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ESD Operators: Roles and Duties for the Environmental Monitoring Activities of ARPA Puglia

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Abstract: ARPA Puglia (Italy), the Regional Agency for the Environmental Prevention and Protection, has chosen to use the Scientific Diving Operator figure (ESD) in order to meet some of the environmental monitoring activities foreseen by European Directives, such as WFD-Water Framework Directive 2000/60/EC and the MSFD-Marine Strategy Framework Directive 2008/56/EC. Regarding the environmental monitoring obligations of the aforementioned Directives, many of them involve underwater operations. For example, both Directives (MSFD and WFD) require *Posidonia oceanica* monitoring *in situ*, by collecting data on shoot density and other eco-biometric parameters, also describing the main ecological aspect of seagrass meadows; about *Pinna nobilis,* the visual census of its distribution and abundance is carried out underwater; the non-indigenous species census provided by MSFD requires the qualitative and quantitative sampling of the benthic communities of hard bottoms in harbors performed by a scratching technique. All the described activities need operations by ESDs, so ARPA Puglia developed a path for the implementation of good practices on the subject: adopting the national Guide Lines "*Good practices for the safe performance of the underwater activities*" (ISPRA manual n. 94/2013; D.D.G. n.229/2016); identifying the diving equipment as Personal Protective Equipment (PPE); allowing the acquisition or renewal of ESD scientific license for the operational staff; allowing the annual medical check-up for the ESD operational staff; opening of a national call in order to acquire specialized figures, selected according to ESD Panel standards. Details of environmental monitoring activities carried out by ARPA Puglia ESDs are described in this document.

Keywords: European Scientific Diver, European Scientific Panel, ARPA Puglia, Environmental Agencies, Underwater Scientific Activities, *Pinna nobilis*, *Posidonia Oceanica*, Not Indigenous Species

1. Introduction

The professional figure of European Scientific Diver (ESD) is still poorly known and spread in the European Countries, despite the Scientific Scuba Community strongly works to reach this target. ARPA Puglia (Regional Agency for the Prevention and Protection of the Environment), adopting the Guide Lines "Good Practices for safe underwater scientific activities of ISPRA and the Regional Environmental Agencies" (ISPRA Manuali e linee guida 94/2013 ISBN: 978-88-448-0625-5), has recognized this professional figure, and through a tiring path, has created a specific team. In particular, this operative team works in the "Centro Regionale Mare" of the Agency and it is involved in a large number of sampling and monitoring activities according to European Directives as well as other technical-scientific rules.

2. ARPA Puglia Roles and Aims

The Italian law n°132/2016 established the National System for the Protection of the Environment (SNPA), a

network system on the national territory involving ISPRA (Higher Institute for Environmental Protection and Research), 19 ARPA (Regional Environmental Agencies) and 2 APPA (Provincial Environmental Agencies). SNPA, ARPA and APPA play a leading role in water monitoring, whose results are necessary for the classification of the quality status of water bodies as well as for the implementation of programs of measures to be applied for the achievement/maintenance of the good environmental status.

Specifically, one of the mission of the Regional Environmental Agencies is the protection of the marine and coastal environment, trough specific monitoring activities. For example, we can mention the monitoring of water bodies pursuant by the Water Framework Directive [1], those provided for Bathing Water Directive [2] and the ones required by the Marine Strategy Framework Directive [3]. In addition to these, recently the Agencies have the task of carrying out some activities under the Habitat Directive [4].

The Apulia Regional Environmental Protection Agency was established with the Regional Law no. 6 of 22 January 1999, while the institutive Act was the Regional Law n. 27, of 4 October 2006. The head office of the Agency is located in Bari, the Puglia capital town, but other departments are located throughout the region.

3. The "Centro Regionale Mare" (CRM) of ARPA Puglia

With its 1,040 km of coastline, the Puglia alone represents 14% of the overall development of the Italian coasts. To ensure the implementation and coordination of all the sampling and monitoring activities relating to the marine and coastal environments ARPA Puglia planned the institution of the Regional Sea Center (CRM), that was established with the D. D. G. n. 179 of 29/03/2018. The CRM is placed in a building at old time a maritime railway station, located close - inside the port of Bari (Figure 1).

Among the various and different tasks in charge of the CRM, there are also activities to be carried out by Scuba Diving. For this reason, rooms dedicated to underwater activities have been planned during the building renovation works, special equipment were purchased and a warehouse too (Figure 2), and mostly an ESD specialized Team was organized.

Figure 1. *The CRM headquarters.*

Figure 2. *Some equipment dedicated to underwater scientific research.*

4. The Steps of ARPA Puglia for the Recognition of the ESD Profession

The route for the constitution of the ESD Team in the Agency began in 2015.

The first step was the implementation of safety protocols for the dives based on the provisions of the Italian Guide Lines "Good Practices for the safe underwater scientific activities of ISPRA and the Regional Environmental Agencies". The above-mentioned Guide Lines were officially adopted by ARPA Puglia in 2016 with a specific Act; thus, the underwater scientific activity assumed a well-defined role in the Regional Agency.

Diving equipment and specific training of employees were the priorities in the initial stage of team constitution; in the 2018 the Agency authorized an updating course for safety (BLS-D, OX-Provider, Scuba Rescue) and a Scientific Diving Course for the maintenance of the standards set as required by European Scientific Diving Panel. This specific

course was directed by the International School for Scientific Diving (ISSD).

Together with the training, medical specialist controls for underwater job duties start to be planned to ensure work safety during underwater scientific activity.

Later, in the 2019 ARPA Puglia opened a national call for the acquisition of new professional figures as the Underwater Scientific Operator, to enlarge the ESDs team in the CRM.

Finally, in the 2020 the diving equipment was included in the Agency's list of "Personal Protective Equipment" (PPE), in order to assure the highest safety level during underwater operations.

5. ESD's Specific Activities in ARPA Puglia

As already mentioned, the ESD Team of CRM is organized according to the Italian Guide ISPRA 94/2013 [5], regulating operators functions and roles according to different level of responsibility for all the phases of the work. Therefore, the CRM diving organigram provides a Scientific Scuba Supervisor, a Scientific Scuba Chief, several Scientific Scuba Operators and a Surface Assistants.

Among the different activities carried out, according the Water Framework Directive the CRM ESDs are involved in the monitoring of Biological Quality Elements for the evaluation of the marine waters' ecological status, such as the seagrass *Posidonia oceanica* and the macrobenthos communities [6].

According to the Marine Strategy Directive, the CRM ESDs are involved in the monitoring of the Descriptors 1 and 2, in particular: Not Indigenous Species (NIS), benthic habitats (i.e. coralligenous), *Posidonia oceanica* meadows (Dir. Habitat too), and the protected species *Pinna nobilis* (Dir. Habitat too). Moreover, CRM ESDs carry out other technical activities, for example visual census for the evaluation of habitat distribution and species populations, evaluation of anthropic impacts on the sea bottoms, sampling of species, sediments and water (Figure 3).

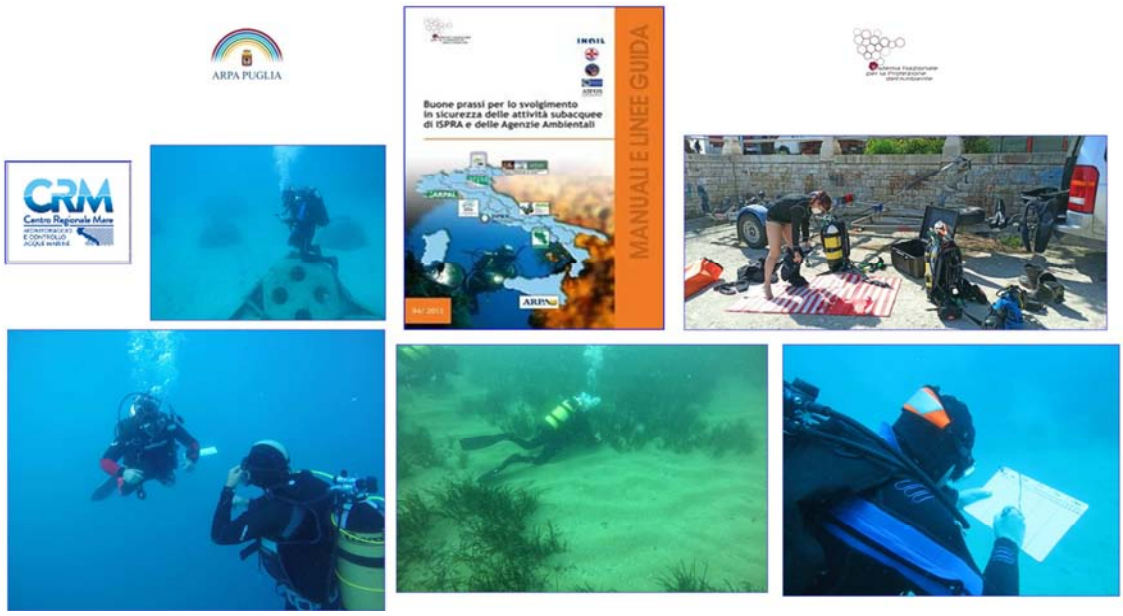

Figure 3. *Some examples of Scientific underwater activities.*

6. The ARPA Puglia ESD Role in the Monitoring of *Posidonia oceanica* Meadows

As a rule, for the monitoring of *Posidonia oceanica* meadows (under the WFD and MSFD Directives), the ISPRA protocol [7] is applied, locating two monitoring stations (one at -15 m depth and the other at the meadows Lower Limit depth) for each chosen sites. In Puglia the sites monitored by the Agency are 17, where the meadows Lower Limit does not exceed 30 meters depth[8]. Thus, Safety Diving Standards [9] are always respected being the first dive on the deeper station (Lower Limit), so the NDL (no decompression limit) is never exceeded. During the dives, the scientific operators take information about some bioecological parameters: plant density, coverage, presence of *Posidonia* flowers, bottom type, anthropogenic disturbing factors, presence of other invasive species (es. *Caulerpa spp* and other), etc. Moreover, bottom sediments samples [10] are collected for the chemical lab analysis as well as orthotropic plants in order to lab evaluation on lepidocronology and morphology.

In the-15 m station a hierarchical sampling strategy is applied, which consists in the survey and samples collection on the meadow in n. 3 separate areas of about 400 square meters each and spaced about 10 meters apart (Figure 4). Table 1 shows all the operations carried out by the underwater scientific operators during the sampling dive on this station.

Table 1. *Parameters detected by ESDs during the dive at -15m on Posidonia oceanica meadows (Legislative Decree 152/06).*

n. 3 zones x 3 measurements = 9 plant counts in square metal (40x40 cm) for density measurements (bundles / m^2) and% of plagiotropic and dig out bundles
n. 3 zones x 6 bundles = removal n. 18 orthotropic bundles, (three-year frequency)
n. 3 zones x 1 = 3 estimates of the coverage of the Posidonia on the seabed;
visual detection of some bioecological parameters (blooms in progress, type of substrate, disturbing factors anthropic, presence of invasive / alien algal species, etc.)
n. 2 bottom samples taken for analysis grain size and T. O. C.
n. 1 data-logger positioned on the bottom with pole metal in the prairie for continuous recording of temperature and light, with autonomy of over 1 year.

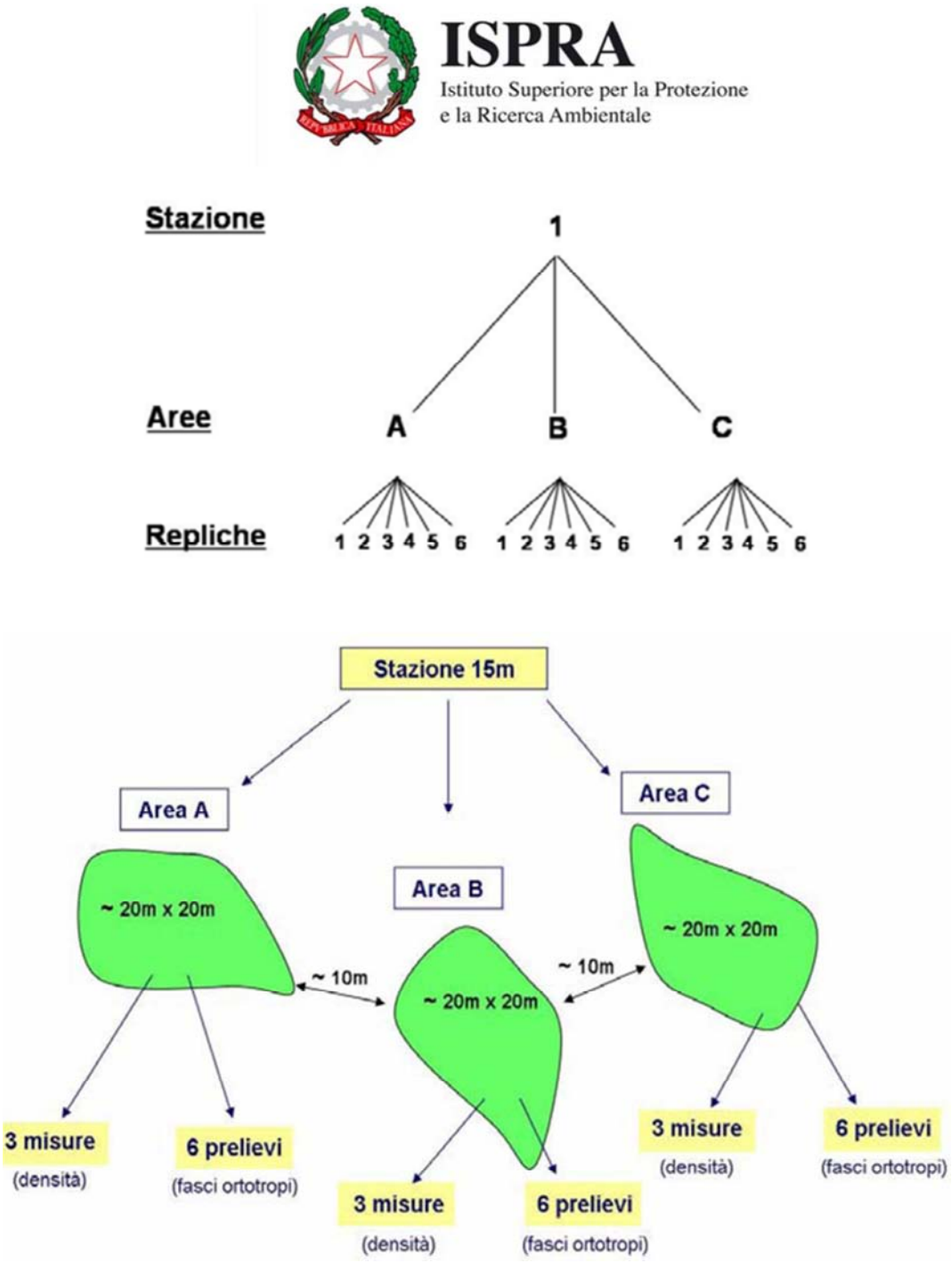

Figure 4. *Hierarchical sampling strategy applied to the station closed to -15 m depth (from ISPRA"Scheda di campionamento delle praterie di Posidonia oceanica" rif Bertrandy et al, 1986).*

At the Lower Limit station, the monitoring consists in the examination of the limit on a 50-60-meter-long transept (Figure 5) [11]. The Table 2 shows all the operations carried out by the underwater scientific operator during the dive on this station.

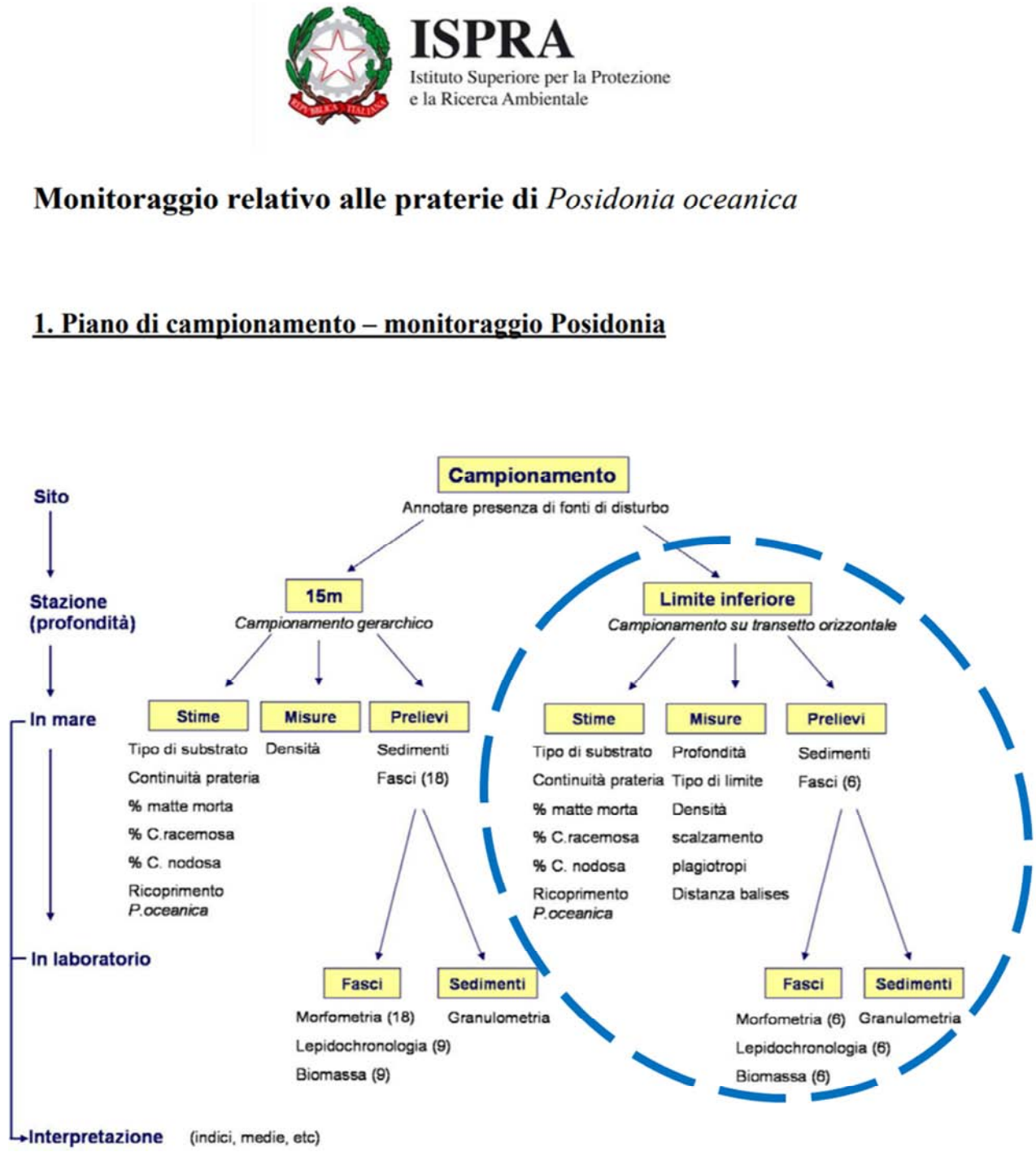

Figure 5. *horizontal transept sampling applied on the Lowe Limit (the circled part in the image) (from ISPRA"Scheda di campionamento delle praterie di Posidonia oceanica" rif. Bertrandy et al, 1986).*

Table 2. *Parameters detected by ESDs during the dive at L. L. on Posidonia oceanica meadows (Legislative Decree 152/06).*

n. 3 zones x 3 measurements = 9 plant counts in square metal (40x40 cm) for density measurements (bundles / m2) and% of plagiotropic and dig out bundles
n. 3 zones x 6 bundles = removal n. 18 orthotropic bundles, (three-year frequency)
n. 3 zones x 1 = 3 estimates of the coverage of the Posidonia on the seabed;
visual detection of some bioecological parameters (blooms in progress, type of substrate, disturbing factors anthropic, presence of invasive / alien algal species, etc.)
n. 2 sediment samples taken for analysis grain size and T. O. C.
Survey of the type and depth of the Lower Limit part of the meadows with contextual video shooting underwater
survey of lower limit variation measurements (balisage)

All the operations described above are done by two different Scuba operators [12].

To carry out the activity the following tools are used (Figure 6):

a. 40x40 cm plastic or metal squares;
b. underwater camera;
c. underwater video camera;
d. sample holder net;
e. illuminators;
f. spatula and jars for sediment collection;
g. steel poles;
h. cable ties;
i. irradiance sensor.

Figure 6. *Some tools used from ESDs during the dives for Posidonia oceanica monitoring.*

7. The ARPA Puglia ESD Role in the Monitoring of *Pinna nobilis*

The ARPA Puglia ESDs are involved in the visual census about the population of *Pinna nobilis* [13]. The purpose of this monitoring is to evaluate the distribution and density of the species as well as to verify the health state of the population in the surveyed area [14]. The monitoring protocol is described in the methodologic schedule used in Italy for the application of the MSFD [15].

In Puglia the Agency actually investigate 15 zones (5 square km each), from 10 to 20 meters deep, and in each of them 3 sub-areas 100m x100m have been identified (A, B, C); for each sub-area three transepts (t1, t2, t3) are considered at a regular distance from each other (Figure 7). The three transepts are covered by two scientific operators, that during the dive carry out the visual census considering a strip 6 meters wide (3 m for each visual side). In this way 600 square meters are investigated for each single transept.

To carry out this activity, the surface assistants lowered 100 meters of lead rope to the bottom using cartographic references for start and finish, positioning surface buoys. The pair of scuba operators approaching the signals and following the compass direction, proceeds to roll out a reel of 100 meters. The reel wire act as a physical reference on which carry out the visual census. Usually each transept corresponds to one dive, in the event that (for example shallow depths) the couple has sufficient air or nitrox breathing mix supply they proceed to another transept. During every single dive the presence of any waste or litter on the bottom is noted on a special marine blackboard together to data collected on the species presence (n. specimens, dimensions, status) (Figure 8).

Figure 7. *Graphic arrangement of the survey areas and transepts.*

Scheda di Campo – *Pinna nobilis*

Rilevatori SUB:	**Data:**
Operatori di superficie:	
Descrizione del sito di rilevamento	
Nome area di indagine: N. sito (cella): Coordinate centro cella (100*100m): Lat° N Long° E	Livello di protezione sito: Presenza criticità e/o impatti: N° Verbale: MM /AA

Dati sul popolamento		
N. transetto: 1-2-3 A B C	Direz. linea base: °N	Direz. transetti: °N
N. esemplari per cella:		

Tansetto ID	Individuo ID	Stato di salute	Profondità (m)	Tipo di substrato	Biometria			Note
					UL (cm)	W (cm)	w (cm)	

Dati su residui plastici			
Tansetto ID	**Tipo di Rifiuto**	**Abbondanza**	**Note**

Note:

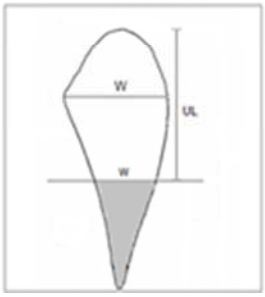

Figure 8. *Data sheet recorded by the ESDs during the dives for monitoring the population of Pinna nobilis.*

To carry out this activity the following tools are used (Figure 11):

a. 100 m of leaded rope;
b. various cordage;
c. surface buoys;
d. safety buoys;

e. reels with high visibility rope;
f. sub slate;
g. compass.

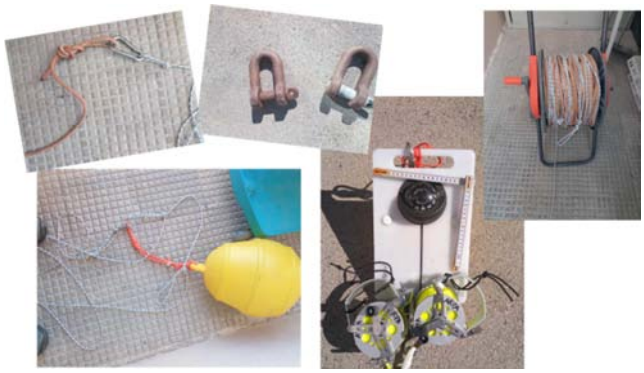

Figure 9. *Some tools used from ESDs during the dives for Pinna nobilis monitoring.*

8. The ARPA Puglia ESD Role in the Monitoring of NIS (Not Indigenous Species)

The ARPA Puglia ESDs carry out in coastal marine areas the monitoring of invasive alien species (IAS) [16] also, according to the MSFD obligations.

Different approaches are used for the specific activity, through surveys that involve standard sampling methodologies such as scratching, bucket or box corer, fishing gear depending on the substrate or visual census [17].

ARPA Puglia carry out the monitoring of NIS in some harbor areas along the regional coast, where the sampling consists in the scraping of hard substrate (artificial jetty) (Figure 10); during a single dive in which 3 ESD operators are involved, a metal square 32x32 cm is used with 3 replicas at different depths (3 and 9 meters) [18] (Figure 11). Two divers work for samples recovering and storage (to be analyzed in lab), while a third one makes photos of the fixed surface to be scratched, in order to estimate the species coverage.

Figure 10. *N. 3 ESDs during the sampling phases of scraping on an artificial jetty.*

Figure 11. *The metal square 32x32 cm used by ESDs during the scientific diving.*

To carry out this activity the following tools are used (Figure 12):

a. 32x32 cm metal squares;
b. net with very fine mesh;
c. underwater camera;
d. illuminators;
e. trowel or similar instrument to scratch.

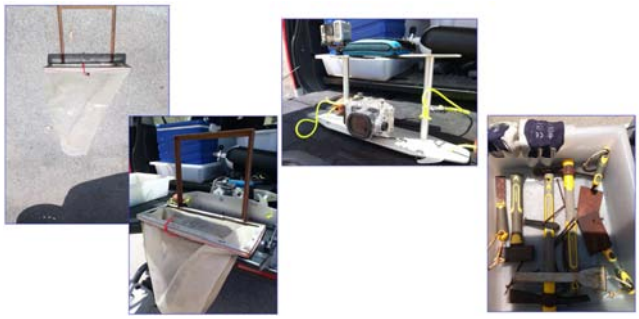

Figure 12. *Some tools used from ESDs during the dives for NIS monitoring.*

9. Conclusion

According to the ARPA Puglia institutional mission, the different phases and timing for reaching the recognition of the ESD professional figure within the Agency were described.

Moreover, the main underwater activities carried out by the ARPA Puglia-CRM ESD Team have been detailed; currently, about 200 dives are carried out annually by the ESDs team of the Agency. The underwater environmental activities are constantly evolving in Puglia as well as in Italy, so the ESDs can be considered as a resource to expand the range of institutional services from Environmental Protection Agencies.

Although much was done in ARPA Puglia, there are still some steps to finalize. In particular, there is the need for recognition of indemnities linked to the specific risks, as well as have to be formalized the physical health maintenance protocol (specific training program), as a form of prevention from diving accidents (DCS, etc.).

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