Abstract

Anthropogenic litter and plastics in particular pose a huge threat to marine ecosystems around the world. The environmental issue of marine plastics is interdisciplinary as it not only negatively affects the environment and its inhabitants, but also human health and economies. Marine litter removal technologies and approaches from different sectors have been developed and implemented. Due to the large spatial and temporal dimensions of this problem citizen science approaches could be the solution to mitigate the plastic pollution. The Dive Against Debris initiative is encouraging recreational and professional divers to participate in underwater clean-ups and contributing their findings to a global database. The Seabin Project developed a device that removes floating litter in marinas. Besides the product the organization puts a high focus on involving people from the public in their research project. By implementing the Share Programme, they offer the opportunity of a citizen science project that collects data on microplastics. By evaluating these two approaches factors that determine the success or failure of citizen science projects were identified. The results show that approaching a large-scale environmental problem such as the marine plastic pollution can happen most efficiently by involving citizen scientists in the data collection and research process. Volunteers benefit from learning about ecological processes and science benefits from cheap labour and an extensive database.
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Lynn Jula Kessler
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1 Introduction

1.1 Problem Statement

Anthropogenic litter poses major threats to the environment as it can be found all over coastal and marine ecosystems (Pham et al., 2014). Originating mainly from terrestrial, land-borne sources (Oosterhuis, Papyrakis, & Boteler, 2014) litter ends up in our oceans and becomes so called marine litter which is defined as “[...] any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine or coastal environment” (Pham et al., 2014, p. 1). This problem has gradually increased since the 1950’s. This period marks the time when the production of plastic products started (Barnes, Galgani, Thompson, & Barlaz, 2009). Over the past few decades the production and demand for plastic products has radically increased. In 2011 it 280 million tonnes of plastics have been produced (Gall & Thompson, 2015).

Litter entering marine environments constitutes a global issue as approximately 6,4 million tonnes of debris are entering the oceans each year (Pham et al., 2014). Especially plastic debris marks a major concern for environmentalists and policymakers worldwide. Studies have found that the composition of marine litter is quite diverse but consisting to a vast majority of plastics (Pham et al., 2014).

Characteristics of plastics include persistency in the environment and its sheer abundancy, with increasingly more plastics entering the oceans on a daily basis. Macro- as well as microplastics pose an immense threat not only to marine and coastal habitats and species but also to human health. Entanglement and ingestion of microplastics are the main two threats marine species are facing. This also jeopardise human health as microplastic-infested seafood is impossible to avoid (Gall & Thompson, 2015).

Plastics do not only damage ecosystems and their inhabitants but also destroy the aesthetic value of beaches and shorelines. This, in turn, can lead to a decrease in tourism followed by economic losses (Gall & Thompson, 2015).

Approaches from various research fields have been underway for decades now, trying to tackle the issue of marine debris. It is noteworthy that most approaches are focussing on the prevention rather than the collection of the debris that is already in the oceans. One example for a preventive policy is the Honolulu Strategy which aims at the prevention and management of marine litter (Xanthos & Walker, 2017a).

While preventive approaches are necessary and relevant, the amount of debris that already
accumulated in marine ecosystems needs to be removed in order to avoid further pollution of macro- and microplastics.

The Horizon 2020 project CLAIM is concentrating on new approaches that aim at cleaning plastics from marine and coastal environments in the Mediterranean and Baltic Sea. Set up only recently the project comprises of stakeholders from 14 European countries (CLAIM, 2017).

It is shown that the highest accumulation of marine debris is found in the Northern hemisphere. This is due to higher population densities along the coastlines, higher demand in plastic products, and currents that carry debris over miles to these areas (Barnes et al., 2009). The demand for innovative technologies to remove marine litter certainly exists in these regions and therefore deserves further research and investigation.

Besides new technologies and preventive policies, voluntary schemes become increasingly more present within the field of marine conservation. These approaches aim at gathering data on environmental issues by getting citizens involved in the collection process. Citizen scientists are contributing to projects concerning climate change, conservation, invasive species, and monitoring of populations and other ecological processes (Silvertown, 2009).

While these voluntary activities are already widely implemented in terrestrial projects (Hochachka et al., 2012), marine and coastal projects are only beginning to take advantage of having citizen scientists contributing to the data collection process.

Seeing, that the environmental issue of marine litter is a global one that affects stakeholders from environmental, economic, and social sectors, the use of citizens to collect data would be a sensible step. Monitoring the distribution and composition of marine debris is a large-scale project that requires a great number of contributors to a global database. Many authors claim that especially conservation projects can benefit from involving citizen scientists in the research to address spatiotemporal dimensions (Burgess et al., 2017).

Large-scale environmental science such as monitoring the marine debris issue can thus greatly benefit from citizen science as a support tool (Silvertown, 2009).

The purpose of this research project is to gain insight into the concept of citizen science. By defining relevant factors that determine the success or failure of such voluntary activities, existing gaps can be discovered and improved.

Two approaches were chosen to be evaluated in particular: (1) the Dive Against Debris initiative, which is a global network for scuba divers to enter data about litter they found on their dives, and (2)
the Seabin Project which has a high focus on awareness campaigns and involving people from the public in scientific data collection.

1.2 **Objective of the study**

Having voluntary schemes in place to collect useful data about an environmental issue has become increasingly more popular, especially within large-scale terrestrial research projects such as the Earthwatch programme in which volunteers pay for the privilege to be involved in field research (Silvertown, 2009). Asking tourists to collect information about birds, mammals, or plants has proven to be quite useful for scientific researches.

Expanding this concept to marine and coastal environments can help to create a sufficient and detailed database that environmentalists, scientists, and policymakers can fall back on when it comes to decision-making processes and further research.

Evaluating two specific approaches that focus on including people from the public into data collection and research processes helps to identify the factors that can determine success or failure of such approaches. Furthermore, it can help to identify possible gaps and recommendations for improvement to increase the effectiveness of environmental voluntary schemes.

1.3 **Research question and sub-questions**

**Main research question:**
How can citizen science approaches effectively contribute to mitigating the issue of marine litter pollution?

**Sub-questions:**

1. What are the factors that contribute to the effectiveness of citizen science projects?
2. What are the success and failure factors of the Dive Against Debris initiative?
3. What are the success and failure factors of the Seabin Projects’ awareness campaigns?

1.4 **Structure of the report**

This report provides some contextual background about the environmental issue of marine plastic pollution. Furthermore, already existing marine litter removal technologies briefly described.
The concept of citizen science projects is introduced in the next paragraph, followed by possible factors that potentially determine the success or failure of such approaches.

The conceptual framework section introduces the framework of this research project. The main concepts of this research problem will be outlined, namely: the concepts of citizen science, the *Dive Against Debris* initiative, and the *Seabin Project*. Additionally, relevant stakeholders are being identified.

The methodology part provides an overview and descriptions of the methods used for the data collection and analysis processes. The methods being described are:

- Literature review,
- Internet-based survey,
- Expert interviews, and
- SWOT analysis

The data collected is presented in the results section of this report, which comprises of the SWOT analyses for both the *Dive Against Debris* initiative and the *Seabin Project*. Strengths, weaknesses, opportunities, and threats are being determined.

The discussion part contains the interpretation of the results and the significant findings. Limitations to this research project are presented in this section as well.

The conclusion sums up main findings by answering the research question and sub-questions. Recommendations for further research and concluding remarks are given.

References to the literature used, as well as the results from the internet-based survey, interview guides, and transcriptions of interviews can be reviewed at the end of this report.
2 Theoretical background

2.1 Introduction

The following paragraphs provide an overview of the relevant literature concerning marine litter pollution and already existing technologies and approaches that aim at fighting this environmental issue.

Existing literature about the success and failures of environmental voluntary schemes are covered in the last section of this chapter.

2.2 Marine litter as a global threat

Marine debris and marine plastics have been the focus of scientific papers for a couple of decades. Listing all existing literature would exceed the constraints of this research project. Therefore, only the most relevant and suitable papers, articles and case studies have been consulted. However, the general consensus is that marine debris “[...] is listed among the major perceived threats to biodiversity, and is cause for particular concern due to its abundance, durability and persistence in the marine environment.” (Gall & Thompson, 2015, p. 170).

According to existing literature, plastic litter holds the major share in the composition of marine debris. The fact that this issue does not only affect stakeholders from environmental institutions but from all kinds of fields has been widely recognized.

Xanthos and Walker (2017) state that the marine plastic pollution is affecting governmental sectors, non-governmental organizations, and people from the public all over the world.

Overall findings are that most marine litter is land-borne with the majority of it being plastics and only a minor share being discarded fishing equipment (Ramirez-Llodra, de Mol, Company, Coll, & Sardà, 2013). It is estimated that plastic debris accounts for 60 to 80% of marine debris (Xanthos & Walker, 2017).

Accumulation of litter is highest in areas of river mouths, coastal zones that are highly inhabited and/or popular tourism destinations, and highly frequented shipping routes (Ramirez-Llodra et al., 2013).

Scholars from various fields and geographical areas agree that “[...] marine debris does not belong, nor does it need to be in the marine environment” (Gall & Thompson, 2015).
The need for interdisciplinary approaches has been recognized and a variety of approaches have been implemented.

### 2.3 Existing technologies and approaches

Within the existing technologies one can find certain distinctions in the way the issue is being approached. Firstly, there is the difference between preventive and non-preventive technologies and approaches. These two categories are further divided into economic instruments, policy instruments, monitoring activities, and technological innovations. The following paragraph summarizes these solutions and gives some examples for each category.

Oosterhuis et al. (2014) conducted an evaluation of market-based instruments. The geographic scope for their research included the North Sea and the Baltic sea; they did however, also look at approaches outside these areas. They conclude that “economic instruments do not prescribe the use of certain technologies or adoption of specific standards nor do they dictate that all firms or consumers reduce their marine litter by a prescribed amount” (p. 49). Economic approaches rather provide (dis)incentives which may help companies and consumers for a more flexible and sustainable approach in waste management (Oosterhuis et al., 2014).

Marine plastics are considered a challenge for economies and local communities as they need immediate intervention and clean-up strategies. Oosterhuis et al. (2014) seem rather optimistic about economic instruments being efficient to reduce the amount of marine litter. They mainly refer to deposit-refund schemes and a ban on plastic bags.

Economic and policy instruments are somewhat linked and overlap. Xanthos and Walker (2017) examined the efficiency of such policy instruments using the example of the ban on plastic bags. They realized that immediate action from a governmental level is necessary to tackle the problem of increased plastic amounts swamping the oceans. They furthermore acknowledge that the simple existence of plastics in marine ecosystems slows down economic development (Xanthos & Walker, 2017). Aesthetic values decrease due to plastics washing up on shorelines and beaches, which has a negative impact on the tourism sector. Floating debris causes damages to shipping vessels which in turn reduce tourism activities and cause a decrease in tourism revenues. Fishing and aquaculture activities also suffer from a high amount of marine debris. On the environmental side the increase in plastics can lead to damages in marine and coastal environments as well as a wider distribution of invasive species. Public health can suffer from the increase in marine debris due to all of the facts mentioned above (Xanthos & Walker, 2017).
Monitoring activities are another common approach. Literature distinguishes between monitoring programmes that survey and record marine debris, and monitoring programmes that look at indicator species.

The former approach collects data on stranded or floating marine litter to categorize it and to find out more about their composition and distribution. A two-part multi-criteria analysis of beach monitoring programmes in the North Atlantic and North Sea has been conducted (Schulz, Neumann, Fleet, & Matthies, 2013). The framework of the OSPAR was evaluated for monitoring programmes.

The data collected during these monitoring activities is used to help identify spatial and temporal trends of marine litter. “Examination of existing monitoring data of marine compartments, such as OSPAR beach litter monitoring data, is a prerequisite to define the good environmental status (GES) of marine waters and to identify indicators in the achievement of GES” (Schulz et al., 2013, p. 61).

The monitoring of indicator species that are in direct contact with marine debris is another widely applied approach. Matiddi et al. (2017), for example, looked at Loggerhead sea turtles, a species which can also be found in the Mediterranean Sea. They combined their research with policy instruments like the Marine Strategy Framework Directive drafted in 2008 by the European Commission. This directive aims at achieving GES “[…] and the loggerhead sea turtle (Caretta caretta) was selected for monitoring the amount and composition of litter ingested by marine animals” (Matiddi et al., 2017, p.199).

Technological innovations to collect and transform collected debris are becoming increasingly more popular and easier to implement. Examples include the Beat the Bag project which focusses on using recycled materials to produce reusable shopping bags, decreasing the use of single-use plastic bags. They provide social employment and are saving valuable raw materials from being wasted in an incinerator (‘Beat The Bag’, 2018).

The Trash Wheel Project from Baltimore is another example of removing marine litter by applying technological innovations. The wheel is using the rivers’ current to turn and remove waste from the harbour. In case the current is not strong enough for the wheel to turn, a solar panel provides the Trash Wheel with energy. The goal of this project is to make the harbour area swimmable and fishable by 2020 (‘Trash Wheel Project’, 2018). This technology has not yet been replicated in other areas.

The CLAIM project is looking at four categories of marine litter removal technologies: 1) Litter collection technologies, 2) litter transformation technologies, 3) innovations installed at wastewater treatment plants, and 4) marine litter monitoring approaches.
The monitoring technology introduced by CLAIM is a technical addition to the Ferry Box. This not yet fully developed technology is supposed to monitor the distribution of microplastics (‘CLAIM’, n.d.).

2.4 Effectiveness of environmental voluntary schemes

The concept of citizen science is as old, if not older, as science itself (Silvertown, 2009). Nowadays citizen science describes the concept of “[...] identifying ecological patterns across broad spatial and temporal extents” (Hochachka et al., 2012, p. 130). The field of citizen science gets burgeoning attention and importance from numerous research fields: During the annual meeting of the Ecological Society of America in 2008, 60 scientific papers alone mentioned the subject of citizen science (Silvertown, 2009). Furthermore, a peer-reviewed journal for citizen science researchers and practitioners was launched in 2016 (Citizen Science: Theory and Practice) (Ellwood, Crimmins, & Miller-Rushing, 2017).

Silvertown (2009) identifies three factors responsible for the explosive increase in the use of citizen science as a scientific tool: (1) technical tools are easily accessible, such as the internet, (2) professional scientists start realising that making use of the public offers a “free source of labour, skills, computational power and even finance”, and (3) project-related outreach leads to public accountability, meaning that people gain a better understanding and appreciation of where their tax money is being spent (Silvertown, 2009, p. 467).

The subject of citizen science caught attention on regional, national, and even global scales: government agencies, as well as universities started to adopt citizen science as an official scientific tool (Ellwood et al., 2017, p. 1).

Involving people from the public into the process of data gathering bears a lot of advantages as well as challenges.

Advantages include the potential of increasing the capacity and efficiency with which environmental activities, such as conservation efforts, can be conducted. “Research taking place at the intersection of conservation and citizen science holds great potential for advancing both fields as well as for addressing grand challenges in the field of conservation” (Ellwood et al., 2017, p. 1).

Especially large-scale projects profit immensely from citizen science approaches. Some scientific projects would not be possible without volunteers contributing to databases or helping out in the field (Ellwood et al., 2017).

Even with the technical innovations available to use for the data gathering process it is proven that only humans are able to reliably observe and identify species (Hochachka et al., 2012).
Although, a citizen science approach has a lot of advantages and potential, the challenges attached to it should not be underestimated. A lot of volunteers involved in the data collection means a lot of data that needs to be managed properly. This requires the planning of efficient data-management as well as applying sufficient methods that are simple enough to be followed by citizens and maintain their motivation to continue at the same time (Hochachka et al., 2012; Silvertown, 2009). The data collected needs to be controlled and validated on a regular basis (Silvertown, 2009). This is to avoid “observational biases” which are likely to happen with a huge variety of volunteers (Hochachka et al., 2012, p. 130).

There should be some way of rewarding people for participating in citizen science. Feedback on their contribution and how it is used within the research is very important in that aspect (Silvertown, 2009).

Even though citizen science has been recognized as a useful scientific tool, especially for large-scale research projects, many scientists still struggle with implementing it. To some researchers citizen science approaches still seem to slow down the scientific process as they only see them as ways of “[...] educating the public or monitoring the environment” (Silvertown, 2009, p. 470). On the other hand, a huge percentage of scientists work with volunteers on projects that have been especially designed for amateurs to participate in.

If a citizen science project is well designed the volunteers benefit from gaining education and the project is benefitting from having volunteers contributing to it (Silvertown, 2009).

A more conceptual description of citizen science can be found in section 3.3.

2.5 Conclusions

The literature review reveals that the issue of marine debris is a globally recognized environmental problem. Governments, environmental organizations and stakeholders from numerous fields know of the threat. Not only the environment and its inhabitants, but also human welfare is affected by microscopic pieces of plastic that can easily be ingested.

Approaches to tackle the problem are being developed and implemented. However, there is still space for further research. Approaches that might work in some areas may not be applicable to other areas. A constant development and improvement of existing technologies and approaches is necessary to continue the fight against marine debris and in particular marine plastics.

A citizen science approach seems promising in terms of its potential to collect data for large-scale projects that require a huge dataset. Seeing that the distribution of marine debris poses a global
environmental threat that affects all marine environments, the spatial dimension of this environmental problem is immense. The long lifespan of marine plastics adds a second dimension to the issue. Both spatial and temporal dimensions need to be supported with sufficient data. The quantity required for this project can hardly be collected by only a selected few.

Citizen science research projects in terrestrial fields have proven that with the right method and a well-structured project design, people from the public can assist in the data collection process. Both parties involved, scientists and volunteers, can benefit from this citizen science approach.

3 Conceptual Framework

3.1 Introduction

This chapter introduces the main concepts that guided through the process of finding answers to the research question and sub-questions. First, the conceptual framework is shown and explained. Following, the individual concepts are described in more detail and relevant definitions are given.

3.2 Conceptual framework

To identify factors that determine the success or failure of marine litter removal technologies, certain concepts need to be used. Figure 1 provides an overview of the concepts used and their relation to one another.

Looking at the broad field of marine litter removal technologies allows for a base from which to narrow down the scope. Monitoring approaches and activities are a popular tool in marine litter removal technologies and lead directly to the inclusion of citizen science. Using the Dive Against Debris initiative and the Seabin Project as examples shows the reasonably broad spectrum on which citizen science approaches can work. After analysing the two technologies, the results can be used once more to reflect on citizen science as a potential solution to the marine debris issue. The results and findings then can be applied to the broader picture of citizen science projects in general.
3.3 Citizen science

Paragraph 2.4 describes factors that influence the success or failure of already existing citizen science approaches. This paragraph is looking at the concept of citizen science and how it suits into to the goal of gathering data about marine debris.

As mentioned before citizen science projects offer great potential in their ability to contribute to research and the education of their participants at the same time, creating environmental awareness (Ellwood et al., 2017).
Citizen science is an already widespread tool used in mainly terrestrial research projects such as the monitoring of ecological processes to create extensive databases (Hochachka et al., 2012). Citizen science projects allow volunteers to participate in “scientific endeavours” (Hochachka et al., 2012, p. 130). Applying the same principles to marine environments can work if some principles are being followed.

One of the major challenges citizen science projects are facing is how to keep volunteers motivated. To allow meaningful scientific outcomes, the projects need to be designed well enough for volunteers to adapt to it (Ellwood et al., 2017, p. 2).

Individuals tend to show different motivations to participate in citizen science projects. Ellwood et al. (2017) define three different incentives: (1) motivation to expand their education, (2) motivation to enact change, and (3) motivation to support popular organizations. Knowing that there are different factors that drive people from the public to participate in citizen science projects is useful in developing the methods.

The design of such projects need to follow a good balance between data quality and data quantity. Quantity of data is especially important for large-scale projects which need sufficient information over a broad spatial and temporal dimension. Quality on the other hand forces the design of the project to keep the possibility of incorrect data entry to an absolute minimum. Using the appropriate software and technical tools that suit each project the best is essential for a successful citizen science project (Hochachka et al., 2012).

3.4 Stakeholders involved

A stakeholder analysis helps the understanding of which stakeholders are being prioritized in terms of their involvement in decision making processes (King, Keohane, & Verba, 1994).

For the scope of this research project I have not conducted a full stakeholder analysis as part of the methodology but have used an adapted version to identify relevant stakeholders.

“A stakeholder is defined as persons or groups whose interests and activities strongly affect and are affected by the issues concerned, who have a ‘stake’ in a change, who control relevant information and resources and whose support is needed in order to implement the change” (Aligica, 2006, p. 79). Everyone involved in a decision or action and is affecting or affected by it, is a stakeholder (Freeman, 1984).

The first step of the stakeholder analysis includes the identification of the same. The stakeholder identification helps in choosing the methods needed to approach the relevant key parties (Chevalier
& Buckles, 2008). Table 1 provides an overview of the stakeholders involved from different sectors. Additional steps can be found in 0.

Categorizing individuals, groups, and organizations according to their sector helps to gain a better overview of the stakeholders involved in the problem (Table 1). Listing all stakeholders involved in the core problem – not simply the ones that were addressed for data collection – reflects the interdisciplinary complexity of the environmental issue of marine litter. For the scope of this research project however, the focus has been narrowed down to stakeholders directly linked to either the Dive Against Debris initiative or the Seabin Project.

Seeing that both the Seabin Project and the Dive Against Debris initiative are situated within the private sector category (Table 1) only stakeholders from these areas were addressed during the data collection process. Customers as well as developers/professionals were addressed to cover two perspectives on the citizen science approach.

For gathering data about the Dive Against Debris initiative, both professional divers and/or dive centre owners and recreational divers were approached to share their experiences with the citizen science programmes by the Project AWARE foundation.

End-users of the Seabin Project are representatives form yacht clubs, marinas, and docks. Developers/professionals include representatives that directly work with the Seabin Project.
### Table 1 Stakeholders involved in the problem of marine plastics

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<th>Governmental stakeholders</th>
<th>Private sector stakeholders</th>
<th>Interest groups</th>
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<th>Liminal/inarticulate stakeholders</th>
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<td>Governments</td>
<td>Dive Against Debris</td>
<td>NGOs (Mission Blue, 5 Gyres, Ocean Conservancy, NOAA)</td>
<td>Research centres &amp; institutes</td>
<td>Ecosystems affected</td>
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<td>Municipalities</td>
<td>Project AWARE</td>
<td>Consumer associations</td>
<td>Consultancies</td>
<td>Species affected (plants, coral reefs, sea mammals, fish)</td>
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<td>PADI</td>
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<td>Advisory councils</td>
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<td>Lobby groups</td>
<td>Dives centres</td>
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<td>Planning offices</td>
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<td>Dive professionals: Managers, instructors, divemasters (DMs)</td>
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<td>Dive clubs</td>
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<td>Tourism sector: Hotels, tour operators, cruise ships</td>
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<td><strong>The Seabin Project</strong></td>
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<td>(Developer, marketing, campaigning, scientific research)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yacht clubs, marinas, docks, harbours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Schools, universities involved in Seabin projects/campaigns</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.5 Dive Against Debris

The Project AWARE Foundation partnered up with the international Scuba Diving institution PADI to develop two distinctive specialty courses for recreational divers. One of these specialty courses is the Dive Against Debris programme which first launched in 2011. Since its first kick-off the website claims to already have over 50,000 divers in 114 different countries participating in the programme and contributing to the worldwide database (Project AWARE, n.d.).

Dive Against Debris advertises their initiative with the slogan “Don’t let your dives go to waste” (Project AWARE, n.d.). The whole idea behind the initiative is to get recreational divers become more aware of the environmental issue of marine debris and provide them with the skills and tools to safely remove trash during their dives.

So far Dive Against Debris is the only underwater debris data collection programme that claims itself to be a “flagship citizen-science program” (Project AWARE, n.d.). “Divers have a proud history of removing rubbish from the ocean but despite our best efforts the trash keeps piling up. In response Project AWARE created Dive Against Debris, a global survey of underwater rubbish in our ocean” (PADI, 2015, p. 5).

The information collected by citizen divers can be added to a global online database, which provides detailed information about composition, distribution, quantities, and other important facts about the items removed. Details can be reviewed by everyone on an easily accessible map online (Project AWARE, n.d.). The map provided by Project AWARE online has various tools to find out in more detail about debris composition and distribution. Figure 2 shows the map with a filter on that shows which surveys collected data on plastic.

Dive Against Debris and PADI developed a survey guide. The PDF version of the survey guide can be downloaded online for free and is available in 13 different languages. Recreational divers therefore can find out more about the programme if they are interested. Participating in the full Dive Against Debris PADI Specialty Course will cost the diver some money, depending on the location he or she is doing the course in. The paid specialty course comes with the survey kit: a mesh bag, the printed survey guide, and underwater slates to take on the dive.

The Dive Against Debris survey guide provides step-by-step instructions on how to conduct a Dive Against Debris survey dive. It explains how to choose a dive site, the collection process, safety standards, recording of data, and how to continue to take action. Furthermore, it provides the diver with information and facts about the issue of marine debris using strong visuals to support their arguments. By pointing out that 70% of marine debris cannot be found floating but at the bottom of
the ocean floor, the survey guide provides the diver with a good incentive to take action. The limits to recreational diving stop at 40 metres so obviously not all of the seabed can be covered by divers, but the survey guide is pointing out that “Only divers have the training, knowledge and skills to remove marine debris from underwater” (PADI, 2015, p. 11).

*Dive Against Debris* is showing the complexity of the issue by pointing out that not only marine environments and animals are endangered, but also human health and the economy are affected. Third parties also experience the negative impacts of plastic debris: Municipalities of coastal villages have to manage the washed-up debris even though the own council is not responsible for it (PADI, 2015).

The concept of *Dive Against Debris* is to make recreational divers more aware of the pressing issue of marine litter and encouraging them at the same time to take action and share their experiences with the online and offline community. It is important to gather data from various dive sites to have a sufficient database. “In addition, the data you report will help drive real change – changes to policies to improve waste management, changes to infrastructure so rubbish is stopped before it reaches the ocean, and changes to behaviours so we waste less and dispose of our waste with care” (PADI, 2015, p. 5).

*Figure 2 Dive Against Debris Map of collected plastic* (Project AWARE, n.d.)
3.6 The Seabin Project

In 2014 two Australian surfers, Pete Ceglinski and Andrew Turton, started the Seabin Project to contribute to the global fight against marine debris. Their idea is as simple as it is genius: “If we can have rubbish bins on land, why not have them in the ocean?” (‘The Seabin Project’, n.d.).

The V5 Seabin is a floating unit that is especially designed for the calm water conditions of marinas, yacht clubs, and docks. The device moves up and down with the tides, always staying right at sea level. A submersible water pump sucks in water from the surrounding and passes it through a catch bag and then back out of the Seabin. All floating debris in its vicinity stays inside the catch bag. The pump is capable of displacing 25,000 LPH (litre per hour) (Ceglinski & Turton, 2017). Pictures can be found in Appendix C.

The developers claim that a single Seabin can remove up to 90,000 plastic bags per year. Additionally, the Seabin is supposed to also be able to remove a percentage of oils and pollutants off the water surface. The Seabin is able to catch microplastics up to 2 mm in size within its catch bag.

On a day with good weather and sea conditions a single Seabin can remove up to 1,5 kg of floating debris (Ceglinski & Turton, 2017).

In terms of servicing and maintenance, the Seabin needs a 110/220V outlet and uses up less than 1$ per day. The catch bag inside the Seabin can hold up to 20 kg of caught materials and should be checked twice a day and emptied as needed. A thorough clean of the Seabin is necessary at least once a month and the whole technology and system should be checked regularly (Ceglinski & Turton, 2017).

The Seabin Project works with strategic placing of the devices to make use of currents, tidal movements, and wind directions as much as possible. The availability of electricity outlets is another factor when it comes to decide on “debris problem areas” in which to place the units (Ceglinski & Turton, 2017).

Marinas, ports, and yacht clubs offer the perfect conditions for the Seabin to be installed because they are protected from huge open ocean swells and storms, they provide a relatively controlled environment, and wind and currents are constantly moving the floating debris towards them (Ceglinski & Turton, 2017).

Recently, the Seabin Project developed a new addition to their fight against marine plastics: The Seabin Projects’ Share Programme. This programme is targeting organizations and institutions that follow the same goal as the Seabin Project: To reduce the amount of marine litter. The idea is that the Seabin Project provides partners with a Seabin over a trial period of 6 - 12 months. In exchange
the Seabin Share Programme partners must execute weekly data collection, sampling, and monitoring following pre-designed protocols.

Samples can be sent to Jenna Jambeck with whom the Seabin Project is collaborating. Jenna Jambeck is a renowned sea plastic pollution scientist and in charge of analysing the data. Furthermore, the partners are asked to share their experiences on various media platforms in order to raise awareness about the issue and the Share Programme (Ceglinski, 2018).

Partners of the share program get the benefit of testing the product first-hand and “[...] being involved in a research program that will enable scientists and Seabin Project to collect high quality data to advance in the fight of plastic pollution” (Ceglinski, 2018).

Two sets of data are being collected: (1) data on the functioning of the catch bag including a micro fibre pouch, and (2) data on the microplastics sampling device and how it works in numerous different locations.

The data collected can be used to scientifically analyse the amount and composition of microplastics in harbours around the world (Ceglinski, 2018).

The Seabin Projects’ Share Programme is organized as a citizen science project. This means that the participation and data collection processes are designed in a simple manner.

Once partners agree on a working relationship with The Seabin Project and a suitable marina has been chosen, the Seabin can be shipped and installed. From that point onwards, the marina is responsible for the maintenance of the Seabin (cleaning, servicing, making sure it runs smoothly).

The data collection on the other hand is the partners’ responsibility. The collection process is simple and not time-consuming but will nonetheless lead to the assortment of high quality data. Detailed protocols are provided by the Seabin Project (Ceglinski, 2018).

There is a similar separate project implemented, at the moment, that has been running for 9 months already: Participants are also collecting data on a weekly basis. The difference is that within the Share Programme the partners are all experts and professionals in ocean conservation (Ceglinski, 2018).
4 Methodology

4.1 Introduction

A mixed-method approach was chosen, in order to capture the complexities of the study and its interdisciplinary nature. Figure 3 visualizes the mixed-methods approach which consists of a literature review, internet-based surveys, and face-to-face expert interviews. This approach allows to identify the Strengths, Weaknesses, Opportunities and Threats necessary to conduct SWOT analyses for both the Dive Against Debris initiative and the Seabin Project.

![Figure 3 Visualization of methodological working-steps](image)

4.2 Literature review

A review of the relevant literature is necessary to gain an appropriate overview of the research already done on the topic.

The theoretical background of this research project consists of literature about marine debris as a global threat, preventive and non-preventive marine litter removal technologies, and the effectiveness of environmental voluntary schemes.

Via Google Scholar and the VU Library Search function, scientific articles and papers were found and reviewed. Both, the Dive Against Debris initiative and the Seabin Project, are relatively new
approaches which means additional background information about them was gathered from websites, reports, and newspaper articles.

4.3 Internet-based survey

Choosing internet-based surveys to collect data on the experiences end-users/customers made with the Seabin Project and the Dive Against Debris initiative, has numerous advantages.

Clearly, internet-based surveys are the fastest and easiest way to distribute questionnaires on a global scale (Fricker & Schonlau, 2002). Surveys are not aimed at describing individual opinions or behaviour, but to gather information about a population from a sample (Stoop & Harrison, 2012).

End-users and customers of the Seabin Project and the Dive Against Debris can be found all over the world which speaks for the use of internet-based surveys to reach as many locations as possible.

The low cost of internet-based surveys is another advantage. Compared to paper or telephone surveys, the internet-based option has little to none operation costs and is less time-consuming than the ones mentioned before (Deutskens, Ruyter, Wetzels, & Oosterveld, 2004).

Especially considering time constraints are important as the more time is spent on the data collection the less time is left for the analysis (Fricker & Schonlau, 2002).

Internet-based surveys are known as a data collection method with a relatively high response rate. Studies show that the design of an internet-based survey has quite an impact on the response rate: “[..] past research on traditional mail surveys has gathered extensive evidence on the influence of several format and design parameters on response rate and response quality” (Deutskens et al., 2004).

Survey Monkey is a web-based programme which makes the design of surveys easy and allows for numerous collection methods – via email, social media, or as a weblink.

All survey questions and answers were phrased in English.

Two surveys were developed for this research project: Survey 1 addressing divers familiar with the Dive Against Debris initiative, and Survey 2 addressing representatives of harbours, yacht clubs, and marinas that have a Seabin installed.

Both surveys used pre-defined criteria and sub-criteria as a guideline for their design (see Table 2).

Due to the interdisciplinarity of the issue of marine litter, criteria from three sectors were defined: Environmental/technical, economic/financial, and social/institutional criteria. Within each sector another five sub-criteria were defined. The survey questions were developed according to these sub-
criteria. Respondents of the survey were also asked to rank the criteria according to their personal values.

To prevent ambiguous questions, the survey was pre-tested by friends. All survey questions and answer possibilities can be reviewed in 7.3 Appendix B.

**Target groups:**

Survey 1 addressed people that either work with or participate in the *Dive Against Debris* initiative. There are three target groups to distinguish: (1) dive centre managers or owners, (2) dive professionals such as instructors or divemasters, and (3) recreational divers that participate in clean-up dives and/or did the *Dive Against Debris* PADI Specialty Course.

The survey questions are phrased differently depending on which target group the respondent falls into: Dive centre owners/managers and professionals got the same set of questions, whereas the recreational divers answered questions that are phrased differently. All questions are still based on the criteria listed in Table 2. The difference is simply in the phrasing and the perspective of the respondent.

Dive professionals are generally more experienced divers and can show a more detailed insight on how the dive industry works. Recreational divers provide more insights from a customer’s perspective.

The target group for the *Dive Against Debris* survey was approached via personal contacts from the diving industry as well as sharing the weblink to the survey on social media and in relevant Facebook groups. The snowball-effect helped to reach more respondents than the personal network provided.

Survey 2 targeted end-users of the *Seabin Project*. These include marinas, yacht clubs, harbours, and docks worldwide that have one or multiple *Seabins* installed. The survey is based on the list of relevant criteria shown in Table 2. Respondents were asked to answer the survey questions based on their personal experiences with the *Seabin*.

Only end-users of this approach were addressed with this survey. Developers of the product were easier to approach with expert interviews (see 4.4).

Potential respondents were approached via phone calls and follow-up emails that included the weblink to the survey.

**Respondents:**

The *Dive Against Debris* survey had a total of 40 respondents. 28 of which are grouped in the category “dive professionals”. They are either managing or owning a dive centre and/or are working as instructors or divemasters. The remaining 12 respondents are grouped in the category of
“recreational divers”. This means they are certified divers participating in the *Dive Against Debris* initiative but are not working in the diving industry. A total of 19 countries were represented by the respondents (Figure 4).

The *Seabin* survey had a very low response rate of only one harbour, which is in France. By conducting expert interviews the low response rate could be balanced out.

*Table 2 List of relevant criteria from environment, economic and social sectors*

<table>
<thead>
<tr>
<th>Sector</th>
<th>Criteria</th>
<th>Dive Against Debris</th>
<th>Seabin Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental/Technical</td>
<td>Sustainability</td>
<td>Energy usage</td>
<td>Energy usage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Composition of material collected</td>
<td>Composition of material collected</td>
</tr>
<tr>
<td></td>
<td>Efficiency</td>
<td>Weather conditions</td>
<td>Weather conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amount of debris capable of removing</td>
<td>Amount of debris capable of removing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Depth-reach</td>
<td>Depth-reach</td>
</tr>
<tr>
<td>Economic/Financial</td>
<td>Costs</td>
<td>Implementation costs</td>
<td>Installation costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complexity of implementing course</td>
<td>Maintenance &amp; service costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivation for clients to pay</td>
<td>Motivations for customers to install a Seabin</td>
</tr>
<tr>
<td></td>
<td>Infrastructure</td>
<td>Disturbance of boat traffic</td>
<td>Disturbance of boat traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Instructor/DM training</td>
<td>Complexity of installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recycling of collected debris</td>
<td>Recycling of collected debris</td>
</tr>
<tr>
<td>Social/Institutional</td>
<td>Raising awareness</td>
<td>Awareness campaigns</td>
<td>Awareness campaigns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Involvement of local community</td>
<td>Involvement of local community</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Global interest &amp; reach</td>
<td>Global interest &amp; reach</td>
</tr>
<tr>
<td></td>
<td>Research</td>
<td>Supporting research</td>
<td>Supporting research</td>
</tr>
<tr>
<td></td>
<td>Cultural services</td>
<td>Crowdedness of dive sites</td>
<td>Loss of aesthetic value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Willingness of citizens to participate</td>
<td>Willingness of customers to install Seabin and participate in awareness campaigns</td>
</tr>
</tbody>
</table>
4.4 Expert interviews

The internet-based surveys were an effective data collection method for gathering information about the Dive Against Debris initiative. Compared to the Seabin Project, the Dive Against Debris initiative has a relatively big target group. Due to the fact, that the Seabin Project only launched in November 2017, finding enough respondents to fill out the survey was rather difficult. In addition to the internet-based surveys expert interviews were necessary to collect sufficient data on the Seabin Project.

The stakeholder identification showed that potential partners for expert interviews can mainly be found within the private sector stakeholder group. Approaching harbours, marinas, and yacht clubs that have already installed the Seabin was the first step to initiate the process of conducting expert interviews.

The advantages of in-depth, semi-structured and face-to-face interviews are that the interviewer can react flexible to what the interviewee is responding. Nonetheless it is necessary to provide the interviewer with an interview guide to help gather the information needed. Described as “the interactional exchange of dialogue” in-depth interviews provide the possibility to have a social conversation-like situation with both the interviewer and the interviewee being flexible enough to react to certain questions. Another advantage is that the response rate during an interview is much
higher than it would be with a survey. Also, people tend to respond more honestly during an interview than in a survey (Mason, 2002).

A total of three expert interviews was conducted. One of them was to get additional data about the Dive Against Debris initiative, the other two to find out more about the Seabin Project. The interview guide was adapted according to the interview partner. It did however, follow the criteria and sub-criteria listed in Table 2. All interviews were held in English.

**Interview partners:**

**INTERVIEW 1 – Dive Against Debris, Dive professional:** Maria Jose Arroyo Gerez graduated with a MSc in Environmental Governance. She worked as site manager, volunteer liaison, and fisheries management supervisor for Operation Wallacea. She has years of experience as a dive professional and managed and owned a dive centre (Appendix C.6).

**INTERVIEW 2 – Seabin Project, research:** Sergio Ruiz-Halpern is the head of scientific research and education at the Seabin Project, based in Palma de Mallorca. His position includes the design, implementation and improvement of the educational projects and monitoring programs the Seabin Project initiated (see Appendix C.7).

**INTERVIEW 3 – Seabin Project, Installation:** Edwin van der Meulen works as an administrate assistant for installing floating scaffolding for Poralu Marine Netherlands. Poralu Marine is one of the Seabin Project’s pilot partners and has over 35 years of experience in developing long-lasting pontoons (Poralu Marine, 2018). The first Seabin in the Netherlands was installed at Marina Muiderzund in Almere. The marina is known for its sustainable business model (Marina Muiderzund, 2018) (see Appendix C.8).

### 4.5 SWOT analysis

SWOT analyses simply get their name from the characteristics they assess: Strengths, Weaknesses, Opportunities, and Threats (Bull et al., 2016).

The SWOT analysis is recognized as an analytical tool with which external and internal factors that affect a business or organization can be identified (Pickton & Wright, 1998). This tool is aiming at scanning an organizations’ environment taking into consideration external markets and competitors, as well as internal strengths and weaknesses. This process is called “environmental scanning” (Pickton & Wright, 1998, p. 102).

A major advantage of this analytical tool is its simplicity and practicality (Bull et al., 2016; Pickton & Wright, 1998). Conducting SWOT analyses helps focussing on key issues which affect an
organizations’ or businesses’ growth and development (Pickton & Wright, 1998). SWOT analyses focus on factors that contribute to either the organizations’ success or failure. By doing so, possible solutions and opportunities will show up (Bull et al., 2016).

The most basic form of a SWOT framework is a “naïve tool which may lead to strategic errors (Pickton & Wright, 1998, p. 101). To avoid the analysis being too simplistically a more detailed analysis of the characteristics under discussion is necessary.

By applying the SWOT framework to this research project, it will be possible to identify factors which determine the success or failure rate of both the *Dive Against Debris* initiative and the *Seabin Project*. The SWOT analysis highlights those factors that are most likely to determine the success or failure of an organization (Pickton & Wright, 1998).

Simplistically speaking, a SWOT analysis is a list of factors that influence a firm, organization, or group (Bull et al., 2016; Pickton & Wright, 1998). Figure 5 visualizes the individual working steps to convert the collected data into the four SWOT themes (adapted from: Bull et al., 2016).

The data derived from the internet-based surveys 1 and 2 as well as the transcribed expert interviews 1,2 and 3 are being carefully assessed focussing on key topics. The criteria list created for developing the internet-based surveys (see Table 2) helps to identify items of interest. After re-reading the responses these items of interest can be sorted into categories. Using the information derived from the data collection process helps to evaluate the meaning of each item. The responses then need to be re-examined taking the key themes (strengths, weaknesses, opportunities and threats) under consideration.

Finally, the outlines of each theme can be constructed by focussing on underlying meanings. Labels can eventually be assigned according to the SWOT themes (Bull et al., 2016).

Strengths and weaknesses appertain to factors internal to the organization, whereas opportunities and threats are external factors. Results can then be portrayed in a 2x2 matrix. This chart should give an appropriate overview of the main issues that need to be taken into account (Bull et al., 2016).
Figure 5 The analytical process performed upon responses to survey 1 & 2 and interview 1,2 & 3 to develop SWOT themes (adapted from Bull et al., 2015)
5 Results

The methodological steps described above provided sufficient data to conduct the SWOT analyses. The following paragraphs lists all the results derived from the data collected.

5.1 SWOT analysis Dive Against Debris

Table 3 shows the SWOT analysis conducted for the Dive Against Debris initiative. All data was derived from the survey responses and the expert interview. Each factor is being described according to its result in the sections below.

Table 3 SWOT analysis for Dive Against Debris

<table>
<thead>
<tr>
<th>POSITIVE</th>
<th>NEGATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERNAL</td>
<td>STRENGTHS</td>
</tr>
<tr>
<td>• Energy usage</td>
<td>• Disturbance of boat traffic</td>
</tr>
<tr>
<td>• Easy implementation of specialty course</td>
<td>• Little involvement of local communities</td>
</tr>
<tr>
<td>• Detailed and informative survey guide</td>
<td>• Additional prices customers need to pay</td>
</tr>
<tr>
<td>• Database accessible to everyone</td>
<td>• Attractiveness of specialty course</td>
</tr>
<tr>
<td>• Variety of other awareness campaigns by Project AWARE</td>
<td>• Short debriefing times limit possibility to raise awareness</td>
</tr>
<tr>
<td>EXTERNAL</td>
<td>OPPORTUNITIES</td>
</tr>
<tr>
<td>• Material collected being plastics</td>
<td>• Weather conditions &amp; strong currents</td>
</tr>
<tr>
<td>• Amount of litter capable removing during one dive</td>
<td>• Depth-reach</td>
</tr>
<tr>
<td>• Not more crowded than normal dives</td>
<td>• Collected debris not being recycled</td>
</tr>
<tr>
<td>• High potential for global interest &amp; reach</td>
<td>• Untrained divers</td>
</tr>
<tr>
<td>• Potential to motivate more divers</td>
<td>• Tendency of customers to compare to more pristine dive sites</td>
</tr>
</tbody>
</table>

5.1.1 Strengths identified for Dive Against Debris

Energy usage: Dive professionals indicated that compared to a normal dive, the energy usage of a Dive Against Debris dive is either the same (42.86%), or slightly more exertive (50%). Only 7.14% indicated that it is a lot more exertive.

The majority of the recreational divers indicated that the energy usage is the same as for a normal dive (41.67%). 8.33% said it is slightly less exertive, 25% said it is slightly more exertive, and another 25% said it is a lot more exertive than a normal dive.
**Complexity of implementing course:** Most of the dive professionals indicated that it is fairly easy to implement the *Dive Against Debris* PADI specialty course (42.86%). 14.29% said it is neutral and another 14.29% said it is fairly difficult. 28.57% did not answer the question.

25% of the recreational divers indicated that it is extremely easy to participate in the *Dive Against Debris* Specialty Course. Another 25% said it is fairly easy and 33.33% said it is neutral. 16.67% did not answer this question.

**Detailed and informative survey guide:** The guide developed especially for citizen science purposes is available for everyone online. Besides general information about debris it also provides the reader with potential risks and tips on how to avoid these.

**Database:** The database is accessible for everyone online. Every diver can log what kind of debris they found where without needing to have purchased the Specialty course.

**Awareness campaigns:** Of the professional divers 28.57% know of 3-5 other awareness campaigns by *Project AWARE*. Another 28.57% know of 2 other campaigns. 21.43% know of no other awareness campaign and 7.14% know of one other. 14.29% know of more than 5 other awareness campaigns besides the *Dive Against Debris* initiative.

50% of the recreational divers know of 1 other awareness campaigns. 16.67% know no other campaign. 8.33% know two, 16.67% know 3-5, and 8.33% know more than 5 other awareness campaigns besides *Dive Against Debris*.

The *Project AWARE* foundation offers various awareness campaigns and projects that provide tourists with the opportunity to become environmentally active. It has been noticed that diving customers are more willing to become proactive if campaigns are already organized and they just need to participate in them, such as beach clean-ups (Fehler! Verweisquelle konnte nicht gefunden werden.).

### 5.1.2 Weaknesses identified for Dive Against Debris

**Disturbance of boat traffic:** 35.71% of the dive professionals indicated that there is little disturbance of the local boat traffic due to divers. 28.57% said there is high disturbance of the local boat traffic. 21.43% said the disturbance is on a medium level whereas 14.29% indicated that there is no disturbance of the local boat traffic due to divers.

Of the recreational diver, 25% said there is little disturbance of the local boat traffic. Another 25% said there is some disturbance and 16.67% indicated they experienced high disturbance of local boat traffic. Another 16.67% indicated they experienced no disturbance. 16.67% did not answer the question.
Involvement of local community: Of the dive professionals, 42.86% indicated that they recognize little involvement of the local community in the Dive Against Debris initiative. 21.43% said that there is no involvement of the community. 14.29% said there is some, and 7.14% said there is high involvement of the local communities. 14.29% did not answer this question. 33.33% of the recreational divers said there is little involvement of the local community. Another 33.33% indicated there is some involvement. 16.67% experienced no involvement, whereas 8.33% said there is high involvement. The remaining 8.33% said there is very high involvement of the local community in the Dive Against Debris initiative.

Prices: Customers who already pay money on their dives are unlikely to spend more money on a specialty course such as Dive Against Debris. The interview with a dive professional revealed that customers are not willing to pay extra for something they can get included in the price of a normal dive. The willingness to pay a little extra to become a certified Dive Against Debris Specialty Diver is very low.

Attractiveness of specialty course: According to Fehler! Verweisquelle konnte nicht gefunden werden, this particular specialty course is not that popular among tourists. There are other specialty courses offered by PADI and Project AWARE that appear more attractive like the Fish ID specialty or the Bull Shark Diving specialty course.

Short debriefings: Debriefings are the time when recreational divers can talk about their dives. It is also the time for an instructor or divemaster to teach customers important facts about the reefs and make them aware of the problem of marine litter. In many tourism areas such as Cancun, Mexico there is very limited time available for debriefs which leads to a lower motivation for customers to get more involved (Fehler! Verweisquelle konnte nicht gefunden werden.).

5.1.3 Opportunities identified for Dive Against Debris

Material collected being plastics: 57.14% of the dive professionals indicated that 50-70% of the collected debris consists of plastic. The remaining 42.86% indicated it is 70-100%. The majority of the recreational divers (58.33%) indicated that 70-100% of the collected debris is plastic. 8.33% said it is only 0-10%, another 8.33% say it is 10-30%, and the remaining 16.67% said it is 30-50%.

Amount of debris capable of removing: 42.86% of the professional divers said that 1-2 kg of debris can be collected throughout a dive. Another 42.86% said 2-3 kg is possible. 14.29% did not answer this question.
Of the recreational divers, 16.67% indicated that they feel comfortable to remove 0-1 kg of debris. 25% said 1-2 kg, 8.33% said 2-3 kg, and 16.67% feel comfortable removing 3-4 kg of debris throughout a dive. A significant 33.33% indicated that they feel able to collect more than 4 kg of debris throughout one dive.

**Crowdedness:** Of the dive professionals 50% indicated that they experience similar crowds at *Dive Against Debris* divesites compared to normal divesites. 14.29% said there are extremely less crowds, and 7.14% said there are fairly less crowds. Only another 7.14% indicated that they experience fairly more crowds. 21.43% did not answer this question.

Of the recreational divers, 41.67% experienced similar crowds at *Dive Against Debris* divesites compared to normal divesites. 25% said there are extremely less crowds, and 8.33% said there are fairly less crowds. Another 8.33% said there are fairly more crowds and 8.33% indicated those divesites were extremely more crowded than normal divesites. 8.33% did not answer this question.

**Global interest and reach:** 50% of the dive professionals indicated that there is some global interest and reach. 35.71% said the global interest and reach of the *Dive Against Debris* initiative is high. The remaining 14.29% said there is little global interest and reach.

The majority of the recreational divers (66.67%) experienced some global interest and reach. 16.67% said there is high and 8.33% say there is little global interest and reach. 8.33% did not answer this question.

**Motivation:** 50% of the professional divers indicated that they experience some motivation amongst divers to pay for and participate in *Dive Against Debris* dives. 21.43% said there is no motivation, and 7.14% said there is little motivation. 14.29% said there is high motivation. 7.14% did not answer this question.

Amongst the recreational divers 41.67% of the respondents said there is very high motivation to participate in *Dive Against Debris* dives and contribute to the worldwide database. Another 41.67% said the motivation to do so is high. 8.33% said there is some motivation, and another 8.33% said there is little motivation.

5.1.4 **Threats identified for Dive Against Debris**

**Weather conditions:** 85.71% of the professional divers indicated that a safe *Dive Against Debris* dive can be conducted in calm seas. 78.57% said it is also safe with a slight surge being present, and 21.43% said surge and current are still safe to dive in. The remaining 7.14% responded that *Dive Against Debris* dives can safely be conducted in any weather condition.

Of the recreational divers, 75% feel safe to conduct *Dive Against Debris* dives in calm conditions and
75% feel safe with slight surge. 16,67% feel safe to dive in surge and current and 16,67% would conduct *Dive Against Debris* dives in any condition. Multiple answers were possible for this question.

The ability to remove debris safely from the reef strongly depends on the geographic location and strengths of currents. In Cozumel, Mexico the currents are so strong that there is no possibility of stopping and remove trash from the reef. Depth reach: Most of the professional divers indicated that recreational divers can collect debris mainly in a depth of 10 – 20 metres (50%). 28,57% said 20 – 30 metres, and 7,14% said 30 – 40 metres. The remaining 14,29% did not answer this question.

8,33% of the recreational divers indicated they can conduct *Dive Against Debris* dives in a depth of 0 - 5 metres. Another 8,33% said a depth of 10 – 20 metres is possible. The majority of this target group is able to dive to 20 – 30% (58,33%). The remaining 25% is able to go down to 30 – 40 metres.

**Recycling of collected debris:** 35,71% of the professional divers said that none of the collected debris is being recycled. Another 35,71% said that a bit is being recycled. 14,29% indicated that a fair amount is being recycled and only 7,14% said that a lot is being recycled. Another 7,14% did not answer this question.

Most of the recreational divers indicated that none of the collected debris is being recycled (41,67%). 25% said that a bit is being recycled. 16,67% said that a fair amount is being recycled and only 8,33% said that a lot is being recycled. Another 8,33% did not answer this question.

The expert interview supports the results above: The waste management in countries such as Mexico is not very sufficient and recycling schemes are barely implemented. Collected debris from dives are most likely to end up on landfills instead of being properly recycled.

**Untrained divers:** Divers who are not fully comfortable underwater yet need to focus on improving their abilities first before starting to remove debris from the reef. Especially in tourism areas such as Mexico many of the divers are not very experienced. Dive professionals must guarantee their clients’ safety and can therefore spend less time on collecting debris themselves.

**Tendency to compare:** Customers with more dive experience tend to compare a lot to previous dives in more pristine conditions.

**Clientele:** Dive destinations that attract mainly short-time tourists offer more courses that suits that kind of clientele. Like Discover Scuba Diving courses, which is only one dive. Tourists on holiday are likely to go on dives a fun activity but are not motivated to spend more time on participating in
environmental surveys and specialty courses. Customers often do not perceive marine litter as an environmental threat but more as a loss of aesthetic value. Furthermore, they want to experience as many attractive tourism activities as possible within their limited time (Fehler! Verweisquelle konnte nicht gefunden werden.).

**Number of dive clubs:** Tourism destinations like Mexico offer a lot of dive centres and dive shops. Those are targeting short-term tourists that either want to go on a couple of dives or want to do their course. Dive clubs on the other hand have members that spend more time in the area and are more likely to become environmentally active with initiatives such as Dive Against Debris (Fehler! Verweisquelle konnte nicht gefunden werden.).
5.2 SWOT analysis Seabin Project

For conducting the SWOT analysis data from both the internet-based survey and the expert interviews has been used. Table 4 shows the conducted SWOT analysis for the Seabin Project.

Table 4 SWOT analysis for The Seabin Project

<table>
<thead>
<tr>
<th>POSITIVE</th>
<th>NEGATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERNAL</td>
<td>STRENGTHS</td>
</tr>
<tr>
<td>• Energy usage</td>
<td>• Can only operate sufficiently in calm weather conditions</td>
</tr>
<tr>
<td>• Amount of debris capable of removing per day</td>
<td>• Only removes floating litter from the surface</td>
</tr>
<tr>
<td>• Simple installation of the Seabin</td>
<td>• Only floating-dock module available</td>
</tr>
<tr>
<td>• No disturbance of the local boat traffic</td>
<td></td>
</tr>
<tr>
<td>• Low price</td>
<td></td>
</tr>
<tr>
<td>• Simple maintenance</td>
<td></td>
</tr>
<tr>
<td>• No negative effects on the environments</td>
<td></td>
</tr>
<tr>
<td>EXTERNAL</td>
<td>OPPORTUNITIES</td>
</tr>
<tr>
<td>• 30 – 50% of material collected is plastic</td>
<td>• Fouling</td>
</tr>
<tr>
<td>• High global interest &amp; reach</td>
<td>• Customers being sceptical about product</td>
</tr>
<tr>
<td>• Numerous other awareness campaigns around the Seabin Project</td>
<td>• Waste management of location in which the Seabin is installed does not allow for proper post-collection disposal of debris</td>
</tr>
<tr>
<td>• Community outreach &amp; free activities</td>
<td>• Lack of resources to find sufficient data</td>
</tr>
<tr>
<td>• Strong social media appearance</td>
<td></td>
</tr>
<tr>
<td>• Potential to involve local communities</td>
<td></td>
</tr>
<tr>
<td>• Potential to support and contribute to further research</td>
<td></td>
</tr>
<tr>
<td>• Good baseline for developing citizen science programs</td>
<td></td>
</tr>
<tr>
<td>• Current relevance and presence of the environmental issue</td>
<td></td>
</tr>
<tr>
<td>• New Seabin projects are being developed</td>
<td></td>
</tr>
<tr>
<td>• Seabin Foundation to gain extra funding</td>
<td></td>
</tr>
<tr>
<td>• Creates positive image for marinas</td>
<td></td>
</tr>
</tbody>
</table>

5.2.1 Strengths identified for Seabin Project

Energy usage: The survey respondent indicated that the energy usage of the Seabin is little. The Seabin needs a 110/220V outlet and the pump displaces 25,000 litres of water per hour. The daily costs for electricity are around 1 – 3 Euros.
**Amount of debris capable of removing:** The survey respondent indicated that the Seabin can remove more than 4 kg of debris per day.

**Installation of the Seabin:** The survey respondent indicated that the installation is fairly easy. The expert interviews confirm this result saying that the installation process is very simple and does not take longer than one hour (Fehler! Verweisquelle konnte nicht gefunden werden. & Fehler! Verweisquelle konnte nicht gefunden werden.).

**Disturbance of local boat traffic:** The survey respondent indicated that there is no disturbance of local boat traffic due to the Seabin. The expert interviews confirm this result by implying that the Seabin is reasonably small and does not take up a lot of expensive boat space (Fehler! Verweisquelle konnte nicht gefunden werden. & Fehler! Verweisquelle konnte nicht gefunden werden.).

**Price:** Everything needed for the installation of the Seabin is included in the price of 3300 Euros, shipping is not included (Fehler! Verweisquelle konnte nicht gefunden werden.). For a marina or harbour the initial costs are not a great investment as they earn a lot of money by renting out boat spaces (Fehler! Verweisquelle konnte nicht gefunden werden.).

**Maintenance:** Servicing and cleaning of the Seabin and its catch bag is very easy and does not ask for special training or staff (Fehler! Verweisquelle konnte nicht gefunden werden. & Fehler! Verweisquelle konnte nicht gefunden werden.).

**No negative effects on the environment:** Fish do not get sucked in by the currents created by the Seabin. The Seabin is very quiet (60 decibel) and does not scare fish or other aquatic life away (Fehler! Verweisquelle konnte nicht gefunden werden.).

### 5.2.2 Weaknesses identified for Seabin Project

**Weather conditions:** The survey respondent indicated that the Seabin can work sufficiently in calm seas, with slight surge, and in surge and current. Places with too much water movement, such as rivers, are not suitable locations for the Seabin (Fehler! Verweisquelle konnte nicht gefunden werden.).

**Depth-reach:** The survey respondent indicated that the Seabin can remove debris from 0 – 5 metres. The expert interviews confirm that the Seabin moves up and down with the water level and is only able to catch debris floating at the surface (Fehler! Verweisquelle konnte nicht gefunden werden. & Fehler! Verweisquelle konnte nicht gefunden werden.).
Recycling of collected debris: The survey respondent indicated that no collected material is being recycled.

Floating-dock module: The *Seabin* can only be installed on floating docks where it can move up and down with the water level. Other solutions are being developed now (Fehler! Verweisquelle konnte nicht gefunden werden.)

5.2.3 Opportunities identified for Seabin Project

Material collected being plastic: The survey respondent indicated that 30 – 50% of the collected debris is plastic.

Awareness campaigns: The survey respondent knows of 3 – 5 other awareness campaigns initiated by the *Seabin Project*.

The simple installation of the *Seabin* made people more aware of the marine litter pollution. Boat owners notice the *Seabin* on a regular basis and learn about the subject (Fehler! Verweisquelle konnte nicht gefunden werden.).

Community outreach and engagement: A high focus of the *Seabin Project* is to get local communities involved in the initiatives. Schools and universities are always invited to learn about the *Seabin* and beach clean-ups are organized on a regular level. Those community activities are offered for free to ensure a big turn-up (Fehler! Verweisquelle konnte nicht gefunden werden.). Fehler! Verweisquelle konnte nicht gefunden werden. confirms that during the installation of the Seabin at Marina Muiderzund a lot of people were present.

Global interest and reach: The survey respondent indicated that the global interest and reach of the *Seabin Project* is high.

Strong social media appearance: The *Seabin Project* has a strong appearance on social media platforms and receive a lot of positive feedback through them (Fehler! Verweisquelle konnte nicht gefunden werden.).

Involvement of local community: The survey respondent indicated that there is some involvement of the local community. Schools and universities are invited to join *Seabin*-related projects and activities (Fehler! Verweisquelle konnte nicht gefunden werden.).

Supporting research: The survey respondent indicated that there is some encouragement for further research.

The expert interviews revealed that a collaboration with Jenna Jambeck from the University of
Georgia has been arranged to contribute to data sampling and monitoring of micro plastics. For this project the Seabin is used as a micro plastic sampling device. The data collected can be useful for various scientific assessments (Fehler! Verweisquelle konnte nicht gefunden werden.).

**Baseline for developing citizen science projects:** The more harbours have a Seabin installed the more data from different locations about micro plastics can be collected. The sampling method is easy and not too complex. The Seabin Share Programme is already running and currently looking for more partners (Fehler! Verweisquelle konnte nicht gefunden werden.).

**Relevance of the problem:** The environmental issue of marine debris is widely recognized and on the agenda of the European Union. The broad picture of the issue allows for interdisciplinary approaches and development of new strategies (Fehler! Verweisquelle konnte nicht gefunden werden.).

**New projects planned:** The Seabin Project is currently working on new solutions for different types of water bodies. A fixed-dock solution would be able to be installed in river mouths and an open ocean solution could be installed in protected bays (Fehler! Verweisquelle konnte nicht gefunden werden.).

**Image:** Harbours and marinas that have a Seabin installed benefit from it by getting positive appearance in the news and on social media (Fehler! Verweisquelle konnte nicht gefunden werden. & Fehler! Verweisquelle konnte nicht gefunden werden.).

**Seabin Foundation:** The Seabin Project started this foundation to gain fund for their community activities (Fehler! Verweisquelle konnte nicht gefunden werden.).

### 5.2.4 Threats identified for Seabin Project

**Fouling:** One major threat the Seabin developers a currently trying to find a solution for, is the impact of fouling on the Seabin. Depending on the water conditions the Seabin is situated in, this can affect parts immensely and decrease their lifespan (Fehler! Verweisquelle konnte nicht gefunden werden.).

**Customers being skeptical about the product:** The Seabin is a fairly new device on the market and potential buyers are still sceptical about its abilities (Fehler! Verweisquelle konnte nicht gefunden werden.).

**Lack of resources to find sufficient data:** Due to its novelty the Seabin is not supported by a great set of data on its functionality. Citizen science programs could improve on that (Fehler! Verweisquelle konnte nicht gefunden werden.).
5.3 Perception of marine litter – Dive Against Debris

During the internet-based survey both professional and recreational divers were asked to indicate their perception on factors related to the issue of marine debris.

Dive professionals were asked how they think their customers perceive marine litter during a dive. 57.14% indicated that the customers seem to be concerned about litter. 35.71% said that customers even seemed highly concerned. Only 7.14% said that customers were only slightly concerned about marine litter.

The recreational divers were asked how they feel about marine litter during a dive. 50% said that they find it highly irritating. 25% even indicated that marine litter ruins the dives for them.

When asking dive professionals if they ever had customers complain about marine litter 57.14% indicated that this was sometimes the case. 28.57% said that was very often the case and only 14.29% said that they never had customers complain about marine litter during a dive.

5.4 Perception of marine litter – The Seabin Project

In the survey the respondents were asked to indicate how they think their customers perceive floating litter.

The survey respondent indicated that their customers are concerned about floating litter.
5.5 Weighing of criteria – Dive Against Debris

In the internet-based survey respondent were asked to weigh certain criteria according to their importance. The following shows a visualization of the responses for both dive professionals and recreational divers.

1. **Sustainability vs. Efficiency**

   ![Sustainability vs. Efficiency for Professional Divers](image1)
   ![Sustainability vs. Efficiency for Recreational Divers](image2)

2. **Costs vs. Accessibility**

   ![Costs vs. Accessibility for Professional Divers](image3)
   ![Costs vs. Accessibility for Recreational Divers](image4)

3. **Raising awareness vs. Supporting research vs. Aesthetic value**

   ![Raising Awareness vs. Supporting Research vs. Aesthetic value for Professional Divers](image5)
   ![Raising Awareness vs. Supporting Research vs. Aesthetic value for Recreational Divers](image6)
5.6 Weighing of criteria – The Seabin Project

In the internet-based survey the respondents were asked to weigh some factors according to how important they are perceived. The following shows the judgement of the Seabin end-user.

Seeing, that there was only one respondent to the survey, the results will not be shown in pie charts but simply listed as the respondent ranked the criteria.

1. **Sustainability vs. Efficiency**

   Most important: Efficiency

   Least important: Sustainability

2. **Costs vs. Accessibility**

   Most important: Accessibility

   Least important: Costs

3. **Raising awareness vs. Supporting research vs. Aesthetic values**

   Most important: Aesthetic values

   Less important: Supporting research

   Least important: Raising awareness
6 Discussion

6.1 Significant findings

Dive Against Debris – Over-estimation of abilities

The internet-based survey produced some interesting findings. One of which is the over-estimation of recreational divers when it comes to judging their own abilities. During the survey both, professional and recreational divers were asked, how much debris a single diver can collect throughout one dive. The dive professionals agreed on 1 – 3 kilos as a realistic amount. The recreational divers on the other hand indicated that more than that is possible to be collected. 33% of the respondents even indicated that they would be able to collect 4 kg of debris during one dive.

This difference can easiest be explained by the different level of diving experience. Professional divers usually have more experience and a higher level of diving. Therefore, they can better judge what is realistic. Especially weight is an important factor in diving as with increasing depth there is more pressure on an object and the diver carrying it.

Finding this significance can help to avoid potential safety hazards. When developing a citizen science project, it is important that the participants are aware of their limitations. Especially with diving, over-estimation of abilities can lead to accidents.

Perception of marine litter and motivation to become proactive

During the Dive Against Debris survey the respondents were asked on the perception of marine litter. Dive professionals were asked how they think their customers perceive marine litter. Recreational divers were asked how they feel about marine litter themselves.
The results are quite interesting in terms of how marine litter is perceived depending on the professional level of the respondent.

Dive professionals who responded to the survey are in general under the impression that their customers are concerned (57%) or even highly concerned (36%) about seeing marine debris on their dives.

50% of the recreational divers are highly irritated by marine debris and 25% even claim that seeing litter on the reefs ruins the whole dive for them.

This significance has two possible explanations.
1. Dive professionals in general think that their customers do not have environmental incentives and are only interested in a good holiday.
2. The respondents to the survey are all environmentally conscious and therefore agreed to take part in a marine litter–related survey. Their answers to the questions then obviously reflect on that environmental consciousness.

However, it is quite remarkable that so many of the recreational divers have such strong feelings about marine litter. It proofs the omnipresence and increasing awareness of the issue. A lack of interest in the problem does not seem to be the challenge marine related citizen science projects are facing.

The interviews with the Seabin experts also revealed that they receive a lot of interest in the issue of marine debris.

A similar result is revealed in terms of motivation. Dive professionals were asked to indicate how high they would judge their customers’ motivation to pay for and participate in Dive Against Debris dives. 50% said there was some motivation, no one said there was high motivation amongst customers. Recreational divers on the other hand gave a different response: 42% said they felt very high motivated, another 42% they had high motivation to participate in Dive Against Debris dives. This again shows that among citizens a motivation and willingness to become proactive does exist.
Recycling of collected debris

The internet-based survey and the expert interviews revealed some shocking results about the post-collection processes. 39% of the dive professionals and 46% of the recreational divers indicated that none of the collected debris is being recycled properly.

The expert interview with the dive professional in Mexico showed a similar picture: if there is no efficient waste management implemented, the collected marine debris is highly unlikely to be disposed of sustainably.

Popular dive destinations accumulate a lot in tropical areas and in developing countries. Often a sufficient infrastructure for waste disposal is not in place. Collected debris is likely to end up on landfills from where it can easily end up back in the oceans again via wind or rivers.

What was shocking to see though, is that also the Seabin respondent from France indicated that none of the collected debris is being recycled. A developed country like France should work on their waste management and recycling schemes as they have the resources to do so.

The Seabin Project is always making its customers aware that the device itself is not the solution to this large-scale issue. Everything attached to it from raising awareness to implementing proper waste management and policies is connected to the issue. The Seabin Project is trying to support its customers as much as possible to find ways to properly recycle the debris collected.
6.2 General findings

The Dive Against Debris initiative was especially designed to be a citizen science project. People from the public are encouraged and enabled to collect data on the ecological issue of marine litter.

In a way the Dive Against Debris initiative can be compared to the eBird project. Same as the diving-project the bird-programme was designed for citizens to contribute to a database. The project is used by birders, scientists, and conservationists all the same. The database helps the better understanding of bird populations, their distributions, and factors that might influence them – both environmental and anthropogenic. There are over 10,000 different species of birds that can be found in all terrestrial and even coastal and marine environments which makes this a large-scale monitoring project (Sullivan et al., 2009).

Marine litter has also a big spatial dimension: Currents, winds, and tidal movements carry marine debris to the remotest areas of the ocean – including deep sea beds. To understand such a large-scale environmental issue, an extensive database is needed.

Advantages that Dive Against Debris shows, compared to eBird, include the fact that marine debris is easier to identify for citizens. Instead of over 10,000 bird species the survey respondent only needs to recognize and describe the composition and size of the debris found (plastic, glass, metal, etc.). This minimizes the risk of faulty data entrance.

The PADI survey guide to the Specialty Course is available in 13 different languages (Project AWARE, n.d.) whereas the eBird website only operates in three languages. Until now the eBird programme only is accessible for the Western hemisphere and New Zealand. Dive Against Debris on the other hand is working globally (Sullivan et al., 2009).
However, there is one factor which poses a challenge to the *Dive Against Debris* initiative: the respondents group. Basically, every citizen can contribute to *eBird*, whereas the *Dive Against Debris* respondents group is limited to certified Scuba Divers.

Both citizen science approaches however, take advantage of the fast advancing technological possibilities (Silvertown, 2009; Sullivan et al., 2017).

The *Seabin Project* did not initially start off as a pure citizen science project. The *Seabin* device is used as a tool to get peoples’ attention. Around the product evolved a good set of awareness campaigns and research opportunities. Compared to other citizen science approaches such as *Dive Against Debris* and *eBird*, the *Seabin Project* is still only at the beginning of their movement. The question arises whether it would be more sensible for the *Seabin Project* to focus first on a wider distribution of the product before continuing advanced community outreach and awareness campaigns.

The comparison of the two projects global distributions shows that the *Dive Against Debris* (Figure 6) initiative collects data in more locations than the *Seabin Project* (Figure 7). Especially when looking at collecting more data on microplastics a more global distribution of the *Seabins* is necessary.

However, seeing that the *Seabin Project* only launched in 2017 it already has an impressive global outreach. Handling the distribution of the product, the development of research projects, and organizing awareness campaigns is quite the challenge. Having the sales from the *Seabin* to fuel all community-based activities shows that there are more perspectives on the issue: economic and financial aspects have to be put into account as well as the environmental incentive behind actions.

![Figure 6 Map of D.A.D. surveys conducted (Project AWARE, n.d.)](image-url)
6.3 Limitations

Throughout the research project I experienced some limitations especially within the data collection process (Phase 3 of methodology).

**Expert interviews:**
The expert interviews were aimed as an additional source from which to derive data particularly targeting experts from the *Seabin Project*. Calling and emailing harbours and marinas in numerous countries did not result in the response rate I was hoping for. Some (Finland, France, Spain) did not speak sufficient English to understand what I was asking for, others were not familiar with the *Seabin* even though their website indicated they had one installed. I did, however, receive a positive response from representatives of the *Seabin Project* directly which balanced this limitation out.

Two of the three expert interviews conducted were via Skype as the interviewees are based in different countries (Spain and Mexico). Due to some difficulties with the internet connection it was at times hard to have a fluent conversation and understand everything properly.

**Internet-based surveys:**
Both surveys were targeted at quite limited target groups. For the *Dive Against Debris* survey respondents who are certified divers and know about the initiative or dive professionals were sought after. The target group for the *Seabin* survey was even smaller: representatives from harbours and marinas that have the *Seabin* installed. As expected the survey for the *Seabin* had a low response.
rate. The amount of marine debris collected by divers could not be grasped by the survey. To fully evaluate the effectiveness of divers collecting debris, additional data is necessary. Until now only the collected material within the Dive Against Debris programme is being recorded, but divers collect litter all the time.

**SWOT:**

There are a lot of voices that say a SWOT analysis as a scientific tool is too simplistically and naïve and therefore would lead to strategic errors (Pickton & Wright, 1998). SOWT analyses are often conducted upon the views of one individual or a biased few which “contributes to the naïveté of the analysis” (Pickton & Wright, 1998, p. 104). Other limitations to SWOT analyses include: Inadequate definition of factors, the lack of prioritization of factors, and a potential over-subjectivity in the generation of factors (Pickton & Wright, 1998).

### 7 Conclusion

#### 7.1 Answering research questions and sub-questions

**Main research question:**

**How can citizen science approaches effectively contribute to mitigating the issue of marine litter pollution?**

Citizen science approaches are a widely used scientific tool in large-scale terrestrial projects. Their success is because a high quantity of data can be collected from all over the world. Using technological innovations and possibilities, such as the internet, makes it increasingly easier for people from the public to contribute to scientific data bases.

Large-scale projects, both terrestrial and marine, have two dimensions: spatial and temporal. Gathering sufficient data to cover both dimensions can take up a lot of time which often is hindering further research.

Citizen science approaches such as the Dive Against Debris initiative and the Seabin Projects’ Share Programme open the possibility to collect data from all over the world and over long periods of time.

Using internet survey sheets makes it easy for volunteers to collect and submit data.

A huge database is necessary to tackle the environmental issue of marine litter pollution. Only with
huge datasets, scientists and conservationists can continue their research to find out more about the distribution and composition of marine debris.

Giving people from the public the opportunity to participate in scientific research increases their sensitivity for environmental topics. They benefit from adding to their education as well as from the knowledge of contributing to relevant scientific research. Citizens who are more involved in scientific processes become more aware of environmental issues.

**Sub-questions:**

1. **What are the factors that contribute to the effectiveness of citizen science projects?**

Factors that contribute to the success of citizen science projects include: The methods need to be simple and appealing to the volunteers. Data collection protocols should be designed in a clear and understandable manner (Ellwood et al., 2017).

Efficient data management and validation processes need to be in place to minimize the risk of getting irrelevant or faulty data. Making use of technology to simplify the data-entry process is desirable. The easier it is for a volunteer to enter data the more likely he or she is to participate in the citizen science project (Hochachka et al., 2012).

To keep the participants motivated is another important factor for the success of a citizen science project. Adjusting the methods according to the volunteers’ motivation will keep them motivated. Volunteers also need to feel rewarded for their contribution. Providing them with insights into the research and assuring them how important their contribution is to the scientific project will make them continue with data collection.

2. **What are the success and failure factors of the Dive Against Debris initiative?**

The factors that speak for the success of the Dive Against Debris initiative are: participants do not need to go beyond their abilities to conduct Dive Against Debris dives as they are not more exertive than normal dives and doing or teaching the course is not difficult. The litter collection is quite effective as per diver a reasonable amount of debris can be picked up throughout a dive of which a majority is being plastics. The tools provided by Project AWARE are informative and the survey guidelines are easy to follow. The use of the internet makes an access to the global database easy and has the potential for even more media appearance.

Factors that might influence the failure of the Dive Against Debris initiative include: The success of litter collection is highly reliant on weather conditions and currents. Untrained divers, as well as divers pushing their depth-limits can lead to serious accidents. Depending on the diving destination, divers might show little interest in the Specialty Course as it seems unattractive compared to other options. Prices also affect
people’s decision on whether they want to participate. A low number of dive clubs and a high number of
dive centres can lead to an increase in plastic pollution and a decrease in survey dives conducted.

3. What are the success and failure factors of the Seabin Projects’ awareness campaigns?

Factors that contribute to the success of the Seabin Projects’ awareness campaigns include: The product
itself proves to be very energy-efficient, needing low maintenance efforts, and being available at a fair
price. The citizen science project is supported by a strong social media appearance and global distribution
of the Seabin. There is huge potential to organize even more community outreach, awareness campaigns,
and research support than is already happening. The Share Programme is an excellent baseline for
implementing the citizen science project of sampling microplastics. The collaboration with renowned
Jenna Jambeck might fuel the motivation and interest of research institutes to be part of the Share
Programme.

Factors that might contribute to the failure of the project are: The product itself only operates in calm
conditions and only on floating-docks. Fouling might become an issue in terms of maintenance efforts.
The waste management and recycling infrastructure might be an issue when it comes to sustainably
dispose of the material the Seabin collected.

7.2 Recommendations

For further research it would be interesting to look at not only the professional level of divers but also at
their demographic and educational background. Throughout the data collection-process it became quite
eminent that people perceive marine litter and, therefore marine litter removal approaches, differently
depending on where they are coming from and what their level of academic education is. If the internet-
based survey was ever conducted again in a more extensive scope I would recommend inquiring about
the respondents’ background before leading them to the actual survey.

Another recommendation is to focus more on what motivates and drives people to participate in citizen
science projects such as Dive Against Debris. For this two groups of respondents should be targeted: (1)
recreational divers that actively participate in Dive Against Debris, and (2) recreational divers that have
not done the course yet.

In terms of collecting data for the effectiveness of the Seabin Project, more interviews would be desirable.
Representatives of marinas that work with the Seabin Project and marinas that have not yet installed a
Seabin.
7.3 Concluding remarks

Citizen science approaches are widely used in large-scale terrestrial projects. Considering the fast advance of technological innovations that can be integrated in the data collection process and the increasing motivation of people to become more active, citizen science approaches should be a scientific tool for marine sciences. The large spatial and temporal dimensions of the marine litter pollution call for an extensive database to understand the sources and distribution of the problem. Science and volunteers hugely benefit from citizen science projects.

The Seabin Project and Dive Against Debris show that the involvement of people from the public can be hugely beneficial for all parties involved. Using a technological device to distribute awareness and attach citizen science projects to it, is a great approach to fight the plastic soup. Making divers on holiday more aware of the fact that they can actively contribute to mitigate the problem of marine litter pollution gives them higher motivation to become more pro-active.

Seemingly little contributions to the issue can lead to a massive movement against marine litter pollution and support research and environmental awareness at the same time.
References


Appendix

Appendix A  Rainbow diagram of stakeholders involved

After identifying the stakeholders involved it is helpful to write down (or draw) the name of each stakeholder on its own card. Stakeholders can also be put together in groups to avoid a too extensive list (Chevalier & Buckles, 2008).

The next step of the stakeholder analysis is to create a rainbow diagram (Figure 8) and place the identified stakeholders in it. The diagram consists of three semicircles that each stand for a certain level of affectedness. From left to right the diagram is divided into three different parts. Now the stakeholder cards can be placed in the diagram according to their affectedness and their influence: “Insert cards that represent stakeholders that are the most affected by the problem or action in the small semicircle. In the middle semicircle insert stakeholders moderately affected by the problem or action. In the large semicircle, insert cards of stakeholders who are the least affected by the problem or action” (Chevalier & Buckles, 2008, p. 74). Stakeholders are either affected by the problem in a negative way, or they are influencing it in a positive manner. The left side of the diagram represents the stakeholders that influence the core problem or action the most. On the left side the stakeholders that influence the least can be placed. The rainbow diagram can be adapted depending on what specific characteristics one wants to look at (Chevalier & Buckles, 2008).

For the scope of this research project I will stick to the suggested “influence” and “affectedness” categorization.

![Figure 8 Rainbow diagram](image-url)

Dive Against Debris

The Seabin Project

Schools, universities, research institutes

Yacht clubs, marinas, docks

Moderate Influence

Most Influence

Least affected

Moderately affected

Most affected

Dive centers

Dive clubs

Tourism sector

Figure 8 Rainbow diagram
Appendix B  Internet-based surveys

.1 Initial Questions – Dive Against Debris survey

This questionnaire is part of a research project of the Vrije Universiteit Amsterdam. The study is looking at the efficiency of a number of marine litter removal technologies. Participation in this survey will take you no more than 15 minutes. Your responses are based on your experience with the Dive Against Debris Project by the Project AWARE initiative. Please base your answers on your personal experience. All responses will be treated strictly confidential.

At the end of the questionnaire you can add comments.

Your participation is greatly appreciated, and the results of this survey will be helpful for further research.

Q1: I am a ...
- Dive professional teaching Dive Against Debris specialty courses
- Dive centre owner/ manager
- Recreational diver participating in the Dive Against Debris project
- Other

Q2 Country/ Site of participation

.2 Target Group “Dive Professionals”

Q3 Please select how much energy it takes a diver to collect debris during a dive compared to a normal dive.
- A Lot less exertive than a normal dive
- Slightly less exertive than a normal dive
- Same as a normal dive
- Slightly more exertive than a normal dive
- A lot more exertive than a normal dive
- N/A

Q4 What percentage of the material collected during Dive Against Debris is plastic?
- 0 – 10%
- 10 – 30%
- 30 – 50%
- 50 – 70%
- 70 – 100%
- N/A

Q5 In what weather conditions can a diver safely collect debris during a dive? Multiple answers possible.
- Calm sea
- Slight surge
- Surge and current
- High surge
- Any condition

Q6 What is the capacity of debris a diver can collect through one dive?
- 0 - 1 KG / 0 - 2 LB
- 1 - 2 KG / 2 - 4 LB
- 2 – 3 KG / 4 – 7 LB
- 3 – 4 KG / 7 – 9 LB
- MORE THAN 4 KG / 9 LB
- N/A

Q7 To what depth is a recreational diver able to collect debris?
- 0 - 5 M / 0 - 16 FT
- 5 - 10 M / 16 - 33 FT
- 10 - 20 M / 33 - 66 FT
- 20 - 30 M / 66 - 98 FT
- 30 - 40 M / 98 - 130 FT
- N/A

Q8 How much are the costs for one individual diver per one dive (including equipment rental, cylinder fillings, etc.). Please indicate your currency.

Q9 Please select how difficult it is to implement Dive Against Debris specialty courses.
- Extremely easy
- Fairly easy
- Neutral
- Fairly difficult
- Extremely difficult
- N/A

Q10 Please select how high the disturbance of local boat traffic is due to divers.
- No disturbance of the local boat traffic
- Little disturbance of the local boat traffic
- Medium disturbance of the local boat traffic
- High disturbance of the local boat traffic
- Very high disturbance of the local boat traffic
- N/A
Q11 How costly is the instructor/DM training per one individual dive professional to teach Dive Against Debris PADI specialty courses? Please indicate the currency you are working with.

Q12 Please select how much of the collected debris is being recycled.
   - None is being recycled
   - A bit is being recycled
   - A fair amount is being recycled
   - A lot is being recycled
   - All of it is being recycled
   - N/A

Q13 How many other awareness campaigns by Project AWARE do you know of?
   - None
   - 1
   - 2
   - 3 – 5
   - More than 5
   - N/A

Q14 Please select how high the involvement of the local community is in the Dive Against Debris programme.
   - No involvement of the local community
   - Little involvement of the local community
   - Some involvement of the local community
   - High involvement of the local community
   - Very high involvement of the local community
   - N/A

Q15 Please select how high the global interest and reach of the Dive Against Debris project is. (This refers to the awareness and implementation of the Dive Against Debris programme around the world)
   - No global interest and reach
   - Little global interest and reach
   - Some global interest and reach
   - High global interest and reach
   - Very high global interest and reach
   - N/A

Q16 Please select how crowded the dive sites you conduct Dive Against Debris dives are compared to a normal divesite.
   - Extremely less crowded than a normal divesite
Q17 Please select how you would judge the motivation of recreational divers to pay for and participate in a Dive Against Debris specialty course.

- No motivation to participate
- Little motivation to participate
- Some motivation to participate
- High motivation to participate
- Very high motivation to participate
- N/A

Q18 How do you think customers perceive marine litter during a dive?

- They are not bothered by marine litter
- They are slightly bothered by marine litter
- Neutral
- They are concerned about marine litter
- They are highly concerned about marine litter
- N/A

Q19 Did you ever have customers complain about finding marine litter during a dive?

- No, never
- Sometimes
- Yes, very often

Q20 Which criterion do you think is more important for marine litter removal technologies? Please select 1 next to the more important criterion and 2 next to the less important criterion.

- Sustainability
- Efficiency

Q21 Which criterion do you think is more important for marine litter removal technologies? Please select 1 next to the more important criterion and 2 next to the less important criterion.

- Costs
- Accessibility

Q22 Which criterion do you think is more important for marine litter removal technologies? Please select 1 next to the more important criterion and 3 next to the least important criterion.
- Raising awareness
- Supporting research
- Aesthetic values

Q23 Please rank the following 3 fields according to how important they are to your business. (1st = very important, 3rd = least important)

- Environment
- Economy
- Society and institutions

Q24 Comments

3. Target group “Recreational Divers”

Q25 Please select how much energy it takes you to collect debris during a dive compared to a normal dive.

- A Lot less exertive than a normal dive
- Slightly less exertive than a normal dive
- Same as a normal dive
- Slightly more exertive than a normal dive
- A lot more exertive than a normal dive
- N/A

Q26 What percentage of the material you collect during a dive is plastic?

- 0 – 10 %
- 10 – 30 %
- 30 – 50 %
- 50 – 70 %
- 70 – 100%
- N/A

Q27 In what weather conditions do you feel safe to collect debris during a dive? Multiple answers possible.

- Calm sea
- Slight surge
- Surge and current
- High surge
- Any condition

Q28 What is the maximum capacity of debris you as a diver feel able to collect through one dive?

- 0 - 1 KG / 0 - 2 LB
Q29 To what depth are you able to collect debris?

- 1 - 2 KG / 2 - 4 LB
- 2 – 3 KG / 4 – 7 LB
- 3 – 4 KG / 7 – 9 LB
- MORE THAN 4 KG / 9 LB
- N/A

Q30 How much are the costs for one single dive (including equipment rental, cylinder fillings, etc.)? Please indicate the currency you are using.

Q31 Please select how difficult it is to participate in the Dive Against Debris PADI specialty course compared to other specialty courses.

- Extremely easy
- Fairly easy
- Neutral
- Difficult
- Extremely difficult
- N/A

Q32 Please select how you experience the disturbance of the local boat traffic due to divers.

- No disturbance of the local boat traffic
- Little disturbance of the local boat traffic
- Medium disturbance of the local boat traffic
- High disturbance of the local boat traffic
- Very high disturbance of the local boat traffic
- N/A

Q33 How much does the Dive Against Debris PADI specialty course cost you in total (including equipment rental, cylinder fillings, etc.)?

Q34 Please select how much of the collected debris is being recycled.

- None is being recycled
- A bit is being recycled
- A fair amount is being recycled
A lot is being recycled
All of it is being recycled
N/A

Q35 How many other awareness campaigns by Project AWARE do you know of?
None
1
2
3 – 5
More than 5
N/A

Q36 Please select how high you experience the involvement of the local community in the Dive Against Debris programme.
No involvement of the local community
Little involvement of the local community
Some involvement of the local community
High involvement of the local community
Very high involvement of the local community
N/A

Q37 Please select how you experience the global interest and reach of the Dive Against Debris project. (This refers to the awareness and implementation of the Dive Against Debris programme around the world)
No global interest and reach
Little global interest and reach
Some global interest and reach
High global interest and reach
Very high global interest and reach
N/A

Q38 Please select how crowded the divesites you conduct Dive Against Debris dives on are, compared to normal dive sites?
Extremely less crowded than a normal divesite
Fairly less crowded than a normal divesite
Similar crowds to a normal divesite
Fairly more crowded than a normal divesite
Extremely more crowded than a normal divesite
N/A

Q39 Please select how motivated you are to participate in Dive Against Debris dives and to contribute to the worldwide database.
No motivation to participate
Little motivation to participate
Some motivation to participate
High motivation to participate
Very high motivation to participate
N/A

Q40 What motivated you to do the Dive Against Debris PADI specialty course?

Q41 How do you feel about marine litter during a dive?

Q42 Which criterion do you think is more important for marine litter removal technologies? Please select 1 next to the more important criterion and 2 next to the less important criterion.

Q43 Which criterion do you think is more important for marine litter removal technologies? Please select 1 next to the more important criterion and 2 next to the less important criterion.

Q44 Which criterion do you think is more important for marine litter removal technologies? Please select 1 next to the more important criterion and 3 next to the least important criterion.

Q45 Please rank the following 3 fields according to how important you think they are for dive operators?

Q46 Comments
.4 Target Group “Seabin end-users”

This questionnaire is part of a research project of the Vrije Universiteit Amsterdam. The study is looking at the efficiency of a number of marine litter removal technologies. Participation in this survey will take you no more than 15 minutes. Your responses are based on your experience with the Seabin Project. Please base your answers on your personal experience. All responses will be treated strictly confidential.

At the end of the questionnaire you can add comments. Your participation is greatly appreciated, and the results of this survey will be helpful for further research.

Q1 Country/ Site of participation

Q2 Name of harbour / dock / yacht club / marina

Q3 Year of Seabin installation

Q4 Please select how much energy the Seabin uses per day.
   - Very little energy usage
   - Little energy usage
   - Some energy usage
   - High energy usage
   - Very high energy usage
   - N/A

Q5 What percentage of the debris collected by the Seabin is plastic?
   - 0 – 10%
   - 10 – 30%
   - 30 – 50%
   - 50 – 70%
   - 70 – 100%
   - N/A

Q6 In what weather conditions can the Seabin operate sufficiently? Multiple answers possible.
   - Calm sea
   - Slight surge
   - Surge and current
   - High surge
   - Any condition

Q7 How much debris does the Seabin catch approximately per day?
   - 0 - 1 KG / 0 - 2 LB
   - 1 - 2 KG / 2 - 4 LB
   - 2 – 3 KG / 4 – 7 LB
   - 3 – 4 KG / 7 – 9 LB
   - MORE THAN 4 KG / 9 LB
Q8 To what depth is the Seabin able to remove debris from the water?
  - 0 - 5 M / 0 - 16 FT
  - 5 - 10 M / 16 - 33 FT
  - 10 - 20 M / 33 - 66 FT
  - 20 - 30 M / 66 - 98 FT
  - 30 - 40 M / 98 - 130 FT
  - N/A

Q9 How much does the initial implementation of the Seabin cost? Please indicate your currency.

Q10 Please select how difficult the installation of the Seabin is.
  - Extremely easy
  - Fairly easy
  - Neutral
  - Difficult
  - Extremely difficult
  - N/A

Q11 Please select how high the disturbance of local boat traffic is due to the Seabin.
  - No disturbance of the local boat traffic
  - Little disturbance of the local boat traffic
  - Medium disturbance of the local boat traffic
  - High disturbance of the local boat traffic
  - Very high disturbance of the local boat traffic
  - N/A

Q12 How much does the maintenance and service of the Seabin cost per month? Please indicate the currency you are working with.

Q13 Please select how much of the collected debris is being recycled.
  - None is being recycled
  - A bit is being recycled
  - A fair amount is being recycled
  - A lot is being recycled
  - All of it is being recycled
  - N/A

Q14 How many other awareness campaigns by the Seabin project do you know of?
  - None
  - 1
  - 2
Q15 Please select how high the involvement of the local community in the Seabin project is.

- No involvement of the local community
- Little involvement of the local community
- Some involvement of the local community
- High involvement of the local community
- Very high involvement of the local community
- N/A

Q16 Please select how high the global interest and reach of the Seabin project is. (This refers to the awareness and implementation of the Seabin project around the world)

- No global interest and reach
- Little global interest and reach
- Some global interest and reach
- High global interest and reach
- Very high global interest and reach
- N/A

Q17 Please select how you judge the Seabin project encouraging further research.

- No encouragement for further research
- Little encouragement for further research
- Some encouragement for further research
- High encouragement for further research
- Very high encouragement for further research
- N/A

Q18 Please select how high the loss of aesthetic value is due to the presence of the Seabin?

- No loss of aesthetic value
- Little loss of aesthetic value
- Some loss of aesthetic value
- High loss of aesthetic value
- Very high loss of aesthetic value
- N/A

Q19 Please select how you think your customers perceive floating litter?

- Not bothered by floating litter
- A little bothered by floating litter
- Neutral
Concerned about floating litter
• Highly concerned about floating litter
• N/A

Q20 Which criterion do you think is more important for marine litter removal technologies? Please select 1 next to the more important criterion and 2 next to the less important criterion.
• Sustainability
• Efficiency

Q21 Which criterion do you think is more important for marine litter removal technologies? Please select 1 next to the more important criterion and 2 next to the less important criterion.
• Costs
• Accessibility

Q22 Which criterion do you think is more important for marine litter removal technologies? Please select 1 next to the more important criterion and 3 next to the least important criterion.
• Raising awareness
• Supporting research
• Aesthetic values

Q23 Please rank the three fields according to how important they are to your business. (1st = very important, 3 = least important)
• Environment
• Economy
• Society and institutions

Q24 Comments

Appendix C Expert interviews

.5 Interview Guide

Before the interview – Preparation
• Before approaching note: Interview number, date & time, location, surroundings
• Define terms and vocabulary for each category to avoid confusions
• Ask interviewee if it is okay to record the interview

During the interview - Interview questions
• Closed-ended initial questions
  • Respondents name
  • How long have they been working for government/company/NGO?
  • How long have they been living in their country?
• Semi-structured open-ended questions following environmental/technical criteria
• Semi-structured open-ended questions following economic/financial criteria
• Semi-structures open-ended questions following social/institutional criteria

After the interview – Data analysis

• Thank respondent.
• Save recording on laptop and upload to Dropbox to make sure information does not get lost.
• Transcription of recordings and/or written notes immediately after the interview.
• Analyse collected information.
• Send copy of transcription to interviewee to confirm that everything was understood correctly.

.6 Expert interview 1 – Dive Against Debris, Dive professional

Date: 07.06.2018
Time: 17:00
Duration: 23 minutes
Type: Skype video interview – Amsterdam, Netherlands to Playa del Carmen, Mexico
Interviewer: Lynn Jula Kessler
Interviewee: Maria Jose Arroyo Gerez

Lynn: Just to tell you a bit about my research project: The Dive Against Debris initiative is quite interesting in terms of having this voluntary approach of getting people involved and actually do something about marine litter. So now I am looking at finding out what is the different perspective from firstly recreational divers and secondly professional divers and see what could be improved, like what would make people more proactive to do something about it. Because I think the initiative is a good start but there is still room for improvement, I guess.

I guess you have a lot of experience with divers in general and managing dive centres. Did you ever implement the Dive Against Debris PADI specialty?

Maria: Not really because the company I worked with was mostly DSDs [Discover Scuba Diving] and already certified people but not really like environmentally interested, I would say. I think it was mostly because of the price, they were already paying for the dives that when you offered any specialty on top of that, one single dive would be over 150 Dollars. I mean I always made them aware that there was a lot of trash to come up with from the dives. But in the dive centre I managed towards Cancun there wasn’t really as much trash on the reef but coming here to Playa [del Carmen] where there’s a lot of people, it’s horrible. We’re always taking stuff up with us, all the time when we are diving. And some of them even started on their own to pick up trash, like not all the time because we asked them to be careful because it can be dangerous. And when they weren’t great divers I didn’t want them to be picking stuff up from the reefs, but if there was anything on the reef that they would see like piece of like long plastic and stuff they would normally point it out to us and we would either go and take it out or pick it up, so they wouldn’t have to take it out with their own hand. There was a lot of bottles, sometimes we would find tons and tons of like Corona - little bottles – especially in Cozumel, but again, like in Cozumel there’s not much that you can do. The current is super strong so basically everything just comes flying at you, you catch it. So, there’s no way of coming back and taking it out from the reef.
L: Yes, fair enough. But like, because I don’t really understand the principle behind this particular specialty course, because I mean basically you pay for getting taught how to pick up trash underwater.

M: Yeah exactly.

L: I looked at the survey guide that PADI provides and it’s quite informative. There’s information about debris in general and that you have to be careful and stick to your limits. But what I wasn’t aware of before is that they actually also have this massive database that every diver can contribute to and you don’t even have to be signed up for that like you don’t have to pay for the specialty to contribute.

M: Yes, you can say what you’ve found and where you’ve found it and that’s it.

L: Yeah, I think that’s pretty interesting in terms of like looking at distribution and composition of debris underwater.

M: It’s perfect yes.

L: But when I spoke to other divers I feel like everyone was more or less like “Yeah we don’t really work with Dive Against Debris” cause it’s like people are not really motivated to pay for it cause it’s just like “Yah if I see trash I pick it up, but I don’t need to pay an extra 50 Dollars for that.”

M: Exactly, and I think here on this side here there are not many dive clubs around, actually there is only one in the region and it’s managed by a dive shop. So, there is not really a dive club per se as in Europe, or California or places like that. So, I think it would work better in a dive club situation, rather than a dive shop. Because people probably paying a lot of money to go diving and as you said they don’t want to be taught to pick up rubbish for an extra 25 Dollars for the card and 25 Dollar for the course.

L: Yeah exactly.

M: Yeah, I think it’s mostly that what turns people away. Like even from getting an actual certification they are not great specialties to have. But like Fish ID and things like that, if you tell them if they want to become a specialty diver for that? “No.” That’s it.

L: True. Also, the other things that project AWARE offers is this shark and ray survey specialty course and compared to the “pick up trash” specialty that sound way more interesting, right?

M: Right, and even here like diving with bull sharks. There’s a course director and some other people from ProDive that made the specialty about bull shark diving in Playa del Carmen. It takes only two dives and that’s pretty much it. All you have to do is go down and see the sharks, how they behave, and then come back up, talk about it, learn a bit about the bull sharks and what they do, and pay, and they say: “No, I just want to go dive”. And then it’s like okay, but you are already paying two dives, pay me a little bit more and you get this card. “No, it’s fine.” Alright... So that’s the problem, they don’t want to pay more for things that they could get for free or just already get with the dive.

L: Do you, with your customers or clients or students in general, do you feel like they perceive litter or marine litter, and plastics, as like a bad thing actually? Or are they like: “I don’t really care about it”?

M: Mostly, like ... working with like 5-star-clients they kind of – depends where they come from. But most of the time they would complain. They see debris and they don’t want it there. And then students that’s kind of easier to regulate when they view the reefs for the first time. We would normally tell them that reefs are super close to the beach therefor there’s a lot of litter everywhere and that’s something they should consider when they go to the beach with their parents or whoever they are with when they are not diving. And I think it’s ... yeah, some of
them are more like annoyed like: “Why am I paying so much for a dirty reef?” Well, doesn’t matter if you pay 5 Dollars, or 20 or 50 it’s not our litter so... But yeah, I think it’s a different point of view depending on also if they dived a lot in I don’t know, places like the Maldives and things like that, they come and are like: “Oh, when I was in Maldives ...” They tend to compare a lot and they would normally say things like: “Oh, there was more big stuff there or more little stuff there”. I think it depends a lot on their level of diving as well. Some of them just, they don’t care. But most of them, if there was a lot of litter, they would compare it to other places where they have been diving.

L: But do you have the feeling that they would actually be motivated to become more proactive about it, or were they just complaining and comparing it? Because I mean, if you see litter then you must think: “Okay, where is it coming from? What can I do against it?”, right?

M: Some of them would do, like they would act if there were like beach clean-ups and stuff around town. Others just, they would just complain. Mostly, I would say, Americans would complain. Europeans tend to be a little bit more concerned about it. But American people they just don’t care...

L: I guess it’s also like if they pay for it, they feel obliged to get like the full package like: beautiful reefs, no currents, great visibility, and no litter ...

M: Exactly, they expect things like that yes.

L: It’s actually quite interesting to think about it geographic-wise. As you were saying Americans tend to care less than Europeans. It probably also has to do a bit with their educational background and with like, okay Europeans are more aware of recycling methods and okay like “we shouldn’t use single-use plastics” and stuff. Whereas Americans tend to be more like “Well, whatever.”

M: Consuming stuff in whatever package it comes in, yeah. I think it’s also like a generational thing. Older people, I think, they tend to complain less but also, they do less for it. And like people our age, I think they are more aware of what things are where and why are they there, where they are coming from. And younger people like teenagers they just don’t care. They are there because either their parents made them or because they love the ocean but they ... some of them like there was a girl from Denmark and she was like: “Oh, it’s so full of rubbish.” And I told her it was coming from the beach, it’s literally right there and she was like: “It shouldn’t be allowed!” And I was like: “Yeah, it shouldn’t”. But other kids are just like: “Oh pretty fish ...” And then they just follow the fish... So yeah, I think it’s also generational, amongst the geographical, it’s quite generational. Also, like people from California, I’ve noticed a lot, they’re super like green-minded. Most of them come with their own water bottle and they refuse to put on sunblock and things like that. While people from the mainland... they just don’t care. And they also have no idea what it does when they flush a toilet and things like that. So, I think it’s also, it has to do a lot with the environmental perception itself.

L: Yes, I guess so. I mean it makes sense, obviously if you ask people like us we would always say stop plastic pollution because it doesn’t belong in the ocean but if you were never raised like that then yeah, why would you get that incentive all of a sudden?

M: And care about it, yeah.

L: That’s just sad. But what do you think, of the Project AWARE initiative? It’s quite nice that everyone can contribute to the database without doing the specialty course and can get the survey guide for free. But I still feel like not a lot of people are that aware of it?

M: I think it’s also because well, like in places where I was more involved with divers like the 5-Star hotels, they are there on holiday. So, they just want to have one dive in and that’s it. Like afterwards you see them around the pool their beers and cocktails and stuff. I would say maybe like 5% of them come back into the dive shop and talk about their dives.
L: Really?

M: Yeah, and if you are a dive instructor you don’t have time to go and do a proper debrief with them. Your debriefing on the way back from the dive, you’ve got five minutes maybe and then you have to wash and set their gear aside and then run to do another thing. You don’t come from the dive and you can chill and you can talk about what fish you saw and everything. And also, not even on the Bull Shark Diving Specialty, because we ask them here to do a survey to see which sharks have been coming back year after year. They are quite easy to spot, they’re like 2 or 3-meter-long beasts, you can easily spot them. And there’re like 9 of them so it’s not like you have to identify different species. It’s one species and 9 individuals, that’s it. And people like, not even then they come back and fill out the survey. All you have to do is, you have to say which mark you think it was and then say what the fish was doing. Like swimming actively, hiding, or whatever. They don’t do it because... I think it was mostly that part. Because I have seen other dive shops where they do have a proper debriefing time and there I see them more active. Like with the fish species books and stuff like that. So, I think it’s mostly the environment that I was working at, that they didn’t have time for any debriefing at all.

L: That’s sad, I mean me as a client I would then be like okay if my instructor doesn’t have time to tell me more about it why should I be bothered? So, if you have half an hour afterwards to learn a bit about the shark and the species itself maybe then you would be more interested.

M: Like in Maroma, where I was near Cancun, there was two or three times a week this party boat coming out and they have lot of like crisp things [packages] kind of like this big [indicates size] like airline-sized. And you could tell when the previous night had been a night of sunset-cruise or whatever because you would find like five or ten of them on the reef. And the bottles of beer or coke or whatever. But on other days when there was no cruise around you wouldn’t find as many. So, they don’t even really care and then you see them the next day on the sunset cruise and you think “Why?!”

L: I’m so surprised because I feel like especially marine litter at the moment it’s such a present topic. I mean, it’s everywhere. You just have to open Facebook or Instagram and you get like tons of articles about marine litter and animals suffocating and being entangled in it. And I feel like there’s more and more awareness about it, but I still think it’s more of a like an image thing... like it’s not really making people do more about it – yet.

M: I think it’s just starting. It’s kind of like you know, when they want people to donate to sick children and stuff like that, they put like the most traumatic images out first to call for conscious and like get your heart to dictating you something. Some people are like, very aware of it. I know last year here in Playa there was a group of girls – three, yes, three girls – like dive instructors and dive professionals who started a campaign called “Mermaids against Plastic” it’s been doing some, like surveys around here to see who used single-use plastics and how to reduce those uses in dive centres. And their results were kind of like ... not everyone took the ten minutes to take the survey. And the ones who did it, they say it’s horrible how much single-use plastic we are forced to use in a way. Again, like people coming in [into the dive shop] and it’s like we have this plastic bottle – five litre water bottle – that we just refill with drinking water. And many people are like: “Oh, you don’t have a plastic bottle for me?” You know, those little tiny ones? Again airline-sized, that’s what people would use otherwise you would give them half a litre and you would be throwing out half of that. And like our reusable cups: “Are they clean?” “Yes, they are! Just the water here doesn’t let clear plastics stay clear. We just washed them this morning.” “Oh, okay:”

L: People are weird.

M: Yes.
How is it in terms of recycling? Because that also depends on the country, I guess. There’s no point really in ... well, obviously there is a point, but like getting plastics out of the ocean and then just put them on the next landfill and with the next wind it just ends up in the ocean again.

Exactly. Here in Mexico there is not great recycling. For some things, yes. Like metal, glass, some plastics but not all of them, cardboard, paper and that, yes. But I would say all of the plastic bottles and water bottles that end up in the ocean, they are not recyclable. Like, really poor people would get them out of the bins sometimes.

So, you also don’t have a deposit-refund-scheme?

No, it all goes into the same bag to the landfill.

It makes you want to cry, it’s so easy, so simple. Oh well, but what can we do? Well, that’s everything from my side. Thank you so much for taking the time to talk to me.

No problem, any time!

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**Expert interview 2 – Seabin Project, research**

Date: 04.06.2018
Time: 11:20am
Duration: 31 minutes
Type: Skype video/voice call – Amsterdam, Netherlands to Palma de Mallorca, Spain
Interviewer: Lynn Juliana Kessler
Interviewee: Sergio Ruiz-Halpern

**Sergio:** Hi Lynn, how are you doing?

**Lynn:** Hi good, thanks. How are you?

**S:** Good, thanks. Hold on let me get the earphones quickly.

**L:** Yes, sure.

**S:** Sorry about that. I am ready.

**L:** Awesome, first of all thank you so much for skyping with me I really appreciate it.

**S:** No problem.

**L:** First of all, is it okay if I record our conversation?

**S:** Yes, yes. No problem.

**L:** Thank you. So first maybe I can tell you a bit about myself and the research I’m doing and then we can take it from there. So, I am doing my master’s programme in Amsterdam, about Environment & Resource Management. And my thesis is about marine litter removal technologies. So, what I am doing is, I am basically finding criteria that make them most efficient from different sectors. I am looking at environmental criteria, social criteria but also economic and financial criteria and trying to figure out, okay which ones are most important to make a technology run most sufficiently. That’s basically the broad idea behind my thesis and I’m trying to contact as many end-users of technologies such as the Seabin and their developers and see their perspective on the topic.

**S:** First of all, I think it’s a very important thing and it’s now on the agenda of the European Union so yeah, the thesis is likely to have quite a bit of impact, I think. So, I am happy to help you in any capacity that I can.
L: Thank you so much! Maybe first tell a bit about you and your position within the Seabin project?

S: Can you say that again? The screen froze...

L: Sorry, can you tell me a bit about your position within the Seabin Project?

S: Let me remove the video cause it’s freezing up a little bit and I don’t know if it’s your connection or mine. So, you won’t be able to see me, but we’ll have a better connection.

Alright, so I’m the chief scientist really, I’m a marine biologist myself. And the reason I started working for Seabin is that in the very beginning they asked: “What happens to the fish?” so if the fish get caught in the Seabin and also the founders needed answers, which we still don’t have, and I started collaborating and doing some little assessments and whatnot and then we realised that there was a broader picture to that and a scientist was needed to establish a bit of a database with the Seabins so, my aim – and I still don’t know how am I going to do this, like we lack a lot of resources for that – is to establish some kind of a citizen science programme and work and where ever there is a Seabin, someone goes there and collects the data so we have meaningful data to understand not only how the Seabins are working and if they are doing their job but also, you know, if it could be a source of other information for various other assessments. Right now, we partnered with Jenna Jembeck from the university of Georgia and we’ve implemented a list - a specific Seabin list - in the DataTracker, a marine debris tracker, so that anybody can collect data from the Seabins themselves. So, I manage all of that. And I take care of the education side of things. So, we do a lot of community outreach and engagement. So, on next Wednesday I will be flying out to Ibiza to show a bunch of school kids how the Seabin is working, going to the beach and taking a look, and learning about microplastics because the real solution doesn’t lie in only one technology. There isn’t a single approach to this problem. It’s a wider perspective. So, we need to turn off the tab on land and that goes to information and education and pushing legislation as well. So, on the science side as well, like with the Seabin, we have a smaller but also a bit of a Eureka-moment and we started doing some microplastic assessment in the marinas and we realized by fitting the Seabin with the same kind of material that regular scientific tools for microplastic sampling are used, we can use the Seabin as a sampling device. So, we can implement monitoring programmes because the Seabins were already going to be in the marina and quite cheaply we can install these sampling things and we can do monitoring.

L: So, you are looking at finding more data about the distribution and composition of marine litter?

S: Yeah, in any way we can. Like, there is no data on microplastics in marinas, so we don’t know if they’re different than from other microplastics.

L: You already try to position the Seabin in a tactical position according to currents and wind, right?

S: Yes, so the reason we target marinas in particular is that they are the interface between sea and land, so they already provide that infrastructure. And there are not so many new marinas, most of them are having the historical problem of being where the litter ends up. So, they are definitely hotspots which are suitable for installing Seabins.

L: Could you explain step by step how the whole installation process works? Starting at a customer ordering a Seabin until installation at the marina?

S: We partnered with Poralu as our manufacturer. So, when a marina orders a Seabin, or multiple Seabins, Poralu manufactures them and ships it to the marina. It comes with an instructions booklet which makes the installation very simple. Like, every marina has personal that know how to follow instructions to successfully set-up a device like this. So, the installation is very simple.
L: How much are the initial costs and what is included in the price?

S: Everything needed for installation is included in the price. The Seabin comes with two catch bags so in case one needs to be cleaned or emptied there is a back-up. Obviously, if parts need to be replaced they can re-order them. The Seabin itself costs 3300 Euros plus shipping costs and tax, that’s not included in the price.

L: The Seabin runs on electricity, right?

S: Yes, the marina needs to provide a 110/220V outlet. The pump can pump can displace 25,000 litres per hour.

L: So, also in terms of maintenance you would say it’s easy to service the Seabin?

S: Yes, the maintenance and cleaning of the catch bag is very simple. We have one issue though that we are currently working on and that is fouling. So, the Seabin is made of plastic and – despite a couple of parts we needed for the pump – fully recyclable. But there is no anti-fouling on it so depending on the conditions and how long the Seabin is in the water there can be growths on it both on the outside and the inside. So, what they need to do, and we always make them aware of that, is they need to take the Seabin out of the water and use a pressure hose to clean it. Depending on the marina conditions and how much growths are on there, they need to do this quite regularly.

L: But that doesn’t seem like too much effort?

S: Well, it depends, if a marina has 4 – 6 Seabins and they all need to be cleaned, that’s a lot of hours of work and also must be considered in the infrastructure of the marina. But you don’t need to clean them all at once, but clean one on one day and the next one in the following week. It’s not complicated work but it needs to be done and we make our customers always aware of that.

L: Interesting. Speaking of infrastructure. Have you ever gotten complaints about the Seabin disturbing the local boat traffic in any way?

S: No, that is never the case. But also, because the Seabin is really small. It has two reasons firstly, we don’t want to take up too much boat space – for example in Poralu a boat space costs up to 5000 Euro per day – and also we don’t want the Seabin to be too heavy to be serviced by one person. They should still be able to empty the catch bags on their own. If we make it bigger then you will need extra machineries to lift the catch bags - like cranes.

L: So, there are no plans of expanding the Seabin, physically speaking?

S: Yes, there are. So, the first Seabin is a floating-dock module. That’s the one that is available now. We are working on getting a fixed-dock solution as well. So that Seabins can also be installed on fixed docks. And from there we can start installing it in river mouths, canals and rivers as well.

And the next step will be an open ocean solution. That would obviously be bigger in size and we want to start implementing it in areas like protected bays and such. It will need to have the right size for a boat to maintain it.

S: We are trying to do all sorts of ... we want less marine plastics mining for profits ... so, want to do something with garbage collected with the Seabins. Litter collected is obviously mixed with organic material. So, we all think we want to do something with it cause if we put it on landfills, chances are that it’s going to end up in the oceans again and if we burn it all types of problems are connected with that. Super bad for the air and it’s not ideal either. So, those are the various barriers we try to work through. Plastic is not a bad product itself, but we need to make sure to use it right and don’t waste it. It’s an amazing material but especially single-use plastics need to be stopped being produced. There’s also no point in taking collected marine debris that was
single-use plastic before and make it into new single-use plastic again. We need to find a way to get rid of it in a sustainable manner.

L: That makes sense. Sorry, how do you actually find your customers, do you address them directly or do they approach you?

S: We have a very strong following on social media. And it’s been the driver right now. Right now, we now we have a, we can take the orders through the websites. And the longest communicational reach right now. So, we more than 6000 Seabins ordered already and we can’t really attend all that demand.

L: That’s pretty impressive. So, you think that the perception of floating litter or trash in the ocean in general. It’s quite a pressing topic at the moment, so you think that contributes to having so many orders?

S: Yes, of course. We’ve done a good job on social media. Everybody seems to be liking it, so it got a lot of acceptance and a lot of people push the marinas. Users say we can’t afford not to install.

L: So, it also has to do with having a good image, I guess?

S: Yes, yes definitely.

L: Definitely a step in the right direction I think. The whole development and the idea behind the Seabin Project. Making people aware that plastics in the oceans is not good. Because I am focussing on different relevant criteria: I would like to know which criteria you would weigh more/value higher: sustainability or efficiency of a certain marine litter removal technology?

S: If the Seabin wasn’t efficient, then the rest of the things would not be meaning to happen. So, I would say “emergent property” if you want to call it an ecological term. So, efficiency of all the parts as in smooth running. So, no actions behind it’s more of the addition of each of them separate.

L: In terms of financial aspects. Because you also have to consider the economy and how to get funding, I guess?

S: Yes, so that’s a very interesting model which we haven’t fully developed yet. We set up a foundation and we are hoping that in time the foundation will fuel all of this community activities. But for now, we got really, really low on funds and need to be very creative, you know, to afford the activities. So, it will be the sale of the Seabins that will sort of always keep the foundation a float and then we be open to gather funds from various other sources, of course. So, for those education, it’s all free activities.

L: So, you do have quite a high focus on the awareness campaigns and the research support?

S: Yes, that’s central to our mission.

L: From the whole project, your main goal is not making a lot of money, but to spread the word about marine litter and contribute to science and research?

S: Yes, that’s exactly what we are aiming for!

L: Awesome. Actually, I don’t have any more questions. But is there anything you wanting to add, or that would be relevant for me to know?

S: Send me a copy your thesis when you’re done.

L: Yes, definitely.

S: And on the science part of things. I had a master student involved. So, I had a master student using the Seabin as a - evaluating the capacity of the Seabin as a microplastic capturing and
So, that was his thesis and then if you want I can send you the pdf of his thesis and we’re now writing a paper which is about to be published. And then we also have the share program which is a program whereby, any organisation that has a similar mission and vision to ours will be able to try the Seabin for free. For a period of 6 to 12 months. In exchange of high quality data collection, because we have a serious ambition of finding out about microplastic contribution. So, we want to have data. Which means now, by any chance, you would like to get involved in that through your university, we can stay in contact about it.

L: That sounds really interesting.

S: So, we donate the Seabin for free. We ask the organisations to pay for the transport, and a few other items for which the university should be a pretty good source: like tweezers, sampling jars and maybe send the samples to Jenna Jembeck.

L: I’ll speak to my supervisor about it.

S: Yes, and if you want to go visit a Seabin, there is one that’s not in Amsterdam, but it’s not far away, like 45 minutes away.

L: Yes, I already spoke to Edwin [van der Meulen] and we actually going to meet up soon.

S: Excellent, alright. That sounds good. If you want, I can send you the thesis and feel free to contact me if you need anything else.

L: Thank you so much for your time, Sergio!

S: Not a problem!
E: It’s like this [shows picture of Seabin and points to big tank] this is filled with water, and the pump sucks it in and empties it all the time. There’s a timer installed in it which shuts it on and off. You can see, when you clean this filter now, it runs much better. You can see the water in it.

L: Do you ever have problems with fish getting caught in it?

E: No, not fish. Only dead fish, of course because they float. But no, not fish and other animals is not a problem. Because it’s moving so they are a little bit scared of it. So, we don’t catch much fish or animals.

L: Okay, because I was also talking to Sergio, you know him? Head of research from the Seabin Project?

E: Yes, I know him.

L: And he was saying that in the beginning it was a bit of an issue with fish getting caught in it and not getting back out again, but not anymore.

E: No, it’s not. It’s only the plankton and the really really small fish, maybe they get caught sometime.

L: Do you collect data on what you catch?

E: Yeah, we have some contacts here with the Marina Muiderzund and we ask them “What do you catch?” But for us it’s not like about the results from that many garbage, it’s more about the people to know what this is. More talking about it, it’s better for us.

L: So, you do a lot of awareness raising?

E: Yes!

L: When you installed it [the Seabin] was there a huge turn-up?

E: Yes, it was a lot of people and much attention. But yeah, it’s not the saver from all the plastic issue in the world, it’s not. It supports it and it’s well knowing for people. And we’ll have a sign here with a little plate and an explanation of what it does. And we’ll make a place there [points at shore close to pontoon where the Seabin is installed] for people to see it because it is a bit different now. So yeah, it’s not the solution from the plastic.

L: But it is to make people aware...

E: Yes, that’s the main goal. If it takes out some plastic, great! But we don’t have results from so much kilo being caught.

L: When I looked through the whole Sebin information online, a big focus seems to lie on supporting research and involving also schools and universities in the whole process

E: Yes, and children of course.

L: Awesome, and also beach clean-ups in other places. So, there is quite a lot of programmes around the Seabin.

E: Yes definitely.

L: This Seabin is the first one in the Netherlands, right?

E: Yes, we have two versions. We have a version before this one and that was not so powerful, not so strong. This one has more strength. And it’s also a different system to hang it up. This one for sale before this one, it was not working so great. And this is like one of the baby steps from the Seabin, from this point it will always get much better and better. Because, you know, you learn more about it and what it does.

L: Do you know what, ... Do you actually work for the marina?
E: We have a lot of products here all around, that you can see that’s from us – Poralu. We have a good connection [with the marina] and they were the first to say, we want to work with you, with the Seabin, it’s a great idea. And now it’s running, and it’s been running for like a month – since May it’s running. It’s not been running for a year or half a year.  
L: So, it only properly got installed this year?  
E: Yeah, we have some demonstrations in the next week and the week after and then we can sell some Seabins. But we, how do you say? The responsibility is by the port or marina.  
L: So, they maintain it and ...  
E: Yes, and they have to clean it.  
L: What do you think was the first incentive of the marina to install it? Is it because plastics is becoming more and more of an issue also in the news and on social media? Or is it just to make their image look better?  
E: This is a very clean port, marina. Marina Muiderzund is a small of group of more marinas in Holland – the Thuishavens group it’s what they’re called. You have one in Zeeland, you have one in Delta Marine, and you also have so much more. They are very clean, and they are aware of the port seems good for the people and the boats, of course. And they are also trying to make things better. We also have a big problem here with the water plants, they go up from down at the bottom to up the water level and they go into the boats screws.  
L: Oh really?  
E: Yes, that’s a big problem. They are always looking for solutions and they think this [the Seabin] is a solution for the garbage in the water. And it supports a good like marketing.  
L: Yes definitely.  
E: But you can see you can clean it already, because there are algae growing already.  
L: How fast does it grow on it? Is this like a week old, or a month?  
E: Oh, this! It’s like a month.  
L: Okay. So that’s still doable, you don’t have to clean it like once a week – like the whole thing, I mean?  
E: I think with the catch bag you have to see what day it is. Like now, there is not so much algae in the water. But when there is a lot of algae, you have to check it more often.  
L: What about water conditions? You were saying earlier, today was the perfect day for it, because it’s calm?  
E: Yes.  
L: So, if it’s windy or too much waves it doesn’t work that well?  
E: More than three knots, they say it’s not catching any more stuff. But we say, the wind is not all the time hard, it’s sometimes it is calm or in the night it is calm. In the end the Seabin going to win from the weather conditions. If there’s a storm – I was here sleeping [points at little hut on floating dock] this is a little house where you can sleep – there was a lot of storm, a lot of wind and it [the Seabin] don’t catch anymore but it holds it in its bag.  
L: So, it doesn’t get out? The stuff that’s already inside doesn’t get out?  
E: No.  
L: That’s at least something.
E: Yes, it’s good because otherwise you catch something, and it’s gone again. But you are here in a port, this is different than an open sea. In the open sea you have waves. And the waves are much lower here, 0,3 waves. This [the Seabin] is for places where it’s more sheltered.

L: That’s what they developed it for, right? Because I mean these are all private boats, right?

E: Yes.

L: So, it’s all private owners?

E: Yes.

L: And you think that they notice it [the Seabin] and they become a bit more aware?

E: Yes, of course! I was working on this and people walk by and they say “Oh great, you’re working on it! It’s a great idea!” People are much happy about it.

L: That’s great! Yeah, I think it’s a lot about making people aware that they shouldn’t just throw their coke bottle in the water.

E: Yeah, and cigarettes and stuff like that. You can see in the news now how many years it takes the nature [to degrade plastic]. It’s over 50 years. That’s a lot.

L: Yes, it’s crazy. Plastics in general are just...

E: Yes, but it starts with people, right?

L: Exactly!

E: We have some technology. But who’s going to find a solution about this problem? Is it the people or the technology? We say, it’s the people. Technology helps us and aware us, but it starts with people. When I’m in the city I see a lot of people throwing trash on the street. It’s so easy but they just don’t know how.

L: I mean, I think it has a lot to do with education as well, right? Because a lot of people don’t know that if they throw trash on the streets in Amsterdam it might end up in the ocean. And it can degrade to microplastics which gets eaten by fish and they eat the fish.

E: Yes, and then they get sick. Also have you heard of the whale in the news? That had 80 kilos of plastics inside the stomach?

L: Yes, I saw that! So sad. Turtles as well...

E: And you like diving? In years it will be much more difficult to dive any more...

L: Yes, it’s not going to be as it is now. It’s already horrible now, when you go to some places. That’s actually why I write my thesis about this topic. Last year I went to Indonesia and I was working on this really really remote island, like no people. And I go into the water and there is like tons and tons of plastic bags when you just start asking yourself Where is this coming from? The currents carrying it there. And there’s no infrastructure in place to get rid of it or educational awareness campaigns for teaching people not to throw their stuff in the ocean. But I think it’s getting there. I feel like there is more and more awareness campaigns and on social media it’s a very present topic. I think also the Seabin is working a lot with social media appearance, right?

E: Yes, of course.

L: When I was talking to Sergio he told me that most of their orders come through social media because they have such a strong appearance there. They get more and more marinas and harbours to contact them.
E: My experience is that the ports show some interest, but they won’t begin with one [Seabin] because they don’t know the product. So, it’s slowly building. And maybe in about three or five years from now you see the Seabin everywhere.

L: Yeah maybe. It’s like, it’s around 3000 Euros to get one, right?

E: Yes.

L: It’s not like a little investment, is it? It’s something to consider, I guess especially if you don’t know if it works that well.

E: It works well, that’s not the problem. But the mindset is that it’s not a vacuum cleaner in a port. It supports to catch some trash. And for a port it’s not so much money. A port or harbour makes like 4 – 500,000 Euros. Some costs off it. It’s not so much, it’s okay. But yes, if you go to the store and say: “I want a Seabin!” Then, yeah ... for your private pool in Germany, Hamburg, then yeah, it’s a little bit too much.

L: [Laughs] Okay, fair enough good point. I guess they make a lot of money with all the boat spaces.

E: Yes, like a boat over there that stays one year – it’s 50,000 Euros. And for the winter they go on the wall – like 300 Euros more. So, it’s doable for a port.

L: Okay I guess so. And I mean the maintenance costs – I think the electricity doesn’t take up too much?

E: No, it’s like 2 Euros a day. And the pump runs 24/7, it stays on which is also good.

L: And the cleaning and servicing is really easy to learn? Do you have to train staff especially for that?

E: No, no not at all. It’s not so difficult. The system of it is pretty easy. The water pump, like we call it, it’s used a lot in the daily work from people. When there is water, like in a tub, and you want it out, you put the water pump in and the water flows out. That principle is the same as this. It’s not so difficult, it’s not rocket science.

L: That’s so great about it because it’s a simple technology but somebody just needed to have the idea to put it there [in the water].

E: And this pipe is for the air to get out.

L: Sergio was telling me that they started this project where they want to start sampling and monitoring microplastics, have you heard about that?

E: Yeah, the microplastics. What we are like, like Dutch people, how do you say? Sober? [austere, unemotional] And of course we also want microplastics to be caught, but we think that the first step is to remove little bottles of plastic. You see the lid from the plastic bottle is harder plastic than the bottle itself. The bottle top takes like 50 years to go away or break up. And the plastic bottle takes 20 – 30 years. Our main goal is to catch some bottles first and then we can move on to the microplastic but this one [the Seabin] is also catching microplastics, of course.

L: But it only catches stuff that’s on the surface directly? It can’t go below the water level?

E: No, it’s stuck with this [points at pontoon]. Because it’s a driving pontoon that can go up and down with the water level. It’s difficult for microplastics because you can’t see it. You have to pull it out and have to see it closely, it’s very difficult. I think this is, what I already said, this is a very clean port. In the Netherlands, like more in the city, you have also ports – for example Sneek in the North – that have more youths. Here you have not that old people, but like 40, 50, 60 years old. And also, in the city there is more children and they throw a lot of trash of course. If you go there you can see wow, trash is everywhere, and then you think: “Oh, it’s [the Seabin]
is actually catching some!” But here it’s difficult to see because the port is really clean. Some plastics get caught but it’s not much.

L: So, it practically to see how it works and for people to see how it works. And then maybe someone from another harbour sees it and thinks: “Maybe we should get one, too.”

E: Yeah, I have daily contact with customers, because they say: “Oh well, it’s nice for us.”

L: And I mean if you say it’s not that expensive for harbours.

E: No.

L: And it doesn’t take up much space. It’s not like it takes away a whole boat space and they lose so much money when they install it.

E: Yeah. I mean we also have something for the fuel in the water. We have like 900 tanks from the boats on the water, and that’s a lot. And every time they fill up the boat, some fuel comes out of it, like with your car when you put petrol in.

L: Like oils and stuff?

E: Yeah, it’s getting into the water. It happens every time, and ship have to fill their tanks 10 or 20 times a year. If they go out once a week. So, this is an oil pad, you can take a picture of it. We can make it stuck on the filter, on the bottom. It takes the water in it and the fuel goes through.

L: So, it sucks it up?

E: Yes, and then you have the fuel on this pillow.

L: So, is that [the oil pad] already in there [the Seabin]?

E: No, no this time not. Because it was a little bit heavy because of the water. So yeah, it’s a little bit difficult. We first want to go for plastics and maybe we going to develop another one for only oils. For tanks and some places.

L: It’s [oils] only, or mostly on the surface so it would make sense.

E: Yes, it’s on the top of the water, right? It’s not in the water. It’s the rainbow colour that you can see, that is being taken out.

L: That makes sense. How often do you have to exchange these [the oil pads]? Do they get filled up quickly?

E: Yeah, it’s difficult because it’s like, it depends on the area. If you have an area with like a lot of fuel around, then you have to go once a week to clean it up.

L: But you can reuse that [the oil pad]?

E: Yeah.

L: Okay, so it’s not like you have to throw it away once it’s full?

E: No, not at all. Now you can see some fish around it [the Seabin]. You see?

L: Oh yes! They really don’t seem too bothered by it. They look more happy about the algae growing on the Seabin. I guess it makes a bit of noise under water?

E: But the noise is like 60 decibel, so it’s like too much noise. It’s like you would hear in a river.

L: Would this actually work in a river?

E: Does it work in a river? I don’t think in a river, because in a river there is a lot of water around that’s going fast. It’s more like in a calm setting where it works. Like in the canals from
Amsterdam or on houseboats and stuff like that, it’s working. But in rivers, I don’t think because there is too much flow and currents.

L: But this is a good start.

E: Yes, of course.

L: It’s nice to see it! I’ve read so much about it and watched videos and now I can actually see it.

E: [Laughs] Okay, nice. It’s also like a kind of therapy, listening to it.

L: [Laughs] Yes, it’s quite soothing.

E: We can try and see if it also catches a wine bottle. It’s very heavy.

[Throws in wine bottle; Seabin catches wine bottle after a bit]

E: Because it’s heavy it takes more time for the water to catch it. If you have full bottle it’s more difficult than an empty bottle. So, weight plays a role.

L: So, you have to turn it off every time you want to empty the catch bag?

E: Yes, because otherwise the system doesn’t work.

[Turns off Seabin and removes catch bag]

E: I can show you now how it catches fuel.

[Places oil pad at bottom of catch bag and positions it with cable ties; puts catch bag back into Seabin and turns it back on; a small film of oils is being sucked into the Seabin and gets absorbed by oil pad]

L: How long does the whole installation process take?

E: Like 1 hour.

L: Oh, that’s really quick.

E: This is something we still need a good idea for [how to attach the oil pad to the catch bag].

L: What is it [the oil pad] actually made off?

E: It’s normal material they use a lot in the boat scene. They use it to catch some oil.

L: How do you clean it [the Seabin]? Just rinse it with water?

E: Yeah, I use high pressure hose, it’s much easier. There’s water on the pontoon. And it takes like a minute to clean it.

L: Alright, thank you very much for you time, Edwin! This was really helpful and informative and it’s nice to see the Seabin in action. Thank you so much!

E: No problem, glad I could help out.
Pictures of the Seabin at Marina Muiderzund, Almere

Figure 9 The Seabin at Marina Muiderzund, Almere (Picture by Lynn Jula Kessler)

Figure 10 Hemp catch bag with caught debris including piece of microplastic (Picture by Lynn Jula Kessler)
Figure 11 Components of the Seabin (Ceglinski & Turton, 2017)