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Citizen-Based Reporting Program for Native and Invasive Marine Biodiversity in Lebanon

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Authors:
Manal R. Nader, Ph.D.: Director, Institute of the Environment
Rawan Al Jamal, M.Sc.: Research Assistant, Marine and Coastal Resources Program
Andre Kammoun, **M.Sc.:** Research Assistant, Marine and Coastal Resources Program

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MCR - Marine and Coastal Resources Program at the
IOE - Institute of the Environment at the
UOB - University of Balamand
CS - Citizen Science
CBMS - Citizen Based Monitoring System
MPA - Marine Protected Area
SVT - Sorting and Validation Team

I. Introduction

The marine ecosystem in Lebanon is under extreme anthropogenic pressures ranging from pollution to sea filling to climate change. Therefore, protecting biodiversity and the services it provides is essential for a sustainable future. This is best achieved through the implementation of effective protection measures based on targeted applied scientific research and medium to long-term monitoring programs. However, monitoring programs are usually costly and require extensive commitment in human, material, and financial resources.

In response to challenges experienced in monitoring biodiversity in general and marine biodiversity in particular, community-based monitoring systems emerged to increase data collection across broader spatial and temporal scales. Such systems rely on non-specialist local communities to collect data for scientific inquiry either from daily and or recreational activities or through volunteer programs. This practice would provide governmental organizations and other investing bodies with sufficient data that can be used as bases for proper planning and implementation of various interdisciplinary projects (Ben Lamine et al., 2018; Freiwald et al., 2018).

Under the Activity 2.7. “Develop a citizen-based reporting program for marine conservation” of the current project entitled “Conducting an evidence-based Non-State Actors Campaign on Marine Protected Areas Network”, funded by the European Commission, and in partnership with the Lebanese Environment Forum, the Marine and Coastal Resources Program at the Institute of the Environment at the University of Balamand (MCR-IOE-UOB) developed a protocol with clear criteria for citizens to monitor trends in the occurrence, distribution and status of native and invasive marine species.

II. Citizen science and citizen-based monitoring systems

Integrating this approach within scientific fields is proving to be incredibly advantageous, specifically when addressing issues of the environment. One of the biggest challenges that face the environmental sector is the vastness of the material under study and the inability to continuously monitor occurrences and changes within these natural systems, which are considered crucial for implementing effective management plans (Goffredo et al., 2010). The establishment of a local body to monitor and relay data to researchers and decision-makers in real time would create efficient response plans that can repair any sudden damages or unwanted introductions within natural systems in general and protected ones in particular. This involvement of local communities would specifically provide protected areas with a stronger support system that would increase the efficiency of their productivity. It will also create within these communities a generational heritage in consolidation with healthy environmental practices that encourage the need to protect nature (Hermoso et al., 2021).

The establishment of such a monitoring program can fall under two broader categories. The first known as “**Citizen Science**” (**CS**), and the second as “**Citizen Based Monitoring System**” (**CBMS**). These two axes share the involvement of the local community in establishing a network of communication between the environment and the research community, but they differ in the level of citizen involvement and are defined as follows:

i. **CS** involves training groups of people (divers, fisherfolk, locals, sea enthusiasts, etc.) on proper methodologies used to identify and relay information (Aristeidou & Herodotou, 2020; Koss et al., 2009). Specific expeditions equipped with teams of scientists, volunteers, and fishermen are needed to properly collect information from the target site; divers must undergo training in proper scientific diving methodologies; and any other individual interested in joining the effort must undergo prior training to reach the suitable knowledge to carry out appropriate monitoring (Bruce et al., 2014). **CS** can therefore be considered time consuming and not very cost effective when dealing with marine protected areas (MPAs) (Seytre & Francour, 2008). Since most MPAs are located in coastal waters, different training programs are required for the different coastal habitats and associated species (rocky shores, benthic environments, pelagic environments, taxonomic identification of species, amongst others…). In addition, taking into consideration the time and resource investments needed to achieve this type of monitoring, local communities will most likely be hesitant to participate. This results in weak programs that will not meet their objectives (Lorenzo et al., 2011).

ii. **CBMS** depends on the local community's willingness to participate in monitoring while engaging in their day-to-day activities. This approach would eliminate the need to rely purely on trained individuals, inviting a bigger pool to take part in the program. Divers, fisherfolk, and sea enthusiasts are asked to relay their sightings into databases or information centers where these recordings will be validated through scientific approaches in order to verify the quality of the data and later added to the area's databank. The removal of the restrictions burdening the **CS** approach would increase participation allowing an ideal coverage of the area, whether spatially or temporally. Beyond contributing to research, **CBMS** allows the involvement of stakeholders in the management of marine resources while enhancing public scientific knowledge and environmental awareness and education. In addition, it has been proven to be an effective and low-cost approach to expanding the database in a remarkably short period (Mannino & Balistreri, 2018). The data entered by local communities are not of high-scientific quality since the reporting does not follow scientific methodologies (Seytre & Francour, 2009). However, after evaluation by scientific professionals, they may be considered as information to characterize MPAs as well as management-relevant data.

III. Structure of the Program

Based on the potential of success and the different needs for resource investment between CS and CBMS, the current report recommends the establishment of a CBMS through the creation of a community-based monitoring program (Kelly et al, 2020), either as a specific application developed for such a purpose or by using existing social media platforms (V: Social media platform vs Application) (Cigliano et al., 2015). Either way, such a program, regardless if it is a social media platform or an application must be founded on a well-developed system that optimally connects all involved parties and ensures quality of information (IV: Submission, Sorting, Validation and Feedback). It will depend on the local community of fishers, divers, and sea enthusiasts as a starting point for information collection. First, they should be familiarized with biodiversity guides already produced for easy identification of species and second, they should be able to collect information on newly encountered ones not mentioned in such guides. All submissions should then be relayed to a team responsible for sorting and validating the recordings which will later be presented to scientific professionals for further authentication as needed (Cerrano et al., 2016). Once validated, results will be submitted to decision-makers and practitioners on a regular basis to introduce/adjust protection measures of marine resources, raise awareness and promote education on marine ecosystems. The validated data should also be made available to the public accompanied with any important knowledge that clarifies its relation with the area's environment (Figure 1).

Biodiversity guides such as the ones developed by the MCR-IOE-UOB team for the AR2020 ([AR2020](AR2020)) and Hima Anfeh project (https://scholarhub.balamand.edu.lb/handle/uob/7262), as well as other publicly available guides (online and otherwise) can be used in order to minimize errors in the identification process. International/regional/national and local guides can be further enriched by other identification guides for the Mediterranean in general and Lebanon in particular, providing a larger database for marine species identification.

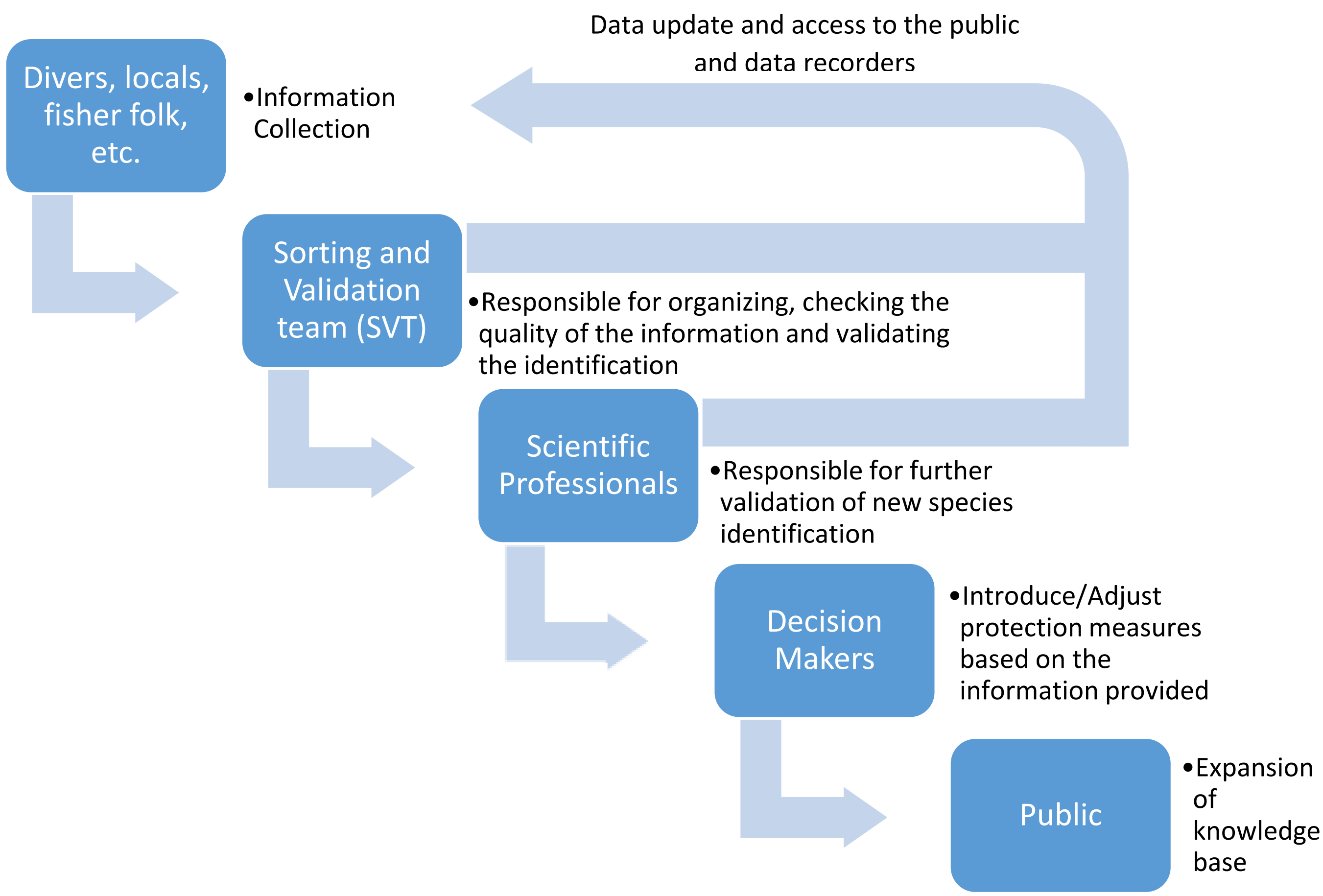

Figure 1: Citizen-Based Monitoring System (Source: Nader et al, 2022)

IV. Submission, Sorting, Validation and Feedback

Recreational divers, fisher folk, snorkelers, and sea enthusiasts are essential for the success of such monitoring programs since an increasing number use social media platforms for posting digital videos and photographs, with some of them providing important metadata through their mobile phones and diving computers revealing location, time of observation and other information. This will enhance local knowledge of marine organisms while at the same time create a broad ecological data platform of photographs of an array of species validated by scientists and available to the public. Such information complements existing and future scientific studies in focusing marine conservation efforts and introducing necessary measures (Hesley et al., 2017; Nader et al., 2022). Regardless, all recorders should not be permitted to upload low-quality photos that will not allow proper identification of the species in question. Such a filter can be built within the platform that allows only certain quality of photos to be uploaded.

Divers, fisherfolk, sea enthusiasts, and interested individuals will be responsible for recording information regarding sightings in the target areas. Encountered species will be identified according to available guides. If an encountered species is not included in such guides, expert identification will take place.

In brief, collected information will be inserted into the system for validation by the SVT before posting. If the latter is not able to identify the organism, the collected data will then be transferred to scientific professionals for accurate identification and validation. After validation, the "newly" identified species will be uploaded to the platform to be viewed by the community at large. The role of such a database is to store information to be validated either by the SVT or by scientific professionals, when necessary, to uphold the accuracy of and maintain confidence in the entire monitoring program (Lodi & Tardin, 2018). This can be available through specific online websites, customized platforms for the CBMS, applications curated by the MPA's managing team, or through pre-existing gateways (Liconti et al, 2022).

1. Submission

A platform (either social media platform or an application) for submission of observations and for accessing all guides is to be developed. Data will be entered on sheets (Table 1) that can be available either as physical copies or through electronic servers (applications or websites) where the individual can submit the sighting to be reviewed by the team in charge of validation. The electronic servers must not be directly available for public viewing; they will first be reviewed and validated by the SVT before being published.

Table 1: Proposed template of fields that may be included in the datasheet.

Full Name الاسم الكامل	
Activity Type (نوع النشاط)	
Scuba diving الغوص	
Free diving الغوص الحر	
Snorkeling الغوص مع استخدام أنبوب التنفس	
Recreational fishing الصيد الترفيهي	
Commercial fishing الصيد التجاري	
Shore observation مشاهدة عن الشاطئ	
Date of Observation تاريخ المشاهدة	
Time of Observation وقت المشاهدة	
Species Name سم الكائن	
Location of Observation موقع المشاهدة	
Depth of Observation عمق المشاهدة	
Habitat Type (نوع الموئل)	
Rocksصخور	
Sandy bottom قاع رملي	
Seagrass أعشاب بحرية	
Open water المياه المفتوحة	
Environmental conditions (الظروف البيئية)	
Water clarity (e.g., clear, murky, etc.) صفاء المياه (صافية,	
Water temperature (if available) درجة حرارة الماء (إن وجدت)	

Weather conditions (sunny, cloudy, rainy) أحوال الطقس (مشمس ، غائم ، ممطر)	
Behavioral Notes (If available) (إن وجدت) ملاحظات سلوكية	
Feeding أكل	
Mating التزاوج	
Resting استراحة	
Number of Individuals (an estimate of the number of individuals observed) عدد الأفراد (تقدير لعدد الأفراد الذين تمت ملاحظتهم)	
Individual فرد	
A small group مجموعة صغيرة	
A large school مجموعة كبيرة	
Condition of the Specimen حالة الكائن	
Alive حيا	
Dead ميت	
Injured مصاب	
Distressed (i.e., entangled in fishing gear, …) مضطرب (أي متشابك في معدات الصيد ، …)	
Threats or Disturbances Observed (If available) التهديدات أو الاضطرابات التي لوحظت (إن وجدت)	
Pollution تلوث	
Fishing nets شباك الصيد	
Boats القوارب	
Coastal development التنمية الساحلية	

As for the accurate identification of organisms, it is necessary to:

- Familiarize the local community with its marine biodiversity for accurate identification of encountered organisms.
- Photograph the organism sighted with a georeferenced location.
- Fill the datasheet (Table 1) as accurately as possible to ensure the integrity of the data collected.
- Minimize the level of interaction with sighted organisms.
- Flag organisms that seem unfamiliar or unusual. In extreme cases where the person cannot identify the species, is almost certain that it has not been recorded yet, and where a picture would not be sufficient for its identification, a sample of the organism can be collected, kept on ice and relayed to the scientific professionals for proper identification within a period not exceeding 48 hours.

For photographs to be uploaded, they should clearly show for the species:

- Full body
- Size when possible
- Coloration pattern
- Any distinctive feature that can be caught on camera

Further attention should be paid to the following:

- Focus: clear and not blurry picture.
- Resolution: High-resolution images.
- Lighting: The subject should be well-lit, avoiding shadows or overexposure.
- Full view: The entire organism should be visible in the photo if possible. For larger species, multiple angles (top, side, and underside) are helpful.
- Close-up of key features: If the species has distinct identifying features (such as fins, scales, patterns, or coloration), close-ups of those parts are encouraged.
- Scale or reference object (like a coin, ruler, or familiar object) helps scientific professionals estimate the size of the organism.

In case there are multiple recorders reporting on the same sighting or species in the same area, this could be used for cross-verification. Therefore, this multi-sourcing method can increase the reliability of the data.

2. Sorting and validation

Upon the transfer of information from observers to a storing database, a team of individuals will be responsible for validation based on scientifically endorsed taxonomic references. Such a team is best formed from persons of different educational levels ensuring sustained interest that allows long-term survival of the program. This group, made up of local employees and/or volunteers, should be created through the selection of individuals with specific sets of qualifications:

- Minimum level of education for proper handling of excel sheets, computer programs, and any applications or websites that will be used in storing and presenting the collected data.

- Willingness to familiarize with the local and scientific terminologies needed to fill in the data.
- Willingness of the team to learn about the species present in the area which will be accessed via biodiversity guides and other sources.
- Minimum level of interest in the process of species identification to correctly validate the information submitted.

In case of uncertainty throughout the process of validating submissions, the personnel of the team would then be required to contact a scientific professional that will help in proper proofing of information and identification of species (Figure 1).

3. Feedback

A notification system should also be set up to inform the recorders and users about the following:

- Submission Confirmation: to inform recorders that their photo/report has been successfully submitted.
- Validation and Feedback: to notify recorders once scientific professionals have reviewed and identified the species.
- Requests for more information from the recorder in cases where the submitted image is unclear or lacks necessary details, therefore a notification can request additional information and/or better photos.
- Reminders and Alerts: to remind users of upcoming events, best practices for species spotting, or seasonal species to look out for.
- Error or Rejection Notifications: to notify the recorder if their submission couldn't be processed or the species couldn't be identified due to poor image quality or insufficient details.
- Encouragement and Motivation**:** encourage recorders to continue contributing by acknowledging their input or setting milestones for their activity (optional).
- Educational Notifications: to provide recorders with interesting information or tips about the species they submitted or marine biodiversity in general (optional).

Additional features in the CBMS can include:

- Citizen science training through online tutorials, videos, and guides to teach participants about species identification, photography best practices, and the importance of data accuracy.
- Certification programs where recorders can level up their skills through quizzes or successful submissions, turning them into "trained citizen scientists" who can submit higher-quality data.
- Promoting data accessibility and transparency by making the data from the program publicly accessible to researchers, policy-makers, and conservation organizations, which adds credibility and scientific value to the program.
- Dedicated section for recorders and users to submit questions related to marine biodiversity, the reporting process, or specific species they encounter and where scientific professionals can respond to submitted questions in a timely manner. Questions and answers are to be publicly visible so that the wide public can benefit from the information

provided. A notification can be sent when questions have been answered or if there are updates related to their inquiry.

V. Social media platform vs Application

For a citizen-based monitoring program, and as previously stated, a social media platform or a dedicated web application can be used. Therefore, weighing the pros and cons of each approach is essential. Table 2 outlines the benefits and drawbacks of both platforms, highlighting key aspects such as resource requirements, long-term costs, and operational efficiency. This comparison can guide decision-making based on the program's specific needs and available resources.

Table 2: Pros and cons of social media[1] vs application [2,3]

Social media		Application	
Pros	**Cons**	**Pros**	**Cons**
Ease of Use: Familiar interface; citizens are likely already using social media, so there is no learning curve and no need for user training.	**Limited Data Structure:** Posts and comments may lack the standardized structure needed for scientific data collection.	**Customization:** Can be tailored specifically to the needs of the biodiversity monitoring program, including data entry fields, geotagging, and species identification tools.	**Development and Maintenance Costs:** Requires funding and expertise to develop and maintain the application.
Large Audience Reach: Ability to reach and engage a large number of people quickly through shares, hashtags, and groups.	**Privacy Concerns:** Sensitive information, such as location data, may be shared publicly, even if the user abstains from inputting the location (due to the open and social nature of the platform).	**Data Security and Ownership:** Full control over how data is stored, shared, and used, ensuring compliance with privacy laws (users should have trust that the application securely manages this data and does not misuse or share it without consent).	**User Adoption:** Citizens may need training or encouragement to use the platform, as it is unfamiliar compared to social media.
Real-Time Interaction: Immediate feedback, comments, and discussions can foster	**Data Ownership Issues:** Data uploaded to the platform might become the	**Standardized Data Collection:** Allows for structured input formats, making data easier to analyze.	**Limited Reach:** The user base is limited to those who actively sign up, reducing

[1]Izquierdo-Gómez, D. (2022). Synergistic use of facebook, online questionnaires and local ecological knowledge to detect and reconstruct the bioinvasion of the Iberian Peninsula by Callinectes sapidus Rathbun, 1896. Biological Invasions, 24(4), 1059–1082. https://doi.org/10.1007/s10530-021-02696-0
[2] Fishial.AI | Fish Identification for Everyone!
[3] iNaturalist

Social media		Application	
Pros	**Cons**	**Pros**	**Cons**
engagement and build community.	property of the social media company.		spontaneous participation.
Cost-Effective: No need to build and maintain a separate application (use of existing platforms like Facebook or Instagram).	**No Customization:** Limited control over features and functionality tailored to biodiversity monitoring needs.	**Integration with Other Tools:** Can integrate with databases, APIs (e.g., for species identification), and GIS mapping software.	**Access Issues:** Participants without smartphones or reliable internet access may face barriers in using the platform.
Increased Visibility: Posts can go viral, drawing attention to the program and increasing awareness of marine biodiversity issues.	**Distractions:** The platform's primary purpose (e.g., social interaction) may distract users from the program's goals.	**Longevity and Focus:** The application can remain dedicated to the program without competing with other distractions on social media.	Slower Engagement: Lacks the virality and network effects of social media for attracting new participants.
Human Validation Ensures Accuracy: A sorting and validation team reviews submitted data to ensure the accuracy of species identification, which enhances data reliability.	**Ongoing Human Resource Commitment:** The platform requires a long-term investment in keeping both the validation team and scientific experts engaged and active.	**Long-Term Efficiency:** After an initial time and financial investment, AI can handle species identification with minimal human intervention, significantly reducing ongoing operational costs.	**High Initial Investment:** Development requires significant upfront time and money to design, build, and train the AI for accurate species identification.
Expert Involvement: Scientific professionals are available to identify species when the validation team is unable to, maintaining a high level of expertise in the process.	**Sustained Costs:** Payment for the validation team and scientific experts represents a continuous financial obligation, making it resource-intensive in the long run.	**Scalability:** The application can process large amounts of data without requiring additional human resources, making it cost-effective as usage increases.	AI Limitations: AI may require periodic updates and maintenance to stay accurate, which could involve occasional additional costs and technical expertise.

VI. Ecological Evaluation Capacity

Data collected through community-based monitoring systems is not of utmost accuracy for statistical evaluation since it is not collected according to approved scientific methodologies (Pikesley et al, 2015). Nonetheless, it can provide a general evolutionary outline for the detected species through time which will permit monitoring the effect of the protection effort on the conserved area. This is extremely dependent on the data collected, entered, and validated (Nader et al., 2022). The SVT should also be trained on discerning missing or questionable data to eliminate from the system. If enough data is collected on target parameters for species, indices may be derived that could provide the management bodies with the “probable” state of the protected ecosystem and will help with the preparation for needed steps for scientific evaluation and proper intervention in case of setbacks (Matear et al, 2019).

VII. In summary

The development of CS and/or CBMS for MPAs dependent on local communities are becoming universal approaches for the maximization of the effectiveness of conservation in a timely and efficient manner, albeit at different levels. Both allow wide monitoring efforts through space and time, integrate the local community in MPA protection, raise awareness, and allow a timely response to any profound changes occurring within the environment. Nevertheless, and for the current action, a CBMS is recommended over CS due to its limited resource investment, broader community engagement, and the ability to collect valuable data without the need for extensive training or specialized knowledge.

VIII. References

Aristeidou, M. & Herodotou, C. (2020). Online Citizen Science: A Systematic Review of Effects on Learning and Scientific Literacy. Citizen Science: Theory and Practice. 5. doi: 10.5334/cstp.224.

Ben Lamine, E., Di Franco, A., Romdhane, M. S., & Francour, P. (2018). Can citizen science contribute to fish assemblages monitoring in understudied areas? The case study of Tunisian marine protected areas. *Estuarine, Coastal and Shelf Science*, *200*, 420–427. https://doi.org/10.1016/j.ecss.2017.11.031

Bruce, E., Albright, L., Sheehan, S., & Blewitt, M. (2014). *Distribution patterns of migrating humpback whales (megaptera novaeangliae) in Jervis bay, Australia: A spatial analysis using geographical citizen science data.* Applied Geography (Sevenoaks), 54, 83-95. doi:10.1016/j.apgeog.2014.06.014

Carballo-Cárdenas, E. C., & Tobi, H. (2016). *Citizen science regarding invasive lionfish in dutch caribbean MPAs: Drivers and barriers to participation.* Ocean & Coastal Management, 133, 114-127. doi:10.1016/j.ocecoaman.2016.09.014

Cerrano, C., Milanese, M., & Ponti, M. (2016). *Diving for science - science for diving: Volunteer scuba divers support science and conservation in the Mediterranean Sea Wiley*. doi:10.1002/aqc.2663

Cigliano, J. A., Meyer, R., Ballard, H. L., Freitag, A., Phillips, T. B., & Wasser, A. (2015). *Making marine and coastal citizen science matter.* Ocean & Coastal Management, 115, 77-87. doi:10.1016/j.ocecoaman.2015.06.012

Freiwald, J., Meyer, R., Caselle, J. E., Blanchette, C. A., Hovel, K., Neilson, D., Dugan, J., Altstatt, J., Nielsen, K., & Bursek, J. (2018). Citizen science monitoring of marine protected areas: Case studies and recommendations for integration into monitoring programs. *Marine Ecology*, *39*, e12470. https://doi.org/10.1111/maec.12470

Goffredo, S., Pensa, F., Neri, P., Orlandi, A., Gagliardi, M. S., Velardi, A., Piccinetti, C., & Zaccanti, F. (2010). Unite research with what citizens do for fun: “Recreational monitoring” of marine biodiversity. *Ecological Applications*, *20*(8), 2170–2187. https://doi.org/10.1890/09-1546.1

Hermoso, M. I., Martin, V. Y., Gelcich, S., Stotz, W., & Thiel, M. (2021). Exploring diversity and engagement of divers in citizen science: Insights for marine management and conservation. *Marine Policy*, *124*, 104316. https://doi.org/10.1016/j.marpol.2020.104316

Hesley, D., Burdeno, D., Drury, C., Schopmeyer, S., & Lirman, D. (2017). *Citizen science benefits coral reef restoration activities. Journal for Nature Conservation*, 40, 94-99. doi:10.1016/j.jnc.2017.09.001

Izquierdo-Gómez, D. (2022). Synergistic use of facebook, online questionnaires and local ecological knowledge to detect and reconstruct the bioinvasion of the Iberian Peninsula by Callinectes sapidus Rathbun, 1896. *Biological Invasions*, *24*(4), 1059–1082. https://doi.org/10.1007/s10530-021-02696-0

Kelly, R., Fleming, A., Pecl GT,von Gönner J, Bonn A. (2020) *Citizen science and marine conservation: a global review.* Phil.Trans. R. Soc. B 375: 20190461. http://dx.doi.org/10.1098/rstb.2019.0461

Koss, R., Miller, K., Wescott, G., Bellgrove, A., Boxshall, A., McBurnie, J., Bunce, A., Gilmour, P., & Ierodiaconou, D. (2009). An evaluation of Sea Search as a citizen science programme in Marine Protected Areas. *Pacific Conservation Biology*, *15*(2), 116. https://doi.org/10.1071/PC090116kelly

Liconti, A., Pittman, S. J., Rees, S. E., & Mieszkowska, N. (2022). *Identifying conservation priorities for gorgonian forests in italian coastal waters with multiple methods including citizen science and social media content analysis Wiley*. doi:10.1111/ddi.13553

Lodi, L., & Tardin, R. (2018*). Citizen science contributes to the understanding of the occurrence and distribution of cetaceans in southeastern brazil – A case study*. Ocean & Coastal Management, 158, 45-55. doi:10.1016/j.ocecoaman.2018.03.029

Lorenzo, B., Ilaria, V., Sergio, R., Stefano, S., & Giovanni, S. (2011). Involvement of recreational scuba divers in emblematic species monitoring: The case of Mediterranean red coral (Corallium rubrum). *Journal for Nature Conservation*, *19*(5), 312–318. https://doi.org/10.1016/j.jnc.2011.05.004

Mannino, A. M., & Balistreri, P. (2018). Citizen science: A successful tool for monitoring invasive alien species (IAS) in Marine Protected Areas. The case study of the Egadi Islands MPA (Tyrrhenian Sea, Italy). *Biodiversity*, 1–7. https://doi.org/10.1080/14888386.2018.1468280

Matear, L., Robbins, J. R., Hale, M., & Potts, J. (2019). *Cetacean biodiversity in the bay of biscay: Suggestions for environmental protection derived from citizen science data*. Marine Policy, 109, 103672. doi:10.1016/j.marpol.2019.103672

Nader, M., Al Jamal, R. & Kammoun, A. (2022). *Citizen Based Monitoring System.* "Marine and Coastal Biodiversity Conservation in Anfeh Hima". Marine and Coastal Biodiversity Conservation in Anfeh Hima

Nelms, S. E., Eyles, L., Godley, B. J., Richardson, P. B., Selley, H., Solandt, J., & Witt, M. J. (2020). *Investigating the distribution and regional occurrence of anthropogenic litter in english marine protected areas using 25 years of citizen-science beach clean data. Environmental Pollution (1987)*, 263(Pt B), 114365. doi:10.1016/j.envpol.2020.114365

Pikesley, S. K., Godley, B. J., Latham, H., Richardson, P. B., Robson, L. M., Solandt, J., Witt, M. J. (2016). *Pink sea fans (eunicella verrucosa) as indicators of the spatial efficacy of marine protected areas in southwest UK coastal waters.* Marine Policy, 64, 38-45. doi:10.1016/j.marpol.2015.10.010

Seytre, C., & Francour, P. (2008). Is the Cape Roux marine protected area (Saint-Raphaël, Mediterranean Sea) an efficient tool to sustain artisanal fisheries? First indications from visual censuses and trammel net sampling. *Aquatic Living Resources*, *21*(3), 297–305. https://doi.org/10.1051/alr:2008043

Seytre, C., & Francour, P. (2009). The Cap Roux MPA (Saint-Raphaël, French Mediterranean): Changes in fish assemblages within four years of protection. *ICES Journal of Marine Science*, *66*(1), 180–187. https://doi.org/10.1093/icesjms/fsn196