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Charting New Waters: Leveraging Recreational Boating Communities for Citizen
Science

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Abstract

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Oceanographic models are necessary to predict future effects of climate change. These models must be based on data, which can be difficult to collect due to the need for vessels and infrastructure in the open ocean - necessitating the integration of novel methods for data collection such as citizen science. This study explores the potential of recreational boaters as participants in citizen science (CS) projects. A survey of 439 recreational boaters, primarily from the Pacific Northwest, reveals that over 75% are interested in using their boats for CS data collection. Familiarity with CS significantly predicts interest in participation; 87.1% of those aware of CS are interested, compared to 59.8% of those unfamiliar. Boaters who had participated in CS projects in the past cited care for the natural environment (77%) and curiosity (44%) as key motivators. The primary barriers for non-participants were a lack of awareness of CS (56.3%) and nearby opportunities (42.5%). The study underscores the importance of targeting

non-academic settings for recruitment and suggests leveraging platforms like Facebook and recreational boating forums to increase participation. Results also suggest that the adoption and adaptation of private-industry outreach concepts such as Search Engine Optimization (SEO), cold email outreach, and social selling may be beneficial for projects aiming to recruit boaters. The findings emphasize the potential of recreational boaters in contributing to oceanographic research and the need for further studies to explore actual participation rates and the impact of demographic factors on recruitment. This research provides a foundation for future initiatives to engage recreational boaters in CS, offering a cost-effective solution to expanding oceanographic data collection.

Introduction

In the face of challenges like climate change, there is a growing need for more and new oceanographic data to better understand risks to social-ecological systems. The ocean sequesters carbon, an essential element of fighting climate change. However, climate change-induced sea level rise can significantly alter coastal food webs and displace peoples from previously inhabitable land (Duan et al., 2021). Climate change also fuels ocean acidification - the rise in pH as a result of the ocean sequestering greenhouse gasses - which can diminish and even eliminate fisheries that are essential to global economies and local subsistence (e.g. Speers et al., 2016). Oceans are also responsible for essential regulation of worldwide atmospheric conditions. The impact of ocean-related processes on human populations is highlighted by their inclusion in UN Social Development Goals for 2030, under Goal 14 - “Conserve and sustainably use the oceans, seas and marine resources for sustainable development” (United Nations, n.d.). The intense effects of climate change through its modification of oceanographic processes are often invisible until they have reached a critical point. To act proactively instead of reactively, there is a need to predict trends before they reach that point.

Robust models exist to forecast and understand changes on coastal and open-ocean systems, but a lack of abundance of data related to important oceanic variables (e.g. temperature, salinity, pH) has been cited as a limiting factor for their power (Montella et al., 2018; Simoniello et al., 2018). That lack of data may also contribute to research bias, where current knowledge of ocean trends are based only on those areas which have regular research cruises or are otherwise more easy to access (Diviacco et al., 2021b). There are many gaps in data on marine environments because they are typically remote, have harsh conditions, and are by nature vast. While suitable technology exists to sample these areas, research vessels can cost \$10,000- \$40,000 USD per day (OC-UNESCO, 2017) and require both a dedicated research team and an experienced crew. This has led to uneven geographic sampling of oceanographic variables, including a limited number of repeated research routes in areas like the Southern Pacific, which are especially

important for observing trends over time (GOOS, 2021). This combination of a need for data, made more urgent by climate change, and the difficulty collecting that data necessitates new data collection methods and out-of-the-box thinking.

Citizen science, also known as community science (Van Eck, 2021; Daniels et al., 2022) or in some cases crowd-sourced data (Diviacco et al., 2021a), presents a promising solution to these challenges. Citizen science can be defined broadly as “public participation in organized research efforts” (Dickinson et al., 2012). While some oceanographic data collection requires formal scientific training to understand and implement with high validity, most data can be *collected* by anyone attentive and motivated who is trained in basic methods. For example, temperature sampling and other device-based data collection (pH, salinity, dissolved oxygen, etc.) can be performed with very little training when effective technology is implemented (Diviacco et al., 2021b). Citizen science (CS) has the potential to help meet our oceanographic information needs by harnessing large groups of people - and, importantly, their vessels - to accomplish extensive data collection at increased geographic and temporal scales and decreased cost. While some compelling examples of CS projects that utilize recreational boaters exist (see Simoniello et al. 2019 for a brief review), the literature describing these studies is scarce.

In addition to the benefits it provides the scientific community, citizen science can provide co-benefits to its participants. Participants may have a personal interest in the subject matter of the CS project (i.e. Skelton et al., 2018), giving them an opportunity to feel connected to something they care about. Participation in a CS project can also provide a sense of agency for those later in life, providing them with an opportunity of their choice that feels meaningful (Callow, 2004). As CS participants are trained in project protocols, they gain new skills that can be useful in other areas of their lives (Phillips et al., 2018). In addition to generating data, the projects can be an avenue for public awareness of issues that affect an entire geographic community, such as water quality (Weitkamp, 2017), because those involved then share

their engagement with friends, family, and other community members. Finally, nature-based CS projects can improve mental and physical health and produce a sense of well-being for participants (Pocock, 2023).

Citizen science is a promising method, but there are unique challenges to its effective utilization. Since the motivations for formal science do not apply to CS participants, any new project requires a new perspective - who should be involved, and what are their motivations? Without insight into these motivations, it may be difficult to recruit and retain participants, which are essential aspects of making this method effective. Because engagement in most projects does not require a specific academic background, participants are likely to have a wider range of values and experience than you would find in a formal research project. This is a strength of the method, as multiple perspectives in research can create results that are helpful to more groups (Asmal, 2022), but there may need to be an initial training period to ensure the citizen scientist can participate in a meaningful way (Aceves-Bueno et al., 2017).

Some research has been done on the factors influencing participant motivation in CS projects in specific contexts. For example, Dury et al. (2015) examine the effects of individual characteristics, resources, and social factors influencing likelihood to volunteer in older adults. Their study indicated that education, religiosity, and never having been married were all positive predictors for volunteering. Skelton et al. (2018) investigate recruitment and motivations for a wombat-tracking project, finding that the overwhelming motivator of their participants was specific interest in wombats. Dohn (2021) examines factors that affect student's interest in an eDNA CS project - while not specifically related to motivations for recruitment, their findings suggest that factors such as gender and educational track may influence interest in specific aspects of the project, which can be useful when considering recruitment. Phillips et al. (2019) identified several additional factors that influenced participants' motivation across a variety of CS projects: environmental concern, community concern, political distrust, scientific credibility, career,

place-nature, social connections, learning, and contribution. Many researchers in the CS field recognise the need for more studies about participant motivations and recruitment processes in order to facilitate more effective and appealing CS projects (i.e. Filograna, 2023; Domroese & Johnson, 2017; Lakomy et al., 2020; Callow, 2004). At the time of this study, no such paper exists that is specific to a marine context or to recreational boaters as a population.

This paper addresses some of that gap by utilizing a nation-wide survey to examine factors potentially influencing the likelihood of recreational boaters to use their vessel as a means to collect citizen science data. Because this population is not specifically defined and there is no contact list, an online survey was opportunistically distributed to as many boaters as possible in a short data collection period. The online survey was an ideal distribution method because it was low-cost and data from many questions was reliably reported in one document.

This study first aims to assess whether recreational boaters are a population that is likely to participate in citizen science. Additionally, it attempts to identify which factors, if any, influence boater interest in using their own vessels for citizen science. In particular, we investigate how factors such as past experience in a CS project, education, boat type, boat cost, the channel through which participants have interacted with CS concepts, and overall familiarity with CS concepts influence a respondents' interest in engaging with marine CS projects. Finally, through an analysis of the study's outreach methods in conjunction with some pertinent survey questions, this paper contributes to the growing literature on recruitment methods for CS.

Methods

I designed a survey to collect information about recreational boaters' attitudes of and experience with Citizen Science. Respondents were recruited through multiple unpaid sources. Participants were first

recruited actively, through word of mouth and an email campaign to 27 marinas and yacht clubs in the greater Seattle metropolitan area. Fliers were also posted at some local sites. While this region was the initial focus of the study, the author then chose to expand the audience by recruiting passively through forums and social media channels (e.g., Facebook groups, Instagram, Reddit).

Survey Design

The survey questions were created through a combination of the author's personal knowledge as a boater (10 years, Puget Sound area and west coast US) and building on themes from other CS and/or boater-related studies in academic literature (e.g. Asingizwe et al., 2020; Callow, 2004; Diviaccio et al. 2021; Li et al. 2023; Montella et al., 2023 and others). IRB exemption was obtained from the University of Washington (IRB ID: STUDY00019162). The questionnaire was administered in English, online using Google Forms (Appendix A). The survey was divided into branching subsections based on the respondent's past experience (or lack thereof) with citizen science. Section (1) included socio-demographics and boater attributes (e.g., type of vessel, experience boating, seasons, location), and was completed by all participants. If a respondent had no past experience with CS, they were taken directly to section (3), which asked questions about potential participation and current levels of awareness. If respondents had participated in CS in the past, they were taken to section (2a) and asked questions about their perceptions of the projects they had participated in. If the past project was related to marine science, they additionally completed section (2b) which addressed more specific data questions. Participants were asked 15-32 questions, depending on which survey branch they completed.

Email Campaign

Emails requesting to distribute the survey were sent to 27 different marinas and yacht clubs between November 2023 and February 2024. Because emails with links in them are sometimes marked as spam and not delivered, some emails (5) were sent with the active survey link and the other 19 asked for a

response before sending the link. Six of the marinas were known to the author, and so contained slightly different wording, but the majority of the emails followed the same format. The survey was closed to new responses on January 31st, 2024.

Social Media and Forums

The author made postings on Instagram and Facebook via their personal accounts, stating in all postings that they were both a boater themselves and a graduate student. In addition to posting in numerous Facebook groups, they also posted in 11 different subreddits devoted to boating, sailing, or citizen science/data, and four different boating forums.

In-Person Recruitment

The author posted fliers with a QR code linking to the survey at 9 different public locations near marinas (coffee shops, marinas, and various locations on-campus at the University of Washington). These locations were selected opportunistically by visiting marinas and identifying nearby locations that might have recreational boaters as clientele. The University of Washington has a large boating community, particularly in South Campus where marine-related departments are housed. South Campus is also situated directly adjacent to waterways and many buildings are open to the public. The author also promoted the survey via word of mouth to personal connections known to be involved with recreational boating.

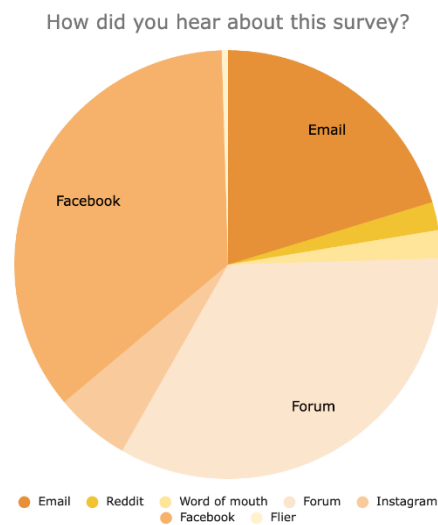


Figure 1 - Channels through which participants found the study survey

Location Processing

A survey question asked of all participants was “Where has the majority of your boating taken place?”. The answers were entered via text and then adapted by the authors to a map. For large regions, the GPS location of one state central to that region was assigned (for example, Virginia for the “East Coast” and “Midatlantic” category, Maine for the “New England” category, Washington for the “Pacific Northwest” category).

Results

Outreach & Survey Participants

The survey instrument was completed by 439 participants through a combination of fliers, word of mouth, social media channels, and email outreach to marinas and yacht clubs. Of the organizations emailed, 7 responded, 4 agreed to distribute the survey, and 2 agreed to post a flier. None of the emails with active hyperlinks received a response. Two main factors lead to variable sample size on some questions. First, respondents were able to skip questions they felt uncomfortable answering. Second, the survey was

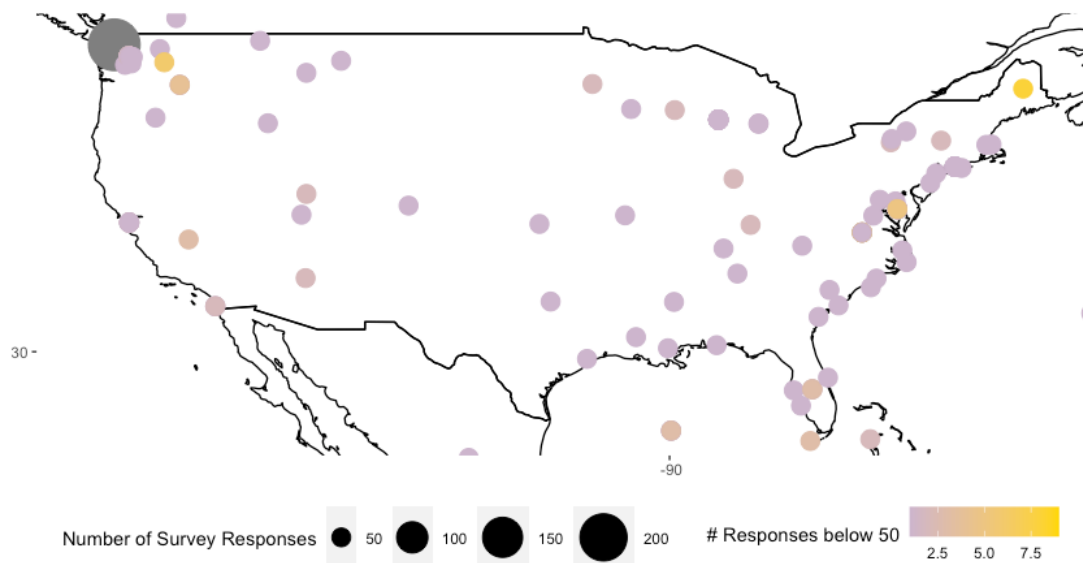


Figure 2 - Continental U.S. survey response locations - number of responses overall are shown by size of the points, number of responses per location for <50 responses is shown by color.

designed in a branching format in order to gather more nuanced information dependent on some answers without multiple rounds of surveying.

The most common channels through which participants learned of the survey were Facebook (35.6%), Forums (33.7%), and email outreach (20.3%).

The survey reached boaters who had a boating history in at least 110 self-reported regions of varying scales, ranging from a specific body of water to “worldwide” - Continental US responses shown in Figure 2. A large

proportion of those participants (43%) indicated that the majority of their boating has taken place in the Salish Sea, where the survey originated. The term “boaters” was defined in the survey as anyone who owns or frequently uses a boat. Of the boaters surveyed, 93.6% owned their own boat. Boaters owned a variety of vessels (Figure 3), including 45% owning (only) a sailing vessel, 44% owning (only) a power vessel, and 9% owning both types of vessels. The remaining 2% owned small personal watercraft (kayak, canoe, etc.) or some combination of the previously listed options.

The value of the vessels that survey participants owned ranged from less than \$1000 USD (4%) to over \$100,000 USD, with the most frequent values being over \$100,000 (29.3%) USD and \$10,000 - \$30,000 USD (22%). The vast majority of respondents have been boating for 10+ years (75% of survey respondents) and participate in recreational boating during 3 or more seasons out of the year (81.5%). Almost half (41.1%) of the survey respondents report participating in recreational boating year-round.

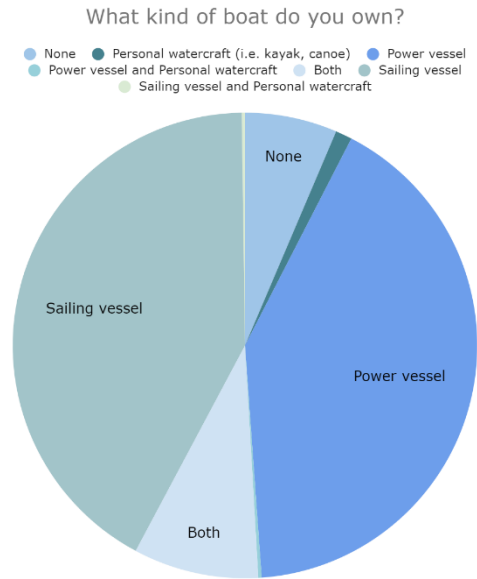


Figure 3 - Type of vessel owned by survey participants

The majority of the survey population was highly educated. Participants were asked to select their highest level of education: 83.7% of respondents received an associate's degree or above, and 41.3% received a Master's, Doctorate, or Professional degree.

Citizen Science Results

Participants were asked if they would be interested in using their own boat for citizen science data collection. While only sixty-two out of the 439 participants who responded to the survey reported that they had participated in a citizen science project in the past, over 75% of respondents who owned a boat indicated they would be interested. Participants who had not heard of citizen science were less likely to express interest in using their boat to collect CS data (59.8% vs 87.1% of those who were familiar with the concept, $p < 0.000001$).

Chi square tests were run on hypothesized predicting factors to determine whether any of these factors significantly affected participant interest in using their boat to collect data as part of a citizen science initiative (Table 1). Of these factors, both relating to familiarity were found to be significant predictors: those who had participated in CS in the past and those who had heard of citizen science before were more likely to be interested in using their boat to collect citizen science data.

Survey respondents who had participated in past CS projects were asked about their initial motivations to join that project. The most common reason was care for the natural environment (77% of past participants). Other major reasons included curiosity (44%), interest in the end result (38%), a personal connection with the organization or researcher (38%) and that the respondent felt it was a fun activity to do with friends or family (28%). All answers are summarized in Table 2.

Table 1 - p values of Chi Square analyses of possible predictors for participant's interest in using their own boat for citizen science data collection.

Predictor	p-value
Familiarity with CS n=374	2.55E-08
Past participation in CS n=438	0.001
Boat Cost n= 434	0.35
Education n= 438	0.31
Boat Type Owned n=436	0.53
Survey Channel n=424	0.76

Table 2 - Motivations of recreational boaters for participation in past CS projects (n=61)

What motivated you to participate in your past CS project?	
Care for the natural environment	77%
Curiosity	44%
Interest in the end result	38%
Personal connection with the organization or researcher	38%
Fun activity to do with friends or family	28%
Part of Work	5%
Personal Enjoyment	2%
Monetary Incentive	2%

When those who had not participated in citizen science projects in the past were asked which factors contributed to their lack of participation, the three most common answers all had to do with awareness. The most common answer (56.3% of respondents) was that they “had never heard of citizen science”, the second most common answer (42.5% of respondents) was that they “had not heard of an opportunity nearby”, and the third most common answer (22.6%) was that they “did not know where to find opportunities”. Table 3 lists these and other reasons that survey respondents identified for not having participated in such projects.

Table 3 - Reasons participants had not participated in CS in the past (responses provided by participants are indicated with **) (n=318)

Why haven't you participated in citizen science before?	
I have never heard of it	56.3%
I have not heard of opportunities nearby	42.5%
I don't know where to find opportunities	22.6%
I don't have time	11.6%
It seems too difficult	2.5%
It would detract from my boating experience	1.3%
I don't think it's valuable	0.9%
It is too costly	0.9%
I don't know how I could help **	0.3%
I have tried but did not interest from organizations doing it. **	0.3%
Lack of compensation	0.3%
Physical Limitations **	0.3%
Privacy concerns **	0.3%

Outreach Channels

In addition to being asked where they found this survey (Figure 4a), survey respondents were asked three additional questions about their channels of interaction with CS. Those who had participated in citizen science programs in the past were also asked where they had found that program (Figure 4c). The results were varied, but the three most common channels were word of mouth (41% of respondents), email lists (19%), and university listings (17%).

Those who had not participated in citizen science programs were asked two questions: Where they had heard of CS in the past (Figure 4b), and where they would look for more information about CS (Figure

4d). The most common channels where participants had already heard of CS were word of mouth (43%) followed by social media (“Facebook” at 21%, “Instagram” at 5%, “Other Social Media” at 14%, combined for 40%), and local media such as radio or television (17%). When asked where they would look for more information, the most common response was a search engine (73% of respondents). After search engines, social media was the next most common channel that respondents identified as a place they would look for more information on CS (Facebook 18%, Instagram 9%, other social media 9% for a total of 36% of respondents). Email lists and University Listings were other common responses (13% and 12% respectively). A comparison of the responses to all four of the questions related to outreach channels is shown in Figure 4.

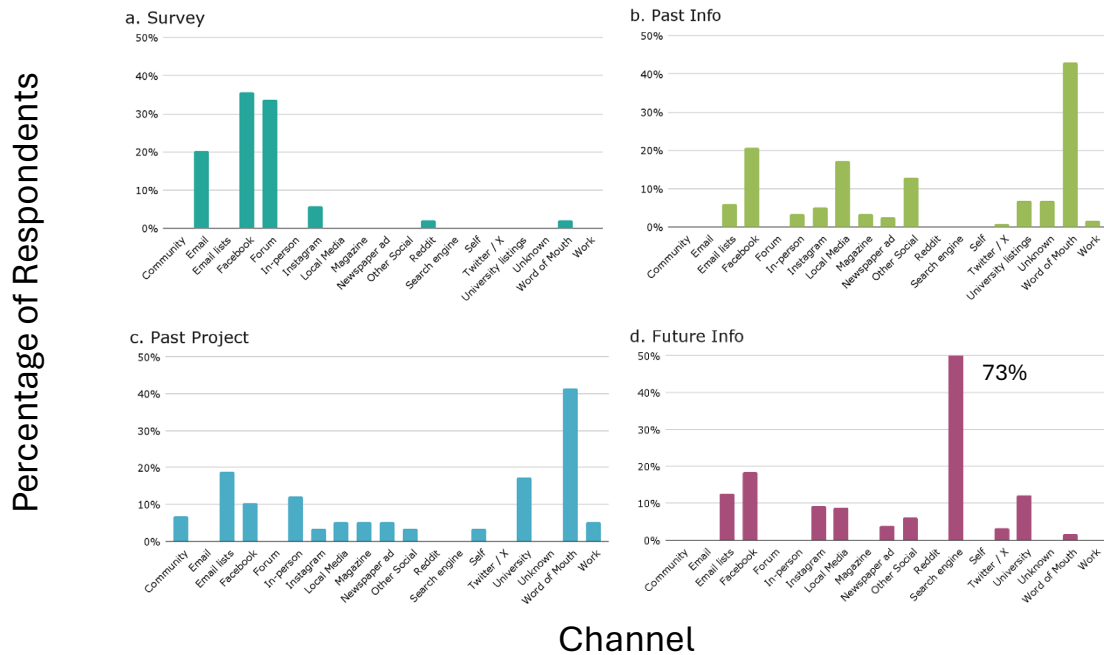


Figure 4 - Comparison of channels of interaction with CS in various contexts. Each panel represents the answers to one of four questions: **4.a.** Where did you find this survey (n=424) **4.b.** Where have you heard about CS in the past (n=116) **4.c.** Where did you find the CS project you participated in (n=58), and **4.d.** Where would you look for more info on CS (n=310)

Discussion

The results of this study represent a geographically diverse group of respondents who share a willingness to use their vessels to participate in citizen science. While there was variation in the cost and type of the vessels owned, the education of the respondents, and other factors among the surveyed population, the only factors found to be significant predictors of desire to participate related to familiarity with citizen science, with those more familiar being more interested in participating (Table 2 and Table 3). This presents a promising opportunity for researchers designing studies in this field: if you can familiarize recreational boaters with the concept of citizen science, they are more likely to participate.

While some research exists, previous authors have identified CS recruitment as an essential gap in the CS literature (Jennett et al., 2016; Filograna et al., 2023). The majority of that research centers on current or past participants in CS and their motivations for participating. In one paper, participants who chose not to participate in a malaria control study in Rwanda self-reported that their barrier to participation was a lack of understanding of the enrollment process (Asingizwe et al., 2020). A rare study done of the general population (regardless of CS familiarity) in Germany identified “High time consumption” as the primary barrier to participation (Ngo et al., 2023). In the study discussed in this paper, “I don’t have time” was the fourth-most popular response for not having participated in CS before (11.6% of participants). The most common reasons respondents in this survey identified for not having participated in CS before were not knowing what citizen science is (56.3%) or not having heard of any citizen science opportunities nearby (42.5%) (Table 3).

There are several explanations for this difference - first, this study was specifically targeted at recreational boaters. This could indicate recreational boaters are more likely to donate their time. Ngo et al. (2023) performed their research only in Germany, while this study was worldwide, but biased toward the US and

specifically the west coast of the US. Values differ internationally, which may affect barriers to willingness to participate in CS. Moreover, both studies were relatively small - 209 participants (Ngo et al. 2023) and 439 participants in this study. Finally, the difference could be due to the contextual information the participants received. Ngo et al. (2023) provided several case studies in various research fields for their participants to review before asking them about the possibility of future participation. This study referenced general maritime data collection, subtext in the question clarified: “Examples of this type of work include things like taking a passive environmental sensor with you on a cruise or keeping track of marine mammal sightings”. The lack of further research makes it difficult to compare the two studies, but emphasizes the importance of future research in this field.

Our study suggests that the question of recruitment among this demographic hinges on outreach - ways in which to reach more boaters - rather than the time investment or other factors. To that end, the survey for this study itself can serve as a cursory case study. The results shown in Figure 4 present several interesting trends, which we will discuss in-depth below.

Authors of relevant literature (see West & Pateman 2016 and Unell and Castle 2012) have emphasized the use of “gatekeepers” or volunteer brokers when recruiting for CS projects. They identify these as third party groups like volunteer organizations that are already connected to other existing volunteers. The methods we use build on this, expanding the concept of gatekeepers to those who may have access to a target group in any capacity (not just in terms of volunteering). For oceanographic CS and beyond, there are likely other adjacent organizations that could expand the use of the gatekeepers concept to reach more of a target audience. Examples of online “gatekeepers” included in this study are boating-related Facebook Groups, marinas with active email lists, and boating-related forums.

Of the 424 participants who provided the channel through which they accessed this survey, 36% found it on Facebook. Out of those who had heard of CS in the past, 21% had heard about it on the Facebook platform (n=116). Of the 310 respondents who answered where they would look for more information on CS, 18% said they would look on Facebook. But the percentage of people who have actually *found* their projects there is lower, only 10% (n=58). This indicates that Facebook might be a relatively untapped resource for promoting citizen science initiatives to boaters, which is aligned with the findings in other CS domains (see Skelton et al., 2018). This study was published to specific Facebook Groups related to recreational boating and citizen science, but was made public and was shared by some group participants, blurring the reporting between “word of mouth” and “facebook”. Participants were not asked which part of Facebook they found the survey on (group, through a friend’s posting, by direct message) so further research might aim to understand nuance within the platform.

While Facebook appears to be an excellent target for outreach in this context, navigating social media can be a challenge for researchers. An early attempt was unsuccessful in recruiting participants for research projects there and the researchers found that, for example, “‘engineering’ interest in a project through tweeting and retweeting is more complex than [they] originally anticipated” (Boydell et al., 2014). Guides for “social selling” - the process of “using a brand’s social media channels to connect with prospects, develop a connection with them, and engage with potential leads” among the marketing and sales industries may be particularly helpful to facilitate continued engagement (see McLachlan & Newberry, 2023 for an example).

Email lists and University listings were some of the most common ways participants found their past projects (19% and 17%, respectively), and these were also listed as sources where those who have not participated had heard of CS in the past (6% and 7% respectively). The results of Figure 4.a. show that outreach by email may also be effective in another manner: through cold outreach to related

organizations. Cold outreach here refers to attempted direct communication with parties you have no prior connection to. The emails sent to marinas in this study were a form of cold outreach, but cold calling or reaching out via social media are other possible methods. When sending a cold email, practices are best informed by experience in the sales industry. Specifically, the prevalence of spam email has led to filters on most cold emails, a concern to researchers (Boydell et al., 2014). Best practices adapted from sales and marketing research should be attended to to avoid landing the email address in spam mailboxes. One of the easiest ways to improve the throughput of cold emails is to eliminate any links. Phishing schemes and other spam often require the target to click a link, which makes those emails likely to be filtered out. In this study, none of the emails with links sent received a response. While it was a smaller number of emails, because the author was aware of this issue, this may likely have been a factor. Other studies have identified the use of fliers, social media, and even press releases as useful tactics (see Schumann et al. 2024 for a recent review of recruitment methods), but few mention cold emails.

Another somewhat novel form of outreach used in this study was the posting of the survey on boating-related forums. While no respondents identified having heard of past projects or the general topic on forums, nor did they think of looking there for future projects, more than 1/3 of respondents found this survey on forums. The channel through which participants found the survey was not a predictor of how likely they were to participate in future projects. Therefore, even though they might not think to look there, this may be another untapped channel through which to reach potential participants.

Posting on forums and even blogs has been used for other research studies (e.g. Bergstrom 2017; Schumann et al. 2024) with mixed results. Posting on forums, like Facebook groups, often requires moderator approval. In this study, our post was not approved for several of the forums and groups targeted. Others have found that posting on forums may be ill-received by some who find them unwelcome and distracting to more relevant content - but they note some of this hostility may be

overcome by utilizing a gatekeeper: “Forum participants seemed much more willing to respond to an insider from the community” (Bergstrom, 2017). In this survey, it is likely the author acted as a gatekeeper and received a particularly positive response as they were a part of the community themselves. Bergstrom (2017) provides several helpful words of caution to researchers hoping to use forums - among them, she advises returning an end result to participants. Many of the participants of this study requested just that, and the author plans to distribute this final paper and provide a zoom link to their presentation of research in any places they posted the survey.

Almost half of survey respondents identified that they would look for CS opportunities by using a search engine. While this result is not unexpected given how ubiquitous these search engines have become, it does have important implications for researchers. Search Engine Optimization (SEO) is “the practice of optimizing web pages in a way that improves their ranking in [the] organic search results” (Li et al., 2014). It is a free alternative to paying for ad space on search engines, and could be adapted to CS recruitment in order to help potential participants find projects. While there are some marketing firms that do this work on behalf of clients, there are robust guides online that could enable researchers to broaden their reach.

Since past participation in any (not necessarily marine-related) citizen science project is a predictor of willingness to use personal watercraft to aid in data collection efforts, researchers should look to existing formal or informal databases of citizen science participants to recruit for their own projects. In particular, nature-based projects may have good crossover for recruiting potential oceanography or marine citizen science participants since 77% of past CS participants noted that they were motivated to participate by their care for the natural environment. For example, programs such as iNaturalist already have large followings, so promoting marine citizen science projects to recreational boaters that already participate in that project may be fruitful.

This survey was distributed disproportionately to those in the Pacific Northwest (256 respondents in Washington out of 439 respondents total). This bias was due to the location of the primary researcher and the fact that only local marinas/organizations were targeted for email outreach. Therefore the location data presented should not be taken as representative of the distribution of boaters, or even of boaters with interest in this topic. However, the answers across all other survey questions are based on a large enough sample (n=439) to serve as a general representation of the experience of recreational boaters in the US. The results of this study therefore provide the impetus for a more comprehensive study, and indicate an opportunity for utilizing citizen science for oceanographic data collection.

The results of this study are particularly important in the field of oceanography, where recreational boaters can help overcome some of the challenges that limit oceanographic data by providing their own vessels. For example, monitoring ocean acidification is an important initiative as climate change intensifies (U.S. House of Representatives, 2024), which requires an abundance of pH recordings. CS-friendly technology for recording pH tied to smart phones is already available, and could greatly expand the number of datapoints available to oceanographers (Li et al., 2023). The results in this survey were not disaggregated by fresh and saltwater locations - CS research may still be useful for inland areas, but additional research specifically targeting marine recreational boaters and in particular long-distance boaters would be useful. There are many forums specifically designed for these populations, especially among the sailing community, and the results in Figures 1 and 4a indicate that these would likely be effective places to interface with long-distance cruisers - 33.7% of respondents found this survey on such a forum.

While this study indicates that recreational boaters have a high reported interest in citizen science projects, there are important issues that it does not address. First, reported interest or intent is not the same

as actual participation - it takes significantly more effort to participate than to express interest in participating. Second, interest and participation does not guarantee quality or accuracy of data. There is mixed qualitative and quantitative evaluation of the accuracy of CS data sets, and that accuracy is influenced by several factors including “location, participation length, monitoring frequency, group size, training, and volunteer type” (Aceves-Bueno et al., 2017). While the passive nature of some oceanographic sensors may prevent a portion of user error, proper training and screening of participants is essential.

Conclusion

This paper provides evidence that recreational boaters are a promising demographic to recruit for Citizen Science. Across all factors, just over 75% of survey respondents indicated that they would be interested in using their own boat for citizen science data collection. There are almost 12 million recreational boaters in the United States alone (Statista, 2023), making this a huge group of potential participants. Given that research vessels for marine research are often prohibitively expensive (OC-UNESCO, 2017), and many sailors travel along common routes for oceanic crossings (Simon, 2023), this represents an invaluable resource for marine researchers.

Our results also help inform the best ways to reach boaters. The results of our analysis indicate that, of the variables included in this study, only those related to familiarity with CS, either generally or through past experience, predict the likelihood to participate in CS. Boaters who have participated in citizen science research have generally found those projects through word of mouth or through university listings and email lists. These settings are relatively inaccessible for recreational boaters who may not have strong ties to academic communities. This survey, however, was particularly effective in reaching people through non-academic settings through social media, boating forums, and emails to their marinas.

Taken together, these findings present important guidance to those wishing to utilize this population: there is a need to increase postings in non-academic settings. Since education itself was not found to be a predictor of future participation, those reached through channels related to boating are just as likely to participate in CS projects, and are more likely to be in the target population.

The research presented in this paper focuses entirely on recruitment and stated intent. In the future, it would be useful to investigate actual participation compared to stated interest among boaters. While there was no predictive power of channels on whether there was *interest* in participation, there might be differences in actual participation that are influenced by other factors. Another major area of future research should be examining this data through a demographic lens. It is well known that different social media platforms attract different audiences in terms of at least age, and likely socioeconomic status. This may result in other useful trends for recruiting specific target populations among boaters.

Citizen Science is an invaluable research tool for providing large datasets at lower cost. Since funding and access are especially important barriers in the field of oceanography, recreational boaters are a promising, underutilized resource. The results of this survey indicate that in addition to the inherent qualities that make this true, there is also generally strong interest among this population in participating.

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Appendix A – Online Survey

6/4/24, 10:24 AM

Recreational Boating & Citizen Science Survey

Recreational Boating & Citizen Science Survey

1. How did you hear about this survey?

Mark only one oval.

- Email
- Flier
- Reddit
- Sailboat Owners Forum
- Sailnet Forum
- Instagram
- Word of mouth
- iBoats Forum
- Cruisers Forum
- Facebook
- Other: _____

2. What type of recreational boat do you most often use?

Mark only one oval.

- Sailing vessel
- Power vessel
- Equal use of sailing and power vessels
- Personal watercraft (i.e. kayak, canoe)
- Other: _____

3. Do you own a boat? If so, what type?

Mark only one oval.

- Yes - Sailing
- Yes - Power
- Yes - Both
- No
- Other: _____

4. If you own a boat, what is its current approximate value? (if you own more than one boat, answer this for the boat you use most often)

Mark only one oval.

- Less than \$1,000
- \$1,000 - \$5,000
- \$5,000 - \$10,000
- \$10,000 - \$30,000
- \$30,000 - \$50,000
- \$50,000 - \$100,000
- \$100,000+
- I do not own a boat

5. During what seasons do you participate in recreational boating?

(check all that apply)

Check all that apply.

- Winter
- Spring
- Summer
- Fall

6. During the seasons you participate in recreational boating, how many days per month do you typically use your boat?

Mark only one oval.

- Nearly every day
- 10-20 days
- 5-10 days
- Less than 5 days

7. How long have you been recreationally boating for?

Mark only one oval.

- 1 year or less
- 1 - 5 years
- 5 - 10 years
- 10+ years

8. Where has the majority of your boating experience taken place?

(If 'Other', please specify where)

Mark only one oval.

Puget Sound

Other: _____

9. What is your highest level of education?

Mark only one oval.

Some schooling, no High School diploma or GED

High School Diploma or GED

Some college, no degree

Associate's or Bachelor's Degree

Master's or Professional degree

Doctorate Degree

10. Would you be interested in using your own boat for citizen science data collection?

***Please note that this is not a commitment, only a question to determine interest at a community level.*

Examples of this type of work include things like taking a passive environmental sensor with you on a cruise or keeping track of marine mammal sightings.

Mark only one oval.

- Yes
- No
- I don't own a boat

11. Have you ever participated in a citizen science project?

Mark only one oval.

- Yes *Skip to question 12*
- No *Skip to question 31*

Skip to question 35

Past Citizen Science Participant

12. What was the name of the project?

If there was no exact name, please include any sort of description - for example, "Seabird ID at the University of Washington".

If you have participated in more than one project, include all of them.

Feel free to include as many details as you feel are relevant.

13. Where did the project take place?

Mark only one oval.

Puget Sound

Other: _____

14. How did you find out about the project(s) you participated in?
(check all that apply)

Check all that apply.

- Instagram
- Facebook
- Twitter / X
- Tik Tok
- Other Social Media
- University listings
- Craigslist/Other free add listing service
- Newspaper ad
- Printed Fliers
- Local Media (Radio, Television)
- Email lists
- Word of mouth
- In-person recruitment (canvassing)
- Other: _____

15. For how long did you participate in this project?

Mark only one oval.

- Less than 1 month
- 1 month - 3 months
- 3 months - 6 months
- 6 months - 1 year
- More than 1 year

16. Are you still participating in this project?

Mark only one oval.

Yes

No

17. What motivated you to participate in this project?

check all that apply

Check all that apply.

Curiosity

Monetary Incentive

Interest in the end result

Fun activity to do with friends or family

Personal connection with the organization or researcher

Care for the natural environment

Other: _____

To what extent do you agree with the following statements?

18. The project was well organized overall.

Mark only one oval.

1 2 3 4

Strongly Disagree

19. The protocols for our work were clearly communicated.

Mark only one oval.

1 2 3 4

Strc Strongly Disagree

20. If I had questions about the project, I had a contact to reach out to.

Mark only one oval.

1 2 3 4

Strc Strongly Disagree

21. The work was relatively easy.

Mark only one oval.

1 2 3 4

Strc Strongly Disagree

22. I had fun participating in the project.

Mark only one oval.

1 2 3 4

Strc Strongly Disagree

23. I learned something by participating in the project.

Mark only one oval.

1 2 3 4

Strc Strongly Disagree

24. The data we collected has meaningful applications.

Mark only one oval.

1 2 3 4

Strc Strongly Disagree

25. The project was what I expected it to be.

Mark only one oval.

1 2 3 4

Strc Strongly Disagree

26. I felt a sense of purpose while participating in the project.

Mark only one oval.

1 2 3 4

Strc Strongly Disagree

27. I would like to participate in more citizen science projects.

Mark only one oval.

1 2 3 4

Strongly Disagree

28. Did your project directly involve marine data collection?

Mark only one oval.

- Yes Skip to question 29
- No Skip to question 35

Skip to question 35

Past Participant - Marine Data Collection

If you have ever participated in a citizen science project that involved marine data collection or using a recreational boat, please answer the questions below.

29. What kind of vessel did you use while collecting data?

Mark only one oval.

- Sailing vessel - personal
- Power vessel - personal
- Research vessel - Sailing
- Research vessel - Power
- None (shore-based)
- Other: _____

30. What type of data did you collect?
Select all that apply

Check all that apply.

- Water temperature (surface)
- Water temperature (multiple depths)
- pH
- Salinity
- Dissolved Oxygen
- Turbidity/Visibility
- CO2
- Water color
- Phytoplankton concentration
- Marine mammal sightings
- Other specimen collection
- Other: _____

Skip to question 35

Potential Citizen Science Participant

31. How familiar are you with the concept of citizen science?

Mark only one oval.

1 2 3

Not Very familiar with it

32. What factors have influenced why you haven't participated in citizen science in the past?

Check all that apply

Check all that apply.

- I have never heard of it
- I have not heard of opportunities nearby
- I don't know where to find opportunities
- I don't have time
- It seems too difficult
- I don't think it's valuable
- It is too costly
- Other: _____

33. If you have heard of citizen science in the past, how did you hear about it?

(check all that apply)

Check all that apply.

- Instagram
- Facebook
- Twitter / X
- Tik Tok
- Other Social Media
- University listings
- Craigslist/Other free add listing service
- Newspaper ad
- Printed Fliers
- Local Media (Radio, Television)
- Email lists
- Word of mouth
- In-person recruitment (canvassing)
- Other: _____

34. If you wanted to find out more about citizen science and opportunities to participate, where would you look for that information?

(check all that apply)

Check all that apply.

- Instagram
- Facebook
- Twitter / X
- Tik Tok
- Other Social Media
- University listings
- Craigslist/Other free add listing service
- Newspaper ad
- Local Media (Radio, Television)
- Email lists
- Search engine like Google, Bing, etc.
- Other: _____

Skip to question 35

Thank you!

Thank you so much for participating in this survey.

If you have any questions about the intersection of citizen science and recreational boating, feel free to reach out via email:

mgood3@uw.edu

- 35. Is there a resource related to this topic I could create that you would find valuable as a boater? Feel free to include any thoughts and ideas about what it might look like or where it would be published for accessibility.

- 36. Do you have any additional questions or comments?

***** Please note that if you want an answer you will need to email me personally, (mgood3@uw.edu) as I will not record your email address or contact information from this survey in order to protect your privacy. *****

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