Citizen Science, Civics, and Resilient Communities (CSCRC)

Summative Evaluation Report

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This evaluation report would not have been possible without the cooperation of many people. The evaluation team would like to thank the project leadership team and their partners for their participation and assistance with planning and coordination. This leadership team includes David Sittenfeld, Sara Benson, Katie Baur, and Emily Hostetler, and their partners include SciStarter, the National Informal STEM Education Network (NISE Net), the Helmuth Lab at Northeastern University, and the Consortium for Science, Policy, and Outcomes at Arizona State University. We would also like to thank former evaluation team members who helped with the earlier stages of this project: KT Todd and Owen Weitzman. We would like to thank the following sites, who hosted the forums and citizen science activities for this project:

- Cape Cod Museum of Natural History
- Cape Fear Museum of History and Science
- The Children's Museum of Treasure Coast
- Discovery Lab
- Explora
- ExplorationWorks
- Gateway Science Museum
- Hardin Planetarium
- Insights El Paso
- Jesse H. Jones Park and Nature Center
- Kentucky Center for African American Heritage
- Long Island Explorium
- McAuliffe-Shepard
- Montana State University
- Museum of Science and Industry
- North Carolina Museum of Natural Sciences
- Nurture Nature Center
- Owensboro Museum of Science and History
- Pensacola MESS Hall
- Science Museum Oklahoma
- SEE Science Center
- South Dakota Discovery Center

Finally, we would also like to thank all the participants in the forums and science-to civics activities. These participants go unnamed, but without their support, the depth of information reported in this document would not have been possible.

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EXECUTIVE SUMMARY

The Citizen Science, Civics, and Resilient Communities (CSCRC) project is a three-year project funded by the National Oceanic and Atmospheric Administration's (NOAA) Environmental Literacy Program (Grant Number NA18SEC0080008) and by the Museum of Science, Boston (MOS), in collaboration with Arizona State University (ASU), SciStarter, Northeastern University (NEU), and the National Informal STEM Education Network (NISE Net). The goal of the Environmental Literacy Program is to support "education programs that use NOAA science to promote stewardship and informed decision making." [1]

To accomplish this, the CSCRC project builds off prior work conducted for the Science Center Public Forums project (Grant Number NA15SEC008005) where eight forums were held at different sites across the US related to four climate hazards (drought, sea level rise, extreme heat, and extreme precipitation). The CSCRC project expanded this model to incorporate 23 program sites across the US and paired the existing forum materials with citizen science activities with the goal of deepening learning and engagement around climate hazards, possible solutions, building community resilience, and policy.

Members of the MOS Research & Evaluation Department worked with each of the 23 sites as evaluation mentors in order to coordinate data collection logistics for each site's citizen science and forum events which were collected via an online survey through Qualtrics. A total of 53 people completed the forum survey and 22 completed the citizen science survey. Survey data was also collected from participating museum professionals to learn about their experiences holding these events. A total of 14 surveys were collected from this cohort.

Key findings are summarized below:

- Forum and citizen science participants were similar and had a moderate starting knowledge around climate topics. However, after the activities, both cohorts had statistically significant increases in knowledge around climate hazards, resiliency strategies, the impacts and complexity of these topics, and ways they could contribute to science.
- Forum and citizen science participants increased their confidence and interest in engaging with climate topics. This included ways to take action around community climate hazards, contributing to citizen science efforts, and contributing to public policy. Forum participants appreciated the opportunity to learn from one another, while citizen science participants valued the direct opportunity to contribute their data.
- Museum professionals found that the project positively impacted their ability to implement science to civics activities, felt supported by the trainings and materials, and planned to continue implementing these programs provided they had continued access to materials, tools, and experts.

Overall, despite difficulties caused by the COVID-19 Pandemic, the CSCRC project was successful in accomplishing its goals. These results highlight the strength of the program's forum materials and facilitator trainings, especially when paired with citizen science programming.

[1] http://www.noaa.gov/office-education/elp

TABLE OF CONTENTS

I. Introduction 7
1.1 Project Overview 7
1.1.1 About the program and forum sites 7
1.2 Evaluation Overview 10
1.2.1 Project goals 10
II. Methods 11
2.1 Data Collection Methods 11
2.1.1 Forum and citizen science post-surveys 11
2.1.3 Museum professional survey 13
2.2 Data Analysis 13
2.3 Limitations 13
2.4 Evaluation Sample 15
2.4.1 The demographics for the forum and citizen participants were similar 15
2.4.2 Half of citizen science survey respondents participated in a forum while most forum respondents did not engage with a citizen science activity 18
2.4.3 Most survey respondents participated in sea level rise or drought events and half of citizen science respondents participated in extreme precipitation activities. 19
III. Results and Discussion 20
3.1 Learning 20
3.1.1 Forum participants had a moderate amount of knowledge around climate topics prior to their participation, but increased knowledge across all goals, particularly around communities and resilience plans. 20
3.1.2 Forum participants learned about the complexity of climate hazards and resiliency plans, including the different impacts on community members, stakeholders, and industries, and how science plays a role in planning. 22
3.1.3 Similar to the forum, citizen science participants had a moderate starting knowledge around climate topics and significantly increased their knowledge about all the goals. .. 23
3.1.4 Citizen science participants learned about the complexity of resilience planning and climate hazards, the role of science, and ways they can contribute to this work 24
3.2 Engagement 26
3.2.1 Both forum and citizen science participants had increased interest and confidence in taking action, including participating in citizen science and policy advocacy. 26
3.2.2 Forum participants valued the opportunity to talk to and connect with one another while citizen science participants valued the opportunity to contribute to science 29
3.3 Museum Professional Results 31

3.3.1 Most professional respondents reported that the project positively impacted their abilities to implement science to civics activities, with the materials & trainings and citizen science activities supporting their abilities..... 32
3.3.2 Professional participants reported that to continue implementing science to civics activities that they would like access to materials and tools, science equipment for citizen science, and access to experts. 34
3.3.3 Professionals reported they were appreciative of being able to participate in the project, but that the pandemic made the project difficult. 35
IV. Conclusion 37
References 38
Appendix A: Additional Demographic Data 39
Appendix B: Qualitative Forum Data 39
Appendix C: Qualitative Citizen Science Data 45
Appendix D: Forum/Citizen Science Post-survey 49
Appendix E: Professional Impacts Survey 58

I. INTRODUCTION

1.1 PROJECT OVERVIEW

The Citizen Science, Civics, and Resilient Communities (CSCRC) project (Grant Number NA18SEC0080008) is a three-year project led by the Museum of Science, Boston (MOS), in collaboration with Arizona State University (ASU), SciStarter, Northeastern University (NEU), and the National Informal STEM Education Network (NISE Net). It was funded by the National Oceanic and Atmospheric Administration (NOAA) through their Environmental Literacy Program. The purpose of the NOAA Environmental Literacy Program is to support "education programs that use NOAA science to promote stewardship and informed decision making."[2]

This project builds off of its predecessor, the Science Center Public Forums project (Grant Number NA15SEC008005), which hosted eight project forums at sites across the US related to different climate hazards and was evaluated by members of the MOS Research & Evaluation Department (R&E). Findings for this summative evaluation can be found in the *Science Center Public Forums Summative Evaluation Report* (Todd, et al., 2019). The current project extended the prior model and paired its existing forum materials with related citizen science activities to deepen learning and engagement outcomes.

Formative evaluation was conducted for this project in 2019 and 2020. Data collected during this phase was used to inform future project activities including forum materials, citizen science activities, and the format of these events. This report covers findings from the summative evaluation which examine how the implementation of forums and citizen science activities affected participants' levels of knowledge and engagement across multiple national sites.

1.1.1 About the program and forum sites

Participating sites for the summative evaluation were recruited with help from the NISE Net via an online application on the project website.[3] This project website also outlines additional information. As a requirement for taking part in the CSCRC project, project sites were required to select one of the four climate hazards (drought, extreme heat, extreme precipitation, or sea level rise), work with citizen scientists and local resilience planners, create a plan for collecting and disseminating citizen science data, and coordinate a forum event related to their climate hazard. Due to in-person limitations caused by COVID-19, sites were given the option of running their own local virtual or in-person forum or taking part in one of four nation-wide virtual forums coordinated and run by the MOS on each climate hazard.

Selected sites were given a $2,000 stipend to cover the associated planning costs and access to resources (MOS and project personnel help, forum materials, and training webinars). Each site was also given the option to create a microsite for their events through SciStarter with links to their citizen science and forum events. An example of the MOS microsite can be found at

[2] http://www.noaa.gov/office-education/elp
[3] https://www.nisenet.org/CSCRC

https://scistarter.org/noaa-museumofscience. A timeline of overarching project events, including dates for the four national forums, can be seen below:

General project timeline

- December 1, 2020 – CSCRC project site application opens
- January 15, 2021 – CSCRC project site application deadline
- February 15, 2021 – CSCRC applicants notified of award status and acceptance as a project site
- February - March 2021 – Project sites participate in training webinars held by MOS
- April - September 2021 – Project sites design and implement local citizen science projects
- April - September 2021 – Project sites hold virtual individual local forum or participate in virtual national forum

National Forum Dates

- June 23, 2021 – Virtual Forum on Climate Hazard Resilience: Sea Level Rise
- June 30, 2021 – Virtual Forum on Climate Hazard Resilience: Drought
- July 7, 2021 – Virtual Forum on Climate Hazard Resilience: Extreme Heat
- July 14, 2021 – Virtual Forum on Climate Hazard Resilience: Extreme Precipitation

Overall, there were 23 program sites located across the United States. A map outlining the locations of each site and their chosen hazard can be found in Figure 1 below. Table 1 is a separate list of the sites with their associated climate hazards.

Figure 1. Locations of the 23 project sites

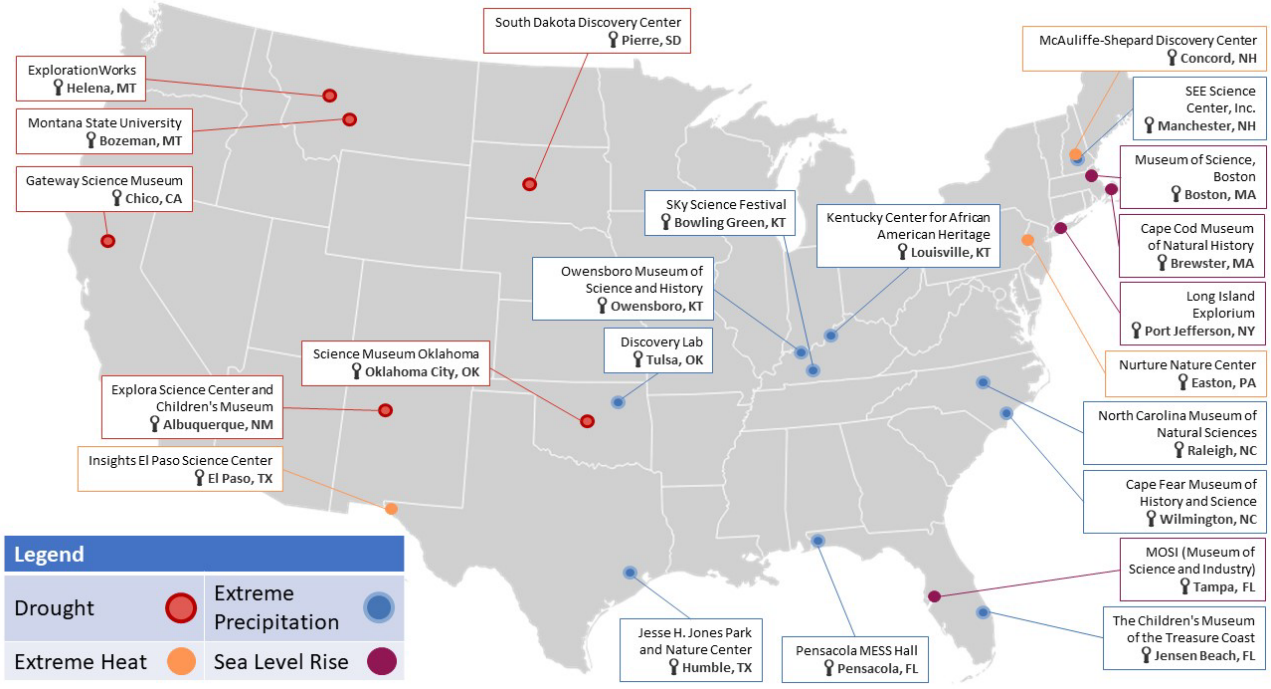


Table 1. Number of participating sites by climate hazard

Project Site	Climate Hazard			
	Drought	Extreme heat	Extreme precipitation	Sea level rise
Cape Cod Museum of Natural History				X
Cape Fear Museum of History and Science			X	
The Children's Museum of Treasure Coast			X	
Discovery Lab			X	
Explora	X			
ExplorationWorks	X			
Gateway Science Museum	X			
Hardin Planetarium			X	
Insights El Paso		X		
Jesse H. Jones Park and Nature Center			X	
Kentucky Center for African American Heritage			X	
Long Island Explorium				X
McAuliffe-Shepard		X		
Montana State University	X			
MOSI				X
Museum of Science, Boston				X
North Carolina Museum of Natural Sciences			X	
Nurture Nature Center		X		
Owensboro Museum of Science and History			X	
Pensacola MESS Hall			X	
Science Museum Oklahoma	X			
SEE Science Center			X	
South Dakota Discovery Center	X			
Total number of sites per climate hazard	**6**	**3**	**10**	**4**

1.2 EVALUATION OVERVIEW

As mentioned previously, this project builds off the findings from the previous Science Center Public Forums grant which created and implemented eight climate hazard related forums across the country. The focus of this summative evaluation was to understand the ability of the forum materials in conjunction with the citizen science activities to enhance participants' engagement and learning outcomes.

1.2.1 Project goals

The primary audience for this project is members of the public who participated in the citizen science projects and forum programs. Each site was responsible for recruitment and implementation of the citizen science activities and forum.

The project team based its goals off of the previous Science Center Public Forums grant in the hopes that they would be achieved by participants attending both the forum and taking part in the citizen science activities. The goals for the project are:

1. *Knowledge, awareness, and understanding.* Participants will have an increased understanding of:
    a. The ways human and natural systems interact in the context of environmental hazards and extreme weather events.
    b. Measures that communities can take to become more resilient to environmental hazards and extreme weather events.
    c. The potential impacts of resiliency measures on the environment and on different kinds of stakeholders.
    d. The nature of the scientific process and uncertainty.
2. *Engagement or interest.* Participants will:
    a. Demonstrate sustained participation in science to civics activities.
    b. Practice scientific process skills of collecting, synthesizing, and presenting data that contribute to public policy and community resilience.
    c. Engage in discussions and decision-making activities about complex socio-scientific environmental decisions.
    d. Develop increased interest and confidence in contributing to public policy around community resilience.

This report describes the findings of the summative evaluation including how the forums and citizen science activities achieved the knowledge and engagement goals above. Data were also collected on the professional impacts that resulted as part of the project. Additional information on evaluation methods can be found in the next section.

II. METHODS

Data collection for the summative evaluation took place between summer 2021 and early fall 2021. The timing of the data collection varied based on the schedule each site had for their forum and citizen science activities. Staff members from the MOS R&E Department worked with members of each project site as evaluation mentors, coordinating data collection logistics for their citizen science and forum events. This included learning about their site-specific events, audiences, and specific evaluation needs (i.e. Are they including youth? Will it be a virtual or in-person forum event? What are the best ways to acquire participant emails?). Additional details about the data collection can be found in the sections below.

2.1 DATA COLLECTION METHODS

Surveys were the primary form of data collection for this project's summative evaluation. In total, 90 participants completed at least one of the evaluation surveys. Fifty-three people completed the forum survey, and 22 completed the citizen science survey. Only two people completed both surveys (See Table 2 below). Because so few individuals completed evaluation surveys for both the forum and citizen science activities, the evaluation was not able to study the impacts of participating in both of these project activities. Instead, this report focuses on sharing findings from about the impacts of participation in the forum and impacts of participating in the citizen science (see Limitations). A third survey was sent out to staff members at each of the 22 sites to understand impacts of implementing the program on those individuals. A total of 15 people completed that survey. All of the surveys were online surveys sent through Qualtrics.

Table 2. Sample size and response rate for forum, citizen science, and professional impacts survey

Survey type	# of participants	# of surveys sent via Qualtrics	Response rate
Forum post-survey	53	132	40%
Citizen science post-survey	22	193	11%
Professional impacts survey	14	38	36%
Total	90	486	25%

2.1.1 Forum and citizen science post-surveys

Questions for the forum and citizen science surveys were nearly identical to one another, with the words "forum" or "citizen science" substituted when needed. References to the four climate hazards was swapped in to match the hazard chosen by each site, meaning participants who

participated in sea level rise events would have surveys with the phrase “sea level rise” swapped in, while participants who did the drought activities would have references to “drought” instead.

On the post-survey, participants were asked to rate their level of knowledge, interest, and confidence around climate and climate resiliency topics before and after the event. Open-ended questions were included to ask participants to explain what they learned, what they valued about the experience, general suggestions for improvement, and how they heard about the program. To pair the data, participants were asked to provide their birth year, first letter of their first name, last name, and email address.

Participants 13 and older were eligible to take part in the evaluation. Youth aged 13-17 were also required to have a guardian fill out the virtual consent form and youth assent form before taking part in the survey. Screenshots of this survey can be found in the Appendix.

Forum post-surveys were emailed to participants after taking part in the forum. These emails were collected through each site’s individual sign-up process or via Eventbrite in the case of the four national forums. Surveys were sent out using Qualtrics’ survey distribution system along with 2-3 survey reminders afterwards. Using these methods, a total of 53 surveys were collected from approximately 132 forum participants for a response rate of 40%.

While citizen science projects varied from site to site, the majority of them opted to use online, app-based citizen science methods that were tested during the formative phase of the project. Each site was able to coordinate with SciStarter, a partner organization focused on promoting local citizen science efforts and events, to create a project site page that included general information about the project and a way to sign up for their chosen citizen science app. These apps offer an opportunity for participants to observe, collect, and log their data to share with others on their platform. Examples include ISeeChange, CoCoRaHS, iNaturalist, and MyCoast.

Once signed into the app, participants were given the option of linking their app to the SciStarter website which would add their email to the participant list. MOS evaluators, SciStarter team members (who had the list of emails), and site representatives coordinated with one another to determine the best timing and cadence to send out citizen science surveys to individuals who had shared their email address through SciStarter.

In addition to the app-based citizen science methods, other sites had in-person citizen science events where they included youth, families, and held other special activities. For example, one site in California had participants sign up for times to work with a local scientist to measure and collect local river water to learn about drought conditions. These sites would send their participant email lists directly to the MOS evaluation team.

Overall, using this combination of methods, a total of 22 surveys were collected from approximately 193 citizen science participants for a response rate of 11%.

2.1.3 Museum professional survey

Data was also collected in December 2021 from participating museum professionals to learn about their experiences holding the project events. While this data was not originally intended within the initial project plans, it was added in order to supplement low participant response numbers and after listening to stories from each of the project sites during one of the final debrief meetings. As a result, there was interest in learning about the professional impacts of the project, future plans, and how the work of the professionals could be supported in the future. To gather this information, the main partner from each site was sent a brief Qualtrics survey.

A screenshot of the Qualtrics survey can be found in Appendix E. Questions include how the project impacted their ability to implement citizen science activities at their institution and why, what supports would they need to continue doing this work, and any other comments they would like to add about the project. A total of 14 surveys were collected from 38 participants for a response rate of 39%.

2.2 DATA ANALYSIS

This project took a mixed methods approach, and data collected as a part of the project were both qualitative and quantitative in nature. Qualitative data was coded inductively. Inductive coding analysis involves "immersion in the details and specifics of data to discover important patterns, themes, and interrelationships" and allows the coding scheme to emerge from the data (Patton, 2002, p. 41)

Quantitative data were analyzed using descriptive statistics (counts, means, and percentages). Additionally, Wilcoxon signed-ranks were used to compare individual responses from retrospective pre/post questions. These statistics were used to identify changes in knowledge, interest, behaviors, and attitudes due to the forum or citizen science programs. For all statistical tests, the level of significance was set to 0.05. Effect sizes were calculated to describe the magnitude of statistically significant changes. The reported effect size calculation of r is calculated by dividing Z by the square root of N, and is interpreted as being a "small" effect size if the resulting value is between 0.1 and 0.3, "medium" if it is between 0.3 and 0.5, and "large" if it is greater than 0.5 (Rosenthal, 1994).

While the original intent was to have matched data from the citizen science and forum participants, only two people had done both surveys. Results from this report focus on the separate impacts of the forum and citizen science and not the cumulative aspects of both events. Similarly, findings will not be broken up by climate hazard due to the variability in the number of survey data for each hazard.

2.3 LIMITATIONS

Much of this project has been characterized by the upheaval caused by the COVID-19 pandemic which affected all aspects of this project in some capacity. The majority of the work was done between late-spring through early fall of 2021, a time when the world was learning to adjust to pandemic life. Project team members worked tirelessly, transforming onsite programming into virtual sessions, extending timelines, and exercising flexibly to account for each site's ever-

shifting COVID policies. Unsurprisingly, these challenges impacted the evaluation in a number of ways and should be kept in mind when considering the context of this project's methods and outcomes.

Recruitment during this time period was particularly challenging for both the forum and citizen science cohorts. While there is no hard evidence, project team members hypothesize that people may have felt "burnt out" around virtual activities since in-person events were slowly returning. Team members across each site, including the national events, reported lower attendance to virtual events overall. This, coupled with the lower than expected survey response rate, meant that the project's original plans to have paired forum and citizen science data had to be adjusted. Unfortunately, only two participants took both surveys, so plans to look at the cumulative effects of the forum and citizen science data were adjusted. Also, several project staff members were found to have taken the survey. These data sets were removed due to their heavy involvement with the project.

Another area of difficulty was the timing of the email surveys. For forum participants, the most optimal time to distribute surveys was immediately after the event followed by regular reminders afterwards. However, it was difficult to determine the optimal timing for citizen science participants. These participants were able to engage with the project asynchronously on their own schedules, and evaluators were not able to understand the depth to which those who had signed up engaged with the citizen science activity. Additionally, some sites, such as those with rain gauges, distributed their materials on a rolling basis. This, compounded with the necessity to pair the data collection app with SciStarter in order for their email to be logged, meant that the evaluation likely did not include all of the individuals who participated in citizen science activities.

While the forum was intended for adult participants, many sites had target demographics lower than the intended age range. An addendum was added to the IRB protocol to allow participants 13 and older to take part in the evaluation as long as they were able to fill out the guardian consent and participant assent forms. This may have created additional barriers and only one youth was found to have taken part in the survey. Sites who had activities targeted for participants younger than 13 and were not family events (i.e. camp programs) were not included as part of the evaluation because of IRB issues.

Finally, some sites encountered lower than expected participation due to climate change factors or inclement weather. Several sites who had chosen water-related hazards (i.e. sea level rise, extreme precipitation) encountered severe drought conditions or had no high tides which affected people's ability to take measurements. Another site experienced a tornado warning on the day of their event, which severely impacted attendance as well.

2.4 EVALUATION SAMPLE

While data from the forum and citizen science events could not be paired, demographics for both cohorts was similar across the two activities. In both surveys, participants were asked about their gender, race/ethnicity, age, highest level of education completed, and income. They were also asked how they heard about the event or citizen science activity and whether or not they had participated in the citizen science (if they were filling out a forum survey) or had done a forum (if they were filling out a citizen science survey).

2.4.1 The demographics for the forum and citizen participants were similar

Each site had the choice of hosting their own in-person or virtual forum or recruiting participants to take part in one of four national forums hosted by the MOS. Citizen science activities for each site had a wide variation, with some being scheduled events to asynchronous activities such as using rain gauges to log them via one of the citizen science apps.

Despite the variety of participation opportunities, demographics for both the forum and citizen science are mostly similar to one another with minor variances. When looking at gender demographics, the majority of respondents for both activities were female (71% for forums and 55% for citizen science). For citizen science, there were slightly more male respondents (35%) and those identifying as another gender (10%).

Race and ethnicity were also similar. The majority of respondents identified as white or Caucasian (69% for forums; 60% for citizen science), followed by Hispanic or Latinx reporting 15% for both surveys, followed by Black or African American (6% for forums; 5% for citizen science). Asians and Asian Americans account for 4% of forum respondents, but there were none who self-identified for the citizen science survey. Age demographics nearly mirrored one another with nearly 75% of respondents identifying between the ages of 25 to 45. The majority of survey respondents also had a graduate degree (66% for forums; 60% for citizen science).

Finally, when asked about income, most participants reported a household income of $100,000-$149,000 (27% for forums; 19% for citizen science). However, more citizen science participants answered “prefer not to say” (24%) compared to forum participants (10%), and 18% of forum groups reported a household income of $75,000-$99,000 compared to citizen science’s 5%. Otherwise all other categories are within 1-2% of each other. Information for these demographics can be seen below in

Figure 2, Figure 3, and

Figure **4**. Additional demographics can be found in Appendix A.

Figure 2. Forum and citizen science gender, race/ethnicity, and age demographics

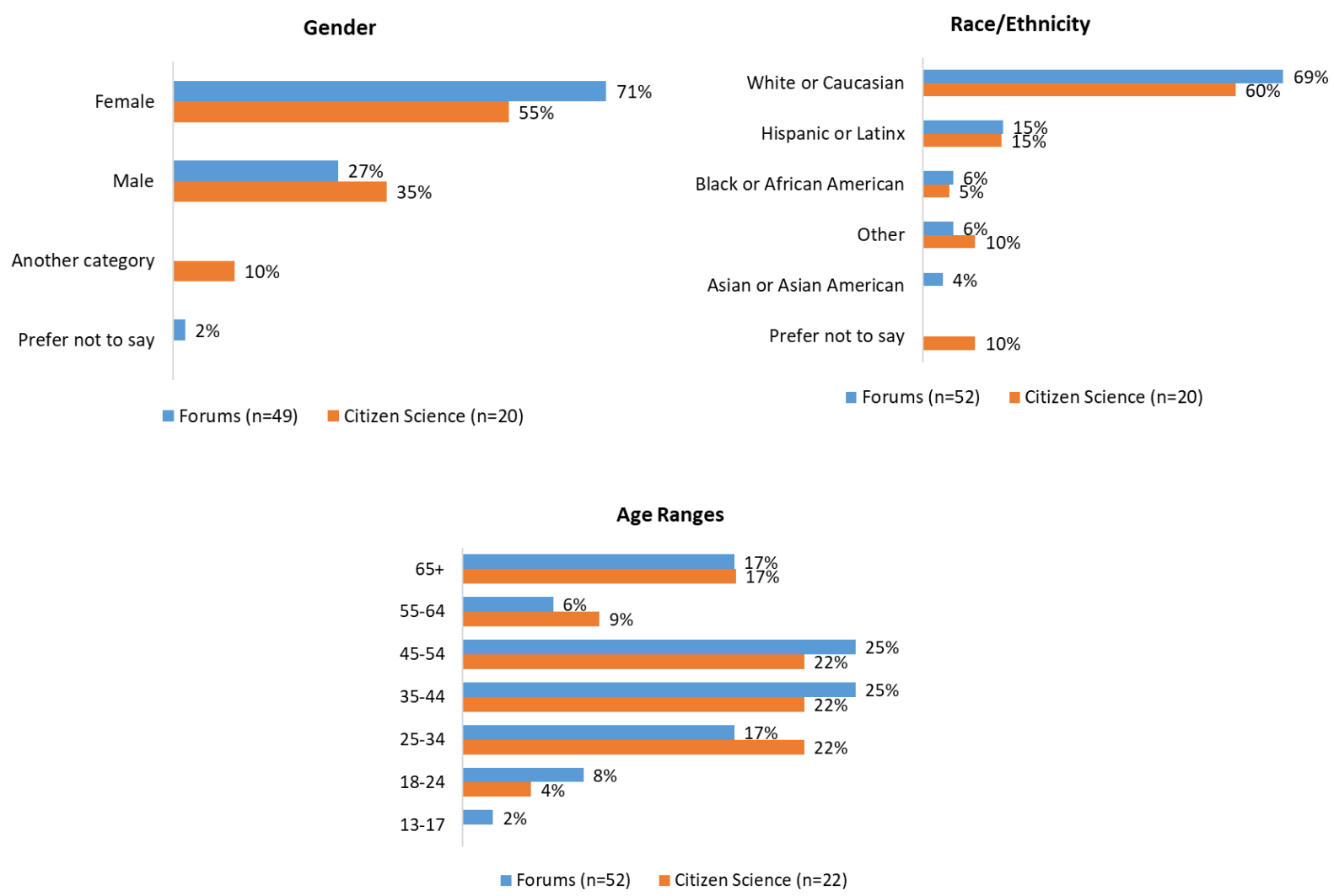


Figure 3. Forum and citizen science education levels

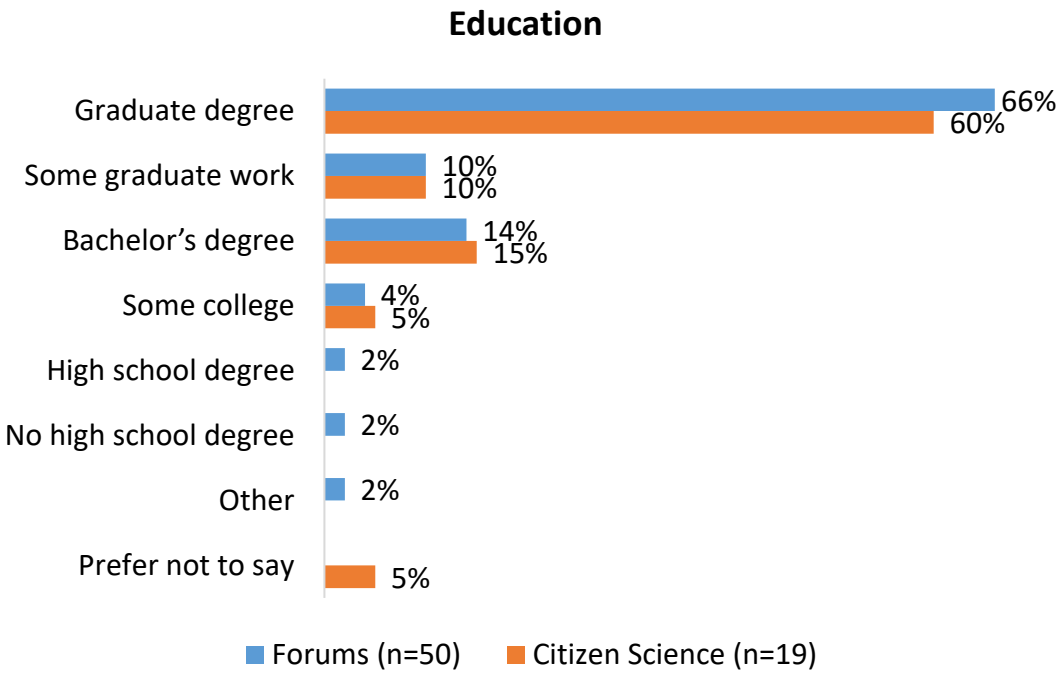
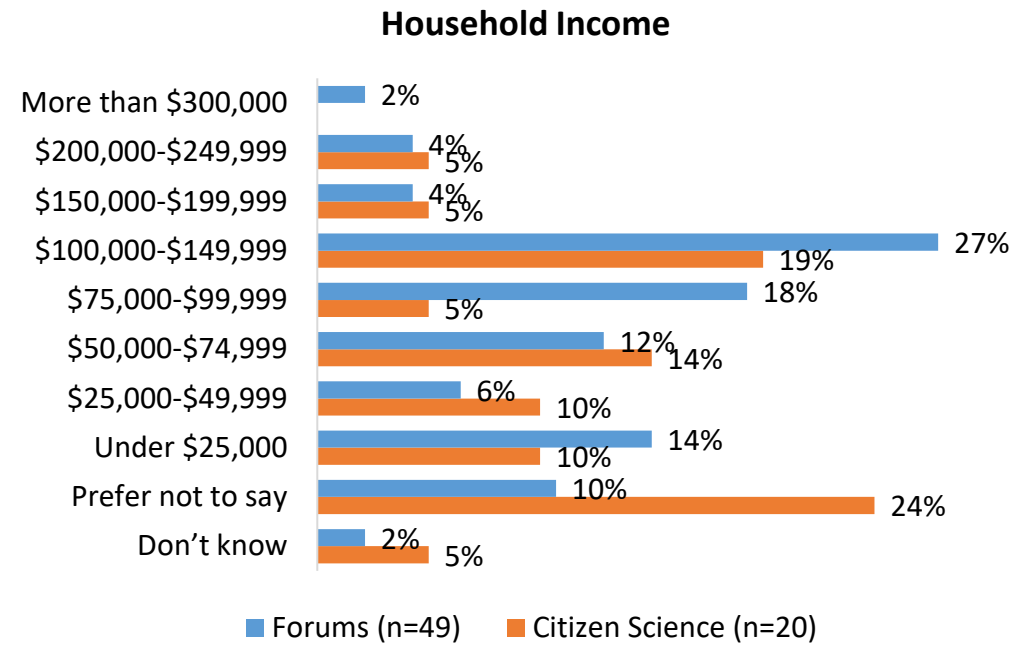


Figure 4. Forum and citizen science household income

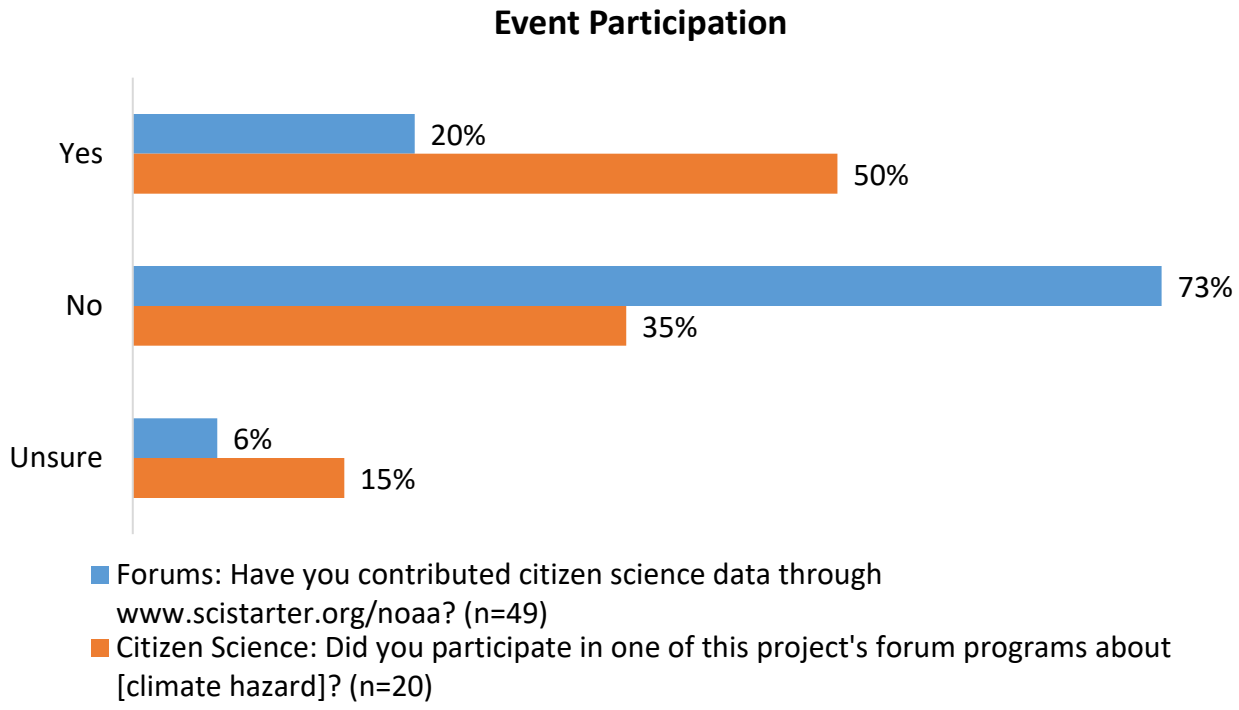


2.4.2 Half of citizen science survey respondents participated in a forum while most forum respondents did not engage with a citizen science activity

Participants for both activities were asked if they had also done the other corresponding event. For example, participants who were filling out the forum survey were asked if they had participated in a citizen science activity, and citizen science participants were asked if they had done a forum. Responses indicate that half of citizen science participants took part in a forum event, but only 20% of forum respondents had participated in citizen science (See Figure 5 below).

Reasons for this outcome may be due to the logistical order of the events, with some sites conducting their citizen science initiatives long after the forum, or because citizen science methods were covered during the forum event which drew more people to these activities. Several respondents reflected on forum topics within their open-ended responses for the citizen science surveys which support this idea. For example, when asked about what they valued in regards to the citizen science activity, one respondent commented about the forums, saying that, "It was interesting to look at all the different options and opinions of the different stakeholders." This response refers to part of the forum activity where participants learn about the viewpoints of different climate stakeholders.

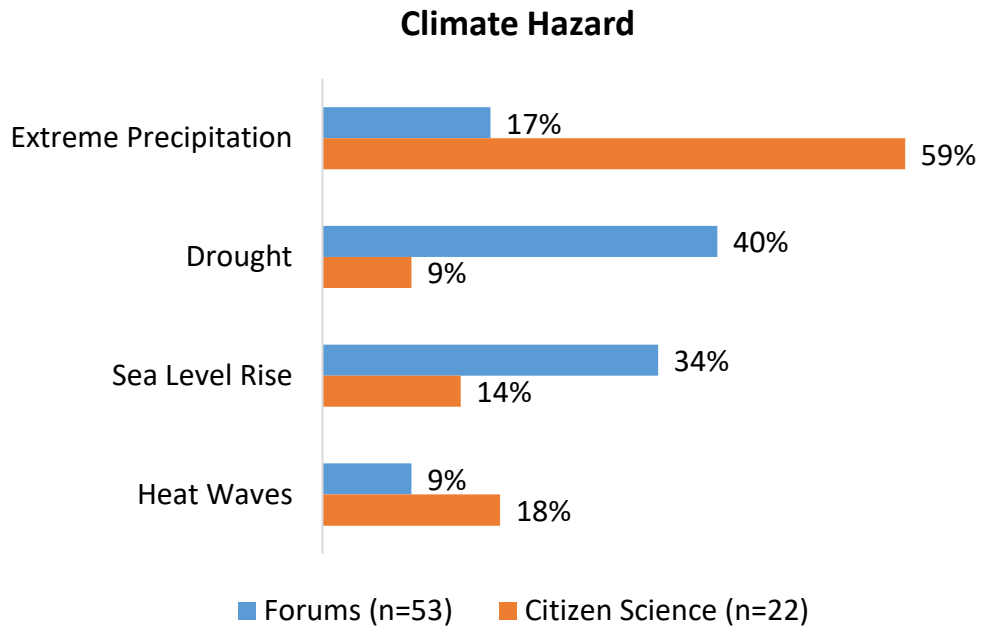
Figure 5. Forum and citizen science event participation



2.4.3 Most survey respondents participated in sea level rise or drought events and half of citizen science respondents participated in extreme precipitation activities.

Separate surveys were sent out for each of the four climate hazards, which allowed researchers to gather information on which climate hazard event respondents attended. Climate hazards for the forum respondents were fairly spread out, with the highest concentration being for drought (40%; see Figure 6, below) and Sea Level Rise (34%). This pattern dramatically differs for citizen science respondents where over half of respondents (59%) indicate doing a citizen science project related to extreme precipitation. Extreme precipitation and drought were the two climate hazards with the most assigned sites (10 and 6 sites respectively; see Table 1). This may be the reason why drought was the most used forum and extreme precipitation was the most used citizen science activity. Another reason for the popularity of extreme precipitation citizen science activities may be that many of these projects came with a free rain gauge.

Figure 6. Percentage of forum and citizen science respondents by hazard



III. RESULTS AND DISCUSSION

3.1 LEARNING

The knowledge goals for the CSCRC project were the following:

1. *Knowledge, awareness, and understanding.* Participants will have an increased understanding of:
    a. The ways human and natural systems interact in the context of environmental hazards and extreme weather events.
    b. Measures that communities can take to become more resilient to environmental hazards and extreme weather events.
    c. The potential impacts of resiliency measures on the environment and on different kinds of stakeholders.
    d. The nature of the scientific process and uncertainty.

The quantitative data indicated that the CSCRC program was successful in meeting its learning goals. Findings were similar across both the forum and citizen science activities. Both cohorts had a moderate level of knowledge around climate hazards and resilience planning prior to engaging in either activity, but they still had a statistically significant increase in knowledge across all of the learning goals after completing them.

When looking at their qualitative data, both cohorts were also similar, particularly in learning about different kinds of resiliency plans (Goal 1b) along with the ways climate hazards and resiliency plans can have different positive or negative impacts on community members and stakeholders (Goal 1c). Lastly, both groups partially fulfilled Goal 1d in learning about how science can be used to model future plans. However, there was only one individual who specifically mentioned the goal around the uncertain nature around the scientific process: ("Science is based on evidence but that changes so it is not set in stone and has to be adapted to and can't be ignored as simply opinion").

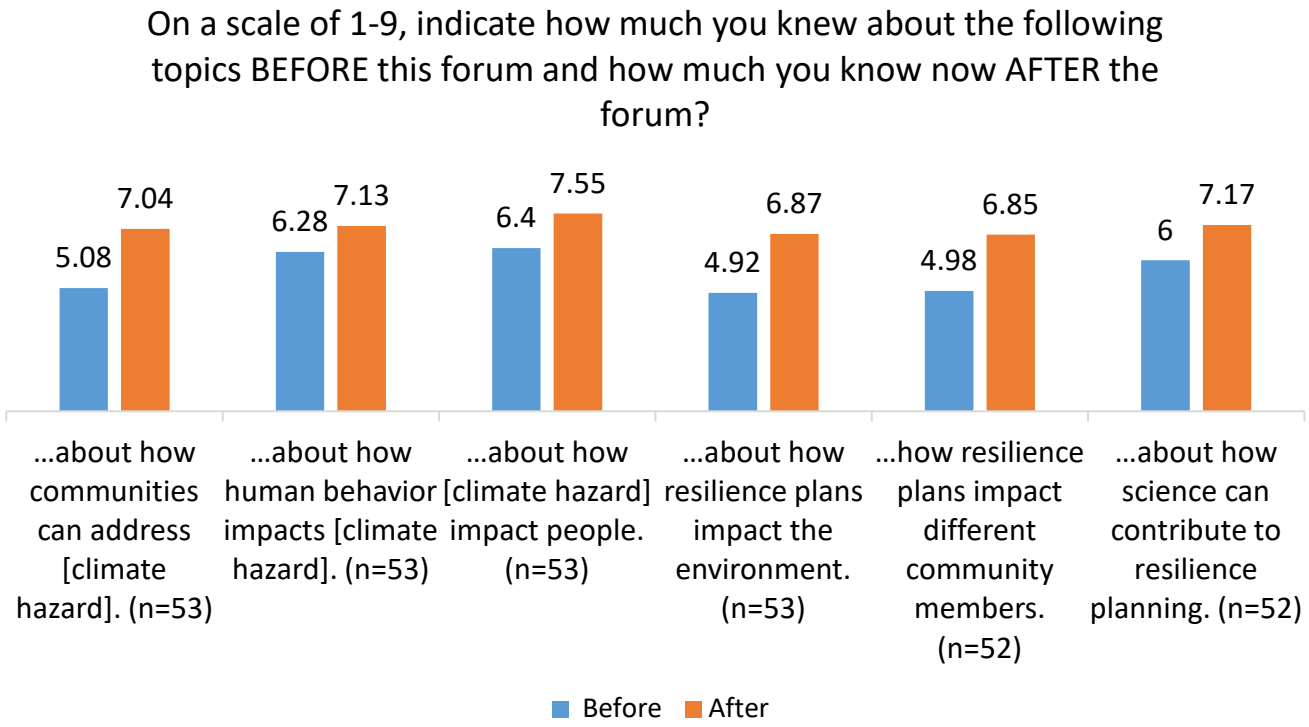
3.1.1 Forum participants had a moderate amount of knowledge around climate topics prior to their participation, but increased knowledge across all goals, particularly around communities and resilience plans.

In order to gauge how the forum events impacted learning, survey participants were asked to rate their level of knowledge around several statements related to climate hazards and resiliency before and after the event using a 9-point scale. As detailed below, participants had an increase in knowledge across all six learning goals. These increases were statistically significant and had large effect sizes, indicating that the forum program was successful in reaching its goals around knowledge.

As seen in Figure 7, below, forum participants had a moderate level of knowledge across the six different statements. The forum participants reported that they had the highest average prior

knowledge about how humans and climate hazards impact one another (6.28, and 6.4, respectively), how science can contribute to resilience planning (6), and how communities are addressing their specific climate hazard (5.08). Meanwhile, forum participants indicated the lowest average before program knowledge in how resilience plans impact the environment (4.92) and different community members (4.98). When comparing pre and post ratings, the areas with the greatest gains in knowledge were related to communities and resilience plans, including how communities can address their climate hazard (from 5.08 to 7.04; a 1.96 average increase), how resilience plans impact the environment (from 4.92 to 6.87; a 1.95 average increase), and their impacts on different community members (from 4.98 to 6.85; a 1.87 average increase).

Figure 7. Forum respondents level of knowledge[4]



[4] Wilcoxon Signed Rank Test:
How communities can address [climate hazard]: n = 53, Z = -5.534, p < .000, r = 0.760
How human behavior impacts [climate hazard]: n = 53, Z = -4.466, p < .000, r = 0.613
How [climate hazard] impacts people: n = 53, Z = -4.779, p < .000, r = 0.656
How resilience plans impact the environment: n = 53, Z = -5.626, p < .000, r = 0.773
How resilience plans impact different community members: n = 52, Z = -5.580, p < .000, r = 0.774
How science can contribute to resilience planning: n = 52, Z = -4.671, p < .000, r = 0.648

3.1.2 Forum participants learned about the complexity of climate hazards and resiliency plans, including the different impacts on community members, stakeholders, and industries, and how science plays a role in planning.

Qualitative questions were included for a more in-depth look into the specifics of what participants had learned around the six different learning goals during the forum. Looking holistically, the most salient information was about the different types of climate change solutions, followed by the complexity and diverse positive and negative impacts surrounding this topic. When asked what they learned about how communities can address the specific climate hazard, the most common response that participants gave was that they learned about the different solutions related to climate change (15 of 36). One participant, for example, reflected on how the knowledge they gained in the forum around solutions helped them understand their applications, "I learned the major methods to fight against sea level rise. I had a really knowledgeable group so I got a lot of information about how these methods are applied and before I knew some theory but no practical applications." Participants also learned about the logistical complexities around this topic (9 of 36) which is reflected in one participant's statement, "This issue is highly complex and there are many competing interests."

Responses related to this complexity, particularly around the differentiated impacts of each climate hazard or resiliency plan on different stakeholders (including community members, certain demographics, and industries) come up repeatedly in participant responses. For example, for the question "What, if anything, did you learn about how resilience plans impact different community members?", nearly all respondents mentioned learning about the different impacts it has (15 of 19). One participant wrote:

> "The community profiles helped me to have a broader view of how different individuals are impacted by heat waves at both personal and societal/community levels. I have previously learned about the impacts on vulnerable populations, but I hadn't learned much about infrastructure impacts."

Similarly, when asked to explain what they learned about how climate hazards impact people, over half of the respondents (13 of 22) mentioned these variations. One participant mentioned how some may experience positive impacts as a result of sea level rise, "I learned that some people and their businesses can thrive from sea level rise, but the majority of people would suffer huge economic, social, and environmental negative impact."

Beyond these topics, participants also learned about the role science plays in taking action around climate change. When asked what they learned, the most common response was learning how science can predict future climate impacts and inform decision-making (7 of 19). This included specific tools, measurements, or insights into possible applications. For example, one participant reflected on how it can be used in planning and wrote, "I better understand how science can predict what will happen over time by looking at past and present events. Science is very helpful with planning safety measures." Others (4 of 19) also felt that the forum emphasized the importance of further stakeholder and community involvement. "Science is doing a lot of research to help with the resilience plan. They need the government and communities to gather together in community forums."

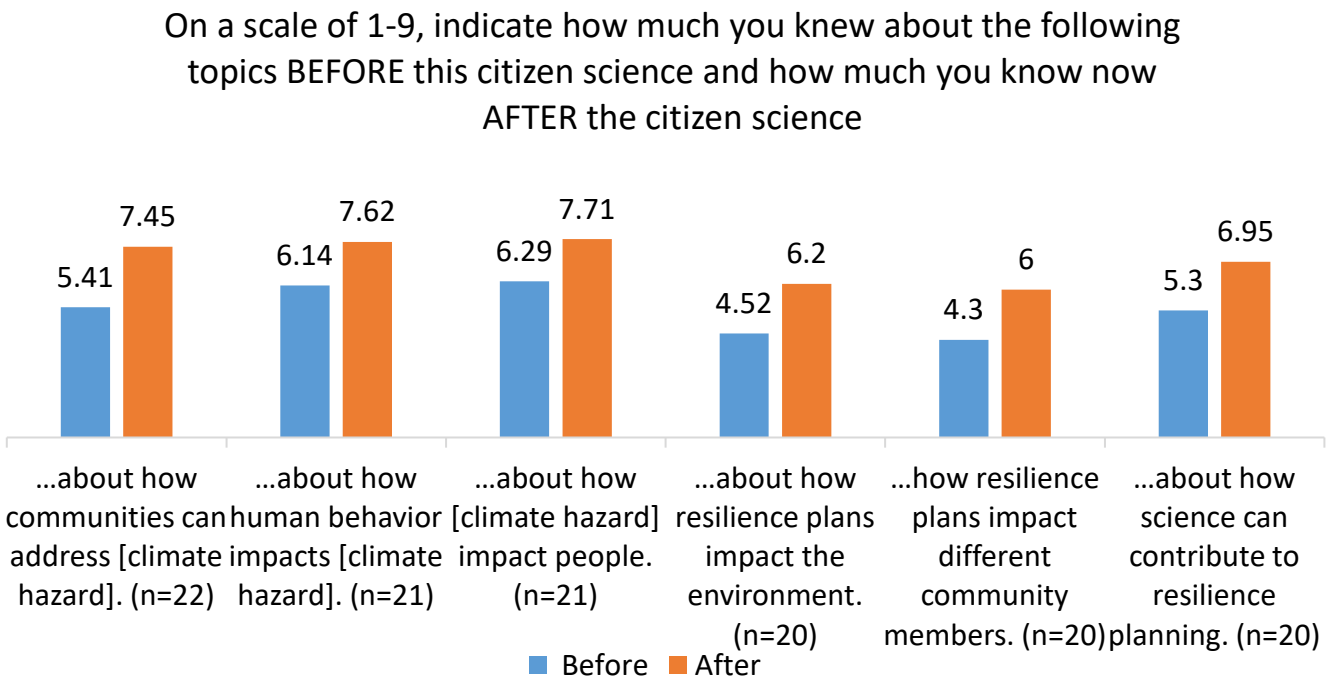
Additional responses related to participant learning can be found in Appendix B of this report.

3.1.3 Similar to the forum, citizen science participants had a moderate starting knowledge around climate topics and significantly increased their knowledge about all the goals.

The same retrospective pre-post question asked of forum participants was also asked for citizen science participants. Findings were similar to forum participants, and there were statistically significant increases in knowledge across all six statements. Those who did the citizen science rated themselves as having a moderate level of knowledge around climate and climate resiliency topics, with the highest average being how humans impact climate hazards and how they impact people and the lowest relating to resilience plans and their impacts on the environment and different community members.

After taking part in the citizen science activity, respondents rated themselves as having increased knowledge related to how communities can address their climate hazard, the impact of resilience plans on the environment and different community members, and finally how science can contribute to resilience planning. These findings are similar to what was found for forum participants, with respondents reporting a moderate level of knowledge across the six different statements. As seen in Figure 8 below, the highest average prior knowledge level was for how climate hazards impact people (6.29), and how human behavior impacts the climate hazard (6.14). The lowest averages prior knowledge level were around how resilience plans impact different community members (4.3) and how these plans impact the environment (4.52). The areas with the greatest increases from pre to post were related to communities and resilience planning, including how communities can address their climate hazard (from 5.41 to 7.45; a 2.04 average increase), how they impact different community members (from 4.3 to 6; a 1.7 average increase), and how resilience plans impact the environment (from 4.52 to 6.2; a 1.68 average increase).

Figure 8. Respondents level of knowledge before and after the citizen science[5]



3.1.4 Citizen science participants learned about the complexity of resilience planning and climate hazards, the role of science, and ways they can contribute to this work.

As with the forum survey, qualitative questions around the specifics of what they had learned were included for citizen science participants. Although the number of responses by comparison is much lower, we are still able to get insight into several themes related to what people learned via their participation with the citizen science activities. The findings from these responses are similar to what was found for qualitative data around the forum activities. The data show that as a result of the citizen science activities, participants reported learning about climate resiliency strategies and decision-making, different tradeoffs, and how human behavior directly impacts climate hazards. They also learned about the role of science to model and inform decision-making as well how they can contribute to the data collection process.

Similar to the forum event, the citizen science gave participants a glimpse into the different tools, solutions, and overall complexity involved in climate resiliency planning. When asked what they learned about how communities can address climate hazards, 5 of 15 groups mentioned specifics such as "flood control" or the use of policies like "water restrictions" in preventing drought.

[5] Wilcoxon Signed Rank Test:
How communities can address [climate hazard]: n= 22, Z = -3.446, p = .001, r = 0.735;
How human behavior impacts [climate hazard]: n= 21, Z = -3.210, p = .001, r = 0.700;
How [climate hazard] impacts people: n= 21, Z = -3.084, p = .002, r = 0.673;
How resilience plans impact the environment: n= 20, Z = -3.320, p = .001, r = 0.742;
How resilience plans impact different community members: n= 20, Z = -3.219, p = .001, r = 0.720;
How science can contribute to resilience planning: n= 20, Z = -3.219, p = .001, r = 0.720

Furthermore, they learned about the different impacts that communities, areas, or stakeholders might face when encountering climate hazards or creating resilience plans. Half of participants (of 10) who responded to "What if anything did you learn from these citizen science activities on how the [climate hazard] impacts people?" highlighted the complexity of these impacts. For example, one participant noted how "areas low within a watershed are the most vulnerable. Extreme precipitation can destroy homes and ruin infrastructure." Meanwhile, another participant considered the impacts and tradeoffs of drought policy which "can have a direct impact on how people use water, how they landscape their home, and its financial impact to them." Similar statements also emerged in half (3 of 6) responses to a question asking what they learned about the impact of resilience plans on the community. As one participant considered how there may be both positive and negative effects to consider when planning and wrote, "Resilient plans may be more beneficial to the businesses of a community than it is to the citizens of a community."

Participants learned about the role of science around climate hazard resiliency planning and the role that they can play by engaging with citizen science. Six (of 8) responses to the question "What did you learn from these citizen science activities about how science can contribute to resilience planning?" focused on how science can be used to make predictive models to inform decisions ("With science we are able to do things like install desalination plants, and also understand how the ways water is captured will affect the environment.") Several responses to this question (3 of 8) also highlighted the importance of community engagement and collaboration ("Science is based on evidence but that changes so it is not set in stone and has to be adapted to and can't be ignored as simply opinion. With the help of communities for wildlife can be identified and preserved in some cases.").

Finally, participants also learned about how to collect citizen science data in general. When asked about what they learned around what communities can do, one participant wrote, "I had not made the connection between my actions and the community decision makers access to the data I created" in reflection of the impact of their work. Others learned about citizen science programs in general and enjoyed the ability to contribute (4 of 15), such as one participant who said they "liked the citizen science project, CoCoRaHS - it gives me a way I can help". These results are reflective of what was heard around what they most valued about the citizen science program, which was the ability to feel like they were taking action around climate resilience.

Tables of these findings can be found in Appendix C.

Overall, the forums and citizen science were successful at achieving the learning goals and giving participants an increased understanding around climate resiliency, its impacts, and how science can contribute to resiliency planning. Participants frequently bring up the complexity of the topic, its different solutions, and varying positive or negative impacts on stakeholders as the most salient information gained from their experience. These findings suggest that future projects should continue to focus on the complexity around resiliency planning and impacts, particularly around stakeholders which may help participants further relate to their community needs. Furthermore, the emphasis on the role science can plan should continue to be emphasized as participants gained new ways to engage in the scientific process, their community, and contribute to resilience planning via citizen science opportunities.

3.2 ENGAGEMENT

The engagement goals for the CSCRC project were the following:

2. Engagement or interest. Participants will:

a. Demonstrate sustained participation in science to civics activities.
b. Practice scientific process skills of collecting, synthesizing, and presenting data that contribute to public policy and community resilience.
c. Engage in discussions and decision-making activities about complex socio-scientific environmental decisions.
d. Develop increased interest and confidence in contributing to public policy around community resilience.

Overall, the data suggest that the CSCRC program was successful in meeting the majority of its engagement goals. While it is unclear if respondents' participation was sustained due to the lack of paired forum and citizen science data (Goal 2a), quantitative data from both groups reported statistically significant increases related to continued interest around climate resiliency actions. Indeed, participants from both groups increased their interest and confidence in taking actions to address climate hazards in their community, contributing to citizen science efforts and public policy (Goal 2d).

When asked what they valued about the event, qualitative data from forum participants mentioned the opportunity to talk to others and connect with their local community (Goal 2b). Citizen science participants, on the other hand, valued the opportunity to practice scientific process skills, including contributing to science and policy in general (Goal 2c). These findings lend evidence that participants engaged with these behaviors and also found them a key part of the CSCRC experience.

3.2.1 Both forum and citizen science participants had increased interest and confidence in taking action, including participating in citizen science and policy advocacy.

Forum and citizen science survey participants were asked to do a retrospective pre-post and rate their interest and confidence in regards to engaging with resiliency strategies. Participants rated their level of interest and confidence on a scale of 1-9 in response to three statements on resiliency activities: taking action to address climate change within their community, contributing to citizen science efforts, and contributing to public policy around climate change. Overall, pre- and post- ratings for the forum and citizen science were similar to one another for both interest and confidence. Both activity cohorts demonstrated similar increases across all of the three statements, particularly around engaging with citizen science around their specific climate hazard.

As seen in Figure 9 and

Figure 10, below, participants from both surveys already had a moderate interest in taking action prior to the event. However, there was still a 1-2 point increase after their participation in either

activity across all three statements for each cohort. This increase was statistically significant and also had a large effect size. For both the forum and citizen science, the highest average score after participation was for interest in "contributing to citizen science efforts" around their climate hazard. Forum participants rated an average of 7.51 with a range of 2 to 9, and citizen science participants rated an average of 7.5 with a range of 5 to 9.

Figure 9. Mean ratings of forum participants' self-reported interest[6]

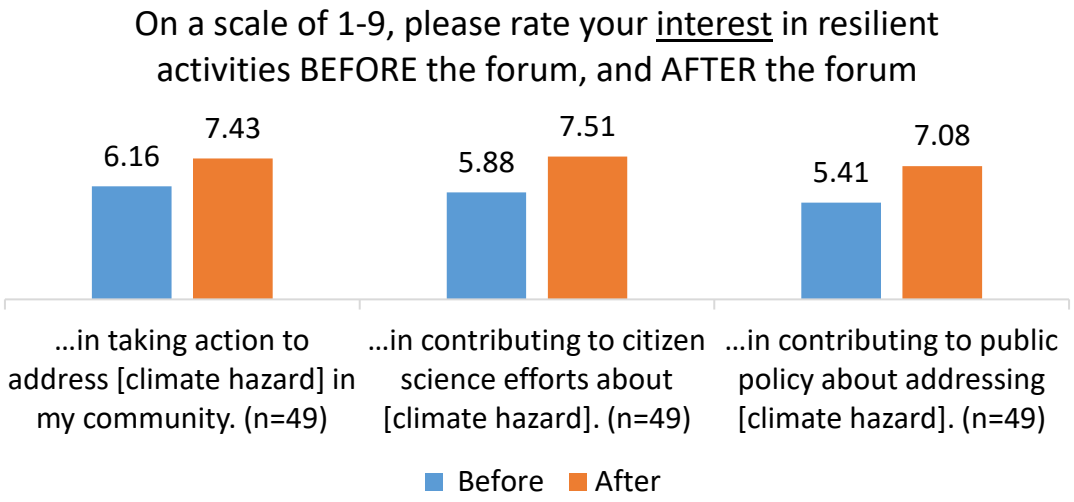
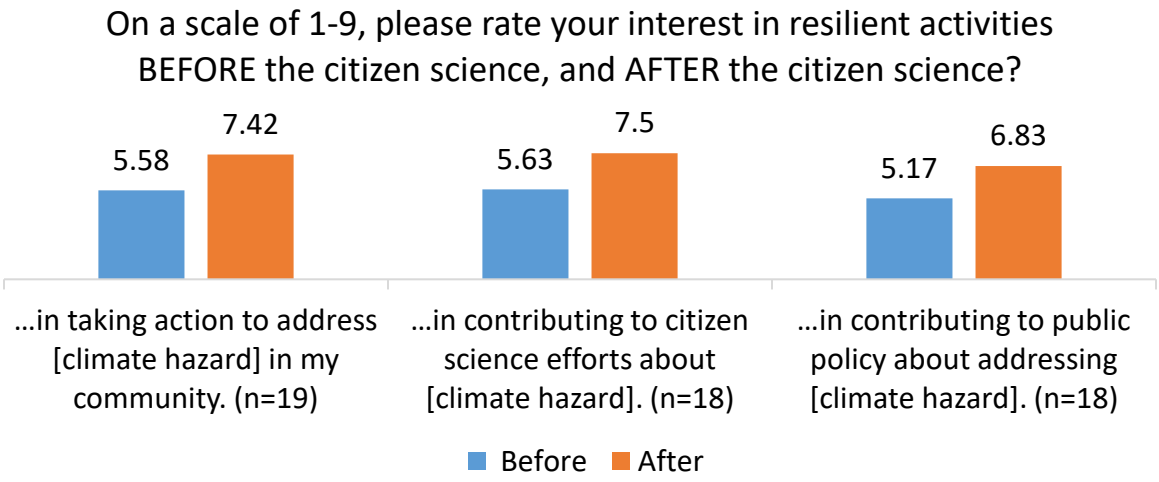


Figure 10. Mean ratings of citizen science participants' self-reported interest[7]



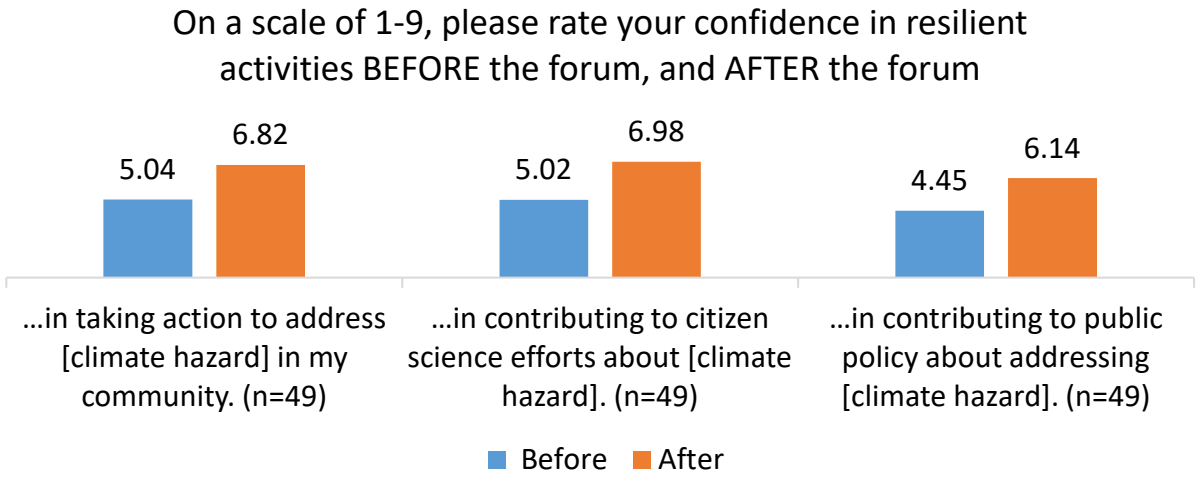
[6] Wilcoxon Signed Ranks Test: Taking action in my community: n = 49, Z = -4.763, p < .000, r = 0.680; Contributing to citizen science efforts: n = 49, Z = -4.957, p < .000, r = 0.708; Contributing to public policy: n = 49, Z = -5.279, p < .000, r = 0.754

[7] Wilcoxon Signed Ranks Test: Taking action in my community: n = 19 Z = -3.211 p < .001, r = 0.736; Contributing to citizen science efforts: n = 18 Z = -2.248 p < .025, r = 0.529; Contributing to public policy: n = 18 Z = -3.088 p < .002, r = 0.727

Compared to interest, respondents' initial confidence ratings were slightly lower overall with similar ratings. When asked to rate their level of confidence afterwards, both datasets had similar results with statistically significant increases in confidence with a moderate to large effect size for each statement which shows that participants' level of confidence increased after taking part in either one of these activities.

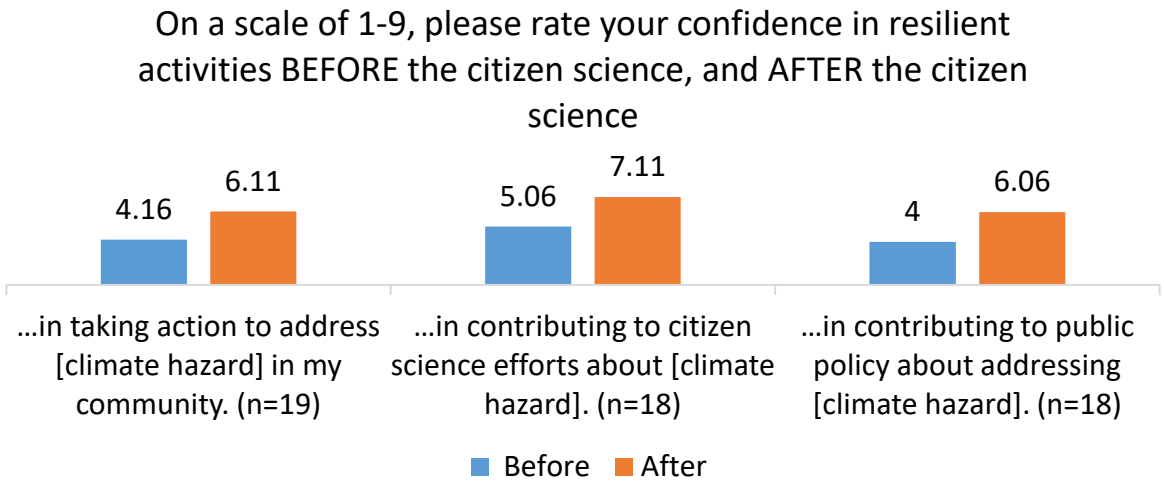
As seen in Figure 11 and Figure 12 below, findings around confidence were similar across both groups and closely followed what was seen for ratings around interest. Participants rated their initial levels of confidence slightly lower across all three statements compared to their interest ratings, but still had a statistically significant 1-2 point increase afterwards with large effect sizes. Similarly, the highest rated statement after participating was related to "contributing to citizen science efforts" around their climate hazard. Forum respondents had an average rating of 6.98 with a range of 2 to 9, while citizen science participants had an average of 7.11 with a range of 2 to 9. While these ratings are similar between both groups, citizen science participants have a slightly higher average for engaging with citizen science which is most likely due to having recently participated in that activity.

Figure 11. Mean ratings of forum participants' self-reported confidence[8]



[8] Wilcoxon Signed Ranks Test:
Taking action in my community: n = 49, Z = -4.904, p < .000, r = 0.701;
Contributing to citizen science efforts: n = 49, Z = -5.269, p < .000, r = 0.753;
Contributing to public policy: n = 49, Z = -5.137, p < .000, r = 0.734

Figure 12. Mean ratings of citizen science participants' self-reported confidence[9]



3.2.2 Forum participants valued the opportunity to talk to and connect with one another while citizen science participants valued the opportunity to contribute to science

Survey respondents were asked what they valued about their participation in the forum or citizen science. Across both activities, participants highlighted how they valued the hands-on or action-oriented opportunities they provided.

Forum participant respondents indicate that the program was successful in fulfilling Goal 3b around engagement or interest ("Engage in discussions and decision-making activities about socio-scientific environmental decisions"). Nearly half of forum participants (see Table 3Table below) valued the opportunity to talk to, learn from others, and hear different perspectives from other participants and speakers ("The discussion with other community members about topics I hadn't considered and how are group choices resulted in changes") that the forum offered them. For some, this included the opportunity to learn from others involved with similar issues ("hearing the ideas and advice that others from my community had."). Others mentioned that the forums allowed them to learn about what was happening in their local communities around climate resilience planning. For example, one participant learned that their community was "interested in natural infrastructures to improve their community resilience."

[9] Wilcoxon Signed Ranks Test: Taking action in my community: n= 19, Z = -3.192, p < .001, r = 0.732;
Contributing to citizen science efforts: n= 18, Z = -3.195, p < .001, r = 0.753;
Contributing to public policy: n= 18, Z = -3.077, p = .002, r = 0.725

Table 3. Forum: What, if anything, did you value about your participation in this project? (n=30)

Code	Count	Example
I valued the opportunity to talk to others, including experts, and to hear their different perspectives	12	"I valued the interaction that I had with the other participants in my break-out group. It was great to hear other perspectives and see issues from a different point of view."
I liked the format and activities	7	"Liked the format - was worried about the "engagement" piece and breakout rooms but I think it worked well."
Learning about or becoming more aware of climate hazards and/or strategies	7	"I am glad I attended and believe many more people from my state should have as well. Especially our State Reps. I learned a lot and aware of so much more now that I attended."
Learning about what actions my community is doing around climate resiliency	5	"I learned that communities in my area are interested in grass-root ways to reduce the impacts and recover from pollution issues related to flood events."
Other: Reflections on policy and resilience strategies, N/A	4	"…Mostly it is all a breaking of the commonality of the modern capitalist comforts that will allow any approach to solutions that greatly reduce the effects experienced in today's climate and going forward. Are modern humans brave enough to endure these 'discomforts' to ensure a future where all can thrive including our already destroy and threaten ecosystems?"

While there were fewer responses from the post-citizen science surveys, respondents indicated appreciating their ability to contribute to science and help influence policy decisions ("I hope that I could contribute to information about drought in my community"). Others were excited for the opportunity to share their citizen science data at their institution event, learn about citizen science in general, or think of ways to incorporate the materials to engage others (See Table 4 below).

Table 4. Citizen Science: What did you value about the citizen science? (n=9)

Code	Count	Example
Being able to contribute to science and influence policy	5	"I like knowing that my personal data collection can matter for the bigger picture."
Reflections on the forum	2	"It was interesting to look at all the different options and opinions of the different stakeholders."
Sharing the CS data with others	1	"I shared the CoCoRaHs findings with the summer campers that we had at our park this year and I believe they gained something from it."
Learning about CS and climate	1	"The knowledge that I acquired during the activity"
Ideas on how to create future engagement in CS with others	1	"Ideas on how to help students become citizen scientists where they have positive impact on changing things in their community for the better."

Both the forum and citizen science activities were successful in accomplishing the project's engagement goals. Participants from both cohorts particularly valued the action-oriented aspects of these events. Future projects should continue to emphasize and build on the different strengths that forums and citizen science provide. Data from this evaluation indicates that forum events were useful in connecting community members to one another and informing participants on local events, while citizen science provided an opportunity for people to make active contributions to science and policy through their data.

3.3 MUSEUM PROFESSIONAL RESULTS

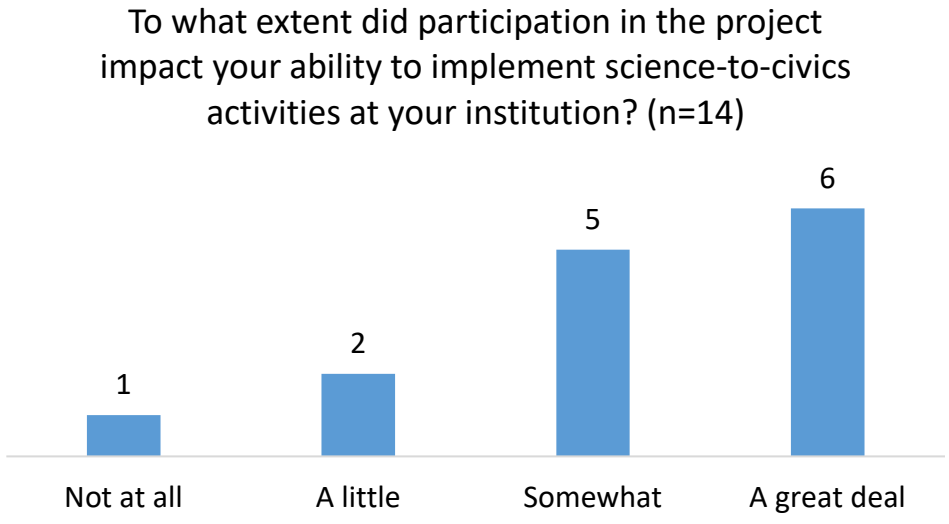
While the focus of this project was on understanding impacts of participation on the public, the CSCRC team decided that it was important to collect data from the museum professional participants as well. This decision was made in recognition of the effects that the COVID-19 pandemic had on the project as well as in recognition of the learning that took place among museum professionals.

Overall, data collected from the museum professionals indicated that participation in CSCRC positively impacted their abilities to implement science-to-civic activities, but that the pandemic made facilitating the project for their public participants difficult. The museum professionals indicated that providing materials, science equipment, and access to experts would make it easier for them to continue their science-to-civics work with their audiences in the future. The findings about the museum professionals are described in more detail in the next sections.

3.3.1 Most professional respondents reported that the project positively impacted their abilities to implement science to civics activities, with the materials & trainings and citizen science activities supporting their abilities.

Museum professionals who led CSCRC activities were asked to complete a short survey. In total, 14 of these museum professionals filled out the survey. Responses indicate that museum professionals generally felt that their involvement in CSCRC positively impacted them with 11 (of 14) indicating that participation in the project impacted their abilities to implement science-to-civic activities at their institutions "somewhat" or "a great deal" (See Figure 13, below).

Figure 13. Project impacts of implementing science to civics activities for professional respondents



Museum professionals were then asked a follow-up question to understand what about the project made them give these ratings (See Table 10, below). Most commonly, museum professional respondents (4 of 14) called out materials and trainings as positively impacting their skills. One professional said, "The forum materials can be pulled out and use again when we find an audience ready to engage." The citizen science activities were also called out by some museum professionals (3 of 14) as positively impacting their abilities to implement this work. One of those professionals said, "The project gave us a concrete way to start doing citizen science activities with our community." Other aspects of the project that professionals reported positively impacted their abilities to do science-to-civics activities included building relationships with others through the project (2 of 14) and building on previous work (2 of 14 respondents).

Table 5. What about the project made you feel this way about implementing science-to-civics activities? (N=14)

Code	Count	Example
The materials and training provided positively impacted my ability to implement science-to-civics activities	4	"The forum deliberation materials and training were well-produced and the resources complete and easy-to-implement. I have been able to use these for teacher workshops. …"
Learning about / using the citizen science activities positively impacted my ability to implement civic-to-science activities	3	"Through the project, I became aware of how SciStarter functions as a hub for community-based science activities. I also learned about iSeeChange and CoCoRaHS networks and began the process of connecting local communities to them."
The pandemic limited our ability to implement civic-to-science activities	3	"The pandemic more than anything is what limited our ability to engage community members and our ability to implement science-to-civics. We feel that in another year (non-pandemic) our engagement and community participation would have been much higher. "
Other	3	"We had never done anything like this before, so this was a great opportunity."
Building connections with others through the project positively impacted my ability to implement civic-to-science activities	2	"From participants to community partners, the understanding that it was part of a national effort with museums, volunteers, and other community organizations involved made it feel bigger than more localized projects. The sense of connectiveness during this time virtual conferences was also appealing to some."
This project built on my previous work positively impacting my ability to implement civic-to-science activities	2	"We have experience implementing science to civic activities in the past. The difference with this project is that it allowed us to bring in partners outside the [museum] and content experts to enhance and scale up the reach of the citizen science project."

3.3.2 Professional participants reported that to continue implementing science to civics activities that they would like access to materials and tools, science equipment for citizen science, and access to experts.

The museum professionals were also asked what supports they would need to continue implementing science-to-civics activities (See Table 6, below). Most commonly, respondents (5 of 14) reported that having access to materials such as the forums and training documents would support them in this work. One of these respondents said, "…I really enjoyed the Extreme Heat forum but felt I was too busy at that time to fully engage in how I would facilitate it with others. I would like to go back and learn to facilitate those forums; perhaps these train-the-trainer resources already exist? If not, I would like them." Beyond access to materials, some museum professionals (3 of 14) said that they would need access to tools and science equipment to continue their science-to-civics activities. One of these museum professionals said, "I feel like SciStarter has been an invaluable resource in terms of support, tools, and materials. It would be awesome to be invited to apply for kit materials that we can disseminate to other smaller organizations…" Beyond these requests, some museum professionals (3 of 14) said it would help them to continue this work if they had access to experts. One of these respondents said, "We would need content experts and curriculum related to the project [to continue this work]. We can source for materials and tools." Other supports that museum professionals said would help them in this work included help from professionals in science-to-civics activities, assistance in moving these activities from a virtual into an in-person space, and training in engaging diverse audiences.

Table 6. If you were to continue implementing science-to-civics activities at your institution, what supports would you need to do it successfully? This can include tools, materials, as well as external professional support. (N=14)

Code	Count	Example
I need access to materials	5	"I think materials and tools would be the most needed…"
I would need access to tools / science equipment	3	"Our project investigated heat. We did not use instrumentation to collect citizen science data, but we feel utilizing instruments, e.g. temp sensors, would increase participant engagement and provide real, scientific data that could be utilized and shared with scientists and city planners. Therefore, funding for instrumentation/tools would be idea."
I would need access to experts	3	"...We would use local experts to make sure local connections are made."
I need professional support	2	"...External professional support is also helpful, but we are finding that informing and then involving may work for longer engagement."
I need support in how to make this an in-person activity	2	"To continue implementing community-based science activities, I need support for face-to-face workshops and forums. Online networking has worked to engage some members of our community but we need to get outside with more volunteers to engage and support a broader base."

I need support in how to engage diverse audiences	2	"I think more training in reaching out to diverse groups to get more actual participants…"
Other	2	"The group that participated in CSCRC were so inspirational and it was awesome to see and hear all the amazing work they were doing. Listening to the various centers report out and the creative ideas they had spurred creative thinking at our institution and gave us the motivation to keep doing this type of work - we are not alone and there are others who can help and bounce ideas off of!"
Not Answered	1	

3.3.3 Professionals reported they were appreciative of being able to participate in the project, but that the pandemic made the project difficult.

Beyond building their skills, museum professionals reported an appreciation for being able to participate in this project. When asked what else they had to add, some museum professionals (3 of 14) described general appreciation for the project (See Table 7, below). One of these respondents said, "[I] appreciate the opportunity to have participated in this project." Other participants reported appreciation for specific parts of the project. A couple of participants (2 of 14) reported that they were appreciative that the project allowed them to expand their network. A sentiment that was echoed in previous questions on this survey. One of these respondents said, "…I enjoyed learning from others around the country and made a few new connections…" One participant (of 14) reported appreciating that this project provided funding for them to do the work. Finally, another participant appreciated the work that the team put in to figure out how to complete this project in the middle of a pandemic.

Table 7. Is there anything else you would like to add? (N=14)

Code	Count	Example
Not answered	7	
We appreciated participating in this project in general	3	"We really enjoyed participating in this program!"
I appreciated that participation expanded our network	2	"It was great participating in this program. It really helped expand our network."
I appreciated the work of the team to figure out how to do this during a pandemic	1	"Under the circumstances created by continued spread of COVID-19, this project went remarkably well. I'm grateful to organizers for rallying to find alternative ways of promoting community-based science projects and offering community forums."
I appreciated the funding	1	"...I always appreciate when we get funding, no matter the size, to support others in rural communities. This project was well-fun and much appreciated!"

We are trying to think about how to make our citizen / community science welcoming	1	"We are currently looking at a way to encourage dedication to practicing citizen and community science that seems welcoming. There does seem to be some concern that some members of our audiences and guests we feel it is important to involve see involvement in community science as political when it is not."

While responses to the project were very positive, it should be noted that three (of 14) professional respondents called out the pandemic as limiting their ability to complete this project. One of these participants said, “The pandemic made things much harder. We didn't push much on getting engaged with our local governments, etc., because we knew they had lots going on. But we now have ideas about some things we could engage with them on.”

Data collected from museum professional participants indicates that they felt the CSCRC project was successful in supporting them to build their skills in implementing science-to-civics activities. Aspects of the CSCRC project that the professionals felt helped them build their skills included the materials that were provided such as the forum discussion activities, and the citizen science projects. These types of resources were also called out as things that would help them continue science-to-civics work in the future. Participants were appreciative of the project, but felt that if the pandemic had not been a factor, they would have been able to do more. These findings suggest that future projects should continue to provide public activities to help professionals do science-to-civics work and build their skills.

IV. CONCLUSION

Overall, the Citizen Science, Civics, and Resilient Communities (CSCRC) project was successful in fulfilling its knowledge and engagement goals and highlights the strengths of the program's forum materials and guidance in implementing these in conjunction with citizen science programming. Data for both the forums and citizen science programs conveyed a series of activities that were effective at teaching audiences about climate hazards, resiliency strategies, and ways that they could contribute to science. Survey respondents from forum and citizen science participants were similar to one another, and had similar findings around increases in their knowledge, confidence, and interest in climate topics.

CSCRC participants had a moderate level of knowledge around climate change and resiliency topics prior to taking part in either of the activities. Afterwards, they reported having statistically significant increases in each of these areas. They gained knowledge on the different types of resilience strategies that are available, the complexity involved in resilience planning, and how these and climate hazards have different positive or negative impacts on others including communities, individuals of varying socioeconomic backgrounds, geographic regions, and industries. They also learned about how science played a role in resilience planning, especially around predictive modeling. For citizen science participants, this understanding may have been reflective of the fact that half of the respondents reported taking part in a prior forum event.

Similarly, respondents reported moderate feelings around their confidence and interest with engaging with climate resiliency topics, which included taking action to address community climate hazards, contributing to citizen science efforts, and contributing to public policy, and reported significant increases afterwards as a result of their participation. These participants also found value in action-oriented opportunities. For forum participants, this manifested as the opportunity to talk to others within their community and learn about the types of actions they were taking, while citizen science respondents particularly valued the opportunity to directly contribute to science with their data along with learning about opportunities that they or others in their community can be directly involved.

Finally, while originally unplanned, data collected from museum professionals who ran science-to-civics activities for their public audiences indicated that they benefited from their participation. Museum professionals indicated that the project positively impacted their abilities to implement science-to civic activities, with the materials and trainings as well as the introduction to the citizen science activities being particularly helpful. Museum professionals asked for a range of resources in order to continue their science-to-civics work. Some of the more common things that the museum professionals asked for included access to materials such as the forums themselves, science tools such as rain gauges, and connections to experts. Overall, professionals reported that they were appreciative of the Museum of Science for allowing them to participate in the project, but they lamented that the COVID-19 pandemic made it difficult for them to do all of the activities that they would have liked to for this project.

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APPENDIX A: ADDITIONAL DEMOGRAPHIC DATA

Table 8. How did you hear about the forum? (n=37)

Code	Count
Specific Institution	13
Friend or colleague	8
Email	6
School, program, or network (includes NISENet)	6
Website or app (SciStarter, iSeeChange, CoCoRahs, Eventbrite)	3
Social media	2

Table 9. How did you hear about the citizen science? (n=19)

Code	Count
Specific institution	6
Email	4
School or Program	4
Friend or Colleague	3
I don't know	2

APPENDIX B: QUALITATIVE FORUM DATA

Table 10. What, if anything, did you learn from this forum about how communities can address [climate hazard]? (n=36)

Code	Count	Example
The different solutions related to climate change	15	"This forum gave me a better idea about how the different solutions are related, e.g. how widespread distribution of air conditioning in a community then impacts the power grid."

I learned about different stakeholders involved in climate change and how they may be affected by climate or resiliency plans	10	"I learned that the way cities address sea level rise can affect each member of the community differently. Not everyone can benefit."
The complexity of climate resilience	9	"I learned that water saving technologies and strategies [take] more time and funding than can be expected, which can also adversely effect different stakeholders in unique ways.
How communities are working towards climate resilience strategies	2	"I learned about many groups working together with volunteers and other groups to work on climate resilience."
The importance of community feedback and collaboration with policy makers and scientists to build climate resilience	2	"It takes community support from all citizens to work on solutions. These solutions need to work on asap."
Communication strategies to get communities and policy makers involved in climate resilience	2	"How to better communicate to the community scientific information about flooding events and remediation strategies. Also received excellent techniques for soliciting community feedback about how extreme precipitation impacts them."
Other	1	"I learned that some responses I thought would be not acceptable are relevant."

Table 11. What, if anything, did you learn from this forum about how human behavior impacts [climate hazard]? (n=21)

Code	Count	Example
Nothing new or I don't know	6	"I feel like this is a subject I was already very familiar with"
How human behaviors can have a positive or negative impact on climate change	5	"Humans have choices in how they use or conserve water. Everyone's collective choices impact everyone else."
Taking action isn't a concern or priority for all people	3	"I was reminded that the human perception of water tolerant landscapes varies, not everyone thinks they are cool!"

I learned about different stakeholders/industries and how they are impacted by climate change	2	"The different areas of water use for human consumption, industry and agriculture." "Farmers have it rough"
The importance of educating others on climate and climate resilience	2	"I learned that education is key to creating a positive impact on human behavior."
The importance of laws and policies related to climate	2	"If there are rules then people will follow them."

Table 12. What, if anything, did you learn from this forum about how [climate hazard] impacts people? (n=22)

Code	Count	Example
I learned how different communities, stakeholders, and industries are impacted by climate change	13	"I'm from a farming community, so I know a lot about how drought impacts agriculture, but I hadn't thought about the housing market, and I rarely think about big corporations."
I learned about how climate change can negatively impact human lives overall	4	"Droughts can ruin income, livelihood and quality of life. It. Can also displace citizens."
I learned about how climate change affects human health	4	"Learned about the hog manure contaminated floodwaters polluting residents' homes, learned about the potential pressure on hospitals dealing with a role as a community center during a crisis, in addition to the added load of ER patients because of a given climate emergency."
I learned about climate change's impact on homes, systems, and infrastructure	4	"I learned about how water treatment plants, sewer systems, etc. can be greatly impacted by extreme precipitation and flooding and the related health impacts."
Taking action isn't a concern or priority for all people	3	"Heat issues are a concern and people want solutions as long as it doesn't inconvenience them in their daily lives."

Nothing new	1	"Having lived in a city with continual flooding issues, I didn't learn much from this forum in relation to impact on people."

Table 13. What, if anything, did you learn from this forum about how resilience plans impact the environment? (n=20)

Code	Count	Example
I learned about the different positive and negative impacts of different resilience plans, including on the environment and for different stakeholders.	10	"I learned that it is necessary to consider what is important to the area impacted and move on what is best for the community and not necessarily individuals. We can preserve personal history, but should not if it risks lives, environmental structures, and major businesses such as hospitals and power plants."
I learned about different resilience plans	6	"I think I have underestimated how much planning is already underway."
I learned about the need for communities to be involved in resilience planning	2	"It takes the help of the communities and government to have a good plan for the environment. It can not be done without both."
I learned about the level of complexity involved in resilience plans	2	"…Much of what needs to be done requires all to take a active stake. There really seems to be not enough money available or money willing to be made available for this greatly vertical threat."
Not much	2	"Not much"
Taking action isn't a concern or priority for all people	1	"…People expect solutions but refuse to pay for them or participate in those solutions…"

Table 14. What, if anything, did you learn from this forum about how resilience plans impact different community members? (n=19)

Code	Count	Example
I learned about the positive and negative impacts of certain resilience plans on different communities and stakeholders	15	"This was the biggest takeaway, of thinking about how various plans will impact the different stakeholders and the groups they represent. The finalized scenarios also highlighted that there really aren't any right answers, just different impacts on different groups."

I learned about the different perspectives stakeholders have on different resilience plans	6	"Most of the forum was about people's reactions to the various plans so it gave a good perspective on the range of responses and typical positions about different plans--so it gave a good range of perspective."
I learned about the importance of community involvement in resilience planning	3	"The case study was a great way to demonstrate that no plan is going to solve problems or make everyone happy. There is usually no win-win solution. All stakeholders and community members have to advocate for themselves but the reality is not everyone will always be happy with a solution."
Certain communities were not mentioned	1	"There was not much mention of poor citizens and its disproportionate effect of minorities and working class people and people of color."

Table 15. What, if anything, did you learn from this forum about how science can contribute to resilience planning? (n=19)

Code	Count	Example
Science can model future impacts of resilience plans and inform decision-making	7	"I better understand how science can predict what will happen over time by looking at past and present events. Science is very helpful with planning safety measures."
I learned how forum and community involvement can play an important role in resilience planning	4	"Science is doing a lot of research to help with the resilience plan. They need the government and communities to gather together in community forums. There is not a community forum in the state I reside in. I believe that needs to change and soon."
Not much	4	"I do this as part of my job."
I learned about different resilience plans	2	"Develop auxiliary power sources to be used by individuals and organizations. Backup for when grid slows down."
Research is helpful, general	3	"While planning will always take into account economic and other factors, science is an integral part of anything to do with resilience planning"
There are competing interests which deprioritize climate change as a major issue	1	"The facts don't lie but the economics manipulate any and all illusions of solutions."

Table 16. What do you think can be done to make the forum better? (n=30)

Code	Count	Explanation	Example
Suggestions around reading and text	7	Includes distributing reading materials ahead of time, simplifying the text, there was too much text, and concerns around reading out loud especially for ESL participants	"…I had at least 4 second language learners at my table and it was very uncomfortable asking that everyone read out loud when it seemed difficult for them to do with ease, and in front of a group of strangers. I thought some attention to readability and access could be considered…"
Suggestions around stakeholders:	6	Include more diverse communities, make a group member a stake holder, concerns about stereotyping, wanting more community stakeholder focus, including cultural history sites, or has plans for continuing to use these resources in the future	"Incorporating stake holders that include poor communities and communities of color." "I would love to adapt the materials for a class about UHIs for our museum."
Comments or suggestions around broadening participation:	5	Including diverse backgrounds, community outreach, holding the event with policy makers and other key stakeholders, schools, and in general	"…community outreach just needs to go even further so we can reach even more people."
Suggestions around Zoom	4	Bigger breakout rooms; toggling between pages was hard; everyone was crowded around 1 laptop	"It was hard to toggle between the Zoom screen and the map screen. The facilitator couldn't realistically bounce back and forth every time we needed to look at the information in the map layers…"

Suggestions around discussion:	4	More discussion time, one person wanted to hear from more experts	"Have more time after break-out room to converse about the plans each room came up with." "…have some expert speakers address the audience/impart some expert knowledge."
Suggestions around including more information:	3	Including additional solutions, wanting more information on economic factors, and costs	"Perhaps add a bit more about how the costs were derived - some seemed lower than I would have expected."
No improvements	3	No improvements or n/a	"…This was really a pleasure in which to participate."
Suggestions around the topic:	2	Focusing on a specific place, wanting to hear more about causes	"Focus on a place (e.g., Boston) that the participants are familiar with…"
In-person	2	Prefers an in-person event	"In person would make it way more engaging. (but i know in-person is difficult during a pandemic)."

APPENDIX C: QUALITATIVE CITIZEN SCIENCE DATA

Table 17. What, if anything, did you learn from these citizen science activities about how communities can address [climate hazard]? (n=15)

Code	Count	Example
I learned about different solutions related to climate change	5	"I learned about flood control and how water flows within watersheds."

I learned how to collect citizen science data which can to help climate decisions.	4	“I had not made the connection between my actions and the community decision makers access to the data I created”
I learned about how different strategies affect various stakeholders	2	"I learned how drought effects different parts of a community (such as businesses and the public) differently, and policy decisions will affect those parts of society in a different way."
I learned about climate change, general	2	“I've learned more about the signs of drought in my community and the policy decisions, such as water restrictions, community leaders make to prevent drought.”
Other	2	"How I could incorporate them into my lessons"

Table 18. What, if anything, did you learn from these citizen science activities about how human behavior impacts [climate hazard]? (n=10)

Code	Count	Example
I learned about how human behaviors have contributed to climate change and ways to reduce the effects	5	“Activities like excessive watering of lawns wastes precious water.”
I learned how human infrastructure and design can impact climate hazards	2	“I learned that insufficient drainage systems and too much concrete can lead to extreme precipitation.”
Other	2	“How I can better these concepts to my students” “the world is having a problem with the CO2 which makes sea level is rising thats why my machine dill with the CO2”
Nothing new	1	“As an Arctic researcher sadly nothing is new here since the writing has been on the wall for decades here.”

Table 19. What, if anything, did you learn from these citizen science activities about how [climate hazard] impacts people? (n=10)

Code	Count	Example
I learned about climate change's impacts on human activities, systems, and infrastructure	5	"A drought may spur new policy which can have a direct impact on how people use water, how they landscape their home, and its financial impact to them."
I learned how different communities, areas, and stakeholders are impacted by climate change	5	"I kind of intuitively knew it already, but people who are already disadvantaged are most heavily impacted by this issue" "I learned that areas low within a watershed are the most vulnerable."
I learned about different climate resilience strategies	1	"There are a huge variety of options on how to deal with sea level rise in our cities."
Nothing new	1	"Nothing new"

Table 20. What, if anything, did you learn from these citizen science activities about how resilience plans impact the environment? (n=9)

Code	Count	Example
I learned about different resilient strategies along with their tradeoffs	5	"Each plan is a balance of protecting the environment, preparing the public, and building new infrastructure. Some trade-offs may have a positive or negative impact on the environment, but they are all trying to make a community more resilient."
The importance of resilience planning and community involvement	2	"Making investments at the local levels are needed and can not be pushed aside. Also we need the communities to be more involved and invested and that starts with education."
Had not thought about it before	1	"Something I had not thought about"
More action is needed	1	"as i see it u r not doing everything to stop it"

Table 21. What, if anything, did you learn from these citizen science activities about how resilience plans impact different community members? (n=6)

Code	Count	Example
I learned about how resilience plans impact different stakeholders	3	"Different resilient plans effect parts of a community is different ways. Resilient plans may be more beneficial to the businesses of a community than it is to the citizens of a community."
Had not thought about it before	1	"Something I'd not thought about"
Other	1	"it will affect all of us "

Table 22. What, if anything, did you learn from these citizen science activities about how science can contribute to resilience planning? (n=8)

Code	Count	Example
Science can model and inform decision-making around climate resilience	6	"Using scientific tools to monitor things like rain and snowfall we predict how to properly respond to drought scenarios "
It's important for community members and scientists to be involved in resilience planning	3	"It can help a great deal but we also need to see what new forms of community knowledge are created. Remember: Think global, act local."
I learned how to collect citizen science data	1	"It's fun to see how much doing something simple like measuring rainfall at my home can matter for this"
Science can change over time	1	"Science is based on evidence but that changes so it is not set in stone and has to be adapted to and can't be ignored as simply opinion."
Other	1	"as i see it u have to use the right technology for this which i invented for dilling with the CO2"

Table 23. What do you think can be done to make the citizen science better? (n=11)

Code	Count	Example
Suggestions for ways to increase CS engagement in the community, including younger audiences, a CS-centric forum, or funding more CS opportunities	6	"The forum did a great job showing how policy and drought affects a community. It would be great to have the forum structured to show how citizen science data could be used in making policy decisions." "I would love to see more steps taken to engage a larger part of communities."
Logistical suggestions around email reminders or the app	3	"You must send reminders with links to zoom and calendar reminders if people are to participate." "Easier uploading of information. A fill-in-the blanks approach via an app."
Comments and reflections on the forum	2	"Potentially address the conflicting ideas of having electric cars by Tesla being promoted by a person who is burning lots of fossil fuels for unnecessary space travel."
It's fine, no changes are needed	1	"I think it is great as is."

APPENDIX D: FORUM/CITIZEN SCIENCE POST-SURVEY

Post-surveys for the forums and citizen science activities were mostly identical to one another. The word "forum" swapped in for "citizen science" for questions related to what they learned after the event or activities and the question asking if they had contributed citizen science data through the SciStarter website was replaced with the, "Did you participate in one of this project's forum programs about [climate hazard]?" Finally, all references to the particular climate hazard (i.e. sea level rise, drought, extreme heat, or extreme precipitation) were swapped in for the topic of the event.

Sea Level Rise Event Survey

Hello! Thank you for your willingness to complete this survey! The purpose of this survey is to evaluate the effectiveness of the Citizen Science, Civics, and Resilient Communities project and learn about your knowledge, interest, and engagement in climate resiliency.

Please select the choice that best describes you:

I am an adult

I am age 13-17

I am 12 or younger

Thank you for your willingness to complete this survey! The purpose of this survey is to evaluate the effectiveness of the Citizen Science, Civics, and Resilient Communities project and learn about your knowledge, interest, and engagement in climate resiliency.

How long will it take?

- The survey should take about 10 minutes to complete.
- The survey includes questions about your knowledge and interest in climate resilience and gathers your feedback about the program.

Information about your participation:

- This survey is optional, and you can skip any questions or stop at any time.
- You must be 18 years or older to participate in this survey.
- Your survey responses will be confidential. No identifying information will be shared outside the research team.
- The information you provide will be used to assess and improve future project activities.
-
- Because the information we collect may be useful for other studies, we may use this information in the future or share it with other researchers, without asking for additional permission. If we do so, your name and identity will not be shared with the future researchers.

Thank you for your willingness to participate and your efforts to improve this project. Please contact Katie Todd at ktodd@mos.org with any questions about the survey.

→

The following identifiable information will never be shared, and will be removed from your responses.

We will use it to track your participation in the project.

In what **year** were you born?

What is the **first letter** of your **first name**?

What is your **last name**?

What is your **email address**? (Note: If you have a SciStarter account, please use the same email you used to sign up for SciStarter)

For the questions below, please pick one BEFORE number and one AFTER number to indicate how much you knew about the following topics BEFORE this forum and how much you know now, AFTER this forum. If you learned something about a topic, please share what you learned.

	BEFORE the forum, I knew...	AFTER the forum, I know...
...about how communities can address sea level rise.		

What, if anything, did you learn from this forum about how communities can address sea level rise?

	BEFORE the forum, I knew...	AFTER the forum, I know...
...about how human behavior impacts sea level rise.		

What, if anything, did you learn from this forum about how human behavior impacts sea level rise?

	BEFORE the forum, I knew...	AFTER the forum, I know...
... about how sea level rise impacts people.		

What, if anything, did you learn from this forum about how sea level rise impacts people?

	BEFORE the forum, I knew...	AFTER the forum, I know...
...about how resilience plans impact the environment.		

What, if anything, did you learn from this forum about how resilience plans impact the environment?

	BEFORE the forum, I knew...	AFTER the forum, I know...
...how resilience plans impact different community members.		

What, if anything, did you learn from this forum about how resilience plans impact different community members?

	BEFORE the forum, I knew...	AFTER the forum, I know...
...about how science can contribute to resilience planning.		

What, if anything, did you learn from this forum about how science can contribute to resilience planning?

The next question is about your interest in resilience activities. For each activity, please pick one BEFORE number and one AFTER number.

	BEFORE the forum, I was...	AFTER the forum, I am...
...in taking action to address sea level rise in my community.		
...in contributing to citizen science efforts about sea level rise.		
...in contributing to public policy about addressing sea level rise.		

The next question is about your confidence in resilience activities. For each activity, please pick one BEFORE number and one AFTER number.

	BEFORE the forum, I was...	AFTER the forum, I am...
...in taking action to address sea level rise in my community.		
...in contributing to citizen science efforts about sea level rise.		
...in contributing to public policy about addressing sea level rise.		

Have you contributed citizen science data through www.scistarter.org/noaa?

- Yes
- No
- Unsure

What, if anything, did you value about your participation in this project?

How could we make this project better?

How did you hear about this program?

With which racial or ethnic group(s) do you identify? (Check all that apply)

- American Indian or Alaskan Native
- Asian or Asian American
- Black or African American
- Hispanic or Latinx
- Native Hawaiian or Pacific Islander
- White or Caucasian
- Other, write in:
- Prefer not to say

What is your gender?

- Male
- Female
- Another category, please specify:
- Prefer not to say

Which of the following categories best represents your highest level of education?

- No high school degree
- High school degree
- Technical diploma
- Some college
- Associate's degree
- Bachelor's degree
- Some graduate work
- Graduate degree
- Prefer not to say
- Other, write in:

What is your yearly household income?

- Under $25,000
- $25,000-$49,999
- $50,000-$74,999
- $75,000-$99,999
- $100,000-$149,999
- $150,000-$199,999
- $200,000-$249,999
- More than $300,000
- Don't know
- Prefer not to say

APPENDIX E: PROFESSIONAL IMPACTS SURVEY

Museum of Science®

Thank you for your willingness to complete this online survey! The purpose of this online survey is to evaluate the impacts of the NOAA Citizen Science, Civics, and Resilient Communities project. **Please complete this survey by December 17.**

How long will it take?

- The entire survey should take about 5-10 minutes to complete.
- The survey includes some questions about your knowledge and interest in holding future civics-to-science programs.

Information about your participation:

- This survey is optional, and you can skip any questions or stop at any time.
- Your survey responses will be confidential. No identifying information will ever be shared outside of the research team.
- The information you provide will be used to assess and improve the NOAA Citizen Science, Civics, and Resilient Communities project.
- Because the information we collect may be useful for other studies, we may use this information in the future or share it with other researchers, without asking for additional permission. If we do so, your name and identity will not be shared with the future researchers.

Thank you for your willingness to participate and your efforts to improve the NOAA Citizen Science, Civics, and Resilient Communities project. Please contact Liz Kollmann ekollmann@mos.org with any questions about the survey.

Museum of Science®

We define **science-to-civics** as:

- the process of engaging community members in collecting and analyzing data about environmental issues; and
- inviting these community members to discuss and share their recommendations, priorities and concerns about how to address these issues. The outcomes of the participatory data collection and public discussions are included in local resilience planning or shared with resilience planners.

To what extent did participation in the project impact your ability to implement science-to-civics activities at your institution?

- ◯ Not at all
- ◯ A little
- ◯ Somewhat
- ◯ A great deal

What about the project made you feel this way about implementing science-to-civics activities?

If you were to continue doing implementing science-to-civics activities at your institution, what supports would you need to do it successfully? This can include tools, materials, as well as external professional support.

Is there anything else you would like to add?