BLUEMED

Activity 4.4
Validation framework (method, types of assessment, KPIs, questionnaires, impact checklists etc.)

Deliverable 4.4.3
D4.4.3 Impact checklists developed (incl. climate change) and report on measured environmental impact to marine ecosystem after completion of pilot activities

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I. INTRODUCTION

The aim of this deliverable is the preparation of a checklist for evaluating natural and anthropogenic impacts on marine ecosystem and biodiversity and environmental impact assessment report after measurement conducted at each pilot site. The Oceanography Centre, University of Cyprus (OC-UCY) is the responsible partner for the implementation of this deliverable.

The information and the data that were gathered for the implementation of the deliverable 4.2.5, "Preliminary marine biodiversity and abundance study of MPA/UM/DP marine areas", are being used here for the preparation of the checklist. The Oceanography Centre, University of Cyprus (OC-UCY) was also the responsible partner for recording the marine biodiversity found at the pilot sites.

II. DESCRIPTION OF THE PILOT AREAS

A. ITALY

1. Baia

The marine area of Baia, as well as the extended area of the Gulf of Naples, is characterized by an immense biodiversity and beauty of volcanology, biology, and archaeology. The Gulf of Naples has a wide range of underwater caves, marine parks, and submerged Roman ruins. The water currents of the Gulf of Naples bring lots of nutrients to the Gulf of Pozzuoli and especially the marine environment of Baia, constituting Baia as an area of high marine biodiversity and abundance. Furthermore, the mussel farms located within the Bay of Pozzuoli further increase the nutrients in the water making them eutrophic. Underwater visibility can sometimes be limited (less than 5m) due to the presence of suspended sediments. However, the high biodiversity of marine life in combination with underwater Roman ruins is very attractive to divers. In addition to this, the shallow waters and the close proximity of the marina to the archaeological marine park of Baia is further contributing to the attractiveness of the site to divers.

Sponges and molluscs were the most common invertebrate found in the Villa. Other invertebrates included sea worms, anemones, sea urchins, barnacles, mollusks, crabs, sea cucumbers, and bryozoans. Green, Red, and Brown algae were recorded. All of them are very common for the area. Among the brown algae, *Dictyota dichotoma var intricata* was the most common species in the Villa. Another species of brown algae, *Colpomenia sinuosa* is used in human diet, as a raw salad vegetable. It is also used as a fertilizer and as an indicator of metal pollution in the water.

2. Capo Rizzuto

The Marine Protected Area (MPA) of Capo Rizzuto extends about 15,000 ha. The area includes the shipwrecks and archaeological sites of Cala Cicala, Bengala, Punta Scifo D, and Relittone. The Torre Vecchia Cave is of interest to divers as well. The MPA of Capo Rizzuto is characterized by a mainly rocky bottom with sandy patches. The seagrass *Posidonia oceanica* is common in the area, stabilizing the seabed, breaking swells and waves, and encouraging the deposit of sedimentary particles. Posidonia is considered to be an indicator species of the overall quality of coastal waters since it is very sensitive to pollution and can only grow in clean unpolluted waters. It supports a wide variety of animal species that use these habitats for breeding, feeding and shelter. Due to the presence of Posidonia, underwater visibility is excellent, making the area very attractive to divers. Furthermore, the wrecks and archaeological sites proved a wide range of depths (from 6m down to 25m) for the divers.

Sponges were the most common invertebrates found in the marine park of Capo Rizzuto. Green, Red, and Brown algae were recorded, with brown algae being the most common (6 different species present). The Angiosperm *Posidonia oceanica* (Neptune grass) covered the area extensively. The most common species recorded was the brown algae *Padina pavonica* (Peacock's tail) and the red algae *Peyssonnelia orientalis* (Leather rock), which is used by the Marine Strategy Framework Directive (MSFD) as one of the indicator species for monitoring habitat distributional range. Another species of brown algae, *Zanardinia typus* (Penny weed) is considered a "characteristic species", reflecting the good ecological status of the environment. Penny weed has a relatively high antimicrobial activity, which allows it to fight against microbial attacks. The extracts of this algae also have antifungal, antiviral, cytotoxic and antimitotic properties.

B. Croatia

The Underwater Cultural Heritage (UCH) sites and UCH diving parks in Cavtat, are among the most attractive and biologically rich areas in Croatia for advanced level divers to dive. These amphorae, pithoi and old pots sites harbouring many of the world's plant and animal species and providing important ecological services. The high biodiversity and abundance of marine species found in these areas is often one of the factors that constitutes them very attractive to tourists, as well as snorkelers and divers.

The majority of marine life recorded in the area were invertebrates (35%) while a wide range of algae (52%) and fish (13%) was also recorded (figure 14). Macroalgae - Rhodophyta (*Peyssonellia rosa-marina, Mesophyllum alternans, Peyssonellia squamaria* and *Hydrolithon cruciatum*) were found to be more abundant 73% in the dive site, specifically on and between the amphorae. Tracheophyta (*Posidonia oceanica*) were found the second most abundant species between and next of the amphorae inside the cage.

1. Cavtat Cage

From Cavtat in Croatia it is possible to dive at one of the biggest amphorae and pithoi sites underwater which lie there for 2000 years ago.

Amphorae dive site characterized by high biodiversity and abundance of marine species like sponges, sea anemones, moray eels, starfish, fish, mollusks, seagrass meadows on the seabed and green algae, red algae and brown algae, between, on and under the amphorae. Rhodophyta (*Peyssonellia rosa-marina, Mesophyllum alternans, Peyssonellia squamaria* and *Hydrolithon cruciatum*) were found to be more abundant 73% in the dive site, specifically on and between the amphorae. Important species were recorded in amphorae dive site e.g. *Posidonia oceanica* which is endemic to the Mediterranean Sea and forms large underwater meadows that are an important part of the ecosystem. Tracheophyta (*Posidonia oceanica*) were found the second most abundant species between and next of the amphorae, inside the cage. However, another species *Muraena helena* which recorded from a video is an important fish and is listed in the Red list of Europe and IUCN.

Due to the fact that the Archeology Department of Cavtat performs periodic maintenance for the conservation of the amphorae and to keep those in an attractive condition for the visitors, more species could have been found.

2. Cavtat Dulia

At another dive site (Pithos) close to the amphorae several huge pithoi can be found. These are huge storage containers which were most probably used to transport water on ships.

Pithos diving site, as the Cage diving site, characterized by high biodiversity and abundance of marine species like sponges, sea anemones, moray eels, starfish, fish, mollusks, seagrass meadows on the seabed and green algae, red algae and brown algae, between, on and under the pithoi. Seagrass meadows (*Posidonia oceanica*) were found to be more abundant 26% in the dive site. *Posidonia oceanica* is an important habitat-forming species and provides habitat for many species. Nursery grounds for the juveniles of many commercially important fishes and vertebrates. The Rhodophyta (*Lithophyllum racemus, Lithothamnion valens, Peyssonnelia squamaria, Mesophyllum alternans* and *Hydrolithon cruciatum* were the second most abundant species between, on and under the pithoi.

C. GREECE

1. Alonnisos

Peristera is the largest and most important Classic Age shipwreck that is legally recognized as Underwater Museum in Greece but is also an important habitat and refugee for many marine organisms.

Thirty-one (31) marine species in total were recorded at Peristera shipwreck. Specifically, 11 species of macrophytes (1 species – *Posidonia oceanica*) and macroalgae (10 species) together were recorded, whereas another 9 species of invertebrates were identified as well. Moreover, 11 species of fish were recorded from the video. The majority of marine life recorded in the area were invertebrates (32%) while a wide range of algae (32%) and fish (34%) was also recorded.

The species from macroalgae that was found in the most quadrats is *Padina pavonica* at 22%, whereas the invertebrate that presented the highest numbers was *Agelas oroides* at 4%, in the photo-quadrats. The videos showed that *Chromis chromis* was one of the most abundant fish in the shipwreck. Many individuals of *Muraena helena* were also observed in the amphorae of the shipwreck.

Important species were recorded in Peristera shipwreck e.g. *Posidonia oceanica* which is endemic to the Mediterranean Sea and forms large underwater meadows that are an important part of the ecosystem. It is a priority habitat *1120 in the Habitats Directive (92/43/EEC) and it is included in Annex II of the Bern Convention as species of flora strictly protected. *Muraena helena* is also an important fish and is listed in the Red list of Europe and IUCN. *Sciaena umbra* that was recorded in the shipwreck is categorized as Near Threatened (NT) in the list of IUCN. Hence, Peristera shipwreck is a significant underwater museum, important habitat for marine life and a beautiful diving site.

2. Cape Glaros

Glaros Cape is located in an area opposite of Nies, a coastal village in the prefecture of Magnesia and close to the city of Amaliapolis. Amaliapolis is located near Almiros and 54 kilometers from Volos, on the western coast of the Pagasetic Gulf. Glaros found to be one of the most abundant areas in the Pagasetic Gulf hosting 33 species of 10 macroalgae, 17 invertebrates and 6 different fish species. The majority of marine life recorded in the area were invertebrates (52%) while a wide range of algae (32%) and fish (34%) was also recorded (figure 23). *Halimeda tuna* presented the highest numbers among the macroalgae at 31% within the quadrats, while *Chondrosia reniformis* among the invertebrates, reaching 14%.

It is really worth visiting the site and diving among the plentiful and varying objects indicative of ancient cargoes and get close to the beautiful marine species that call this area home such as the Muraena *Helena* and the *Sciaena umbra* which are listed in the Red list of Europe and IUCN.

3. Kikinthos

The islet of Kikinthos is a natural breakwater, lying at the east of Amaliapolis bay, on the west side of the Pagasetic gulf. The remnants of a Byzantine shipwreck cargo of mainly pithoi (large storage containers) are located at around 3 to 11 from the seabed hosting a diversity of marine life.

At the shipwreck of Kikinthos one macrophyte (*Cymodocea nodosa*), 5 macroalgae, 9 invertebrates and 5 species of fish were recorded. The majority of marine life recorded in the area were invertebrates (45%) while a wide range of algae (30%) and fish (34%) was also recorded (figure 26).

The most abundant macroalgae was *Flabellia petiolata* at 22%, whereas the most abundant invertebrate was *Aplysina cavernicola* at 20% in the sampling area.

Diving in Kikinthos the visitor will have the chance to get close to important marine species such as the *Cymodocea nodosa* which is protected by the Bern Convention and Barcelona Convention and if lucky to encounter the fast-swimming *Seriola dumerili*.

4. Tilegrafos

Tilegrafos Bay is located in the prefecture of Magnesia and close to the city of Amaliapolis. In total, 27 species of marine organisms were recorded in Tilegrafos shipwreck. Specifically, 8 macroalgae, 15 invertebrates and 4 species of fish were recorded in the shipwreck of Tilegrafos. The majority of marine life recorded in the area were invertebrates (56%) while a wide range of algae (30%) and fish (34%) was also recorded. *Halimeda tuna* and *Codium bursa* were the most abundant macroalgae in the shipwreck of Tilegrafos at 25% both. *Agelas oroides* and *Chondrilla nucula* were the most abundant among the invertebrates with a total of 10% and 9%, respectively.

Hosting 27 different species Tilegrafos constitutes an important habitat for marine life where the diver will not only dive into history but also enjoy the diverse and beautiful marine environment the area has to offer.

III. EU INDICES FOR MONITORING THE MARINE ENVIRONMENT

Two main legislative tools are proposed by the EU for the monitoring of marine environment: the Water Framework Directive (2000/60/EC) and the Marine Strategy Framework Directive (2008/56/EC). Specifically, the Water Framework Directive (2000/60/EC) proposes specific quality elements for the classification of ecological status of coastal waters that are shown in table 1.

Table 1. Quality elements for the classification of ecological status of coastal waters, Water Framework Directive (2000/60/EC).

Quality elements for the classification of ecological status		
Coastal waters		
Biological elements	Composition, abundance and biomass of phytoplankton	
	Composition and abundance of other aquatic flora	
	Composition and abundance of benthic invertebrate fauna	
Hydromorphological elements supporting the biological elements	Morphological conditions	depth variation
		structure and substrate of the coastal bed
		structure of the intertidal zone
	Tidal regime	direction of dominant currents
		wave exposure
Chemical and physico-chemical elements supporting the biological elements		
General	Transparency	
	Thermal conditions	
	Oxygenation conditions	
	Salinity	
	Nutrient conditions	
Specific pollutants	Pollution by all priority substances identified as being discharged into the body of water	
	Pollution by other substances identified as being discharged in significant quantities into the body of water	

In addition, Qualitative descriptors for determining good environmental status are described in the ANNEX I of Marine Strategy Framework Directive (2008/56/EC) (table 2).

Table 2. Qualitative descriptors for determining good environmental status, Marine Strategy Framework Directive (2008/56/EC).

Qualitative descriptors for determining good environmental status
1. Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions
2. Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.
3. Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
4. All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
5. Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.
6. Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.
7. Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.
8. Concentrations of contaminants are at levels not giving rise to pollution effects.
9. Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.
10. Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
11. Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

The overall goal of the MSFD is to achieve 'good environmental status' (GES) in the marine waters of EU Member States. Both the WFD and MSFD focus on integrated catchment management and ecosystem-based approaches (Borja et al. 2010). The directives share a number of basic elements but there are also significant differences in terms of how class boundaries and reference conditions are defined, the types of indicators used, and the integrated assessment.

Using the analogy of a car dashboard, the Biological Quality Elements (BQEs) are equivalent to the speedometer, giving the driver an indication of their performance in relation to ecological status boundaries (equivalent to the legal 'speed limit'), while the supporting elements represent the other dials and warning lights on the dashboard that allow the driver to diagnose possible reasons for the biological 'engine' not running as smoothly as desired. A low ecological quality ratio (EQR) for a nutrient-sensitive BQE may indicate a problem with nutrients, but there may be other explanations (macrophytes, for example, are sensitive to both nutrients and hydromorphology).

The combination of a low EQR and exceedance of a nutrient boundary, therefore, is a stronger indication that nutrients may be responsible for the failure to achieve GES than a low macrophyte EQR alone. This allows broad-scale overviews of problems and the likely costs for dealing with these to be established at a regional or national level. What the exceedance of supporting element boundaries does not do is provide an unambiguous indication that the ecological status of any particular water body is compromised solely by one pressure and that others may not also play a role (European Commission, 2018).

A consideration should be given to both directives, in order to establish a monitoring protocol for each area. Since the publication of these directives a lot of biological indices have been produced. A biological element that is abundant in most of the pilot areas and could be used as biological index is *Posidonia oceanica*. Three examples of biological indices that use *Posidonia oceanica* for the evaluation of the ecological status of water are POMI (Romero et al., 2007), BiPo (Lopez y Royo et al. 2010) and PREI (Gobert et al. 2009).

The PREI (*Posidonia oceanica* Rapid Easy Index) is applied at specific monitoring stations. This technique requires SCUBA divers working on monitoring stations at constant depths (at 15 + 1m depth) and on fixed points at the lower limit of the meadow. At each station, three 400m areas each being 10m apart are investigated as replicates.

Measurements to be collected in situ include:
- shoot density: by counting shoots present in three replicate samples.
Values are expressed as number of shoots/m^2
- depth of the lower limit;
- type of this limit (regressive, progressive or stable).

Estimates on the percentage cover of *P. oceanica*, typology of substratum, continuity of the meadow, percentage of dead matter, percentage of *Caulerpa racemosa* and percentage of *Cymodocea nodosa* are estimated at each monitoring stations.

Six orthotropic shoots of *P. oceanica*, randomly chosen, are uprooted for laboratory analyses. Measurements to be obtained by processing samples in the laboratory include:
- shoot leaf surface area: length and width of each leaf have to be measured and the leaf surface area per shoot calculated
- E/L (ratio between epiphytic biomass and leaf biomass) measured on shoots: Epiphytes are to be scratched off with a blade to estimate their epiphyte biomass as dry weight after 48 hours at 60°C. Leaf (adult and intermediate) biomass will be calculated as dry weight after 48 hours at 60°C in order to calculate the E/L ratio.

At the lower limit of the meadow for each monitoring station, another 6 randomly selected shoot density measures have to be carried out and a further 6 orthotropic shoots have to be uprooted for subsequent laboratory analyses.

The EEI Index (Ecological Evaluation Index) was also developed by Orfanidis et al. 2001, in order to estimate the ecological status and identify restoration targets of transitional and coastal waters, using marine macroalgae and macrophytes. Marine benthic macrophytic species (seaweeds, seagrasses) were used to indicate shifts in the aquatic ecosystem from the pristine state with late-successional species (Ecological State Group I) to the degraded state with opportunistic (ESG II) species. The first group comprises species with a thick or calcareous thallus, low growth rates and long life cycles (perennials), whereas the second group includes sheet-like and filamentous species with high growth rates and short life cycles (annuals). Seagrasses were included in the first group, whereas Cyanophyceae and species with a coarsely branched thallus were included in the second group. The evaluation of ecological status into five categories from high to bad includes a cross comparison in a matrix of the ESGs and a numerical scoring system (Ecological Evaluation Index).

BENTIX (Simboura and Zenetos 2002) is a biotic index that uses zoobenthos as biotic quality element for the evaluation of coastal waters, based on WFD. The biotic index (BENTIX) is based on the relative percentages of three ecological groups of species grouped according to their sensitivity or tolerance to disturbance factors and weighted proportionately to obtain a formula rendering a five step numerical scale of ecological quality classification.

When looking for correlations between the biology and nutrient concentrations in order to derive nutrient thresholds it is important to know the limiting nutrient, since a strong correlation can only be expected to exist between the limiting nutrient and the biology. However, the patterns of nutrient limitation suggest that determination of the limiting nutrient can be challenging, since limitation can vary on small spatial scales and between seasons. Hence boundary values should be established for, and monitoring programmes should consider, both nitrogen and phosphorus (European Commission, 2018).

Phosphorus is often the limiting nutrient in Mediterranean (Margalef, 1963; Berland et al., 1980; Lazzari et al., 2016; Thingstad et al., 2005), although it is closely followed by nitrogen in this limiting role (Estrada, 1996).

The dissolved nitrogen to phosphorus ratio in the Mediterranean has been reported to be about 21 to 23 in the western part (Bethoux et al., 1992), and even higher in the eastern basin (Krom et al., 1991), which is quite different from the ratio of 15 found in the global ocean (Tyrrell, 1999).

UNEP/MAP’s Pollution Programme (MEDPOL) has a monitoring programme since 1999, based on the contribution of data from Mediterranean countries, including chlorophyll-a. MEDPOL monitoring data was used for this assessment, noting that there are several gaps in the database where there has been inconsistent data reporting from each country over the years.

Coastal Water types reference conditions and boundaries for chlorophyll-a in the Mediterranean were agreed and adopted in the IMAP decision of 2016. (UNEP/MAP, 2016). These criteria were applied for the first time applied on the data available for the Mediterranean through the MED POL Database.

For eutrophication, it is accepted that surface density is adopted as a proxy indicator for static stability of a coastal marine system. More information on typology criteria and setting is presented in document UNEP(DEPI)/MED WG 417/Inf.15:

Type I	coastal sites highly influenced by freshwater inputs
Type IIA	coastal sites moderately influenced not directly affected by freshwater inputs (Continent influence)
Type IIIW	continental coast, coastal sites not influenced/affected by freshwater inputs (western Basin)
Type IIIE	not influenced by freshwater input (Eastern Basin)
Type Island	coast (western Basin)

Coastal water type III was split in two different sub basins, the western and the Eastern Mediterranean s, according to the different trophic conditions and is well documented in literature. It is recommended to define the major coastal water types in the Mediterranean for eutrophication assessment (applicable for phytoplankton only; Figure 1).

	Type I	Type IIA, IIA Adriatic	Type IIIW	Type IIIE	Type Island-W
σ_t (density)	<25	25<d<27	>27	>27	All range
salinity	<34.5	34.5<S<37.5	>37.5	>37.5	All range

Figure 1. Major coastal water types in the Mediterranean

With the view to assess eutrophication, it is recommended to rely on the classification scheme on Chlorophyll a concentration (μg L-1) in coastal waters as a parameter easily applicable by all Mediterranean countries based on the indicative thresholds and reference values presented in Figure 2.

Coastal Water Typology	Reference conditions of Chl*a* (µg L^{-1})		Boundaries of Chl*a* (µg L^{-1}) for G/M status	
	G_mean	90% percentile	G_mean	90% percentile
Type I	1,4	3,33* - 3,93**	6,3	10* - 17,7**
Type II-FR-SP		1,9		3,58
Type II-A Adriatic	0,33	0,8	1,5	4,0
Type II-B Tyrrhenian	0,32	0,77	1,2	2,9
Type III-W Adriatic			0,64	1,7
Type III-W Tyrrhenian			0,48	1,17
Type III-W FR-SP		0,9		1,80
Type III-E		0,1		0,4
Type Island-w		0,6		1,2 – 1,22

Figure 2. Coastal Water types reference conditions and boundaries in the Mediterranean

* applicable to Gulf of Lion

** applicable to Adriatic

Deterministic and probabilistic criteria recommended by the Organization for Economic Cooperation and Development (OECD; Vollenweider and Kerekes, 1982) are widely used as reference criteria for eutrophication level assessment of inland waters and marine transitional systems. The OECD probabilistic classification, defined an 'open boundary system', i.e. without fixed lower and upper limits for each trophic class, is based on overlapping lognormal probability distributions for each trophic category, defined by corresponding annual means and standard deviations of the most relevant variables of water quality (Figure 4). It refers to single analytical variables like chlorophyll a, total nitrogen and total phosphorus concentrations as well as peaks of chlorophyll-a and Secchi depth measurements. Those variables are recommended because of their expected inter-correlated response coupled with the trophic degree of a water body (Vollenweider and Kerekes, 1982; Figure 4).

Variable (annual geometrical means)	Oligotrophy	Mesotrophy	Eutrophy
Chlorophyll *a* (μg/l)			
Mean	1.7	4.7	14.3
Mean ± S.D.	0.8–3.4	3.0–7.4	6.7–31
Mean ± 2 S.D.	0.4–7.1	1.9–11.6	3.1–66
Total P (μg/l)			
Mean	8.0	26.7	84.4
Mean ± S.D.	4.85–13.3	14.5–49	48–189
Mean ± 2 S.D.	2.9–22.1	7.9–90.8	16.8–424
Total N (μg/l)			
Mean	661	753	1875
Mean ± S.D.	371–1181	485–1170	861–4081
Mean ± 2 S.D.	208–2103	313–1816	395–8913
Secchi depth (m)			
Mean	9.9	4.2	2.45
Mean ± S.D.	5.9–16.5	2.4–7.4	1.5–4.0
Mean ± 2 S.D.	3.6–27.5	1.4–13	0.9–6.7

Figure 4. Preliminary classification of trophic state in the OECD eutrophication programme (modified by Zurlini 1996, from Vollenweider and Kerekes, OECD, 1982).

Pagou et al. 2002 made also an attempt to produce estimates on nutrient thresholds for Eastern Mediterranean coastal marine ecosystems. These thresholds are depicted in figure 3. Four levels of eutrophication are defined in this scale: eutrophic, higher mesotrophic, lower mesotrophic and oligotrophic. These levels could be considered as corresponding to the five categories of environmental status as defined by the WFD: eutrophic for bad, higher mesotrophic for poor, lower mesotrophic for both moderate and good and oligotrophic for high. Therefore, nutrient concentrations above the limit defining eutrophic conditions could be considered as estimates of threshold values for marine coastal areas of Eastern Mediterranean. In addition, nutrient concentrations which define higher mesotrophic conditions indicate “sensitive” ecosystems (can be eutrophic in the future, if an increasing trend in eutrophication parameters is detected). Thus, concentrations characteristics of higher mesotrophic conditions can serve as “red flags” for ecosystems potentially threatened by future human impacts.

Parameter	Oligotrophic	Lower mesotrophic	Higher mesotrophic	Eutrophic
Phosphates (PO_4)	<0.07	0.07-0.14	0.14-0.68	>0.68
Nitrates (NO_3)	<0.62	0.62-0.65	0.65-1.19	>1.19
Ammonium (NH_4)	<0.55	0.55-1.05	1.05-2.2	>2.2
Phytoplankton	$<6x10^3$	$6x10^3$-$1.5x10^5$	$1.5x10^5$-$9.6x10^5$	$>9.6x10^5$
Chlorophyll α	<0.1	0.1-0.6	0.6-2.21	>2.21

Figure 3. Trophic classification ranges based on nutrients (phosphates, nitrates, ammonium), chlorophyll a and total number of phytoplankton cells. Ranges are given for the oligotrophic,

lower mesotrophic, higher mesotrophic and eutrophic system. Nutrients concentrations are given in µM, phytoplankton cells number in cells l^{-1} and chlorophyll in µg l^{-1}.

The above information should be considered in the attempt for the establishment of a monitoring protocol for each pilot area.

IV. CONSERVING THE MARINE ENVIRONMENT

Coastal-marine environments are some of the most biologically diverse areas on Earth, harbouring many of the world's plant and animal species and providing important ecological services. They are also destinations to hundreds of millions of people who either live near or visiting coastal-marine areas, and the pressure they put on these ecosystems, is intense. Many activities taking place such as diving, snorkelling, recreational fishing, and cruising may have a negative impact and cause extensive damage to important near-shore marine ecosystems.

Responsible marine activities, especially in protected UCH sites, are critical to both preservation unique ecosystems and the continued economic health of the local communities. Adopting good practices can help protect the integrity of the unique landscapes, habitats and species that attract visitors in the first place and sustain the high-quality visitor experiences that will ensure the ongoing financial viability of local businesses.

Best practices for the use of the marine protected UCH sites include: boating practices (proper anchoring, boat operation and maintenance, boat sewage and garbage disposal), snorkeling/diving/scuba diving, as well as recreational fishing. Analytical guidelines for promoting these best practices, are provided in Deliverable 4.3.5 – Training methodology for pilot training courses aimed at target groups (Pas, Ums, MPAs, DPs, tourism and diving industry, etc.) of the project.

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