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A Survey of Perceptions and Attitudes about Water Issues in Oklahoma: A Comparative Study

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Abstract: Understanding people's perceptions of the environment, drinking water issues, and protecting and preserving water resources is of great importance. This study aims to assess and compare the perceptions of the general public (*n* = 414), post-secondary students (*n* = 103), and water professionals (*n* = 104) in Oklahoma on water issues in the state. To address these goals, a 53-item paper questionnaire was first administered to a randomly sampled mailing list of Oklahoma residents. As a follow up to the initial survey, post-secondary students at Oklahoma State University were sampled in addition to Oklahoma water professionals at regional conferences. Respondents ranged from 18 to over 65 years old, with all three demographics agreeing the top water priority to be clean drinking water. The majority were satisfied with their home water supply and felt it was safe to drink, while they were not sure of the quality of ground and/or surface water. Age was a key factor in information delivery and learning preferences as the older participants favored print material versus the younger demographic interest in technology. Data collected via this study provide insight into the perceptions, priorities, and learning preferences of these three populations. Despite our finding that clean water is a priority in Oklahoma, regardless of demographic, results suggest more education and outreach is needed to provide additional information regarding water in Oklahoma.

Keywords: *environmental concerns, learning preferences, water priorities*

Water is one of the most important natural resources (Mahler et al. 2013). Because of this, the United Nations (2015) is working to improve water quality, increase the efficiency of water use, integrate water management programs, and achieve universal and equitable access to safe drinking water for all by 2030. Public support will be critical to achieving these objectives. The theory of planned behavior (TPB) has been used extensively to help explain an individual's behavior based on their attitude, subjective norms, and perceived behavioral control related to their intention to ultimately perform an identified behavior (Ajzen 1991). As a result, numerous studies have evaluated the attitudes and perceptions of underrepresented populations (Kozich et al. 2018) and the general public on water related issues (Mahler et al. 2010; Adams et al. 2013; Boellstorff et al. 2013; Borisova et al. 2013; Mahler et al. 2013; Evans et al. 2015; Gholson et al. 2018). Regardless of the population of interest, perceptions of water issues, environmental impacts, and the protection and preservation of natural resources play a key role in meeting future national and global water supply needs. In particular, failure to allocate equitable water resources among stakeholders may lead to controversies such as that of Lake McClure in California, Canton Lake in Oklahoma, and Lake Granbury in Texas and historic controversies such as at Mono Lake in

California (Loomis 1987; Loomis 1995; Casteel 2013). In Oklahoma, water use in the southeastern part of the state is a long litigated regional issue with conflicting interests of the tribal nations, state of Oklahoma, city of Oklahoma City, and the Tarrant County District in North Texas (Casteel 2013). Further understanding of the public's perceptions can help water managers predict water related behaviors (Jorgenson et al. 2009; Willis et al. 2011) and determine future needs and impacts of water related decisions – e.g., reusing reclaimed water (Parsons 2018) or produced water (Eck et al. 2019) to meet future needs.

The overarching objective of this study is to assess and discuss the perceptions of the general public, post-secondary students, and water professionals on water issues in Oklahoma. For the context of this study, the perceptions and attitudes of participants were considered as potential factors impacting water related decisions as an individual's intentions are assumed to encompass these motivating factors leading to the behavior (Ajzen 1991). Specifically, this study describes participants' perceptions and behaviors related to 1) key water issues and actions, 2) their drinking water sources, 3) protecting surface and groundwater quality, and 4) learning opportunities.

Materials and Methods

The 2018 Water Issues in Oklahoma survey was designed as a follow-up to the 2008 Water Issues in Oklahoma survey, which was part of the National Water Needs Assessment Program (Mahler et al. 2013). The 53-item survey included four sections addressing perceptions regarding the environment, drinking water issues, protecting and preserving water resources, and collecting socio-demographic and learning preference data. Section one assessed 27 items related to the participant's importance of each of the water issues (see Table 1) on a five-point scale of agreement (1 = Not important, 2 = Somewhat important, 3 = No opinion, 4 = Important, 5 = Very important).

Section two included four questions addressing drinking water perceptions, asking participants "where they primarily get their drinking water?", details regarding "their home drinking water system.", "do they feel their tap water is safe to drink?", and "do they have their home drinking water tested?". When addressing the protection and preservation of water resources, ten questions were used, including: 1) "What is the quality of groundwater in your area?"; 2) "What is the quality of surface waters where you live?"; 3) "Do you regard water quantity as a problem?"; 4) "Do you know of or suspect that any of the following pollutants affect either surface or groundwater quality in your area?"; 5) "In your opinion, which of the following are the most responsible for the

Table 1. Identified water issues.

Better management of recreational activities (boating, fishing, ATVs)
Better management of shoreline access to prevent erosion
Building new water storage structures (dams, reservoirs)
Clean drinking water
Clean groundwater
Clean rivers and lakes
Educating municipal officials
Hypoxia (Gulf dead zone)
Improving agricultural practices
Improving home and garden practices
Improving municipal practices
Improving storm water runoff
Improving water quality monitoring to detect pollution
Interstate transfer/sale of water rights
Involving citizens in collecting water quality information
Making water quality and quantity data available to public
Preserving and restoring buffer zones and wetlands
Preserving agricultural land and open space
Residential water conservation
Treating storm water runoff
Water for agriculture
Water for aquatic habitat
Water for commerce/industry/power
Water for household landscapes
Water for municipal use
Water for recreation
Within state transfer/sale of water rights

existing pollution problems in rivers and lakes in Oklahoma?"; 6) "Do you know what a watershed is?"; 7) "How well do you feel each one of these groups is fulfilling their responsibility for protecting water resources?"; 8) "The likelihood of your area suffering from a prolonged drought is:"; 9) "If treatment methods of produced water are successful, would you (check all that apply):"; and 10) "Have you or someone in your household done any of the following as part of an individual or community effort to conserve water or preserve water quality?". Learning preferences were assessed through five questions: 1) "Have you received water resources information from the following sources?"; 2) "If you had the following kinds of learning opportunities to learn more about water issues, which would you be most likely to take advantage of?"; 3) "Have you ever changed your mind about a water issue as a result of:"; 4) "Do you think that the amount of water in your area will change as a result of climate change?"; and 5) "Where do you normally get your news?". The final eight questions were related to socio-demographic data, including, sex, age, education, location, zip code, length of time in Oklahoma, and town population.

Three populations of interest were included in the study - the Oklahoma public, post-secondary students in the College of Agriculture Sciences and Natural Resources (CASNR) at Oklahoma State University (OSU), and Oklahoma water professionals. To collect information regarding the public's perception of water issues in Oklahoma, a random sampling method was implemented through the purchase of a mailing list for 2,000 Oklahoma residents. Following the tailored design method of Dillman et al. (2014), four rounds of communication were utilized. The first survey went out via postal mail to the entire sample and included a personalized cover letter, a 53-item survey questionnaire, and a postage paid, pre-addressed business reply envelope. A reminder postcard was sent to non-respondents two weeks later. The third follow-up included another complete survey packet, which was sent four weeks after the initial survey to all non-respondents, followed again by a final reminder postcard two weeks later. Between each follow-up, individuals who returned the survey or contacted the researchers and indicated they did not want to participate were removed from any additional mailings. Out of the 2,000 initial surveys sent, 192 were returned undeliverable and 414 surveys were completed and returned for an adjusted response rate of 22.9%. Of the 414, only 400 complete surveys were available for data analysis.

Based on the demographics of the completed surveys, we lacked representation of perceptions of a younger demographic. Thus, the second demographic of interest became CASNR students at OSU. The survey for this demographic used the same questionnaire as for the public, with the addition of one question asking participants to "place an X on the line indicating how you see yourself on environmental issues:", and two questions related to learning preferences for water education: "Have you ever participated in any of the following learning activities?" and "Would you like to learn more about any of the following water quality issues?". Although these three questions were added to the survey for student distribution, the results were not included in this paper, as the data was not collected from all groups. A convenience sample of two regularly scheduled classes in the CASNR were utilized for data collection, one class in the fall of 2018 and one class in the spring of 2019. The two classes combined provided a potential of 108 students receiving the survey, of which 103 voluntarily completed it, resulting in a 95.4% response rate.

The third group consisted of 'water professionals' engaged in a water related career in Oklahoma. The water professionals were sampled at two water conferences in Oklahoma, the first in the fall of 2018 and the second in the spring of 2019. Professionals were asked to complete the same survey as the CASNR students at both conferences and a collection box was made available for the completed surveys to be returned. Four hundred surveys were distributed between the two conferences with 104 completed surveys returned, giving a 26% response rate for the water professionals.

This study provides descriptive comparisons between the three samples related to their perceptions of water issues in Oklahoma. IBM SPSS Version 23 (IBM 2015) was utilized for data analysis.

Results

The 2018 Oklahoma water issues survey resulted in a combined respondent age range of 18 to over 65 years of age and an equal split of males and females with 44% each and 12% choosing not to respond to the gender question (Table 2). The majority of respondents (63%) lived inside city limits, and 77% had lived in Oklahoma for more than 10 years. A total of 54% of respondents lived in communities of 25,000 people or more.

Environmental Perceptions

Participants were asked how they feel about the environment by identifying how important each of 27 potential Oklahoma water issues were to them on a five-point Likert-type scale (i.e., not important to very important). Four of the top five priorities were related to clean water/water quality (Table 3) based on mean scores for the public. The water issue receiving the lowest mean score (3.46) was *water for household landscapes*, while the lowest percent agreement (46.6%) was on *interstate transfer/sale of water rights.*

OSU CASNR students had a slightly different perspective on water issues in Oklahoma. Although the most important issue for them was also *clean drinking water*, the leaning towards agriculture indicated by these CASNR students is clearly observed in three of their top five priorities (Table 4) based on mean scores, including, water for agriculture, preserving agricultural land and open space, and improving agricultural practices. Interestingly, on the other end of the spectrum, the issue receiving the lowest mean score (3.23) from CASNR students was *water for recreation*, while the lowest percentage of agreement (46.6%) amongst students was *interstate transfer/sale of water rights*, the same as the public.

Similar to the general public, the water professionals identified clean drinking water, groundwater, and rivers and streams as the top three water issues in Oklahoma (Table 5). However, unlike public respondents, water professionals identified water for aquatic habitat and municipal use as their fourth and fifth priorities. Also similar to the general public, the water professionals identified *water for household landscapes* as the least important item (2.78 mean score), and this topic had the lowest percentage of agreement (38.5%).

All three demographic groups prioritized *clean drinking water* and were all concerned with *clean rivers and lakes* as well. Overall, only one item fell below a mean of 3.0, which was *water for household landscapes* (receiving a 2.78 from the water professionals). All 27 Oklahoma water issues were of at least some importance to our participants. Other issues which were of less concern (although still receiving a mean score above a 3.0) were items related to within state and interstate transfer or sale of water rights, along with water for recreation, and water for household landscapes.

Drinking Water Issues

The majority of respondents across groups utilized public water supplies (i.e., municipal or rural water district) for their home drinking water. Although the majority of participants were satisfied with their home drinking water and felt it was safe to drink, substantially more CASNR students and water professionals shared this view than did the general public (Figure 1).

Further, very few (13.3-22.1%) respondents, regardless of group had tested their drinking water to confirm its quality. Despite the high level of satisfaction and trust in their drinking water, a large percentage of CASNR students and water professionals utilized a home water treatment system, while the general public, with lower percentages satisfied, was less likely to use one.

Protecting and Preserving Water Resources

Ten questions evaluated participants' perceptions related to *protecting and preserving water resources*. Just as the majority of public participants did not know what the groundwater quality was and either did not know or felt surface waters were normal (Table 6), most also did not know what if any pollutants (i.e., pathogens, fertilizer, heavy metals, minerals, pesticides, salinity, pharmaceuticals, petroleum products, algae, sediment, or turbidity) could potentially affect the surface or groundwater quality in their area.

Respondents across groups consistently identified groundwater quality as higher than

Table 2. Demographics of the general public, CASNR students, and water professionals participating in study.

Demographic		Public 2018 % (n)	Students % (n)	Professionals % (n)
Gender	Male	46.0 (184)	30.1 (31)	49.0 (51)
	Female	42.5 (170)	54.4 (56)	38.5 (40)
	No response	11.5 (46)	15.5 (16)	12.5 (13)
Years lived in Oklahoma	All my life	40.5 (162)	47.6 (49)	36.5 (38)
	>10 years	44.3 (177)	10.7 (11)	29.8 (31)
	5 - 9 years	3.0 (12)	1.9 (2)	13.5 (14)
	<5 years	1.5 (6)	27.2 (28)	9.6 (10)
	No response	10.7 (43)	12.7 (13)	10.6 (11)
Size of residence community	> 100,000	31.3 (125)	9.7 (10)	35.6 (37)
	25,000 - 100,000	20.3 (81)	38.8 (40)	30.8 (32)
	7,000 - 25,000	14.5 (58)	14.6 (15)	17.3 (18)
	3,500 - 7,000	9.5 (38)	8.7 (9)	3.8 (4)
	< 3,500	17.0 (68)	26.2 (27)	9.6 (10)
	No response	7.4 (30)	1.9 (2)	2.9 (3)
Education	Less than or some high school	3.8 (15)	-	-
	High school graduate	19.0 (76)	13.6 (14)	1.0 (1)
	Some college	34.8 (139)	74.0 (77)	8.7 (9)
	College graduate	24.0 (96)	-	32.7 (34)
	Advanced college degree	16.8 (67)	7.8 (8)	57.7 (60)
	No response	1.8 (7)	3.9 (4)	-
Age	18 - 34	5.0 (20)	87.4 (90)	16.4 (17)
	35 - 49	15.0 (60)	1.0 (1)	34.6 (36)
	50 - 64	29.5 (118)	-	29.8 (31)
	>65	38.8 (155)	-	6.7 (7)
	No response	11.7 (47)	11.6 (12)	12.5 (13)
Residence location	Inside city limits	63.2 (253)	52.4 (54)	73.1 (76)
	Outside city limits, not farming	25.0 (100)	15.5 (16)	14.4 (15)
	Outside city limits, farming	10.3 (41)	32.0 (33)	12.5 (13)
	No response	1.6 (6)	-	-

Note: n = 400 for 2018 public; n = 103 for students; n = 104 for water professionals.

surface water quality. Few (<16%) identified groundwater quality as poor/unacceptable; however, a quarter to a third of respondents identified surface water quality as poor-unacceptable. CASNR student opinions varied regarding the quality of surface and groundwater (Table 6), although most CASNR students surveyed did not know if pollutants were affecting the surface water or groundwater in their area. In contrast, the majority of water professionals felt both surface and groundwater to be normal to good, although over 60% of them identified pathogens, fertilizers, minerals, pesticides, algae, sediment, and turbidity to be a suspected or known problem affecting surface and/or groundwater. When asked about potential sources of pollution in rivers and lakes, there was no clear consensus across the three groups, with the highest percentages of respondents identifying oil/gas production (15.8%) and animal agriculture (11.5%) as potential sources.

A need for greater understanding of water quality, pollution sources, and other aspects of water resources was clearly shown through study results. In addition to the 45% of the public not knowing the quality of groundwater in their area, almost half of the public (47%) and students (44%) surveyed did not know what a watershed was, although 96% of the water professionals did.

When participants were asked if they regarded water quantity as a problem in the area where they lived, the majority of students and public surveyed either did not know or believed it not to be a problem. In contrast, over half of the water professionals surveyed considered water quantity was either probably or definitely an issue (Figure 2).

When participants were asked if they felt the incidence of prolonged drought was increasing or decreasing, 40.9% of respondents felt it was staying the same, while 32.5% identified an increase, 10.1% thought it was decreasing, and 16.5% had no opinion. As a potential solution to help drought-proof some regions of the state, the salty and petroleum contaminated water produced as part of the oil and gas extraction process, known as *produced water,* is being tested as a possible source of water for industry, agriculture, and other uses. Participants were asked if they would consider the use of produced water, assuming

Table 3. Water issue priorities for the general public in Oklahoma in 2018.

Issue	*M*	*SD*	% Agreement[a]
Clean drinking water	4.97	0.16	79.7
Clean rivers and lakes	4.75	0.49	78.2
Clean groundwater	4.70	0.59	75.9
Water for agriculture	4.51	0.685	74.6
Improving water quality monitoring to detect pollution	4.47	0.78	72.2

Note: 1 = Not Important; 2 = Somewhat Important; 3 = No Opinion; 4 = Important; 5 = Very Important.
[a] Items marked either a 4 or a 5.

Table 4. Water issue priorities for CASNR students in 2018.

Issue	*M*	*SD*	% Agreement[a]
Clean drinking water	4.90	0.30	100.0
Water for agriculture	4.75	0.48	98.1
Preserving agricultural land and open space	4.72	0.53	98.1
Improving agricultural practices	4.63	0.69	95.2
Clean rivers and lakes	4.44	0.79	93.2

Note: 1 = Not Important; 2 = Somewhat Important; 3 = No Opinion; 4 = Important; 5 = Very Important.
[a] Items marked either a 4 or a 5.

Table 5. Water issue priorities for Oklahoma water professionals in 2018.

Issue	*M*	*SD*	% Agreement[a]
Clean drinking water	4.94	0.23	100.0
Clean groundwater	4.83	0.41	99.0
Clean rivers and lakes	4.78	0.48	99.0
Water for aquatic habitat	4.58	0.62	95.2
Water for municipal use	4.58	0.50	100.0

Note: 1 = Not Important; 2 = Somewhat Important; 3 = No Opinion; 4 = Important; 5 = Very Important.
[a] Items marked either a 4 or a 5.

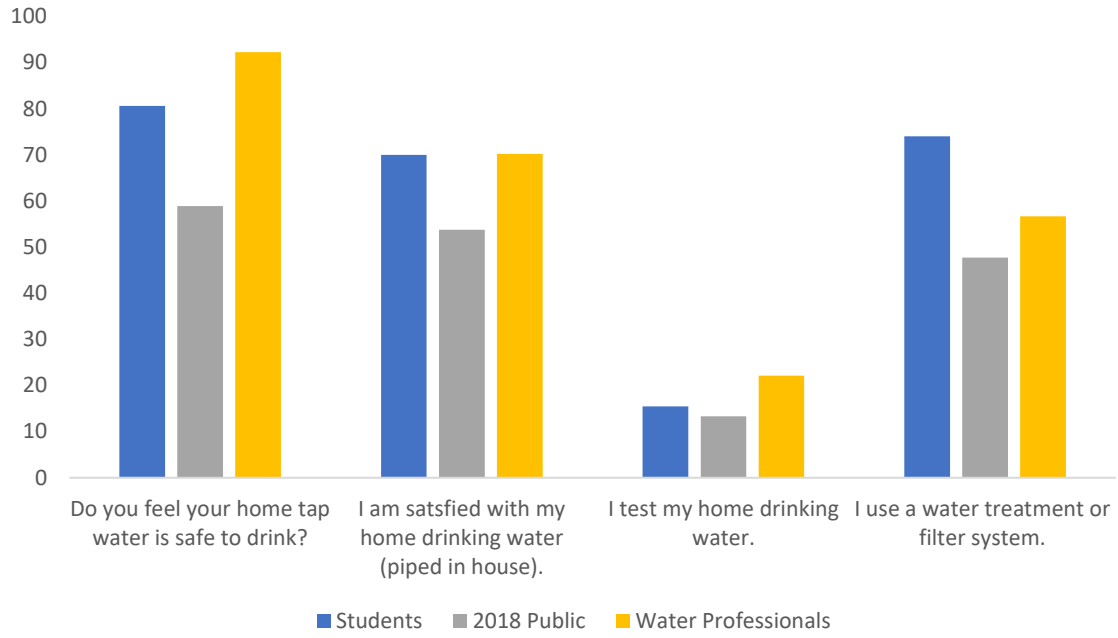

Figure 1. Comparison of perceptions related to drinking water.

Table 6. Perceived groundwater and surface water quality in Oklahoma in 2018.

Population	Condition	Groundwater % (n)	Surface water % (n)
Public	Excellent	4.7 (19)	1.2 (5)
	Good	17.0 (68)	16.0 (64)
	Normal	17.3 (69)	34.7 (139)
	Poor	12.8 (51)	21.3 (85)
	Unacceptable	3.2 (13)	3.8 (15)
	No opinion/don't know	45.0 (180)	23.0 (92)
Students	Excellent	5.8 (6)	1.0 (1)
	Good	29.1 (30)	18.4 (19)
	Normal	27.2 (28)	35.0 (36)
	Poor	9.7 (10)	27.2 (28)
	Unacceptable	1.0 (1)	4.9 (5)
	No opinion/don't know	27.2 (28)	13.6 (14)
Water Professionals	Excellent	9.6 (10)	2.9 (3)
	Good	40.4 (42)	31.7 (33)
	Normal	30.8 (32)	26.0 (27)
	Poor	5.8 (6)	30.8 (32)
	Unacceptable	0.0 (0)	2.9 (3)
	No opinion/don't know	13.5 (14)	5.8 (6)

Note: n = 377 for 2018 public; n = 103 for students; n = 104 for water professionals.

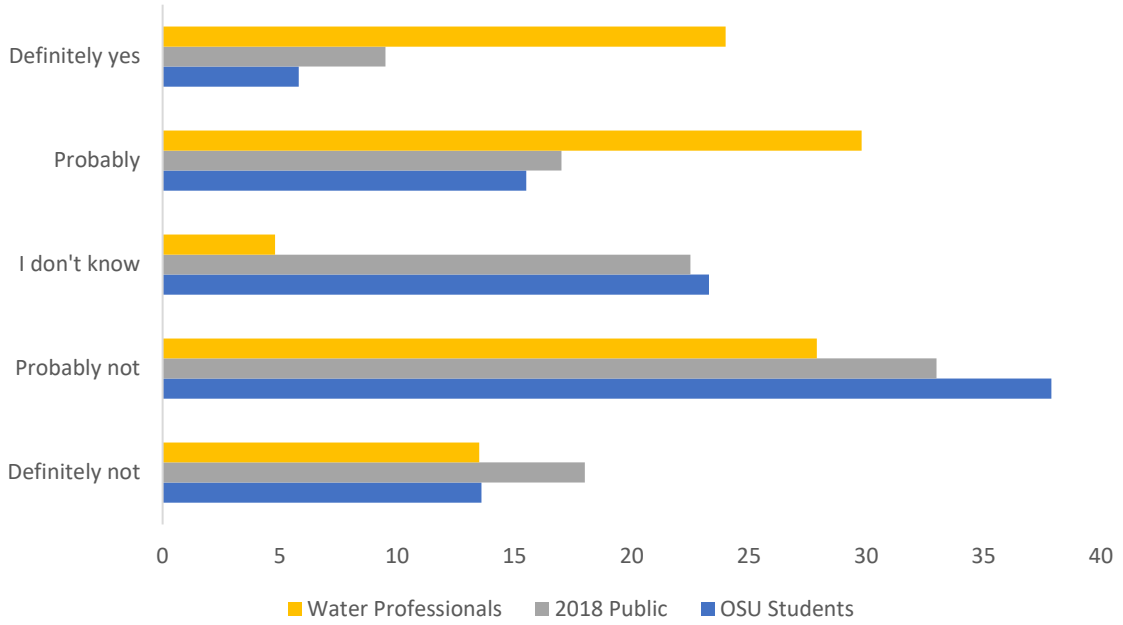

Figure 2. Responses from Oklahoma water professionals, the public, and students regarding whether they considered water quantity as a problem in the area where they lived.

treatment methods are deemed successful, as a potential water source for five uses – drinking water, food production, non-food crop production, environmental flows, and industrial processes (Figure 3). Respondents were generally supportive of reuse of produced water for industrial processes and non-food agricultural production; however, less than 25% of respondents were supportive of using produced water for drinking water.

Finally, participants from all three groups were asked about their efforts to conserve water and preserve its quality. Overall, 30% of respondents have implemented new technologies or changed how often they water their yard, and 20% have changed their use of pesticides, fertilizers, or other chemicals.

Learning Preferences

The overwhelming majority of participants, regardless of demographic group, have received water related resources from one or more sources. The most commonly reported sources of water related information were city/municipal water districts, television, and Universities/Extension across groups. Not only have participants received water related resources information, but 53% of those surveyed have changed their mind on a water issue based on news coverage (i.e., TV, newspaper, internet, etc.), while 48% have made a change based on financial considerations. Speeches by an elected official were much less impactful, resulting in less than 6% of respondents changing their mind on a water issue. Considering participation in learning opportunities about water issues, learning preference varied by population. The public, the majority of which was 50 years old and older, preferred learning via reading printed fact sheets or watching TV coverage. In comparison, students (18-34 year olds) preferred social media or informational videos, while water professionals (35-64 year olds) preferred visiting a website or attending a short course or workshop.

Discussion

Data collected from the Oklahoma public, CASNR students at OSU, and Oklahoma water professionals via this study provide insight into the perceptions, priorities, and learning preferences of these three populations. The vast majority of our public demographic was at least 50 years old, with nearly 40% of the public response coming from those over 65 years of age. This older demographic is of interest as they tend to be concerned with

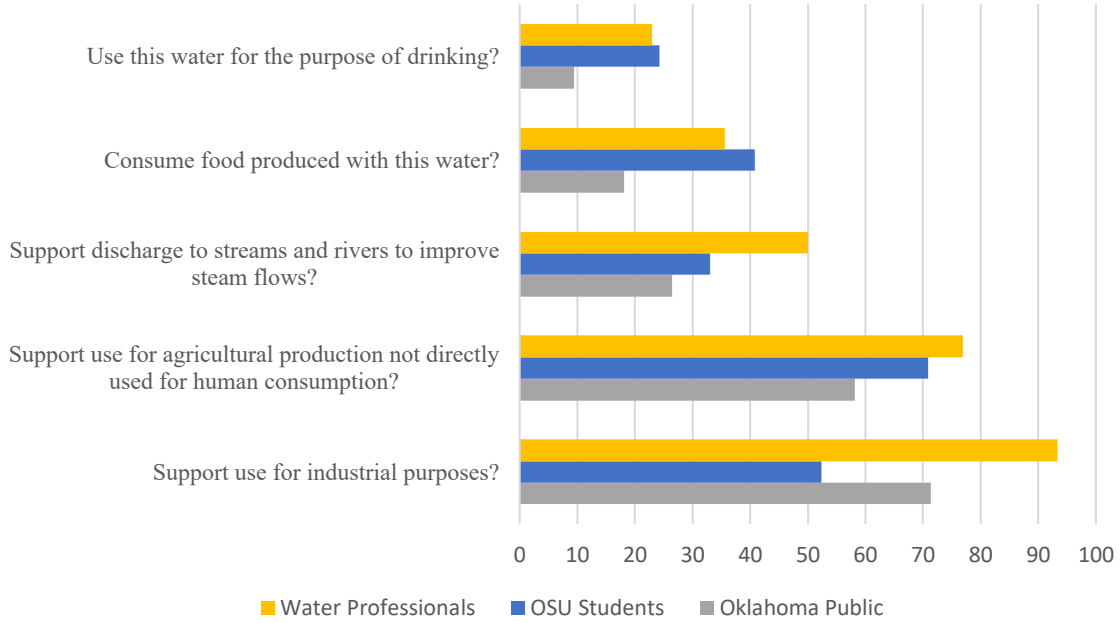

Figure 3. Opinions of treatment and reuse of produced water.

water conservation efforts and aim to conserve water themselves, although they spend more time in the home, leading to greater home water consumption according to Fielding et al. (2012). Likewise, proportionately higher representation of more formally educated, male, and urban residents was similar to that reported by Evans et al. (2015). The public in our study value clean drinking water, clean rivers and lakes, and clean groundwater, and feel their home drinking water is safe to drink. The OSU students surveyed agreed that their home drinking water was safe to drink, although over 70% of them utilized a home water filtration system for their drinking water. The students also agreed with the public on the number one priority being clean drinking water and felt clean rivers and lakes were of importance, although the remaining top five priorities for the OSU students were related to agricultural needs. The student's importance placed on water issues for agriculture is likely related to their being undergraduate students in the college of agriculture at OSU. Water professionals also ranked clean drinking water as the highest priority, followed by clean groundwater, and clean rivers and lakes, aligning with the public's opinion, although the professionals also prioritized water for aquatic habitats and water for municipal use. Outside of this study, clean drinking water has been identified as a key factor related to water perceptions (Mahler et al. 2004; Kopiyawattage and Lamm 2017). Similarly, Adams et al. (2013) found clean drinking water as more important than water for recreation and landscapes in their study of water users from nine southern states.

Ground and surface water quality was largely considered to be normal to excellent, except for the large percentages who did not know what the quality was (Table 6). The large percentages of respondents not knowing the quality of their water, potential pollution sources, or other basic water resources terminology (i.e., watershed definition), provide a strong indication that greater education and outreach regarding water issues is needed in Oklahoma. Not surprisingly, there was no clear consensus on pollution causes and sources possibly because these differ by watershed and region.

Water professionals commonly considered water quantity to be an issue, whereas the students and public considered it to be much less of an issue (Figure 2). This is surprising considering the extent of the drought in Oklahoma in 2011-2012. However, Oklahoma received average rainfall across the state for 2018 (Mesonet n.d.), potentially impacting the views of students and the public as

found by previous studies (Evans et al. 2015). Further, regional differences may have impacted results as well. Eastern Oklahoma generally receives adequate rainfall, whereas western Oklahoma is drought prone. Despite this, the state of Oklahoma and its legislature certainly see water quantity as an issue and have performed extensive water planning (OWRB 2012) to ensure sufficient supplies are available in the future, setting a goal of using no additional freshwater in 2060 than it did in 2010 (Oklahoma Water for 2060 Advisory Council 2015). Of the strategies being considered, reuse of various marginal quality waters is a high priority. In our study, all three demographics supported the reuse of produced water for non-food agricultural production and for industrial purposes, although the support for food production use was much lower from the public and students, while the water professionals were split on the issue.

The disparity of public opinion on interstate transfer/sale of water rights is particularly interesting. Recent court battles between Texas and Oklahoma and concerns regarding tribal water rights (O'Brien 2017) have placed this topic at the forefront with some supporting the sale of water to Texas to bolster state coffers, while others wish to protect state and tribal waters for future use and environmental flows. Despite court settlement of these matters, there is no consensus of public opinion.

Finally, demographics play a huge roll in preferred learning methods and information delivery methods as found in this study. Having demographics ranging from 18 to over 65 years of age provided a wide spectrum of preferences related to news outlets and information delivery. Understanding the target demographic is of key importance when developing water related outreach and information, as we found the younger demographic to prefer social media and informational videos, as opposed to the older demographics' preference for printed fact sheets and articles.

Conclusion

Our study clearly showed that clean water is a priority in Oklahoma, regardless of demographic. However, more education and outreach are needed, particularly in the areas of groundwater quality, pollution causes and sources, and water quantity. In order to effectively impact behaviors, education programs should be developed based on TPB and utilizing the survey's findings regarding perceptions, attitudes, and beliefs (Ajzen 1991) related to water resources. Furthermore, in order to effectively conduct these needed education and outreach programs, it will be important to understand target audiences and provide information using the methods preferred by each audience. Based on the findings of this study, accomplishing this goal will require the use of printed materials and television (for those over 50), along with social media and informational videos (for those under 34) to reach the broader public and better inform the attitudes and behaviors (Ajzen 1991) of individuals living in Oklahoma related to water issues in the state.

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