# Lessons and Challenges in Piloting "*Sargassum* Watch," A Citizen Science Program to Monitor Pelagic *Sargassum* Landings in South Florida

# Lecciones y Desafíos para Pilotear un Proyecto de Ciencia Ciudadana para Monitorear las Arribazones de *Sargazo* Pelágico en el Sur de la Florida

# Enseignements et Défis Liés à la Mise à l'Essai d'un Projet de Science Citoyenne Visant à Surveiller les Échouages de *Sargasses* pélagiques au Sud de la Floride

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## ABSTRACT

Citizen's involvement monitoring large geographical areas over long periods of time is becoming an effective way to support scientific projects. The influx of pelagic *Sargassum* is a regional problem throughout the NW Tropical Atlantic. While satellite imagery can estimate *Sargassum* blooms on a regional level, it is difficult to have systematic *in situ* abundance observations. Additionally, the impacts of *Sargassum* in the Caribbean vary between geographical locations. Here we present a brief analysis of the citizen science project, "*Sargassum* Watch". We piloted the study using two apps, "CitSci" and "Epicollect5." Three categories of citizens send entries to the project: "target group (n = 36 members)" that have standardized daily or weekly observations associated with established monitoring programs; members of our lab (n = 10) that sends opportunistic observations; and friends, family or the general public (n = 10) that send opportunistic observations. Between March 2018 and October 2019, a total of 1067 observations were reported by participants in South Florida. Most of the observations reported were daily or weekly observations from the target groups (n = 900) compared to our lab members (n = 100) and the public (n = 22). These observations provide a first perspective of *Sargassum* landings at a large scale. Using the citizen science apps effectively requires in-person training and constant feedback between project managers and participants. We envision strong improvements by adding and maintaining target group engagement supplemented by opportunistic observations from the general public. Regardless of the challenges, this citizen science program has potential to expand *Sargassum* monitoring efforts at both a local and regional level.

KEYWORDS: *Sargassum*, citizen science, monitoring, Epicollect, macroalgae

## INTRODUCTION

The influx of pelagic *Sargassum* is a regional problem throughout the Atlantic, from Brazil to Florida in the west, and equatorial coasts in Africa in the east (Smetacek and Zingone 2013, Franks et al. 2016, Hu et al. 2016, Wang et al. 2019). Pelagic *Sargassum* influxes can cause a shift in benthic submerged aquatic vegetation in local coastal systems (van Tussenbroek et al. 2017) and deplete oxygen, inducing anoxic conditions that cause mass mortalities in coastal marine fauna (Cruz-Rivera et al. 2015, Rodríguez-Martínez et al. 2019). While the effects of *Sargassum* influxes on subtidal coastal systems are dire, we still know very little about their effects on the intertidal sandy beach areas. Our knowledge of differences in impact between local and regional levels is also limited, especially given the geographic variation within the greater Caribbean region. Understanding the different levels of impact from the *Sargassum* influxes is crucial for effective management of those influxes that depend on the abundance of each arrival event.

To monitor the abundance of incoming *Sargassum,* most efforts rely on using satellite imagery and remote sensing techniques (Hu et al. 2015, Dierssen et al. 2015, Wang and Hu 2016, Wang et al. 2018). The Florida State University Optical Oceanography Lab's "Satellite-based *Sargassum* Watch System" (SaWS) is one of the primary examples of remote sensing used to monitor *Sargassum* (Hu et al. 2016). The SaWS can compute predictive models of where *Sargassum* would be based on the favorable environmental conditions conducive for *Sargassum*, and the light refractions from the Sargassum that is received from the satellites (Hu et al. 2015). Satellite imagery is useful to investigate questions related to abiotic factors related to the growth and transportation of Pelagic *Sargassum* landings, including nutrient availability, temperature, and water currents (Franks et al. 2016, Brooks et al. 2018). These methods provide a forecast of where and when Sargassum could hit along the Caribbean before it reaches the shore (Hu et al. 2016). While satellite imagery can estimate *Sargassum* blooms on a regional level, those estimates can benefit from systematic *in situ* abundance observations, especially in the more coastal areas (500 km from shore) where the *Sargassum* blooms cannot be modeled due to coarse-level resolution and false positives given from the satellite imagery. Additionally, it is impractical to document the species composition of *Sargassum* using remote sensing techniques. Local-level ground-truthing can complement satellite imagery by sampling those areas for species composition of *Sargassum*.

Citizen science is becoming an effective approach to monitor phenomena in large geographical areas over long periods of time (Cohn 2008, Devictor et al. 2010, Cigliano et al. 2015). Many ecological citizen science projects either collect sightings of biodiversity (Theobald et al. 2015, Chandler et al. 2017, Pocock et al. 2018) or of physical disturbances

(Hidalgo-Ruz and Thiel 2013, Ansari and Schubert 2018). Previous studies demonstrated successful implementation of citizen science projects to track distributions of invasive algae (Gillis et al. 2018) and areas susceptible to algal blooms based on environmental conditions of the area (Cunha et al. 2017, Scott and Frost 2017). For these citizen science programs to be successful, they require a clear outlining of the objectives, constant communication between the project managers, planning and execution of a simplified and effective protocol for data collection, and quality control of the data collected (Crall et al. 2011, Wiggins and Crowston 2011, Newman et al. 2012, Burgess et al. 2017, Ellwood et al. 2017). One way that the data collection can be streamlined is through the use of smartphone applications (also known as "apps" and will be referred to as such for the rest of this article). Apps are becoming an effective tool for the non-scientist public to be engaged in data collection.

The impacts of *Sargassum* in the Caribbean vary between geographical locations, providing an opportunity to use citizen science techniques to characterize and monitor Pelagic *Sargassum* landings at a local level. Here we present the status of our ongoing citizen science program, including the composition of citizen science participants and the number of observations collected. We also address the lessons and challenges associated with piloting a citizen science program and provide recommendations for improving the program itself so that others interested can learn from our experiences.

## METHODS

The citizen science program, named "*Sargassum* Watch", started in August 2018 and is currently ongoing, with two stages that differ in the technology used for data collection and storage (Figure 1) and the network of participants used (Table 1). The initial stage (August 2018 – March 2019) utilized multiple apps for data collection and storage, and citizen science participants were restricted to members of the Marine Macroalgae Research Lab at Florida International University, Miami, and any close acquaintances of the lab members willing to support the project. Observations were collected opportunistically whenever the observer(s) was on a coastal area, and photos were sent via WhatsApp or email to the program manager. Participants reported their time and location of the observed *Sargassum* landing, and the species found, if applicable. The collected observations are then uploaded and curated onto the CitSci.org website (Wang et al. 2015). On the website, we approximated the GPS coordinates of the observation based on the reported location name, and added any additional information provided by the participants.

The second stage of the citizen science program (April 2019 – present) is a response to the need for more systematic, detailed, and streamlined data collection. Systematic observations were made through a smartphone app Epicollect5 (Aanensen et al. 2009). The Epicollect5 app can be designed to capture detailed information such as date and time of location, site and region name, GPS coordinates, and relevant environmental conditions such as the condition of the *Sargassum*, water color, smell, and wind conditions. Participants were also asked to enter three photos of the site at different angles and one photo that shows the *Sargassum* species. The Epicollect5 app was tested using a network of volunteers from three different organizations that conduct monitoring programs ensuring regular visits to their working sites (Table 1), although other people in the public were encouraged to use the app. To aid in the training of volunteers, we planned one in-person training session for each of the target groups, and followed up with constant communication to maintain the high quality of the data. Each of the target groups had a set number of monitoring sites that were compatible with their working locality (Table 1). Participants were asked to collect observations of their monitoring sites regardless of whether there is a presence or absence of *Sargassum* influxes.

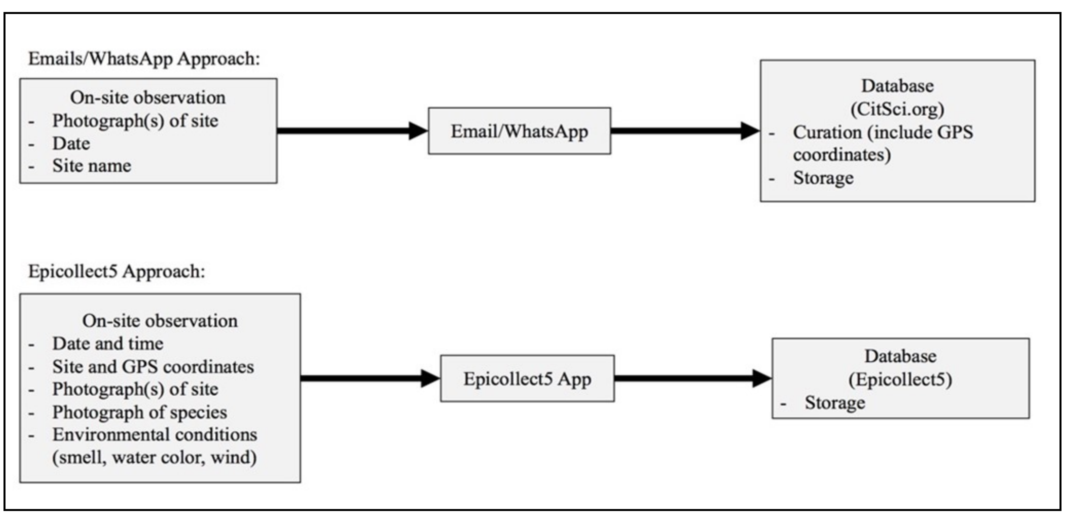


**Figure 1**. Flowchart showing the data collection methods for the citizen science program. Top flowchart shows the "Email/WhatsApp" approach, while the bottom flowchart shows the "Epicollect5" approach.

Participants who do not belong to a target group were initially encouraged to use "*Sargassum* Watch" in Epicollect5. However, due to the high number of steps used, those non-target group participants have the option of using a simplified version of the form "EZ *Sargassum*" that only asks for the date, GPS coordinates, one photo of the site, and one photo of the species. In both cases, observations submitted by the participants were uploaded onto the website database accompanied by the app project.

## RESULTS

Using the Emails/WhatsApp approach, we collected 72 observations of *Sargassum* landings in South Florida alone (Figure 2). The most frequent accumulation level collected was "very low accumulation" (n = 30), followed by "low accumulation" (n =28). Moderate accumulation (n = 9), high accumulation (n = 3), and very high accumulation (n = 2) occurred at much less frequencies. Observations that were found to be moderate to very high accumulations were found on the Florida Keys. We also collected observations from the Bahamas (n = 2), México (n = 3), and Puerto Rico (n = 2), although the sample sizes for each site are too small to conduct meaningful analyses.

From the 56 citizen science participants that aided us in the monitoring of pelagic *Sargassum* on the coasts (Figure 3), the highest number of participants came from the BCSTCP (n = 25), followed by the Marine Macroalgae Research Lab (MMRL) at Florida International University (n = 10). Nonprofit organizations Deering Estate (n = 9) and the Miami Waterkeepers (n = 2) also joined the citizen science initiative, although the number of trained participants is lower. Observations that were not identifiable based on a target group were considered to be part of the unaffiliated public (other) (n = 10). Based on coordinating efforts, the BCSTCP monitors daily at nine sites, while Deering Estate and Miami Waterkeepers monitors weekly. Deering Estate monitors one site, while Miami Waterkeepers monitors four sites. The MMRL and the unaffiliated public collects observations opportunistically, and the number of sites varies with the opportunistic approach (Table 1).

The number of observations collected per group were compiled from both the CitSci.org and Epicollect5 databases, and reviewed as of October 31$^{st}$, 2019 (Figure 4). The BCSTCP has the highest number of observations collected (n = 900), followed by the MMRL having the second highest (n = 100). The Miami Waterkeepers (n = 17), Deering Estate (n = 28), and unaffiliated public (n =22) currently has less than 30 observations. It is important to note that the BCSTCP started their monitoring efforts at April 2019, while Deering Estate and Miami Waterkeepers started their monitoring efforts in August 2019.

## DISCUSSION

Results of this study report the current status of a developing systematic citizen science project that monitors pelagic *Sargassum* at local coasts. Initially, we used a multiple-app approach that used email and WhatsApp to transfer photos from observer to the project manager to then be curated onto the "Sargassum Watch" database in CitSci.org. We found this method to be very inefficient, as it requires multiple apps to upload a data point onto the database. Also, while CitSci does have an app, we found the app to be very user-unfriendly and highly susceptible to glitches. This method is continually used for opportunistic observations at present, and can supplement for the later target group approach primarily used for this program.

Ultimately, we learned quickly through the Emails/ WhatsApp approach that opportunistic, uncoordinated observation collection efforts using less popular citizen science apps will lead to minimal success of collecting data. This goes in stark contrast to other apps that have a much wider network of participants and can sustain activity through opportunistic observations, such as the citizen science app iNaturalist (Nugent 2018, Seltzer 2019), or other citizen science programs that used popular and accessible platforms such as Facebook (Table 2). Citizen science programs that use iNaturalist or Facebook can work very well for certain levels of information, although collecting paired species and site photograph data can be tedious for an average citizen science participant. Therefore, there is a need to maintain a strong effort with interested target groups that are willing to collect data at much higher frequencies and with a more sophisticated app. We found a substantially higher amount of data collected when we started collaborating with the BCSTCP, but the amount of data collected had a large geographical bias towards beaches of Broward county. Hence, we started to address this bias by collaborating with target groups in Miami-Dade county (Miami Waterkeepers and Deering Estate), and also plan to include target groups in the Florida Keys and the greater Caribbean region. While both Miami-Dade target groups have started the monitor-

**Table 1**. List of citizen science groups in the *Sargassum* citizen science monitoring program.

| Name of group | No. of participants | Frequency of data collection | No. of sites | No. observations collected |
|---|---|---|---|---|
| BCSTCP | 25 | Daily | 9 | 900 |
| Deering Estate | 9 | Weekly | 1 | 100 |
| Miami Waterkeepers | 2 | Weekly | 4 | 17 |
| MMRL | 10 | Opportunistic | Varies | 28 |
| Public (Other) | 10 | Opportunistic | Varies | 22 |

ing program very late post-season, over time we expect these target groups to collect more data, especially in the next summer season where we predict another *Sargassum* influx.

Some of the challenges we found when piloting the citizen science program includes management and communication with the participants and the technological barriers associated with using an app. These challenges ironically go together, considering the complexities of using an app. For instance, we found that the Epicollect5 app interface asks for citizen scientists to upload the text data and the photos separately and consecutively. Participants who uploaded the text data but not the photographic data led to incomplete data that cannot be used optimally. To compensate for this issue, we scheduled the target groups to have an in-person training session prior to the start of their monitoring of the area. We would also check the databases periodically and contact the target groups if their observations on specific sites did not include the photos. Another challenge for the study is the quality of the photos themselves taken by the participants. This especially applies to photos taken of the species, as the quality of the photos varies with the participant's willingness to handle the *Sargassum* found on shore (Figure 5). Mitigating this issue requires revisiting the photos and determining the presence of a species through easily identifiable characteristics, such as the fronds or level of complexity of the *Sargassum* found. Ground-truthing of the species found by visiting some of those local areas and collecting photos and herbarium specimens is another solution.

Our citizen science program is unique in that it asks participants to take photos of the site and the species associated with the *Sargassum* influxes within the same observation. We identified other collaborators who are also

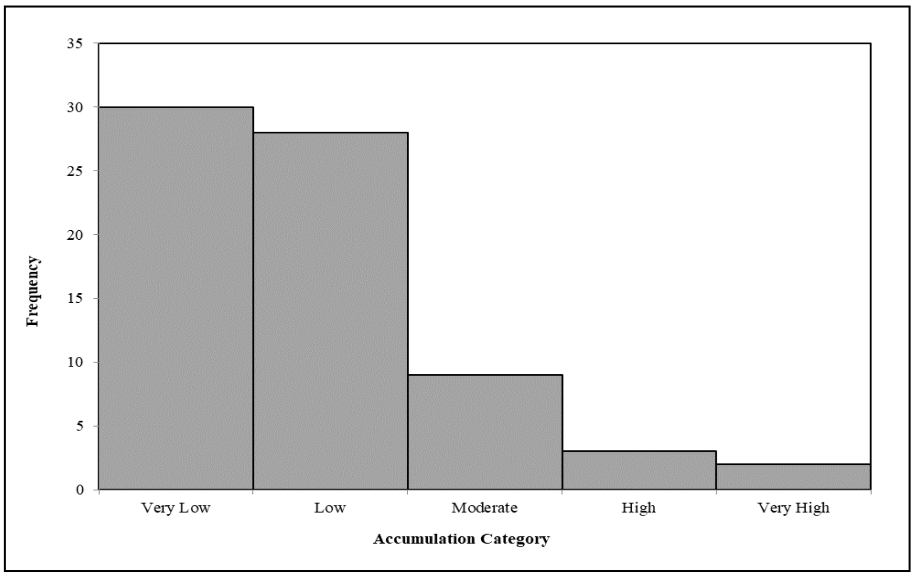


**Figure 2.** Frequency of *Sargassum* accumulations in South Florida (n = 72) categorized from photographs collected with the Emails/WhatsApp approach. Time frame of Data is from March 2018 – October 2019.

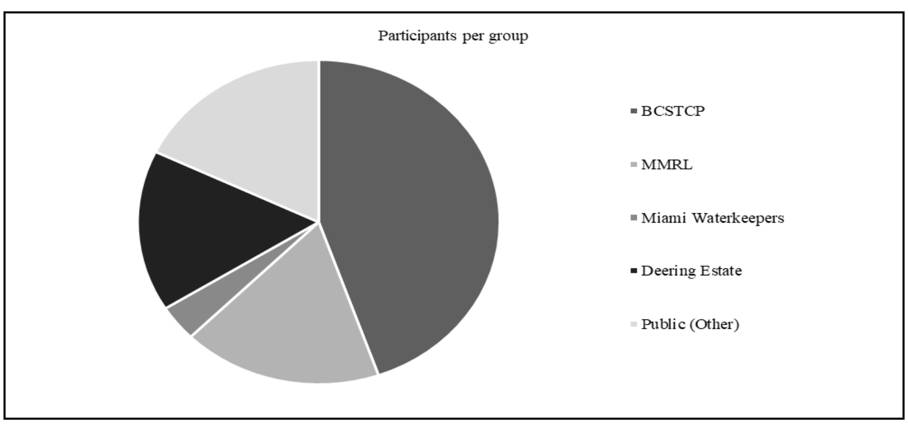


**Figure 3**. Pie chart showing the number of participants in each of the citizen science groups. Number of participants were reported by the head of each target group. Unidentified people who do not belong in a target group, determined by the site of the observation reported, were classified as "public (other)." Data compiled from both the CitSci.org and Epicollect5 databases.

conducting citizen science programs related to pelagic *Sargassum*, though their data collection protocol varies slightly (Table 2). Given the greater amount of data that can be potentially used for a much larger study, further coordination on the type of data collected, especially in photographic from, will be essential. Proper citation of data used for larger studies will also be needed in the future, especially with collaborators using each other's free and open-source data to use for their respective audiences such as tourists. Initiating collaborations between smaller citizen science programs related to monitoring pelagic *Sargassum* will also lead to a much larger "collaborative citizen science initiative" between citizen science programs that have slightly different data collection goals and protocols.

Despite the challenges in conducting this citizen science program, this initiative provides plenty of opportunities for the public to be engaged in the monitoring of a region-wide phenomena on a local scale, which can later be scaled to a much larger initiative. Success in the collection and use of detailed information require a certain level of training and commitment, and the data collected can be compatible with already established monitoring programs. Thus, the citizen science data and established monitoring programs can enrich each other. Due to the multidisciplinary and regional challenge, we recommend to have a dedicated session or webinar to analyze and coordinate different efforts conducted by the citizen science community to support the ground-truthing and sharing of information.

**Table 2**. List of potential databases and collaborators that can bolster the citizen science initiative on monitoring pelagic *Sargassum.*

| Program name | Medium | Geolocation | Time-Stamp | Photos of site | Photos of species | Source |
|---|---|---|---|---|---|---|
| *Sargassum* Watch | Citsci/ Epicollect5 | Yes | Yes | Yes | Yes | https://five.epicollect.net/project/sargassum-watch |
| EZ *Sargassum* | Epicollect5 | Yes | Yes | Yes | Yes | https://five.epicollect.net/project/ez-sargassum/data |
| *Sargassum* Monitoring © | Varies, primarily Facebook | Yes | Yes | Yes | No | http://sargassummonitoring.com/ |
| Monitoreo de sargazo pelágico en el Atlántico mexicano | iNaturalist | Yes | Yes | Sometimes | Sometimes | https://www.inaturalist.org/projects/monitoreo-de-sargazo-pelagico-en-el-atlantico-mexicano |
| Xacacel-Xacelito (MPA) | Facebook | Yes | Yes | Yes | No | https://www.facebook.com/santuariotortugamarinaxcacel/ |
| Collective View | Standalone App | Yes | Yes | Yes | No | https://play.google.com/store/apps/details?id=appinventor.ai_javier_arellano_verdejo.ERIS_SMS&hl=en_US |

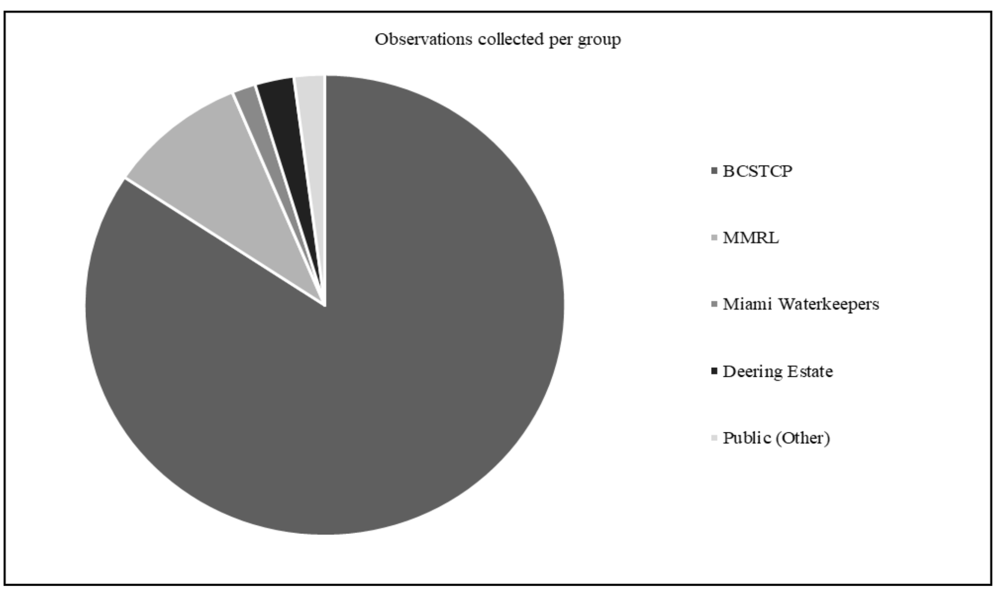


**Figure 4**. Pie chart showing the number of observations from each of the citizen science groups. Data compiled from both the CitSci.org and Epicollect5 databases.


**Figure 5**. Example entries of the *Sargassum* species from Epicollect5 labeled according to the quality. Quality of the photo is based on whether the species or morphotypes of the *Sargassum* can be identified manually.

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