to make well-informed decisions. Further research should be done to truly understand the public's perceptions and values regarding WHBs as well as what management actions can be implemented with the public's support. Research into the public's values and perceptions, coupled with a messaging and communication system that includes social media, may increase the public's support and understanding of free-roaming equids and their management.

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### Supplemental material

Supplemental material can be viewed at <https://digitalcommons.usu.edu/hwi/vol16/iss2/11>.

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Associate Editor: Dwayne Elmore



**HOLLEE S. WOOD** graduated with a B.S. degree in wildlife ecology and management from Utah State University in 2021. She also completed a Master of Business Administration degree from Utah State University in 2022.



**S. NICOLE FREY** received her Ph.D. degree in wildlife biology from Utah State University (USU) in 2004. She has worked for USU Cooperative Extension since 2004, addressing issues in wildlife conservation, human–wildlife interactions, and youth education in southern Utah. Her interest in wildlife management focuses on increasing the positive interactions between human activity (towns, agriculture, recreation) and wildlife. She currently is an extension wildlife professor for Utah State University and resides in Cedar City, Utah.



**TERRY A. MESSMER** (retired) was a professor and extension wildlife specialist in the Department of Wildland Resources at Utah State University in Logan, Utah. He was also the director of the Jack H. Berryman Institute for Wildlife Damage Management, Quinney Professorship of Wildlife Conflict Management, and Utah Community-Based Conservation Program. His research, teaching, and extension activities included identification, implementation, and evaluation of conservation strategies, technologies, and partnerships that can benefit local economies, community dynamics, leadership and social structure, and new and traditional wildlife stakeholders.

