Rivers and river basin management issues and concerns in the Pacific Northwest, USA

R. L. Mahler[1] & M. E. Barber[2]
[1]*Soil Science Division, University of Idaho, USA*
[2]*Department of Civil and Environmental Engineering, University of Utah, USA*

Abstract

Over 90% of Pacific Northwest residents consider clean rivers and effective river basin management to be important issues in the Pacific Northwest. The large Columbia-Snake River Basin provides irrigation water to 5,000,000 ha, water for navigation, drinking water to more than 5,000,000 people and electricity (hydropower) to more than 8,000,000 people within Washington, Idaho, Oregon and British Columbia. The purpose of this paper is to document public perceptions, attitudes, and concerns about the Columbia-Snake River Basin. Two identical statistically designed regional surveys were conducted in 2011 and 2014. Approximately 98, 98, 90, 80, 80 and 54% of the survey respondents considered the Columbia-Snake System important for providing water for mountain snowpack, power generation, agriculture, recreation, drinking, and commerce, respectively. A majority of the public also rated quality and quantity aspects of the river system as good or excellent. A majority of residents in 2011 (52.0%) and 2014 (62.1%) felt that climate change should be addressed regardless of cost. The percentage of survey respondents that believed scientific merit of climate change to be good or overwhelming increased from 47.1% in 2011 to 71.1% in 2014. The loss of mountain snowpack was the most frequently cited critical issue associated with climate change in the Columbia-Snake River Basin.
Keywords: public concerns, public opinion, Columbia River Basin, water quality, water quantity.

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1 Introduction

The Columbia-Snake River Basin has a large economic impact in both Canada and the USA. This system is key to the economies of British Columbia, Washington, Idaho and Oregon as it supports agriculture (5,000,000 irrigated ha), commerce, power production, direct human water consumption, food processing and recreation. Previously conducted surveys of the public have shown than that people are concerned about both water quality and water quantity issues within this large river basin [1–3].

2 Background

Even though river basin planning and management has occurred in most regions of the world over the last 85 years, results have often been disappointing [4]. Results have often fallen short of goals because many approaches have failed to be adequately integrated [5]. At times the failures of sound and effective institutional arrangements have also reduced the effectiveness of such programs [6]. Many times programs sold as integrated have failed to be comprehensive. To be both comprehensive and interdisciplinary the plan framework must include economic, technical, environmental, social and legal aspects [7, 8]. The concept of river basin and river basin management has changed significantly over time [9]. For instance, international river basin treaties have largely focused on water use and water quantity issues; however, water quality aspects have become much more important in recent years [10].

More recently considerations about potential climate change and participatory management have become points of focus for river basin and management plans. Issues including the impact of changing climate on forests, range and other biomes is now an important planning consideration [11, 12]. Others suggest that because of projected climate change river basins significantly impacted by dams will require more intervention to protect people than in basins with free-flowing rivers [13].

The importance of social learning in water resource management and sustainability science is increasing [14]. Eight commonly reported themes important in social learning identified by researchers include: (1) role of stakeholder involvement, (2) politics and institutions, (3) opportunities for interaction, (4) representativeness, (5) framing and refining, (6) motivation and skills of leaders and facilitators, (7) openness and transparency, and (8) adequate resources [15, 16]. In addition to these themes computer decision support tools for participatory management are also important [17]. In addition to data analysis these support tools also enhance communication, forecasting, experimentation and training.

The three most important issues in the last decade in the Columbia-Snake River System include: (1) the impact of climate change on water management, (2) fish migration and management, and (3) trans-boundary water management. Several studies have suggested that climate change models indicate that the quantity of mountain snow and the timing of its melt will impact reservoir storage, shipping

commerce and water available for irrigated agriculture [11]. Both dams and the associated production of hydroelectricity have in the past and will continue to impact fish populations and fish migration in the river system. In addition transboundary water management issues are currently being renegotiated, as treaties need to be revised and signed between Canada and the USA in the next few years. These three issues along with other interests have kept the public in the region aware of the importance of water management in this river system [1–3, 18].

The purpose of this paper is to document public perceptions, attitudes, concerns and actions taken to protect river resources in the region. Public input has been sought on a regular basis (2002, 2007, 2012 and 2014) to identify major river issues. Statistically designed regional surveys were the instruments used to identify the river issues of most concern to the public. A map of the Columbia-Snake River System is shown in Figure 1.

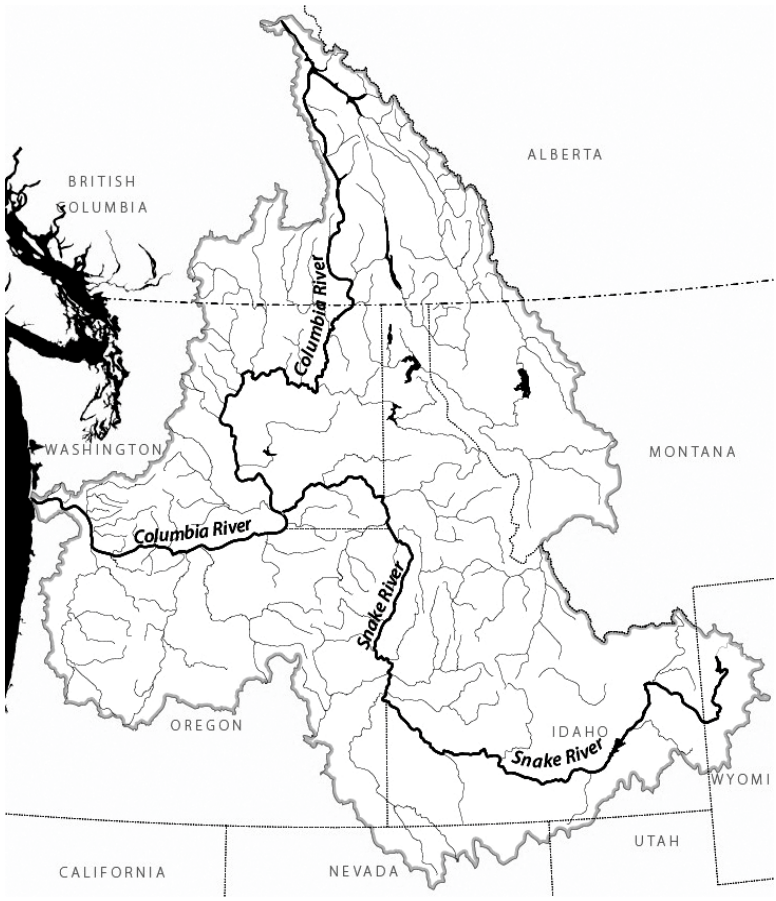

Figure 1: Map of the Columbia-Snake River Basin (courtesy of the Columbia River Inter-Tribal Fish Commission, Portland, OR, USA).

3 Methodology

A survey instrument containing 40 questions was developed to access public attitudes, priorities and concerns about water resource issues, river management and the potential impacts of climate change in the Pacific Northwest. The same survey was administered to the general public in 2011 and 2014 to evaluate changes over time because there was a perception that public attitudes about climate change have been rapidly changing. The survey questions discussed in this article deal with activities that the public associate with river basin management and the potential impacts of climate change. The survey target audience was a representative sample of the 8,000,000 adult residents of Idaho, Oregon and Washington that live within the Columbia-Snake River Basin or highly dependent on its waters. In addition, demographic information, including state of residence, community size, and length of time residing in the region, gender, age, and educational level were also collected from survey respondents.

In both 2011 and 2014 a target of 1,000 completed questionnaires was chosen as the survey goal to result in a sampling error of 4 to 6% [19]. The survey process was designed to receive a completed survey return rate in excess of 50%. Addresses were obtained from a professional social sciences survey company (SSI, Norwich, CT). Four mailings were planned to achieve the 50% return rate [20]. The mailing strategy used was identical to other water resource surveys that had been conducted in the region since 2002 [1–3].

Surveys were actually sent to 2,300 residents in both 2011 and 2014; however, because of address changes, deaths of people on the mailing list and delivery problems, the actual sample population was 2,116 in 2011 and 2,074 in 2014. The survey process was designed to receive a completed survey return rate in excess of 50%. If more than 943 surveys were returned completed, sampling error could be assumed to be less than 5% [19–21].

It only took three mailings were to achieve this target return rate of 50% in both 2011 and 2014. The first mailing included the water issues survey form, a business reply envelope, and a cover letter that: (1) identified the survey's authors; (2) explained the purpose of the survey; (3) assured the respondent of anonymity; and (4) asked the respondents to fill out and return the survey via the business reply envelope. The second mailing (four weeks later) consisted of a postcard that stressed the importance of the survey and remind the respondent to fill out and return the survey sent out in the first mailing. Five weeks later the third mailing was sent to residents who did not respond to the first or second mailing. This mailing included a reminder letter, another copy of the water issues survey, and a business reply envelope.

Survey answers were coded and entered into Microsoft Excel. Missing data were excluded from the analysis. The data were analysed at two levels using SAS [21]. 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 [19–21]. Similar response rates were observed for the 2011 and 2014 surveys and consequently data analyses procedures were identical in both years.

4 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 ascertain useful information. The survey methodology was designed to access public attitudes, priorities and concerns about water resource issues, river management and the potential impacts of climate change in the Pacific Northwest.

The 2011 River Basin Management Survey achieved a return rate of 51.1% (1,081 either fully or partially completed and returned out of 2,116). 52% of the survey respondents were male. Over 37% of survey respondents lived in communities of more than 100,000 people. Conversely, 17% of respondents lived in towns with less than 7,000 people. 89% of survey respondents were high school graduates.

A return rate of 53.3% (1,106 either fully or partially completed and returned out of 2,074) was achieved with the 2014 survey. Over 39% of survey respondents lived in communities of more than 100,000 people. Conversely, 18% of respondents lived in towns with less than 7,000 people. 53% of the survey respondents were male. 86% of survey respondents were high school graduates.

Overall, the demographics of the respondents for both surveys closely reflected the actual demographics of adults in the region. Consequently, when coupled with the low sampling error of the survey, respondents are often equated to residents in the following discussion.

4.1 Benefits of the Columbia-Snake system

A majority of surveyed residents felt that the Columbia-Snake River System provided many benefits (Table 1). When the results of the 2011 and 2014 surveys were combined and the responses of very important and important were added together it was apparent that the public places a high value on the river system. Approximately 98, 98, 90, 80, 80 and 54% of the survey respondents considered the Columbia-Snake System important for providing water for mountain snowpack, power generation, agriculture, recreation, drinking, and commerce, respectively (Table 1).

Table 1: The importance of the Columbia-Snake River System in providing the following benefits to residents of the region based on the 2011 and 2014 basin surveys. Note that the results from both surveys are combined.

Benefit provided	Very Important	Important	Not Important	No Opinion
	%			
Mountain snowpack	95	3	0	1
Power generation	84	14	2	2
Agriculture	60	30	7	3
Recreation	51	29	16	4
Drinking	20	60	8	12
Commerce	10	44	40	6

The public also had favorable views on the quality and quantity aspects of the Columbia-Snake River System (Tables 2 and 3). When the good and excellent water quality responses were added together over 55% of respondents in 2011 and 57% of the 2014 respondents viewed the quality of waters in the river system favorably (Table 2). Conversely, only about 10% of the public in both 2011 and 2014 considered water quality poor.

Table 2: Public views about the quality of surface waters (rivers) in the Columbia-Snake River System based on the 2011 and 2014 basin surveys.

Quality of surface waters	2011 survey	2014 survey
	---------- % ----------	
Excellent	31.4	28.7
Good	23.9	29.2
Fair	19.7	17.2
Poor	10.3	9.6
No opinion	14.7	15.3

Table 3: Public views about the sufficiency (quantity) of surface waters (rivers) in the Columbia-Snake River System to meet regional needs based on the 2011 and 2014 basin surveys.

Quantity of surface waters	2011 survey	2014 survey
	---------- % ----------	
More than adequate	52.6	55.4
Adequate	16.3	13.5
Somewhat less than adequate	12.5	13.4
Much less than adequate	4.8	4.6
No opinion	14.8	13.1

The majority of the public felt that the river system provided enough water to meet quantity needs in the region (Table 3). Over 68% of the public in both surveys felt that water quantity was adequate or more than adequate for human needs. Conversely, less than 5% of respondents in both surveys considered water quantity supplies to be much less than adequate.

4.2 Most important benefit

Even though the public identified many benefits provided by the Columbia-Snake River System, when asked to identify the most important benefit there was a strong consensus. Over 60% of the public in both 2011 and 2014 identified power production as the most important benefit provided by this river system (Table 4). Following power production, recreation, drinking water and food production were each cited by approximately 10% of the survey respondents.

Table 4: Public perception of the most important benefit of the Columbia-Snake River System based on the 2011 and 2014 basin surveys.

Most important benefit	2011 survey	2014 survey
	---------- % ----------	
Power production	60.6	63.0
Recreation	14.2	13.5
Drinking water	10.5	9.3
Food production (agriculture)	10.0	8.3
Transportation/commerce	2.2	3.0
Fisheries	2.0	2.1
Other	1.1	0.8

4.3 Impact of Climate Change

Climate change has become an important topic in basin management studies. Pacific Northwest residents consider this issue important. In fact a majority of residents in 2011 (52.0%) and 2014 (62.1%) felt that climate change should be addressed regardless of cost (Table 5). In addition another 14.8% (2011) and 13.4% (2014) of residents thought that climate change should be addressed if the financial cost is not too great. It should be noted that the importance of this issue increased significantly between 2011 and 2014. Both gender (Table 6) and education level (Table 7) impacted how the public viewed climate change.

Table 5: The importance of climate change as an issue based on the 2011 and 2014 Basin surveys.

Importance of climate change	2011 survey	2014 survey
	---------- % ----------	
Important, should address	52.0	62.1
Important, should address if economical	14.8	13.4
Don't know	20.3	14.3
Not important, should not address	12.9	10.2

Table 6: The impact of gender on respondents indicating that climate change is an important issue that must be addressed based on the 2011 and 2014 Basin surveys.

Gender	2011 survey	2014 survey
	---------- % ----------	
Male	43.5	46.5
Female	61.5	74.8
All combined	52.0	61.4

Table 7: The impact of formal education level on respondents indicating that climate change is an important issue that must be addressed based on the 2011 and 2014 basin surveys.

Formal education level	2011 survey	2014 survey
	%	
Less than high school diploma	36.6	37.2
High school diploma	40.9	46.6
Some college	52.7	61.8
College BA or BS	57.7	66.0
Advance college degree	63.9	78.5

Females were more likely to cite climate change as an important issue that should be addressed than males (Table 7). In fact this difference due to gender actually increased with time (2011 vs. 2014). Education level also impacted the importance of addressing climate change. Increasing levels of formal education increased the desire to address climate change as an important issue in both survey years (Table 7).

The percentage of survey respondents that believed in the scientific merit of predicting climate change is good or overwhelming increased from 47.1% in 2011 to 71.1% in 2014 (Table 8). This data indicates that climate change became more accepted by people in the region over time. Conversely, less than 10% of survey respondents believe that the scientific evidence behind climate change is not compelling.

Table 8: Public attitudes toward the merit of scientific arguments that predict climate change based on the 2011 and 2014 basin surveys.

How compelling is the science?	2011 survey	2014 survey
	%	
Overwhelming	15.3	20.4
Good	31.8	50.7
Don't know	14.3	10.3
Scientific community is in disarray	29.0	12.6
The science is not compelling	9.6	6.0

Residents identified many things that would be negatively impacted by climate change (Table 9). Based on the 2014 survey 59.4, 39.2, 36.1, 35.9 and 32.5% of residents felt that the loss of mountain snowpack, reduced water for hydropower, reduced levels of groundwater, reduced river flows and loss of soil moisture for agriculture were important issues associated with climate change, respectively (Table 9).

Table 9: The issues cited by residents that would be impacted by climate change in the Pacific Northwest based on the 2011 and 2014 basin surveys.

Issue of concern	2011 survey	2014 survey
	---------- % Citing----------	
Loss of mountain snowpack	51.4	59.4
Reduced water for hydropower	26.5	39.2
Reduced levels of groundwater	32.8	36.1
Reduced river flows	21.4	35.9
Loss of soil moisture for agriculture	33.0	32.5
Sea level rise	27.0	29.4
Decline in forests (warm/dry summers)	26.0	28.3
Reduced fish stocks	15.6	18.4
Reduced water in private wells	14.7	15.6
Increased winter flooding	9.0	11.4
Reduced water for economic development	10.1	8.6
Reduced recreational activities	3.3	6.9

When residents were restricted to citing only one impact of climate change the loss of mountain snowpack was cited most often (Table 10). Over 25% of survey respondents in 2011 and 2014 cited loss of mountain snowpack as the most critical issue. Sea level rise, reduced levels of groundwater and reduced water for hydropower production were cited as the issue of most concern by between 9.7 and 16.8% of survey respondents.

Table 10: The issue of most concern cited by residents that would be impacted by climate change in the Pacific Northwest based on the 2011 and 2014 basin surveys.

Issue of most concern	2011 survey	2014 survey
	---------- % Citing----------	
Loss of mountain snowpack	25.3	28.3
Sea level rise	12.5	16.8
Reduced levels of groundwater	14.1	12.6
Reduced water for hydropower	9.7	12.4
Loss of soil moisture for agriculture	9.4	7.2
Reduced river flows	4.9	6.0
Decline in forests (warm/dry summers)	6.0	4.8
Reduced water in private wells	5.0	3.8
Increased winter flooding	3.0	3.4
Reduced fish stocks	3.3	3.0
Reduced water for economic development	5.1	1.0
Reduced recreational activities	1.0	0.6
Other	0.7	0.2

Homeowner concerns about climate change increased between 2011 and 2014. Homeowners were most concerned about the prospects of increasing power rates (hydropower more expensive), the increasing frequency of summer droughts, and more winter and spring flooding in urban areas. It is noteworthy that the urban public has been thinking about how climate change could impact their lives from a homeowner viewpoint.

5 Conclusions and recommendations

Residents of Idaho, Oregon and Washington appreciate the benefits provided by the Columbia-Snake River Basin in the Pacific Northwest. These benefits have both direct and indirect positive impacts on all residents of this region. The public has positive views on both the quality and quantity of water in the river system. Residents understand that climate change is an issue that can have many multiple negative impacts on both people and on ecosystems in the region. Key findings of this study include:

- Approximately 98, 98, 90, 80, 80 and 54% of the survey respondents considered the Columbia-Snake System important for providing water for mountain snowpack, power generation, agriculture, recreation, drinking, and commerce, respectively.
- Over 55% of respondents in 2011 and 57% of the 2014 respondents viewed the quality of waters in the river system favorably.
- Over 68% of the public in both surveys felt that water quantity was adequate or more than adequate for human needs.
- Over 60% of the public in both 2011 and 2014 identified power production as the most important benefit provided by this river system.
- A majority of residents in 2011 (52.0%) and 2014 (62.1%) felt that climate change should be addressed regardless of cost.
- The percentage of survey respondents that believed the scientific merit predicting climate change is good or overwhelming increased from 47.1% in 2011 to 71.1% in 2014.
- Approximately 59, 39, 36, 36 and 33% of residents felt that the loss of mountain snowpack, reduced water for hydropower, reduced levels of groundwater, reduced river flows and loss of soil moisture for agriculture were important issues associated with climate change, respectively.
- The loss of mountain snowpack was the most frequently cited critical issue associated with climate change in the Columbia-Snake River Basin.
- Homeowners were most concerned about the prospects of increasing power rates (hydropower more expensive), the increasing frequency of summer droughts, and more winter and spring flooding in urban areas.

This survey study will be again conducted in 2017 to continue the evaluation of public attitudes and beliefs over time about the usefulness and management of the Columbia-Snake River Basin in the Pacific Northwest.

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