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Engaging recreational scuba divers in marine citizen science: Differences according to popularity of the diving area

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Abstract

1. Characterizing the composition of divers visiting different diving areas could help to design marine citizen science (MCS) projects that support biodiversity monitoring and marine conservation.
2. Recreational scuba divers mostly prefer warm and clear waters with coral reefs, and based on the Duffus and Dearden's wildlife tourism framework we hypothesized that a more popular diving area is visited mostly by generalist divers, whereas in a less popular diving area a higher proportion of specialist divers would be found.
3. Recreational scuba divers were surveyed in diving centres at two diving areas, Rapa Nui (more popular, with warm and clear coral-reef waters) and the Chilean mainland (less popular, with productive and temperate–cold waters), to determine their diving profile, visiting profile, marine species knowledge, and interest and participation in MCS.
4. Support for our hypothesis (generalist divers on Rapa Nui and specialist divers on the mainland) was weak, but recreational divers on Rapa Nui were mostly foreign visitors who come for single visits, whereas divers from the mainland were predominantly Chileans who return repeatedly to the diving area. In both diving areas the divers expressed a strong interest to be trained and to participate in MCS, but divers from Rapa Nui were interested in brief pre-dive inductions, whereas divers from the Chilean mainland preferred intensive training courses.
5. Based on these findings we recommend specific MCS strategies for divers in both types of areas, e.g. simple protocols in more popular diving areas, with short pre-dive briefings for divers, and medium or long-term programmes in areas where most divers are local with high return rates. In these latter conditions more extensive training will be useful, which allows divers to gain more experience and assume higher responsibilities within an MCS project.

KEYWORDS

Chile, Easter Island, participatory science, Rapa Nui, scuba, underwater, volunteers

1 | INTRODUCTION

Marine research, and especially the monitoring of marine organisms and communities, requires a high investment of resources (e.g. expensive equipment and extensive time) that small research institutions generally find difficult to accommodate (Danielsen et al., 2005; Morrison et al., 2013). This often restricts the spatial and temporal extent of these studies. Marine citizen science (MCS) has emerged in the past decade as a suitable complement to marine research requirements by involving marine users in scientific studies.

Divers have been one of the main groups involved in MCS (Thiel et al., 2014) and their participation has contributed useful data for science (Edgar et al., 2014; Forrester et al., 2015; Ward-Paige & Lotze, 2011; Wolfe & Pattengill-Semmens, 2013); however, although most divers have shown a strong interest in participating in MCS, many of them have never participated or did so only once (Lucrezi et al., 2018). Thus, improving the strategies to attract and retain participants in MCS still remains an important challenge (Cigliano et al., 2015). A better understanding of the profile and participation preferences of divers in MCS would help to make the design of citizen science projects more effective.

1.1 | Diversity of recreational scuba divers and marine citizen science

In general, recreational scuba divers are well characterized in the scientific literature, being mostly male (60–70%), aged between 30 and 50 years, with a high level of education, and with an income that is above average (Garrod & Gössling, 2008; Lucrezi et al., 2017; Salim et al., 2013). Recreational scuba divers are also a very diverse group, however, and information about the differences in their profile (demographic composition, and socio-economic or diving background) have been useful to predict skills, knowledge, perceptions, and behaviours (Anderson & Loomis, 2011; Bentz et al., 2016; Hammerton, 2017; Kirkbride-Smith, Wheeler, & Johnson, 2013). This information has helped to establish more efficient strategies in diving tourism (Garrod, 2008) and it could also be useful to predict interests, preferences, and the motivation to participate in MCS. For example, an interest in MCS is often positively related with level of education (Hermoso et al., 2019; Martin et al., 2016). Lucrezi et al. (2018) determined that older divers were more participatory in MCS, whereas Martin et al. (2016) reported a stronger interest in MCS for divers aged <45 years. Diving experience can also help to explain diver interests in MCS. For example, Cerrano et al., (2016) found that divers with more diving certifications participated more actively in the Reef Check project in Italy. Similarly, Lucrezi et al. (2018) determined that variables related to higher diving experience were associated with higher participation in MCS. Also, in a MCS project that required a minimum of 50 dives, most of the selected divers had actually logged more than 300 dives (Edgar & Stuart-Smith, 2014). In summary, taking into account that diver profile can affect participation in MCS, and knowing how this varies among different dive areas, can help to define better strategies in the design of local MCS projects.

1.2 | Local variation in diver profile

The tourist area life cycle model (Bulter, 1980) explains that a tourist area is dynamic and experiences evolution, starting with its discovery for tourism, with low numbers of visitors, followed by increasing numbers of tourists over time, until consolidation or collapse. On the other hand, the recreational specialization theory (Bryan, 1977, 2000) explains that a participant in an outdoor activity goes through a process from the beginning of participation, with less experience and a general interest in the activity, to more experienced participation, with higher involvement and more specialized interests. Duffus and Dearden (1990) combined the recreational specialization theory with the tourist area life cycle model (Bulter, 1980) to propose the Duffus and Dearden wildlife tourism framework (WTF). This framework postulates that when the popularity of a wildlife tourist area increases, the proportion of specialist tourists will decline, and generalists will become more common. This framework has been successfully applied to a variety of wildlife tourism places, including diving areas (Augustine et al., 2016; Catlin et al., 2011; Dearden et al., 2006). Thus, according to the WTF, in a more popular dive area most divers should be generalists, whereas in a less popular dive area more specialized divers are expected.

In general, recreational scuba divers prefer warm and clear waters with colourful wildlife, with coral reefs being the most attractive ecosystem for scuba diving (Parsons & Thur, 2008; Uyarra et al., 2005), whereas colder and more productive waters (with less visibility) are less attractive to most divers (Garrod & Gössling, 2008). Some authors suggest that motivations and attitudes of divers in temperate–cold waters differ from those who dive mostly in warm waters (Jones et al., 2009; Todd, 2003). At sites with cooler waters it is expected that most divers will be local and have a strong attachment to the place (Moskwa, 2012; Palau-Saumell & Sa, 2018), whereas many divers at popular coral reef sites are international tourists, often with limited place fidelity (Augustine et al., 2016). These differences can be important to determine the profile of divers that dominate in a diving area.

As the profile of divers could affect their interest or participation in MCS (Cerrano et al., 2016; Hermoso et al., 2019; Martin et al., 2016), it is important to understand the differences among divers from different diving areas better in order to design effective strategies for local MCS projects. The aim of this study was to compare the diver profiles between two contrasting dive areas to test the hypothesis that the popularity of diving areas is negatively related to diver specialization. Divers from Easter Island (Rapa Nui) and the continental coast of Chile were interviewed, with Rapa Nui being a popular diving area (coral reef with warm waters) and with continental Chile considered a less popular diving destination (productive temperate–cold waters). Divers were asked about their demographics, dive habits, and interests in order to determine whether the characteristics of divers indeed differed between these two areas. This information was then used to recommend more effective design strategies for MCS projects.

2 | METHODS

2.1 | Study area

Chile represents an ideal model system for a comparative study of divers in two contrasting ecosystems: (i) the Chilean mainland; and

(ii) Rapa Nui. The less popular diving areas on the continental coast of central Chile, from Caleta Chañaral de Aceituno (20°S, 71°W) to Quintay (33°S, 72°W), are dominated by the Humboldt Current System, with highly productive and cold waters (Thiel et al., 2007). The more popular diving area in Rapa Nui (27°S, 109°W) is characterized by extensive coral reef systems in oligotrophic and warm waters with very high visibility (Friedlander et al., 2013) (Figure 1).

Both areas have a characteristic isolation factor, with the Chilean mainland stretching between the south-east Pacific coast and the Andean mountains, and with Rapa Nui known to be the most remote inhabited place in the world (Diamond, 2007). Rapa Nui is not among the most popular diving areas of the world (Garrod & Gössling, 2008), but over the past 30 years recreational scuba diving has steadily been increasing, and in 2019 there were 10 diving centres, each year guiding hundreds of divers to popular coral reef diving spots.

2.2 | Survey

A questionnaire (survey) with 26 questions was designed to characterize divers at the two different diving areas based on their demographics, diving background, characteristic of the visits to the diving area, knowledge about marine species, and willingness to participate in MCS (Appendix A). A total of 96 recreational scuba divers were surveyed at different localities on the Chilean mainland from January to March 2016 at a total of 15 dive centres. On Rapa Nui, 81 divers were surveyed during October and November 2014 and January 2015 at two dive centres. In both areas, recreational scuba divers were asked after their dives whether they would be willing to participate in the survey, which required about 15–20 min. The survey was divided into five main domains: (i) demographic profile, regarding nationality, age, gender, education level, and income; (ii) diving profile, looking at their motivation to dive, and diving experience and frequency; (iii) diving area visit, considering the motivation for their visit, duration, and intention to return; (iv) local marine species knowledge, previous training experience in marine species identification, and interest and preferences for future training; and (v) willingness to participate in MCS projects. At the time of the fieldwork for this study, no formal approval from the ethics committee was required, but the research has been guided by the ethical principles of our university. All divers interviewed were informed about the purpose of this study and agreed to their anonymized data being evaluated and shared within a scientific publication.

2.2.1 | Demographic profile

Some contact data, such as name and email, were required in this section. Other data, such as age, gender, country of residence, and profession, were requested at the beginning of the survey. Furthermore, participants were asked about their education (primary school; middle school; technical; advanced technical; college degree; postgraduate degree) and monthly income (<US$300; US$300–750; US $750–2,000; US$2,000–4,500; or >US$4,500).

2.2.2 | Diving profile

This section of the survey aimed to characterize the diving background of the divers. Divers were asked about their motivation and diving experience. For the main motivation to dive, divers had to choose among the following categories: (i) adventure and experience; (ii) fauna and flora; (iii) marine landscape; (iv) leisure and pleasure; and (v) for work. Diving experience was measured as the total number of dives logged (numerical variable) and dive certification level: (i) first level (open water, first star, or similar); (ii) second level (second star, advanced, or similar); (iii) third level (rescue diver or similar); and (iv) fourth level (professional levels from dive master to instructor levels). Divers were also asked for their actual diving frequency: (i) almost every day; (ii) 2–5 times per week; (iii) 2–5 times per month;

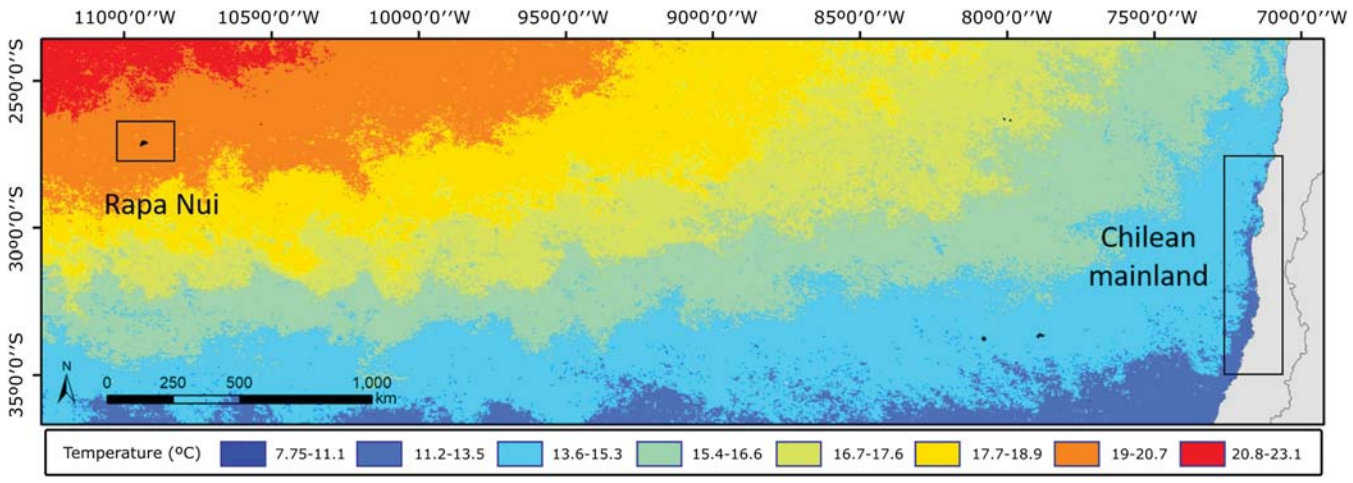

FIGURE 1 Study area map with a representation of the differences in water temperature based on free available data from the Aqua Modis Satellite in September 2014 (https://www.bio-oracle.org/)

(iv) 7–11 times per year; (v) 2–6 times per year; and (vi) once per year or on special occasions. Finally, they were asked whether they had dived in other countries and, if they answered yes, where. Based on the regions of Spalding et al. (2007), destinations in the tropical Atlantic, tropical East Pacific, central Indo-Pacific, eastern Indo-Pacific, and western Indo-Pacific were classified as 'warm waters'. Destinations in the temperate North Atlantic, temperate South America, temperate southern Africa, temperate Australasia, temperate North Pacific, and Artic were classified as 'temperate–cold waters'. We evaluated the total number of destinations that each diver had visited for diving in warm and in temperate–cold waters.

2.2.3 | Dive area visit

A diving area was considered as 50 km around the respective diving centre, and if divers lived in that area they were considered as residents. In order to know the main motivation for visiting the diving area, the divers had to choose from a list of seven options: (i) culture and geography; (ii) diving; (iii) nature; (iv) social motivations; (v) for work; (vi) being in transit; and (vii) other. They were also asked about the duration of the present visit (i.e. number of days), the number of times that they had visited the place in total, and if they planned to return in the future (yes, maybe, probably not, or no).

2.2.4 | Marine species knowledge and training preferences

To determine their marine species knowledge, two indicators were used. The first indicator was their self-determination of knowledge of local marine species in three categories: limited knowledge (less than five species); medium knowledge (between five and 15 species), and high knowledge (more than 15 species). Then their actual knowledge of local species was evaluated through determining how many species they could correctly recognize on an identification (ID) chart of common species in the area; a marine species knowledge score was calculated counting the percentage of marine species recognized by each diver on an ID chart with common species of the area (Appendix A). Divers only had to point at the species they recognized from their recent dives, and neither the common nor the scientific name of the species was required. We also asked them whether they had some training in marine biodiversity identification and which type of learning resource they typically used for species identification (books, internet, ID charts, talking to other people, or other). Finally, to determine their interest to be trained in marine species recognition, divers were asked if they would be interested to learn about typical flora and fauna of the area and their willingness to pay for training, and which kind of training they would prefer, with three choices: short introduction (10–15 min before a dive); extensive classes (1–3 h); or a course lasting for several days with a few hours every day during one week.

2.2.5 | Willingness to participate in MCS and actual participation rate

In the final section of the survey, divers were asked about their interest to collaborate with science and if they had an underwater camera to record marine biota. Divers who had a camera were asked about their willingness to share their pictures with the project for scientific purposes. Finally, to study the actual participation, divers were invited to contribute to science with pictures of the fishes and other organisms that they had photographed during their dives, as this is a typical format of participation in MCS (Thiel et al., 2014). We informed divers that we would send them an email to request photographs from their dives with the aim to be used for scientific research. Approximately 1 month after the survey, an email was sent to the divers who had expressed their willingness to share their pictures, asking about photographs or videos. Another 1 month later (i.e. approximately 2 months after the survey) another reminder was sent to those who had not yet replied, and the final response rate was calculated.

2.3 | Data analysis

With the intention to make results easier to interpret, the following dependent variables were categorized into two groups: nationality (Chilean/Foreign); educational level (college or postgraduate studies, yes/no); income (<US$2,000/>US$2,000); total dives accumulated (≤40/>40 dives, based on the minimum number to become a professional diver under the Professional Association of Diving Instructors (PADI) scheme); total number of times visiting the area (only once/more than once); and visit duration (<4 days, 4–10 days, or >10 days). Data were analysed and managed with R STUDIO (R Team, 2016). Each response variable was compared between divers from both areas; for numeric variables Kruskal–Wallis tests were used and for categorical variables Pearson χ^2 tests were used.

3 | RESULTS

3.1 | Demographic profile

Recreational divers in both study areas shared similar demographic characteristics but had different nationalities. Most divers from the Chilean mainland were Chilean nationals, whereas most recreational divers on Rapa Nui were of foreign origin, with France (10%), USA (9%), and Spain (8%) being the most frequent nationalities among the international visitors (Table 1). Divers were mostly male, aged 25–45 years (36.2 ± 11.7 years, mean ± standard deviation, on the Chilean mainland; 37.4 ± 10.3 years on Rapa Nui; $H = 0.4$, $P = 0.53$), with a college degree or postgraduate degree, and with a monthly income of >US$2,000. There were no significant differences between the two study areas (Table 1).

TABLE 1 Demographic profile of divers from both study areas

Demographic profile	Chilean mainland *n* = 96	Rapa Nui *n* = 81	χ^2	*df*	Significance
Nationality (% Chilean)	84.4	32.1	76.9	1	***
Gender (% women)	20.8	30.9	4.8	1	0.18
Education level (% university studies)	78.3	85.2	0.8	1	0.38
Monthly income (% more than US$2,000)	70.9	81.6	2.0	1	0.16

Divers were interviewed in person at dive centres on Rapa Nui and the Chilean mainland in 2014/15 and 2016, respectively.
***$P < 0.001$.

3.2 | Diving profile

The diving profile of divers showed significant differences between the two areas. The main diving motivation for divers on the Chilean mainland was for 'adventure and experience' or for 'leisure and pleasure', whereas on Rapa Nui most divers reported 'flora and fauna' as their motivation (Figure 2; $\chi^2 = 34.26$, $df = 4$, $P < 0.001$). Divers in both areas had similar certification levels ($H = 3.3$, $df = 3$, $P = 0.29$), with large proportions of the divers having the most basic certification level (34.4% on the Chilean mainland and 43.2% on Rapa Nui) or the second level (35.4% on Chilean mainland and 33.3% on Rapa Nui). More divers (57.5%) on the Chilean mainland had completed 40 or more dives, whereas on Rapanui only 39.5% had reached that threshold (Figure 2; $\chi^2 = 4.91$, $df = 1$, $P = 0.026$). Also, the diving frequency was higher in divers on the Chilean mainland, who mostly dive 2–5 times per month, versus the divers surveyed on Rapa Nui, who mostly dive 2–6 times per year (Figure 2; $\chi^2 = 30.2$, $df = 5$, $P < 0.001$); this result suggests a slightly higher experience level of divers on the Chilean mainland. Even so, more divers on Rapa Nui had dived in other countries outside of Chile (Figure 2; $\chi^2 = 18.84$, $df = 12$, $P < 0.001$), with a higher average number of countries overall (3.8 ± 2.3 countries on Rapa Nui versus 2.8 ± 1.6 countries on the Chilean mainland, $H = 5.73$, $P < 0.001$). Furthermore, the divers surveyed on Rapa Nui had visited more countries with warm waters than the divers on the Chilean mainland (Table 2; $H = 4.3$, $df = 1$, $P = 0.04$), but there were no differences for temperate–cold waters ($H = 0.1$, $df = 1$, $P = 0.75$).

3.3 | Diving area visits

Significant differences were found in the characteristics of the visits by the recreational divers from the two diving areas (Figure 3). For example, most divers on the Chilean mainland came specifically for diving, whereas on Rapa Nui most divers came for the culture and

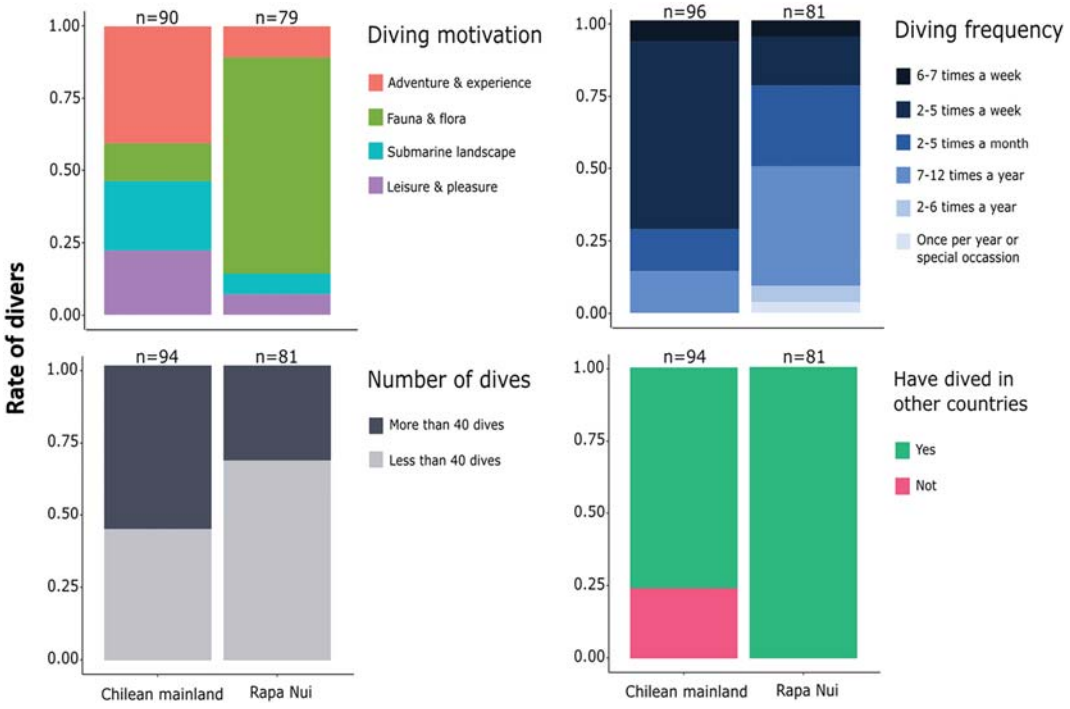

FIGURE 2 Main differences in diving profiles of divers surveyed in both study areas. Divers were interviewed in person at dive centres of Rapa Nui and the Chilean mainland in 2014/15 and 2016, respectively

TABLE 2 Main diving destinations around the world, based on the marine ecoregions described in Spalding et al. (2007), and the proportion of divers who had dived in different ecoregions

	Marine ecoregion											
Driving area	TA w	WIP w	CIP w	EIP w	TEP w	A t–c	TNA t–c	TNP t–c	TSAm t–c	TSAf t–c	TAu t–c	SO t–c
Chilean mainland (%)	41.6	8.8	9.7	4.4	8.0	0	13.3	2.7	22.1	0.9	0.9	0.9
Rapa Nui (%)	52.4	31.5	46.8	24.2	17.7	1.6	38.7	6.5	8.1	8.1	4.0	1.6

Abbreviations: TA, Tropical Atlantic; TNA, Temperate Northern Atlantic; TSAm, Temperate South America; TEP, Tropical Eastern Pacific; TSAf, Temperate Southern Africa; TAu, Temperate Australasia; CIP, Central Indo-Pacific; TNP, Temperate Northern Pacific; A, Artic; EIP, Eastern Indo-Pacific; SO, Southern Ocean; WIP, Western Indo-Pacific; t–c, temperate–cold waters; w, warm waters. Percentage of divers that have dived in the different ecoregions.

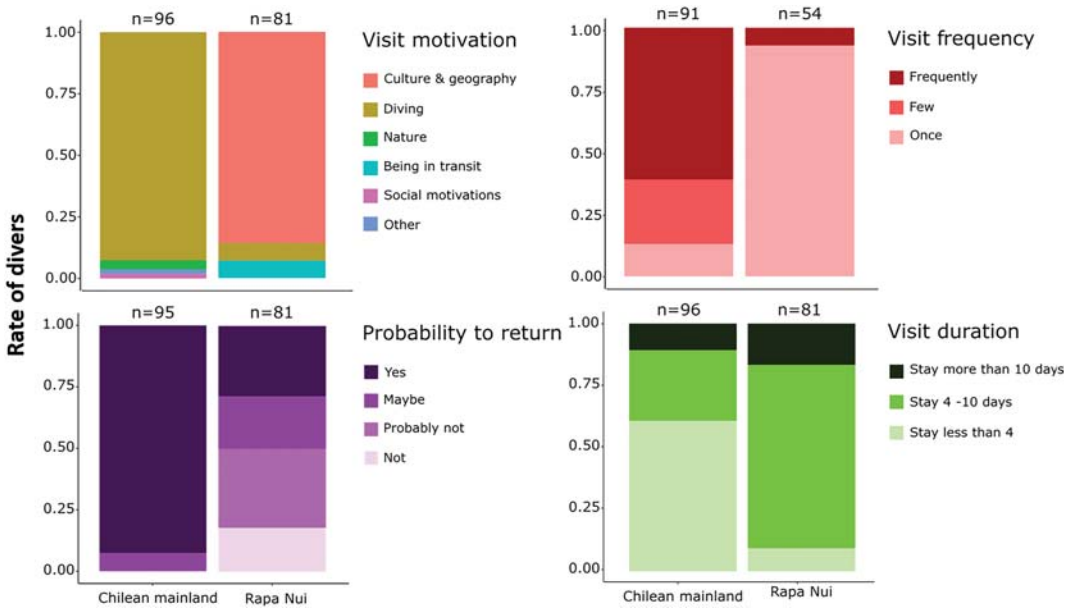

FIGURE 3 Main differences in diving area visit of divers surveyed in both study areas. Divers were interviewed in person at dive centres on Rapa Nui and the Chilean mainland in 2014/15 and 2016, respectively

geography of the area but also used the opportunity to go diving (Figure 3; χ^2 = 114.4, *df* = 6, *P* < 0.001). Most divers from the Chilean mainland had visited the diving area more than once, whereas on Rapa Nui just 6.3% had come frequently to the island (Figure 3; χ^2 = 70.2, *df* = 1, *P* < 0.001). Also, 92.7% of the divers from the Chilean mainland thought that they would return to the area in the future, whereas this percentage was significantly lower on Rapa Nui (Figure 3; χ^2 = 49.1, *df* = 1, *P* < 0.001). The duration of the visit was shorter for most divers visiting the Chilean mainland, with a typical stay of less than 4 days, whereas the divers surveyed on Rapa Nui stayed between 4 and 10 days (Figure 3; χ^2 = 78.8, *df* = 2, *P* < 0.001).

3.4 | Marine species knowledge and training preferences

Most of the divers in both areas (64.6% on the Chilean mainland and 69.1% on Rapa Nui) self-determined their knowledge of local species as being 'limited', and the others (34.4% on the Chilean mainland and 30.9% on Rapa Nui) rated their knowledge as 'medium', with just 1.0% of the mainland divers scoring their knowledge as 'high'. There were no significant differences in the self-determined knowledge of divers between the two diving areas (χ^2 = 1.1, *df* = 2, *P* = 0.56). Divers in both areas could recognize a few of the species from the ID chart, with a typical score of between two and 10 of the common species (1.94 ± 0.63 on the Chilean mainland and 1.97 ± 0.85 on Rapa Nui, *H* = 2.16, *P* = 0.14). Only 25% of the divers on the Chilean mainland indicated that they had received previous training in species identification, whereas 61% of the divers on Rapa Nui had received it (Figure 4; χ^2 = 12.1, *df* = 1, *P* < 0.001). On the Chilean mainland, divers had gained experience in species identification by talking to other people (46.9%), followed by ID charts (29.2%), and the internet (25.0%), whereas the divers surveyed on Rapa Nui mostly used the internet (37.2%), ID charts (35.9%), and books (32.1%). Divers on the Chilean mainland and on Rapa Nui declared an interest to be trained in marine species identification (Figure 4; χ^2 = 2.0, *df* = 1, *P* = 0.16),

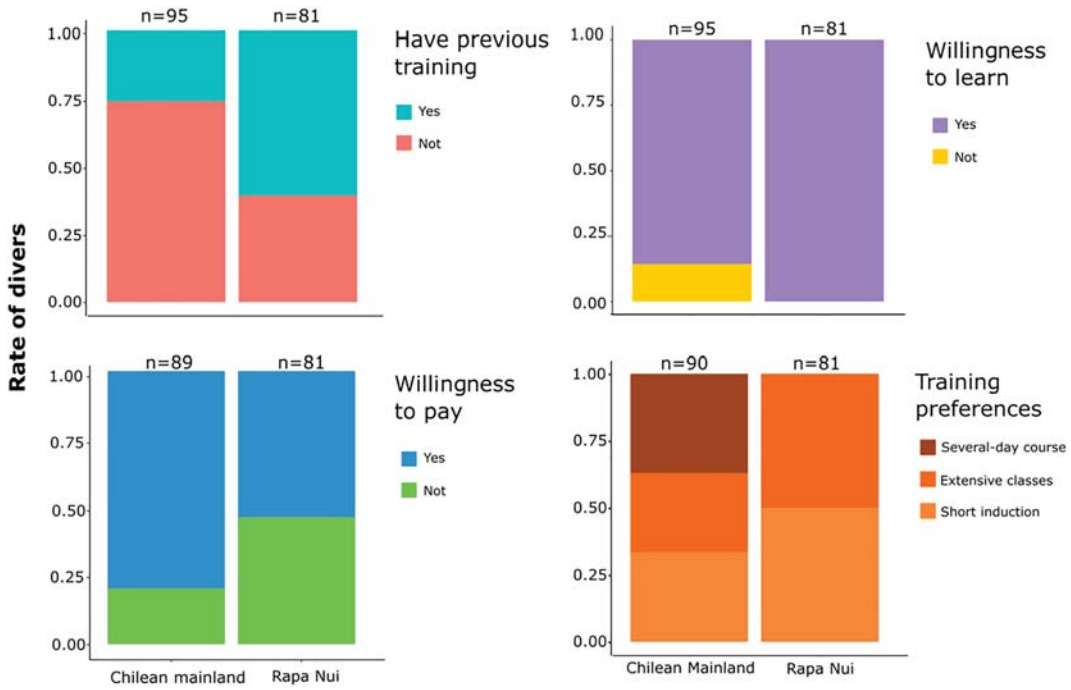

FIGURE 4 Main differences in marine species knowledge and training preferences of divers surveyed in both study areas. Divers were interviewed in person at dive centres on Rapa Nui and the Chilean mainland in 2014/15 and 2016, respectively

but on the Chilean mainland more divers were willing to pay for training than on Rapa Nui (Figure 4; $\chi^2 = 5.1$, $df = 1$, $P = 0.02$). Divers surveyed on the Chilean mainland expressed preferences for a course lasting several days or for extensive classes in marine biodiversity to learn about the marine environment, whereas most divers surveyed on Rapa Nui preferred a short induction before diving (Figure 4; $\chi^2 = 33.13$, $df = 3$, $P < 0.001$).

3.5 | Actual participation rate

Most divers owned an underwater camera, both on the Chilean mainland (73.8%) and on Rapa Nui (63.0%) (Figure 5; $\chi^2 = 1.77$, $df = 1$, $P = 0.18$). Of those who had a camera, most expressed their willingness to share their pictures to be used for science; however, when they were reminded (by email) to share their pictures for this scientific project, only a few responses were received and even fewer of those responses included images, with divers on Rapa Nui having a higher participation rate than divers on the Chilean mainland (Figure 5; 10% on the Chilean mainland and 16% on Rapa Nui, $\chi^2 = 7.00$, $P = 0.03$).

4 | DISCUSSION

This study provided insights into the composition of recreational scuba divers from two contrasting dive areas: one more popular area (warm and clear waters, with extensive coral reefs) and another, less popular area (temperate and productive, turbid waters, with kelp forests). Divers in both areas showed strong interests to participate in

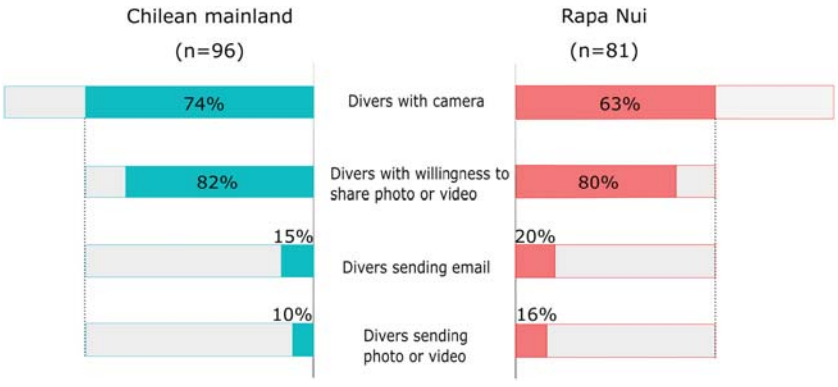

FIGURE 5 Actual participation rate of divers in both diving areas. We first asked divers whether they had an underwater camera. For subsequent questions we considered divers with a camera as representing 100%

MCS. Divers in the less popular diving area were mainly national divers who dive frequently and have a high probability to return to the diving area. These characteristics indicate their potential to become specialized in local marine biodiversity and to participate in long-term MCS projects. Divers in the more popular diving area were mainly foreign visitors, whose visits to Rapa Nui were short and mostly one-off, but they had a slightly higher rate of submitting photographs than the mainland divers. Thus, in popular diving places, such as Rapa Nui, with a high percentage of foreign visitors, it could be more effective to propose MCS projects based on simple tasks, such as sharing photos (for example using iNaturalist or similar platforms). These findings are discussed here to guide MCS project coordinators in designing volunteer-supported programmes in biodiversity monitoring and marine conservation.

4.1 | Similarities and differences between recreational scuba divers

The results of this study show that divers in different diving areas have important differences that could determine their preferences for participation in an MCS project. One important difference between divers from the two diving areas was their nationality, with mostly national divers on the Chilean mainland (a less popular diving area) and primarily foreign divers in Rapa Nui (a more popular diving area). Similar observations had been made for Australia in the Great Barrier Reef (a very popular diving area), where most recreational scuba divers (80–60%) were foreign visitors (Pabel & Coghlan, 2011), whereas in the temperate zone of the country 50–70% of the recreational scuba divers were of national origin (Catlin & Jones, 2010; Hammerton, 2017). This trend of international divers dominating tropical/subtropical coral reef areas is very common (e.g. Augustine et al., 2016; Musa, 2002), whereas in temperate waters it is mainly national divers who are active (Lucrezi & Saayman, 2017). For example, in a study of a rare subtidal crab from the cold–temperate and turbid North Sea (north-west Europe), the participating recreational divers were all local divers (van Moorsel et al., 2017). Rousseau and Fuertes (2020), who investigated divers in a cold-water estuary with limited visibility, also emphasized that divers were mostly local and experienced.

On the other hand, the results of the present study do not provide clear support for our hypothesis that divers were more specialized in the less popular diving area (Chilean mainland), although there was a general tendency for higher specialization among mainland divers. The divers surveyed on Rapa Nui showed less diving experience, with a slightly lower number of dives and lower diving frequency. Those variables are typically associated with less specialized divers (Thapa et al., 2005, 2006) and more generalist tourists (Catlin et al., 2011; Cole & Scott, 1999). On the other hand, the main motivation to visit Rapa Nui was not to dive, which coincides with other studies that show that less specialized divers put more emphasis on characteristics that are not directly related to diving when visiting a place (Augustine et al., 2016; Dearden et al., 2006). These results also fit with the WTF, which predicts that more popular wildlife tourism areas will attract more generalist tourists (Duffus & Dearden, 1990), and with other studies that also suggest that less experienced divers prefer popular diving areas with coral ecosystems in warm and clear waters (Cater, 2008; De Brauwer et al., 2017). On the Great Barrier Reef, one of the most popular diving areas of the world, foreign divers were less experienced than national divers (Pabel & Coghlan, 2011). This suggests that in more popular diving areas there is a higher proportion of foreign tourists, and this implies not just single visits to the diving area but also less experience and possibly a lower commitment to the diving activity (Augustine et al., 2016). Local divers also demonstrate a higher level of attachment to place, and thus have stronger emotional bonds with dive sites (Moskwa, 2012).

Having greater biodiversity knowledge is one of the attributes associated with a greater specialization level (Gündoğdu et al., 2018). Surprisingly, this relationship was not found for the divers on the Chilean mainland, which could be explained by several factors. On the one hand, recreational diving in Chile is relatively new, with the first dive centres on the continent dating from the late 1980s, followed by a boom of new centres after the turn of the century (Javier Naretto, pers. comm.), whereas in other countries, such as the USA or some European countries, the recreational diving industry dates back to the end of the 1960s (Garrod & Gössling, 2008). For example, volunteer divers from the ANEMOON (Analyse Educatie Marien Oecologisch Onderzoek) Foundation in the Netherlands have been participating in biodiversity surveys in the cool waters of the North Sea and adjacent estuaries since the 1990s, gaining important expertise through regular training workshops, which is underscored by their extensive contribution to local biodiversity knowledge (e.g. Gittenberger, 2007; Van Soest et al., 2007; van Walraven et al., 2016). Furthermore, species from continental Chile may be more cryptic, often hidden among abundant seaweeds or behind rocks, whereas tropical species are very distinctive in shape and colour. This might make the recognition of continental species harder, as those visual traits are important for species identification (Alsmadi et al., 2011; Lindenmayer & Likens, 2009). Finally, there are few guidebooks and teaching materials for the marine environment in the south-east Pacific, and previously only limited oceanic literacy in Chile has been shown (Sánchez, 2018), whereas for tropical species (typical in Rapa Nui) there are many guides. This lack of teaching resources could also be reflected in our results, as one of the main strategies to learn about marine biodiversity for divers on the Chilean mainland is through personal communication.

Participation was slightly higher in divers on Rapa Nui, which might be because the invitation to send pictures better suited the generalist divers on Rapa Nui: they likely felt that sharing their picture was a unique way to contribute to the MCS project given the short time they had in the area. On the other hand, more experienced divers on the Chilean mainland might have been less motivated to participate, because they typically seek projects that are challenging their skills or knowledge (Lucrezi et al., 2018), and simply sending a picture of common species did not achieve this.

4.2 | Implications for MCS

There are different strategies that can be proposed for MCS projects in diverse diving areas based on their diving popularity (Figure 6). In the more popular diving areas, because of sporadic visits and possibly a higher proportion of more generalist divers, it is recommended to develop protocols that also include less experienced divers with basic diving skills and no need for local species knowledge or intensive biodiversity training. For example, short-term projects with simple protocols (Bird et al., 2014; Hussey et al., 2013) and/or projects based on opportunistic observations (Boakes et al., 2016; Couturier et al., 2015; Huveneers et al., 2009) or attractive species (Bell et al., 2008; Davies et al., 2012) might be highly suitable for these popular diving areas.

In less popular diving areas, where divers are more frequent visitors (with or without good knowledge of local habitats), long-term projects with more complex protocols can be proposed as divers can improve their skills over time, both by attending specific training courses and by participating in the MCS project (Foster-Smith & Evans, 2003; Vermeiren et al., 2016). For example, many studies with volunteer scuba divers in cold waters (e.g. in Canada or in the UK) are associated with REEF (Reef Environmental Education Foundation). This is an international MCS programme that trains local divers (Montecino-Latorre et al., 2016; Schultz et al., 2016) and classifies them as novice or expert, based on the number of surveys that they have successfully completed (Clauson-Kaas et al., 2017; Foster-Smith & Evans, 2003; Pattengill-Semmens & Semmens, 1998). This type of MCS project requires more continuity, such that divers can be trained regularly and obtain sufficient expertise in the field (Crall et al., 2010; Edgar & Stuart-Smith, 2014; Koss & Miller, 2009).

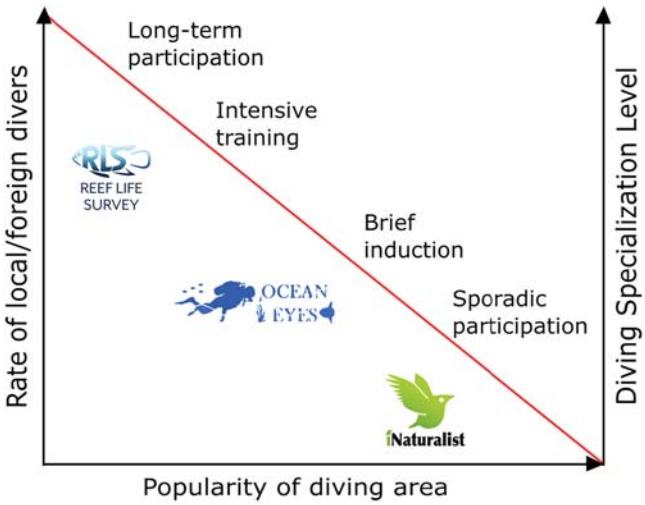

FIGURE 6 Framework for marine citizen science (MCS) project design based on the popularity of a diving area. In less popular diving areas it is more likely to find local, national divers who can participate in long-term projects that require extensive training, contributing to diver specialization. In more popular diving areas it is more likely to find foreign divers who come for single visits, leading to more sporadic participation with less options for training. More challenging tasks, e.g. Reef Life Survey, are recommended for MCS projects in less popular diving areas, whereas more simple diving tasks, e.g. iNaturalist, are recommended for popular diving areas, or intermediate complexity levels, such as Ocean Eyes

Another strategy for MCS in a diving area could be to develop different protocols for visitors and for local divers. Simple and less time-demanding protocols would be more suitable for visitors (e.g. Marshall et al., 2012), whereas more complex protocols that require training would be more effective for local divers (e.g. Edgar & Stuart-Smith, 2014). Involving a wider diversity of divers could not only have benefits for data recording but also help meet the socio-ecological challenges attributed to citizen science (Shirk et al., 2012).

There is a trade-off between using an accessible protocol for more volunteers, but with less reliable data, or more complex protocols with fewer (but more engaged) volunteers, who can generate more reliable data (Edgar et al., 2016; Holt et al., 2013). In order to select the most suitable protocol it is important to know not just the capability of the divers but also their level of interest and time availability (Cigliano et al., 2015). For example, the results of this study show that the divers on Rapa Nui (a more popular diving area) prefer very brief pre-dive inductions, whereas divers on the Chilean mainland (a less popular diving area) expressed strong interest in more extensive training sessions. This information allows citizen science coordinators to develop adequate protocols for recreational divers in different diving areas: simple in popular (warm water) diving areas; more complex in less popular (cold water) diving areas. Nevertheless, in popular diving areas more complex or long-term protocols could also be developed, but in that case it would be more effective to work with local people and define specific strategies focused on them (e.g. local divers, spear fisherman, or dive instructors).

5 | CONCLUSIONS

Scuba divers and the recreational diving industry have a high potential to contribute to MCS; however, it is important that any MCS project is well designed in order to match the interests and profiles of the participating volunteers. Potential volunteers could differ in knowledge, skills, interest, and dedication, all of which can affect their participation in a citizen science project. This study compared divers in two contrasting diving areas based on the popularity of the marine ecosystems for the diving industry. Divers in both areas showed strong interests in participating in MCS, but in the more popular area it is more likely to find foreign divers who visit the area only once and usually travel around the world to other popular diving areas. In less popular areas there will be more local divers who dive more frequently in that area. Finally, designing an MCS project for divers with different levels of specialization, with specific protocols adapted for each type of diver, for example, could lead to improved marine conservation.

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APPENDIX A: INTERVIEW QUESTIONS WITH ENGLISH TRANSLATIONS

A.1 | Interview questions: English

1. Demographic profile
   a. Name:
   b. Age:
   c. Gender:
   d. Country of residence:
   e. Profession:
   f. E-mail:
   g. General education level:
      i. Primary school
      ii. Middle school
      iii. Technical
      iv. Advanced-technical
      v. College degree
      vi. Postgraduate

2. Diving profile:
   a. Main motivation to dive (one choice)
      i. Artisanal fisher
      ii. Flora and fauna
      iii. Marine landscape
      iv. Leisure & pleasure
      v. For work
   b. Total number of dives logged (numerical)
   c. Diving certification level
      i. First level (open water, first star, or similar)
      ii. Second level (second star, advanced, or similar)
      iii. Third level (recue diver or similar)
      iv. Fourth level (professional levels from dive master to instructor level)
   d. Diving frequency
      i. Almost every day (6–7 times per week)
      ii. 2–5 times per week
      iii. 2–5 times per month
      iv. 7–11 times per year
      v. 2–6 times per year
      vi. Once per year or in special occasions
   e. Have you dived in another country?
   f. Which one?
3. Dive area visit:
   a. Main motivation to visit the area (one choice)
      i. For the culture & geography
      ii. For diving
      iii. For nature
      iv. For social motivations
      v. For work
      vi. Being in transit
      vii. Other
   b. How long are you staying on the island (number of days)
   c. How many times have you dived here?

   d. Do you think you will be coming back to dive?
      i. Yes
      ii. Maybe yes
      iii. Probably not
      iv. Not

4. Marine species knowledge and training preferences
   a. How do you classify your knowledge about biodiversity of the diving area?
      i. High knowledge (I can recognise more than 15 species)
      ii. Intermediate knowledge (I can recognise more 5–15 species)
      iii. Limited knowledge (I can recognise fewer than 5 species)
   b. Could you see any of this species in your dive? (Shown an ID chart with typical local species in each diving area, see Appendix B)
   c. Do you have any knowledge or training to identify marine species?
   d. Do you use any particular method to identify these species? (multiple choice)
      i. ID charts
      ii. Books
      iii. Internet
      iv. Talking to other people
      v. Other
   e. Would you be interested in learning about marine flora and fauna of the area? (yes/no)
   f. What type of training do you prefer?
      i. Short briefing before diving (10 min approx.)
      ii. Extensive classes (1 h approx.)
      iii. Several-day course (with hours spread over several days)
   g. Would you be willing to pay for these training? (yes/no)
5. Willingness to participate and actual participation rate
   a. Do you have an underwater camera here?
   b. In general, do you have interest to collaborate with science?
   c. We send emails to those who said yes by requesting underwater images of their visit to the diving area.

A.2 | Interview questions: Spanish (original)

1. Perfil demográfico
   a. Nombre:
   b. Edad:
   c. Género:
   d. País de residencia:
   e. Profesión:
   f. E-mail:
   g. Nivel de educación general:
      i. Escuela primaria
      ii. Escuela media
      iii. Estudios técnicos
      iv. Estudios técnicos-avanzados
      v. Estudios Universitarios
      vi. Postgrado

2. Perfil de buceo:
   a. Principal motivación para bucear (elección única)
      i. Aventura y experiencia
      ii. Flora y fauna
      iii. Paisaje submarino
      iv. Ocio y placer
      v. Trabajo
   b. Número total de buceos acumulados (número)
   c. Nivel de certificación en buceo
      i. Primer nivel (*open water*, primera estrella o similar)
      ii. Segundo nivel (segunda estrella, avanzado o similar)
      iii. Tercer nivel (buzo de rescate o similar)
      iv. Cuarto nivel (niveles profesionales desde nivel de *dive master* a instructores)
   d. Frecuencia de buceo
      i. Casi cada día (6–7 veces por semana)
      ii. 2–5 veces por semana
      iii. 2–5 veces por mes
      iv. 7–11 veces por año
      v. 2–6 veces por año
      vi. Una vez al año o en ocasiones especiales
   e. ¿Has buceado en otro país? (sí/no)
   f. ¿En cuáles? (enumera)
3. Visita al área de buceo:
   a. Principal motivación para visitar el área de buceo (elección única)
      i. Por la cultura y geografía
      ii. Por el buceo
      iii. Por la naturaleza
      iv. Por una motivación social
      v. Por trabajo
      vi. Estoy de paso
      vii. Otra
   b. ¿Cuantos días vas a estar? (número de días)
   c. ¿Cuántas veces has buceado aquí?
   d. ¿Crees que volverás a bucear aquí?
      i. Sí
      ii. Quizás sí
      iii. Probablemente no
      iv. No

4. Conocimiento de especies y preferencias de entrenamiento
   a. ¿Cómo clasificarías tu conocimiento sobre la biodiversidad marina del área de buceo?
      i. Extenso conocimiento (Puedo reconocer más de 15 especies)
      ii. Conocimiento medio (Puedo reconocer entre 5–15 especies)
      iii. Escaso conocimiento (Puede reconocer menos de 5 especies)

iv. Desconocimiento total

b. ¿Pudiste ver alguna de estas especies en tu buceo? Les mostramos una Id chart con especies comunes del área de buceo. (Pueden encontrar las ID chart en Appendix B).

c. ¿Tienes algún entrenamiento en el reconocimiento de especies marinas?

d. ¿Usas algún método particular para identificar especies? (Elección múltiple)
   i. ID charts
   ii. Libros
   iii. Internet
   iv. Hablando con la gente
   v. Otra

e. ¿Estarías interesado en aprender sobre la flora y fauna del área de buceo? (sí/no)

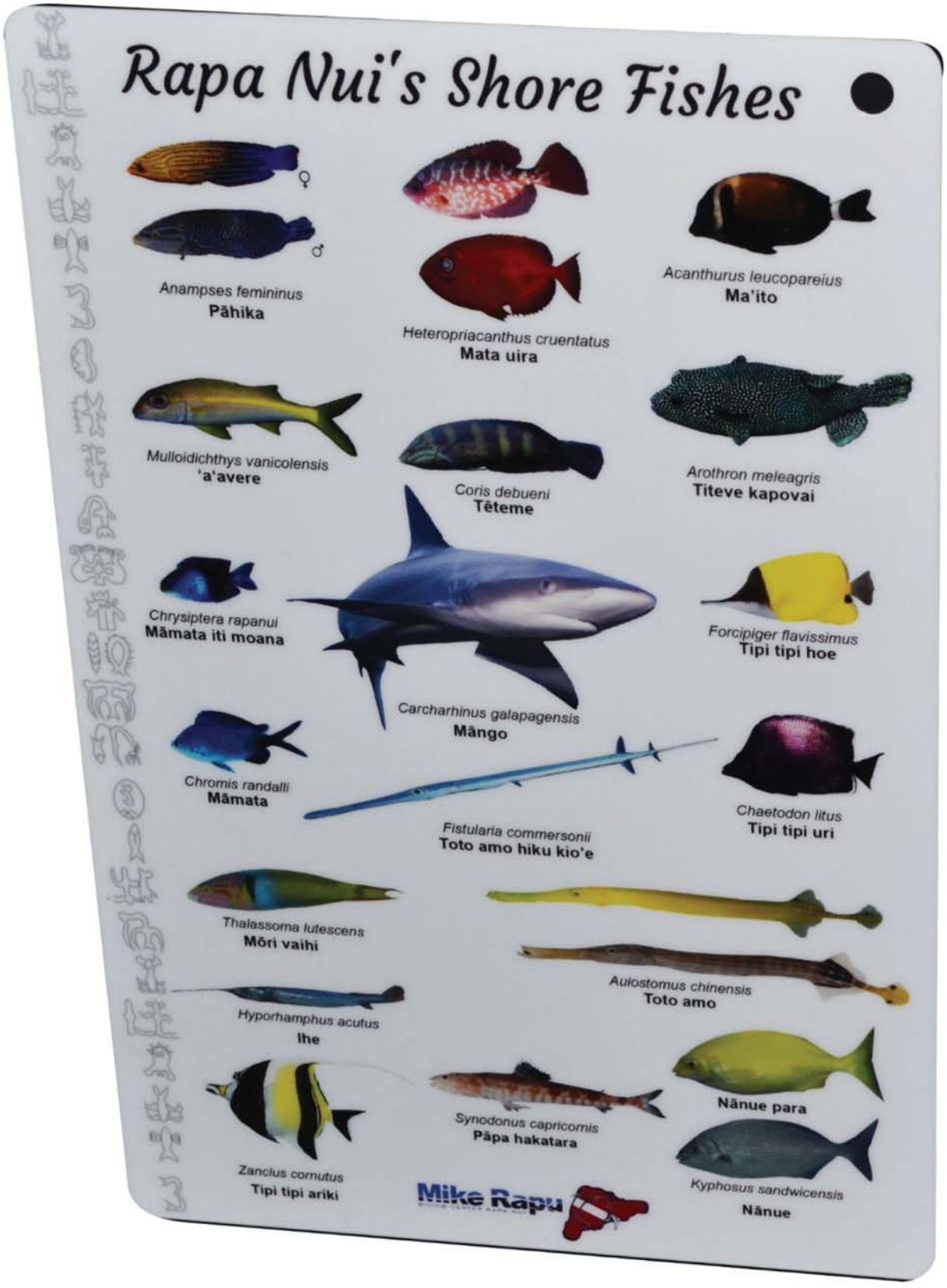
f. ¿Qué tipo de entrenamiento preferirías?
   i. Pequeño resumen antes del buceo (10 minutos aprox.)
   ii. Una clase más extensa (1 hora aprox.)
   iii. Un curso breve (varias horas repartidas en diferentes días)

g. ¿Estarías dispuesto a pagar por el entrenamiento? (sí/no)

5. Tasa de participación real
   a. ¿Cuenta con su cámara de registros submarino?
   b. En general, ¿Tiene interés en colaborar con la ciencia?
   c. Envíanos mails a los que dijeron que sí solicitándoles imágenes submarinas de su visita a la zona de buceo.

APPENDIX B: ID CHARTS OF COMMON SPECIES IN BOTH DIVING AREAS

Id Chart with common species of Chilean mainland



Id Chart with common species of Rapa Nui