

Learning on Vacation: Knowledge Gain and the Value of Phytoplankton Sampling

CAPSTONE PROJECT
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Abstract

Travel to Antarctica is increasing with more than 123,000 visitors traveling to the Southern continent last season (IAATO 2024). As visitation increases, participatory science programs (PSP) enable tour cruise operators to incorporate sustainability messaging and a sense of purpose into the travel experience. Antarctic tour expedition vessels are increasingly incorporating PSP on board as engagement activities for travelers to contribute to scientific efforts. This project evaluates in what ways participatory science programs enhance visitor experiences in Antarctica. The main objective is to assess how participation in PSP could foster environmental awareness and meaningful connections. I focused on the FjordPhyto program, which engages travelers in phytoplankton sampling aboard cruise ships along the Western Antarctic Peninsula (Cusick et al. 2020). Traveler responses can help tour guides and operators understand the role of PSP in the overall satisfaction of passenger experience. They can also help to develop programming to further enhance the traveler experience and environmental literacy, with the potential to mold travelers into polar advocates and community science participants upon return home.

Introduction

Tourism to Antarctica has been increasing since the 1990s, and the industry has seen a nearly ten-fold increase in visitations since 1991 (Bender et al. 2016, IAATO 2024). In the 2023-2024 season, 122,072 travelers visited Antarctica, a significant change since the 47,000 visiting in 2016-2017 (IAATO 2024). This surge in visitations allows more people than ever to experience Antarctica, a journey that can be powerful and emotional (Powell et al. 2012). The increase in tourism is an opportunity to build public knowledge of the continent (Lamers et al. 2024).

One way public knowledge can increase is through participatory science programs (PSP), which offer a unique experience where non-scientists work with scientists to gather data in support of research, bridging the gap between the public and academia, and increasing environmental literacy. PSP encourages the public to participate in research and monitoring efforts, increasing environmental literacy and bridging the gap between the “scientist” and the “general public” (Bonney et al. 2015). Additionally, PSP has the potential to impact the lives of participants in significant ways (Bonney et al. 2015).

Recently, the inclusion of PSP on Antarctic cruise vessels offers travelers a unique experience centered on hands-on education. FjordPhyto is a polar program engaging visitors with phytoplankton, microscopic algae, and their ecological importance in Antarctica and operates annually on fifteen cruise ships throughout the western Antarctic Peninsula (Cusick et al. 2020). Travelers aid in gathering phytoplankton samples led and facilitated by FjordPhyto trained expedition guides. After engaging in participatory science activities with FjordPhyto, travelers can volunteer to fill out a post-participation survey (Cusick et al. 2025).



Figure 1: FjordPhyto guide engages with citizen science participants. *Photo credit Sandra Walser.*

Methods

Questionnaire design

The survey to evaluate the outcomes of FjordPhyto participants during their trip to Antarctica consisted of English language post-trip surveys (Figure 2). Surveys were implemented with the intention of understanding educational outcomes of the program in regards to knowledge gain of phytoplankton and NASA research. Additionally, surveys aimed at understanding the attitudes, experiences, and sense of environmental stewardship of participants. Surveys contained likert scale and open-ended questions about motivation for travel to Antarctica as well as knowledge of participatory science programs, NASA ocean color research, and the role of phytoplankton in the ecosystem (Figure 2). Survey design and analysis with collaborators Ms. Brooke Dixon, Dr. Martina Mascioni, Dr. Allison Cusick, and Dr. Daniela Cajiao. Data includes responses to open-ended questions about experience and perceived value of participation. Preliminary analysis of this data set was built upon the analysis of 81 surveys collected between from 2017-2019 (Cusick et al. 2025).

Visitor pre-survey → Country/City of Residence: _____

Thank you for agreeing to participate in this survey. Your responses are helping us gain an understanding of how participation in polar citizen science impacts individual travelers. The survey is confidential and should take between 10-20 minutes to complete.

1. How did you travel to Antarctica?
☐ Alone ☐ Couple or significant other ☐ Family ☐ Friends ☐ Other

2. Birth Year: _____ 3. Sex: ☐ Female ☐ Male ☐ Non-binary ☐ Not listed ☐ I prefer not to say

4. What is your primary motivation for traveling to Antarctica?

5. Prior to booking this trip, were you aware that citizen science projects would be available to you to participate in?
☐ Yes ☐ Not sure ☐ No

Citizen science is the practice of involving members of the public in scientific research.

6. Respond to the following statements regarding your participation in citizen science:

	Yes	No
I have participated in citizen science projects prior to this trip	☐	☐
I participated in a citizen science project during this trip	☐	☐
If your response to this is "No" please skip to question 13*		
I participated in the FjordPhyto citizen science project	☐	☐

7. Would you say that participating in citizen science enriched your travel experience?
☐ Yes ☐ No

8. Please rate how accurately the following statements reflect your experience participating in citizen science projects during this trip:

	Very poor	Disappoint- ingly poor	Neutral	Satisfac- torily good	Very good
I enjoyed participating	☐	☐	☐	☐	☐
Participating added another dimension to my trip	☐	☐	☐	☐	☐
Participating improved my perception of the value of citizen science	☐	☐	☐	☐	☐
Participating helped me understand the scientific process	☐	☐	☐	☐	☐
Participating added purpose to my trip	☐	☐	☐	☐	☐
Participating gave me resources and initiative to take further action	☐	☐	☐	☐	☐

FjordPhyto looks at the influence of melting glaciers on phytoplankton through NASA satellite data and samples collected from the water by citizen scientists. If you participated in FjordPhyto, please answer questions 9-12

9. Prior to this trip, were you aware that NASA collects data about the Earth's oceans and glaciers?
☐ Yes ☐ Not sure ☐ No

10. How well did your participation in FjordPhyto help you understand the following topics?

	Not well at all	Slightly well	Moderately well	Very well	Extremely well
The role that phytoplankton play in Antarctic ecosystems	☐	☐	☐	☐	☐
Phytoplankton are influenced by melting glaciers	☐	☐	☐	☐	☐
Phytoplankton samples can be combined with satellite data to monitor ocean changes	☐	☐	☐	☐	☐

11. Briefly describe what phytoplankton means to you following your participation in FjordPhyto:

12. What else would you like to tell us about your experience participating in citizen science on this trip?

13. In the future, are you likely to participate in additional citizen science projects?
☐ Yes ☐ Not sure ☐ No

14. In the future, will the availability of citizen science projects influence your decision to book one trip over another?
☐ Yes ☐ Not sure ☐ No

Thank you so much for taking the time to complete this survey. Your responses are helping us gain an understanding of how participation in polar citizen science impacts individual travelers as well as the polar tourism industry. To learn more about polar citizen science and for updates regarding this research, please visit <http://FjordPhyto.org/Info> and follow #FjordPhyto on Twitter, Facebook, Instagram, and YouTube.

Figure 2: Images of the survey distributed to FjordPhyto participants

Distribution and Collection

Surveys were distributed to participants and then collected on board 15 different IAATO-member cruise expedition vessels while in Antarctica between November and March during 2021-2025, five years after the FjordPhyto program's initial launch. Travelers were invited to respond to this anonymous and voluntary survey after participating in the FjordPhyto activity when expedition guides handed out surveys during the final lecture. Responses were collected and then sent to FjordPhyto researchers for analysis. These efforts to distribute surveys to on board participants resulted in 257 completed surveys. Based on the total passenger capacity of expedition vessels that collaborated with FjordPhyto, FjordPhyto estimates that an average of 20-30% of travellers participated in the program onboard. Using this number and the 257 surveys collected over four years, survey response rate is estimated to be 6.4% (pers. comms).

Analysis

Survey responses were handwritten and thus needed to be converted to a digital spreadsheet. Analysis was performed on two multiple choice questions (Q1, Q2) and two open ended questions (Q3, Q4):

Q1: "Prior to booking this trip, were you aware that participatory science projects would be available for you to participate in?"

Q2: "In the future, will the availability of participatory science projects influence your decision to book one trip over another?"

Q3: "Briefly describe what phytoplankton means to you following your participation in FjordPhyto."

Q4: “What else would you like to tell us about your experience participating in participatory science on this trip?”

Qualitative analysis software ATLAS.ti 25.0.1 was used to generate a word cloud to analyze word frequency in response in Q3. To analyze Q4, answers were sorted into themes based on labels created to identify categories of responses. Two major themes emerged: Meaning and Appreciation for Guides, therefore, I focused my analysis to explore further on themes *Added Meaning* and *Appreciation for Guides*.

Results

Demographics of Respondents

The largest number of responses (69 surveys) came from the 60-70 year range (Figure 3). Only one respondent was under 20 years old. This distribution is expected for Antarctic tourism, where half of all travelers tend to be over 60 years old (Cajio et al. 2022).

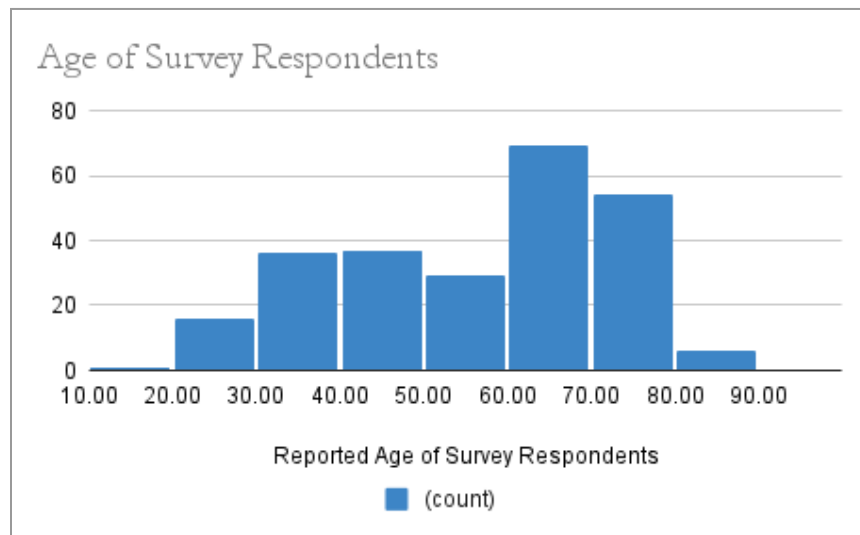


Figure 3: Age of Fjordphyto survey respondents.

Multiple Choice Questions

Multiple-choice question **Q1** “Prior to booking this trip, were you aware that citizen science projects would be available to you to participate in?” revealed 61.8% said “no,” 4.7% said “not sure,” and 33.5% said “yes.”(Figure 4). Two-thirds of respondents reported that they were unaware of the availability of participatory science programming aboard their cruise trip.

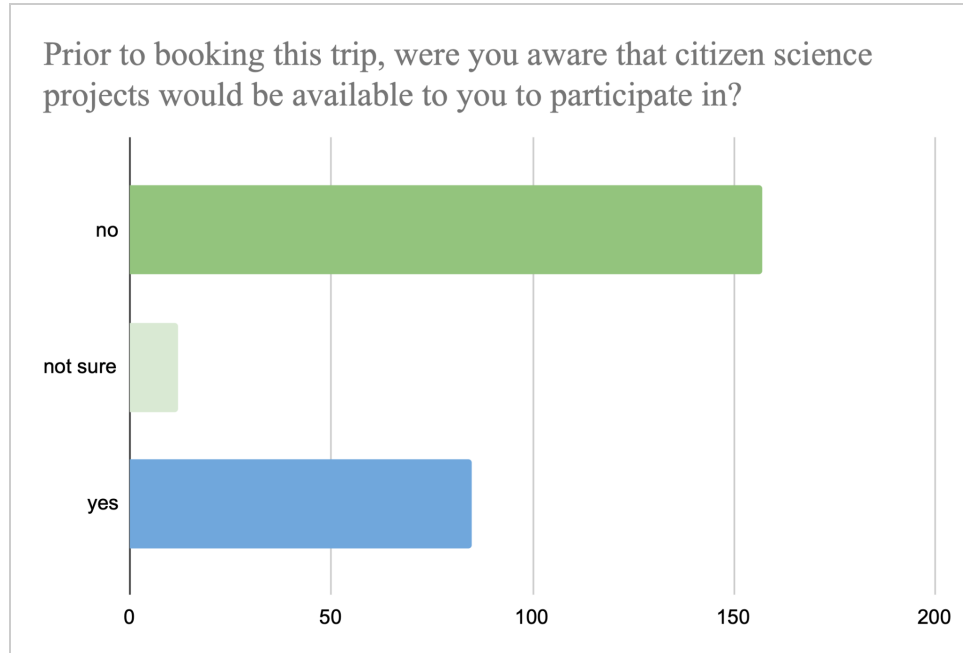


Figure 4: Participant response to Q1

Participants were also asked in **Q2**, “*Will the availability of citizen science projects influence your decision to book one trip over another?*” in which 65.1% said “yes,” 6.5% said “no,” and 28.3% said “not sure.” (Figure 5). To summarize, two-thirds of respondents reported that the availability of programs would influence their decision to book trips in the future.

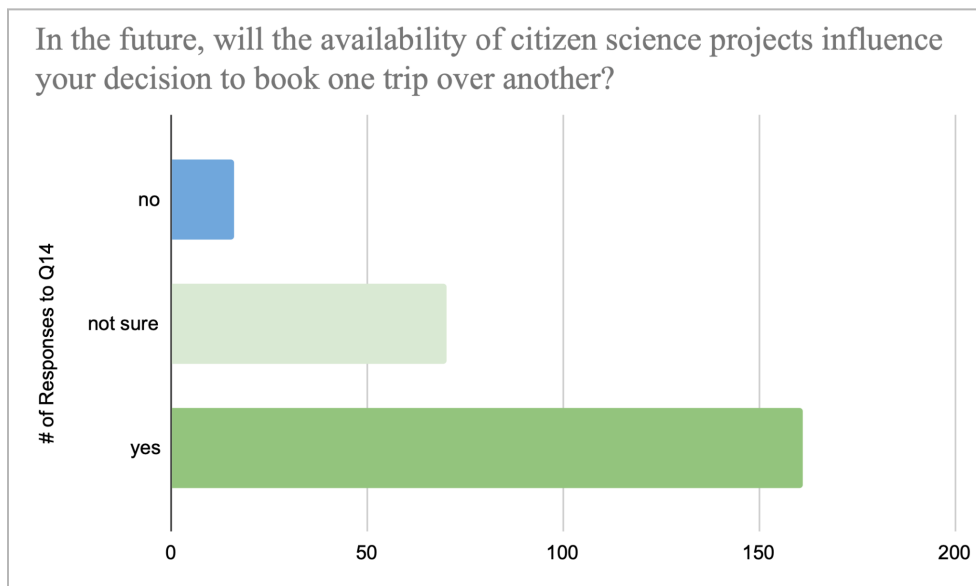
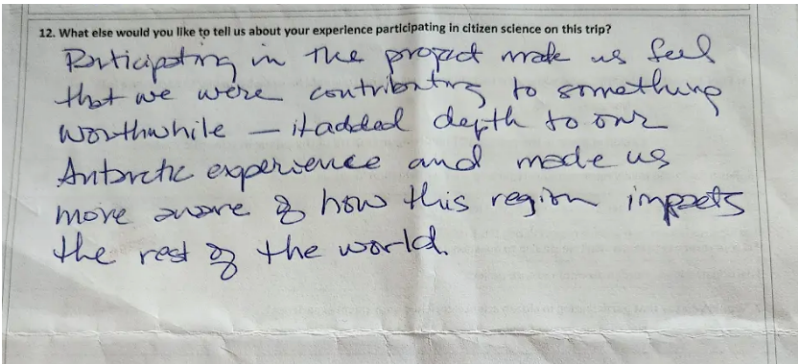


Figure 5: Participant response to Q2

Open-ended questions

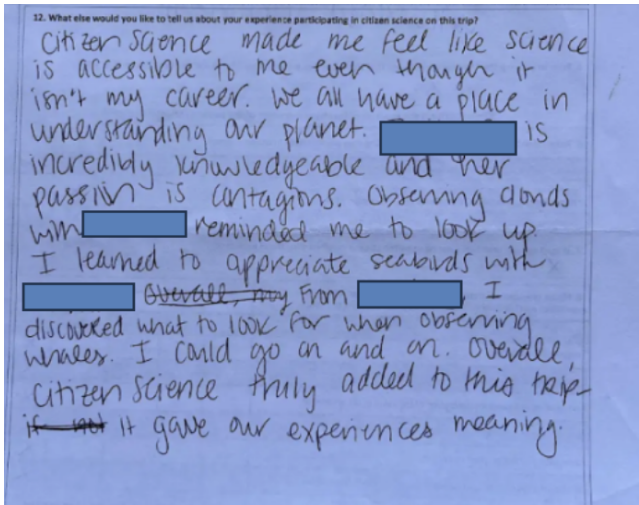
The first open-ended question (**Q3**) I looked at was: “*Briefly describe what phytoplankton means to you following your participation in FjordPhyto.*” Responses were analyzed using ATLAS.ti to generate a word cloud, in which larger words represent those that appeared more

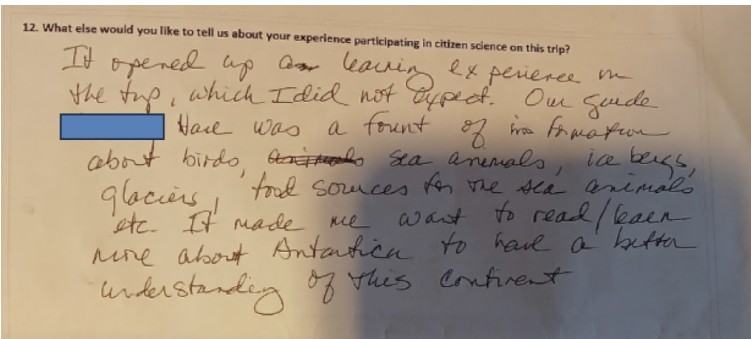
	Respondent writes: “Participating in the project made us feel that we were contributing to something worthwhile—it added depth to our Antarctic experience and made us more aware of how this region impacts the rest of the world.”
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Appreciation for Guides

Many of the responses to Q4 attributed this feeling of *Added Meaning* via participation to the knowledge or ability of their guides (Table 2). These responses were labeled *Appreciation for Guides*. In quotes below (Table 2), names of guides are hidden to preserve personal information.

Table 2. Examples of the emergent theme “Appreciation for Guides” in response to Q4. Note that guide’s personal names had been covered for privacy reasons.

	Respondent writes: “Citizen science made me feel like science is accessible to me even though it isn’t my career. We all have a place in understanding our planet. Guide A is incredibly knowledgeable and her passion is contagious. Observing clouds with Guide B reminded me to look up. I learned to appreciate seabirds with Guide C. From Guide D, I discovered what to look for when observing whales. I could go on and on. Overall, citizen science truly added to this trip— it gave our experiences meaning.”
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	Respondent writes: “It opened up a learning experience on the trip, which I did not expect. Our guide was a fountain of information about birds, sea animals, icebergs, glaciers, food sources for the sea animals, etc. It made me want to read/ learn more about Antarctica to have a better understanding of this continent.”
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Discussion

The aim of this project was to better understand how the program FjordPhyto was impacting participants. Survey respondents had an expected age distribution (nearly half of travelers over 60 years old)(Figure 3) for Antarctic travel (Cajio et al. 2022). The first multiple choice question, **Q1**, revealed that two-thirds of respondents were unaware of availability of science programming aboard their ships before traveling (Figure 4). 61.8% of participants were not aware that the program would be available to participate in until on board (Figure 4). Other case studies on cruise tourism in polar regions have shown that a majority of participants are aware of the presence of science and research, but many are not aware of specific science activities offered onboard, emphasizing a lack in communication (Lamers et al. 2024). Additionally, participants were asked in **Q2** if the availability of PSP would influence their decision to book one trip over another, in which two-thirds of respondents reported that the availability of PSP would impact their decision (Figure 5). If respondents' decision to book a trip is influenced by the availability of science programs, this reinforces the need for increased communication surrounding program availability found in Figure 4.

Participants demonstrated a heightened awareness of the ecological significance of phytoplankton when asked **Q3** (Figure 6). This survey did not include a pre-trip measure to evaluate knowledge gain post-trip, and therefore cannot quantify learning gains in a traditional sense, but can look at perceived or reported knowledge gain or understanding based on the language of the responses. As noted, prominent terms emphasized phytoplankton's role in the Antarctic food web. Future research could investigate the main topics and concepts used by guides to communicate topics like phytoplankton importance. Participants' heightened awareness of Antarctic ecosystems could be a foundation for increased support of research and conservation in the future (Graham et al. 2024).

Participation in FjordPhyto contributed to travelers' perceptions of a more meaningful travel experience (Table 1), emphasizing the value of engagement in PS. There doesn't just seem to be a connection between travelers and the place they visit, but also an interpersonal connection appears to enhance the perceived value of the experience (Table 2). Guides do more than deliver information—they set the tone for engagement, translate scientific concepts into accessible

narratives, and create an environment where travelers feel inspired and capable. When guides are trained and supported in facilitating PS, they can elevate the program from an optional activity to a defining feature of the travel experience—one that influences consumer behavior and supports environmentally responsible tourism.

Guides' impact on travelers may not simply be a product of hands-on education: literature on transformative tourism experiences emphasizes the need for social interaction; daily interactions with destination residents, focused attention, and shared emotional moods are all “ingredients” that can lead to a transformative experience (Soulard et al. 2021). Results of Table 2 in conjunction with Table 1 question whether guides act as “hosts” of Antarctica and provide connection and meaningful experiences through positive and focused social interactions. Additionally, as groups of travelers perform plankton sampling with a guide, it's a possibility that travelers bond with each other through enjoying the beauty of Antarctica, sharing values of conservation, and working as a team towards a common goal of collecting plankton (Wolf et al. 2015), which could add to feelings of meaningfulness and connection.

Overall, it is difficult to measure knowledge gain and long-term behavior changes, but it is understood that to lead to long-term behavior changes, participants need to pair experience with environmental knowledge (Somerwill and Wehn 2022). Based on the findings in Figure 5, Figure 6, Table 1, and Table 2, PS programs, like Fjordphyto, could open the door for long-term behavior changes through the combination of education and hand-on experience, as well as the influence of guides.

Conclusion and Recommendations

Based on the themes highlighted, hands-on education via participatory science could have the ability to facilitate connections between travelers and the place they visit. Further research could explore connections between people and place through education and identify the powerful role guides have in facilitating the connection. Based on these preliminary findings, I have developed two main recommendations for cruise operators and participatory science practitioners:

1. Invest in Guide Training and Resources

As highlighted in the *Appreciation for Guides* theme, guides play a pivotal role in connecting travelers with Antarctica. Guides were central to the traveler engagement in PSP and communication of scientific information and the facilitation of learning among travelers. Cruise operators and science coordinators can invest in rigorous comprehensive PSP training for guides and help PSP practitioners develop educational materials to support this facilitative role. Additionally, the addition of comprehensive PSP training for guides could be used to demonstrate the value of PS programs to cruise operators.

2. Enhance Participatory Science Program Visibility

Findings reveal a significant gap in awareness of science offerings. This suggests a need for improved communication around programs in marketing materials pre-voyage and post-voyage. Materials made in conjunction with scientists and PSP practitioners would allow for representative, accurate marketing of program goals. Respondents reported that the presence of participatory science projects could influence their choice between expeditions prior to booking and in future bookings (Figure 5). Overall, participation in participatory science while on vacation could open the door to deeper connections to place and promote traveler engagement

with environmental research. Future research should further examine how such programs facilitate place attachment, environmental awareness, and long-term behavioral impacts.

Reflections and Additional Deliverables

Main deliverable and communication tool: Poster presentation at CAPS25

To share my project with the wider participatory science community, I attended the Conference for Advancing Participatory Sciences (CAPS25) in Portland, Oregon from May 27 to May 30, 2025. I was accepted to share my poster with the Bridging the Gap & Learning section. I was able to communicate my findings and gather feedback from the community. Listeners were particularly interested in hearing about the lack of awareness around PSP offering aboard cruise ships (Figure 4). Others noted the positive nature of these findings; listeners noted that it was “hopeful” to hear PSP experiences were reportedly making a positive difference in travelers’ experiences.

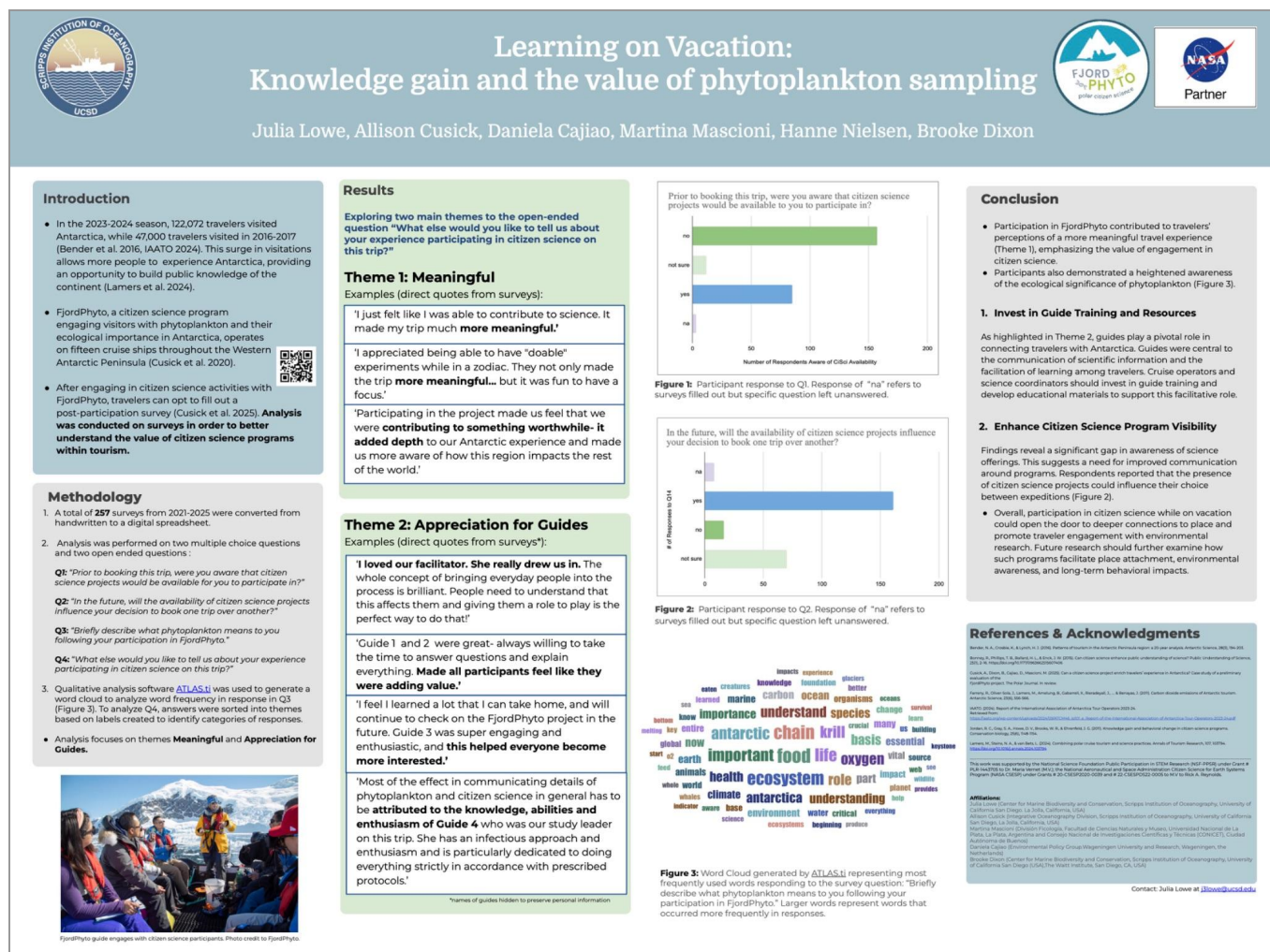


Figure 7: CAPS Poster. Reviewed by Dr. Allison Cusick, Dr. Hanne Nielsen, and Martina Mascioni.
Figures 8a and 8b: CAPS Conference Introductory remarks (A) and Julia Lowe presenting poster (B)



Additional communication tool: Zine: Tiny, Mighty, Many!

Colleague Shailey Heller and I saw an opportunity to connect our two polar participatory science themed projects using a communication tool aimed at spreading information about phytoplankton, the poles, and participatory science. Shailey's project looked at gene expression of phytoplankton collected during the polar night in the Arctic by two citizen scientists, Sunniva Sorby and Hilde Fållun Strøm, through the Hearts in the Ice project (Heller 2025). Using a zine, a mini-magazine, as our method of communication, we aimed to connect Hilde and Sunniva's story with travelers participating in FjordPhyto in Antarctica. Zines are a communication method historically rooted in social and political action (Piepmeier 2008). We used the zine as a science communication method, but our core theme was rooted in community. It was interesting to explore this grassroots communication tool as a science communication method.

We developed a core theme: *Tiny, Mighty, Many*. Phytoplankton are unappreciated, microscopic organisms that play such a large role in the ecology of our planet, including producing much of the air we breathe. Being tiny doesn't inhibit phytoplankton from working together to make a big difference. This resonated with me and Shailey, who found that the reason participatory science can be so powerful is because it provides a layer of accessibility to science and research that can promote a greater environmental awareness. Anyone can play a small part in something much larger, just like phytoplankton. This connection between participatory science and phytoplankton can be found on both poles, across the entire world, where participatory scientists are gathering phytoplankton samples for study.

We worked with members of the NASA Citizen Science team (Sarah Kirn and Marc Kuchner) as well as Ha-Hoa Hamano, a Fellow with the NASA Citizen Science Strategic Working Group who used zines as part of the Heliophysics Big Year project.

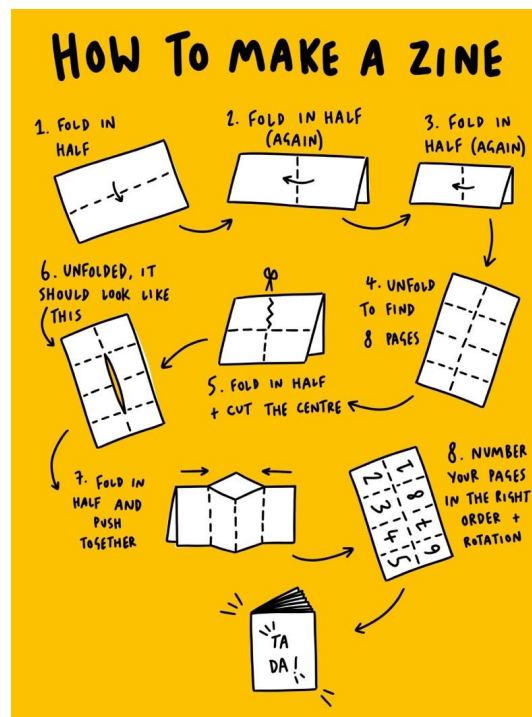
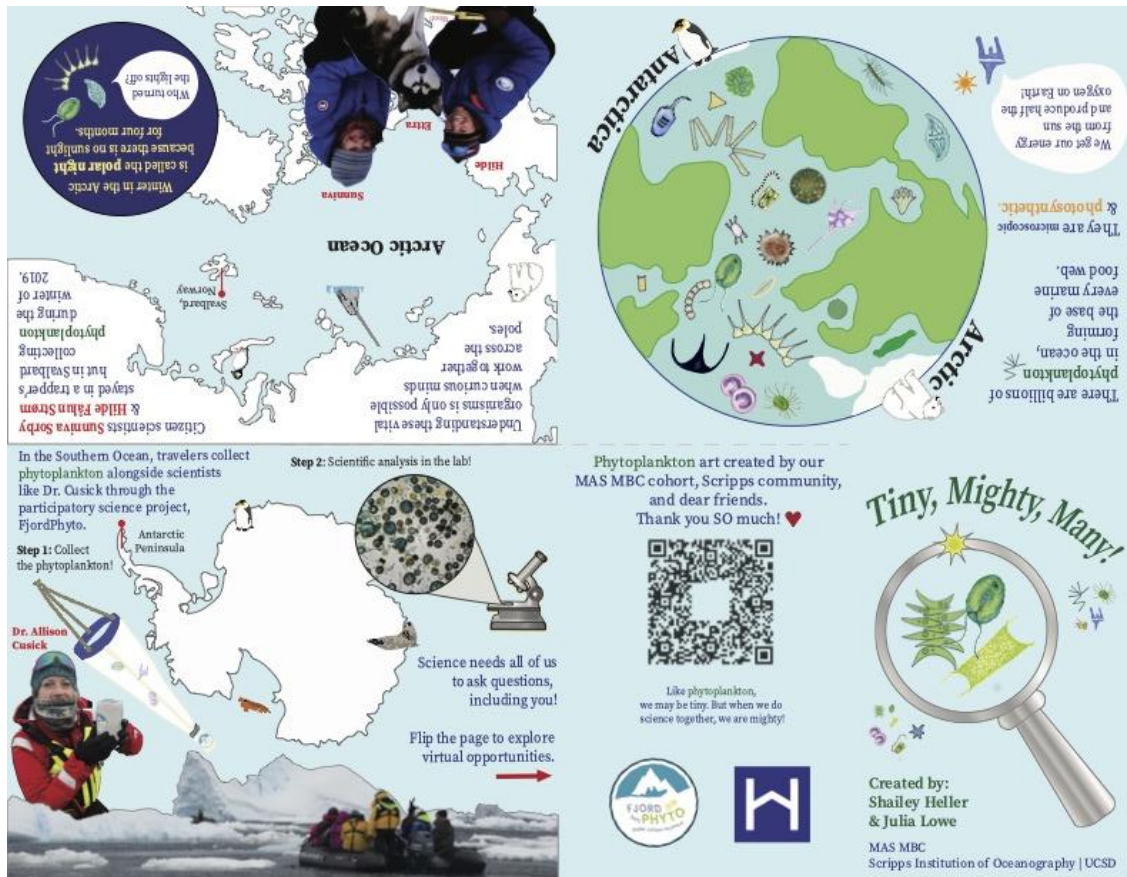


Figure 9a, 9b: Zine in printable form (A), Zine folding instructions (B) via <https://www.42ndstreet.org.uk/>

Shailey and I printed several zines to hand out at CAPS25. While the zine serves as a networking device, it became what felt more like a “gift”. After having long conversations about PSP and the importance of community, we gave our zines to new friends as a gift:

“Zines instigate intimate, affectionate connections between their creators and readers, not just communities but embodied communities that are made possible by the materiality of the zine medium. In a world where more and more of us spend all day at our computers, zines reconnect us to our bodies and to other human beings” (Piepmeier 2008).

Using the zine as a tangible connection within this new community was a positive and rewarding experience, as well as a reflection on the interconnectedness of participatory science, community, and phytoplankton. It was interesting to explore this grassroots communication tool as a science communication method. Zines could be a method of communicating information creatively by distributing at conferences, or on ships, to FjordPhyto participants. Zine as a method of science communication could be further explored when looking for new ways of sharing information in a time when science involving gendered language centered in equality and justice is targeted. This further emphasized our goal of making an accessible communication piece. The zine is available online, is formatted on one page, and is free for anyone with access to a printer to create themselves at: <https://fjordphyto.ucsd.edu/zines/>.

Further Research

To expand upon this preliminary study, I applied to the International Association of Antarctica Tour Operators (IAATO) Antarctic Fellowship 2025. If accepted, I will develop a publication manuscript for this work with FjordPhyto with Dr. Allison Cusick and Dr. Martina Mascioni alongside the Institute for Marine and Antarctic Studies (IMAS) at the University of Tasmania (UTAS) with Dr. Hanne Nielsen. I aim to expand upon this manuscript to explore the role expedition guides play in facilitating programs by running a virtual workshop for those involved in delivering science programs on Antarctic tourist vessels. The workshop will be used to explore the role of expedition guides in facilitating learning and connection and to identify perceived best practices related to communicating PSP opportunities in the Antarctic.

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