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Research article

Exploring participant motivations and expectations in a researcher-stakeholder engagement process: Willamette Water 2100

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HIGHLIGHTS

- Researchers must address participant expectations for better collaborative research.
- Transdisciplinary collaborators differ in expectations for research process/products.
- Participants expect to play different roles during the research process.
- Collaborators participate primarily because they were personally invited to do so.

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ABSTRACT

Many barriers impede managers and policy makers from incorporating the “best available science” into decision making and problem solving. Researcher-stakeholder engagement in research is one way to help overcome such cultural, institutional, and practical barriers. In the Willamette Water 2100 project (WW2100), scientists and stakeholders studied biophysical and socioeconomic drivers of future water scarcity in the Willamette Basin to identify ways to anticipate and respond to it. This study explores the participation, motivations, and expectations of research team members and stakeholders in the WW2100 researcher-stakeholder engagement process. Twenty-six semi-structured interviews of key participants and 137 completed online questionnaires illuminate their perceptions of the engagement process. Qualitative and quantitative analyses demonstrate that participants are motivated to attend for social (ex. knowing other participants), knowledge (ex. interest in the topic), and utility (ex. useful management tool) reasons. Nonparametric statistical analyses show that research team members and stakeholders had similar expectations for the roles participants would play but different expectations for the process and resulting model. For instance, all participants expected research team members to interpret model outputs and stakeholders to provide a “boots on the ground” perspective but only researchers expected the process to provide career experience. In most cases, role, model, and process expectations were fulfilled though not always to the degree expected. Understanding the transdisciplinary research process can lead to better collaboration and more effective problem-solving.

1. Introduction

Ideally, natural resource management and policy should be informed by the best available science. However, many barriers impede the use of science in natural resource use decisions, including uncertainty in the results, conflicting priorities, institutional limitations, miscommunication, differing values, and the lack of results suited to local conditions (Callahan, Miles, & Fluharty, 2013; Gregory et al., 2013; Rayner, Lach, & Ingram, 2005; Riley et al., 2011; Smith, Strzepek, Rozaklis, Ellinghouse, & Hallett, 2009; Weible and Sabatier, 2009; Yang et al., 2013).

To help overcome such barriers, the National Science Foundation (NSF) mandates a broader impacts component to every research project it funds (National Science Foundation, 2012). Yet, a recent review found that only 65% of NSF-funded projects had broader impacts plans and most of these were poorly developed (Nadkarni and Stasch, 2013).

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Researchers use a variety of methods to address the NSF mandate, particularly in studies of climate change, variability, and alternative scenario evaluations (Snover, Mauger, Whitely, Krosby, & Tohver, 2013). Stakeholders may consult with researchers in a decision-making context, where the goal is to address an immediate need, create a specific tool, or develop plans for climate change adaptation (Holzkämper, Kumar, Surridge, Paetzold, & Lerner, 2012; Mackenzie, Tan, Hoverman, & Baldwin, 2012; Cross et al., 2013). Stakeholders may also be engaged to guide and inform research agendas (Lienert, Monstadt, & Truffer, 2006). In sustainability research, scientists and stakeholders from multiple disciplines may network to find solutions to resource management problems (Mader, Mader, Zimmermann, Görsdorf-Lechevin, & Diethard, 2013; Stubbs and Lemon, 2001), whereas in alternative futures research, they often collaborate to develop and explore scenarios of potential future conditions (Santelmann et al., 2004; Sheppard et al., 2011).

Understanding the various roles, motivations, and expectations of participants is an important step towards improving the impact of transdisciplinary research (Lang et al., 2012; Tuler, 1998). A study on scientists and citizens engaging in citizen science research (Rotman et al., 2012) identified four main participant motivations: 1) personal gains though working together (egoism); 2) mutual benefit that each party receives through collaboration (collectivism); a sense of giving something to the other party (altruism); and the belief that citizen-science engagement is worthwhile on the principal that science should be accessible to everyone (principalism). A survey of scientists in Madrid (Martin-Sempere, Garzon-Garcia, & Rey-Rocha, 2008) found that scientists' greatest motivations for engaging with the public were to increase interest and enthusiasm for science and appreciation of scientists. Well-established scientists expressed a sense of duty in communicating their findings to a larger audience while young scientists were motivated by personal satisfaction and enjoyment of outreach and engagement events.

It is equally important to recognize differences among individuals participating in a researcher-stakeholder engagement process. Freitag (2014) found that university scientists, fishermen, and managers possess different kinds of knowledge and that these differences led to different frames for water quality issues and potential solutions. Similarly, hydropower government officials and academics expressed different perspectives on the biophysical, socio-economic, and geopolitical impacts of dams (Tullos et al., 2010), and in a wind turbine development project, policymakers, technology developers, and industry representatives defined problems differently, preferred different solutions, and held different value systems leading them to arrive at different conclusions (Grin and van de Graaf, 1996). Differing experiences prior to the engagement process may manifest as different motivations and expectations, and influence the meeting of expectations among participants. Identifying cultural and political differences at the project outset can provide cues on how to build a transdisciplinary project which meets participant expectations and achieves project goals (Farkas, 1999).

Transdisciplinary projects are increasing in number, but little is known about the people involved, their motivations to participate, and their expectations of the researcher-stakeholder engagement process itself. Expectations play a key role in the value individuals ascribe to a task (Eccles and Wigfield, 2002), but research team members and stakeholders have expressed different perceptions of the same experience in natural resource contexts (ex. Grin and van de Graaf, 1996). To better understand the transdisciplinary researcher-stakeholder engagement process, we sought to answer four questions: 1) What are participants' motivations for attending; 2) What are participants' expectations for the process; 3) Were those expectations met; 4) How do motivations and expectations differ between researchers and stakeholders? Once we understand transdisciplinary participant motivations and expectations, we can design researcher-stakeholder interactions to address and achieve them.

2. Methods

The Willamette is the largest river basin in Oregon, home to approximately 70% of the state's population and farming and forestry industries. The Willamette Water 2100 project (WW2100) is a five-year collaborative effort across three universities, multiple academic disciplines, and numerous state, federal, and private agencies which uses a coupled human-natural system model to investigate where and when water scarcity will occur in the Willamette Basin through the year 2100 as a result of climate change and human land and water use decisions. It provides a case study to inform current and future researcher-stakeholder engagement processes for broader impacts. Throughout the project, academic researchers and expert stakeholders have worked together as part of the project's broader impacts plan to explore the future of water in the Willamette Basin. Stakeholders have contributed to output metrics of the WW2100 model, assessed model assumptions, and helped develop two future scenarios.

This study takes an exploratory, sequential, mixed-methods approach (Creswell, 2003) to examine motivations, values and expectations of the participants of WW2100 as a case study of the engagement process among scientists and stakeholders. Semi-structured interviews of key participants provided qualitative data regarding motivations and expectations and also influenced the design of a quantitative survey which was then administered to all members of the researcher-stakeholder engagement mailing list. For more information on the WW2100 participants, see the project website (WW2100, 2015). This research with human participants was in compliance with the university Institutional Review Board requirements.

2.1. Semi-structured interviews

Semi-structured retrospective interviews regarding participant expectations, motivations, outcomes, and general reflections on the researcher-stakeholder engagement process were conducted in the fifth year of the project. Interviewees were purposively selected (Patton, 2002) based on their participation in the process and representativeness of various expertise. Fourteen research team members (of 81) and twelve stakeholders (of 254) were interviewed. Each interview lasted between 26 and 89 min (average: 55 min). Interviews were conducted in person, via skype, or via telephone according to the interviewee's preference. The interview sessions were digitally audio recorded, transcribed using Express Scribe Transcription software, and sent to the interviewees as a form of "member checking" (Miles, Huberman, & Saldana, 2014).

Interview transcripts were analyzed through an open coding process (Auerbach and Silverstein, 2003) with the aid of the computer software MaxQDA. Transcripts were read with the research concerns (roles, motivations, expectations, outcomes) in mind and following a refinement of the first round of coding (Miles et al., 2014), led to the identified themes we present. These themes also contributed to the survey development for the second phase of data collection.

2.2. Online survey

The quantitative phase utilized a census design to survey all members of the WW2100 mailing list. Subscribers to the WW2100 project mailing list were invited by e-mail to complete a questionnaire via an online survey website. Of 281 people invited to

Table 1
Total respondents, total surveys sent, and response rate for each respondent category.

Respondent category	Total respondents	Total surveys sent	Response rate
Research team	45	72	62.5%
Stakeholder group	92	209	44%
Total	137	281	49%

participate, 137 responded (45 research team members, 92 stakeholders), leading to a 49% response rate (Table 1). A wave analysis to check for response bias found that average weekly survey return items did not change over time (Creswell 2003). The authors heard from several potential survey participants that they did not take the survey because they participated only once, could not remember the project, or because they had subscribed to the list serve to be informed but had not actually participated. Given the response rate, conclusions about the WW2100 participant population can be inferred with 90% confidence (Vaske, 2008).

Through the questionnaire, respondents reported their perceptions in two sections: professional information (capacity in the project, expertise, geographic location), and expectations for WW2100. Respondents self-selected into one of two categories 'research team member' or 'stakeholder'. Expectations for research team members to perform various roles in the project, for stakeholders to perform various roles in the project, for the process and the model, and how well those expectations were met were taken directly from responses and analyzed as dependent variables. All variables were measured on a scale from 1 "strongly disagree" to 5 "strongly agree," that they expected members of either group to perform or witnessed performing the roles in question.

2.3. Statistical analyses

IBM SPSS statistical software was used for all analyses. We used Mann Whitney U Tests to compare the expectations between research team members and stakeholders. We calculated point biserial correlation effect sizes to evaluate the strength of association among these variables. We used Wilcoxon Sign Rank tests to examine whether participants had different expectations for research team members and stakeholders, and to answer whether expectations for research team member and stakeholder roles were met. Wilcoxon Sign Rank tests also indicated whether participant expectations for the process and model were met. In these cases, we calculated Cohen's *d* effect sizes to evaluate the strength of the relationship among these variables.

To aid in the discussion of expectation types, we conducted an Exploratory Factor Analysis to group expectations of both the researcher-stakeholder engagement process and the WW2100 model into expectation factors (Table A1). We grouped respondents into one of two groups using a K-means cluster analysis according to their responses to process and model expectations. We then compared membership in stakeholder or research team groups to either of the two expectation groups through chi-square analysis.

3. Results

3.1. Participant motivations

The survey instrument asked respondents to agree or disagree that they were motivated to participate by a list of seven motivations which had emerged as recurring motivations in the semi-structured interviews. Fig. 1 shows that all of the motivations suggested in the survey were motivating factors for most survey respondents (mean > 3). Although no one factor distinguished itself from the others (evidenced by overlapping error bars), concern for water in the future, professional relevance, and seeking new tools to address water issues were the most highly rated motivations. Representing a larger group (i.e. agency, constituency, organization, discipline) in the researcher-stakeholder engagement process and the regional (Willamette Basin) focus were the least motivating factors for participants overall. The high rating for the "other" motivation category indicated that the choices available for this survey question did not entirely characterize motivations. Three categories of motivation were identified from the semi-structured interviews with key participants and the open-ended "other" responses to the survey question. Attendees were motivated to participate in WW2100 for social reasons, for knowledge, and for the promised research products.

Social motivations for participating in WW2100 centered around two themes. Many participants were invited in to the project by others with whom they had a pre-existing relationship; participants were also drawn to the project by its interdisciplinary strategy to address climate change and water resources. When asked what led them to be involved, the most common response from interviewees was "*I was invited.*" They traced their participation to someone involved in WW2100 with whom they had worked on other projects. One stakeholder exemplified this motivation,

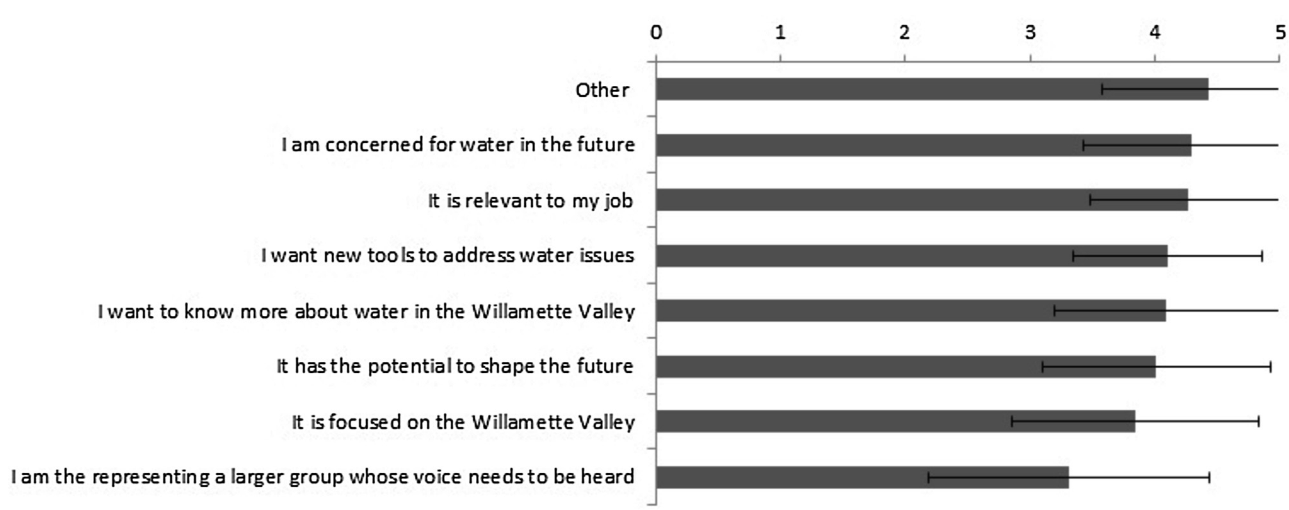

Fig. 1. Motivations of survey respondents. X-axis values are on a scale from 1 "strongly disagree" to 5 "strongly agree" that survey participants were motivated to participate in WW2100 because of the listed reasons. Error bars are standard deviations.

attributing his participation to a long-standing relationship with a research team member:

"*I had a prior relationship with [a research team member]. So I've known [him] for years... So when...he calls me up and says, hey I'm working on this Willamette Water 2100... We have a National Science Foundation grant to do some modeling but it also has kind of a sociological aspect to it, are you interested? Yeah, that sounds really interesting. I'd love to be interested."*

Many interviewees also expressed that they were drawn to the project by its interdisciplinary approach to water resource management. Research team members were excited by the potential to integrate various disciplines, to learn from each other, and to address a natural resource problem requiring a collaborative approach. One research team member explained:

"Since water is just [an] essential thing to look at from both human dimensions and other biophysical dimensions...it creates a new opportunity for collaborative research."

Knowledge was another key motivation. Participation in WW2100 offered an opportunity to gain knowledge on water as it related to individuals' personal interests and/or professional projects. Interviewees sought knowledge about water resources related to climate change, human demand, ecological demand, and the future economy. Water *"is our business"*, said one stakeholder, who attended to understand where the future of his business might go. Interviewees also hoped to inform other projects with knowledge gained from WW2100. Researchers working on reservoirs, other river basins, and at finer scales, as well as policymakers interested in long-term planning, cross-county water issues, and state regulations attended WW2100 to inform their external projects. Many were interested in the impacts of climate change on water resources and understanding how all water processes interact. One researcher summarized her interest in this way:

"To me it's not the projections... The interesting part is if we could actually sit down... and we actually start to see... really compelling hypotheses about interactions between people and fish and flows, that to me would be a far more interesting compelling science problem."

Participants sought information and were also motivated to participate by the anticipated products of the project. These include a tool to model alternative water resource futures, a conversation on water policy and planning, and achieving scientific broader impacts. WW2100 researcher-stakeholder engagement offered a way to extend the research results beyond academia. One researcher expressed his broader impact motivation to participate in WW2100:

"[It's] where I was really the most interested because a lot of times these cool projects are done and then it's just for the research. And it doesn't really go anywhere afterwards."

Other participants were motivated by the research results or the desire to be part of a conversation about water policy and future planning related to climate change. One survey respondent expressed the obligation to participate in water policy and future planning conversations:

"Decision makers and those that support decisions need to do more critical thinking, problem-solving, planning, and policy implementation for a future so we don't have 'water emergencies' that focus solely on humans' unlimited demand of water."

WW2100 developed and parameterized a modeling tool (*Envision*) to explore alternative future scenarios of population growth, climate change, and land use decisions. This tool brought many interviewees to the project, as expressed by one research team member:

"*There are big challenges for our society in this century... We have a chance of doing something about it if we can...think more clearly about what might happen in the future. And this tool gives us a way of doing that.*"

3.2. Participant expectations

Participants in WW2100 expressed many expectations for the engagement process, the model *(Envision)* used by the project team, and the model outcomes. Some participants indicated that they did not know what to expect or that they were surprised by certain elements of the process.

Many participants expected a smooth process, that stakeholders would be engaged in research, and that it would be an opportunity for personal and professional development. Interviewees expected that the process *"would go more smoothly and more quickly"* and *"that it would be a strong component of stakeholder involvement."* Four of the five expectation factors (interaction, progress, opportunity, monitor; Table A1) refer to expectations for the engagement process (Table 2). Survey respondents expected a certain degree of interaction (mean = 3.35, SD = 0.88) and understanding (mean = 3.70, SD = 0.94) between research team members and stakeholders throughout the process. They also expected to be involved throughout the process of the project by being kept up to date on its progress (mean = 3.94, SD = 0.83) and learning to improve the model (mean = 3.99, SD = 3.99). Questionnaire items were measured on a scale from 1 strongly disagree to 5 strongly agree such that a score > 3 indicated that the item was expected and/or was met. Participants most expected that the process would provide an opportunity for personal and professional development by providing opportunities to work with others, to learn, and to satisfy their curiosity.

The general sentiment among participants was that these expectations were not delivered to the degree expected. Speaking of her expectation for stakeholder engagement, one interviewee said:

"I thought that we were going to have a robust range of input from people that were not necessarily involved in water...from an academic point of view...but that really didn't come to fruition in as robust a way as I would have liked."

All expectations but one ("Frequent interaction with stakeholders", mean = 2.88, SD = 0.90) were delivered to some degree by the process, as indicated by mean scores > 3 (Table 2). Several process expectations were met including "gain career experience (3.28)", "opportunity to share what I know (3.65)", and "stakeholders to make attempts to understand concerns for the project (3.30)". All other item expectations were met, but not to the degree expected. For example, "an opportunity to learn" was the most expected opportunity provided by the process (mean = 4.38, SD = 0.55). Respondents rated that the degree to which it was delivered was significantly less than expected (mean = 3.98, SD = 0.81, $p < 0.001$); however, a mean >3 still indicates that the process provided an opportunity to learn. The same is true for many of the other items that are met significantly less than expected.

Participants also expected certain characteristics of the *Envision* model. Interviewees expected that the research would provide new numbers to update old research, that the model would speak to specific interests and that it would be an accessible tool for non-research team members. Specific expectations for the model varied from addressing the value of ecosystem services to evaluating the impact of climate on stored water availability. One interviewee *"was looking forward to the groundwater component, but later learned there was not a detailed groundwater model or a water qual-*

Table 2
Expectations for the WW2100 model and engagement process and whether or not they were met.

	Expected	Met	*Z*-value	*p*-value	Effect Size Cohen's *d*
Progress					
To use what we learn to improve the model	3.99 (0.81)	3.32 (0.95)	4.33	<0.001	0.76
Transparency on the project's progress	3.96 (0.79)	3.40 (0.94)	4.23	<0.001	0.64
To be kept up to date as the model evolved	3.94 (0.83)	3.40 (0.96)	3.79	<0.001	0.60
Some of my assumptions to change as the project progressed	3.93 (0.69)	3.58 (0.88)	2.60	0.004	0.44
Opportunity					
I expected to gain career experience	3.31 (1.06)	3.28 (0.86)	0.40	0.692	0.03
An opportunity to work with others in my field	3.93 (0.87)	3.74 (0.86)	2.23	0.026	0.22
An opportunity to share what I know	3.56 (0.93)	3.65 (0.97)	0.90	0.367	0.09
An opportunity to learn	4.38 (0.55)	3.98 (0.81)	4.43	<0.001	0.58
An opportunity to work with others outside of my field	4.01 (0.90)	3.76 (0.91)	2.85	0.004	0.28
Satisfy my curiosity	3.90 (0.88)	3.58 (0.82)	3.52	<.001	0.34
Interaction					
Frequent interaction with stakeholders	3.35 (0.88)	2.88 (0.90)	4.17	<0.001	0.53
Stakeholders to make attempts to understand my concerns for the project	3.47 (0.95)	3.30 (0.85)	1.60	0.109	0.19
Research team members to make attempts to understand my concerns for the project	3.70 (0.94)	3.24 (1.00)	3.22	0.001	0.47
Frequent interaction with research team members	3.35 (0.90)	3.05 (0.96)	2.81	0.005	0.32
Applicability					
Model results that I could use in my job	3.84 (0.98)	3.31 (0.90)	4.29	<0.001	0.56
An integrated model of water in the Willamette Valley	4.34 (0.85)	3.62 (0.84)	5.49	<0.001	0.85
Model results that would contribute to science	4.31 (0.82)	3.68 (0.71)	5.41	<0.001	0.78
Monitor	3.56 (1.01)	3.47 (0.94)	0.971	0.332	0.09

Cell values are means of reported expectations on a 5-point scale from 1 "strongly disagree" to 5 "strongly agree. A mean value greater than 3 indicates that an item was expected and/or that the expectation was met. Values in parentheses indicate standard deviation.

ity component." The applicability factor referred to respondents' expectations for the model. Many stakeholders had high expectations that the model results would be useful in their jobs, that they would contribute to science and that *Envision* would be a complete and integrated model of water in the region.

As with expectations for the process, expectations for the model were met but not to the degree expected. One interviewee reflected on the realization that the model would not do everything she expected saying:

> *"There were a lot of things that I wanted to know and it turned out that the model just wasn't going to handle everything that a person wanted to know."*

Similarly, survey respondents indicated that their expectations for the applicability of the model, while met, fell short of their expectations (Table 2). Substantial Cohen's *d* effect sizes (Vaske, 2008) indicated that there was a strong association between expectation and delivery for the researcher-stakeholder engagement process and model. The difference between expectation and delivery was greater when a survey item was highly expected, as in the case of applicability.

Some interviewees viewed this project as one among many contributing to water sustainability. They expressed expectations that WW2100 would build on previous projects and would push technological innovation for future projects. One research team member reflected on his expectation for a model representing the complexity of water in the Willamette Valley.

> *"I guess my expectation going into it was that it would be able to both push the state of the art in terms of the science and modeling representation of a quite complex system, and I think we've been somewhat successful in that."*

Many interviewees expressed that they had low expectations or did not know what to expect at the beginning of the process. As a result, they encountered some surprises. The most prevalent theme among the unexpected was the role participants played. Of the roles surveyed, participants most expected stakeholders to "provide a boots-on-the-ground perspective" (mean = 4.15, SD = 0.81) and did not expect them to "develop pieces of the model" (mean = 2.55, SD = 1.10) or "write reports" (mean = 2.27, SD = 0.87). Participants expected research team members to fulfill all of the roles, especially "develop pieces of the model" (mean = 4.65, SD = 0.66) but very little to "provide a boots-on-the-ground perspective" (mean = 3.10, SD = 1.01) (Fig. 2, Tables A2 and A3).

The degree to which role expectations were met varied among stakeholders and research team members depending on the role in question. Stakeholders did not fully meet expectations to "evaluate assumptions," "provide a boots-on-the-ground perspective" or "communicate with stakeholders." However, stakeholders exceeded expectations to "develop pieces of the model" (mean = 3.83, SD = 0.85) and to "write reports" (mean = 3.48, SD = 0.79). All other stakeholder roles were met (Fig. 2; Table A2). Research team members met expectations for all but one role. They were somewhat expected to "provide a boots-on-the-ground perspective" (mean = 3.10, SD = 1.01) but did not meet that expectation (mean = 2.78, SD = 0.91). Although all other roles were reported with means greater than 3, indicating that they were met, they were delivered to a degree significantly less than expected (Fig. 2; Table A3).

3.3. Differences between participant groups

Participants in WW2100 belonged to one of two groups: research team or stakeholder. While research team and stakeholder expectations differed significantly regarding the engagement process and the resulting model, the role expectations for the researcher-stakeholder engagement process did not differ between groups (Tables 3 and 4). Effect sizes indicate that there was a minimal to typical relationship (Vaske, 2008) between group membership and role expectations. For example, there were minimal to typical associations between group membership and expectations that research team members would "provide a scientific perspective" (r_{pb} = 0.21) and "guide research questions" (r_{pb} = 0.16).

Research team members generally had higher expectations than stakeholders for the outcomes of the WW2100 project and its researcher-stakeholder engagement process (Table 5). Research

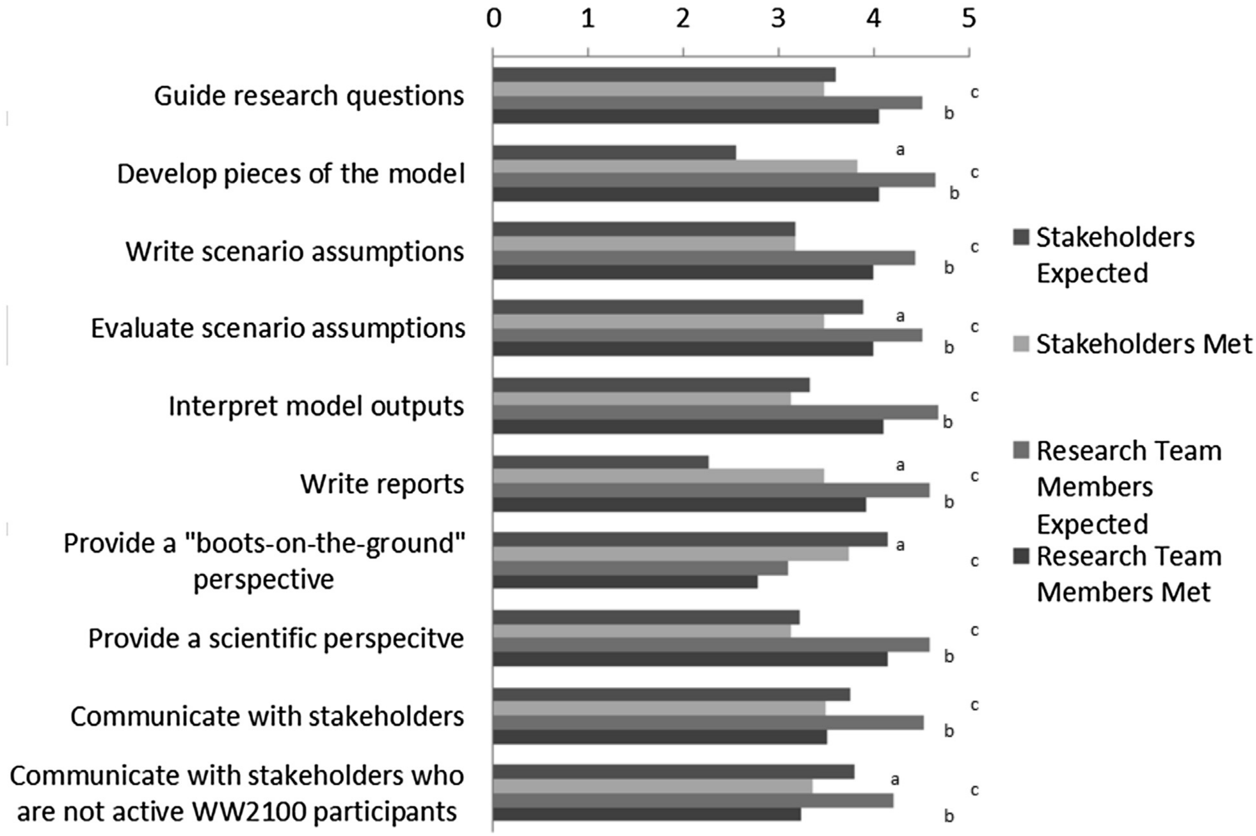

Fig. 2. Expectations for stakeholders and research team members and whether they were met. Values are means ranging from 1 "strongly disagree" to 5 "strongly agree" that the group in question was expected to or fulfilled the following roles. Lower-case letters indicate significant differences at $p < .05$: (a) indicate significant difference between stakeholder expectations and whether they were met; (b) indicate significant difference between stakeholder expectations and whether they were met; (c) indicate significant difference between expectations for stakeholder and research team member roles.

Table 3
Expectations for stakeholder roles by respondent category.

	Research Team	Stakeholder Group	U- value	*p*-value	Effect Size (r_{pb})
Guide research questions	3.56 (0.98)	3.65 (1.02)	0.56	0.575	0.04
Develop pieces of the model	2.25 (1.08)	2.68 (1.07)	1.93	0.053	0.19
Write scenario assumptions	3.13 (1.26)	3.20 (1.11)	0.28	0.784	0.03
Evaluate scenario assumptions	3.97 (0.90)	3.80 (1.04)	0.62	0.536	0.08
Interpret model outputs	3.38 (1.07)	3.31 (1.07)	0.27	0.787	0.03
Write reports	2.28 (1.09)	2.28 (0.86)	0.25	0.806	0.00
Provide a "boots-on-the-ground" perspective	4.21 (0.82)	4.10 (0.85)	0.63	0.532	0.07
Provide a scientific perspective	3.18 (1.01)	3.31 (0.96)	0.53	0.594	0.06
Communicate with stakeholders	3.94 (0.91)	3.72 (0.92)	1.20	0.228	0.11
Communicate with stakeholders who are not active WW2100 participants	3.81 (0.97)	3.82 (0.90)	0.08	0.937	0.00

Cell values are means of reported expectations on a 5-point scale from 1 "strongly disagree" to 5 "strongly agree." Values in parentheses indicate standard deviation.

Table 4
Expectations for research team member roles by respondent category.

	Research Team	Stakeholder Group	U-value	*p*-value	Effect Size (r_{pb})
Guide research questions	4.66 (0.48)	4.45 (0.71)	1.21	0.226	0.16
Develop pieces of the model	4.81 (0.40)	4.59 (0.70)	1.50	0.133	0.18
Write scenario assumptions	4.44 (0.72)	4.49 (0.69)	0.38	0.708	0.04
Evaluate scenario assumptions	4.63 (0.49)	4.50 (0.66)	0.67	0.506	0.10
Interpret model outputs	4.75 (0.44)	4.64 (0.55)	0.85	0.398	0.11
Write reports	4.65 (0.49)	4.53 (0.78)	0.15	0.883	0.08
Provide a "boots-on-the-ground" perspective	2.97 (0.97)	3.21 (1.03)	0.86	0.389	0.12
Provide a scientific perspective	4.78 (0.42)	4.52 (0.66)	1.86	0.063	0.21
Communicate with stakeholders	4.63 (0.55)	4.49 (0.63)	0.95	0.342	0.11
Communicate with stakeholders who are not active WW2100 participants	4.22 (0.71)	4.22 (0.75)	0.14	0.891	0.00

Cell values are means of reported expectations on a 5-point scale from 1 "strongly disagree" to 5 "strongly agree." Values in parentheses indicate standard deviation.

Table 5
Belonging to two expectation groups by professional group in WW2100 researcher-stakeholder engagement process.

Expectation group	Group Belonging[a]					
	Research team	Stakeholder	Total	X^2-value	*p*-value	Effect Size (φ)
				4.71	0.030	0.22
Low to no expectations	21	44	36			
High expectations	79	57	64			

[a] Cell values are counts of individual respondents.

Table 6
Expectations for the researcher-stakeholder engagement process and resulting model by respondent category.

	Research Team[a] (n = 29-35)	Stakeholders[b] (n = 60-64)	U-value	p-value	Effect size (r_{pb})
Progress	4.17 *(0.50)*	3.86 *(0.67)*	2.31	0.021	0.24
To use what we learn to improve the model	4.28 *(0.53)*	3.87 *(0.88)*	2.10	0.036	0.24
Transparency on the project's progress	4.23 *(0.56)*	3.87 *(0.86)*	1.88	0.060	0.21
To be kept up to date as the model evolved	4.03 *(0.67)*	3.87 *(0.89)*	0.71	0.476	0.10
Some of my assumptions to change as the project progressed	4.14 *(0.58)*	3.80 *(0.73)*	2.15	0.031	0.23
Opportunity	4.20 *(0.49)*	3.68 *(0.64)*	3.73	<0.001	0.39
I expected to gain career experience	4.06 *(0.79)*	2.92 *(1.01)*	5.03	<0.001	0.50
An opportunity to work with others in my field	4.26 *(0.75)*	3.75 *(0.91)*	2.82	0.005	0.28
An opportunity to share what I know	3.94 *(0.78)*	3.38 *(0.92)*	2.86	0.004	0.30
An opportunity to learn	4.43 *(0.56)*	4.33 *(0.59)*	0.77	0.440	0.08
An opportunity to work with others outside of my field	4.37 *(0.60)*	3.83 *(0.97)*	2.81	0.005	0.29
Satisfy my curiosity	4.12 *(0.74)*	3.83 *(0.93)*	1.39	0.165	0.16
Interaction	3.79 *(0.58)*	3.22 *(0.84)*	3.66	<0.001	0.34
Frequent interaction with stakeholders	3.65 *(0.76)*	3.13 *(0.94)*	2.65	0.008	0.27
Stakeholders to make attempts to understand my concerns for the project	3.57 *(0.77)*	3.26 *(1.02)*	1.50	0.133	0.15
Research team members to make attempts to understand my concerns for the project	3.94 *(0.73)*	3.48 *(1.07)*	1.88	0.060	0.22
Frequent interaction with research team members	4.00 *(0.76)*	2.98 *(0.88)*	4.83	<0.001	0.50
Applicability	4.33 *(0.55)*	4.07 *(0.80)*	1.44	0.151	0.17
Model results that I could use in my job	3.84 *(0.92)*	3.83 *(1.03)*	0.09	0.925	0.01
An integrated model of water in the Willamette Valley	4.59 *(0.61)*	4.19 *(0.94)*	2.04	0.042	0.22
Model results that would contribute to science	4.56 *(0.66)*	4.19 *(0.87)*	2.20	0.028	0.22
Monitor	3.33 *(0.96)*	3.66 *(1.00)*	1.69	0.092	0.16

Means and standard deviations are measured on a 5-point scale from 1 "strongly disagree" to 5 "strongly agree." Values in parentheses indicate standard deviation.
[a] Research team population varies depending on questionnaire item (n = 29–35).
[b] Stakeholder population varies depending on questionnaire items (n = 60–64).

team members and stakeholders differed in expectations for three of the five factors regarding the researcher-stakeholder engagement process (Table 6). Research team members expected significantly greater inclusion in the progress of the project, opportunities presented by the project and interaction with each other and stakeholders. Research team members and stakeholders expected all but two items to some degree. Stakeholders disagreed with researchers as they did not expect "to gain career experience" (stakeholder mean = 2.92, SD = 1.01) nor "frequent interaction with research team members" (stakeholder mean = 2.98, SD = 0.88). Researchers and stakeholders both expected the process to be "an opportunity to learn," to "satisfy curiosity," that research team members and stakeholders would "make attempts to understand [their] concerns for the project," and that the model would provide "results that [they] could use in [their] jobs." Substantial effect sizes (Vaske 2008) demonstrated a strong relationship between group membership and expectations for the opportunity (r_{pb} = 0.39), namely to "gain career experience" (r_{pb} = 0.50), and for "frequent interaction with research team members" (r_{pb} = 0.50).

4. Discussion and conclusions

Participants in researcher-stakeholder engagement processes are diverse, representing many organizations, motivations, and expectations. As a result, the driving motivations for participation and the expectations of what engagement will achieve vary. However, identifying participant motivations and expectations in one researcher-stakeholder engagement project may aid future projects to clarify participant motivations and expectations and facilitate trust.

Participants were drawn to WW2100 by many motivations. They expressed concern for water in the future and viewed WW2100 as a way to gain knowledge and tools to address future water issues. Some participated because the research was relevant professionally, offered an interdisciplinary approach to water issues, and a way to extend knowledge beyond the project itself. The most common motivation to participate was a simple invitation to attend from a person they knew and trusted.

The social motivations participants identified correspond with the collectivism and altruism motivations described by Rotman et al. (2012), engaging with each other because they anticipated a mutual benefit and/or believe they can help each other. The remaining motivations this study identifies, knowledge, tool, and impact-seeking, correspond somewhat imperfectly with the egoism category of Rotman et al. (2012), indicating that citizen science motivational categories may not transfer to researcher-stakeholder engagement processes. Participants were motivated to participate in the project by what they could gain personally and professionally, however, their motivations were founded not on the superficial exchange of knowledge and tools but deeply on personal relationships with others involved and previous experiences with similar projects.

Transdisciplinary projects like WW2100 typically have three kinds of goals: outcomes for research, outcomes for individuals, and outcomes for social-ecological systems (Shirk et al., 2012). Participant expectations for the WW2100 process, the roles they would play, and the resulting model are consistent with these goals.

Expectations for the researcher-stakeholder engagement process were met, though oftentimes not to the degree expected. Participants had different expectations for the roles stakeholders and research team members would play. On some occasions, stakeholders exceeded role expectations, and on others they fell short. Research team members met all expectations for their roles but to a degree that was less than expected. Research team members did not "provide a boots-on-the-ground perspective" but were not expected to. Finally, participants expected that the resulting model would accurately represent water in the Willamette Valley, contribute to science, and provide results useful to their jobs. The model met these expectations, but to a significantly lesser degree than expected.

It is possible that expectation fulfillment for some aspects of the project may be underestimated here, because this study was conducted during the final year of the project period and not after project completion. A post-process assessment might have yielded different results for some project outcomes, such as the utility of the model in addressing specific questions, as the survey participants would be commenting on a final product rather than one still in development. Answers indicating unfulfilled expectations may simply have indicated uncertainty as to how the project would end. However, because the motivation to participate happened largely in the beginning and because roles were established and experienced by the project's final year, we believe that our results are robust for most of the researcher-stakeholder motivation and the engagement process expectations. Thus they can provide useful guidance towards successful future projects.

Motivations and expectations differed among participant groups in many cases. For instance, only stakeholders expressed a motivation to participate in this project to inform other projects. However, stakeholders and research team members did not differ in the roles they expected each other to play or in their expectations for the research process and resulting model. Research team members were responsible for all of the suggested tasks but providing a 'boots-on-the-ground' perspective. Stakeholders, on the other hand, were expected to provide feedback and communicate results rather than participate in asking questions and conducting research. Stakeholders are commonly expected to contribute knowledge (Johnson, 2011) and based on the expectations for researcher and stakeholder roles, most WW2100 participants expected the researcher-stakeholder engagement process to be a "contributory" project rather than a "collaboration" (Shirk et al., 2012). Contrary to expectation, some stakeholders in WW2100 helped develop pieces of the model and contributed to reports. When stakeholders are included in data interpretation, a project moves into the "collaboration—co-creation" range (Shirk et al., 2012). When all collaborators share in decision-making on a project, true collaboration increases (Kearney, Berkes, Charles, & Wiber, 2007).

Research team members held higher expectations for the process and model than did stakeholders but, in all but one instance, both groups agreed on their expected process and outcomes. Stakeholders differed with research team members on whether they expected to gain career experience through the process, perhaps because the experience gained through engagement is indirectly related to stakeholder careers. When research team members and stakeholders expect the same elements but to a different degree, conflict may arise from differing method and quality standards expectations (Lang et al., 2012). Potential conflicts can be avoided by hosting early engagement meetings to develop shared expectations for the process and each other (Lynam et al., 2010). Several case studies of interdisciplinary research emphasize the importance of establishing expectations and clear roles and responsibilities at the outset of a project (Lang et al., 2012; Mackenzie et al., 2012; Matso and Becker, 2014; Voinov and Bousquet, 2010).

Understanding motivations and expectations for participation in researcher-stakeholder engagement projects is important not only to avoid conflict but also to improve the results produced and the likelihood for future participation. Although researchers tend to emphasize the contributions of their research to science through publications, stakeholders require increased applied research in natural resource management (Johnson, 2011). Furthermore, recent research demonstrates that stakeholder participation in ecological science projects can actually support robust and applicable scientific outcomes in diverse fields such as conservation biology (Conrad and Hilchey, 2011) and ecosystem management (Keough and Blahna, 2006). Equally important, when a project allows participants to meet their needs and expectations, they are more likely to participate again (Eccles and Wigfield, 2002). In WW2100 participants were motivated to join the project by previous positive experiences with other participants. Thus, engaging with stakeholders in transdisciplinary research which meets participant needs and expectations may form relationships and empower stakeholders to participate in future projects.

To achieve, and continue achieving broader impacts through researcher-stakeholder engagement, projects must address what participants expect. In WW2100, participants expected to collaborate with one another through frequent interactions. They expected to gain and share knowledge and to play different roles to contribute to the project. To inform natural resource management through broader impacts, research must address the product expectations of their stakeholders. This project's stakeholders expected a model which accurately represented water in their region and which produced useful results. Future projects can look to WW2100 as an example of what their stakeholders and research team members may expect and use these results to better define and improve their own engagement process.

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Appendix A. Select supplemental survey results and analysis tables

See Tables A1–A3

Table A1
Exploratory factor analysis of researcher-stakeholder engagement process and model expectations.

	Factor Loadings[a]				
	Factor 1/Progress	Factor 2/Opportunity	Factor 3/Interaction	Factor 4/Applicability	Factor 5/Monitor
To use what we learn to improve the model	0.80				
Transparency on the project's progress	0.78				
To be kept up to date as the model evolved	0.79				
Some of my assumptions to change as the project progressed	0.65				
I expected to gain career experience		0.79			
An opportunity to work with others in my field		0.76			
An opportunity to share what I know		0.71			
An opportunity to learn		0.59			
An opportunity to work with others outside of my field		0.57			
Satisfy my curiosity	0.43	0.49			
Frequent interaction with stakeholders			0.86		
Stakeholders to make attempts to understand my concerns for the project			0.82		
Research team members to make attempts to understand my concerns for the project	0.44		0.70		
Frequent interaction with research team members		0.45	0.70		
Model results that I could use in my job				0.82	
An integrated model of water in the Willamette Valley	0.43			0.67	
Model results that would contribute to science	0.51			0.64	
An opportunity to monitor the type of research being done at OSU					0.92
Eigenvalue	3.26	3.17	3.07	2.06	1.33
Percent (%) of total variance explained[b]	18.12	17.60	17.03	11.03	7.36

[a] Principal component factor analysis with Varimax rotation. Only factors with eigenvalues greater than 1 and items with factor loadings greater than 0.40 were retained in the final factor structure (Tabachnick & Fidell, 1996). Items coded on a 5-point scale from 1 "strongly disagree" to 5 "strongly agree".
[b] Total cumulative percent (%) variance explained = 74.

Table A2
Expectations for stakeholder roles and whether they were met.

	Expected[a]	Met[a]	Z-value	p-value	Effect Size Cohen's *d*
Guide research questions	3.60 *(1.01)*	3.48 *(0.72)*	1.01	0.312	0.14
Develop pieces of the model	2.55 *(1.10)*	2.83 *(0.85)*	2.43	0.015	0.29
Write scenario assumptions	3.17 *(1.17)*	3.17 *(0.81)*	0.112	0.911	0.00
Evaluate scenario assumptions	3.88 *(0.99)*	3.48 *(0.74)*	3.12	0.002	0.46
Interpret model outputs	3.32 *(1.09)*	3.13 *(0.72)*	1.30	0.195	0.21
Write reports	2.27 *(0.87)*	2.48 *(0.79)*	1.99	0.047	0.25
Provide a "boots-on-the-ground" perspective	4.15 *(0.81)*	3.73 *(0.78)*	4.18	<0.001	0.53
Provide a scientific perspective	3.22 *(0.96)*	3.13 *(0.82)*	0.88	0.377	0.10
Communicate with stakeholders	3.75 *(0.94)*	3.49 *(0.74)*	1.95	0.051	0.31
Communicate with stakeholders who are not active WW2100 participants	3.80 *(0.92)*	3.36 *(0.73)*	3.31	0.001	0.53

[a] Cell values are means of reported expectations on a 5-point scale from 1 "strongly disagree" to 5 "strongly agree". Values in parentheses indicate standard deviation. Effect size is considered substantial at $d > 0.80$, typical at $d > 0.50$ and minimal at $d > 0.20$.

Table A3
Expectations for research team member roles and whether they were met.

	Expected[a]	Met[a]	Z-value	p-value	Effect Size Cohen's *d*
Guide research questions	4.51 *(0.65)*	4.06 *(0.58)*	4.47	<0.001	0.73
Develop pieces of the model	4.65 *(0.66)*	4.05 *(0.74)*	5.29	<0.001	0.86
Write scenario assumptions	4.43 *(0.72)*	4.00 *(0.57)*	4.07	<0.001	0.66
Evaluate scenario assumptions	4.51 *(0.64)*	3.99 *(0.71)*	4.34	<0.001	0.77
Interpret model outputs	4.67 *(0.52)*	4.10 *(0.70)*	5.46	<0.001	0.93
Write reports	4.58 *(0.71)*	3.91 *(0.80)*	5.55	<0.001	0.89
Provide a "boots-on-the-ground" perspective	3.10 *(1.01)*	2.78 *(0.91)*	3.43	0.001	0.33
Provide a scientific perspective	4.59 *(0.61)*	4.14 *(0.72)*	4.60	<0.001	0.68
Communicate with stakeholders	4.55 *(0.68)*	3.51 *(0.72)*	5.99	<0.001	1.51
Communicate with stakeholders who are not active WW2100 participants	4.21 *(0.75)*	3.24 *(0.95)*	5.93	<0.001	1.13

[a] Cell values are means of reported expectations on a 5-point scale from 1 "strongly disagree" to 5 "strongly agree". Values in parentheses indicate standard deviation. Effect size is considered substantial at $d > 0.80$, typical at $d > 0.50$ and minimal at $d > 0.20$.

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