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"I Won't Use the Term Dumbing It Down, but You Have to Take the Scientific Jargon Out": A Qualitative Study of Environmental Health Partners' Communication Practices and Needs

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Abstract. Effective research translation and science communication are necessary for successful implementation of water resources management initiatives. This entails active involvement of stakeholders through collaborative partnerships and knowledge-sharing practices. To follow up a recent study with the National Institute of Environmental Health Sciences (NIEHS)–funded Center for Oceans and Human Health and Climate Change Interactions (OHHC[2]I) project investigators, the center's Community Engagement Core (CEC) documented center partners' science communication practices and needs to inform a collaborative training and improve investigator-partner bidirectional communication. Thirteen (13) individuals participated in 10 semi-structured qualitative interviews focused on their research translation needs, science communication and dissemination tactics, and interactions and experiences with scientists. Based on our findings, we recommend a collaborative, scientist-stakeholder training to include plain language development, dissemination tactics, communication evaluation, stakeholder and intended audience engagement, and strategies for effective transdisciplinary partnerships. This work contributes to the knowledge and understanding of stakeholder engagement practices specifically focused on science communication that can enhance relationship-building between academia and partners involved in environmental health–focused initiatives in the context of South Carolina but applicable elsewhere.

INTRODUCTION

Bidirectional communication and active engagement with stakeholders is an increasingly common requirement for successful implementation of interventions in environmental health sciences, water resources management initiatives, and addressing complex environmental problems (Megdal et al. 2017; Paulson et al. 2017; Freeman et al. 2018; Reed et al. 2018; Mackenzie et al. 2019; Neet et al. 2019; Misra et al. 2020). The Community Engagement Core (CEC) of the National Institutes of Health (NIH) National Institute of Environmental Health Sciences (NIEHS) funded Center for Oceans and Human Health and Climate Change Interactions (OHHC2I) at the University of South Carolina recently conducted a study with center investigators about their research translation and science communication practices and training needs (Altman et al. 2020). This paper describes a follow-up analysis of the center's partners' science communication practices and needs with the ultimate goal of ensuring clear and productive communication between investigators and their stakeholders. In addition, integrated water resource management will benefit from learning about partner preferences and successful practices for interacting with partners and translating scientific research into useful applications in the context of South Carolina. This work contributes to the knowledge and understanding

of stakeholder engagement practices specifically focused on communication that can enhance relationship-building between academia and partners involved in environmental health–focused initiatives.

There is an emerging trend to restructure research grant application and review processes, provide funding opportunities for research partnerships, and incorporate training and education resources for scientists and community members to ensure that communities are engaged in and benefit from health research (Jessani et al. 2018; Tait and Williamson 2019; Grayson et al. 2020). These cooperative initiatives provide an opportunity for historically excluded segments of the public that have been disenfranchised by the research enterprise to be actively engaged in addressing health inequities within their communities (Prochaska et al. 2014; Huang and London 2016; Neet et al. 2019). The NIEHS and the National Science Foundation (NSF) currently fund four research centers of Oceans and Human Health (OHH) across the United States. These OHH centers examine how human health may be affected by emerging environmental conditions of the Great Lakes, coastal waters, and oceans. The OHHC2I at the University of South Carolina is a collaborative partnership with the College of Charleston, the Citadel, Baylor University, and the University of Maryland Center for Environmental Science. The OHHC2I's specific foci include freshwater harmful algal blooms (HABs), infectious microbes (*Vibrio* spp.), and contaminants of emerging concern (microplastics). The goal of OHHC2I is to enhance knowledge of the potential effects of climate change on *Vibrio* bacterial infections and the production of toxins from freshwater cyanobacteria, both of which may adversely affect human health. The OHHC2I develops tools such as forecast models to inform the public about health risks associated with these organisms and with the occurrence of microplastic pollution in coastal waters. The center consists of four research projects with an administrative core and a community engagement core (CEC; ohh.sc.edu). The CEC helps ensure that research is appropriately translated and helps facilitate information flow between center investigators and center partners, which is an important component of the center. NIEHS defines research translation as the process of communicating and promoting the application of scientific accomplishments, and they developed a translational research paradigm to help researchers design research, identify partners and stakeholders that can use the research in environmental decision-making, and track progress (Pettibone et al. 2018).

OVERALL GOAL

This study aimed to better understand the science communication practices and needs of center stakeholders to improve collaboration between investigators and their key partners, with the ultimate goal of improving multilevel science communication and research translation. The findings will assist with the development of collaborative trainings for investigators and their stakeholders, facilitated by the center's CEC team and key partners. In addition, results regarding stakeholder communication needs will provide the CEC with information on how to support and recommend dissemination strategies of key partners.

BACKGROUND AND RELATED WORK

The current literature on research translation and science communication–related interactions among researchers, stakeholders, and community members demonstrates that the process is evolving toward participatory approaches and knowledge co-production (Fleming et al. 2014; Winterbauer et al. 2016; Beier et al. 2017; Reed et al. 2018; Mackenzie et al. 2019). Collaborative partnerships between researchers and stakeholders can result in substantial environmental policies and social benefits (Brauer et al. 2004; Holmes and Savgård 2009; Freeman et al. 2018; Misra et al. 2020). Increased stakeholder involvement improves relationships and understanding between researchers and their intended audiences and serves as a critical capacity-building factor for environmental decision- and policy making (Holmes and Savgård 2009). In South Carolina, integrating stakeholder and public engagement with resource management planning has been instrumental in the development process of a state water plan. The management of water resources and related issues are local and should include a diverse group of stakeholders in various phases of the planning process (Walker et al. 2019). Some examples of successful OHHC2I community–focused collaborations in South Carolina include ongoing work with center partners at the Lake Wateree WaterWatch citizen-science group (https://sites.google.com/site/watereewaterwatch/), the Midlands Rivers Coalition (https://howsmyscriver.org/), the Check My Beach collaboration (https://www.checkmybeach.com/), and collaborations with the Lowcountry Alliance for Model Communities (LAMC; https://lamcnc.org/). On a statewide scale, the center and its partners are working together to develop a holistic Community-Managed Disaster Risk Reduction (CMDRR) training that is being piloted with participants from environmental justice (EJ) communities around South Carolina (SC). Formally known as EJ STRONG, this collaboration's main activity is a community-level preparedness training for natural disasters such as hurricanes, floods, and wildfires. As part of the training, tools are presented to assist block captains from EJ communities with tasks they will conduct within their communities to enhance community-based disaster preparedness.

Community and stakeholder engagement is a fundamental practice in environmental health sciences to promote public health, and bidirectional communication

between researchers, community members, and stakeholders increases the potential to promote public health initiatives and preventive behaviors from conditions that impact human health and well-being (Friedman et al. 2015). However, multilevel stakeholder involvement, discussion, and collaborative resolution of critical environmental health issues are often lacking. While community-engaged research can help improve community resilience (Burwell-Naney et al. 2019), lack of involvement and representation in decision-making may result in additional environmental burdens on community segments—particularly minority communities, which are already cumulatively burdened by higher environmental health risks (Prochaska et al. 2014). Stakeholder participation can also be obstructed by deficient transparency, inadequate communication of scientific knowledge, stakeholder inability to interpret research findings, and limited capability of policy makers to incorporate scientific results into effective environmental decisions and policies (Holmes and Savgård 2009).

Science communication is the process of providing information that assists an intended audience in making sound decisions and understanding the impacts associated with their decisions (Fischhoff 2013). Communicating research objectives and findings with the community directly affected by the results enhances their participation in future research projects (Brauer et al. 2004; Mackenzie et al. 2019). Disparities in environmental literacy (McBride et al. 2013) and environmental health literacy (White et al. 2014; Finn and O'Fallon 2017; Gray 2018) may influence public advocacy and understanding of environmental issues (Friedman et al. 2015). Engaged research and other initiatives related to boundary spanning and knowledge co-production produce knowledge that is more meaningful for the participants (Mach et al. 2020). In this regard, boundary-spanning organizations help with information dissemination and uptake and help perform key functions that distinguish their work from others (Gustafsson and Lidskog 2018). In addition to the OHHC2I's CEC functions, some examples of such successful organizations in the United States are the National Oceanic and Atmospheric Administration's Regional Integrated Science and Assessments program (https://cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/RISA/About-RISA), the National Estuarine Research Reserve System (https://coast.noaa.gov/nerrs/), and others. Individuals employed by such programs and organizations perform key boundary-spanning functions that include facilitation, strategic planning, and project management (Goodrich et al. 2020).

METHODS

This study used purposive (intentional selection of interviewees with strong topical knowledge) and snowball (participants identified additional interviewees) sampling (Patton, 2002) to invite OHHC2I partners to participate in qualitative interviews. The research team contacted center investigators to request recommendations for key center partners to serve as interviewees, who were then invited via email to participate in virtual qualitative interviews. Twenty-two (22) individuals were contacted on August 5, 2020, and 13 individuals participated in 10 interviews between August 13 and October 1, 2020. One group interview included 3 interviewees; all other interviews only had 1. Informed consent was obtained from all interviewees. Semi-structured qualitative interviews focused on stakeholders' science communication and dissemination strategies and research translation needs. This research was approved by the University of South Carolina Institutional Review Board.

The CEC team created an interview guide, which went through several rounds of revisions. The final version of the interview guide consisted of 24 open-ended questions (see Appendix A). The questions probed for stakeholders' organizational foci, intended audiences, dissemination tactics, science communication needs and preferences, how they communicate uncertainty, and their interests in research-translation training. Each interview lasted 45 to 60 minutes and was facilitated in pairs (one facilitator and one note-taker) by five authors. All interviews were conducted virtually using videoconferencing software, Zoom (zoom.us, 2020), due to in-person meeting limitations during the COVID-19 pandemic. Interviews were audio recorded and transcribed verbatim by a professional transcription service. Original interview audio files were uploaded securely to a password-protected folder with limited user access. Transcripts were reviewed for accuracy by three authors and were uploaded in NVivo 12 (NVivo, 2019), a qualitative data analysis software, for thematic coding.

Data analysis involved a semantic (explicit, as stated) thematic approach (Braun and Clarke 2006, 2019). The authors utilized a hybrid approach to thematic analysis, using both deductive and inductive coding (Fereday and Muir-Cochrane 2006) for a more complete analysis of collected qualitative data. The first iteration of the codebook was deductively developed based on the interview guide by four authors with qualitative data analysis experience. Three authors initially coded two interviews each using the first iteration of the codebook and organized the data into NVivo 12, then analyzed two transcripts to refine the codebook inductively before testing for consistency in coding. Intercoder reliability demonstrated agreement above 95% between the three coders, and 100% coding reliability was achieved after review and discussion between coders in NVivo 12. Coders communicated frequently by phone and email to discuss discrepancies in coding to maintain consensus in coding themes. As new themes emerged from the data during coding, they were added to the codebook, which the

coders continued to refine for consistency using an iterative process (Laditka et al. 2009). Notes taken during interviews were consulted alongside the transcript during the coding and analysis stage, and original notetakers and facilitators were granted review of compiled themes and analyses to ensure full team agreement.

RESULTS

Interviewees' organizations can be categorized as nongovernmental organizations (four), state or federal regulatory agencies (four), water utilities (one), and a water resources research center (one). All interviewees have a mid- to high level of seniority in their organizations. Their work includes water-quality monitoring, meaningful engagement of environmental justice communities, conducting environmental research and populating databases, and supporting and making regulatory decisions or policy recommendations. Organizations' priorities included providing ongoing education, communicating data, and sharing resources to aid decision-making in topics connected to the protection of public health and the environment. When asked to describe the interviewees' environmental health foci and interests related to OHHC2I research, interviewees predominantly mentioned harmful algal blooms and *Vibrio* bacteria. Interviewees also mentioned environmental health topics such as contaminants of emerging concern and unregulated contaminants (microplastics), reproductive health, air quality, environmental justice, and infrastructure needs (e.g., weatherization of homes).

The main themes from the interviews presented in this section include: (1) communication practices, (2) communication challenges, (3) perceptions of research translation, (4) communicating about uncertainty, (5) collaboration with scientists, and (6) training in science communication and research translation. Main themes and subthemes can be found in Table 1, and the full table of results is available in Appendix A.

COMMUNICATION PRACTICES

When asked about the organizations' intended audiences for environmental health communication, interviewees mentioned scientists and academia; policy makers (including congressional outreach and local politicians); water professionals, including large and small utilities in the state; physicians; the general public; government organizations (federal, state, tribal, and local government); and NGOs. Specialty populations mentioned by some interviewees included certain community residents or homeowners' associations, youth, environmental justice groups, African American community members, guidance counselors and members of the education system, and specialty-interest groups. When asked how they define *community* as it pertains to their work, several interviewees defined their community as a geographical location and its residents, while others defined it as the different populations and subpopulations with whom the interviewees work. For others, the community was described as those that utilize the informational resources (e.g., reports, tools, forecasts, advisories, publications, databases) and natural resources

Table 1. Summary of Emergent Themes

Main Themes	Subthemes	Interview Question(s) through which Themes Emerged
Communication Practices	Intended Audiences, Definition of Community, Communication Channels, Dissemination Partners, Ongoing Dialogue, Measures of Communication Effectiveness	5, 6, 7, 9, 10, 11, 17
Communication Challenges	Impact of COVID-19 on Communication, Technology, Building Relationships, Mistrust, Working with Public, Better and More Timely Communication between Entities, Working with Others, Time Constraints	8
Perceptions of Research Translation	Perceptions of Research Translation	12
Communicating about Uncertainty	Experiences with Scientists, Comfort Level with Intended Audiences	19, 20
Collaboration with Scientists	Science Data Sources, Working with Scientists, Providing Information Needs to Researchers, Ongoing Dialogue, Timing of Results Dissemination, Preference for Receiving Research Finding	13, 14, 15, 16, 21, 22
Training in Science Communication and Research Translation	Past Training, Training Needs, Science Communication Needs	18, 23, 24

(e.g., drinking water, lake/reservoir, shellfish harvesting areas, swimming beaches) facilitated by the interviewee.

Interviewees reported multiple communication methods to engage with their intended audiences. The most commonly mentioned were websites, social media, flyers, newspaper articles, in-person communication, and emails. In-person communication channels involved meetings (e.g., community and public meetings, two-day events), one-on-one contact with community representatives or a public participation coordinator, phone calls or an open line to the public via telephone for questions, utility plant or community tours and career days, festivals, and participatory learning and action (PLA) tools like focus groups and charrettes. Other communication channels mentioned include video-conferencing platforms, blogs, radio, reports, videos, press releases, television, and conferences. One interviewee indicated relying on printed advisory signs at points-of-access of recreational waters. Interviewees also reported they often communicate with their audiences through printed communication via peer-reviewed literature, newsletters, academic press, or organization journals. A table with exemplary quotes can be found in Appendix B.

Interviewees also mentioned partnering with multiple academic, federal, state, and professional organizations to disseminate environmental health information, and they stressed the importance of such partnerships. Partners helped each other not only with information dissemination, but also with addressing ongoing and emerging issues of concern, crafting messages, and facilitating community involvement in projects. Many interviewees practiced an ongoing dialogue with their intended audiences. They reported responding to questions and data requests from contractors and members of the public, as well as in in-person meetings and individual interactions through emails and phone calls or at conferences. As federal agencies have legal requirements for stakeholder dialogues, interviewees reported that interested audiences often reach out to them directly.

The majority of interviewees reported that their organizations assessed the effectiveness of their communications efforts and indicated areas for improvement in conducting evaluations. Evaluation strategies mentioned include organizational retreats, online evaluations, follow-up surveys, attendance counts, and other forms of feedback from community members. Some organizations had dedicated units or personnel to perform communication and outreach, along with evaluation of these activities; organizations that did not have a designated person reported having difficulties with performing such evaluations.

COMMUNICATION CHALLENGES

Interviewees identified several challenges with reaching their intended audiences, specifically in engaging certain population segments within the general public. One interviewee identified a challenge in reaching diverse audiences that have not traditionally participated in research, despite attempts to directly engage these community members in locally preferred settings. Another interviewee indicated that funding constraints made it difficult to distribute information to their intended audiences.

Interviewees emphasized the challenge of establishing trust and credibility with their audience (e.g., public, policy makers) to create sustainable partnerships and relationships. Several of the interviewees represented a regulatory agency; for those interviewees, an immediate barrier they worked to overcome is public suspicion and distrust of the government. One interviewee described such public perception and how the agency overcomes it:

> *Being a large state agency, we have to overcome that stereotype that, you know, "we are the government." There is a lot of mistrust you have right off the bat when coming in and trying to help a community, if you're a government agency. I live in this community, [where] I work, you know, I have relationships with them. So that's always, to me, the first hurdle you overcome is establishing that trust, and getting them to see past the large state agency, and what we're there to do. . . . And then our public participation coordinator [builds] these very strong relationships with [some] of the community leaders or the key community [members] of these groups that we're working with, and they give some pretty honest feedback and we always learn from that, too.* (**Interviewee 3**)

Interviewees have attempted to mitigate these barriers by building relationships with various communities, creating and training block captains or citizen academies to reach audiences in a peer-to-peer format and by using bidirectional communication methods on an ongoing basis to ensure that activities were understood by, supported by, and reported back to the community.

> *The community will identify the individual that will serve as—we're calling them block captains—so they were really responsible, let's say, for a street or maybe a street or two in their neighborhood, and they will be the ones that will have robust conversations with their people on their assigned street or streets. And [name of the organization] is the one that will have the direct communication with that individual. We will provide training to them so that they are trained on emergency planning, preparedness, recovery, and also some other training in leadership development and some other things that we find that has been useful for someone that would be a key communication person in a community setting like that.* **(Interviewee 1)**

Interviewees also identified many challenges around the use of technology to communicate with their intended audiences, including (1) lack of access to digital devices or

a reliable internet source, (2) internal constraints on use of social media as an official entity, and (3) limited personnel/time to devote to social media and/or website creation and maintenance. This was made more challenging at the onset of the novel coronavirus, SARS-CoV-2 (COVID-19), pandemic when previously successful and preferred in-person communication methods became virtual. Interviewees' organizations adopted videoconferencing platforms with mixed success, but they had to cancel annual meetings, experienced difficulty facilitating meaningful conversations in an online format, and found that intended audiences were either unfamiliar with or unable to access these platforms. In response, one interviewee found success in utilizing peer assistance to connect audience members to virtual meetings over the phone.

> *But all of those opportunities for citizens' gathering, citizens' meetings have gone out the window. And so, we have done a few surveys trying to follow up with a couple of communities that are trying to—they just want to know what's going on. But that's been the most difficult part, is the interaction with the individuals, and particularly the groups of individuals that share common concerns. You can do a virtual meeting, but with a lot of private citizens trying to do Zoom and Skype and things like that are unfamiliar to them. And it's not a comfortable media for a back-and-forth exchange when only one person at a time can speak. So, to me right now the pandemic is the biggest impediment to interaction with our audience.* **(Interviewee 4)**

Another interviewee found that offering virtual content increased their reach and reduced costs.

> *Our whole model of doing things is based on getting people together in groups and providing in-person training. And so when that became impossible to do we had to switch gears totally to go to virtual content. So that's been a challenge, but it's also been very rewarding in certain ways, because now we're actually able to reach more people. So we've seen an increase in the number of persons that have signed up for some of our workshops and events because it is much easier for them to be able to spend a couple of hours logging on to a webinar, versus [traveling]. And so saving the time and expense and being able to get our content virtually has turned out to be in some ways a positive thing.* **(Interviewee 8)**

PERCEPTIONS OF RESEARCH TRANSLATION

Interviewees defined research translation as (1) the process of communicating science or research findings to their intended audience in a way the key audiences can understand, or (2) the process of applying research to support policy development or actionable steps. One interviewee defined research translation more specifically as framing a message from the perspective and mission of the organization.

The process of science communication to an intended audience was described as a function of increasing awareness about an issue and improving public decision-making. Various factors were listed, including audience identification, making the content relevant, and using the appropriate vernacular or level of detail to ensure understanding. Interviewees included the need to present technical information in plain language and in a format (e.g., graphics, reports, pamphlets) that allowed their intended audiences to quickly and easily understand research findings or scientific messages. Two interviewees shared that they translated research to their intended audiences through nested messages of increasing degrees of technical complexity, allowing consumers of different levels of understanding to dig into the weeds of the analyzed and synthesized data.

> *Being able to translate [the research] to [the] citizenry, and then being able to translate risk to citizenry in plain language. That the message is plain, clear, gives the risks in a—yeah, basically in a very plain language, and maybe even associative to language . . . short, succinct, kind of study, scope, direct impact. And then supporting documentation for further digestion [to] dig into the weeds of it as well.* **(Interviewee 9)**

One interviewee reflected on how feedback helped shape and improve their communication effectiveness:

> *[What] we found out is that the way that we were communicating was going over people's heads. So we changed the language and we have gotten more refined with how we share information, the language that we use, the mechanisms which we share that information . . . so we were using language that they were not familiar with, we were using acronyms, you know, the typical things that you do when you are working in a field of science and technology. We had to break that [down] and be able to communicate with our communities in a language that they could understand. So we provide [an] infographic and then there are further links that go to the abstract, and then there's a further link that provides them the full report.* **(Interviewee 1)**

Some interviewees cautioned that translation of research to plain language should not assume that the average layperson is unintelligent, but that it was important to provide information that is digestible by the general public with varying levels of familiarity with scientific terms and concepts and varying perspectives.

> *I've been to meetings where scientists are trying to explain what they do, you know, and the general public is pretty intelligent. You get people who are artists and people like*

that and they wanna learn, but if you start—if you talk to them in language they don't understand, it's ridiculous. So we need to do better at that. . . . You [want to] disseminate in language that the public understands through blogs and journals and this and that to the public about what [the science] means. And I've found that's sort of an art—how to take the scientific literature and translate it into an intelligent layman's point of view. **(Interviewee 2)**

One interviewee disagreed on the need to translate research when scientists are the intended audience, while most assumed that scientists can grasp others' research.

And that's not easy because we think in very abstract terms, we have languages that are very—and even within science, you know, you talk to somebody else in another field and you say, wait a minute, what are you talking about? **(Interviewee 2)**

I prefer talking with scientists just 'cause even if you're in completely different scientific disciplines, there usually is enough overlap in [educational] backgrounds that you can actually talk with each other about very technical topics and [ask] very relevant questions. (**Interviewee 10)**

From the interviewees' perspective, the process of applying research was the responsibility of the scientist/researcher, and the public/community was considered the recipient of such packaged applications. According to interviewees, this process entailed identifying the impacts of the research findings on a specific audience or on the general public and developing recommendations for policies, prevention targets, or mitigation steps to protect public health. One interviewee commented on how the translation process can be lengthy, and the lack of appreciation of science can be attributed to the public's lack of knowledge of how the scientific process works.

Maybe 20 years from the ideas that come out of a basic lab to its ability to actually impact patient care. That was the tradition of translation, but then I think translation is also the job we have of educating the general public about science, and that's difficult because there seems to be in this country a lack of understanding and appreciation of science. . . . I think the biggest problem we have in "translating" scientific ideas to the general public is people have no idea how science works. I mean, science is a process. **(Interviewee 2)**

COMMUNICATING ABOUT UNCERTAINTY

When asked, "How comfortable do you feel communicating with your intended audiences about uncertain research findings?" all interviewees reported that they were very comfortable. Their comfort in receiving communication from scientists on conditional results was attributed to their understanding of the scientific process and the communication skills of the scientists relaying the information. Regardless of their role in receiving or presenting uncertain findings, interviewees agreed that because science is always evolving, uncertainty is understood as a part of the scientific process. Thus, there was comfort in discussing research findings before peer review. In a similar vein, interviewees discussed the importance of presenting novel, contradictory, and unexpected findings, noting that they add to the literature and inform future studies and research applications.

An interviewee operating as an official entity of its state government, however, described the delicacy of presenting novel findings that are not well studied to other scientists looking for authoritative guidance on an issue that was not yet well understood.

So I have to be very careful in crafting these statements to those, and making sure researchers understand the curb and gutter especially that I have to play in, or our agency has to play in in that we can make definitive statements, and then we have to make sometimes educational statements that don't make it too definitive. And so we have to be very careful that we don't oversell—we don't want to make statements that we have to roll backwards. . . . Research has a lot of eyes on them. **(Interviewee 9)**

Interviewees quickly differentiated between the scientific community and other audiences regarding their comfort around communicating uncertainty. Several interviewees reported feeling very comfortable communicating uncertain findings to their intended audiences, and a few felt that it is necessary to do so in order to protect public health or improve decision-making. However, the majority of interviewees attributed absolute thinking to the general public, which impacted their level of comfort in communicating uncertain findings to audiences that demand firm answers. Some believed this was due to a lack of public understanding of the scientific process in general, while others pointed to the public's need for clear guidance to make decisions for their health and safety.

So, we don't have, for instance, a water quality index where we can take all of our data and parameters and roll that up into a "What's the state of the lake?" and "Is it getting better or is it getting worse?" So, there are things you can point to, but the information is not really well collated or indexed into a measure that you can just say, "Here's the number for right now and here's the trend over time." That would be extremely helpful to be able to do that. . . . When you get to the broader community, [people are] less interested in the hard science and they just want to know, "Is the water safe to swim in? Are the fish healthy? How's that changing and what are the trends?" **(Interviewee 5)**

Right, that's always difficult because the general public wants to have an answer, with no uncertainties. And in science, you just can't. **(Interviewee 7)**

When describing communication about uncertain risk levels to an intended audience, the level of comfort significantly decreased.

Trying to explain [harmful algal bloom] and put the risk in a way that a layperson can understand and accept can be the some of the biggest challenges I've encountered over the years. **(Interviewee 3)**

Interviewees responsible for providing statements or warnings about water quality and harms to public health reported needing to balance the public's need for information to make sound decisions while limiting their misinterpretation of risks. These interviewees also discussed the importance of tone so as not to raise alarm while also not downplaying a potential risk to the point of it being ignored.

So, I think that translation from science and engineering to a lay audience trying to give them some level of comfort and true understanding but not overwhelming them or making them more nervous is a challenge I think with anybody. **(Interviewee 10)**

COLLABORATION WITH SCIENTISTS

Interviewees' relationships with scientists and the needs of their intended audiences dictated their preferences for working with scientists at the beginning of a research project, as well as the timing and format for receiving research dissemination products. When asked where interviewees acquire environmental health data, many interviewees reported generating their own data in addition to using secondary data sources. Secondary sources included federal and state government (e.g., Centers for Disease Control and Prevention, United States Environmental Protection Agency, South Carolina Department of Health and Environmental Control), scientific-based sources (e.g., academia, scientific literature, scientific community), and partnerships (e.g., riverkeepers, utilities, and municipalities to collect data, and partner organizations involved in research).

Interviewees indicated that they have good experiences working with scientists and make progress through communication with scientists. Scientists offered technical expertise and helped interviewees meet the needs of the community, and such collaborations helped translate findings into something more meaningful on a bigger scale. Successes in these experiences were attributed to mutual agreements on the work process (e.g., collaborative problem-solving model and community-based participatory model), close working relationships, and having a cohort of collaborators. Oftentimes collaborations took a long time to establish and maintain, but such relationships built trust and made collaborations more enjoyable.

I have a large cohort of collaborators that I work with. Most of the environmental problems that are out there right now are very multidisciplinary, so you have to have a cohort of specialists. The best thing you can do as a scientist is actually know where your knowledge starts and stops. The worst thing you can do is actually think that you can do more than what you really can do. So, to fill those gaps in, you find people to work with; collaborators. **(Interviewee 7)**

We love partnering with other organizations. We're a relatively small nonprofit organization, so partnering is very helpful. . . . And so we really enjoy being at the table and providing input for our members. **(Interviewee 8)**

Interviewees were asked to describe their experiences in providing information needs to researchers at the beginning of a project; their responses varied from "not being involved in research" to "requests for information occur all the time." A description of information needs that interviewees provided to researchers included contacting and communicating with collaborators' networks, providing data to scientists, supporting trainees with their projects, and providing letters of support for grant proposals. Most interviewees agreed there is encouragement from researchers for ongoing dialogue, which aided the receipt of timely information.

I try to run our center as a collaborative center. And I'm always trying to be open to forming teams of people to work on projects. I've just found from my professional experience that always works better than trying to go out by yourself, design your own project, get your own students, stay in your own little spot, and then send the information out to others. I think it's less productive than kind of collaborating on the front end and getting information from people on the front end. (**Interviewee 6)**

Interviewees conveyed a preference for receiving data and information from other scientists and researchers on a consistent basis, as well as allotting a set time period to distribute and communicate the information to available formats (e.g., publications, website, mobile applications). Many interviewees indicated that such information came from personal networks of established connections with scientists, reaching out to colleagues, and other sources of scientific communication (e.g., presentations and publications). One interviewee described seeking collateral information to help guide decisions, but they ultimately stated that formal decisions cannot be made on uncertain findings due to their impact on the general public.

Some interviewees expressed concerns of constraints on the information flows from the academic community, which

is inherently guided by the peer-review publication process. They noted that the publication process can take too long to wait for release of research results to the public after they are published. Close relationships between scientists and certain interviewees, however, put new research findings on the radar of regulatory and other decision-making authorities before the results were distributed through academic channels.

> *The ones that I know personally are happy to talk to me about what they're seeing, what they think their research is showing and telling them. And then [they] slap the cuffs on and say, "you can't share this with anybody until I get it published.". . . That doesn't necessarily stop us from continuing to work together and build on those. . . . So there is a built-in screen, a built-in blockade between the research community and the policy makers.* (**Interviewee 4)**

Interviewees concurred that the urgency of receiving research results depended on the severity and risk or threat to human health and/or the environment. They preferred to be informed on research progress when scientists were confident in their results and if the results indicated any potential risks to the general public. For example, information with immediate impacts on human health or the environment should be conveyed as soon as possible, as opposed to distributed after publication. In particular, interviewees working in regulatory agencies preferred to receive findings in time to develop health risk communication messages along with developing policies and regulations (if applicable) to protect the public and the environment. All interviewees agreed that research should be made available to the public and that many audiences would benefit from more regular updates to inform health decision-making.

> *It depends on the speed with which that message needs to get to someone. For specific short-term advisories, making sure you're hitting the person that's at the location that may be directly involved in that* [*activity*]*, and may need to know for their immediate needs.* **(Interviewee 9)**

Interviewees indicated a preference in receiving research findings in concise, predigested options, like a one-pager or social media–friendly message, and as a full report or a peer-reviewed article. Some interviewees preferred to receive nested layers of detail in order to present these findings to the public in varying levels of complexity.

TRAINING IN RESEARCH TRANSLATION AND SCIENCE COMMUNICATION

More than half of the interviewees reported having had some training in research translation or science communication (e.g., short courses, seminars, workshops, webinars). However, there was variation in what interviewees considered formal training. A few interviewees defined formal training as college-level coursework, and there was some conversation about how that was lacking in the scientific disciplines. While a few had taken a college-level scientific writing course, none reported any college training in research translation. Half of the interviewees reported that their training in research translation came from experiences on the job or in learning from other scientists and researchers. This included learning more about communities' needs or communication preferences, learning from mistakes, and piloting messages with a test audience.

> *I have no formal training. It's just simply I listen to our internal folks, and I do my best to translate it out. . . . I just literally learned on the job. That's my personal experience with it. . . . But, truly, if we're going to present anything to anybody we practice first, and we try and get a large audience who can provide different perspectives to make sure what we're saying is presentable.* **(Interviewee 10)**

When asked about their science communication training needs, many interviewees mused that they were at the end of their careers or far enough into their careers that they felt sufficiently experienced. A few interviewees, however, identified training in plain language communication as a need.

> *So a big thing that has driven me in my career is trying to make sure that politicians and decision-makers understand science. . . . And so in order to do that—and again, I won't use the term dumbing it down, but you have to take the scientific jargon out. You have to take the heavy-duty statistics out of things and give politicians information they can understand to make decisions. And so I tell that to young researchers all the time. Because the young researchers, they'll understand the science. They're smart. They're smart as heck. They understand the science. They understand the statistics. But what they don't understand is how to explain that to a layperson.* **(Interviewee 6)**

Other interviewees mentioned community engagement strategies when transitioning from in-person methods to others, developing training platforms, developing a system of alerts for findings of concern, helping with information overload, utilizing new tools that may assist in targeting the proper audience, and finding a way to measure those things effectively.

> *What are our science communication needs? It's always just the tools. The way to take maybe technical information and have it translated so it's easy to understand [given] the words we use. I mean, I always think it's great when you have the examples you can give. Also, if there's a lot being done with, you know, symbols and pictures, and [they] translate really well when they're done right. And then with our diversity in our communities, it's always working*

to have it translated in different languages so it can be shared throughout our community. **(Interviewee 3)**

Interviewees also identified training needs in fundraising, project evaluation, media and digital presentation software, and best management practices. Some interviewees mentioned a need to find ways to better disseminate information and to improve engagement with specific, hard-to-reach audiences.

DISCUSSION

Findings from this qualitative study will contribute improved strategies for clear and productive communication between center investigators and center partners to facilitate effective research translation and science communication (see Figure 1 for partners' communication challenges and proposed solutions). Interviewees described their communication practices and related challenges, research translation approaches, uncertainty communication, collaborative relationships with scientists (e.g., center investigators), and research translation and science communication training experiences and needs. Interviewees worked for diverse organizations in environmental health and related sectors. Many of the interviewees worked in the water resources and public health sectors in South Carolina, and, not surprisingly, harmful algal blooms was named the highest-referenced focus area of the OHHC^{2}I's research, which is an increasing issue of concern for both freshwater and marine environments with climate change (Ho et al. 2019; Gobler 2020). While many interviewees reported current partnerships with center investigators and water managers on issues related to HABs, this finding suggests a focus area for collaboration to ensure safety of potentially affected populations. Another commonly mentioned focus area was *Vibrio* bacteria. As *Vibrio* bacteria cause wound infections and seafood safety concerns that are predicted to increase in abundance with warmer temperatures and increased salinity (Deeb et al. 2018), improved collaboration with center investigators on these issues is critical to prevent and mitigate impacts to South Carolina coastal residents, tourists and recreational water users, the aquaculture industry, and seafood consumers. This is particularly important for communities that financially and culturally rely on seafood consumption and harvesting (Ellis et al. 2014; Friedman et al. 2015; Neet et al. 2019) and/or those that are overburdened by additional environmental exposures that increase adverse health outcomes (Prochaska et al. 2014; Wilson et al. 2017). Other focus areas mentioned, including contaminants of emerging concern (e.g., microplastics), reproductive health, air quality, resilient infrastructure, and environmental justice, are also currently represented in a variety of partnerships with center investigators from an interdisciplinary approach as they relate to water quality and public health.

The wide range of intended audiences mentioned by interviewees indicates a need for increased bidirectional dialogue between scientists and partners regarding preferences and information needs early in the research process (Iwamoto et al. 2019; Mackenzie et al. 2019; Norström et al. 2020), as well as, potentially, investigator and partner training in audience segmentation (Prochaska et al. 2014). Tailoring research targets, applications, and packaging with intended audiences in mind can enhance the receipt of information by the end user, inform early decision-making, and ensure relevance (Beier et al. 2017; Iwamoto et al. 2019; Mackenzie et al. 2019; Norström et al. 2020). As interviewees agreed that an ongoing dialogue with their intended audiences is preferred and necessary for public health and safety, the availability of audience-relevant research at various time points in the research process can improve the flow of ongoing or time-sensitive science communication from scientist to community member (Iwamoto et al. 2019).

Interviewees reported both translating research into plain language for their audiences and developing recommendations for environmental and public health policies and prevention and mitigation measures. Specific communication tactics employed by interviewees also varied widely, which demonstrates the need for scientists to provide information to partners in various, often nested levels of complexity so it can be presented in multiple formats (e.g., pamphlets, emails, newsletters) and adapted for presentations at in-person and virtual events, meetings, or trainings, and include links to published results or online communication (e.g., publications or reports, databases, websites, social media pages, etc.). Given the impacts of COVID-19 on in-person meetings, small gatherings, and larger events, many interviewees adapted their methods of communication to online platforms, and many acknowledged some resulting technological barriers, particularly with populations that have limited access to and/or knowledge of internet applications (Atske and Perrin, 2021). Stakeholders with barriers to virtual communication thus may get left out of the research and decision-making process. While virtual communication can improve access where transportation, time, or physical ability may prevent engagement, organizations should implement multiple modes of virtual participation to ensure access for all. As interviewees listed a variety of dissemination partnerships deemed beneficial for tackling ongoing and emerging issues of concern, crafting messages, and facilitating community involvement in projects, similar partnerships should be encouraged or enhanced between partners and center investigators to improve information flows and/or increase their reach (Fleming et al. 2014; Reed and Abernethy 2018; Mackenzie et al. 2019; Neet et al. 2019).

Fischhoff (2013) identifies the evaluation of communication adequacy as an important part of science communication, stating it must (1) contain the information recipients need, (2) in places they can access, and (3) in a form they can comprehend. Interviewees reported performing evaluations of their communication as a beneficial but resource-depleting task. Some interviewees outsourced evaluations to third-party experts and modified their communication tactics based on the feedback (e.g., plain language, nested levels of information). Interviewees without dedicated personnel or resources for those tasks reported challenges in keeping up with evaluation measures for communication activities. Thus, there is an increasing need to add an evaluation component into research grants and budgets. The NIEHS OHH established a dedicated unit, the CEC, that performs such functions for center investigators and can help facilitate internal and external information flow, provide input into the development of messaging and evaluation plans, improve grantsmanship, and implement collaborative trainings on communication tactics for both investigators and partners. While the CEC supports this function for the center through training, technical assistance, and sharing of resources with center partners, moving forward it will be important for the CEC to collaborate with partners to help them identify their own funding sources for these activities, which will be critical for sustainability purposes.

Most participants agreed that scientists both understand uncertainty and do not typically require research translation when communicating about scientific concepts with other scientists. Thus, the targets of their plain language communication and careful messaging about contingent results or risks included the general public and specific subpopulations, which is consistent with other research (Bullock et al. 2019). One interviewee noted the nuances in jargon between scientific fields, however, which was in direct contradiction to another interviewee's opinion that educational training in the sciences enables understanding and communication with others outside a particular discipline. Boundary spanning, and education in this emerging discipline in particular, can facilitate enhanced communication between scientific disciplines (Goodrich et al. 2020). Two challenges the majority of interviewees encountered with their intended audiences were "black-and-white thinking" and what was perceived as a lack of general understanding of the scientific process. This aligns with other findings demonstrating a limited and conditional tolerance for scientific uncertainty from the general public (Gustafson and Rice 2020). Together, these findings suggest that training is warranted in framing uncertainty (Gustafson and Rice 2020), improving public understanding of science through community-engaged research practices (Wallerstein et al. 2020), and improving clear, layered science communication (Fischhoff 2019).

Working relationships with scientists were described by interviewees as mostly positive and highly beneficial when successful. Mutual agreements on the work process (e.g., collaborative problem-solving, community-based participatory research) and trusted, longstanding relationships with scientists were attributed to effective collaboration. Interviewees often built cohorts of scientific partners to meet their information needs and solve interdisciplinary problems. As interviewees identified a range of secondary data sources, these relationships were important for the timely exchange of research needs and emergent findings in order to make decisions and inform their intended audiences of potential risks. Suggested improvements in the information flow from scientist to stakeholder included increased consistency of communication and mitigation of constraints with investigators due to the lengthy publication peer-review process. These findings are consistent with published recommendations for greater interaction between scientists and decision-makers (Bolson et al. 2013, Bracken et al. 2015). As studies have documented the successes and challenges of transdisciplinary environmental partnerships (Huang and London 2016; Reed and Abernethy 2018; Mackenzie et al. 2019; Daniels et al. 2020; Misra et al. 2020), it is important that perceptions of successful factors in relationship-building, sustainability, and information flow be documented and compared for partners in various roles (scientist-investigators, scientist-stakeholders, community partners, etc.) to develop a model for best practices.

Formal training in research translation and science communication among interviewees was lacking, especially at the college level. Mirroring our findings from the investigator perspective (Altman et al. 2020), interviewees identified training in plain language communication as a priority need. Additional training was requested in project evaluation, media and digital presentation software, communication best practices, dissemination tactics, and engagement with hard-to-reach audiences. Interviewees, however, have amassed a wealth of on-the-job experience that can improve center investigator understanding of real-world applications of their research, and investigators can benefit from learning partners' perspectives, therefore promoting mutual learning and increasing understanding for successful implementation of innovations. This presents a unique opportunity for the CEC to facilitate a collaborative training to fill these gaps and increase investigator-partner knowledge-sharing.

LIMITATIONS

Limitations to this study included a small sample size (n=13) and limited categories of stakeholder organization areas of focus and intended audiences. Due to the nature of the study, OHHC2I investigators named center partners for the interviews. These partners have established relationships with center investigators that sometimes span several

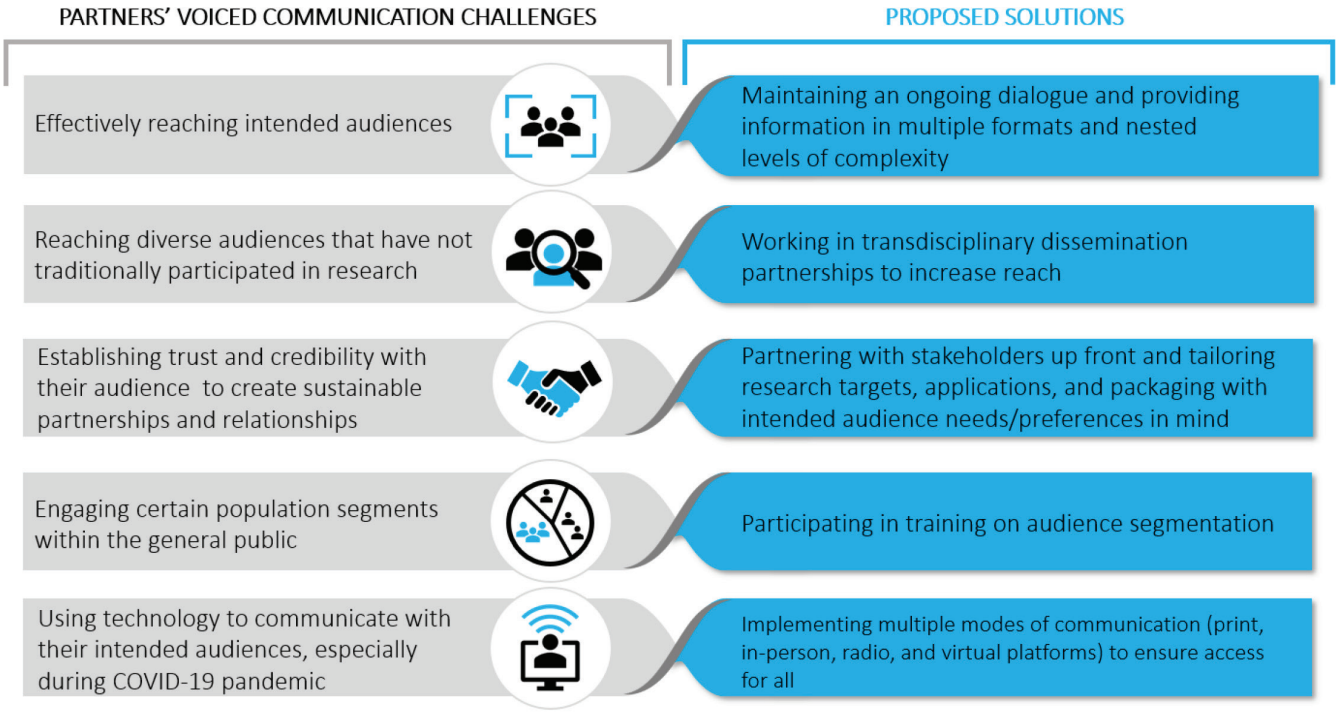

Figure 1. Partners' voiced communication challenges and proposed solutions.

decades. Many of the center partners, like the center investigators, represent an older demographic. Only a few younger professionals were interviewed for the study (those selected by a snowball sample). This represents a potential limitation for data source triangulation. In addition, the majority of the interviewees' work is geographically bound within South Carolina; these results may differ for a larger geographically dispersed and diverse stakeholder sample. As in other geographically restricted studies with small sample sizes (Bergeron et al. 2018), research with a broader and more diverse audience across disciplines, geographies, and subpopulations is warranted. However, recommendations regarding stakeholder engagement and trainings presented in this study may be applicable to other transdisciplinary partnerships.

CONCLUSIONS AND RECOMMENDATIONS

Trainings in a variety of areas, as presented in this paper, are necessary for effective research translation and science communication to increase public access to and understanding of environmental health research that impacts decision-making and community resiliency. There are multiple similarities in center investigator and center partner training needs for communication practices (Altman et al. 2020). It is also crucial that scientists and stakeholders collaborate in transdisciplinary partnerships that facilitate timely information flow, iterative knowledge co-production, and meaningful framing and application for intended audiences, and that they ensure adequate representation of public/community interests at all stages of the research and translation processes. Specific recommendations include incorporating community-engaged and community-based participatory research and knowledge co-production into training, applying these frameworks to improve stakeholder engagement in research partnerships (Winterbauer et al. 2016; Reed and Abernethy 2018; Burwell-Naney et al. 2019), and developing and training investigators and their partners on a systematic approach for engaging their intended audiences (Iwamoto et al. 2019; Mackenzie et al. 2019). Future research on identifying and mitigating individual, institutional, relational, and research-related barriers to investigator-partner engagement from the academic side (Jessani et al. 2018), as well as community-held perceptions and existing knowledge of issues related to oceans and human health and climate change interactions, is warranted for improved science communication and interactions at the local level.

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APPENDIX A. RESULTS PRESENTED BY INTERVIEW QUESTION AND NUMBER OF CODED RESPONSES

Main Theme	Interview Questions & Emergent Subthemes	Number of Coded Responses
Organization Background	Q1. Can you please describe the work that you do? How many years of experience do you have working in the field?	54
Work Outcomes	Q2. In your view, what are 1-2 ultimate outcomes of your work?	12
Organization Priorities	Q3. What are some goals (priorities) of your organization?	50
Environmental Health Topics	Q4. Do you work on issues related to the OHHC2I research?	
	HABs	27
	Vibrio Bacteria	3
	Microplastics	9
	Reproductive health	5
	Unregulated Contaminants	3
	Air Quality	5
	Environmental Justice	1
	Infrastructure	2
Communications Practices		
Intended Audiences	Q5. Are you currently working in an organization that communicates about environmental health topics? If yes, who are the intended audience(s) of such communication? Probes: beachgoers; HOAs; community members; other.	
	Scientists	2
	Gen Public	16
	Residents	15
	Specialty Populations	5
	Youth	5
	Policy Makers	11
	Physicians	2
	Academia	3
	Government	14
	Nonprofits	7
	Emergent codes	11
Definition of Community	Q11. In your opinion, how would you define the word 'community' as it pertains to your work?	27
Communication Channels	Q6. What strategies does your organization use to disseminate environmental health information and to specifically reach your intended audiences? Probes: meetings; reports; flyers; rack cards; etc. Q7. Can you please describe other strategies you have for reaching your audiences?	9
	In-Person Communication	10
	Community Representatives	14
	Meetings	20
	Focus Groups	1
	Charettes	1
	Phone calls	4

Main Theme	Interview Questions & Emergent Subthemes	Number of Coded Responses
Communication Channels (*continued*)	Specific person in the organization	1
	Tour	2
	Career Days	2
	Festival	2
	Video Conferencing	9
	Website	21
	Flyers, Pamphlets, Rack Card	12
	Email	9
	Blogs	7
	Online Training Module	4
	Radio	6
	Reports	7
	Scientific Literature (peer-reviewed)	3
	Social Media	19
	Newspaper articles	11
	Press release	5
	Newsletters	3
	Videos	6
	Television	5
	Advisory Signs	4
	Academic Press	2
	Conference	5
	Journal	2
Dissemination Partners	Q10. Are you currently working or collaborating with any partner organizations to disseminate information about environmental health topics? If so, which organizations and how do they disseminate the information?	
	Academic	17
	Federal Govt	4
	State Govt	16
	Physicians	3
	Local Orgs in Field	6
	Partnerships (Coalitions)	18
	Professional Organizations	15
Ongoing Dialogue	Q17. How does your organization practice an ongoing dialog with its stakeholders? Probe: e.g., stakeholders set agendas and express information needs.	
	General description	19
	Sets agenda	4
	Expresses information needs	3
Measures of Communication Effectiveness	Q9. How do you measure the effectiveness of your organization's communication strategies? Probes: number of website visits, social media metrics, follow up studies to analyze if target audiences understand messages	
	Findings and Changes	7
	Evaluation	21
	Online communication evaluation	10

Main Theme	Interview Questions & Emergent Subthemes	Number of Coded Responses
	Communication Challenges	
Challenges in Reaching Audiences	Q8. What challenges do you experience in reaching your intended audiences? Please explain your response.	11
	Impact of COVID on Communication	22
	Technology	5
	Building relationships	6
	Mistrust	2
	Working with public	10
	Better and more timely communication between entities	4
	Working with others	2
	Time constraints	3
	Perceptions of Research Translation	
Definition Research Translation	Q12: In your opinion, what is "research translation"?	21
	Communicating about Uncertainty	
With Scientists	Q19. What is your experience communicating with scientists about uncertain research findings?	19
With Intended Audience	Q20. How comfortable do you feel communicating with your intended audiences about uncertain research findings? Why?	26
	Collaboration with Scientists	
Science Data Sources	Q13: Where do you typically get data about environmental health topics? a. Probes: Generate in the organization; directly from an in-person source; a government data source; publications; etc.	
	Primary Data (Generated in the organization)	10
	Secondary Data	
	Federal	11
	State	6
	Academic	7
	Scientific literature	4
	Partnerships	6
	Scientific Community	3
Working with Scientists	Q14: Can you describe your experiences working with scientists and how they share research findings with you and/or your organization?	27
Providing information needs to researchers	Q15. Can you describe your experiences with being asked to provide information needs to researchers at the beginning of a project?	17
Ongoing Dialogue	Q16. Is there encouragement for an ongoing dialog with researchers vs. being the recipient of information after it is generated? Please explain.	17
Timing of Results Dissemination	Q21.In your opinion, when should scientists disseminate the results of their studies? a. Probes: while in progress; after completed; only after published in scholarly journal; etc.	
	While in progress	5
	After completed	6
	After published	7
	Report Back to Community	2
	Ongoing process	6

Main Theme	Interview Questions & Emergent Subthemes	Number of Coded Responses
Preference for Receiving Research Finding	Q22. How would you like to receive information about research findings? Probes: content and format	
	One-pager	3
	Peer-review	7
	Pre-digested	6
	Social media	0
	Full report	6
	Nested levels	3
	Training in Science Communication and Research Translation	
Past Training	Q23. What type of training, if any, have you had in research translation or science communication?	26
Training Needs	Q24. What type of science translation training might be you interested in?	20
Science Communication Needs	Q18. What are your organization's science communication needs, if any?	17
	Emergent Topics	
	Alarmist Response	6
	Plain Language	11

APPENDIX B. REPRESENTATIVE QUOTES ABOUT COMMUNICATION CHANNELS

Main Communication Channels	Number of Mentions	Representative Quotes
Websites	21	*So within—we share a lot of information through our [agency branch name] webpage, also. Sometimes, it's hard to find because our webpages are continually being updated. You know, so, as a large agency, your key partners need to know who you are, and we work with them very well to let them know where the links are, the information.* **I 03** *And there's a website that tries to keep up with what are the big occurring health concerns in different parts of the state and in general the different ethnic groups that may be more impacted by certain things than others.* **I 04**
Social Media	19	*We have an official [program name] Twitter and Facebook presence. And as I said, the agency itself has Twitter and Facebook accounts.* **I 04** *We use social media. [Name of the organization] has a Twitter account, so we put information out on Twitter pretty much daily. And with Twitter, that's pretty easily consumable. And if you want to dig deeper into stuff, you can get there through Twitter or you can just quickly consume what we put out there.* **I 06**
Flyers, Pamphlets, Rack Cards	12	*Instead of talking verbally to people when we're in their meetings, we have handouts that we give to them. We have turned to using infographics a lot to explain very complex issues, concerns.* **I 01** *Yeah. We have a couple of brochures that—and that's just happened this year. But it's basically like what is algae? What causes is? How do I deal with it? Can I touch it? Should my pets deal with it? And that sort of thing. So, that's out there and those have been disseminated through email to all of the [organization] membership. There are a couple of those.* **I 05**
Newspaper Articles	11	*We've done—there was a small newspaper on Lake Wateree and we've published numerous articles and communicated back through that way.* **I 05** *I will generally do an editorial or put an opinion piece out for newspapers across the state about the [conference name].* **I 06**
		In-Person Communication
Meetings	20	*We host community and public meetings, and we use our coordinator to host those.* **I 03** *Two-day kind of events where we take a tour of communities to learn more about their concerns from their perspective as well as have a full-day kind of facilitated conversation with the communities about their priorities and strategies to—and prioritize on those concerns and identify some strategies in which we could address some of their concerns during that two-day interaction.* **I 01**
Community Representatives	14	*We walk our communities frequently just to engage residents on a one-on-one basis and get to know them on a personal level.* **I 01**
Phone Calls	4	*But my general work with the public is people calling me with questions about what's the water quality of this pond on this property I'm looking at and what are my concerns and how do I get water samples tested. And so that tends to be more my interaction, is more one-on-one.* **I 04**
Tour	2	*They would often have plant tours and bring the general public in to be able to view their plant.* **I 08**
Career Day	2	*When I've talked to schools and school groups and guidance counselors they largely don't know that these careers even exist. So as we talk to those groups that's helping to inform them about the work that's actually done, and also hopefully recruit some younger people to be interested in professions in the water industry.* **I 08**
Festival	2	*A water festival. So those are all opportunities to help educate folks about water and how it's used and why it needs to be protected.* **I 08**

Main Communication Channels	Number of Mentions	Representative Quotes
Focus Groups & Charettes	1 & 1	*. . . we use focus groups, we use charettes.* **I 01**
Specific Person in the Org.	1	*And, in addition, within the [organization] we have a Public Participation Coordinator . . . and she is our person if communities have concerns and needs. And we work individually with our Public Participation Coordinator to do a lot of communication, outreach and education.* **I 03**
Email	9	*Our weekly updates involve sending flyers to the community presidents as well as links embedded into e-mails that we sent the community presidents that send them directly to, for example, infographics or statistics that we wanna share with them. We send links instead of us trying to explain it in a long e-mail about what it is that we're trying to communicate with them. We now use infographics and links and things like that so that they can follow up with—if they wanna do deeper dives in the information. So those are some of the things that we have worked on.* **I 01** *And we sometimes do email pushes with information too, I guess primarily using MailChimp to get information out to people who have given us their email addresses and asked for information. We have a big list—I guess it used to be a listserv. I don't know if it's called that anymore. But again, we'll push information out through MailChimp to get to people that we're kind of more directly connected to.* **I 06**
		Other Communication Channels
Video Conferencing	9	*Online platforms like GoToMeeting, Zoom, those types of platforms.* **I 01**
Blogs	7	*Right now all I have is the blog, and I really try to think very carefully about what I say in the blog.* **I 02**
Radio	6	*I did get on a radio program, you know, for the general public, maybe about a year and a half ago here in Utah to talk about the issues.* **I 02**
Reports	6	*We also have something called [Organization] Weekly Reports that come out. And [partner organization] has quarterly reports that come out. So, we have a lot of reporting that come out for the general public.* **I 07**
Videos	6	*So we have a course actually, and I'm trying to remember exactly how many sessions there were but it was like maybe eight sessions or something like that. It's online, it's video, it's content, it's—and it's got some quizzes and all that kinda thing in it. And so that's going to be available to the public.* **I 02** *So we really are trying very hard to make the information available to the public through videos, online, through just educational things.* **I 02**
Press Release	5	*Trying to do press releases as much as possible and get to the local news outlets.* **I 09**
Television	5	*I was interviewed by anything from Fox News to CNN to Discovery. It was—ran in like 280 different newspapers. I was also interviewed for Discovery has this show called—what's it called now? It's been a few years. It's a show called What on Earth? I was actually interviewed on that and I was on like 3 or 4 of their episodes talking about weird things about like a bloom or a—something that they found from outer space that looked odd. So, it was kind of interesting to be on TV doing something like that.* **I 07**
Conference	5	*Our association has limited staff and yet we put on 20-24 workshops and major conferences. Our annual conference, [name of the conference], is a big annual conference the size of some national conferences. It's about 1,600 people, 250 vendors.* **I 08**
Advisory Signs	4	*We've got close to 500 signs at all the beach access points for people to see which _____ beach. It's not a, "Oh, by the way, check here for a swimming advisory" or anything. It's, "Here, check for beach information." So it's kind of that consistent language for flags on the beach, swimming issues.* **I 09** *Signs at the affected areas. I mean it's probably one of the most targeted pieces that we do. So you target those that may be accessing a water body.* **I 09**

Main Communication Channels	Number of Mentions	Representative Quotes
Scientific Literature (Peer-Reviewed)	3	*So I guess we use all the traditional academic avenues of information dissemination. So there are academic journals, peer-reviewed journals, non-peer-reviewed journals. We also publish through our university press and our cooperative extension service. . . . And the extension service tends to publish more materials for the non-science audience.* **I 06**
Newsletters	3	*We advertised it in some of the newsletters and things from the neighborhoods.* **I 02**
Academic Press	2	*We have a journal of [name of the journal] that our university press puts out.* **I 06**
Association Journal	2	*We publish a journal every quarter. And our journal magazine has technical content and educational material.* **I 08**