Annex 3

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HOLISTIC MARINE CITIZEN SCIENCE PROJECTS' MAPPING IN THE BALTIC SEA REGION

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Summary

During the months of May through September of 2021, the first-ever holistic study of Marine Citizen Science projects in the Baltic Sea area was undertaken, consisting of targeted stakeholder outreach as well as desk research, with the support of an online questionnaire. A total of 55 projects were identified, which fit the criteria of projects no older than five years prior to 2021; focusing on the Baltic Sea Region marine or coastal environment; and only projects where the data collected by citizen scientists was actually used by researchers for scientific research or for exerting influence on policy-makers. This report presents the review and analysis of the study, considering also the implications for future Marine Citizen Science projects in the Baltic Sea Region.

Background

Understanding the workings and responses of the marine environment to current and future pressures, is crucial for the development and subsequent implementation of sustainable development policies (Garcia-Soto, Carlos et al., 2021). In various efforts to widen the scope of research to include input from the wider public and thus non-scientists, in recent years Citizen Science is becoming more and more mainstream, including not only projects that refer to terrestrial or coastal environments, but also to a large extent those that take the marine environment as their focus (Silvertown, 2009). Understanding the landscape of Marine Citizen Science projects would be a highly valuable resource to get a clear idea of to what extent such projects are truly contributing to relevant scientific endeavours. To date however, there exist no dedicated databases on Marine Citizen Science projects, neither on the European scale, nor on the scale of the Baltic Sea Region. The Baltic community thus has to rely on anecdotal evidence and own desk research, considering also the complicating factor that there are nine national languages spoken in the region.

On behalf of the Baltic and North Sea Coordination and Support Action (BANOS), s.Pro – sustainable projects GmbH has undertaken the first-ever comprehensive study of recent and on-going Marine Citizen Science projects in and around the Baltic Sea Region. The aim was to deliver a study that was not only comprehensive, but also including only relevant projects and assessing their value, as well as lessons learned and potential recommendations for future Baltic Marine Citizen Science projects. This report presents the main results of the review and analysis, together with the database file representing a) the stakeholder outreach and b) the identified projects on which the study is founded, both of which can be found in the Annex.

Taking a similar study done in the North Sea Region (van Hee, 2020) as prime inspiration, the Baltic Marine Citizen Science study set out to deliver a single and holistic baseline study for the Baltic Sea Region, covering not only that information which may be found online, but also through actively engaging with those stakeholders that may play a key role in Baltic Marine Citizen Science projects. As this report will present, the overview may not be fully complete, but it provides a major resource for those interested in pursuing and initiating further Marine Citizen Science projects in the Baltic Sea Region.

Methodology

The study of Marine Citizen Science projects in the North Sea Region (van Hee, 2020) was taken as a core inspiration for this report. This means that the study is using the same structure for the report and includes roughly the same categories for the Excel database in which the identified projects were categorised. Following an extensive reading of the VLIZ study, the authors started off with developing a template database and utilised the existing actors mapping done under the EU4Ocean Ocean Literacy initiative, for which the authors act as the Baltic Sea Focal Point. This mapping includes a database of actors active in Ocean Literacy and Citizen Science in the Baltic Sea Region. Of this database, 74 relevant individual contacts were identified, serving as the basis for a 'snowball' enquiry, whereby the targeted stakeholders were asked not only about MCS projects they were aware of or involved in, but also whether they could point to any individuals that they thought could tell us more.

For the purposes of this study, a Citizen Science project is defined as one where data is collected and where this data is subsequently used for a pre-defined purposes, either scientific in the traditional sense, or serving as input for informed discussions. For this study, the emphasis was on both the marine (the sea) as well as the Baltic Sea Region coastal areas. In addition, it was agreed that the study should have a focus on Marine Citizen Science projects that provide data and **tangible outcomes** and that are as such '**consultable'** - meaning that **the study also considered scientific projects that use or used Citizen Science approaches to their enquiries. This is especially poignant considering that the future BANOS will be a scientific programme**, and taking into account that Citizen Science projects should be considered as 'key enablers' of a future European open science landscape (Garcia-Soto, Carlos et al., 2021).

The approach to the study was three-fold: starting off in May 2021 by a) reaching out with a questionnaire to known stakeholders, b) promoting the study to unknown stakeholders and c) by undertaking a comprehensive online desk research. From May until September 2021, a total number of 119 stakeholders were contacted directly, both per email as well as to a lesser extent per telephone.

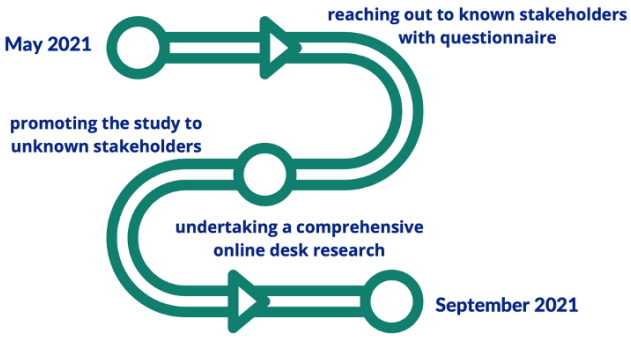

Figure 1: Timeline of Study

Questionnaire

Targeted stakeholders were presented with an online questionnaire that was developed through JotForm (available here: https://form.jotform.com/211522641508347 and in the Annex). Respondents were free to save their input and to retrieve it at a later stage. The average time for filling in the questionnaire was estimated to be around 10 minutes. Some of the questions were made obligatory, while most of them were not.

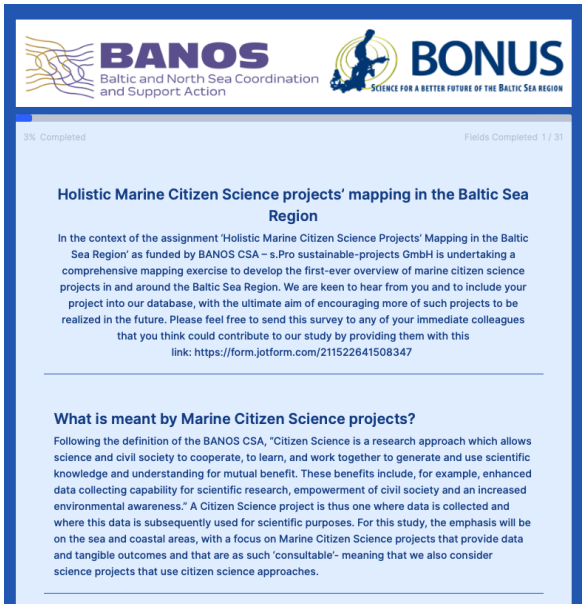

Figure 2: Screenshot of Stakeholder Questionnaire

Targeted stakeholders were given the option of filling the questionnaire in by themselves online or to go through the questions per telephone with the authors. Of the total 119 directly targeted stakeholders, 65 were positively responsive, meaning they either replied to emails sent or answered the phone, with a potential project contribution. A total of 40 persons submitted a response to the questionnaire.

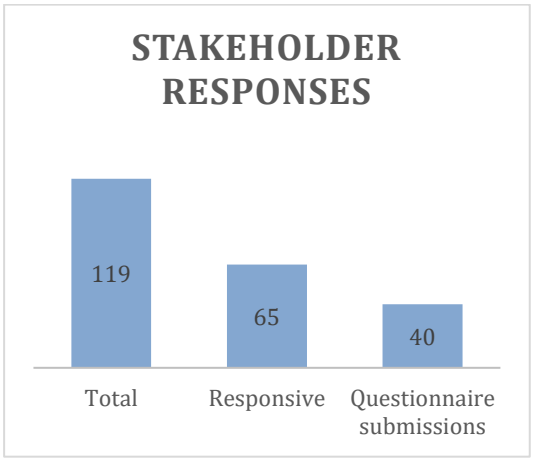

Figure 3: Stakeholder Responses

Categories and variables used in the Study

This study built on earlier work done in the North Sea Region, allowing for the use of a template database as well as previously used search terms and methodology. However, there were some key differences regarding the study area and characteristics. These include for instance the language factor, as there are 9 national languages around the Baltic Sea Region and many of the identified Marine Citizen Science projects are or were organised in national languages. Considering a rough comparison with the North Sea Region study, this means that if the authors had only included a desk study research with English search terms, the study results would be quite biased, as it would most likely deliver a significant percentage of transnationally funded projects. A further differentiating factor between the Baltic Sea Region study and the North Sea Region study also includes the geographic and environmental characteristics specific to the Baltic Sea Region, such as the problem of eutrophication and the transnational approaches to marine litter.

In the final weeks of the study, the authors sent out reminders to targeted stakeholders and further promoted the questionnaire online. In addition, it was decided to extend the study period with two weeks, allowing targeted stakeholders the opportunity to include projects upon returning from their summer holidays. This extension period was promoted through online social media promotion as well as an additional round of targeted emails to those stakeholders integrated in the list of potential Baltic Marine Citizen Science projects collected so far. This additional round focused on a direct question, namely whether the targeted stakeholders considered a potential project to be missing from the draft list of potential projects. This ensured that the study delivered the most comprehensive overview and analysis of Baltic Marine Citizen Science projects as possible, functioning as an additional verification round. The extension period resulted in 7 additional projects suggested by stakeholders.

As the responses to the questionnaire were coming in, the authors verified the categorisations and variables used by the respondents in the questionnaire responses. In some instances, it was needed to double-check the information provided, to add information or correct it, or to actually not consider the suggested project in the study, as it did not meet all the criteria. For all of the suggested projects, strict criteria were applied, considering whether a) a project's timeline was recent enough, b) whether the project focused on the Baltic Sea Region marine or coastal environment, and c) whether the data collected by citizen scientists was actually used by scientists, either for scientific research or for exerting influence on policy-makers.

For the purpose of the study, the authors used the following definition of 'Levels of participation' – meaning the level of knowledge and co-creation that participants of Citizen Science studies had:

- **crowdsourcing**: no subject knowledge required, citizens report observations;
- **distributed intelligence**: certain level of knowledge is required for the sake of interpretation, either pre-existing knowledge or via a training course;
- **participatory science**: citizens define the problem, compose a method and do data collection but scientists still play a leading role in analysing the data and interpreting the results;
- **extreme citizen science**: collaborative science, non-professionals participate in all steps of research but they choose their level of (Shum B., 2012); (Haklay, 2013)

The other definition that was crucial to the structure and analysis of the study, was the definition of 'Type of initiative'. This refers to the degree in which the data collected by citizen scientists in projects, was valuable to the project objective as well as referring to the aim of the project. The three definitions include:

- **descriptive**: data collected without specified intended use;
- **performance**: monitoring and evaluation is crucial, collecting data long-term;
- **composite**: drawing attention to important policy issues by providing a shared conceptual framework as basis for interpretation, analysis and practice (Lehtonen M., 2016)

The above definitions were also included in the questionnaire – ensuring that respondents were aware of the definitions used in the study to categorise projects. It was decided that the focus of the study should be as wide as possible, within limits. This meant that the study considers the whole of the Baltic Sea Region, including all European coastal Member States of the Baltic Sea Region, as well as the Baltic coast of Russia, and excluding Norway and Belarus. The study includes references to projects that are also on the more inland coastlines of countries. It was also decided to delimitate the timeline of projects to be studied. Although the North Sea Region study includes reference to projects going back as early as the year 1960, it was decided that for the Baltic Marine Citizen Science study, it would be of more value to only include those projects that have finalised no earlier than 5 years prior (to the year 2021). Reasons for this decision include the fact that the further in the past the projects took place, the more difficult it is to find accurate and detailed information about the projects, as well as the fact that the Southern coastal countries only entered into the European Union by the year 2004 and thus it may be quite difficult to find information about any projects before this time.

Desk Research

In parallel with the online as well as the targeted outreach to stakeholders, the authors undertook an intensive desk research, consisting both of online research as well as a literature review. Those projects that were identified as relevant for the study were integrated into the Excel database under the category 'Found proactively'. The online research consisted of an intensive Google search for the whole Baltic Sea Region, using specific search terms, including the national terms for 'Citizen Science':

- Danish: *borgervidenskab*
- Estonian: *kodaniku teadus, Kodanikuteadus*
- Finnish: *kansalaistiede*
- German: *Bürgerwissenschaften*
- Latvian: *pilsoņu zinātne*
- Lithuanian: *piliečių mokslas*
- Polish: *nauka obywatelska*
- Russian: *гражданская наука* (*grazhdanskaya nauka*)
- Swedish: *medborgarvetenskap*

The authors used the automatic translation service in the browser Google Chrome to further identify any Baltic Marine Citizen Science projects that satisfied all agreed upon criteria, i.e. whether it had a focus on marine or coastal relevant topics, whether it was

on-going or ended no earlier than 5 years past, and whether the data collected by citizen scientists was actually used for scientific research or used to influence policy-makers. The authors did the same search via social media, including the platforms Facebook, Twitter, Instagram and LinkedIn. In addition, the authors searched through the existing project databases of BONUS, Interreg, EU MSP Platform and the European Citizen Science Association in order to identify relevant Baltic Marine Citizen Science projects.

When contacting the stakeholders, they were asked whether they were aware of any relevant projects that fit the agreed upon criteria, whether they had been involved in it, or whether they could point to any other relevant stakeholders with further knowledge about Marine Citizen Science projects in the Baltic Sea Region. In addition, the identified coordinators of projects as well as those that filled in the questionnaire by themselves, were asked to categorize their projects according to the variables, as it was figured that they know their project best. When a project was suggested to the authors without those variables being inserted or provided, the authors did their own online search to find out more about the project in question.

Results

Considering both those stakeholders that were targeted directly as well as those that responded to the online questionnaire through the general online promotion of the on-going study, a total number of 40 useful questionnaire responses were received. The total number of identified relevant Baltic Marine Citizen Science projects, found both through the proactive desk study as well as those identified by targeted stakeholders and questionnaire respondents, is 55. The following categories were included in the study:

Name of project in EN	**Suggested by respondent or found proactively**	**Name of project in original language**	**Duration of project**	**Start date of project**
End date of project	**Project finished or on-going**	**Scale of project**	**Location of project**	**Language of project**
Frequency of data collection	**Category**	**More precise information about topic of project data collection**	**What kind of data did the project collect and how?**	**How was the data sent to the project lead?**
What is/was the aim of the project?	**Is the dataset available?**	**Lessons learned**	**Number of participants**	**Participant feedback**
Level of participation	**Role of sustainability**	**Other comments**	**Project lead**	**Project co-leads**
Project website	**How is/was the project funded?**	**Project lead contact name**	**Project lead contact email**	

Table 1: Categories used in the study

For the 55 identified projects, the categories in the Excel database were filled with specific variables, although for some of the projects, not all of the information for the categories could be found. If this was the case, the variable was included as 'Unknown'. Of the 55 projects, 28 were found proactively and 27 were suggested by stakeholders, although there is a caveat to be mentioned: some of the projects that were initially identified through proactive desk research, were later also suggested by a stakeholder. If this was the case, the project was then categorised as being 'Suggested by a questionnaire respondent'.

Plastic Pirates – Go Europe! Project (PlastikPiraten) is an on-going Marine Citizen Science project in Germany, led since 2016 by the German Federal Ministry of Education and Research. The aim of the project is to encourage citizens and especially children, to collect marine litter and plastic waste and to help conduct research on the pollution of bodies of water. The project has developed uniform experimental guidelines and working steps for all participants, ensuring that all collected data exists in a comparable format. It is a joint campaign of three national ministries of education, science and research, emphasising the importance of international research collaboration. Since 2016, over 15,000 participants have submitted data sets and samples. Under normal scientific conditions, it would have taken years to collect data with this enormous spatial distribution. Project website: https://www.plastic-pirates.eu/en

Figure 4: Highlight of the Plastic Pirates – Go Europe! Marine Citizen Science project

41 of the identified projects are on-going and 12 were finalised by or before the year 2021. As for some of the projects there was little information available, it was assumed that they were still on-going, as more often than not, the portals for submissions from citizen scientists were still functional. In addition, 2 projects were identified that are in fact upcoming: 'FPCUP EO-Crowd' (scale: national, location: Finland) and 'Roots University of Kiel Citizen Science Project' (scale: local, location: Germany). It was decided to include these projects as they show that Baltic Marine Citizen Science projects are not only a thing of the past, but also very much of the future. The study considered both the name of the projects in English as well as the name in the respective national language and included whether the project information was available in English or in the respective national language. For 21 projects, the information was available in English. In addition, the categories included the project lead institution as well as any relevant co-leads, the project website, the name of the project coordinator as well as their email address.

Where do Baltic Marine Citizen Science projects take place?

Two categories were used to assess the locality of the project: 'Scale' and 'Location'. These two categories are complementary, but a bit different in focus. For example, a project can be categorised as 'National' under the category 'Scale', with 'Finland' as the variable under the category 'Location'. Of the 55 Baltic MCS projects identified, 40 are or were country-specific, meaning that the relevant project took place in national waters, categorised either as local, subregional, regional or national. Of those projects, the most took place in Finland, with 12 projects, and Sweden, also with 12 projects. Ten projects considered a supranational scale, with four projects focusing on the whole Baltic Sea Region, 6 projects focusing on the whole of Europe, and with four projects focusing on a wider international scale.

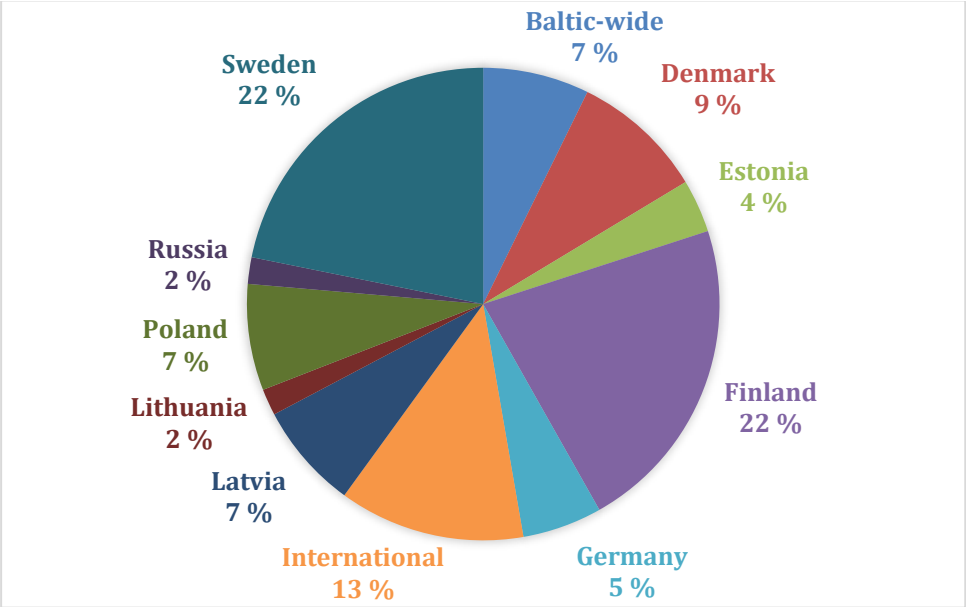

Figure 5: Location of projects

What do Baltic Marine Citizen Science projects study?

In order to get a clear picture of what the identified projects studied, the category aptly named 'Category' was included in the questionnaire and Excel database, with the distribution of variables as illustrated in Figure 5. The projects that studied the category 'Species' were the most common with 13 projects, tying with the category 'Environmental variables (Other)' with also 13 projects. Marine litter was the second-most chosen category, with 8 projects. The least chosen categories were Archaeology and Fisheries, with each category only being chosen once.

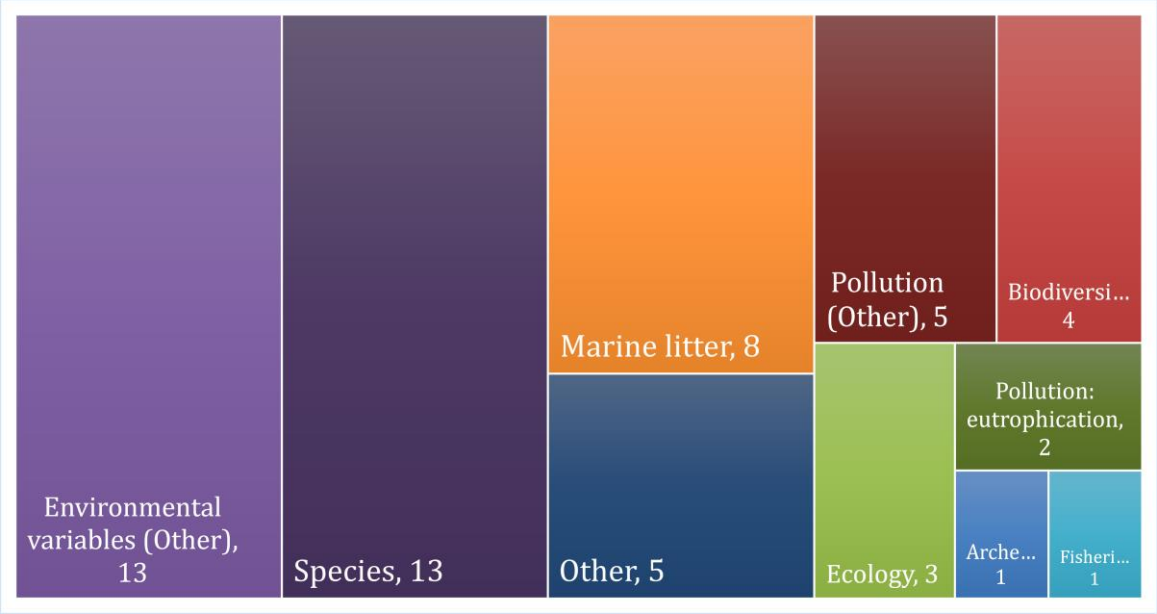

Figure 6: Project Categories

It could be argued that it is logical that marine litter represents a large focus of the study, as marine litter monitoring is now a legal obligation under the European-wide Marine Strategy Framework Directive (MSFD). However, the authors have decided to leave

some of the suggested projects on marine litter out of the scope of the study, as many of these conclusively did not meet the criterium of collected data by citizen scientists being actually used for scientific research. Several of such suggested projects could in fact not be classified as true Marine Citizen Science projects, but rather as beach clean-ups. Although the latter are a key tool in increasing environmental awareness among participants, if a project is 'merely' focusing on an educational purpose and there is no real scientific result, it cannot be classified as a Citizen Science Project (Garcia-Soto, Carlos et al., 2021).

It may also come as little surprise that most projects could be categorised as environmental variables (other) and species, as these are two categories that are highly suitable for monitoring by citizens, meaning that the gathering of relevant data and information may be quite straightforward, e.g. measuring water quality or temperature, counting water birds, or general observations of the marine environment. In fact, most Marine Citizen Science projects tend to involve environmental monitoring of some sort by the citizen scientists (Dean AJ, 2018). However, not all projects that ask volunteer citizen scientists to engage in environmental observation or even monitoring, may be classified as Citizen *Science* projects. For instance, it was decided not to include Naturgucker.de and its English language counterpart, since although they may definitely be defined as citizen *observation* projects, it cannot be categorized as a Citizen *Science* project, since the data that is being provided by the participating citizens is collected, uploaded and integrated onto a map, but then it is not used for any scientific purposes nor for informing discussions with stakeholder groups such as policy makers.

Lake and Sea Wiki (Järvi Meri Wiki) is an on-going Marine Citizen Science project in Finland, focusing on algae observations as well as general observations of Finnish lakes and seas. The project has been running since 2011 and has trained artificial intelligence algorithms that can recognise this species of coral. These AI algorithms also allowing the automatic processing of the thousands of videos and photos collected. The project is run by the Finnish Environment Institute SYKE. Lake and Sea Wiki focuses on both lakes as well as the marine waters including the Baltic Sea. For each location, a discussion forum page has been created where users actively discuss. There are also clear guidelines as well as an abundance of information about the Finnish marine environment. The database is externally available here: https://www.jarviwiki.fi/wiki/Havaintol%C3%A4hetti

Figure 7: Highlight of the Järvi & Meri Wiki Marine Citizen Science project

In order to learn more about how the citizen scientists contributed their data, the categories 'Frequency of data collection' was included in the study, with variable 'Ad-hoc/continuous' taking the lead with 36 projects. This is no large surprise, as most projects either delineated a timeline for the projects during which observations and measurements could take place by citizen scientists, or the collection of data was centred around specific dates and times. To get more details about the topic of the projects, the questionnaire included the category 'More precise information about topic of data collection'. For instance, for the category 'Environmental variables (other)' this could include water colour and water quality, specific items under marine litter such as plastics and fishing gear, or under the category 'Species' or 'Biodiversity' this included molluscs, fish or mammals. Further categories that were used to learn more about the projects included 'What kind of data did the project collect and how', with the following variables:

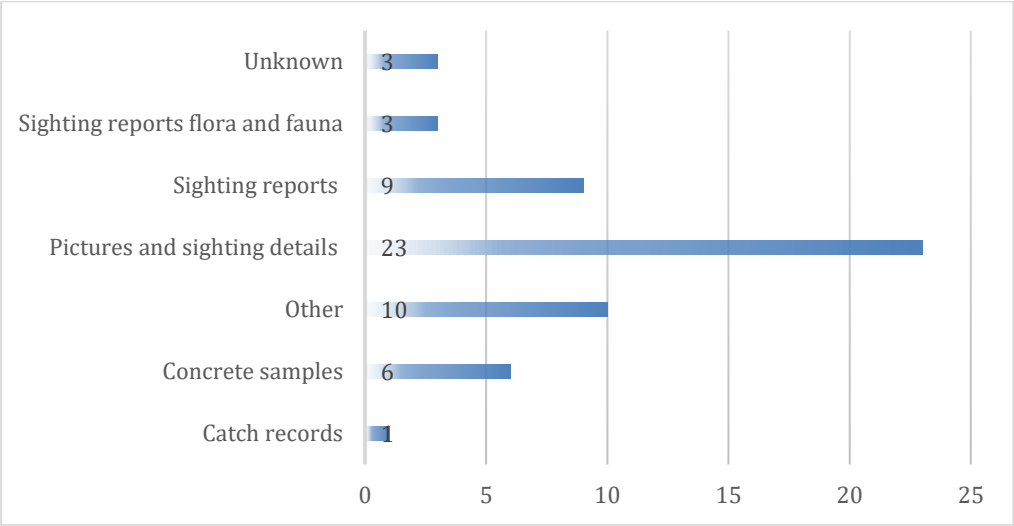

Figure 8: Methods of data collection

The most common variable in this category was 'Pictures and sighting details' with 23 projects, followed by 'Sighting reports' with 9 projects. The category 'How was the data sent to the project lead' assessed whether citizen scientists sent the data via mobile phone application, web portal, phone, email, post, other or unknown, with 'Web portal' with 26 projects taking the lead.

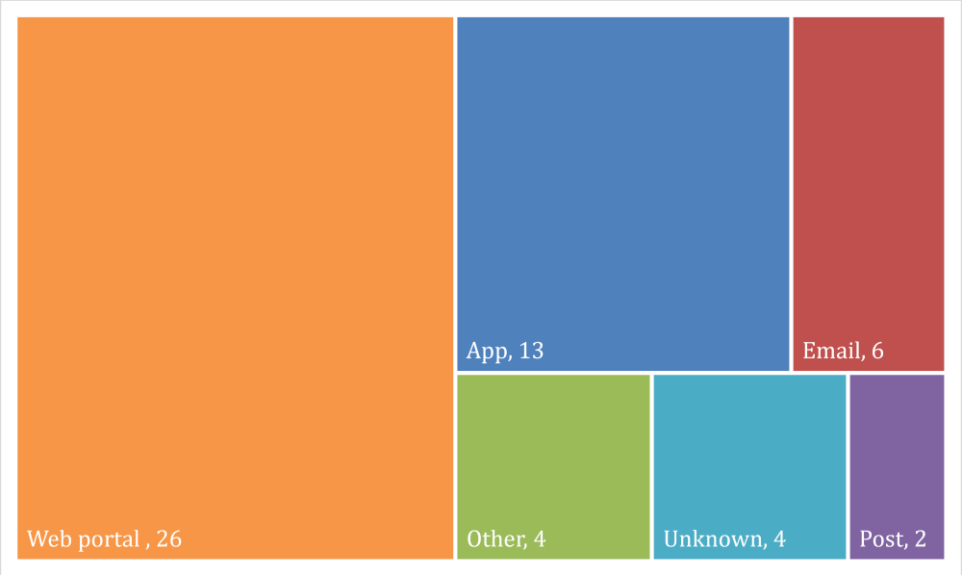

Figure 9: Ways of sending data

This study thus also considers the way in which volunteer citizen scientists had sent their data and information to the researchers, as it may be concluded that with the advent of the digital age, Citizen Science projects have increased enormously due to the widespread use of web portals and phone apps. Of the 55 identified projects, 39 projects used either a web portal or a mobile phone app to allow citizen scientists to send their data to researchers. This may indicate that using the Internet and appropriate technologies such as mobile phone applications, could be a key success factor for future Marine Citizen Science projects (Andrews 2019; (Science Europe, 2018).

Who is organising Baltic Marine Citizen Science projects?

As introduced in Figure 4, most of the identified projects take place in Finland and in Sweden. This very well may be attributed to two aspects: namely that the institutions that organise many of these projects are institutions with a longstanding history in marine research as well as with the engagement of the general public. In addition, the information was often available online through dedicated webpages. For the projects in Finland, the Project leads included very often the Finnish Environment Institute SYKE as well as the Natural Resources Institute LUKE. For the Swedish projects, the Project lead was often a university, such as the University of Gothenburg or the University of Uppsala, or a public authority on different levels, such as the national Swedish Maritime Administration or the local Stockholm County Administration.

Figure 7 highlights roughly the type of Project Leads for the identified Baltic Marine Citizen Science projects. The most common Project Lead is the category University/Education Institute with 19 projects, which supports the finding of the study that most projects are focused on Crowdsourcing and Participatory research, as it may be assumed that at least to a certain degree, universities and other educational institutes see it as a prime objective not only to engage citizen scientists to gather more input data for research, but also especially to include an element of education in their Citizen Science projects.

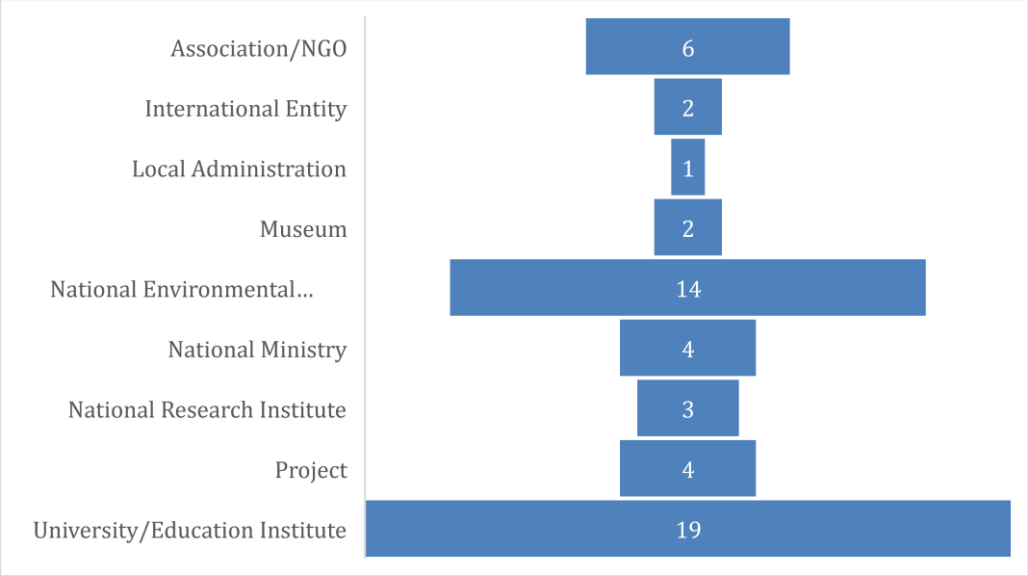

Figure 10: Types of Project Leads

What do organisations aim for?

In order to assess the value of the contributions of the citizen scientists to the identified projects and the degree to which their input was crucial to the overall aim of the projects, the categories 'Level of participation' and 'Role of sustainability' were included in the study.

In the category 'Role of sustainability', 25 projects were categorised with the variable 'Descriptive'. This indicates that for almost half of the identified Baltic Marine Citizen Science projects, the support from volunteer citizen scientists was asked to the extent where their input was collected without a clear purpose for using it, at the time of collection. However, these projects were still included in the study, as the aim of the project adhered to the criteria agreed upon regarding what should be considered a marine Citizen Science project. This means that for instance citizens were asked to contribute their monitoring data or general observations, with the aim of integrating these into proper research at a later stage.

According to a recent article (Garcia-Soto, Carlos et al., 2021), Citizen Science projects can often have a real influence on local policies. In the Baltic study, those projects that could be classified as 'Composite', totaled to a number of seven. This is referring to those projects that empower communities 'by involving them in research that can be used to drive forward policy changes' (Martin V., 2016).

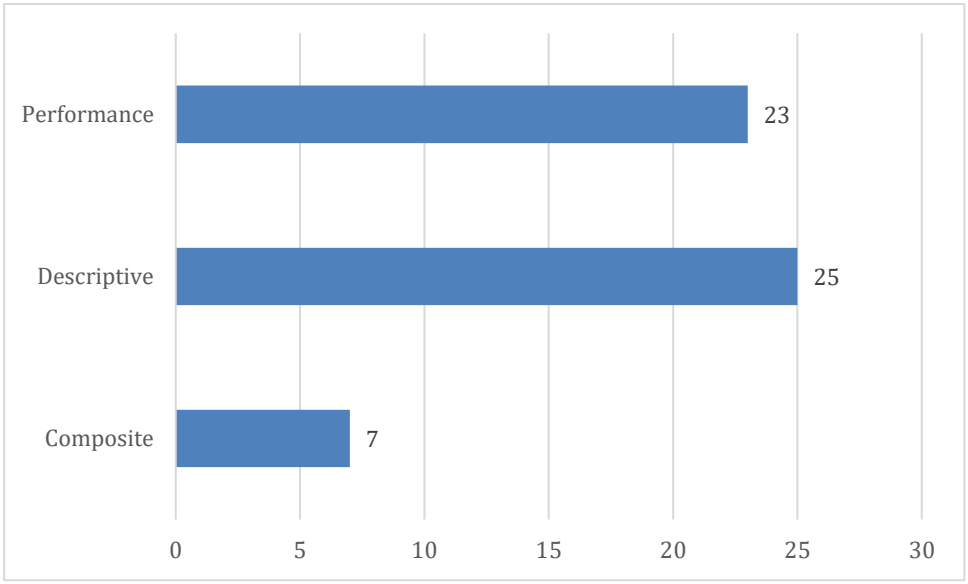

Figure 11: Role of sustainability

As was to be expected, the variable 'Crowdsourcing' meaning that citizen scientists did not need to have any initial knowledge for data collection, were the most numerous under the category 'Level of participation', with 34 projects. As was perhaps to be expected, none of the identified projects could be categorized as 'Extreme Citizen Science'. However, this needn't mean that it will not happen in the future. (Science Europe, 2018). There were only six projects identified that could be categorised under 'Participatory Science'. This can be explained by the fact that is often the limit of many people's participation in a Citizen Science project. However, encouraging participating citizen scientists to take an active role in the design and implementation of a project could increase feelings of ownership (John A. Cigliano, 2015).

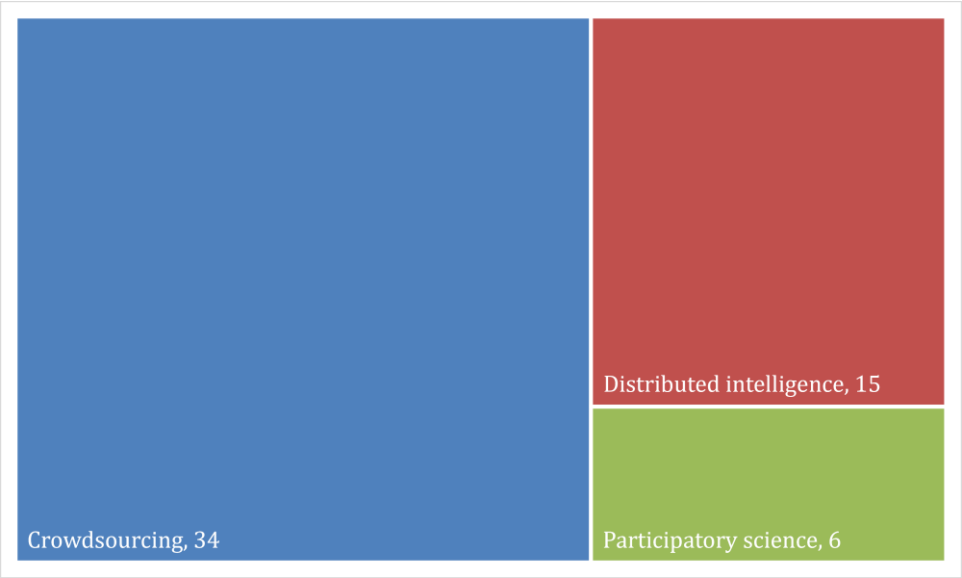

Figure 12: Level of participation

Continuity of Baltic Marine Citizen Science projects

As 41 projects that were identified were still on-going, and two could be identified that are in fact upcoming, this bodes well for the future of Marine Citizen Science projects in the Baltic Sea Region, considering also that for 32 identified projects, more than 100 volunteer citizen scientists joined the project with active contributions.

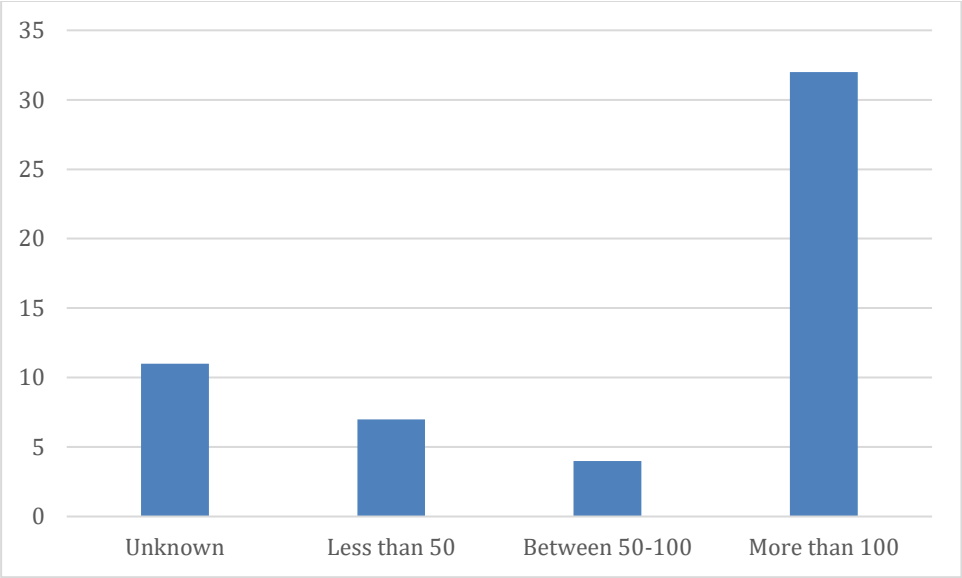

Figure 13: Number of participants

Another aspect that underlines the potential positive continuity of Marine Citizen Science projects in the Baltic Sea Region, is the fact that for 31 projects, the data set is available online to external parties.

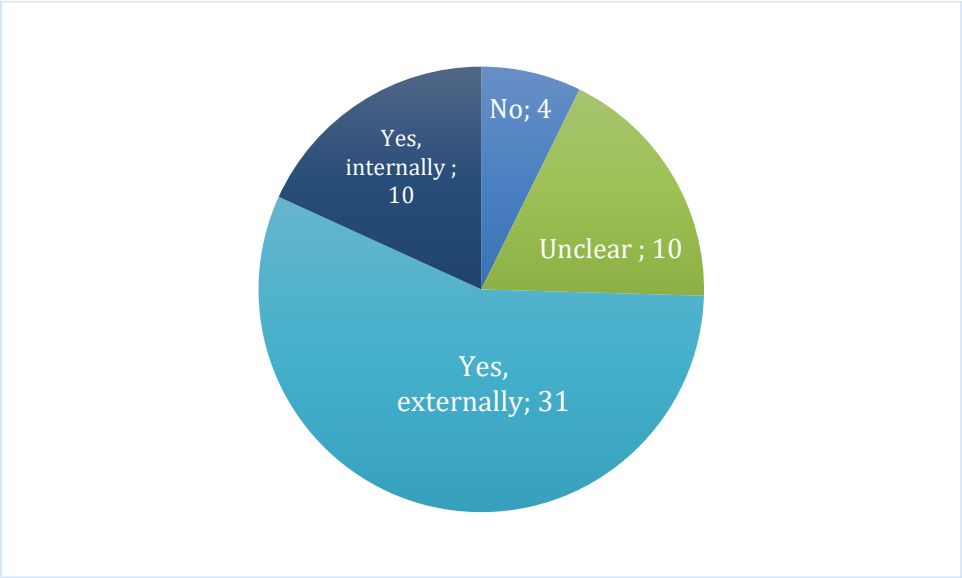

Figure 14: Database available or not

In addition, a relevant category to be considered may be 'How was the project funded', as 26 projects represented the variable 'National funding', meaning that the continuity of Baltic Marine Citizen Science projects may depend heavily on the national support for such initiatives.

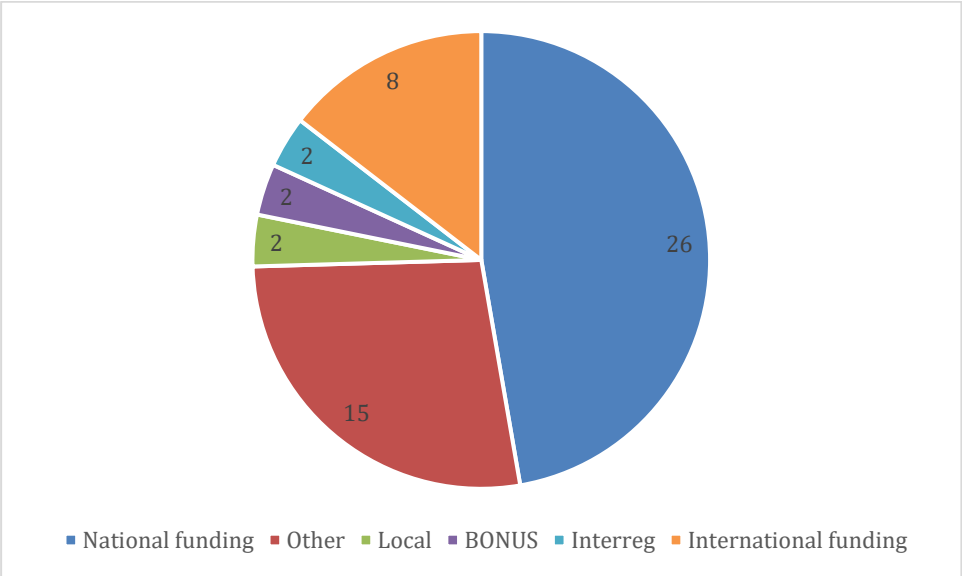

Figure 15: Project funding source

Discussion and recommendations

Perhaps the most interesting categories considered in the study were 'Participant feedback', 'Lessons learned' and 'Other comments'. Many of the respondents included under 'What is/was the aim of the project' aspects such as increasing ocean literacy, education and awareness-raising, providing information to political decision-makers and promoting dialogue between citizens, scientists, policy-makers and other stakeholder groups. In addition, the aims of many of the identified projects included aspects such as documentation, monitoring and forecasting, contributing data for the development of AI-supported prediction tools, and even developing warning systems (related specifically to marine litter and algae blooms). Project aims also included the development of strategies, ecosystem service assessments, studying so-called 'indicator species', assessment of invasive species as well as collecting input to assess current and future impacts of climate change. For many of the projects, the feedback from the participating citizen scientists was positive, and many projects also explicitly sought the feedback from participants, either through an online survey or a discussion forum.

Some of the projects encouraged citizen scientists to set up their own monitoring stations and systems, as well as in some cases even their own 'sub-projects'. Quality assurance of the contributed data and information by citizen scientists was explicitly addressed in some of the projects, while for others there was no mention of such a protocol being in place. The issue of privacy was also quite different between the projects, with some of the projects explicitly emphasising the anonymity of contributions, while others explicitly informed participating scientists that their data (and in some cases even their names and affiliations) would be available publicly.

In addition, the instructions for citizen scientists to participate in the identified projects were not always as clear: whereas some projects developed concise guidance materials, other projects simply included a limited form entry on their website with no further guidance, limitations, or definitions. The Finland Environment Administration published a dedicated webpage with regard to Guidelines on data protection and sharing, which is available here. In addition, they published a dedicated webpage on the topic of 'Campaign for quality control of citizens' perceptions', which is available here. This could be considered good practice for future Marine Citizen Science projects in the future.

Algal Blooms Sweden is an on-going Marine Citizen Science project and information platform in Sweden that started in 2020, led by the Stockholm County Administrative Board together with Ocean Data Factory. The focus of the project is on algal blooms: the mass presence of cyanobacteria, which can be found in lakes, seas, soil and in symbiosis with plants. The aim is to engage the general public to help survey and forecast harmful algal blooms and to develop an AI-based tool to predict these recurring events and that will assess how different types of toxic algae are affected by climate change and that will provide local forecasts for where along the east coast the algae are blooming right now. The database consists of many sighting reports and is externally available here: https://www.gu.se/node/59249

Figure 16: Highlight of the Algal Blooms Sweden Marine Citizen Science project

The authors decided to include the category 'Lessons learned' in the questionnaire, with the aim of encouraging respondents to consider the potential legacy and transferability of their project, so that it may contribute to the stimulation of further Baltic Marine Citizen Science projects in the future. Although this category could not be filled in for many of the projects, it still delivered some interesting results. For example, in some of the projects it was explicitly mentioned that language was a barrier, as well as there being issues with the more technical aspects of submitting data by volunteer citizen scientists. Most notably, for many of the projects it was stressed that Citizen Science volunteers should be made aware of the quality assurance protocols (if available) and to encourage them to correctly follow classification protocols, in order to ensure validity and consistency of the collected data and information. Quite often it seemed a challenge to engage users to follow such guidelines and to motivate them to collect and submit data and information both correctly as well as systematically. Some of the ways in which this was encouraged included for instance the use of existing apps, developing clear instruction manuals as well as (video) tutorials. For the project 'ClimateScan', an article was even published in the online journal *Land*, presenting the 'Potentials and Pitfalls of Mapping Nature-Based Solutions with the Online Citizen Science Platform ClimateScan'.

The analysis of the identified Baltic Marine Citizen Science projects has shown that there are in fact numerous projects either on-going, or recently finalised. Of course, there is no baseline figure to which to compare the number of 55 identified projects to, but there are many indicators that Marine Citizen Science projects are very much prolific in the Baltic Sea Region. Numerous research projects on the European scale as well as beyond are currently on-going or are being planned, focusing on aspects of marine research such as harmful algal blooms, marine litter and other pollution, as well as for example climate change. As this study has shown, the involvement of citizen scientists in such research can be a highly valuable addition. This should also be considered in light of wider supra-European endeavours, such as the United Nations Decade of Ocean Science for Sustainable Development, which indicates that not only *more* marine research is needed and that stakeholders need to become *more* engaged in research, but also especially foresees a greater role for Marine Citizen Science projects in the future. In this light, the Baltic Sea Region should continue to act as forerunner. The authors hope that the report and the study on which it is based, will prove a fruitful resource for those that are keen to start their own Marine Citizen Science projects in the Baltic Sea Region, and that the lessons learned may be taken on board.

Bibliography

Garcia-Soto, Carlos et al. (2021). Marine Citizen Science: Current State in Europe and New Technological Developments. *Frontiers in Marine Science*, 241.

van Hee, F. S. (2020). *Policy Informing Brief: Marine Citizen Science in the North Sea area - and what policy makers can learn from it.* . Oostende: VLIZ Beleidsinformerende nota's BIN 2020_007.

Science Europe. (2018). *Science Europe Briefing Paper on Citizen Science.*

Dean AJ, e. a. (2018). How do Marine and Coastal Citizen Science Experiences Foster Environmental Engagement? *Journal of Environmental Management.*

John A. Cigliano, R. M. (2015). Making marine and coastal citizen science matter. *Ocean & Coastal Management*, 77-87.

Silvertown, J. (2009). A new dawn for citizen science. *Trends in Ecology & Evolution*, 467-471.

Shum B., A. S. (2012). Towards a global participatory platform Democratising open data, complexity science and collective intelligence. . *European Physical Journal* .

Haklay, M. (2013). Citizen Science and Volunteered Geographic Information: Overview and Typology of Participation. In S. E. D. Sui, *Crowdsourcing Geographic Knowledge* (pp. 105-122). Dordrecht: Springer.

Lehtonen M., S. L. (2016). The multiple roles of sustainability indicators in informational governance: between intended use and inanticipated inlfuence. Current opinion in environmental sustainability.

Martin V., S. L. (2016). Citizens as Scientists: What influences public contributions to marine research? *Science Communication*, 495-522.

Annexes

Annex I : Questionnaire Template
Annex II: Overview of identified relevant Baltic Marine Citizen Science projects
Annex III: Overview of directly targeted Stakeholders