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Water Issues in Hawai'i: Public Attitudes in 2004 and 2010

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Water issues are critical everywhere, but they often are more critical for islands, where fresh water sources may be limited. It is important to have an understanding of drinking water issues from the consumer perspective. In this report, readers will learn about Hawai'i residents' awareness of, attitudes about, and actions taken concerning water quality. "Water quality" is a measure of the suitability of water for a particular use, such as drinking, recreation, agricultural irrigation, or protection and maintenance of aquatic life.

In 2004, the University of Hawai'i conducted a similar assessment for the purpose of understanding public awareness, attitudes, and actions about water resource issues and to provide baseline data for future needs (Castro 2005). This 2010 follow-up survey expanded upon the original drinking water issues raised by Hawai'i residents in the previous survey. This report may help members of public service agencies to determine potential audiences and their educational needs and to better plan for the future of their public service programs.

Summary

Drinking water, as an issue, has almost universal support among Hawai'i residents. The results of a survey conducted in 2010 found that almost all respondents (99%) believe that clean drinking water is extremely or very important. Based on this 2010 survey, over 72 percent of residents were satisfied with their drinking water; however, at least 14 percent indicated significant dissatisfaction. Over 85 percent of surveyed residents thought that their home drinking water was safe to drink.

Hawai'i residents were more confident in 2010 about water quantity than in 2004, when a similar survey was conducted. More than half of the respondents believed there was enough water in the area where they lived, less than a third considered water quantity to be a problem, and 12 percent of respondents were unsure.

Less than half of the respondents (47%) believed the environment was receiving enough emphasis from the Hawai'i state government, 23 percent believed state government was not doing enough, and 30 percent were unsure.

The majority of respondents indicated that they presently conserve water by engaging in behaviors that might improve the environment.

Introduction

Drinking water and human health is one of seven priority extension programming areas of the National Integrated Water Quality Program, funded by the United States Department of Agriculture–National Institute of Food and Agriculture (USDA-NIFA). In fact, water resources faculty at land grant institutions are currently developing a set of modules for the online eXtension resource that will provide significant drinking water outreach to the American public. Consequently, it is important for extension professionals to have an understanding of drinking water issues from the consumer perspective. The Hawai'i Regional Water Quality Program (RWQP), in conjunction with the USDA-NIFA Southwest States and Pacific Islands Regional Water Quality Program, conducted a survey of water issues in Hawai'i in 2010.

The purpose of this research was to help the Hawai'i RWQP with their understanding of the public's awareness of, attitudes about, and actions taken concerning water quality in order to build effective educational programs.

This survey was designed, in part, to measure change in responses to questions included in the original 2004 Hawai'i survey and to address additional issues. The survey questions were divided into three main categories: (1) how the participant felt about the environment, (2) what the participant thought about various drinking water issues, and (3) the participant's perceptions about protecting and preserving water resources. In addition, the following demographic information was collected from survey respondents: age, gender, community size, community type, formal education level, island of residence, and length of time lived in Hawai'i.

Research objectives

The primary objectives of the research were to measure attitudes and perceptions among the general public about water issues, to benchmark water conservation behavior, and to evaluate the potential effectiveness of communicating about water issues using different media. A secondary objective was to measure change in responses to questions included in the original 2004 Hawai'i survey.

Research method

Survey

A 57-question survey was designed in 2009, based on a model developed in the Pacific Northwest in 2002, to assess public attitudes about water issues in Hawai'i and to compare results from a similar survey conducted in 2004. Based on Agricultural Experiment Station statistical advice, a target of 480 residents of Hawai'i was set as the sample size so that the sample had statistical reliability at the 95-percent confidence level. Random residential addresses were obtained from a professional social sciences survey company (SSI, Norwich, CT).

In 2010, the survey was sent to 525 Hawai'i residents; however, 45 were returned by the post office as being undeliverable. Consequently, the actual sample population was the target of 480. The survey process was designed to have a completed survey return rate in excess of 50 percent. If more than 240 surveys were returned completed, sampling error could be assumed to be less than 5 percent (Dillman 2000, Salant and Dillman 1994).

Three mailings over a period of two months were used to achieve this return rate (Mahler et al. 2004).

Analysis

Survey answers were coded and entered into a Microsoft Excel spreadsheet. Missing data were excluded from the analysis. The data were analyzed at two levels using SAS (SAS 2004). 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 (Babbie 1983).

Where appropriate, answers to identical survey questions in the 2004 and 2010 surveys were compared. In these comparisons, answers that varied by four percent or less were considered statistically similar.

Bias

The survey estimates are subject to sampling errors and probably other systematic errors and biases. For example, non-respondents may have been generally less concerned about the environment, and this may have introduced a bias into the results.

Survey demographics

The water issues survey achieved a return rate of 54 percent (258 completed and returned out of 480 surveys), significantly more than the average. Seventy percent of the survey respondents were male. Forty percent lived in communities of more than 100,000 people, while 14 percent lived in towns of less than 7,000 people. Almost half of respondents had lived in Hawai'i all of their lives, and 39 percent had lived in Hawai'i for at least 10 years. Generally, the percentages of respondents falling into an age category increased with increasing age; nearly 60 percent were over age 60, while a third were over 70. Almost all (96%) of survey respondents were high school graduates or greater, with half claiming at least one college degree. Most (69%) of surveys were completed by O'ahu residents, followed by Hawai'i island (15%), Maui (11%), Kaua'i (4%), and Moloka'i (1%).

Demographic responses, not including gender and age, were consistent with U.S. Census data from 2000 (US-DOC 2002). Because of this, when considered with the low sampling error, respondents to this survey should be considered reflective of the residents of Hawai'i. It should be noted that approximately half of the surveys

were addressed to female residents, but males responded at a much higher rate. This same observation has been made in the other 41 states where similar surveys have been conducted (Brauer, submitted).

Summaries of responses to survey questions

Clean water and other environmental issues

Survey respondents rated the importance of 14 water issues (Table 1). They were asked to rate each water issue as “not important,” “somewhat important,” “important,” or “very important,” with the option of having “no opinion.” When the “important” and “very important” responses were combined, 99 percent of respondents indicated clean drinking water was the most important among the 14 issues included. Over 90 percent considered clean drinking water, clean beaches, clean groundwater, clean rivers and streams, clean marine waters, and clean bays and estuaries as water issues having high priority. The survey findings are in line with the national trend placing attitudes toward threats to water safety and quality over other environmental issues (Jones 2010). In a 2010 Gallup poll on environmental issues, the top four concerns all dealt with water, with Americans worrying most about drinking-water pollution (Jones 2010).

Over two thirds of Hawai'i residents in 2010 indicated that water for agriculture, tourism, aquatic habitat, municipal use, recreation, and commerce were high-priority items. Eighty-six percent of the respondents indicated that having enough water for agriculture was a high priority. Slightly less than 60 percent of the people who completed the survey considered water for household landscapes a high-priority issue.

Survey response data for identically worded questions from 2010 were compared to those obtained in 2004 (Table 2). The highest-priority issue, clean drinking water, had actually risen by one percent. Using the value of 4 percent as a statistically significant level of change between the 2004 and 2010 surveys, water for commerce and industry and water for recreation had become more important to the public in the state. Conversely, groundwater and water for aquatic organisms had become less important in the six years since the previous survey was conducted.

Added to the water-attitude portion of the 2010 survey were 13 new questions in which respondents were asked to rank the importance of protecting various water resources (Table 3). When the “important” and “very important” responses were combined, a majority

Table 1. How important is each of the following water issues to you? (% of responses ranked “important” or “very important”).

Water issue	Important/ very important
Clean drinking water	99
Clean beaches	97
Clean groundwater	95
Clean rivers and streams	94
Clean marine water	93
Clean bays and estuaries	93
Clean water for near-shore fishing	90
Water for agriculture	86
Water for tourism	83
Water for aquatic habitat	82
Water for municipal use	78
Water for recreation	76
Water for commerce/industry/power generation	75
Water for household landscapes	59

Table 2. The percentage of Hawai'i respondents rating specific water resource issues as important or very important in regional surveys conducted in 2004 and 2010 (% of responses).

Parameter	2004	2010	Change
Clean drinking water	98	99	+1
Clean groundwater	97	95	-2
Water for agriculture	83	86	+3
Water for aquatic organisms	83	82	-1
Water for commerce/industry	66	75	+9
Water for recreation	56	76	+20

of respondents in 2010 considered building new water storage structures (dams, reservoirs) as having high priority (91%). Over 80 percent of respondents considered the following water issues as important or very important: improving wastewater treatment, residential water conservation, preserving agricultural land and open space,

Table 3. How important are the following actions in protecting our water resources? (% of responses that ranked the issue “important” or “very important”).

Issue	Important or very important
Building new water storage structures (dams, reservoirs)	91
Improving wastewater treatment	88
Residential water conservation	86
Preserving agricultural land and open space	82
Better management of recreational activities	81
Preserving and restoring buffer zones and wetlands	80
Better management of shoreline access to prevent erosion	80
Treating stormwater runoff	78
Educating county (municipal) officials	76
Improving water quality monitoring to detect pollution	71
Improving agricultural practices	71
Making water quality and quantity data available to public	70
Improving home and garden practices	67

Table 4. The effect of island of residence on perceived importance of building new water storage structures (% of responses).*

Island	Not important	Somewhat	No opinion	Important	Very important
O'ahu	2	6	24	34	34
Hawai'i	0	11	30	32	27
Maui	0	0	0	38	62
Kaua'i	0	13	25	62	0
Moloka'i	0	33	33	33	0

*Note: In this and following tables where percentages of total responses are given, values may not add up to 100 due to rounding.

better management of recreational activities, preserving and restoring buffer zones and wetlands, and better management of shoreline access to prevent erosion.

The demographic factors of community size, age, gender, education level, and length of residence in the state did not influence answers to most of the water issues; however, island residence did significantly affect one issue (Table 4). Based on the survey reported here, 100 percent of Maui respondents felt building new water storage structures was a high priority, as did a majority of respondents on O'ahu, Kaua'i, and Hawai'i island,

while Moloka'i respondents felt the issue was of less importance. On Maui, Mayor Alan Arakawa has targeted \$44 million for water infrastructure projects in his 2012 budget proposal, including flume rehabilitation, distribution line improvements, and water source development, according to a MauiNews article that appeared in April 2011 (Loomis 2011).

Drinking water

Seven survey questions about drinking water were used to evaluate the following:

- (1) primary source of drinking water
- (2) use of in-home water treatment devices
- (3) perception of home drinking water safety
- (4) perception of home drinking water satisfaction
- (5) common problems with home drinking water
- (6) use and perceptions of bottled water
- (7) frequency of home drinking water testing.

Eighty-four percent of survey respondents identified public water sources (county, city, or municipal) as their primary drinking water source. Another 12 percent indicated that bottled water was their primary source of drinking water. Only 2.4 percent of respondents used private supplies (catchment, ponds, streams), while three respondents did not know their source of drinking water.

The demographic factor of island of residence did have an impact on the primary source of drinking water in Hawai'i (Table 5). While most of the respondents on all islands rely on public water supplies for drinking water, some island-to-island differences are apparent. First, on the two least populated of the islands evaluated, Kaua'i and Moloka'i, 100 percent of the respondents rely on public supplies as drinking water sources. Second, private water supplies provided drinking water only on the island of Hawai'i, and then for only 14 percent of the respondents to this survey. The large rural population on this island with individual rainwater catchment systems, wells, and ponds on private property accounts for this. Third, bottled water is popular, or considered a necessity, on some parts of the three most populated islands, O'ahu, Hawai'i, and Maui. Maui residents are almost twice as likely to use bottled water as are residents of the other two most highly populated islands.

Drinking water safety and satisfaction

Over 85 percent of surveyed respondents thought that their home drinking water is safe to drink. Island of residence affected respondents' perception of safe drinking water (Table 6). Survey respondents of the more populated islands of Maui, Hawai'i and O'ahu were more likely to think their drinking water was not safe to drink than the smaller, less populated islands of Moloka'i and Kaua'i. This observation explains the relatively high use of bottled water on certain islands. In fact, Maui, with the highest use of bottled water (20%), has the lowest percentage of people that think that their home drinking water is safe (68%).

Based on this 2010 survey, over 72 percent of survey respondents are satisfied with their drinking water

Table 5. The impact of island of residence on primary drinking water source (% of responses).

Island	Drinking water source			
	Public	Bottled	Private	Don't know
O'ahu	88	12	0.5	2
Hawai'i	75	11	14	0
Maui	80	20	0	0
Kaua'i	100	0	0	0
Moloka'i	100	0	0	0

Table 6. The effect of island of residence on identifying home drinking water as safe (% of responses).

Island	Drinking water is safe
O'ahu	88
Hawai'i	82
Maui	68
Kaua'i	100
Moloka'i	100

Table 7. The effect of respondent age on the use of an in-home water filter to improve the quality of drinking water (% of responses).

Age	Using home water filter
Less than 30	34
30-39	50
40-49	59
50-59	47
60-69	41
70 or older	27%

quality; however, at least 14 percent indicate significant dissatisfaction. Even though almost three quarters of respondents were satisfied with the quality of their home drinking water, almost 40 percent have a home water filter (primarily on their kitchen sink), up by 12 percent since 2004. Another 7 percent of respondents have a separate home water treatment system. The de-

Table 8. In your opinion, how do bottled and tap water compare? (% of responses).

No difference	53
Bottled water tastes/smells better	27
Bottled water is of higher quality	17
Bottled water is safer	17
Tap water is safer	8
Tap water tastes/smells better	7
Tap water is of higher quality	7

mographic factor of respondent age affected the use of in-home water filters (Table 7). Respondents less than 69 years old were most likely to have a home water filter. Conversely, the use of an in-home water filter decreased with increasing respondent age.

Bottled water vs. tap water

Over 38 percent of Hawai'i residents indicated they "sometimes" or "often" use bottled water for drinking purposes. Conversely, 23 percent of respondents never buy bottled water. People between the ages of 40 and 60 were more likely to use bottled water than respondents less than 30 or more than 60 years old.

When asked to compare bottled water with tap water, 53 percent of respondents indicated no differences between them (Table 8). Proponents of both bottled water and tap water cited safety, quality, and taste/smell considerations, although bottled water proponents outnumbered tap water proponents.

The demographic factors of age, length of residence in Hawai'i, and island of residence had an effect on answers to bottled water questions. Older respondents (60 or older) were more likely to consider tap and bottled water to be similar (63%) than residents younger than age 50 (23%). This also explains why older residents are less likely to use bottled water.

Respondents who have been Hawai'i residents for less than five years were more likely (73%) to say that bottled water either tasted or smelled better than long-time Hawai'i residents (25%). Island of residence also had an effect on how people compared bottled and tap water for drinking purposes. Respondents from the less populated islands of Kaua'i and Moloka'i universally indicated there was no difference between tap and bottled water. How-

Table 9. How important are the following characteristics that you consider when you choose your drinking water? (% of responses, excluding "no opinion").

	Importance			
	Very	Important	Somewhat	Not
Taste	65	29	4	0.5
Smell	67	28	4	0.5
Appearance	66	29	3	1
Convenience	47	42	6	2
Health concerns	84	12	1	1

Table 10. Which, if any, of the following have you experienced with the tap water in your home over the past year? (% of responses).

No problems experienced	56
Hard water / mineral deposits	25
Unpleasant taste	17
Sediment	10
Unpleasant smell	7
Rusty color	5
Other contaminants	3

ever, residents of other islands often indicated that bottled water tastes and/or smells better than tap water—O'ahu (24%), Hawai'i island (38.5%), and Maui (44%)—and this dissatisfaction translated into significant use of bottled water on these three islands, particularly on Maui.

Water testing and contaminants

Some survey respondents (11.5%) had actually had their own drinking water tested. Because of the Safe Drinking Water Act (SDWA), administered by the U.S. Environmental Protection Agency, all drinking water from public supply sources in Hawai'i (>84% of the total drinking water supply) is tested regularly. When the residents using bottled water (12%) are added to the 84 percent of tested water sources, 98.8 percent of drinking water in the state has been tested and contains safe levels of microorganisms, inorganic chemicals, organic chemicals, radionuclides, and suspended solids that are regulated by the SDWA.

Table 11. Comparison of 2004 and 2010 survey answers about in-home drinking water systems in Hawai'i. (% of responses).

	2004	2010	Change
I have a water treatment system (water softener)	2	7	+5
I have a water filter (sink)	28	40	+12
I purchase 5-gallon containers of drinking water	6	5	1
I often use bottled water for drinking purposes	40	38	2
I never buy bottled water	21	23	+2
I am satisfied with my home drinking water supply	74	72	2
I am not satisfied with my current drinking water	20	14	6
My drinking water is separate from my water supply system	4	5	+1

When asked about the importance of certain aspects of their drinking water not regulated as primary standards, over 90 percent of residents thought taste, smell, appearance, and convenience, in addition to health concerns, were important or very important (Table 9).

When asked which characteristics respondents had experienced with their home drinking water in the past year, 56 percent observed no objectionable traits (Table 10). Of the characteristics cited, unpleasant taste and hard water or mineral deposits were experienced most often. Unpleasant taste was not impacted by demographics; however, age did have an impact on experiencing hard water and/or mineral deposits. Here respondents less than 60 years old were two to three times as likely to be annoyed with hard water or mineral deposits than residents younger than 60.

Comparison of 2004 and 2010 survey responses

When comparing the response data for identically worded questions from the 2010 survey to those obtained in 2004, numbers that differed by less than four response points were considered statistically identical (University of Idaho Experiment Station statistician, personal communication, 2008). In both years, most survey respondents considered their home drinking water safe to consume. Because the two values (2004, 89%; 2010, 85%) did not differ by a percentage change of more than 4, the drinking water safety responses are considered the same for both years.

Table 12. In your opinion, what is the quality of surface waters where you live? (% of responses).

Good or excellent	12
Good, and improving	12
Good, but deteriorating	20
Fair	21
Poor, but improving	5
Poor	12
No opinion / Don't know	18

Only a portion of the drinking water questions contained in the 2010 survey was identical to questions in the 2004 survey. However, questions posed about specific home drinking water systems were identical, and thus the answers could be compared over time (Table 11). Using the 4 percent guideline for comparison, a majority of answers about home drinking water systems did not change between surveys. There are three differences, however. First, the use of in-home water softeners increased from 2 to 7 percent. Second, the use of in-home water filters (primarily on the kitchen sink) increased from 28 to 40 percent. Third, fewer people were dissatisfied with their home drinking water in Hawai'i in 2010 (20% vs. 14%). Based on the comparison of the 2004 and 2010 answers, the only significant change that had taken place in six years is that the public became more likely to have home treatment devices (softeners, filters).

Table 13. In your opinion, what is the quality of ocean waters off the coast of the Hawaiian Islands? (% of responses).

Good or excellent	21
Good, and improving	12
Good, but deteriorating	33
Fair	13
Poor, but improving	3
Poor	3
No opinion/ don't know	15

Protecting and preserving water resources

Most of Hawai'i's open water bodies have variable water quality due to storm-water runoff. During dry weather, most streams and estuaries have good water quality that fully supports beneficial uses (like for drinking), but the quality declines when storm-water runoff carries natural and human-related pollutants into surface waters. Natural factors that may affect surface water quality include geology, soils, vegetation, rainfall, ocean-water quality, and air quality. Human-related factors associated with urban and agricultural activities (from pesticides and fertilizers) also may affect water quality (Okamoto 2003). Over forty percent of survey respondents considered surface water quality good or better (sum of "good or excellent," "good and improving," and "good, but deteriorating" in Table 12); however, there is some concern that the quality of this resource is slipping. Almost thirty-eight percent of respondents graded surface water quality as fair or poor (sum of "fair," "fair but improving," and "poor"). Eighteen percent either did not know or had no opinion, suggesting that educational programs about surface water are needed.

Because most Hawaiian streams reach the ocean, more than 400 public beaches along nearly 300 miles of coastline can have their water quality affected after a storm. A near-shore water monitoring program is administered by the Clean Water Branch of the Hawai'i Department of Health, which warns people to stay out of the ocean and streams when contamination of the water with pathogens is observed after heavy rains.

When asked their opinion about the quality of ocean waters off the coast of the islands, the majority of respon-

Table 14. Do you regard water quantity (having enough water) as a water problem in the area where you live? (% of responses).

Definitely not	19
Probably not	41
Don't know	12
Probably	16
Definitely yes	12

dents (66%) rated it good (sum of "good or excellent," "good and improving," and "good, but deteriorating" Table 13). Conversely, 19 percent of respondents graded ocean water quality as fair or poor (sum of "fair," "fair but improving," and "poor"). Almost 15 percent either did not know or had no opinion. The higher positive opinion rate may reflect the decreased number of beach closing and advisory days (2,352 days) in 2009 from previous years (Dorfman 2010). According to the Natural Resources Defense Council's annual survey of water quality and public notification at U.S. beaches, the major factors contributing to the decrease in 2009 in Hawai'i appear to be decreased rainfall causing drought conditions and less storm-water runoff. In its annual Testing the Waters report, NRDC ranked Hawai'i fourth lowest in the nation for the number of pollution-related beach closures and advisories recorded in 2009 (Dorfman 2010).

Hawai'i has 376 perennial streams, 457 groundwater and surface water sources, and 150 water delivery systems to support a population of about 1,360,000. According to a U.S. Geological Service report, Estimated Use of Water in the United States in 2005, 249 million gallons of groundwater and 11.4 million gallons of surface water are withdrawn on a daily basis for public use in Hawai'i (Kenney et al. 2009).

Residents were optimistic about having enough water in the area where they live. Sixty percent of respondents believed their area has enough water (sum of "probably not" and "definitely not"), while 28 percent believed their area does not (sum of "probably" or "definitely yes") (Table 14). Twelve percent of respondents were unsure if there is a water quantity problem in the area where they live.

The demographic factors of community size, formal education level, and island of residence had an effect on answers about water quantity. Respondents living in less

Table 15. Effect of area population on perception of water quantity as a problem (% of responses).

	Definitely not	Probably not	Don't know	Probably	Definitely
> 100,000	18	45	12	23	1
25,000–100,000	21	41	14	11	13
7,000–25,000	19	35	9	21	16
3,500–7,000	29	38	10	5	19
< 3,500	22	22	0	0	56

Table 16. Effect of island of residence on perception of water quantity as a problem (% of responses).

	Definitely not	Probably not	Don't know	Probably	Definitely
O'ahu	21	42	14	18	6
Hawai'i	21	42	8	11	18
Maui	4	36	8	16	36
Kaua'i	33	44	11	11	0
Moloka'i	33	0	0	0	67

Table 17. Effect of education level on perception of water quantity as a problem (% of responses; HS = high school, SC = some college, CG = college graduate, AC = advanced college).

	< HS	HS	SC	CG	AC
Definitely not	27	25	17	17	22
Probably not	9	19	41	43	55
Don't know	46	19	15	7	3
Probably	18	9	14	24	16
Definitely yes	0	28	14	9	5

Table 18. Respondents' perception of water quantity as a problem in 2004 and 2010 (% of responses).

	2004	2010 Change	Change
Definitely	22	12	-10
Probably	24	16	-8
Don't know	8	12	+4
Probably not	24	40	+16
Definitely not	27	19	-8

Table 19. The likelihood of your area suffering from a prolonged drought is . . . (% of responses).

Increasing	41
Decreasing	0.5
Staying the same	41
No opinion	18

populated areas (<3,500 residents) were 46 times more likely to consider water quantity to be a problem than residents living in highly populated areas (>100,000 residents) (Table 15). Similarly, Moloka'i residents were more likely to consider water quantity a problem than residents living on the more populated island of O'ahu (67% versus 24%, respectively) (Table 16).

Survey respondents with more formal education were more likely to indicate that water quantity is not a problem (sum of "probably" or "definitely not") in the area where they live: 58 percent for those with some college or vocational training, 60 percent for college graduates, and 77 percent for those with advanced college or other professional degrees (Table 17).

Table 20. Interaction between island of residence and respondent's opinion about the likelihood of their area having enough water resources to meet all of its needs 10 years from now (% of responses).

Likelihood of water adequacy	O'ahu	Hawai'i	Maui	Kaua'i	Moloka'i
High (likely enough water)	20	32	0	33	0
Medium	39	42	28	33	33
Low (likely not enough water)	29	18	72	11	67
No opinion	12	8	0	22	0

Table 21. Opinion on effect of climate change on future rainfall (% of responses).

Yes, a significant increase in rainfall	6
Yes, a slight increase in rainfall	6
No, no change in rainfall	22
Yes, a slight decrease in rainfall	27
Yes, a significant decrease in rainfall	13
I don't know	26

Comparing the survey response data for this identically worded question from 2010 to that obtained in 2004 showed a significant difference in respondent perceptions about water quantity (Table 18). In 2010, 10 percent fewer survey respondents thought water quantity was a problem compared to respondents surveyed in 2004. Respondents regarding water quantity as not a problem (sum of “probably not” and “definitely not”) increased by 8 percent. Conversely, respondents regarding water quantity as a problem (sum of “probably” and “definitely”) decreased by 18 percent.

Three additional water quantity questions were posed in the 2010 survey. Respondents were asked about the likelihood of their area suffering from a prolonged drought (Table 19). At the time this survey was being conducted, the entire state had been designated an agricultural disaster area by the federal government due to drought conditions. Hawai'i was suffering through an unprecedented drought due to El Niño conditions that had fueled wildfires and destroyed crops from O'ahu to Hawai'i island (Markus 2010). Forty-one percent of respondents indicated that the likelihood of a prolonged drought in their area was increasing, while another 41 percent thought it was staying the same.

Another water quantity question in the 2010 survey asked respondents about the likelihood of their area having enough water resources to meet all of its needs 10 years from now. Responses were 20 percent high likelihood (enough water), 38 percent medium likelihood, 31 percent low likelihood (not enough water), and 10 percent no opinion. Once again, island of residence made a difference, with the majority of Moloka'i (67%) and Maui (72%) respondents indicating that they felt they were not likely to have enough water resources to meet future demands (Table 20).

A topic related to water quantity came in the question of whether respondents thought that the amount of rainfall in their area would change as a result of climate change. A 2010 Gallup update on Americans' attitudes toward the environment showed a public that, over the previous two years, had become less worried about the threat of global warming and less convinced that its effects are already happening (Jones 2010). Interestingly, Hawai'i residents responded that rainfall would change in their area, with 40 percent believing there would be a decrease (sum of slight decrease and significant decrease) as a result of climate change (Table 21). Twenty-two percent of respondents do not think any change in rainfall will occur as a result of climate change while 12 percent believe there will be an increase in rainfall.

In general, participants did not claim to be very aware about any one issue when given a list of factors that affect surface water and groundwater quality (Table 22).

Over 40 percent of respondents indicated they did not know if 11 out of 12 given pollutants affect the water quality in their area (Table 22). The high levels of uncertainty suggest that educational programming about surface and groundwater pollution is needed. Forty percent of respondents indicated they “know” or “suspect” that pesticides affect their water quality. According to

Table 22. Do you know of or suspect that any of the following conditions affect surface water or groundwater quality in your area? (% of responses).

Pollutant	It is NOT a problem			It IS a problem	
	Know	Suspect	Don't know	Suspect	Know
Pathogens	9	18	49	17	8
Fertilizers/nitrates	6	15	43	30	5
Fertilizer/phosphates	7	15	45	29	5
Heavy metals (lead, arsenic, mercury)	9	16	56	15	4
Minerals (iron, manganese, calcium)	7	18	55	14	5
Pesticides	6	15	40	33	8
Salinity (water too salty)	19	23	49	7	3
Pharmaceuticals (antibiotics, personal care products)	9	25	55	10	2
Petroleum products	10	20	53	13	4
Algae	9	15	53	18	5
Product and waste water from mining	24	20	50	4	2
Septic systems	11	18	50	15	6

the Hawai'i Department of Health's latest water assessment data, the causes of impairment to Hawai'i's rivers and streams, bays and estuaries, and coastal shoreline are turbidity, nutrients, ammonia, pathogens, and algal growth (Hawai'i Department of Health 2008). Pesticides are not one of the top causes of impairment to the state's water bodies.

Given an option to choose three (from a list of 12) sources most responsible for existing pollution problems in rivers, water bodies, and coastlines in Hawai'i, more than half (55%) of respondents indicated storm-water runoff among their choices (Table 23). Erosion from roads and/or construction was identified by 38 percent of respondents as responsible for pollution, while only 5 percent indicated outdoor recreation as responsible.

A watershed is an area of land that drains into a body of water such as a stream, lake, or river. There are 551 watersheds in the state; everyone lives, works, and plays in a watershed. In old Hawai'i, ahupua'a was the common land subdivision. It consisted most frequently of a slice of an island that went from the peak of a ridge or volcano summit to the shore, often following the boundary of a stream drainage. When asked if they know what a watershed (ahupua'a) is, 70 percent of the participants answered "yes," while 30 percent answered "no" (Table 24).

Table 23. Which of the following are most responsible for the existing pollution problems in rivers and lakes in your state? (Select three) (% of responses).

Storm-water runoff	55
Erosion from roads and/or construction, repair	38
Wastewater treatment plants	30
Agriculture, crops	30
Industry	26
Septic systems	24
New suburban development	19
Agriculture, animals	18
Runoff from home landscapes	18
Landfills	11
Military bases	8
Outdoor recreation	5

Comparing the survey response data for this question from 2010 to that obtained in 2004 points to a difference in respondents' knowledge. In 2010, nine percent fewer respondents knew what a "watershed" is. As the wording of the two questions had changed by one word, perhaps

the term “ahupua’a” was not known or understood by some survey respondents, causing the decrease.

In 1978, the state’s Constitutional Convention identified the state as having the “obligation to protect, control and regulate the use of Hawai’i’s water resources for the benefit of its people,” thus making water available to all users (Commission on Water Resources Management 2010). Regarding respondents’ opinions about how well this obligation has been met in the communities where survey participants reside, when “very well” and “moderately well” were combined, the state and counties received less than half (46%) of the positive responses (Table 25). The roles of individual citizens and the federal government were held in lower estimation; 27 and 36 percent, respectively, regarded them as doing well. Many of the survey respondents were unsure how well any one group was doing, pointing out an opportunity for more educational programs by government and local environmental groups.

Your environmental behavior

The survey asked participants whether or not they engage in behaviors that might improve water quantity and quality (Table 26). Direct actions by citizens toward protecting and improving water quality are important because these actions indicate awareness of water quality issues, and responses indicate that citizens may place

a high value on protecting water resources. Over half of the survey respondents (58%) have changed how often they water their yard, while half have also adopted new technologies (such as using low-flow faucets). These reported actions are encouraging because they show that a substantial portion of Hawai’i residents desires to protect water resources, and consequently, desires are translating into actions. In fact, the Honolulu Board of Water Supply raised rates in 2008 to compensate for lower water sales they assumed partly stemmed from low-flow toilets and showers decreasing water consumption (Hao 2009).

In other responses, 29 percent of respondents indicated that they have changed how they use pesticides, fertilizers, or other chemicals around their homes, and 29 percent have changed how their yard is landscaped. Only 3 percent of respondents have pumped their septic systems. According to the Hawai’i Department of Health’s Clean Water Branch, 38 percent of Hawai’i residents are served by Individual Wastewater Systems, which includes septic tanks and cesspools (HDOH undated).

Island of residence, age, and gender all had an impact on actions toward adopting new technologies. Residents of Moloka’i and Kaua’i were most likely to adopt new technologies like using low-flow faucets (Table 27). Conversely, residents of the more populated islands of Maui, Hawai’i and O’ahu were less likely to adopt new technologies. Women were more likely than men to adopt a new technology (Table 28).

Age also influenced responses regarding changes in adopting new technology. Residents younger than 70 years were more likely to adopt new technology to conserve water or preserve water quality (Table 29). Respondents aged 70 years or more were least likely to change their approach to adopting new technology.

Table 24. Do you know what a watershed (ahupua’a) is? (% of total responses).

	2004	2010	Change
Yes	79	70	-9
No	23	30	+7

Table 25. How well do you feel each one of these groups is fulfilling their responsibility for protecting water resources in your community? (% of responses).

Responsible agency	Very well	Moderately well	Don’t know	Somewhat poorly	Very poorly
Federal government	6	30	44	15	4
State government	10	37	30	17	6
County, city, or town	9	37	30	18	6
Individual citizens	3	24	42	27	4

Water activity participation

Research has shown that access to opportunities such as becoming a member of an environmental group helps citizens develop a greater sense of environmental responsibility for their community and increases the likelihood that they will engage in environmental and conservation actions (Barr 2003). When asked about participation in specific activities, less than 15 percent of respondents had participated in any of the activities listed in the survey (Table 30).

The demographic factor of education level affected respondent participation in (a) county, municipal, or neighborhood meetings; (b) lake, river, or bay protection groups; and (c) volunteer water quality monitoring (Table 31). Participation in these groups increased with increasing education level. This is logical because it is more likely that residents with more formal education would have increased awareness of these activities and groups and their importance and, therefore, are more likely to participate in them. The increased affluence of college graduates may also result in more discretionary time that can be devoted to volunteer activities.

Table 26. Have you or someone in your household done any of the following in the last five years as part of an individual or community effort to conserve water or preserve water quality? (Check all that apply) (% of responses).

Changed how often you water your yard	58%
Adopted new technologies	50%
Changed your use of pesticides, fertilizers, or other chemicals	29%
Changed the way your yard is landscaped	29%
Pumped your septic system	3%

Table 27. Adoption of water-conserving technologies, by island (% adopting).

Moloka'i	100
Kaua'i	89
Maui	59
Hawai'i	56
O'ahu	43

Learning opportunities

Determining preference for the types of learning opportunities will help extension personnel and water quality educators determine the appropriate outreach activities that maximize the effectiveness of delivery, time, and monetary resources. Three quarters of the respondents indicated that they had received water resources information by reading local newspapers (Table 32), by far the most common learning opportunity compared to the other 13 survey choices. Conversely, extension had a lesser reach.

When the survey asked about three preferred water resources learning opportunities in 2010, about half cited reading printed fact sheets, bulletins, or brochures (Table 33). This preference for printed materials decreased from 62 percent in 2004 to 52 percent in 2010. This is a significant finding because most educators continue to use printed materials.

Table 28. Adoption of water-conserving technologies, by gender (% of responses).

Male	45
Female	55

Table 29. Adoption of water-conserving technologies, by age (% of responses).

Less than 30	67
30–39	50
40–49	63
50–59	54
60–69	60
70 or older	34

Table 30. Have you participated in any of the following activities? (positive responses, percent of total responses).

County, municipal, or neighborhood meetings	14
Lake, river, bay, wetland, watershed protection groups	6
Master gardener program	5
Volunteer water quality monitoring	4

Table 31. The impact of education on the willingness of residents to participate in environmental activities (% of responses).

	County, municipal, neighborhood meetings	Lake, river, or bay protection groups	Volunteer water quality monitoring
Less than or some high school	0	9	0
High school graduate	6	3	12
Some college or vocational training	11	1	0
College graduate	16	6	2
Advanced college or other prof. degree	24	13	8

Table 32. Water resource information sources reported by respondents (% of responses).

Local newspapers	74
Public television	57
Environmental agencies	53
Environmental groups	51
Friends and family	48
Radio	48
Cable television	47
Network television	41
Major newspapers	37
Magazines	35
Internet	32
Universities	32
Schools (K-12)	25
Extension	13

The choice of newspapers and television as preferred learning opportunities for water resources information declined by 9 percent since 2004. As preferred learning opportunities, other declines compared to the 2004 survey were observed for viewing a display, watching a video, visiting a website, and getting trained for a regular volunteer activity. Taking part in a one-time volunteer activity such as water monitoring or a streamside restoration event as a preferred learning opportunity suffered

the greatest decline (12%) compared to the 2004 survey. On the other hand, respondents would take advantage of opportunities to learn more about water issues by attending a fair or festival, attending a short course or workshop, and learning how to conduct a home, farm, or workplace water practices assessment. Apparently, the public is interested in water resource information and is willing to spend time in some but not all learning opportunity options that take place.

Conclusions and recommendations

Results from the 2010 survey indicated that water resource issues were as important in 2010 as they were six years before. In fact, water-related issues, including clean drinking water, clean beaches, clean groundwater, clean rivers and streams, clean marine waters, and clean bays and estuaries increased in importance to citizens based on this survey.

This 2010 survey provided the Hawai'i Regional Water Quality Program with important information that will be used to develop a strategy to meet water education needs of residents of the state. Important findings included the following:

- The survey respondents considered drinking water the highest priority water issue.
- A majority of respondents considered building new water-storage structures (dams, reservoirs) as having high priority, with all of the Maui respondents indicating it as the most important action.
- Over 84 percent of respondents obtained their drinking water from public sources.

Table 33. Comparison of preferences for preferred water resources learning opportunities in 2004 and 2010 (% of responses).

	2004	2010	Change
Read printed fact sheets, bulletins or brochures	62	52	-10
Read a newspaper article or series, or watch TV coverage	57	48	-9
Visit a website	39	36	-3
Attend a fair or festival	15	20	+5
Look at a demonstration or display	25	20	-5
Watch a video of information	22	16	-6
Learn how to conduct a home, farm, or workplace water practices assessment	8	9	+1
Attend a short course or workshop	6	8	+2
Take part in a onetime volunteer activity (i.e., water monitoring, streamside restoration, or education)	19	7	-12
Get trained for a regular volunteer position (i.e., as a watershed steward or a water-quality monitor)	7	4	-3
Take a course for certification or credit	4	3	-1

- 85 percent of respondents felt that their water was safe to drink; Maui residents rated water safety the lowest, at 68 percent.
- Over 72 percent of respondents were satisfied with their drinking water; however, 25 percent cited hard water and 17 percent cited bad taste as problems.
- Based on the comparison of 2004 and 2010 answers to identical survey questions, the only change in home drinking water issues was that the public was more likely to have home treatment devices (softeners, filters) in 2010.
- Storm-water runoff was the pollutant source cited as being the most problematic.
- Most respondents had taken at least one voluntary action in the previous five years to protect both the quality and the quantity of their water.

Respondents overwhelmingly indicated that drinking water was important, so programs addressing drinking water should be well received. Effective programs will have to take into account local scientific data about drinking water, in addition to perceptions found in the

survey, to effectively address educational needs. Based on this survey, policy-makers can be assured that people want this resource protected and that politicians need to follow through regarding these wishes.

The 2010 survey instrument can be accessed at <http://ag.arizona.edu/region9wq/resources.html>.

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