THE ROLE OF SCIENTIFIC DIVERS IN THE ADRIREEF PROJECT: ARPA PUGLIA ACTIVITIES

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Abstract – The ADRIREEF project (INTERREG Italy-Croatia 2014-2020) was targeted to valorization of the natural and artificial reefs in the Adriatic Sea according to the principles of the Blue Growth. The project also includes the development and testing of suitable low-impact technologies for underwater monitoring. As project Partner, the Apulian Regional Agency for the Prevention and Protection of the Environment (ARPA Puglia) identified the coralligenous reef in the Marine Protected Area of Torre Guaceto (Brindisi, Italy) as a case study for the project purposes. According to the project objectives, ARPA Puglia selected some low-impact monitoring methods, in particular, the Agency's scientific divers team applied a standard photographic sampling method for the benthic communities and the visual census (VC) method to describe the fish assemblages. A Remote Operative Vehicle (ROV) was used also in order to test the applied methods and compare the obtained data.
At present, in collaboration with MPA, a *vademecum*, a sort of Guideline, is being published on the sustainable use of the submerged area by recreational divers.

Introduction

Coralligenous habitat is considered the second most important subtidal "hot spot" of biodiversity in the Mediterranean Sea after the *Posidonia oceanica* meadows (Boudouresque 2004). For the many environmental and biological valuable characteristics this habitat has been included in the Habitat Directive (EEC Reg. 1992/43, Annex I; Habitat code: 1170 Reefs), as well as it is monitored by the Water Framework Directive (2000/60/CE) and by Marine Strategy Framework Directive (EC Reg. 2008/56). Coralligenous bioconstructions could build ups into two main different geo-morphologies: rims-structures on submarine vertical cliffs and banks-flat frameworks over horizontal substrata (Pérès and Picard 1964; Laborel 1987; Ballesteros 2006; Bracchi *et al.* 2014). The apulian continental shelf, as in the case of Torre Guaceto MPA, is characterized mostly by the second morphology (Piazzi *et al.* 2019). This kind of bioconstruction is generically called "bank-type" coralligenous biogenic reefs.

The main aim of the case study is to characterize the natural reef selected using low-impact monitoring methods. In particular, the ARPA's scientific divers team applied a standard photographic sampling method for the benthic communities and a visual census (VC) method to describe the fish assemblages. A Remote Operative Vehicle (ROV) was used also in order to test the applied methods and compare the obtained data. These technical methodologies is often used for the ecological characterization of the sea-bottom protected

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habitats and submerged environments affected by pre- and post-construction monitoring activities. Natural and artificial reefs are priceless elements for the scientific community and key resources for Blue Growth. By mapping and monitoring Adriatic reefs and involving relevant stakeholders, Adrireef aims to provide guidelines and a code of conduct illustrating sustainable exploitation models of marine reefs. In Adrireef project, other partners have worked, applying the same techniques, to characterize the artificial reef, for example the wreck of the Paguro offshore oil platform, with the aim of rendering video in post-production and making it possible to dive while staying dry. This is another example of application of the Blue Economy and of what the knowledge of marine resources can be shared in a new and easily usable way with the aim of safe marine environment. The usability of resources combined with knowledge and awareness were the reasons why Arpa Puglia involved and created a working group of scientific divers and chose a PMA as a case study, sharing knowledge, making it accessible to everyone, is the first step to stimulate an ethic of respect and protection.

Materials and Methods

The natural and artificial reefs of the Adriatic Sea are the focus of the ADRIREEF project, financed by INTERREG Italy-Croatia 2014-2020 Program, with the aim to valorize them according to the principles of the Blue Growth. As project Partner, ARPA Puglia identified the coralligenous reef the Marine Protected Area of Torre Guaceto (Brindisi, Italy) as a case study for the project purposes. The MPA of Torre Guaceto is located in the South Western Adriatic Sea of the Puglia Region (Italy); it was formally established in 1991, but entered into force in 2001. The MPA total area is approximately 2227 ha and it is divided into three zones according different protection regime: zone A (total protection, two areas); zone B (general reserve area);-zone C (partial reserve area) (Figure 1).

Figure 1 – Marine Protected Area of Torre Guaceto.

The MPA coast, mainly rocky with some small beaches, is characterized by a rocky plateau that slopes from the shore up to about 10-12 m of depth. Rocky bottoms alternate with sandy areas and *Posidonia oceanica* seagrass beds. From about 20 to 35–40 m depth, coralligenous formations alternate with sand-detritic substrate, while detritic–muddy sediments widely dominate at deeper bottoms (Guidetti *et al.*, 2010). The presence of coralligenous bioconstructions as natural reef, makes the Torre Guaceto MPA a suitable site to achieving the goals of ADRIREEF Project.

To identify the most suitable study area for the project, the first step was to collect the cartographic data available from the BIOMAP Project (BIOcostruzioni MARine in Puglia), promoted by the Puglia Region (Italy). The aforementioned project has mapped and classified most of the Apulian coralligenous reefs, including those of the MPA Torre Guaceto.

To better define the morphological characteristics of the sea bottom in the study area, a Digital Terrain Model (DTM) in raster format was developed. The DTM was subsequently managed with GIS software (Q-GIS ver. 3.16.0-Hannover) using which the isobaths with an interval of 1 meter have been extracted. So, it was possible to identify a potential study area which was subsequently investigated by underwater pre-surveys.

An underwater cliff was chosen as the study area, located 2 km from the ancient "Watchtower", following a path of 60° N (Figure 2). The total area of the coralligenous reef chosen was estimated of about 6700 m², its perimeter is about 350 m and the longest axis is 140 m. It is composed of numerous coastal-type coralligenous outcrops that create a raised structure of an overall elliptical shape, north-south oriented. The reef and its bioconstructions is placed at 27-29 m depths with the top that rises 24-25 m depths. On the east side there is a discontinuous vertical wall 3-4 m high.

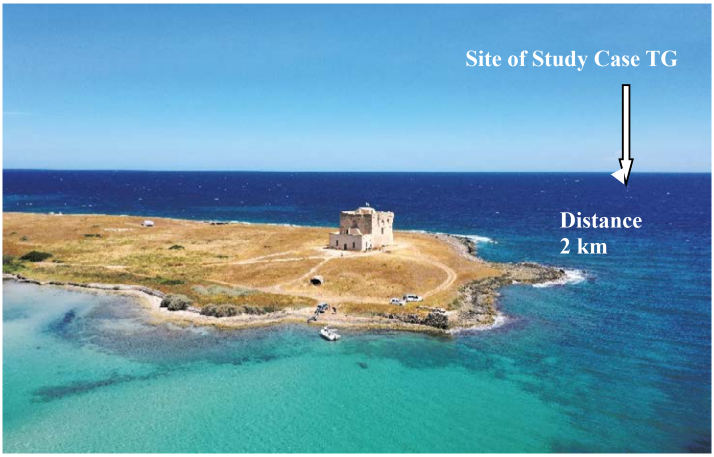
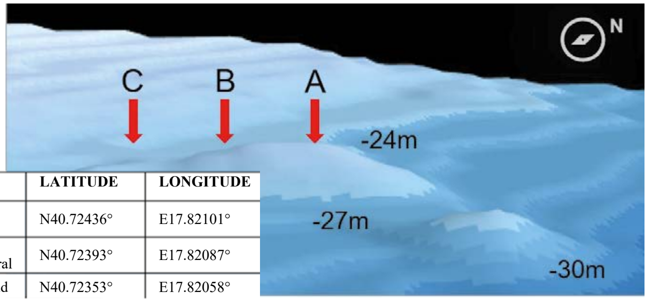


Figure 2 – Location of the natural reef identified.

Three sampling stations have been identified along the longest axis (with NS gradient) of the reef as shown in Figure 3. Sampling stations A, B and C were located along a 100 m bottom transept on the east side of the reef. The stations were placed along the longest axis of the study area with a distance among them of 50 m, at a depth of 24-25 m. Once the sampling station have been defined, the planned monitoring was carried out in 4 scientific surveys, two in the autumn period (15/10/2019 - 12/11/2020) and two during the summer season (23/07/2020 - 08/07/2021).



Site ID	LATITUDE	LONGITUDE
Station A, Nord	N40.72436°	E17.82101°
Station B, Middle/Central	N40.72393°	E17.82087°
Station C, Sud	N40.72353°	E17.82058°

Figure 3 – Q-Gis elaboration showing the DTM and the survey stations localization.

In each station, two low impact sampling methods were performed: the first method was a photographic one for the benthic community settled on the reef, while the other was the visual census to evaluate the fish assemblages.

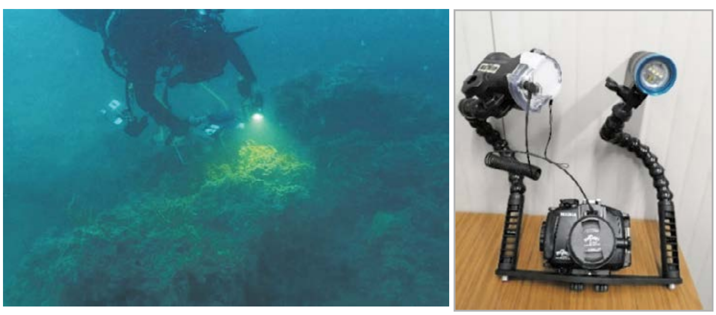


Figure 4 – ARPA Puglia SD during the photographic sampling survey and the Sony RX-100 VI camera used.

With regard to the first method, six photos (3 on the vertical face and 3 on the horizontal face of the reef) were taken in sampling stations A, B and C, using a Sony RX-100 VI camera shooting a standard frame of 21x29 cm; a total of 72 photos were acquired during the four surveys made (Figure 4). PhotoQuad v1.4 software was used for image analysis; in order to estimate the surface occupied by the single species, the "grid cell counts" method was selected (Trygonis and Sini, 2012). For each recognized species, the results include the area occupied by the species as well as their cover percentage.

Figure 5 – Scientific Diver during the Visual Census method.

The other methodology, applied to describe the fish assemblages, give as result the counting of recognized species in the fixed monitoring stations (A, B, C). The underwater activity involved 3 scientific divers at the same time. In each fixed stations, the monitoring surveys lasted 5 minutes for each direction N-E-S-W, for a total time of 20 minutes (Figure 5).

In order to develop and to test the application of an alternative technology for monitoring, a ROV was used also, and the acquired data were compared with the data from the standard methods applied (see above).

The ROV was used according to the same visual census methodology applied by scientific divers, with the aim of evaluating any differences and / or prons and cons. The ROV visual census was carried out in the 3 stations using a 360° camera mounted on the vehicle (Figure 6), and the total observation time was 15 minutes.

Figure 6 – ROV activity.

Results

The video-analysis of 72 photographic shootings highlighted the presence of 61 benthic taxa (Figure 7). The most represented taxa were the red macroalgae (Rhodophyta) of the genera *Mesophyllum* and *Peyssonnelia*, considered the main builders of coralligenous bioconstructions. Furthermore, the filamentous algae (AF), the so-called "Turf", are the third recognized group, mostly in the images from the summer surveys. Porifera is represented with 23 different species, and mostly of them are erect species such as *Axinella cannabina*, *A. damicornis* and *A. polypoides*. Another commonly recorded porifer is an encrusting one, *Spirastrella cunctatrix*. Several erect Bryozoa have also been identified, the most common being *Myriapora truncata* and *Pentapora fascialis*. As concerns the Cnidaria identified, *Parazoanthus axinellae* and *Leptopsammia pruvotii* are very interesting species for recreational diving.

Among the full set of recognized species, the invasive green alga *Caulerpa cylindracea* is the only alien species.

As regards the Visual Census on ichthyofauna, 18 taxa have been identified, all species are typical of Mediterranean coralligenous habitat. Obviously this data represent only a part of what could be the total species and the biomass that characterizes the area. Nevertheless, all the components of the trophic network are well represented, from the benthic to the nectonic species. An indicative element about the good state of health of the area and a good result for an MPA. Moreover, also the number of observed individuals belonging to the single taxa are representative of the ecological habits related to the species themselves, in fact we find gregarious species (high number of individuals) represented graphically (fig. 8) by a very high column (*Chromis chromis*) and more solitary and/or territorial represented by almost imperceptible columns (1-2 individuals of *Dentex dentex*).

The most represented species in the monitoring was *Chromis chromis*, present in all the four surveys with a total of 2572 individuals observed. *Diplodus vulgaris* was another frequently found species, with a total of 110 individuals observed. Several species with a very low number of individuals have been recognized, as in the case of *Dentex dentex*, *Muraena helena*, *Pagrus pagrus*, *Serranus hepatus*, *Spondyliosoma cantharus* and *Trypterigion melanurus*.

Other species have been found in some surveys only, such as *Diplodus annularis*, *Spicara maena*, *Serranus cabrilla* and *Coris julis* even if the number of individuals was seasonally significant (Figure 8).

Most of the species appear to be sedentary or in any case closely linked to the presence of outcropping coralligenous, like a *Diplodus vulgaris* and *Diplodus sargus*.

Flag species such as *Dentex dentex*, *Sciaena umbra* and *Pagrus pagrus* were observed, confirming the importance of the reef investigated as a valuable natural habitat and biodiversity hot spot, useful for sustainable recreational diving.

As regards the use of ROVs during the visual census of the fish community, some critical issues were highlighted due to the disturbance of the electric motors (noise) and artificial lights, however the data obtained in the observation with the 360° camera are similar to the data obtained using standard methods by scientific divers.

Regarding the ASPIM benthic species or benthic species of interest for diving, some differences were highlighted depending on the method used. The greatest number of identified specimens was recorded with the ROV, then with the video camera held by the divers and then by the divers in real time (Figure 9). However, 7 ASPIM species have been identified in the study area: *Axinella cannabina, Axinella polypoides, Cladocora caespitosa, Hippospongia c.ommunis, Paracentrotus lividus, Sarcotragus foetidus, Spongia officinalis.*

Figure 7 – Natural reef's benthic species cover percentage into the A, B, C sampling sites, over the 4 surveys. AF = Filamentous algae; NC = Not classified, MA = Mucilaginous algae.

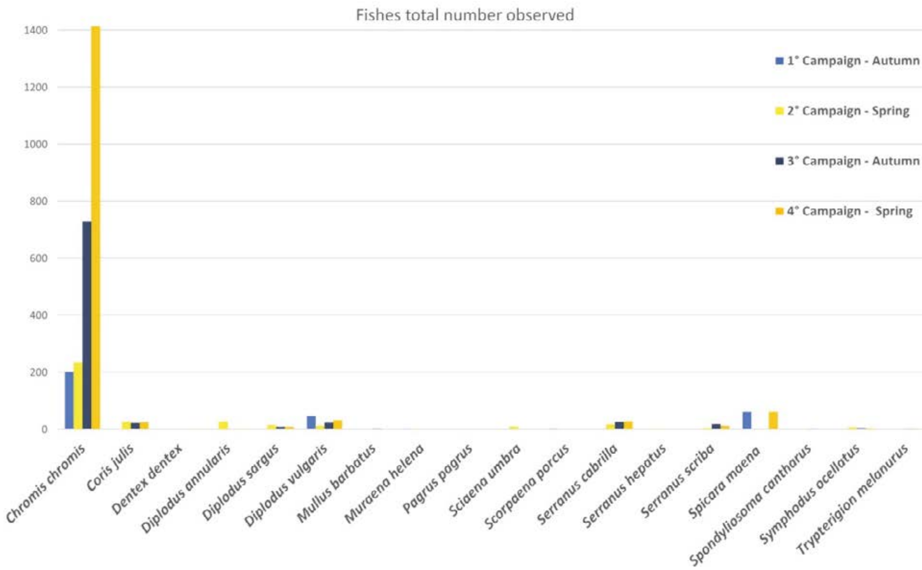


Figure 8 – Fishes total number observed during the 4 surveys.

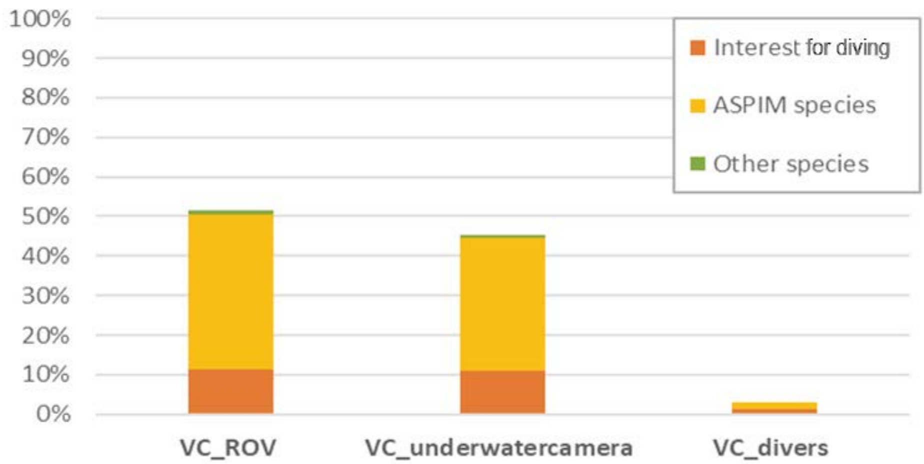


Figure 9 – Percentage of species identified using different VC monitoring methods.

Discussion and Conclusion

Considering the results of the case study and the monitoring sampling strategy applied, the selected site fulfills the purpose of the project and can be considered highly suitable for future tourist exploitation, especially for recreational divers.

From the point of view of natural beauty, the site shows some interesting features such as valuable marine landscapes and different formations such as ravines and cavities created by bioconstructions, very attractive for recreational underwater activities.

The analysis of the benthic community highlights a reef characterized by numerous species typical of the bioconstruction of the coralligenous habitat such as calcareous and poriferous algae, bryozoans, etc.; in particular, sponges of the *Axinella* genus are frequent, creating a sort of wood, which could be very interesting for divers. These species are a source of attraction for divers as they can have different shapes and host different associated organisms, such as nudibranchs (i.e. *Phyllidia flava*). However, it is worth noting the abundant presence of filamentous algae on the bio-construction of the bank, as well as a reduced presence of gorgonians.

The relatively large number of ASPIM species identified could be of interest for the development of some citizen science projects that combine MPA's new coralligenous reef exploration and underwater activities.

Regarding the fish assemblages and the application of the visual census method, the data show variations among species and the number of individuals observed. These results could be attributed both to natural factors (e.g. environmental conditions, biology, ecology and population dynamics of the species) and to limitations of monitoring methodologies. In fact, the direct observation of the diver in real time, to date, is still the best method. The Scientific Diver, while identifying a lower number of species than the ROV, has a greater accuracy in recognizing them. However, the use of underwater vehicles and the development of specific software dedicated to the identification of the species including their sizes are quickly increasing, so there is a reasonable hope for the improving of underwater monitoring techniques in the future.

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