

# PRIORITY WATER USES FROM 1998 TO 2017 FOR URBAN, SUBURBAN AND RURAL RESIDENTS OF THE PACIFIC NORTHWEST, USA

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## ABSTRACT

Water is the most important and most debated natural resource in the Pacific Northwest. Researchers, educators and policy makers give a lot of attention to water resources in the region; however, the knowledge of actual water resource priorities of the public is lacking. Consequently, the purpose of this research study was to document how urban, suburban and rural residents living in the Pacific Northwest prioritize water resource issues over the last 20 years. A survey instrument was developed to ask the public about 10 common water uses in the region. This survey was statistically designed using the Dillman methodology and delivered to the public using a mail-based survey process in 1998, 2002, 2005, 2007, 2010, 2012, 2015 and 2017. Water uses in this study were the importance of water for: irrigated agriculture, aquatic habitat, commerce, drinking water, household landscapes, industry, power generation, recreation, snowpack and wetlands. Each water use could be categorized by survey respondents as very important, important, somewhat important, not important or no opinion. In 2017, drinking water, snowpack, wetlands, recreation, aquatic habitat, industry, commerce, power generation, household landscapes and irrigated agriculture were considered an important or very important use of water by over 95, 80, 79, 77, 76, 74, 64, 63, 52 and 47% of the public, respectively. Over time snowpack, recreation, wetlands and aquatic habitat protection have become more important to the public. Conversely, the importance of water for irrigated agriculture, power generation and commerce have become less important to the public. However, at least 45% of all respondents considered all ten questioned water uses important. Survey respondents were placed into three groups (urban, suburban or rural) based on the population of their home county. Rural residents considered the use of water for agriculture more important than both suburban (84 vs. 46%) and urban (84 vs. 35%) residents. Conversely, urban residents were more likely to consider the preservation of wetlands as very important, compared to suburban and rural residents. The demographic factors of gender, education and age also impacted how the public viewed the importance of different water-related issues. Females were more likely than males to consider most water uses important. Respondents with more formal education were more likely to consider snowpack and aquatic habitat important than those with less formal education. Younger respondents were more likely than older residents to consider wetlands and aquatic habitat important. The information from this study will be used to assist policy makers in their decision-making processes about water resource issues.

*Keywords: Public concerns, public opinion, water quality, water quantity, water issues.*

## 1 BACKGROUND

The four Pacific Northwest (PNW) states consisting of Alaska, Idaho, Oregon and Washington are a water-rich region of the USA. Much of the water in the region falls as mountain snow in the colder months of the year. The water is stored in this snowpack in the winter and when temperatures warm up in April, May and June it melts and flows down the regions rivers where it can be captured to support economic activity within the region. The snowpack, through rivers and indirectly through groundwater recharge, provides irrigation water for over 3,000,000 ha of agricultural land. In addition, over 60% of the USA's hydropower is produced from water flowing through the region's dams. The rivers support the transport of economic goods and provide numerous recreational activities for residents. Indirectly, the mountain snows provide drinking water, wetland habitat and a favorable aquatic habitat that

provides both good water quality and a sufficient quantity of water to meet the needs of the 13,000,000 people that reside in the region.

The public in the PNW are aware of the high quality and sufficient quantity of their water resource [1,2,3,4,5]. Studies have shown that a significant portion of public are interested in water and that they access water information on the Internet [6]. In addition to seeking out water information many individuals have made voluntary lifestyle changes to protect water quality [7,8,9]. Some of these changes include: (1) reducing the use of pesticides both in their homes and yards, (2) protecting fresh water wells by implementing best management practices to protect their wellheads, (3) reducing the disposal of hazardous products into sewers, and (4) reducing the amount of fertilizers on their lawns and in their gardens [7]. Many individuals have also voluntarily acted to help protect the quantity of water in the region. Some of these voluntary actions have included: (1) the installation of low flow devices on showers and toilets within homes, (2) conversion of landscape plantings to more drought resistant species, (3) the installation of drip irrigation systems in home landscapes, and (4) reduction in the amount of irrigation and the frequency of water used on lawns.

Scientists, educators and individuals involved in public policy are interested in how the public prioritizes the use of the region's water resources. The purpose of this project was to document the importance of the following different water uses by the general public in the PNW: (1) aquatic habitat protection, (2) commerce, (3) drinking water, (4) household landscape, (5) industry, (6) irrigated agriculture, (7) power generation, (8) recreation, (9) snowpack, and (10) wetland protection. Consequently, a survey process was developed to gauge these priorities using a survey process that could be repeated over a number of years. This survey project provides a history of water use priorities and allows planners to forecast water needs and preferences for the next decade.

## 2 METHODOLOGY

A survey instrument was developed to access public attitudes, priorities and concerns about water resource issues in the Pacific Northwest, USA. Within this survey instrument was a set of questions that asked recipients to rate the importance of ten different water issues within the region. The surveyed public was asked to rate each of the ten water issues as very important, important, somewhat important, not important, or not expressing an opinion. These ten water issues were: (1) agriculture, (2) protection of aquatic habitat, (3) commerce, (4) drinking water, (5) household landscape, (6) industry, (7) power generation, (8) recreation, (9) snowpack, and (10) protection of wetlands. In 2002, 2007, 2012 and 2017 these 10 survey questions were embedded into a 60-question surveys that were sent to over 2,500 residents of the region. The same 10 questions were embedded into smaller 30-question surveys that were sent to 1,200 residents in 1998, 2005, 2010 and 2015. Consequently, answers to each of the 10 survey questions were obtained in 1998, 2002, 2005, 2007, 2010, 2012, 2015 and 2017.

The survey target audience was a representative sample of the 9,500,000 adult residents of Idaho, Oregon and Washington that live within the four PNW states. In addition, demographic information, including state of residence, community size, length of time residing in the region, gender, age, and educational level were also collected. Community size data was translated into urban, suburban and rural based on the county of residence. Residents were considered urban if they resided in a county (borough in Alaska) with more than 100,000 people. They were considered suburban if they resided in a country with between 30,000 and 100,000 residents. Residents residing in counties with less than 30,000 people were considered rural. Based on census estimates in 2016 there were 28, 34 and 74 counties in the Pacific

Northwest classified as urban, suburban and rural, respectively. On a numerical basis in 2016 the urban, suburban and rural populations of the four Pacific Northwest states were 10,139,000, 2,038,000 and 886,000, respectively.

Each survey was developed using the Dillman methodology and was delivered to clientele via the United States Postal Service [10,11]. A sufficient number of completed surveys was the goal to result in a sampling error of 3 to 5% [11]. The survey process was also designed to receive a completed survey return rate more than 50%. Addresses were obtained from a professional social sciences survey company (SSI, Norwich, CT). Four mailings were planned to achieve the 50% return rate [10,11]. The mailing strategy used was identical in all eight surveys that had been conducted in the region since 1998 [1,2,3,4]. It only took three mailings to achieve the target return rate of 50% in 2002, 2005, 2007, 2012 and 2015. Conversely it took four mailing to achieve the 50% return rate in 1998, 2010, 2017.

Survey answers were coded and entered into Microsoft Excel. Missing data were excluded from the analysis. The data were analyzed at two levels using SAS [12]. The first level of analysis generated frequencies, while the second level evaluated the impacts of demographic factors. Significance ( $P < 0.05$ ) to demographic factors was tested using a chi-square distribution [10,11,12]. Since similar response rates were observed in all survey years, data analysis procedures were identical for each sampling.

Both differences between values within a survey year and between survey years are indicated with p values. Hence, statistics in the tables and discussion section are described with p values. SAS was used to determine statistical differences. Differences between survey years were analyzed based on a repeated measures experimental design. A p value of 0.05 indicates that compared values in a table have a 95% probability of being different; a p values of 0.01 indicates that the probability of differences increases to 99%. From a statistical standpoint, p values less than 0.05 mean numbers in a given table are statistically different. Conversely, p values greater than 0.05 indicate that compared numbers are not statistically different (NS).

### 3 RESULTS AND DISCUSSION

The survey methodology used in the study was not designed to be unique, but rather to be used as a tool to obtain useful information about the importance of ten water issues over a 20-year period. All eight surveys achieved a completed return rate greater than 50%. Fifty-one percent of the survey respondents were male. Over 77% of survey respondents lived in urban counties of more than 100,000 people. Another 15.5% lived in suburban counties of between 30,000 and 100,000 people, while only 6.7% lived in rural counties of less than 30,000 people. Using county populations of 30,000 and 100,000 as divisions between rural, suburban and urban counties – 84.6, 78.5, 60.6 and 52.6% of Washington, Oregon, Alaska and Idaho residents classified as urban, respectively. Conversely, 25.0, 12.2, 5.7 and 2.5% of Idaho, Alaska, Oregon and Washington residents were considered rural, respectively. Almost half of the survey respondents attended at least one year of college. The demographics of the survey respondents mirrored the 1990, 2000 and 2010 USA census data. Thus, the survey respondents were representative of the actual population living in the PNW.

#### 3.1 Importance of water issues

The importance of ten water uses in 2002 and 2017 in the Pacific Northwest are shown in Table 1. In 2002 drinking water (98.0%) and agriculture (82.4%) were considered important water uses by over 80% of the public in the region. Conversely, in 2017 drinking water (95.5%),

Table 1: Percentage of respondents considering water uses important (important + very important+ extremely important) in surveys conducted in 2002 and 2017 in the Pacific Northwest, USA.

| Water use           | 2002                  | 2017 | Significance |
|---------------------|-----------------------|------|--------------|
|                     | -----% important----- |      |              |
| Drinking water      | 98.0                  | 95.5 | NS           |
| Snowpack            | 77.4                  | 80.1 | NS           |
| Wetlands            | 68.1                  | 79.0 | .003         |
| Recreation          | 56.9                  | 77.5 | .0006        |
| Aquatic habitat     | 75.0                  | 76.8 | NS           |
| Industry            | 71.2                  | 74.6 | .04          |
| Commerce            | 65.2                  | 64.8 | NS           |
| Power generation    | 70.3                  | 63.4 | .02          |
| Household landscape | 38.4                  | 52.7 | .0001        |
| Agriculture         | 82.4                  | 47.8 | .0001        |

NS = not significant.

snowpack (80.1%), wetlands (79.0%), recreation (77.5%), aquatic habitat (76.8%) and industry (74.6%) were considered important water uses by over 74% of the surveyed public. The change in perception of the importance of the 10 identified uses was water-use specific over the 15-year study period. Changes in the importance of drinking water, snowpack, aquatic habitat and commerce were not observed. However, the public perceived that the importance of water use for wetlands ( $p=0.003$ ), recreation ( $p = 0.0006$ ), industry ( $p = 0.040$ ) and the household landscape ( $p = 0.0001$ ) increased during the 15-year study. The perceived public importance of water use in agriculture ( $p = 0.0001$ ) and power generation ( $p = 0.02$ ) significantly declined.

The demographic factors of gender, formal education level and age impacted how PNW residents responded to the importance of the 10 studied water issues. From a gender basis the water issues of drinking water, snowpack, recreation, power generation and agriculture are compared in Table 2. Gender did not impact how residents responded to the importance of drinking water and snowpack (Table 2). Males were more likely than females to consider water for recreation more important in both 2002 ( $p = 0.0001$ ) and 2017 ( $p = 0.0004$ ). Conversely, females were more likely than males to consider water for power generation more important in 2002 ( $p = 0.005$ ) and 2017 ( $p = 0.003$ ). In 2002 water responses to agriculture were not impacted by gender; however, by 2017 males were more likely to consider water important for agriculture ( $p = 0.006$ ).

The importance of water as affected by respondent educational level for the water factors of snowpack, aquatic habitat protection, recreation, power generation and agriculture are shown in Table 3. In general, residents with more formal education were more likely to consider water for snowpack, protection of aquatic habitat and power generation more important than residents with less formal education in both 2002 and 2017. Conversely, respondents with less formal education were more likely to consider the use of water for recreation as more important than people with more formal education in both 2002 and 2007. People with

Table 2: Impact of gender on the percentage of respondents considering water uses important (important + very important + extremely important) in surveys conducted in 2002 and 2017 in the PNW, USA.

| Water use        | Male            | Female | Sign. | Male            | Female | Sign. |
|------------------|-----------------|--------|-------|-----------------|--------|-------|
|                  | 2002            | 2002   |       | 2017            | 2017   |       |
|                  | --% important-- |        |       | --% important-- |        |       |
| Drinking water   | 98.1            | 97.8   | NS    | 94.3            | 95.6   | NS    |
| Snowpack         | 79.2            | 76.5   | .03   | 81.4            | 79.5   | NS    |
| Recreation       | 69.2            | 44.6   | .0001 | 85.3            | 68.7   | .0004 |
| Power generation | 63.2            | 77.4   | .005  | 56.8            | 70.0   | .003  |
| Agriculture      | 83.1            | 81.7   | NS    | 54.1            | 39.9   | .006  |

NS = not significant.

Table 3: Impact of the demographic factor of education on the percentage of respondents considering water uses important (important + very important + extremely important) in surveys conducted in 2002 and 2017 in the PNW, USA.

| Water use        | Year | <High                 | High   | Some    | College  | Sign. |  |
|------------------|------|-----------------------|--------|---------|----------|-------|--|
|                  |      | School                | School | College | Graduate |       |  |
|                  |      | -----% important----- |        |         |          |       |  |
|                  | 2002 |                       |        |         |          |       |  |
| Snowpack         |      | 70.2                  | 74.2   | 80.2    | 84.6     | .02   |  |
| Aquatic habitat  |      | 59.2                  | 73.4   | 79.2    | 88.2     | .01   |  |
| Recreation       |      | 68.3                  | 62.1   | 49.2    | 49.8     | .006  |  |
| Power generation |      | 63.6                  | 72.8   | 70.9    | 75.4     | .003  |  |
| Agriculture      |      | 69.2                  | 86.2   | 84.9    | 59.7     | .0001 |  |
|                  | 2017 |                       |        |         |          |       |  |
| Snowpack         |      | 74.1                  | 76.4   | 84.2    | 88.1     | .02   |  |
| Aquatic habitat  |      | 58.2                  | 74.2   | 80.1    | 86.8     | .007  |  |
| Recreation       |      | 79.2                  | 72.4   | 58.4    | 57.6     | .004  |  |
| Power generation |      | 55.4                  | 61.9   | 64.2    | 67.2     | .01   |  |
| Agriculture      |      | 46.2                  | 49.2   | 50.4    | 41.6     | .03   |  |

an intermediate education level (high school graduate or some college) were more likely to consider water use in agriculture as important than people with more or less formal education in both survey years. It is interesting to note that the water importance trends for all five water uses were similar in 2002 and 2017.

Age did not impact the importance of water for power generation (Table 4). Older residents were more likely to support water use in agriculture in both 2002 ( $p = 0.01$ ) and 2017 ( $p = 0.01$ ) than younger survey respondents. Conversely, younger residents were more likely to support protecting aquatic habitats ( $p = 0.0003$  in 2002;  $p = 0.004$  in 2017) and the use of water for recreation ( $p = 0.04$  in 2002;  $p = 0.03$  in 2017). In 2002, residents between 30- and 70-years old thought that snowpack was more important than older and younger residents, but by 2017 differences in opinion due to age disappeared.

### 3.2 Impact of community size on water issues

Previous studies have shown that community size has an impact on how individuals perceive water issues [1,3]. The community size from which a survey respondent comes can be described based on several factors including: (1) the individuals' mailing zip code, (2) the individuals' self-selection of rural, suburban or urban, and/or (3) the population of the individual's county of residence. In this study the individuals' county of residence was used to separate survey respondents into urban, suburban and rural populations. Using this data grouping techniques 75 of the 135 counties (boroughs in Alaska) were classified as rural; however, only 6.7% of the region's population lived in counties classified as rural. Over 15% of Pacific Northwest residents lived in the 34 counties classified as suburban, while 77.7% of the population lived in the 26 urban counties. The completed surveys based on this urban-suburban-rural classification used in this study mimicked the actual US census urban-suburban-rural breakdown percentages. The data from survey years 2002 through 2017 were pooled for this discussion.

Table 4: Impact of age on the percentage of respondents considering water uses important (important + very important + extremely important) in surveys conducted in 2002 and 2017 in the PNW, USA.

| Water use             | Year | <30  | 30-49 | 50-69 | >69  | Sign. |
|-----------------------|------|------|-------|-------|------|-------|
| -----% important----- |      |      |       |       |      |       |
| 2002                  |      |      |       |       |      |       |
| Snowpack              |      | 76.2 | 79.3  | 82.2  | 73.4 | .03   |
| Aquatic habitat       |      | 83.6 | 80.2  | 72.1  | 64.9 | .0003 |
| Recreation            |      | 61.3 | 62.6  | 56.2  | 48.2 | .04   |
| Power generation      |      | 69.2 | 71.3  | 71.2  | 68.9 | NS    |
| Agriculture           |      | 74.0 | 76.5  | 84.2  | 88.6 | .01   |
| 2017                  |      |      |       |       |      |       |
| Snowpack              |      | 82.1 | 80.6  | 79.4  | 79.6 | NS    |
| Aquatic habitat       |      | 83.8 | 79.1  | 75.2  | 65.2 | .004  |
| Recreation            |      | 84.4 | 80.0  | 74.1  | 70.2 | .03   |
| Power generation      |      | 62.8 | 64.6  | 64.0  | 63.2 | NS    |
| Agriculture           |      | 43.0 | 41.3  | 49.4  | 55.2 | .01   |

NS= not significant.

Pacific Northwest resident views of eight of the ten water issues evaluated were impacted by the urban-suburban-rural population demographic (USR split). The USR split did not impact public views on drinking water and commerce (Table 5). Rural residents were more likely to consider snowpack ( $p=0.005$ ) and agriculture ( $p=0.009$ ) water uses as more important than suburban and urban residents. Conversely, urban residents were more likely to consider aquatic habitat preservation ( $p=0.04$ ) and industry ( $p=0.04$ ) water uses as more important than suburban and rural residents. Suburban residents were more likely to consider protection of wetlands ( $p=0.02$ ) and household landscape ( $p=0.005$ ) water uses as more important than urban and rural residents. Finally, urban residents were less likely to consider recreation ( $p=0.01$ ) and power generation ( $p=0.0001$ ) water uses important than suburban and rural residents.

The data presented in Table 5 is logical when stereotypical views of residents living in urban, suburban and rural environments are considered. Rural residents are more tied to the land and often have occupations related to natural resources. Thus, rural people would be expected to consider agriculture, having a snowpack for irrigation and power generation high priorities. Conversely, urban residents are often more environmentally oriented and view aquatic habitat protection more favorably, while not having recreation and power generation as being issues they are very concerned about. Suburban residents have larger yards and gardens thus wanting water for their landscaping and to protect wetlands.

### 3.3 Impact of gender, education and age

Four water issues were selected for discussion for urban, suburban and rural PNW residents (Table 6). The impact of gender, education and age on the importance of the water issues of

Table 5: Influence of county population demographics\* on the percentage of respondents considering water uses important (important + very important + extremely important) in surveys conducted in 2002 and 2017 in the Pacific Northwest, USA.

| Water use           | Urban                 | Suburban | Rural | Sign. |
|---------------------|-----------------------|----------|-------|-------|
|                     | -----% important----- |          |       |       |
| Drinking water      | 97.2                  | 98.1     | 98.6  | NS    |
| Snowpack            | 71.4                  | 76.9     | 86.2  | .005  |
| Wetlands            | 70.0                  | 84.1     | 70.7  | .02   |
| Recreation          | 57.2                  | 77.2     | 78.1  | .01   |
| Aquatic habitat     | 84.4                  | 74.8     | 71.2  | .04   |
| Industry            | 79.4                  | 69.4     | 70.6  | .04   |
| Commerce            | 62.4                  | 67.4     | 64.6  | NS    |
| Power generation    | 47.6                  | 77.2     | 80.1  | .0001 |
| Household landscape | 42.1                  | 61.8     | 35.2  | .005  |
| Agriculture         | 48.6                  | 71.9     | 90.3  | .009  |

NS= not significant; \* = county populations for Idaho, Oregon and Washington, borough populations for Alaska;

Table 6: Urban, suburban and rural resident demographic views on the percentage of respondents considering as important ( important + very important + extremely important) based on pooled survey results from 2002 to 2017 in the PNW, USA.

| Community Size | Demographic      | Issue                  |                   |                 |                       |
|----------------|------------------|------------------------|-------------------|-----------------|-----------------------|
|                |                  | -----% important-----  |                   |                 |                       |
| Urban          |                  | <b>Aquatic Habitat</b> | <b>Industry</b>   | <b>Commerce</b> | <b>Drinking Water</b> |
|                | Gender           |                        |                   |                 |                       |
|                | Male             | 79.2                   | 80.4              | 65.2            | 96.8                  |
|                | Female           | 89.1                   | 79.0              | 59.5            | 97.6                  |
|                | Significance     | .006                   | NS                | .04             | NS                    |
|                | Education        |                        |                   |                 |                       |
|                | <High school     | 56.2                   | 74.7              | 58.1            | 95.2                  |
|                | HS diploma       | 83.6                   | 80.4              | 60.2            | 96.1                  |
|                | Some college     | 89.6                   | 84.1              | 66.2            | 97.9                  |
|                | College graduate | 90.4                   | 82.1              | 64.1            | 98.8                  |
|                | Significance     | .0005                  | .04               | .04             | .04                   |
|                | Age              |                        |                   |                 |                       |
|                | < 30             | 87.4                   | 72.1              | 61.8            | 97.3                  |
|                | 30 to 49         | 87.2                   | 80.8              | 63.9            | 96.8                  |
| 50 to 69       | 82.5             | 84.3                   | 64.2              | 98.0            |                       |
| >69            | 72.8             | 82.3                   | 62.3              | 96.0            |                       |
| Significance   | .02              | .03                    | NS                | NS              |                       |
| Suburban       |                  | <b>Wetlands</b>        | <b>Recreation</b> | <b>Industry</b> | <b>Home Landscape</b> |
|                | Gender           |                        |                   |                 |                       |
|                | Male             | 76.9                   | 83.6              | 69.0            | 62.1                  |
|                | Female           | 92.3                   | 70.2              | 96.7            | 61.5                  |
|                | Significance     | .0001                  | .0006             | NS              | NS                    |
|                | Education        |                        |                   |                 |                       |
|                | <High school     | 63.3                   | 81.4              | 61.7            | 51.3                  |
|                | HS diploma       | 75.2                   | 78.3              | 72.3            | 60.4                  |
|                | Some college     | 89.2                   | 77.8              | 74.4            | 66.8                  |
|                | College graduate | 91.6                   | 70.2              | 71.9            | 69.1                  |
| Significance   | .0001            | .03                    | .03               | .02             |                       |



|                     |                     | <b>Snowpack</b> | <b>Recreation</b> | <b>Power Generation</b> | <b>Agriculture</b> |
|---------------------|---------------------|-----------------|-------------------|-------------------------|--------------------|
| <b>Rural</b>        | Age                 |                 |                   |                         |                    |
|                     | < 30                | 90.4            | 79.5              | 60.2                    | 57.4               |
|                     | 30 to 49            | 88.6            | 87.4              | 74.8                    | 60.2               |
|                     | 50 to 69            | 69.6            | 89.4              | 79.2                    | 65.4               |
|                     | >69                 | 70.1            | 70.3              | 66.8                    | 64.2               |
|                     | <i>Significance</i> | .0001           | .03               | .04                     | .04                |
|                     | Gender              |                 |                   |                         |                    |
|                     | Male                | 87.2            | 85.4              | 75.2                    | 94.2               |
|                     | Female              | 85.8            | 71.4              | 84.6                    | 85.9               |
|                     | <i>Significance</i> | <i>NS</i>       | .02               | .003                    | .02                |
|                     | Education           |                 |                   |                         |                    |
|                     | <High school        | 84.2            | 84.6              | 70.2                    | 87.3               |
|                     | HS diploma          | 86.6            | 81.5              | 84.9                    | 93.8               |
|                     | Some college        | 86.4            | 73.1              | 83.4                    | 94.2               |
|                     | College graduate    | 86.2            | 74.3              | 81.2                    | 84.1               |
| <i>Significance</i> | <i>NS</i>           | .02             | .02               | .01                     |                    |
| Age                 |                     |                 |                   |                         |                    |
| < 30                | 85.2                | 68.5            | 79.3              | 82.3                    |                    |
| 30 to 49            | 84.9                | 85.2            | 82.3              | 87.4                    |                    |
| 50 to 69            | 87.6                | 83.2            | 78.2              | 94.2                    |                    |
| >69                 | 87.0                | 78.4            | 80.6              | 95.8                    |                    |
| <i>Significance</i> | <i>NS</i>           | .03             | <i>NS</i>         | .03                     |                    |

NS = not significant.

aquatic habitat protection, industry, commerce and drinking water for urban residents are shown in Table 6. Gender did not impact the views of industry and drinking water for urban residents; however, gender did affect views on aquatic habitat protection and drinking water. Female urban residents were more likely to want aquatic habitat protection, while males were more concerned with the importance of water in commerce. Education level impacted the responses to all four water issues. Residents without a high school diploma were less likely to consider the water issues of aquatic habitat protection, industry, commerce and drinking water important than urban residents with a higher level of formal education. Age impacted the importance of aquatic habitat protection and industry for urban residents. Urban residents younger than 50 years old were more likely to favor the protection of aquatic habitats. Urban residents younger than 30 years old were less likely to consider water for industry important compared to older urban residents.

The impact of gender, education and age on the importance of the water issues of wetland protection, recreation, industry and home landscape for suburban residents are shown in

Table 6. Gender affected responses to wetland protection and recreation, but not the industry and home landscape water uses. Males were more likely than females to consider the recreation use of water important. However, females were more likely to consider the protection of wetlands important. Formal education level and age affected the responses to wetlands, recreation, industry and home landscape of suburban residents. Suburban residents with a college education were more likely to consider wetland protection ( $p = 0.0001$ ) and home landscape ( $p = 0.02$ ) important uses of water than residents with less formal education. College graduates were less likely to consider the water use of recreation as important as less formally educated suburban residents ( $p = 0.03$ ). Residents aged 30 to 69 were most likely to consider water use for recreation as important.

Gender did not affect rural residents' view of the importance of snowpack. Males were more likely than females to consider water use for recreation ( $p = 0.02$ ) and agriculture ( $p = 0.02$ ) important. Conversely, females considered water use for power generation more important than males ( $p = 0.003$ ). Formal education level affected rural resident views of recreation, power generation and agriculture. Rural residents without a high school diploma were less likely to consider water use for power generation important ( $p = 0.02$ ), while rural residents with a college education were less likely to consider recreation an important use of water ( $p=0.02$ ). Age affected rural residents' views of recreation and agriculture. Rural residents older than 50 years old were more likely to consider agriculture an important water use ( $p = 0.03$ ). Rural residents between the ages of 30 and 69 were more likely to consider the recreational use of water important compared to younger and older residents ( $p = 0.03$ ).

### 3.4 Impact of county population on agriculture

The impact of community size on the importance of water to agriculture over the 20-year survey period is shown in Fig. 1. Five conclusions can be surmised from this figure. First, rural residents are most likely to consider water use as important in agriculture. Second, the use of water in agriculture as seen by urban residents is not as important compared to suburban and rural residents. Third, the trend for water importance by rural residents is upward – water is considered more important for agriculture in 2017 than in the 1998. Fourth, water use by agriculture has become less important for urban residents over time. Finally, suburban residents have an intermediate view of the importance of water use compared to rural and urban residents.

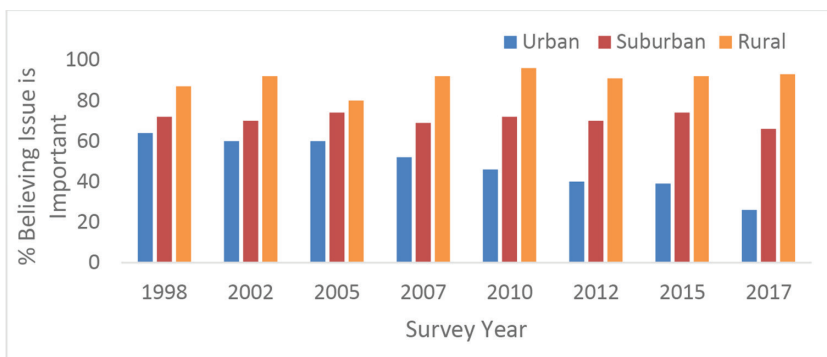


Figure 1: The importance of water for agriculture (irrigated agriculture) based on county population demographics (urban, suburban, rural) between 1998 and 2017 in the Pacific Northwest, USA.

#### 4 CONCLUSIONS AND RECOMMENDATIONS

The majority of PNW residents of have considered the ten evaluated uses of water as important over this 20-year survey project. Key findings of this study include:

- In 2017, drinking water, snowpack, wetlands, recreation, aquatic habitat, industry, commerce, power generation, household landscapes and agriculture were considered an important or very important use by over 95, 80, 79, 77, 76, 74, 64, 63, 52 and 47% of the public, respectively.
- Since 1998 the water uses of snowpack, recreation, protection of wetlands and aquatic habitat have become more important with the public, while water use for agriculture, power generation and commerce have become less important.
- The demographic factors of gender, education level and age often impacted public views on the specific importance of the 10 studied water issues.
- County population demographics had a significant impact of how important water issues were viewed as respondents in rural counties considered drinking water (98.6%), agriculture (90.3%), snowpack (86.2%), power generation (80.1%) and recreation (78.1%) the most important uses of water.
- Suburban county residents considered drinking water (98.1%), protection of wetlands (84.1%), recreation (77.2%), power generation (77.2%) and snowpack (76.9%) the most important uses of water.
- The public in urban counties prioritized drinking water (97.2%), protection of aquatic habitat (84.4%) and industry (79.4%) as important water uses.

This survey study enables research scientists, educators and people involved in public policy to understand the water issues the public prioritizes. These water-based public surveys will continue to be conducted over time to understand where water needs should be concentrated. The information from this study will be used to assist policy makers in their decision- making processes about water resource issues.

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