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LABORATORY OF FISHERIES
AND MARINE BIOLOGY
AT FANO

MARINE SCIENCE
INTERDISCIPLINARY RESEARCH GROUP

Sea Sentinels

DIVERS UNITED FOR THE ENVIRONMENT

Annual Report 2018

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PARTNERS

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PADI — www.padi.com

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www.DUEproject.org

TOURIST AWARDS 2018

Sponsors that reward clubs and diving centers which completed the most questionnaires in 2017.

www.edenviaggi.it

www.nicolaus.it

www.mysunsea.net

www.scubapro.com

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INTRODUCTION

The Mediterranean Sea represents less than 1% of the global ocean area, but is considered a marine biodiversity hotspot, as it hosts 17,000 species that represent the 7% of the worldwide biodiversity, of which 25% to 30% are found nowhere else in the world. The Mediterranean is one of the most densely populated and highly urbanized coastal regions with 450 million people live along its coasts in 22 bordering countries. Moreover, it provide critically important goods and services to people, such as: recreational activities, thus supporting the industry of tourism; coastal protection and habitat/nursery functions for commercial and recreational fisheries; and welfare associated with the diverse natural ecosystems. Despite the provision of multiple valuable services, the Mediterranean Sea is facing a number of direct anthropogenic threats and environmental change is threatening the survivorship of several Mediterranean species. Broad conservation efforts and large-scale monitoring are needed for effective management to prevent biodiversity loss derived from human and climate change impacts. Governmental agencies are often under-funded. In some cases, Citizen Science can overcome economic constraints of data collection by involving citizens in monitoring programs while increasing their environmental awareness.

In ecology, the term "biodiversity" is defined as the number of plant and animal species present in a given place, region, or ecosystem. A natural, unaltered habitat has a high degree of biodiversity because many species of plants and animals live there in ecological equilibrium. On the contrary, an unnatural or altered environment has a low degree of biodiversity because it hosts only few species. Therefore, the level of biological diversity is an indication of the state of the environment. Monitoring is essential for the diagnosis of the state of health of the environment and therefore it is preparatory to the interventions of balanced management and conservation of natural resources. If sensitized and involved, citizens can participate in monitoring actions (Citizen science method). In previous projects divers and snorkelers have already demonstrated their ability to operate as controllers of the marine environment. The "Sea Sentinels - Divers United for the Environment" project (DUEproject) is a four-year (2017-2020) environmental monitoring program which aims to estimate the degree of biological diversity of Mediterranean coastal waters. The starting point of this research are the results of our previous project “Divers for the Environment – Mediterranean Underwater Biodiversity Project” (2002-2005). Recreational divers and snorkelers are the volunteer researchers. They are asked to fill a questionnaire in which they indicate which organisms they encountered during the dive and an approximation of their abundance.

The last three decades have seen a rapid increase in recreational diving that prompted researchers to involve recreational divers as volunteers, making use of their interest in marine life. Many studies use strict data collection protocols, requiring intensive training and asking volunteers to perform surveys at specific sites on specific species to ensure uniform data collection. This method can reduce project appeal, thus reducing the number of volunteers, and affect data accuracy. The DUEproject uses a survey protocol based on casual diver observations. This method allows divers to carry out normal recreational activities and ensures the reliability of collected data. In our previous projects we tested the accuracy of data collected by volunteers, with an average accuracy of 60% (70% of tests recorded a value between 50% and 90% of accuracy). The International scientific community has confirmed the validity of our data with the publication of the results in two of the most important international scientific journals: Ecological Application and Biodiversity and Conservation.

Scuba diving agencies, diving schools and diving centers participate in the realization of the research motivating the volunteers to fill out the questionnaire. The questionnaires are subsequently sent to the University of Bologna for data processing and dissemination of results. SCUBAPRO, one of the world's leading companies in diving equipment, committed to the development of a sustainable tourism as a factor of social and cultural progress, contributes to the costs of the project. PADI, the world's largest scuba diving training organization and supporter of environmental awareness and protection philosophies, promotes the dissemination of the project through its instructors and facilities. ANSA, the leading Italian news agency and one of the world leaders, is the media partner of the project.

RESEARCH GOALS

DUEproject aims to monitor Mediterranean Sea biodiversity by collaborating with volunteer divers and snorkelers. The collected data can be used by local Institutions as a tool to implement conservation and preservation measures. Moreover, the project contributes to the development of ecotourism along the Mediterranean coasts increasing the environmental awareness of tourists. This study, represents the prosecution of previous monitoring programs which gave excellent results and obtained international credits: 1999-2001: Mediterranean *Hippocampus* Mission" (S. Goffredo, C. Piccinetti, F. Zaccanti. *Conservation Biology,* 18: 1492-1503, 2004), followed by "2002-

2005: Divers for the Environment - Mediterranean Underwater Biodiversity Project" (S. Goffredo, F. Pensa, P. Neri, A. Orlandi, M. Scola Gagliardi, A. Velardi, C. Piccinetti, F. Zaccanti. *Ecological Applications*, 20: 2170-2187, 2010) and then by "2007-2015 "STE: Scuba Tourism for the Environment" - Red Sea Biodiversity Monitoring Program (Branchini S., Meschini M., Covi C., Piccinetti C., Zaccanti F., Goffredo S. *PLoS ONE,* 10: e0131812, 2015). These monitoring programs have been developed by the Marine Science Group (www.marinesciencegroup.org) in the Mediterranean Sea and Red Sea and their results have been published in peer-reviewed international scientific journals.

MATERIALS AND METHODS

The questionnaire that was created for this monitoring program contains two sections: the first part is for the identification of surveyed organisms, the second is used for data recording. Surveyed organisms were selected according to the following characteristics:

- ease of recognition by non-professionals;
- expected frequency: common in the whole Mediterranean Sea.

These characteristics make this method user-friendly for the volunteers. Also the presence of litter is recorded as an indicator of negative environmental conditions.

Volunteers are asked to complete the survey questionnaire soon after the end of their dive or snorkeling tour. Data are aggregated according to habitat type, divided into "survey stations" (diving site where at least ten questionnaires have been correctly completed, during the year) and are elaborated by the researchers of the University of Bologna to obtain a marine biodiversity index.

The role of diving centers and scuba instructors is fundamental for involving tourists. Through a "pyramidal system", trained operators (researchers, tour leaders, divemasters and instructors) sensitize thousands of tourists with briefings and by assisting them with the questionnaires. Students that chose to do their thesis internship in the Marine Science Group on the DUEproject, will spend a few months at diving centers located along the Italian coasts promoting the project and encouraging tourists to participate to the data collection. Tourists are also encouraged to participate to our project during public events, where questionnaires and informative material will be distributed. To sensitize and involve the highest number of volunteers, local, Italian and international mass-media are contacted for public dissemination of project goals and methods

(Tab 1). Real-time updates on research progress and relevant initiatives are published on the project website (www.DUEproject.org), Facebook page (dueproject.org), Instagram page (dueproject_org) and sent to volunteers by email.

DUE project is supported by SCUBAPRO, which contributes to the costs of the project; PADI, which promotes the dissemination of the project, and ANSA, which is the project's media partner.

RESULTS AND DISCUSSION

Between March to December 2017, 1385 questionnaires (which correspond to 1218 diving hours) were registered. Almost 50% of the survey questionnaires were registered by divers affiliated to our sponsoring agency PADI (Tab 2). The involvement of several diving centers suggests that this monitoring program could be used as a tool to enhance recreational diving, by encouraging people to dive and/or snorkel in order to collect data that will be used to verify the health status of the Mediterranean Sea. Some diving schools or diving centers have distinguished themselves for their contribution to data collection (Tab 3). The geographical distribution of the surveys carried out covers a rather large area. 20 coastal regions bordering the Mediterranean were covered by surveys, 2 in Malta, 13 in Italy, 3 in Croatia, 2 in Turkey. In quantitative terms, the distribution obtained is rather patchy, for example, almost 33% of the registered questionnaires come from Tuscany alone (Fig 1). Thus, one of our goals for the coming years will be to homogenize the surveyed areas.

The most common depth range was between 0 and 20 m (86.9% of the survey stations had a mean survey depth within this range). The highest survey effort was in summer (74.1% of the survey stations were between June and September) and late morning (the mean survey time in 60.9% of the stations is between 10.00 and 13.00). This sampling distribution reflects the typical pattern of the usual touristic diving activity in the Mediterranean Sea. The first level of recreational diving licence allows a maximum depth of 18-20 metres. Divers prefer summer, when water temperature is higher, and the daytime, since night-dives requires particular devices and advanced training. The environmental distribution of the surveys carried out was not homogeneous, in fact the 87.7% of the registered records refers to the rocky environment, 7.8% to the sandy environment and 4.5% to other environments; as the surveys in the previous project (Tab 4). It was therefore not possible to make a comparative analysis of biodiversity related to the different marine environments.

This unevenness is certainly due to the divers' preference for rocky bottom, which are nicer to visit since they have more species compared with sandy beds and are accessible also to less experienced divers compared to other dive sites/environment, such as wrecks or blue-dives.

The spatial comparison of the marine biodiversity index was made only for the rocky bottom environment, because sandy beds and the other environments have not reached a sufficient number of survey stations to allow a significant statistical elaboration. For the rocky bottom environment, a total of 24 survey stations were identified; we received questionnaires from other 156 dive sites but in the current analysis we could not classify them as survey stations given the limited number of completed questionnaires (less than 10) (Fig 2). The marine biodiversity index was calculated for all the survey stations (2002-2005 and 2017); it was homogeneous among the five years and seemed to show a pattern on the spatial scale. One hundred and sixty-one stations (71.6%) had a “mediocre” marine biodiversity. Twenty-eight stations (12.4%) differed positively from the mean value showing a "good" marine biodiversity quality. The twenty-nine stations (12.9%) that differed negatively showed a "low" biodiversity and seven stations were “very low” (3.1%) (Fig 3). Our results seem to confirm the significant negative correlation between environmental quality and latitude previously found in the “Divers for the Environment” project (Fig 4-5-6). This trend was supported by investigations performed by the Italian Ministry of the Environment in the same period of “Divers for the Environment”.

The preliminary data we obtained until now seem to indicate that the status of the Mediterranean Sea has not changed significantly compared to the status obtained 12 years ago through the “Divers for the Environment” project. However, we need to keep monitoring and protecting our sea, to avoid biodiversity loss in coming years as a result of anthropogenic pressures and climate change impacts.

CONCLUSION

This recreational monitoring allow to collect a significant amount of data with an acceptable level of reliability because: (1) volunteers are trained and assisted during data collection in the field by divemasters and instructors who were previously trained by professional researchers; (2) the method is suitable for amateurs, i.e., user-friendly questionnaire and taxa that are easily recognizable by recreational divers. This project confirms that ‘‘recreational’’ and ‘‘easy and fun’’ citizen science is an efficient and effective method to recruit a large number of volunteers and can

be reliable if well designed.

DUE project aims to estimate the biodiversity status of the Mediterranean Sea and its spatial and temporal variations, providing important indications to the local authorities on the trend of health status of the Mediterranean coastlines and on the effectiveness of the environmental management. Each year the project results will be presented during communication and dissemination activities.

This project presents a successful case study of collaboration among researchers and the public, showing that with appropriate recruitment and training, volunteer-collected data are qualitatively equivalent to those collected by professional researchers and useful for resource management. This work fortifies the effectiveness of citizen science projects as a fundamental tool to provide robust, objective and repeatable data for large-scale and long term monitoring, which can be used to inform marine management. This method could be applied in different countries by local governments and marine managers to achieve large-scale and long-term conservation and management actions, required in a fast-changing world where climate change and anthropogenic uses of natural resources are determining environmental changes worldwide at an unprecedented rate.

Tab 1. Contacts for public dissemination of project goals and methods in 2017.

CONTACTS	
(Readers and Audience)	
PRESS & WEB	
Date	**Name**
24 October 2017	PADI Pros-Europe
4 October 2017	Corriere di Malta
03 October 2017	UNIBO Magazine
28 September 2017	ANSA
25 September 2017	ANSA
17 July 2017	DeAByDay
05 July 2017	La rivista della natura
19 July 2017	Radio 24
03 June 2017	Virgilio.it
June 2017	ARCIPESCA F.I.S.A.
June 2017	Sport Europa – MSP Italia
31 May 2017	ARPA Campania
23 May 2017	European Underwater and Baromedical Society (EUBS)
23 May 2017	Fondali Campania
23 May 2017	Plemmirio.eu
23 May 2017	Regioni e Ambiente
19 May 2017	Green Society
18 May 2017	Il subacqueo
17 May 2017	ANSA
17 April 2017	Science Hunter
05 March 2017	Il Resto del Carlino
RADIO & TELEVISION	
Date	**Name**
01 July 2017	Radio 24
2017 TOTAL CONTACTS: more than 2,000,000	

Tab 2. Survey questionnaires registered by different agencies. (n.s. indicates non-specified agency)

Diving agencies	Web	Recorded questionnaires	%
PADI	**www.padi.it**	**688**	**49.7**
FIPSAS	**www.fipsas.it**	**107**	**7.7**
CMAS	**www.cmas.org**	**81**	**5.8**
SSI	**www.divessi.com**	**58**	**4.2**
PSS	**www.pssworldwide.org**	**49**	**3.5**
SNSI	**scubasnsi.goscubasnsi.com**	**16**	**1.2**
FIAS	**www.fiaas.it**	**12**	**0.9**
Other		**52**	**3.8**
n.s.		**322**	**23.2**
Total		**1385**	**100**

Tab 3. Diving schools or diving centers contribution to data collection.

Diving Center - Club	Città	Web	Questionari compilati	%
Scientific Diving School	Bologna (IT)	www.sdseducational.org	294	21.2
Sistiana Diving	Trieste (IT)	caosdivers.wixsite.com	168	12.1
Liceo Statale Scientifico e Classico «Ettore Majorana»	Monza-Brianza (IT)	www.liceodesio.gov.it	85	6.1
Mandel Diving Center	Livorno (IT)	www.mandeldivingcenter.com	82	5.9
Sub Shark Diving Team	Venezia (IT)	www.facebook.com/AsdSubsharkDivingTeam	77	5.6
AcquaMission	Trieste (IT)	www.acquamission.it	72	5.2
Parma sub	Parma (IT)	www.parmasub.it	51	4
Altri diving center			556	40.1
Non specificati			14	1
Totale			**1385**	**100**

Tab 4. Total surveys, those of the previous project Sub for the Environment (2002-2005) and those of this first year of Divers United for the Environment project (2017-2020).

Year	Total recorded questionnaires	Rocky bottom questionnaires	Sandy bottom questionnaires	Other environment questionnaires
2002	3342	2847	387	108
2003	6230	5544	428	258
2004	5313	4699	452	162
2005	3872	3443	352	77
2017	1385	1215	108	62
Total	**20142**	**17748**	**1727**	**667**

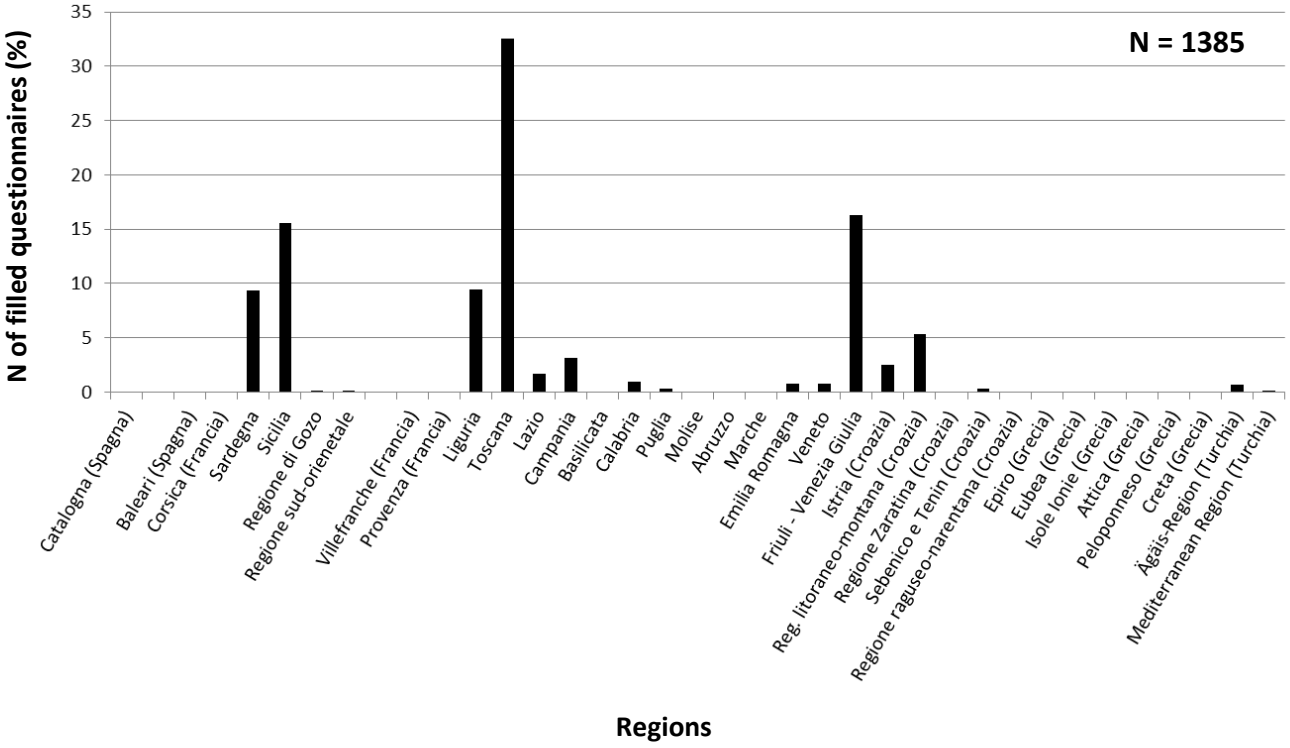

Fig 1. Regions from which we received data in 2017, with percentage of filled questionnaires for regions.

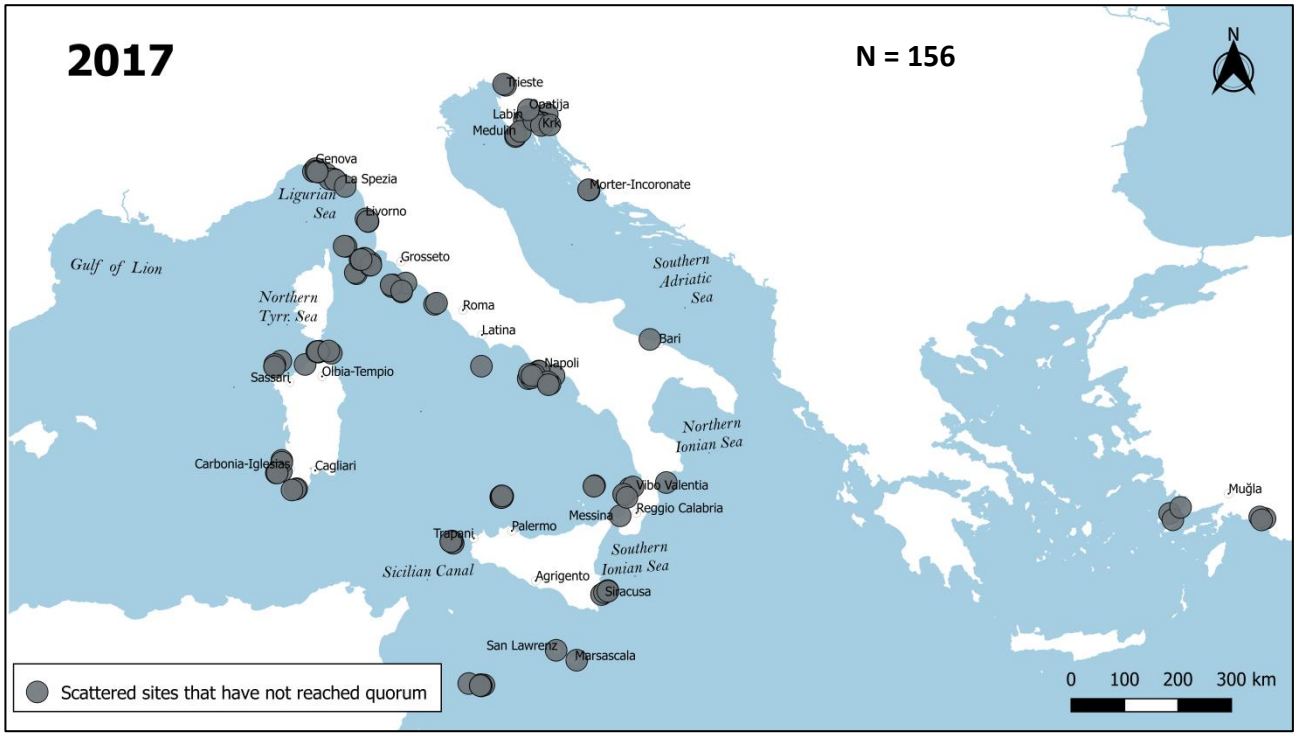

Fig 2. Scattered sites that have not reached the quorum of 10 complete/well filled questionnaires in a year.

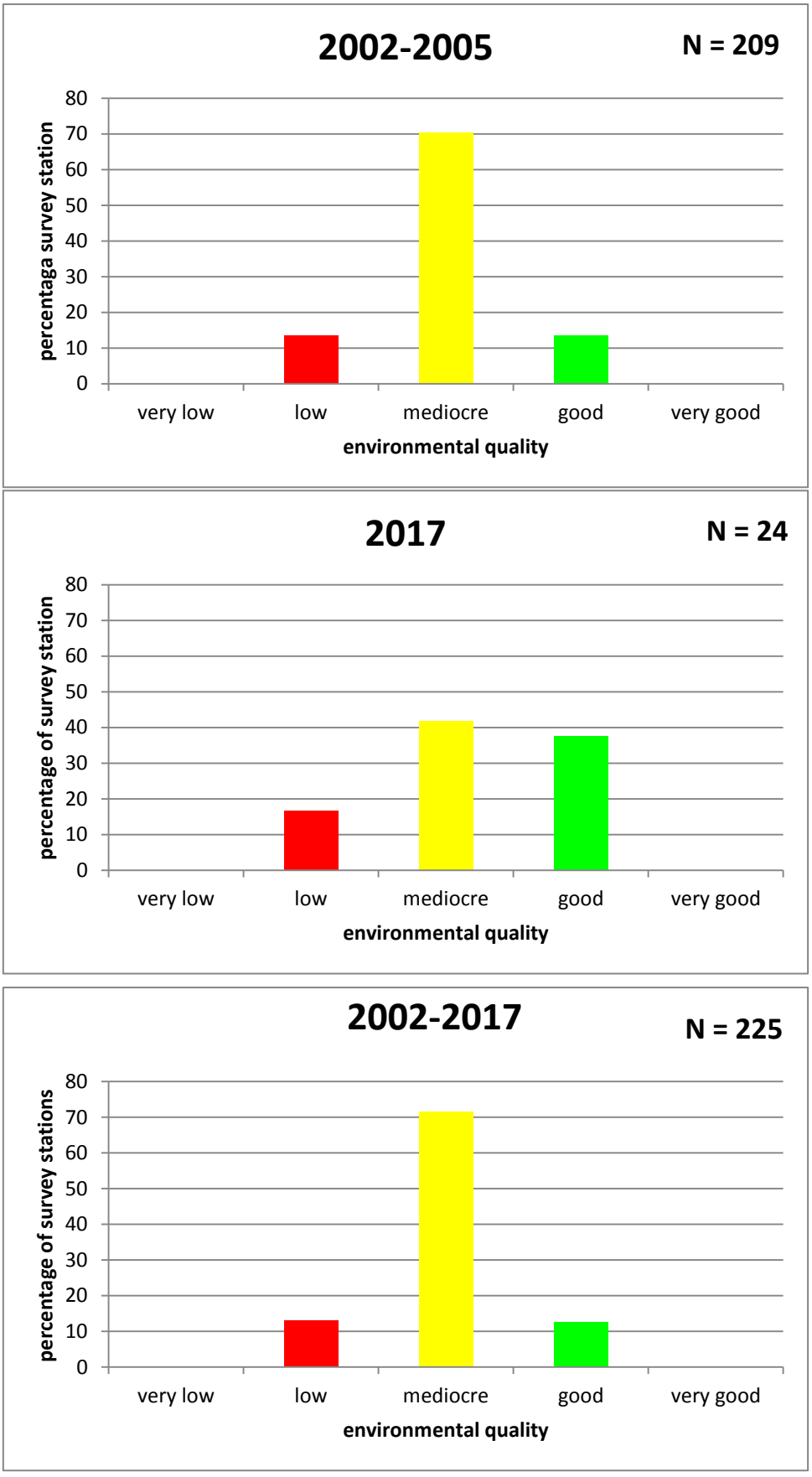

Fig 3 Distribution of survey station depending on environmental quality

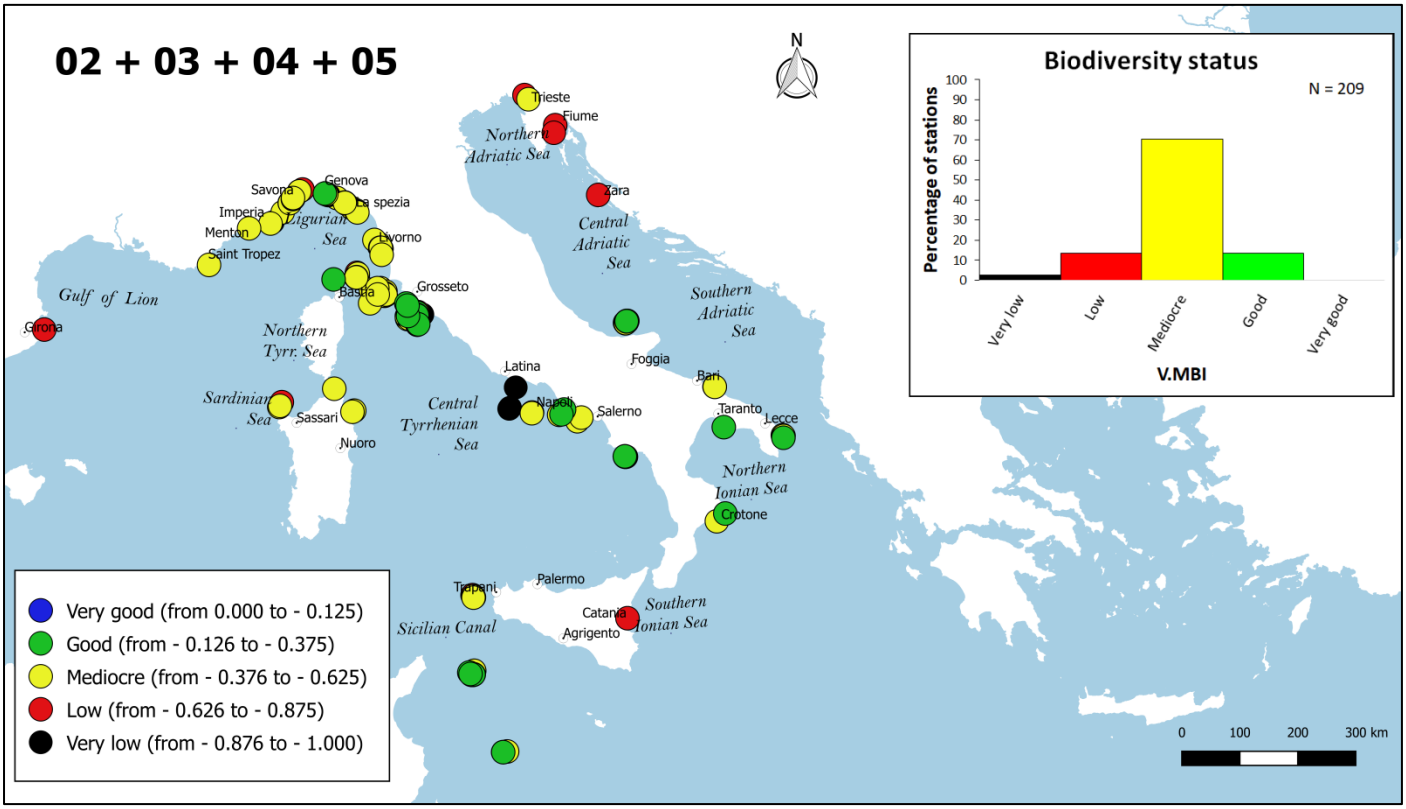

Fig 4. Map of biodiversity status for results of our previous project “Divers for the Environment”, from 2002 to 2005.

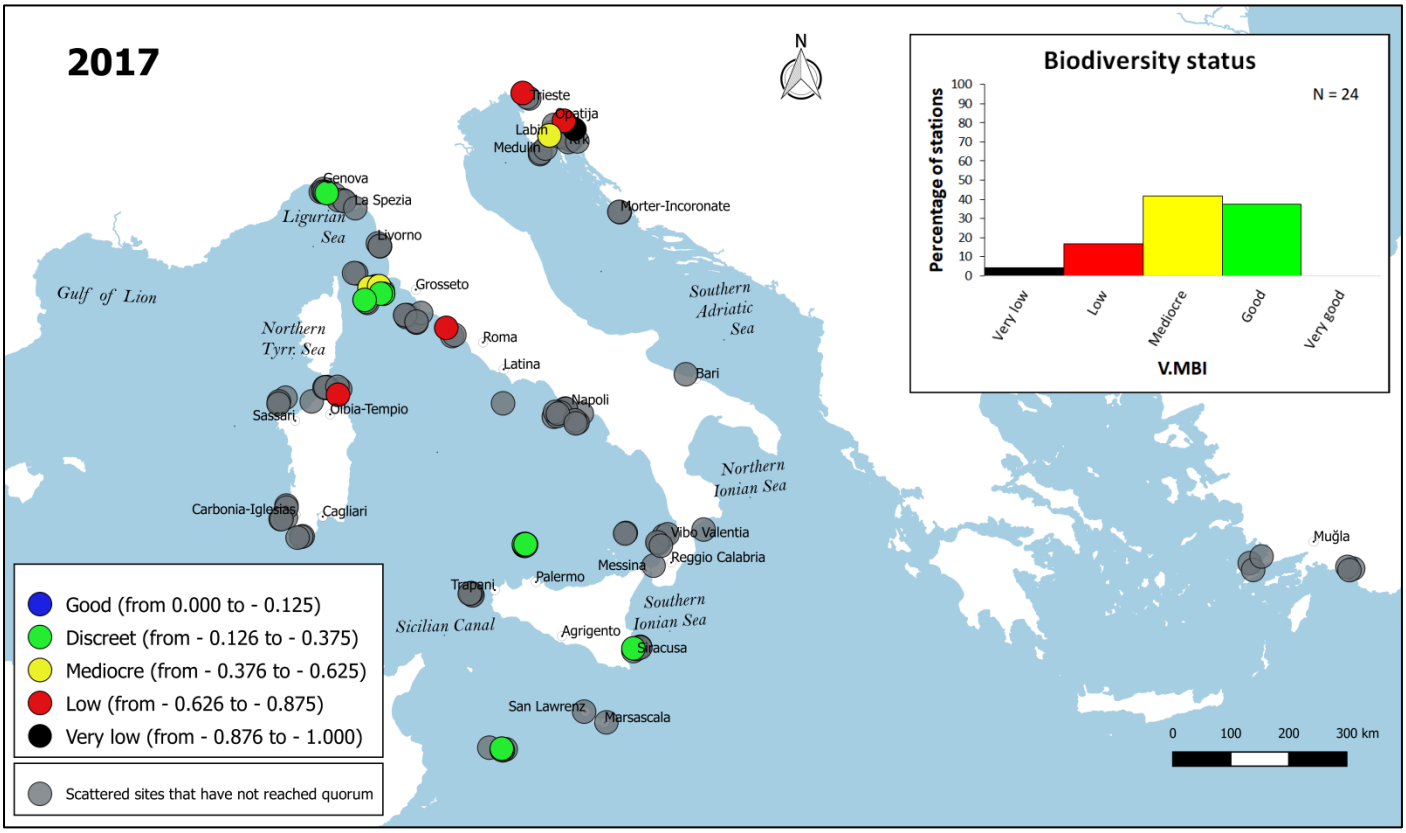

Fig 5. Map of biodiversity status for the first year of DUE project. In grey scattered sites.

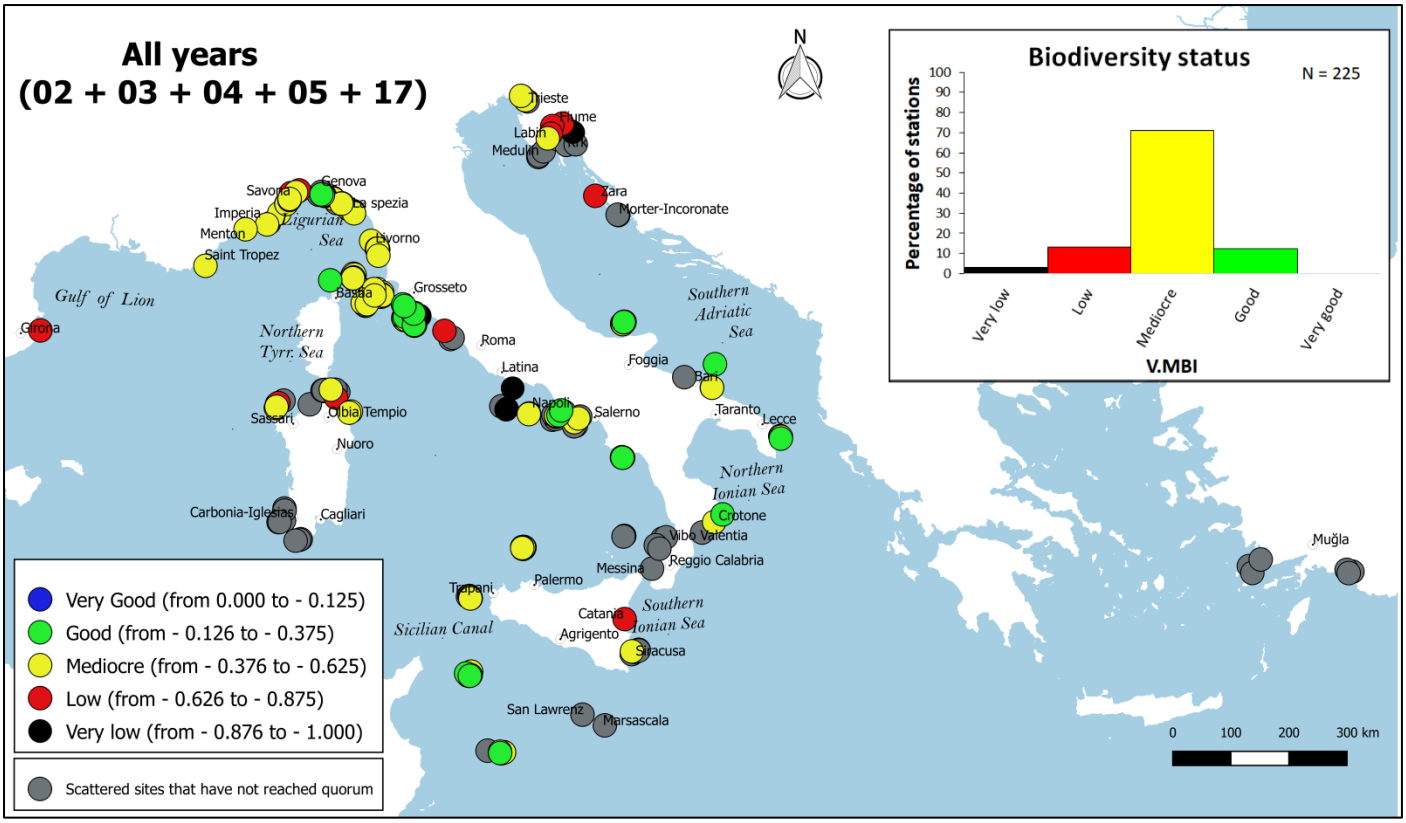

Fig 6. Map of biodiversity status of the 4 years of the previous project and data of first year of DUEproject.