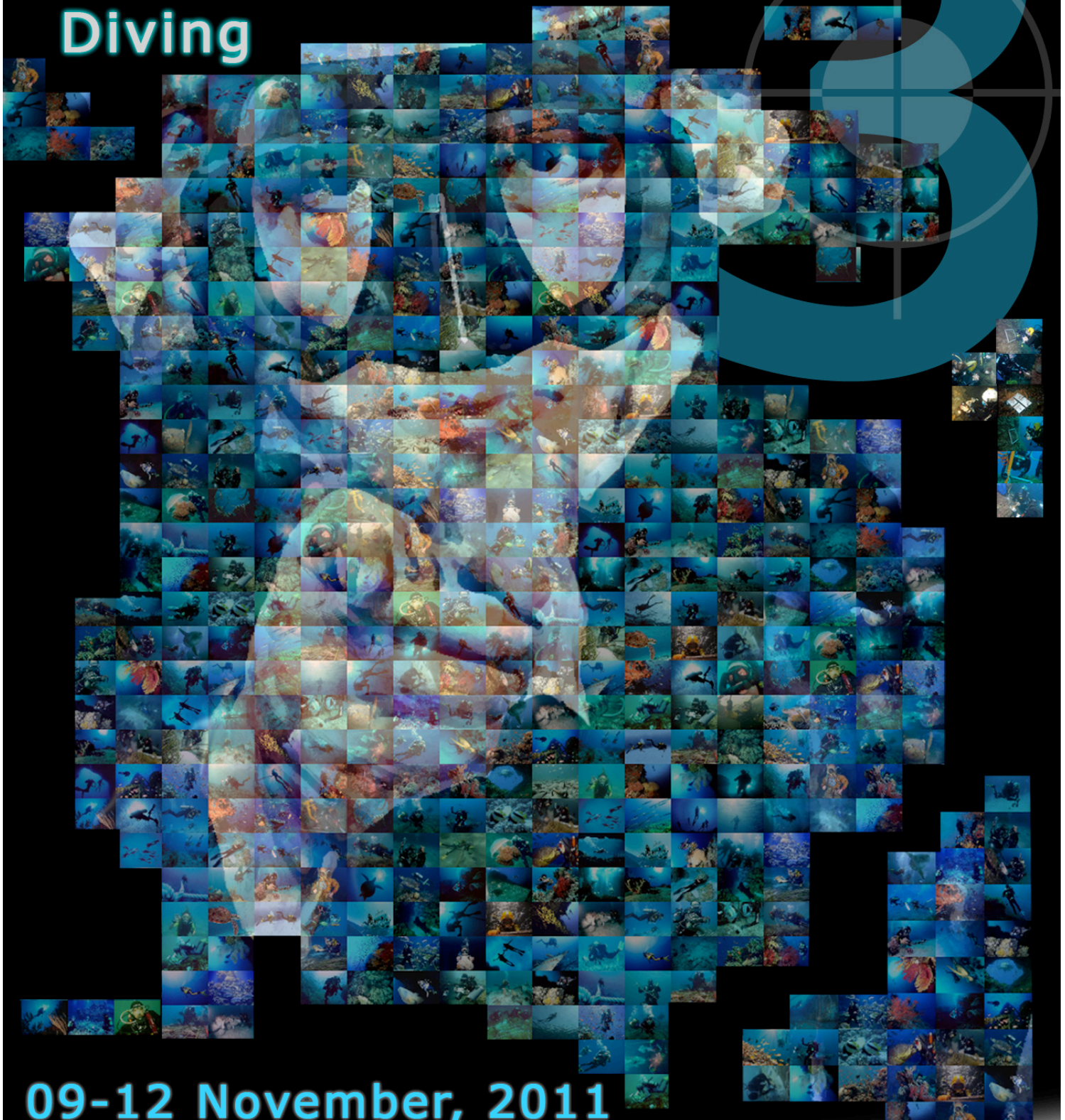
International Symposium on Occupational Scientific Diving



09-12 November, 2011
Porto Cesareo, Lecce (ITALY)

EUROPEAN SCIENTIFIC DIVING PANEL

A.I.O.S.S. - Associazione Italiana Operatori Scientifici Subacquei

FAS federazione archeologi subacquei

CONSORZIO DI GESTIONE AREA MARINA PROTETTA PORTO CESAREO

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3rd International Symposium on Occupational Scientific Diving

Organised by:

Italian Association for Scientific Divers (AIOSS), the Italian member of the European Scientific Diving Panel (ESF MB ESDP)

ABSTRACTS

In collaboration with:

Symposium secretariat:

With the patronage and sponsorship by:

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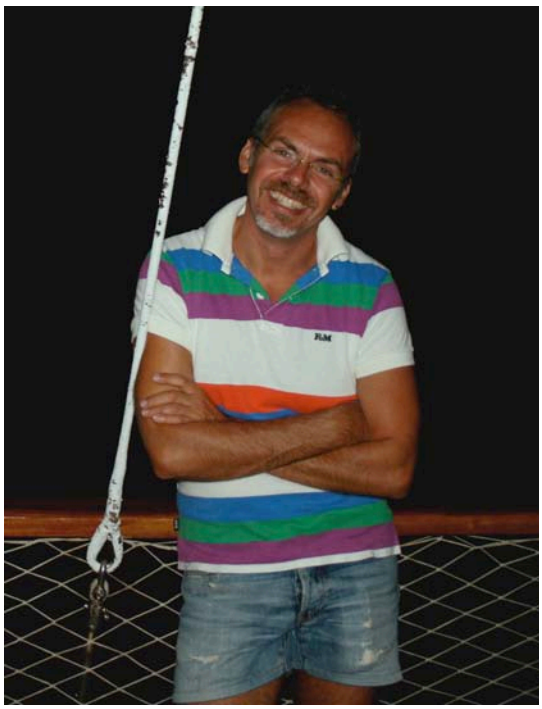
AIOSS – Italian Association of Scientific Divers

Layout and Graphics: Giuseppe Guarnieri

The symposium is dedicated to the memory of Gaetano Ferruzza and Dario Romano, who tragically disappeared the afternoon of October 6, 2009 in a scientific research diving



Gaetano Ferruzza

Dario Romano

PROGRAM

Wednesday 09-11

Afternoon	Arrivals (transfer)	
16:00	**Dive (optional)**	
20:00	**Dinner**	

Thursday 10-11

08:00	**Breakfast**	
08:30	**Registration**	
09:00	**Welcome**	*Local authorities*
09:20		*Philipp Fischer ESDP Steering Committee*
09:30	**Biology and ecology** *Chairmen:* *M. Sayer* *A. Terlizzi*	**Scientific diving techniques to experimentally approach bio-ecological processes**
09:30	***Invited speaker*** *F. Boero*	**You can learn a lot by just looking: diving and marine biology**
10:00	Carlo Cerrano	Ecosystem engineers in the mesophotic coralligenous assemblages
10:20	Lorenzo Bramanti*	The application of mixed gas closed circuit rebreathers in experimental coral ecology
10:40	Massimo Ponti	Manipulative field experiments to investigate the ecology of the coralligenous assemblages
11:00	**Coffee break**	
11:40	**Biology and ecology** *Chairmen:* *M. Weber* *M. Ponti*	**Scientific diving techniques to experimentally approach bio-ecological processes**
11:40	Antonio Terlizzi	Experimental monitoring of human impacts in subtidal systems
12:00	Simone Modugno	Three years of observation about the benthic marine macrofauna and fish composition on the artificial underwater barriers off the Emilia-Romagna coast (north Adriatic Sea)
12:20	Ken Collins	Black bream (*Spondyliosoma cantharus*) nest studies
12:40	Martin Sayer	Seaweed and oomycete benthic diversity in the Canadian marine Arctic: managing scientific diving operations in a remote location
13:00	**Light lunch**	

Cancelled for impossibility to participate

14:20	**Biology and ecology** *Chairmen:* *K. Collins,* *C. Cerrano*	**Scientific diving techniques to experimentally approach bio-ecological processes**
14:20	Roberto Palozzi	A conservation ecology survey on a karst sink-hole in Central Italy
14:40	Christian Lott	Habitat and physiology of a chemosynthetic marine worm – the contribution of field research and its constraints
15:00	Stefano Acunto	Monitoring the recovery of Maldivian reefs ten years after the mass mortality of the 1998
15:20	Miriam Weber	SEDCOR: How sediment influences coral calcification
15:40	**Coffee break**	
16:20	**Geology** *Chairmen:* *M. Schipek* *G. Caramanna*	**Scientific diving as tool in remote or difficult places**
16:20	Franco Tassi	The 2011 seismic crisis at Santorini (Greece): new insights from fluid geochemistry of submarine and subaereal emissions
16:40	Giorgio Caramanna	Scientific diving techniques for the study of flooded sinkholes in Italy
17:00	Marco Ponepal	Continuous measurement of gas discharge at Point 21, Panarea, Italy
17:20	Christin Mueller	Gas geochemistry at the submarine volcano Panarea, Italy - results from 2006 to 2011
17:40	Matteo Vacchi	Scuba scientific diving and beach monitoring: examples from Liguria (NW Mediterranean Sea)
18:00	**Round Table 1** *Chairmen:* *M. Sayer* *G. Caramanna*	**European Scientific Diver: legislation and safety** Planned interventions: Salmasi, Caramanna
20:00	**Social Dinner**	

Friday 11-11

08:00	**Breakfast**	
09:20	**Innovation & Technology** *Chairmen:* *C. Lott* *A. Norro*	**New Technology in Underwater Science**

09:20	Elaine Azzopardi	Diving computers: seeing isn't always believing
09:40	Arne Sieber	Head up display for full face masks
10:00	Benjamin Kuch	GSM/GPS diving computer for underwater tracking and mapping
10:20	Alain Norro	Marine habitat mapping ground truth. Testing the position accuracy of a geo-localization system used for *in-situ* sampling against a 'state of the art' acoustic USBL device
10:40	Marco Palma	From underwater surveys to interactive virtual 3D visualization: new tools for spatial analyses and coastal management
11:00	Andrej Jaklin	Commented photo gallery of marine organisms from Croatia
11:10	**Coffee break**	
11:30	**Poster session**	and ITN ESDTN internal meeting
12:45	**Light lunch**	
14:00	**Archaeology** *Chairmen:* *R. Auriemma*	**Maritime archaeology and coastal landscape**
14:00	***Invited speaker*** *G. Volpe**	**Underwater archaeology and "global landscape archaeology"**
14:30	Essi Keskinen	Cultural heritage in Hossa area
14:50	Vladimir Kovačić	A submerged building in the Busuja bay (Poreč, Croatia)
15:10	Ida Koncani Uhač	Savudrija (Umag, Croatia): a research programme for the harbour and the coastal landscape in the Roman age
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15:50	Giuseppe Mastronuzzi*	New archaeological evidences of relative sea level changes along the coastlines of Apulia (southern Italy)
16:10	**Coffee break**	
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17:00	Cristiano Alfonso	The ancient coastal landscape of Marine Protected Area of Porto Cesareo (Lecce,Italy): recent researches

17:20	Rita Auriemma	The Marano Lagoon landscape during the Roman age: a study in progress
17:40	Caterina De Vivo	Sea level variations since Roman time and coastal landscape modifications in the Marine Protected Area "Gaiola Underwater Park"
18:00	Claudia Pizzinato	Underwater archaeological parks: some ideas for the underwater archaeological sites of Leptis Magna and Apollonia (Libya)
18:20	**Round Table 2** *Chairmen:* *A. Sieber* *S. Acunto*	**Appropriate training path for scientific divers focusing on the worldwide available working scenario** Planned interventions: Sieber, Acunto
20:00	**Dinner**	

Saturday 12-11

08:00	**Breakfast**
10:00	**Dive (optional)**
	Departures (transfer)

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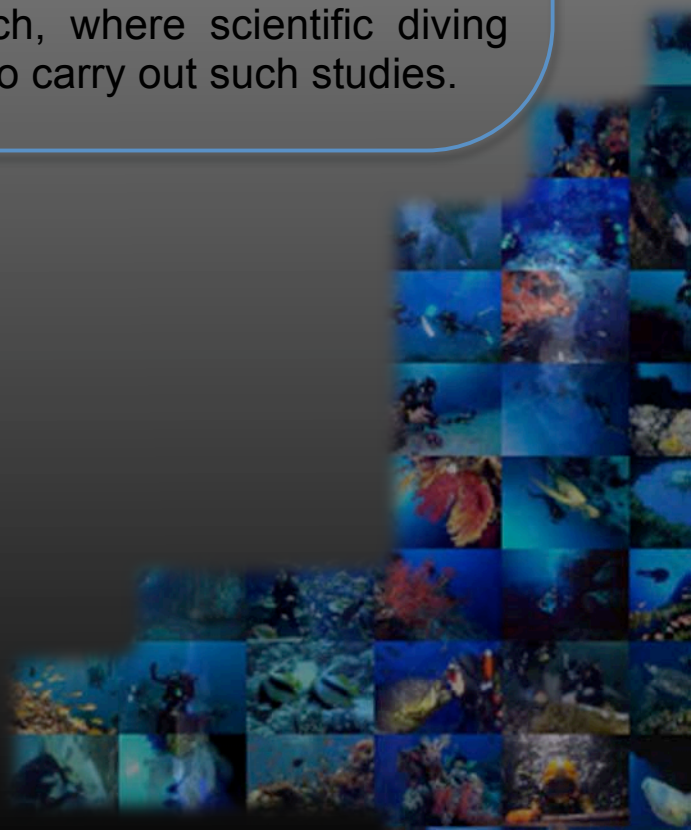
COMUNICATIONS

Session

BIOLOGY AND ECOLOGY

Scientific diving techniques to experimentally approach bio-ecological processes

Aquatic biologists and ecologists are concerned about very different types of researches. Some study areas are based on high observational skills and on descriptive/mensurative approaches; some require manipulative experiments to define cause/effect relationships at a broad range of biotic organisations and environmental interactions. This session will focus on the latter approach, where scientific diving represents often the solely, way to carry out such studies.



YOU CAN LEARN A LOT BY JUST LOOKING: DIVING AND MARINE BIOLOGY

F. Boero

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In the Fifties Rupert Riedl decided to study marine biology by using SCUBA diving. The director of the Stazione Zoologica di Napoli, where Riedl made a proposal for a research collaboration, told him that they needed scientists and not sport men. So Riedl made the Thyrrenia expedition and studied the biology of the caves of the Gulf of Naples. Only SCUBA diving allowed such studies, and the director of the Stazione changed his mind. The use of SCUBA diving in marine sciences, however, is still far from being universal. It is widely practiced in the Mediterranean Sea and in the tropics, but in other seas and oceans the studies are either focused on the intertidal, or use remote sensing or sampling techniques from the surface. In this way, scientists do not "see" directly the environment they are studying.

Now, with ROVs, we can "see" even in the deepest oceanic trenches, but seeing something from a monitor is not the same as being there, and having the possibility of really "being there". Marine scientists that do not dive are deprived of the opportunity of seeing the object of their studies.

We have developed fantastic tools to extract information from marine systems, from satellites to submersibles, but the tools separate the scientists from the objects of their science. All marine scientists should know how to dive and, wherever possible, they should use this instrument to perform this research. Giving up this opportunity, delegating others to go in the sea, deprives the scientists of precious opportunities to really understand the objects of their studies.

ECOSYSTEM ENGINEERS IN THE MESOPHOTIC CORALLIGENOUS ASSEMBLAGES

C. Cerrano[1], C. G. Di Camillo[2], M. Milanese[2], L. Vezzulli[1]

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The mesophotic zone harbours a significant fraction of coastal biodiversity and, being less subjected to climate- and human-driven changes than the upper ocean, is believed to function as the main biodiversity reservoir for the coastal ecosystem. Limited literature on mesophotic zone refers to tropical seas. However, thanks to the recent use of mixed gas diving techniques (usually Trimix), divers are currently allowed to conduct surveys and manipulative experiments in this areas. In the Mediterranean Sea the mesophotic zone hosts exclusive populations including the gold coral (*Savalia savaglia*) and the rare hydrozoan *Lytocarpia myriophillum*. On rocky bottoms *S. savaglia* can develop intricate forests with a rigid skeleton by substituting elastic gorgonian colonies, while *L. myriophillum* shows 1 m high colonies growing on soft sediments thanks to a complex rooting system allowing the growth of suckers-like colonies. The biology and ecology of these species are under study in the Marine Protected Area of Portofino highlighting the key role these species have likely been playing as ecosystem engineers, over thousands of years. As a fairly hot-topic we currently need to gain more knowledge on life history of species inhabiting this zone in order to fully understand the rich mosaic of marine ecosystems complexity. Understanding mesophotic habitats brings along several implications grounded on the fact that marine ecosystems are continuous and interdependent.

THE APPLICATION OF MIXED GAS CLOSED CIRCUIT REBREATHERS IN EXPERIMENTAL CORAL ECOLOGY

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Experimental marine ecology began with intertidal studies, until the Cousteau-Gagnan Aqualung gave biologists access to the sublittoral. Today, certain areas of coral ecology are advancing further again thanks to diving technology. Studying habitats beyond shallow reefs requires more advanced tools than traditional SCUBA, such as ROVs. However, a modern diving crew operating from a small boat is cost effective while offering several advantages over ROVs.Closed circuit rebreather breathing apparatus (CCRs) have seen a steep development in the recreational sector. They enormously increase efficiency of both shallow and deep diving, and were therefore used to execute a project studying restoration protocols of the Mediterranean red coral (*Corallium rubrum*). The conservation of overexploited species requires a non-destructive restoration technique to improve recovery of devastated sites. To this end, marble tiles were installed as artificial substrate on which larvae settled prior to being transferred to sites that lack coral or show weak recruitment. The use of CCRs provided flexibility, extended bottom times due to decompression and thermal advantages, as well as improved communication. The lack of bubbles permitted to work under overhanging walls without disturbing coral located above the divers, while also preserving visibility, which improved safety and facilitated the work. The use of helium based gas mixes even in the traditional air depth range of 30-40m allowed more accurate observations and manipulations and sped up the installation of tiles. Despite the need for far more rigorous training, we conclude that CCRs are useful tools in experimental marine ecology.

MANIPULATIVE FIELD EXPERIMENTS TO INVESTIGATE THE ECOLOGY OF THE CORALLIGENOUS ASSEMBLAGES

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Manipulative field experiments are the only way that allows investigating complex cause-effect relationships. Nevertheless, this approach is rarely applied to subtidal environments, often because of the difficulties involved. The use of recruitment panels allowed investigating a number of important ecological processes that occur in the Mediterranean coralligenous assemblages.
For example, the study of the effects of *Eunicella cavolinii* and *Paramuricea clavata* on the settlement and recruitment of epibenthic organisms made it possible to understand the possible impact of gorgonian mass mortality events on coralligenous assemblages. Gorgonians could affect recruited assemblages by modifying micro-scale hydrodynamism and sedimentation rate, intercepting the larvae before their settlement, creating shading that reduces photosynthesis and providing dim light conditions, competing for food with the filter-feeders and/or producing allelochemicals.
Similarly, thanks to a long-term study, it was possible to understand the bio-construction process and the trophic balance of the coralligenous banks in the northern Adriatic Sea. Contrary to what is expected, a large contribution to the construction comes from filter feeding invertebrates, rather than from calcareous algae, and planktonic food web largely controls this process.

EXPERIMENTAL MONITORING OF HUMAN IMPACTS IN SUBTIDAL SYSTEMS

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Identifying unambiguously the effects of anthropogenic impact on single response variables (e.g., total number of species or individuals, diversity indices, biomass or abundance of a single species) requires a comparison of the magnitude of change in a putatively impacted location to natural changes in multiple locations not affected by the source of disturbance under examination. Beyond-BACI designs, based on analysis of variance, provide a framework to address these issues and are currently among the most powerful tools available in environmental impact assessment. An important feature of beyond-BACI designs is that they can be modified and used to measure differences between a purportedly impacted location and multiple controls when no data have been obtained before the human intervention and thus only 'after' data are available. Such designs, though limited in establishing cause-effect relationships, have been widely used in environmental impact studies.
Here, through the analyses of recent case studies, I highlight the potential of newly developed analytical tools in the assessment of the effects of human disturbance on patterns of assemblage diversity. An emphasis is given on how, in subtidal systems, the high level of replication required by sound procedures of experimental monitoring is also to be associated with advanced skills of the divers involved in sampling operations.
Thus, the need of well-trained scientific divers is becoming mandatory for future quantitative assessment of biodiversity changes in relation to human impacts.

THREE YEARS OF OBSERVATION ABOUT THE BENTHIC MARINE MACROFAUNA AND FISH COMPOSITION ON THE ARTIFICIAL UNDERWATER BARRIERS OFF THE EMILIA-ROMAGNA COAST (NORTH ADRIATIC SEA)

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Positioning of Submerged Artificial Reefs (SAR), represents a well-known system to increase fisheries productivity, to protect coastal environment and improve marine biodiversity. SARs work like breeding and nursery areas for species of commercial interest. In 2006 some type of SARs have been put down along Emilia-Romagna's coast, thanks to AdriBlu Project (InterregIII North Adriatic Sea). Data are available for Ravenna and Cattolica SAR points both for marine fauna and environmental parameters (water column and sediment analysis). Data have been carried out from 2007 to 2010 trough monitoring planning applying underwater visual census and line intercept transect. 36 surveys were taken simultaneously by biologist scuba divers. Two habitats were sampled: on SARs starting from fix point on the top of submerged structures and on sandy seabed near pyramids (TecnoReef). 4 withdrawals during each year have been made even with fishing nets. The results were compared with data obtained from scuba surveys. Even multibeam analysis was made to prepare a digital cartographic model of the SARs. 35 different species of bone fishes were identified, 24 of which were revealed by scuba observations. 41 fish species were collected using fishing nets. Multivariate and univariate analyses revealed various patterns in the data. Index for community structure were investigated. Finally, the results show that SARs contribute to the regional diversity and marine complexity giving also important implications for conservation of marine coastal assemblages. So SARs functioning, after 5 years, is granted and efficient to give biological and economical advantages for local fishery.

BLACK BREAM (*SPONDYLIOSOMA CANTHARUS*) NEST STUDIES

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The black bream (*Spondyliosoma cantharus*) are summer visitors to the south and west coast of the UK, overwintering in deeper waters and migrating inshore to breed from April to June. Bream are demersal spawners, with the eggs laid in a nest excavated by the male as it creates a depression in a sandy gravel substrate. In order to build their nests, male bream expose bedrock and gravel by using their tails to remove the surface layer. The first reported observations of bream nests off the central south coast of the UK were made by the authors in 2000.This study, by side scan sonar and SCUBA diving extends the known occurrence of extensive nesting grounds off the West Sussex coast to the Isle of Wight and Dorset. The nests are typically circular craters 1-2m wide, and 5-30cm in depth which can clearly be seen using side scan sonar as groups of circular depressions. Several hundreds of eggs (1-2mm) are attached to bare rock in the centre of these structures. By July all the eggs have hatched, though adults are still present.
The species is valuable and particularly vulnerable to exploitation by both sport and commercial fishermen during the nesting season. With no minimum landing size, no prescription for Total Allowable Catch or ICES stock assessment, they are suitable for protection under spatial planning measures such as through the use of marine protected areas (MPAs).

SEAWEED AND OOMYCETE BENTHIC DIVERSITY IN THE CANADIAN MARINE ARCTIC: MANAGING SCIENTIFIC DIVING OPERATIONS IN A REMOTE LOCATION

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Knowledge of the diversity of high-Arctic macroalgae and their eukaryotic pathogens (fungi, oomycetes, plasmodiophoraleans) is scarce, particularly in the American Arctic. Global climate change is expected to alter the Arctic bioregion markedly in coming decades and the macroalgae of this region are considered to be very sensitive to physico-chemical impacts related to reductions in ice coverage. In 2009, a diving-based multinational research expedition was undertaken with the specific aims of establishing an inventory of the diversity of seaweeds and their pathogens that was broadly representative of a high-Arctic marine environment. The expedition obtained a significant range of viable isolates and specimens that are now subject of ongoing investigations. In addition, molecular approaches are being used to characterize the largely unknown diversity of seaweed-associated eukaryotic pathogens. Many of the locations had never been dived before and so, as well as collecting biological, sediment and water samples, the diving team took over ten thousand underwater images and many hours of high-definition underwater video. In total 50 diving operations were completed in 12 different locations around the Cape Hatt area of northern Baffin Island. The diving operations were conducted in locations that were remote from any specialized diving medical intervention with the earliest realistic recompression being over 48 hours away. This presentation will highlight some of the logistical considerations associated with conducting diving operations in the high-Arctic and outline the non-recompression treatment pathway that would have been adopted in the event of a diver suffering decompression illness.

A CONSERVATION ECOLOGY SURVEY ON A KARST SINK-HOLE IN CENTRAL ITALY

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A karst sink-hole (called Lake Paterno) in Central Italy has been monitored over one year to detect both the fish fauna and the shore/submerged flora composition with the aim to assess – in a perspective of wide sense conservation ecology – the magnitude of human impact. Since the river crab *Potamon fluviatile* was present in the lake, it was included in our analysis; though indicated only as "near threatened" by the IUCN Red List and not yet protected at the national level, many Italian regional laws acknowledged this endemism as under threat and set protection measures.
Number and abundance of species, space use, seasonal shift and trophic organization were recorded mainly by means of underwater visual census (strip transects) and stable carbon–nitrogen isotopes techniques; the achieved results were then analysed also in connection with geological and ecological parameters and anthropic disturbance, using an artificial intelligence method based on neural networks (self organising maps).
Lake Paterno is an historical site known since pre-roman age, which shows a possibly peculiar ecology due to its hydro-geological genesis and conformation; our results showed however an heavily compromised situation as regards to the naturalness, which would require an immediate and effective ecological management plan, both for the sink-hole and the surrounding area.
The fact that few alien species are the only fish of the lake Paterno and that a narrowest belt of shore forest vegetation survives around the sink-hole can be considered a warning for the conservation of this small ecosystem.

HABITAT AND PHYSIOLOGY OF A CHEMOSYNTHETIC MARINE WORM – THE CONTRIBUTION OF FIELD RESEARCH AND ITS CONSTRAINTS

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The gutless marine worm Olavius algarvensis inhabits permeable sands in the Mediterranean Sea and harbors a consortium of sulfur-oxidizing and sulfate-reducing bacteria. We found populations of up to 25.000 individuals m-2, with the highest abundances at 15 cm sediment depth. In experiments the worms survived anoxic conditions for several weeks. They could not, however, tolerate anoxia indefinitely, indicating that they must wait for the next storm event or periodically migrate to the oxygenated upper sediment layers. For the sulfur-oxidizing symbionts, nitrate could serve as an alternative electron acceptor, particularly after storms, which led to considerable increases in porewater nitrate concentrations in the worm's environment. Although sulfate reduction rates in the sediment were high (10 nmol cm-3 d-1), sulfide concentrations were extremely low (<1 µM). Experiments with a newly developed micro-respiration chamber for single worms showed that the symbiotic sulfur-oxidizing bacteria respired oxygen at 6-fold rates than the worms themselves. In incubation experiments we detected the production of N2O. This indicates that some partners of the consortium use nitrate as a final electron acceptor. In several individuals of the population we found nitrate concentrations to be elevated above background porewater concentrations, indicating the accumulation and/or storing capacity of the symbiosis for nitrate. If the worms are kept under oxic conditions they use up their stored elemental sulfur within hours to few days. Stable isotope experiments showed that the decrease in elemental sulfur results in the uptake of bicarbonate into the consortium. On a single cell level NanoSIMS analysis revealed that the energy gained by the oxidation of elemental sulfur is used by the sulfur-oxidizing gamma-1 symbiont to fix inorganic carbon. The interplay of in-situ methods and lab experiments are discussed.

MONITORING THE RECOVERY OF MALDIVIAN REEFS TEN YEARS AFTER THE MASS MORTALITY OF THE 1998

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The 1998 bleaching episode affected severely most Indian Ocean reefs; the Maldives suffered of up to 90% coral mortality. The high loss of hard corals suggested a possible “phase shift” as short after the mass mortality the reefs were dominated by algae.
In December 2008 and December 2009, we re-examined the status of the Maldivian reefs using SCUBA diving and a video sampling method in two different reefs of the central atolls of the Maldives Archipelago.
The results of our survey led to cautious optimism about the recovery of Maldivian reefs. Hard corals cover had increased to values comparable with those observed before the 1998 mass mortality episode (between 30% and 60% at the depth studied) and a “phase shift” towards the dominance by algae was not observed. This notwithstanding, the proportion of bare coral rock and rubble was often high, probably due to the 2004 tsunami episode that contributed to the dead coral breakage. Moreover, colonies of branched *Millepora* and soft corals were totally absent in the studied sites.
In 2009 the Maldivian reefs were still in an ongoing process of recovery and, as substrate smoothing is known to represent an impediment to coral recruitment and some structurally important elements of the reef ecosystem are still absent or rare, a continued monitoring of Maldivian reefs is necessary to track their future evolution. Given the constrains of SCUBA diving, the high-resolution video technology now available is adequate (fast and effective) for monitoring benthic cover on coral reefs.

SEDCOR: HOW SEDIMENT INFLUENCES CORAL CALCIFICATION

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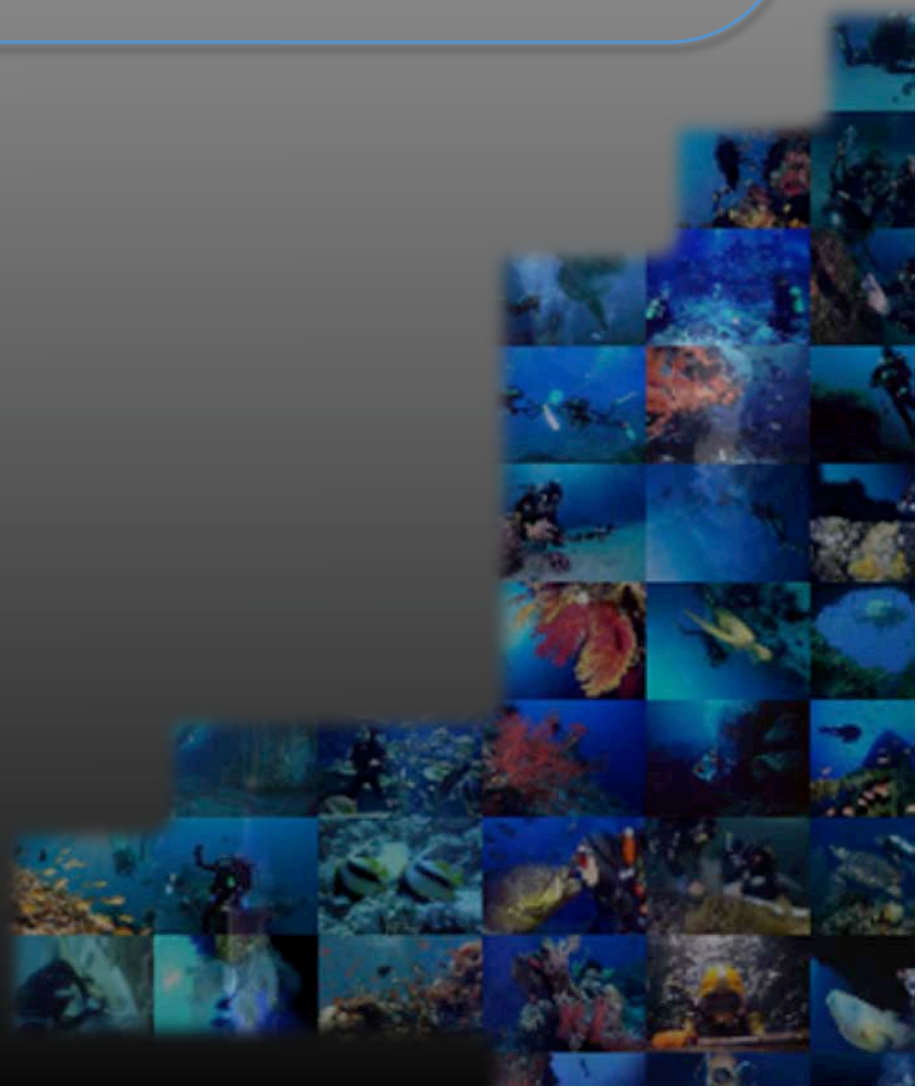
The basis of coral reefs is the rapid growth of calcifying organisms. This process depends on various surrounding water parameters such as for example temperature and pH. Estuarine waters are known to have relatively low pH and carbonate saturation state, however some of them do house coral reefs. Further it is known that organic matter in sediments can reduce the pH depending on the total of biogeochemical processes within this sediment. Here we suggested that organic matter from terrestrial runoff does also reduce the pH, oxygen saturation and carbonate saturation in the boundary layers of terrigenous sediments on coastal reefs. And we hypothesised that calcifying organisms, such as scleractinian corals, and crustose coralline algae living surrounded by such sediments are affected in their ability to calcify.
We conducted microsensor measurements on sediments at four inshore reefs of the Great Barrier Reef. The investigated reefs are directly affected or not by the import of organic rich sediment from the close land. Our field data show that the boundary layers above organically enriched sediments can have a reduced pH, possibly from microbial activities and/or from metal geochemistry. However the reduction of pH seems to be related to the sediment organic content and to photosynthetic activity of organisms living at the sediment surface. A consecutive laboratory experiment was conducted to investigate rates of calcification of two species each of coral, and crustose coralline algae situated within the boundary layer above the three different sediments. The data show that sediments with increased organic content do negatively affect the growth of all tested organisms.
Our mesocosm experiment and field data suggest that we found a key process how nearshore organisms are affected in their calcification rates, and implications can be made how coral reefs will look in the future if the global seawater pH decreases further.

Session

Geology

Scientific diving as tool in remote or difficult places

Scientific diving techniques represent an important research tool for geologist when surface or remote systems are not applicable or reliable. Coastal environments, lakes, caves are just a few examples of areas where scientific diving can be used. This session welcomes presentations of underwater studies where scientific diving represents a valuable way of data collection and survey, especially in otherwise inaccessible places.



THE 2011 SEISMIC CRISIS AT SANTORINI (GREECE): NEW INSIGHTS FROM FLUID GEOCHEMISTRY OF SUBMARINE AND SUBAEREAL EMISSIONS

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At Santorini Island several fluid discharges are located at the summit craters of Nea Kameni Island, as well as at the sea floor (depth < 15 m). This testifies the presence of an active hydrothermal-magmatic system. The submarine emissions give rise to spectacular changes of the sea colour, due to suspension of Fe oxy-hydroxides. In August 2010 and May 2011, we carried out two campaigns to sample gases from the Nea Kameni subaereal and submarine discharges. In 2010, the submarine fumaroles have dominant CO_2, relatively low contents of atmospheric gases and H_2, and relatively high contents of CH_4 and H_2S. This composition is typical of fluid emissions related to a low temperature liquid-dominated fluid reservoir. Differently, the sub-areal fumaroles are fed by two different sources: i) air (N_2, O_2, Ar) and ii) magmatic degassing (CO_2 and H_2). In 2011, we measured a significant increase of the H2 concentrations in the subaereal fumaroles, whereas the hydrothermal gases from the submarine vents have basically remained unmodified. In our opinion, the observed compositional changes are the result of a heat input from depth that affected the shallow fresh/seawater aquifer, causing an increase of H_2 production. The increasing vaporization of this aquifer could have triggered the seismic signals that have recently been recorded in this area. The H_2 concentration in fumarolic fluids is currently to be considered the parameter most sensitive to the changes affecting the Nea Kameni degassing system. A hypothetical strong modification of the activity status of this magmatic-hydrothermal system should also be evidenced by detectable changes of the composition of the hydrothermal submarine exhalations.

SCIENTIFIC DIVING TECHNIQUES FOR THE STUDY OF FLOODED SINKHOLES IN ITALY

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Sinkholes are vertical shafts generally of funnel or cylindrical shape. They can be originated by karst erosion on carbonatic rocks or by the collapse of sedimentary cover in plain areas. In the latter case the presence of a buried karst bedrock is not always assured. If the sinkhole intercepts the water table, it becomes flooded representing a connection between the external environment and the aquifer.
Hereby we present the study of some flooded sinkholes in Central Italy (Latium) in karst and sedimentary environments which have been surveyed by means of scientific diving techniques. The study was focused on the hydrogeology and the submerged geomorphology of the cavities.
The first studied sinkhole was the lake “San Giovanni” which is a karst sinkhole in the travertine outcrop along the “Aniene River” valley. Its origin is likely due to the roof collapse of a water-filled underground cavity.
Nearby the lake there are the hypothermal sulphuric springs of “Acque Albule” which feed the lakes “Regina” and “Colonnelle”. Both lakes host underwater emissions of CO_2 and sulphuric gases.
Another surveyed sinkhole was in the sedimentary cover of the “Pontina” plain. It was originated almost overnight by a sudden collapse in the unconsolidated sediments, and was then flooded by the local groundwater table.
The use of scientific diving allowed for the collection of data that otherwise would not have been possible to gather.
Due to the presence of potential hazards (toxic gases, overhead environments and zero visibility) special diving techniques were used for the underwater operations.

CONTINUOUS MEASUREMENT OF GAS DISCHARGE AT POINT 21, PANAREA, ITALY

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Submarine degassing is observed under various geological settings. These gas emissions might be relevant as greenhouse gases but they are as well indicators for volcanic activities and may help understanding submarine geothermal reservoirs. Main objective of the research was to monitor the gas volume of a strong vent at a water depth of 20 m in Panarea over a time of several months. A gas funnel with an inlet diameter of 40 cm made from soft polyvinylchloride (PVC) sheet was directly placed on the top of fumaroles by a ring of concrete. All pipes and pipe connecting parts are be made from PVC-U which is very resistant against acids and withstand permanent temperatures until 60 °C. The measuring section consists of two impeller with a rotating magnet fixed on a shaft made from polyoxymethylene (POM). Additional to revolution per minute the temperature is logged at the inlet, outlet and from ambient water. Thus it is possible to estimate the gas volume without impeller signal as well. Tidal influences are obviously the dominant trigger for gas flow variations. The gas emissions are inversely correlated with tidal water level fluctuations, but minor impact are registered due to weather and wind conditions as well as seismic and volcanic activities.

GAS GEOCHEMISTRY AT THE SUBMARINE VOLCANO PANAREA, ITALY - RESULTS FROM 2006 TO 2011

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Techniques for gas sampling of active volcanoes are in some way inherently difficult. Sampling gas from a terrestrial volcano involves the risk of sample contamination by ambient air; on contrast sampling volcanic gases at the sea or lake bottom does not involve such a risk, however small amounts of lake or sea water may enter the gas sample. Because in a submarine volcano the discharging gas flows through water-saturated aquifers or stems from submarine geothermal reservoir, temperatures are normally much lower than the boiling curve and water vapour is less dominant. Advantages and disadvantages of different methods to sample submarine fumaroles by scuba divers are discussed and include sampling of large gas volumes (up to 80 liters). The second part of the paper presents results from 5 years of investigations carried out off the island of Panarea (Aeolian islands) with respect to gas composition and concerning major (CO_2, H_2S, O_2, N_2) and trace components (CO, CH4, H2, HCl, HBr, HF, and metals), including helium and other noble gases isotopic ratios. Furthermore the $\delta^{13}C$ of CO_2 and $\delta^{34}S$ of H_2S was determined. Distinct differences of some submarine venting gases are statistically significant and can be used as indicators for different geothermal reservoirs and separation processes. Variations of chemical compositions of the gas reveal evidence for different processes and gas reservoirs in the geothermal and volcanic system.

SCUBA SCIENTIFIC DIVING AND BEACH MONITORING: EXAMPLES FROM LIGURIA (NW MEDITERRANEAN SEA)

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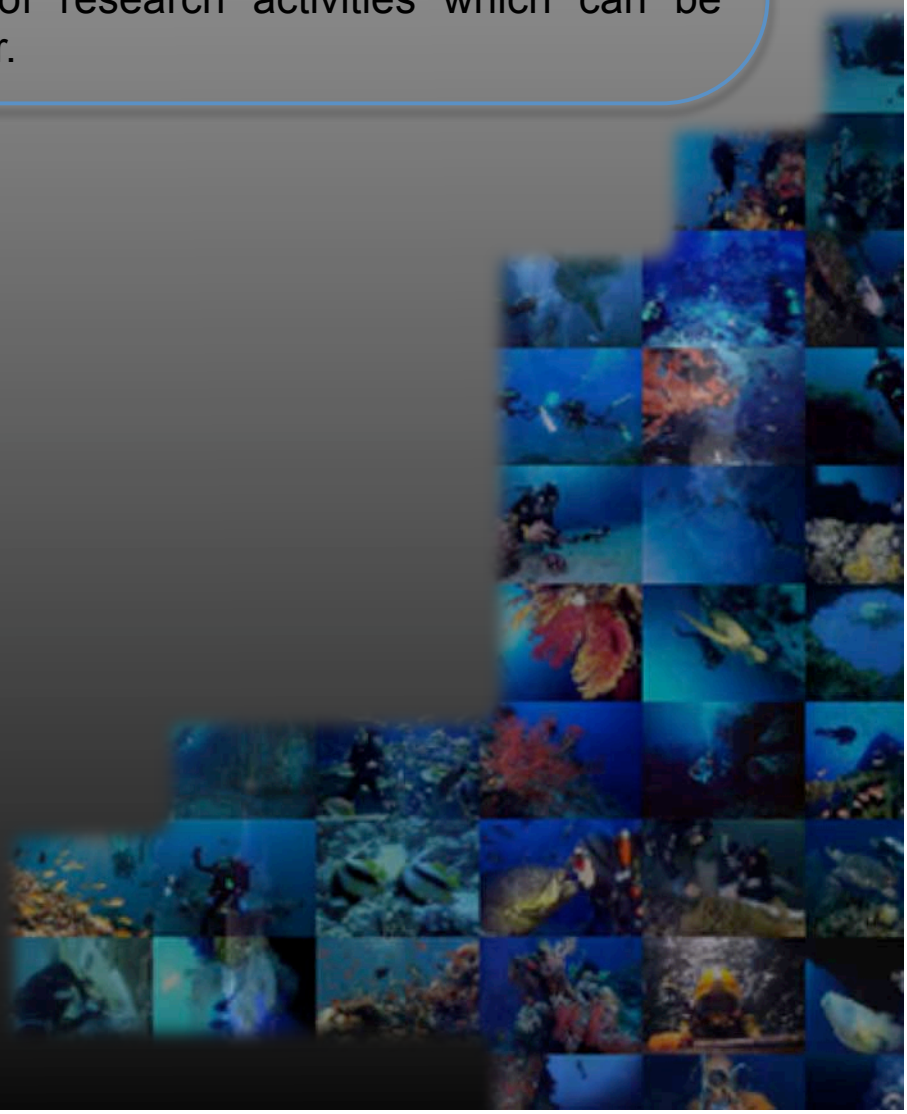
Beach nourishments are one of the main tools used to stabilize beaches, or to restore them after severe retreat events, frequently associated with coastal engineering works aimed at maintaining the restored status over time.
Best practices should involve monitoring pre-, during and post the beach nourishment firstly because it is obligatory due to current laws on Environmental Impact Assessments (EIAs). Secondly, the monitoring is often useful to the beach nourishment manager to assess the efficacy of the intervention and to learn lessons to be used in future interventions.
The most frequently applied monitoring techniques in Italian (and Mediterranean) beaches are topographic and bathymetric surveys carried out at regular time intervals in order to study beach morphodynamic evolution, flanked by sediment sampling along the beach profile. The subsequent grain size analysis plays a crucial role in studying the sedimentary evolution of the beach.
In this study we used innovative SCUBA diving techniques in addition to the traditional surveys in the monitoring of 2 study areas along the Ligurian coast (NW Mediterranean Sea): Ospedaletti (IM) and Vernazzola (GE).
In particular, we used a diver-operated, cost-effective coring system to obtain marine sediment cores and video-transects to obtain information on the status of structures for coast defense (e.g. Groins).
The results allowed to identify the main vertical discontinuities along the submarine beach using cost-effective cores and points of erosion along submarine parts of groins. Such innovative techniques provided data that are not easily achievable with traditional techniques improving significantly the efficiency of beach monitoring.

Session

INNOVATION & TECHNOLOGY

New technology in underwater science

The progress in every field of the underwater sciences requires advances in diver techniques that can extend time and depth of surveys and improve health & safety of the scientific divers. At the same time the new technology provides better and innovative instruments. All of that can increase the range of research activities which can be performed underwater.



DIVING COMPUTERS: SEEING ISN'T ALWAYS BELIEVING

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CE marking is a mandatory conformance mark on many products marketed in Europe. The marking certifies that a product has met European Directives regarding consumer safety, health or environmental requirements. All dive computers manufactured or sold in Europe must have a CE mark. However, this marking is potentially misleading as there are no standards for dive computers *per se*; the mark on dive computers relates only to standards for the measurement of pressure and time. Therefore, at present, manufacturers choose their own methods for utilising, recording and displaying pressure/time data. The design of any dive computer consists of a number of inter-related compromises which must balance such competing elements as: the size and appearance of the unit; the computing power needed or available; the data recording capability (which in itself is a balance between volume of data recorded and the physical storage limits); how data are displayed and/or converted for display (e.g. displayed "depth" is a conversion of measured pressure); power consumption and battery size/capacity, etc. Although manufacturers publish some technical specifications relating to their units, it is presumed that these originate mostly from non-peer reviewed in-house testing. This presentation gives an overview of an ongoing independent study of over 50 models of dive computer presently available for sale in Europe. The initial stages of the study have concentrated on reviewing the technical specifications of all the models and measuring how they record and display depth and temperature. Some preliminary results of decompression monitoring will be presented.

HEAD UP DISPLAY FOR FULL FACE MASKS

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Professional and commercial diving includes often work in challenging underwater environment, where for example low visibility, silt, or contaminated water can be expected. More and more Full Face Masks (FFM) are used, as they provide good protection and can be equipped with underwater communication systems. Especially when there is very low visibility, the diver may be unable to read the gauges, a diving computer or a compass. The aim of the present work was to develop a heads up display especially for FFMs.
Recently our group has published on SUT a paper about a head up display for diving masks. This device was a secondary display for a primary, wrist worn diving computer. Disadvantages of this device were the amount of cables leading between wrist handset, HUD and diving apparatus which may lead to entanglement. For FFMs, a new approach was chosen, where a colour OLED display together with a microcontroller, sensors and a specially designed optics are housed in a small device that is mounted directly on a special port on a FFM. The HUD can be moved axially and rotated to allow an easy adjustment to the user.
3 prototypes were developed and tested on an OTS, a Poseidon and an Ocean Reef Full face mask. The display shows depth, decompression obligations, diving time, heading (3 axial compensated compass) and tank pressure. A rebreather interface is available. The optical system displays a virtual image in a distance of 1m.
With the newly developed HUD for FFMs important diving data are always in the field of view of the diver, even in conditions like zero visibility.

GSM/GPS DIVING COMPUTER FOR UNDERWATER TRACKING AND MAPPING

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Many scientific divers use a compass and a diving computer to navigate. Although ultrasound based navigation systems exist e.g. [E. Gamroth et. al. SUT 29(4)], they only cover small distances and need one or more transmitters to be deployed before the dive. The aim of the present work was to develop an easy-use navigation system which could provide absolute positions without the need for a reference point. Such a system could be a helpful tool for scientific divers especially those employing underwater mapping like, for example, archaeologists or geologists.

A GSM/GPS modem [GM862, Telit] was housed in a modified drybox and attached to a scuba buoy. The modem was connected via a reel-mounted thin 55m long cable to a diving computer. Dive profiles including GPS and temperature data were displayed and logged. A Graphical User Interface was used to download and convert the logged data to KML format for easy visualization in, for example, *Google Earth*. Another feature was the capability to add GPS and depth data to a picture taken during the dive (EXIF), assuming that the camera and the diving computer are accurately time-synchronized.

A prototype was developed and tested in the Mediterranean Sea. Two dive locations (max. depth 45m) were mapped and visualized in *Google Earth* including the depth profile. EXIF data of pictures taken during the dives were complimented by position, depth and temperature information. Under optimal conditions the accuracy of the GPS receiver is <2,5m [GM862 datasheet]. However, in windy and/or rough sea-surface conditions, or where the unrolled cable is longer than the dive depth, it was difficult to maintain the buoy directly above the diver, which increased the measurement error.

MARINE HABITAT MAPPING GROUND TRUTH. TESTING THE POSITION ACCURACY OF A GEO-LOCALIZATION SYSTEM USED FOR *IN-SITU* SAMPLING AGAINST A 'STATE OF THE ART' ACOUSTIC USBL DEVICE

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Ground truth is widely used to assess confidence on marine habitat maps. Data collected by the scientific diver on the sea bed needs to have a better and better accuracy in order to cope with the new standard of maps realized using modern multibeam echo sounding.
In this context, a Global Positioning System (GPS) buoy towed system is used by scientific diver for the geo-localization of sea bed video image and other *in-situ* measurement. This paper describes the experiment that was set-up for testing the accuracy of a low cost, easy to deploy and Platte form independent system against a state of the art Ultra Short BaseLine (USBL) underwater localization acoustic system IXSEA-GAPS. Aiming to reduce the known impact of diver generated bubble on the acoustic signal, two closed circuit rebreather (CCR) dives were realized in 2009 in real condition on the Belgian North Sea continental plate from the r/v Belgica. Time is used to synchronize all measurements and the video images.
That experiment showed despite the high level of noise observed on the acoustic signal (attributed to high incidence angle due to the geometry of the experiment) that the GPS buoy system is providing in real field condition featuring strong tidal current, waves and depth ranging from 12 to 45m a position that is always within 5m of the position provided by the USBL localization system. Moreover, other mapping experiments confirmed a resolution of the system that is of the order of magnitude of one meter.

FROM UNDERWATER SURVEYS TO INTERACTIVE VIRTUAL 3D VISUALIZATION: NEW TOOLS FOR SPATIAL ANALYSES AND COASTAL MANAGEMENT

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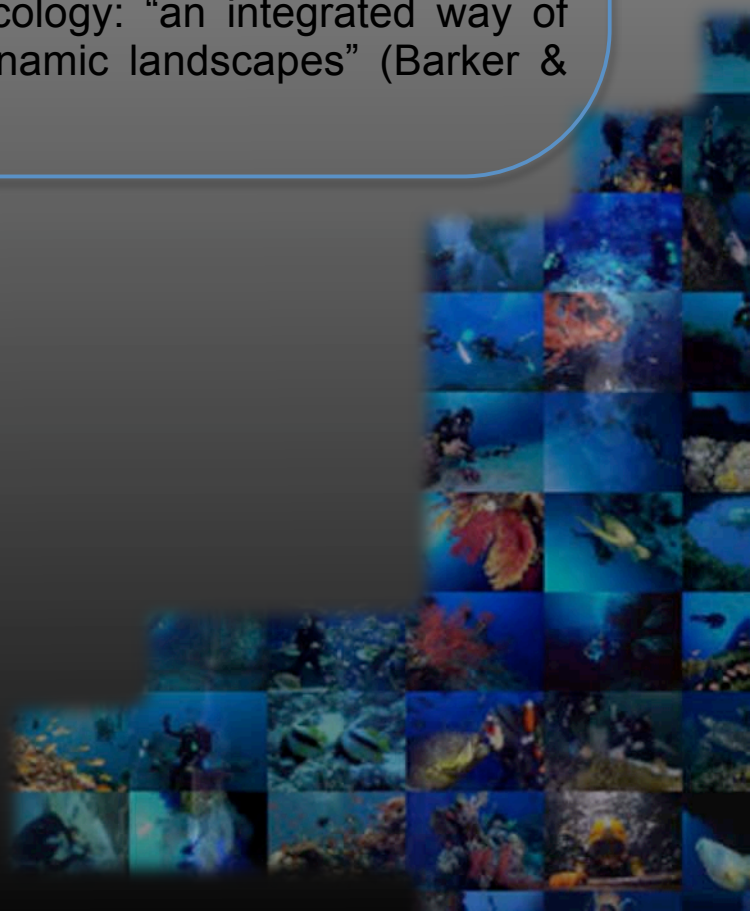
UBICA s.r.l. is an Italian consulting company in the field of underwater biological cartography and marine environmental services. It was established in 2009 as an academic Spin- off of the University of Genoa. Staff is composed by scientific diver marine biologists and experts in information technology. UBICA s.r.l. developed an interactive 3D visualization tool for the biological data interpretation on a 3D sea bed morphology model. The integration of the underwater survey georeferenced data, collected by scientific divers, with the 3D sea bed morphology model, generally obtained by multibeam ecosounder surveys, allowed us to produce cartographic applications that provided a real-time interactive visualization of seabed's geomorphological, biological and archaeological features. In this real-time 3D environment it's also possible to visualize interactively a variety of information layers, like for example human impacts, the ecological status of the benthic assemblages, the health of the populations of target species, the presence of protected species, etc. This scientific visualization approach allows to improve the interpretation of the ecological processes and could support decision making by managers as well as educational and promotional activities.

Session

ARCHAEOLOGY

Maritime archaeology and coastal landscape

The repertoire of the archaeological evidences, which are currently underwater due to the variations of sea level, is quite large. When they are used with a precise methodological approach, some artefacts today submerged can be significant markers of sea level changes and can give us interesting details to support the reconstruction of both the ancient coastal lines and the patterns of the coastal settlement. This session aims to focus interdisciplinary research works in the perspective of the geoarchaeology or human ecology: “an integrated way of understanding humans in dynamic landscapes” (Barker & Bintcliff, 1999).



UNDERWATER ARCHAEOLOGY AND "GLOBAL LANDSCAPE ARCHAEOLOGY"

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Underwater archaeology as a science has turned sixty and should have got through the stage of innocent adolescence, dealing with maturity issues related to their theoretical status, to the methodologies, to the techniques, to the technologies and to professionals. In fact, particularly in Italy, there is still a deficit of theoretical reflection on the discipline, as it continues to be perpetuated, both outside and in some cases, even within the discipline, and idea of the 'underwater archaeologist such as an amateur or a sport diver or a simple technician.
In both research and protection there is still a substantial marginalization further complicated by the inability of the scientific community of a methodological reflection. In this context, there is in fact a greater focus on technical and technological aspects rather than to the methodological ones, risking a drift towards settings which are regarded as 'neutral' and 'objective', without historical questions and limited to the end in itself use of technologically innovative tools places in the service of a method, however, essentially 'old', able to at the best only totally without historical development data.
Underwater archaeology is risking a dangerous self-isolation. It would be necessary to supplement it as part of projects of 'overall archaeological landscapes' (urban, rural, coastal, underwater).
After the 'hangover' of the many archaeologies developed in the post-processual phase, there is now a need to undertake a shift of this articulated and segmented disciplinary, focusing on the two elements that allow more than others, in our opinion, a possible process of aggregation and integration: a) the globality of the approach and of the systems of sources used b) the landscape.
It is a question of underwater archaeology, integral part of the global archaeology of a particular local context, not limited only to the analysis of individual sectoral categories (wrecks, port facilities, architecture, production, trade, artifacts etc..), but able, moving in an environmental, stratigraphic and contextual perspective, to investigate, with the from time to time available and necessary sources and tools, the functional relationships that, over time and in the space, have been created, enhancing the complexity of all forms of dialectical contact that individuals and companies have established in the past between themselves and with the environment, particularly with the water.
This is the methodological approach that has guided the project "Liburna" conducted in recent years along the coast of Albania.
This view also has a twist in the action for the protection and the enhancement, still tied to a conception of 'point', limited to a single site or artefact, extending the action to the whole homogeneous territorial contexts. In the face of the deep process of renewal of archaeology in relation to the phases of research, from diagnosis to the stratigraphic excavation, to the applications of science and innovative technologies, there is a delay in the cultural and organizational system of protection, defined in the first half of the last century. The risks of this situation are very serious: in addition to the destruction of entire sets of data, an even more significant damage is the progressive loss of a role in the society.
To answer to these problems we can not simply barricade ourselves and defense the status quo. We must therefore be aware that the protection is not the exercise of an aseptic and objective action, but the option made on the basis of choices that change in time and in quality of the training of the practitioner; it is obvious that the more subjects, more sensitivity and 'knowledge' will be included in the new decision-making, greater opportunities exist for people wishing to contribute to the solution of problems of preservation and enhancement of heritage.

CULTURAL HERITAGE IN HOSSA AREA

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Hossa area, Eastern Finland has in several ways a very exciting history. Hossa's location has been very crucial for trade and other movement between East and West, in other words, between Gulf of Bothnia and Lake Viena in Russia. Hossa, Suomussalmi, has the very oldest prehistorical places of residence that have been found in Finland so far. The oldest place dates back to 7000-7300 BC. In Hossa area, there has been continuous human settlement since then. Most of the food has come from fishing in the many lakes, ponds and rivers of the area.

A large scale field inventory underwater cultural heritage of Hossa area's lakes and ponds was conductes 2009-2010. Two months of field work was spent searching for cultural heritage under water. More than 30 underwater cultural sites were located, mostly relating to fishing culture. Scuba diving was used as a method.

Some of the fish dam structures were timed with a dendrochronological method and the oldest wooden parts were timed to year 1800. What is most interesting is that, from the same fish dam, were also found pieces of wood that date back to between the WWI and WWII, meaning, that the construction was maintained and repaired for at least 120 years.

A SUBMERGED BUILDING IN THE BUSUJA BAY (POREČ, CROATIA)

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Enigmatic building was unearthed in spring 2011 in the Bay of Busuja (Poreč, Croatia). This powerful structure built of rubble stone develops from east to west over a total length of 48 m and a width of 12.66 m and is divided into several areas of equivalent area. North-south walls are interrupted at their center through openings equipped with slides (saracinesche): they imply the presence of valves to open or close the various spaces, we can call pools. So this is a building that provides the movement of water masses. Presumably, given his position, it works with the sea, perhaps in connection with the tides. Pieces of wood, probably related to valves and in excellent condition, were interviewed on the bottom of a basin. The symmetry of the plan of the building evokes a unitary construction and dating to Roman times is ensured by the presence of bricks and ceramics.
It is premature to propose an identification for this building whose plan does not find any parallel: the least improbable is perhaps that of a pool (vivarium). But this interpretation is facing many difficulties, especially for understanding how it works because it seems that the walls were built into a submerged space. Current research on the level of the sea and the palaeoenvironment should clarify the different assumptions.

SAVUDRIJA (UMAG, CROATIA): A RESEARCH PROGRAMME FOR THE HARBOUR AND THE COASTAL LANDSCAPE IN THE ROMAN AGE

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The reconstruction of the ancient landscape and the evaluation of the shoreline during Roman Age have been carried out following the aims of the research programme (cooperation agreement between the Arheološkog muzeja Istre - Pula, il Muzeja grada Umaga and the DiSCAM - Università di Trieste, *Storie dal mare* Project). Present day shoreline elevation was significantly lower than Roman Age one, because sea level was about -1.60 m lower than nowadays.
The first aim has been the surveying of the underwater harbour structures (using multibeam for the broad view of the area and total station for details). In particular, the surveying focus on the large breakwater dock, 150 m long, and the rectangular "plateau" at the back.
Moreover, emerged coastal structures have been surveyed. They suggest the occurring of both living and manifacturing buildings and retaining walls. A water cistern, quadrangular in shape, is very well preserved.
In the end, an excavation test has been made in correspondence of the inner sector between the two curtains walls of blocks (*opus quadratum*) of the breakwater. The aim was to evaluate the height of the jetty and the depth of the local bedrock, to highlight the building steps and to study the time of costruction and attendance.
Waiting for more detailed verifications, preliminary data allow to guess of the ancient coastal landscape during Roman Age times.

MULTIBEAM APPLICATION IN UNDER WATER ARCHAEOLOGY

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Nowadays multi-beam echo-sounders (MBES) are an available tool to support research in underwater archaeology. We have been surveying with MBES system since 2006 and right from the start one of the applications was documenting underwater archaeological sites. Archaeological applications are diverse and depend mainly on the deployment vessel, water depth and the MBES system used. On the one hand it can be applied as precise tool to map surface structures of underwater sites and on the other hand as tool for general prospection of extensive areas. Raw data from a survey (point cloud) is generalized into different results like contours, digital terrain models and plans which can benefit further diving investigation. Exact plans with plotted features and structures can help divers with navigation while performing their work (finds survey, photo/video documentation etc.) and act as a background for pinpointing the position of artifacts, adding details to the plan and so on. Through various archaeological case studies we'll present two MBES systems that were effectively used on sea, lakes and rivers.

NEW ARCHAEOLOGICAL EVIDENCES OF RELATIVE SEA LEVEL CHANGES ALONG THE COASTLINES OF APULIA (SOUTHERN ITALY)

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The coastal landscape of Southern Apulia from Monopoli to Taranto is characterised by gently sloping rocky coasts marked by deep rias and bays alternate with low cliffs. In these sheltered areas, due to the presence of fresh water springs, the human settlements have been about continuous in time since the Bronze age. The presence in the past of small villages, landing places, structured harbours or cities are today witnessed along the coastline by the extensive outcropping of archaeological sites both submerged or emerged; these are exposed to waves washing and generally buried by Holocene aeolian or colluvial sediments or by soil.
The position of quarries, hut bases, tombs, sewer channels, cisterns, piers, fish tanks and shipwrecks of Bronze, classical and Middle age have been surveyed through topographic measurements to evaluate their precise elevations with respect to the present mean sea level and the tidal range. The study of the archaeological sites of Torre San Vito (Ba), Egnatia (Br), Torre Guaceto (Br), San Cataldo (Le), Otranto (Le), Porto Cesareo (Le), Torre Ovo (Ta) and Torre Saturo (Ta) permitted to obtain a new dataset useful to improve the current estimation of the eustatic sea level curve relative to the last 5ka for this region.

COASTAL LANDSCAPES ARCHAEOLOGY IN SOUTHERN APULIA. ANCIENT SEMI-SUBMERGED STRUCTURES BEHIND THE MODERN HARBOUR IN OTRANTO

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The project is part of research conducted by the Department of Underwater Archaeology University of Salento (Prof. Rita Auriemma) that includes the study of underwater archaeological contexts linked with the coastal landscape. This research aims to highlight the interactions between ancient man and the environment, looking for to reconstruct the ancient coastal landscapes. In this sense, the numerous exploration activities carried out near the pier S. Nicholas at Otranto led to the identification of the remains of an ancient structure in the semi-submerged
concrete. Besides to the study of construction techniques with which the structure was built, we tried to interpret what was its function in relation to Otranto harbour. Moreover, part of the work involved the analysis of bathymetric, as appropriate information for the understanding of the relative changes of sea level in old age and consequently the morphology of the ancient shoreline.

THE ANCIENT COASTAL LANDSCAPE OF PROTECTED MARINE AREA OF PORTO CESAREO (LE): RECENT RESEARCHES

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In the Marine Protected Area of Porto Cesareo (Lecce, Italy) various submerged and semi-submerged evidences have been highlighted/picked out by some recent notifications and preliminary surveys carried out by the Dipartimento di Beni Culturali – Università del Salento, in close collaboration with the Protected Marine Area:

- a *navis lapidaria* wreck, with a cargo of monumental marble columns from Eubea (Greece), of the Roman Imperial age;
- various scattered and decontextualized finds (amphorae, anchor stocks, pottery sherds);
- a beached wreck, probably Medieval, at - 2 m.s.l. and 150 m from the coastline;
- some submerged structures, located between the Scalo di Furno promontory and the opposite islet, at - 2.20 m.s.l; according to the building technique and the morphology, to the presence of Middle Bronze age ware, and mostly to the sea level relative rising values, we could identify them with the submerged part of the Bronze age Scalo di Furno settlement on the headland;
- remains of structures (walls, buildings, burial areas) and finds of Roman age along the shoreline of T. Chianca headland and the close peninsula, partially submerged and eroded.

The last three evidences allow us to hypothesize an ancient coastal landscape significantly different and a “dynamic” outline during the centuries.

THE MARANO LAGOON LANDSCAPE DURING THE ROMAN AGE: A STUDY IN PROGRESS

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A research programme inside the "Storie dal mare - Università di Trieste Project" was carried out in the Marano Lagoon, Udine. The study area is located in correspondence of river mouth which were navigable during ancient times. Human impact deeply affected lagoonal and peri-lagoonal areas since the Neolithic Age. Waterways provided an important business role, which was very important during Roman Age.
Following preliminary researches, many submerged or partly-submerged sites have been surveyed. Diving activities interested mainly the site on Bioni island, remains at S. Andrea island, a place with mosaic pavement at *Piere d'Isela*,remains at Piere del Ficariol and the exceptional building complex at Piere del Tribel, which contains different rooms, maybe used also for goods storage.
Geoarchaeological surveyings provide the evidence of a landscape significantly different from present-day one. A number of remains, located along the lagoonal channels, testify that the lagoon was the *trait d'union* between land and sea routes.

SEA LEVEL VARIATIONS SINCE ROMAN TIME AND COASTAL LANDSCAPE MODIFICATIONS IN THE MARINE PROTECTED AREA "GAIOLA UNDERWATER PARK"

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The object of the study is an area situated on the Posillipo coastline, in the Gulf of Naples, where in 2002 a MPA has been instituted (D.I. n. 304). The hillside of Posillipo is enclosed in the Phlegrean Fields volcanic system, for this reason it is affected by the phenomenon of bradyseism. Since Roman times the whole area has been densley populated and nowadays ancient remains lie along the whole coastline.
In the last years the CSI Gaiola team concentrated on a geo-archaeological survey. The aim was to estimate the changing of the sea level along the Posillipo coastline; using Roman underwater remains such as fishponds, harbors, coastal cavities and geo-morphological analisys to understand how the coastal landscape has been changed troughout the centuries. Marine surveys have been made on a wide range area. After that the analisys have been concentrated in the A Zone of Integral Reserve (12 ha of seabed; maximum depth 5 mt.). The rielievs of underwater features have been made in scuba diving (ARA method). At the end of the study the results clearly show how the present landscape is the product of a combined action: anthropic impact (Roman structures and coastal cavities), natural erosion and volcanic phenomenon interacted troughout the century strongly modifiyng the Posillipo coastline.
All the datas collected have been processed and integrated with ArchGis 9.2 in order to create a geo-archaeological map of the area and used for a research project of reconstruction of the ancient landscape.

UNDERWATER ARCHAEOLOGICAL PARKS: SOME IDEAS FOR THE UNDERWATER ARCHAEOLOGICAL SITES OF LEPTIS MAGNA AND APOLLONIA (LIBYA)

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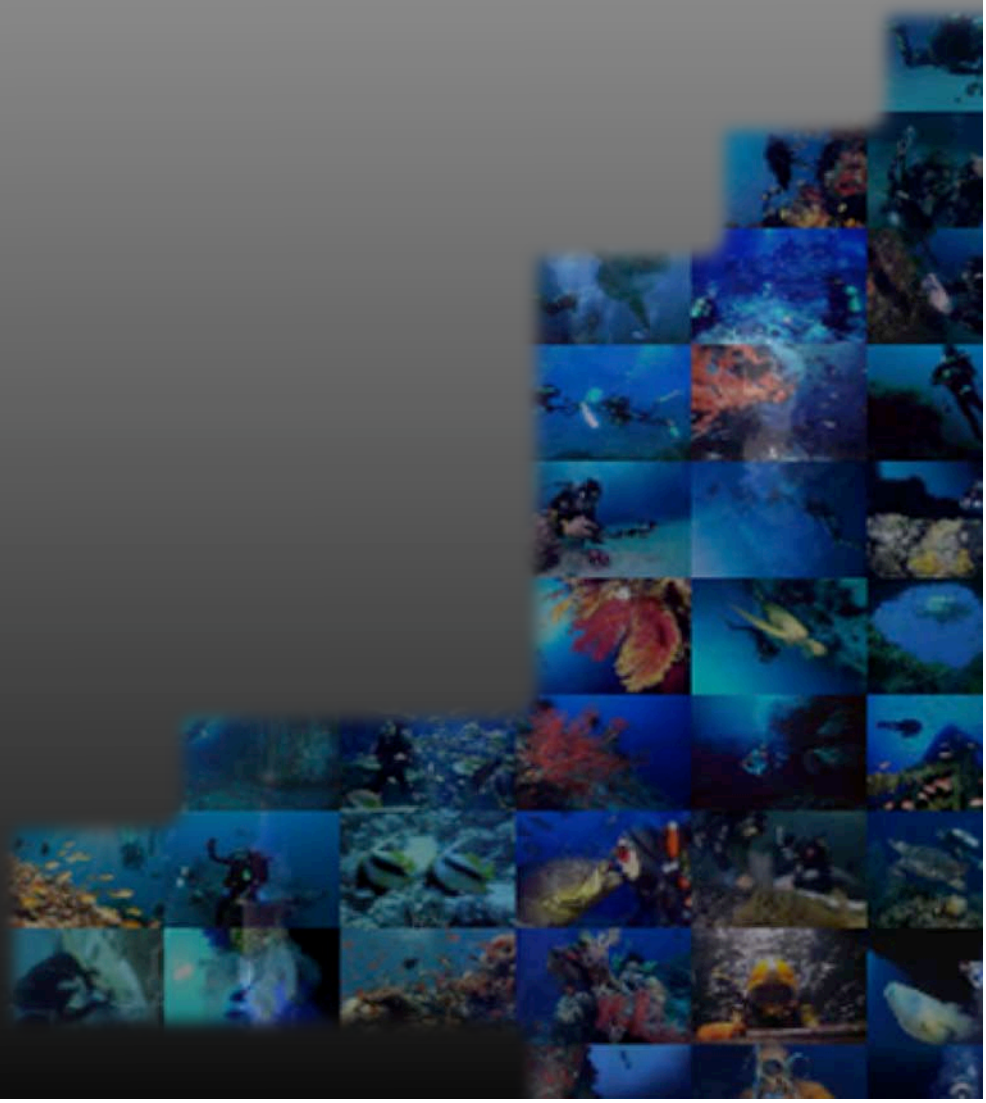
In the 2008 and 2009 the Archeotema society (Venice-Italy) was in charge from the Libyan Governement to draw some projects for the managing of the underwater archaeological sites of Libya as places for underwater tourism. the project was inside a general work of Evaluation and Conservation of the Cultural Libyan Heritage.
The two sites selected were Leptis Magna in Tripolitania and Apollonia in Cyrenaica. Two different kind of approach were proposed based on the different kind of place and structure. In one case, Leptis Magna, we proposed a glass bottom boat and some different itineraries because the place is spread in different points of interests.
In the other case, Apollonia, the nature of place, a harbour with all its structure, let us imagine a real park with an itinerary for divers and even in this case, a glass bottom boat for people who just want to see from the surface without jumping in the water.
Conceptually, an underwater archaeological park is supposed to be extremely useful not only in the protection and enhancement of the archaeological heritage, as the Unesco convention on the protection of the Underwater Cultural Heritage would ask, but also in the generation of new employment in towns and cities located close to the area.
In addition there is the potentiality, in such areas, of setting up research projects on the field of maritime archaeology, marine biology and conservation and thereby creating new professional opportunities for graduates in these subjects.
The organization structure of the underwater archaeological parks will be composed basically by:
- a diving centre;
- a ship with flat transparent bottom or simple zodiacs;
- the submerged area for both surface and underwater tours;
- a didactic centre.

POSTER



UNDERWATER ARCHAEOLOGY REGULATIONS

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Over these last ten years professional diving has developed so as to conform to the more and more specialized market request.
This standardization trend of underwater working procedures has been confirmed by the issue of the IMCA regulations, which are currently the most largely practised all over the world.
The Italian Parliament has recently issued a law that was followed by the creation by AISI (Association of Italian Diving Companies) of the UNI regulations concerning the working and safety procedures of professional diving in the industrial sector.
Moreover many Harbour Authorities have been conforming to the above mentioned UNI regulations.
Even scientific diving (in particular, in the case of underwater archaeology) should be conformed to these current general regulations.
It is necessary to draw up some regulations that are specific to underwater archaeology and concerning the following issues:
- safety, procedures, equipment
- typology of operation
- site of operation (depth, visibility, tides, etc.)
- organization of staff

It is only by means of all these procedure regulations that underwater archaeology will remain a serious and safe profession in the future.

APPLICATION OF UNDERWATER VISUAL CENSUS METHODS TO STUDY THE FISH ASSEMBLAGES OF THE MARINE PROTECTED AREA OF BERGEGGI (WESTERN LIGURIAN SEA)

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Underwater visual census was largely applied inside MPAs because of their efficacy and capability to be sea-friendly, in particular for fish, one of the main component to be managed by the protection measures.
The coastal area of Bergeggi is become an Italian MPA in 2007. A preliminary study on fish was conducted in 2001 in order to get data prior the institution of the reserve, applying two visual census techniques, paths of a time lapse of 15 minutes, to estimate species richness, and stationary census, within a radius of 5 m, to collect quantitative data. After the institution of the MPA, in 2009 and 2010, another study was performed applying the same methodologies.
Census samples were stratified according to 3 bottom typology (rocky, *Posidonia* and sand) and 3 depth ranges (0-3, 4-7, 12-16 and 24-30 m).
78 *taxa*, belonging to 27 families, was identified, increasing the number of species recognize in 2001 (57 species). Rocky habitat present the higher number of species while sands the poorest. To be noted the presence of thermopile species not previously recorded (*Diplodus cervinus*, *Parablennius pilicornis*, *Scorpaena maderensis* e *Sphyraena viridensis*).
The comparison of data collected in 2001 with those collected in 2009 and 2010 provide information on the increase of density especially in the A zone.
Recorded data put in evidence how the first two years of protection were useful for coastal fish assemblage, especially for target species for fishery such as groupers. These results point out the relevance of collecting historical series of data using non destructive methodologies such as visual census, to evaluate the effect of protection and the biodiversity status of Mediterranean coastal areas.

THE USE OF SCIENTIFIC SCUBA DIVING ACTIVITIES TO COLLECT INFORMATION ON FISH AND BENTHIC COMMUNITY FOR THE ESTABLISHMENT OF AN MPA IN THE COASTAL WATER OF MONTENEGRO, ADRIATIC SEA

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Scientific scuba diving activities was employed to carried out a survey on marine component (fishes and benthic flora and fauna) for the establishment of the first MPA in Montenegro. The survey was performed in summer 2010 with fish visual census (VC), assessment of *Posidonia oceanica* meadows and marine protected species.
For the assessment of fish assemblage was applied two underwater VC techniques, RST - Random Swim Technique, for data on the presence of fish species, and SVC - Stationary Visual Counts for quantitative evaluation. *Posidonia* beds were surveyed by two divers performing 13 transects placing inside each transect three stations (lower, intermediate and upper limit). According to its density (measured by counting the leaf shoots inside the 40x40cm frame) beds in equilibrium, disturbed beds and very disturbed beds were recognized.
The fish assemblage observed (72 species) is characterised by typical species of Mediterranean Sea with very poor density data.
Considering the marine protected species, in addition to the elevated depleted stock of date mussel (*Lithophaga lithophaga*), the other species observed during diving activities were *Cystoseira amentacea*, *Tonna galea*, *Pinna nobilis*, *Scyllarus arctus*, *Scyllarides latus*, *Ophidiaster ophidianus*, *Epinephelus aeneus* and *Hippocampus ramulosus*.
Finally, the application of underwater research techniques by scientific divers allowed to collect data on the quality of the marine environment along the study area, underling an high habitat complexity and biodiversity in the coastal area from Dubovica cape to Pecin inlet and in the area surrounding Katic Islets. The collection of data by scientific divers give the opportunity to replicate the survey when the MPA will be established, in order to monitoring the potential recovery of marine environment in the future.

THE MONITORING OF SEAGRASSES THROUGH UNDERWATER PHOTOGRAPHIC IMAGES AND VIDEO: TECHNICAL OVERVIEW ON THE CASE STUDY OF THE MARINE PROTECTED AREA OF CAPO RIZZUTO, (ITALY)

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Seagrass meadows are considered to be among the most important marine ecosystems, for biodiversity, ecological and economic reasons. Their progressive degradation may be due to natural or anthropogenic disturbances and stress, although losses of the seagrass meadows were mainly related to coastal development, pollution, trawling, fish farming, moorings, dredging, dumping and the competition with introduced species. As a consequence it is necessary to establish monitoring programs that follow a unified and complete protocol of actions to preserve these important marine resources. We have developed a new protocol for monitoring the *Posidonia oceanica* and *Cymodocea nodosa* meadows that use underwater photocamera or georeferenced towed underwater video-camera, or alternatively the remotely operated vehicle (ROV). In this work we tested the new protocol at the marine protected area (MPA**)** of Capo Rizzuto (Italy) by divers and/or video systems along 50m x 1m^2 transects that originate within existing seagrass prairies. The considered variables were: area, continuity, proximity, coverage percentage (using the software estimate), and species composition. The combination of these five variables was used to calculate the habitat structure index, H'. The monitoring protocol of the seagrasses by divers or by video systems can be applied to monitor the upper and lower limits of the meadows. This method has several advantages over other techniques: 1) estimates of changes over time; 2) provide positive identification of plants which is not possible with acoustics techniques; 3) provide a permanent archive of visual images.

MONITORING OF THE COASTAL ECOLOGICAL SYSTEM IN THE GAIOLA UNDERWATER PARK: AN INTERDISCIPLINARY APPROACH

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Instituted in 07/08/2002 by the D.I. n. 304 to protect underwater archeological structures, submerged because of the bradyseism, the MPA Gaiola Underwater Park also encloses important biological and geomorphological features. In 2010 the Manager Authority charged CSI Gaiola to realize an environmental monitoring on the MPA seabed in order to collect data for the management plan of the Park.
The monitoring project has been scheduled considering at the same time the geomorphological, biological and the archeological features of the MPA. In four main reference areas, selected according the geo-morphological/archaeological characterizations of the seabed, the following bio-ecological analysis have been made:
1- Analysis on the condition and the distribution of the characterizing benthos population.
2- Qualitative and quantitative analysis on the coastal ichtyofauna (composition, distribution, abundance).
3- Microbiological analysis on the quality of water.
4- Degradation features of anthropic origin.
In-depth examination have been made on photophilous Seaweed Biocenosis, more damaged by anthropic impact (bathing, scuba fishing), and on the Coraligen Biocenosis, one of the protected Mediterranean coastal biocenosis according the RAC/SPA list.
For dive sampling has been chosen *Visual census*, a low impact method considered the more appropriate for MPA surveys. Collected datas have been processed and integrated_by ArcGis 9,2 to realize a reference Informative Territorial System.
The datas concerning the two main areas “Gaiola” and “Cavallara” were particularly interesting: “Gaiola” is characterized by higher diversification of the biocenosis because of the archaeological remains; in “Cavallara” the coralligen biocenosis examination showed a strictly correspondence between facies and geomorphological features.

TUBO – A SIMPLE TOOL FOR FINE-SCALE *IN-SITU* EXTRACTION OF STERILE POREWATER FROM SANDY SEDIMENTS BY DIVERS

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There exist several methods for the extraction of porewater from sediments, both *in situ* and *ex situ.* However, porewater from permeable medium to coarse sandy sediments is difficult to sample with high resolution and accuracy. Here we present a simple low-cost device to be operated by a diver. It allows to obtain a profile of sterile-filtered porewater with 2 cm vertical resolution and a sample volume of up to 15 ml per horizon down to a sediment depth of 25 cm. The system is based on readily available RHIZON soil moisture samplers (Rhizosphere Research Products, Wageningen, The Netherlands) known from terrestrial soil science and already applied on marine sediments. First a plastic cylinder of 20 cm diameter with sealed perforations is pushed into the sediment. After the excavation of the sediment core RHIZON samplers, basically permeable polymer tubes with a Luer lock syringe connector, are pushed through the perforations horizontally from within the cylinder out into the sediment with the help of a plastic liner. After the removal of the liners the samples are collected with syringes. Examples for measured distribution of dissolved components like sulfide and nitrate over depth are presented. Furthermore we present the results of tests for the possible influence of the material of the RHIZON samplers on dissolved substances, for example hydrogen sulfide and acetate. Practical tips for the construction and use of the device are given.

GEOTHERMAL STATE OF THE SHALLOW SUBMARINE GEOTHERMAL SYSTEM OF PANAREA, AEOLIAN ISLANDS (ITALY)

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Thermal measurements concerning thermal conductivity, temperature gradient and heat flow recordings are important parameters to describe the geothermal state and potential of geothermal systems. Due to the non-availability of commercial probes suitable for shallow underwater research, probes were designed and built. Tests in the laboratory and on several submarine diving sites near Panarea (Italy) provide reliable and exiting results. High temperature gradients (>200 K/m) and high heat fluxes (>2500 W/m²) suggest a heat transfer caused by conduction and convection. In a continuous heat flux monitoring for more than 3 days, a significant tidal dependency was observed where recordings vary for more than 400 W/m². The combination of all probes is a powerful tool for future investigations of the submarine geothermal area of Panarea and other submarine geothermal systems. Further field and laboratory especially for heat flux measurements are suggested.

SCIENTIFIC DIVING IN INDONESIA: THE CORAL EYEREEF RESEARCH OUTPOST

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Coral Eye is a new centre developed for applied research in tropical shallow and deep-sea environments. The centre is located on the west side of Bangka Island (North Sulawesi, Indonesia 1.7511° N 125.1331° E), in the middle of the "Coral triangle", the richest place in terms of marine biodiversity in the World. The center is managed by four marine biologists who collaborate with local and foreign research centersand universities.
As a logistic base for research, Coral Eye provides a wide range of facilities and services, including a comfortable resort, a dry lab equipped with microscopes and a wet lab with aquaculture facilities. A full equipped diving centre and diving boat are also available. Field experiments can be run next to the jetty, where there is also a coral farm. The centre can obtain the necessary permits, including CITES, and manage the shipment of materials and samples.
Here students and researchers can develop independent research or support conservation programs in collaboration with local authorities and the worldwide Reef Check organisation. Moreover, for long-term field and lab experiments, the local staff can provide support in terms of sample and data collection.

THE KORALLION LAB (VAVVARU ISLAND, MALDIVES) PROPOSALS FOR TROPICAL MARINE RESEARCH

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"Beautiful place for beautiful research". This is the vision that has driven the idea to establish a Marine Research Centre oriented to coral and coral reef studies in the remote Vavvaru Island (5.4184° N 73.3548° E) in the Lhaviyani atoll, Republic of Maldives.

Thanks to a collaborative project, involving experts from several Institutes around the World and the Maldivian Government, today there is the opportunity to make this vision true. Korallion Lab, based on new environmentally friendly approaches and green-energy technology, will open by August 2012.

On Vavvaru Island (approximately 3 ha) and its lagoon (approximately 95 ha) we will build a fully equipped "field" lab and 4 double accommodations for researchers. The "wet lab" will have a water table with running seawater, as well as many sea water aquariums that will be used for experiments. Then there will a "dry lab" with microscopes, drying oven, and pre-PCR molecular equipment (freezer, centrifuge, fume hood etc.).Diving and boat facilities for underwater surveys and field experiments will be there as well.

Thanks to the collaboration of different institutions, technicians and young scientists we will take turns to keep the lab at work, even for long-term experiments. Korallion Lab will be at the disposal of every Institution interested in tropical marine studies for partial or full rent at request. Local staff will be able to organize logistics and shipping specimens abroad.

"INTERNATIONAL SCHOOL FOR SCIENTIFIC DIVING": 25 YEARS OF TRAINING COURSES FOR SCIENTISTS AND STUDENTS

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The International School for Scientific Diving "Anna Proietti Zolla" (A.C.S.D.I.S.S.D) has been funded in 1989 by a group of professional diving scientists from various universities and other research institutions. The School born on the experience maturated during the courses for scientific diver organized since the 1986.
Among the activities of the A.C.S.D.I.S.S.D there is the training of researchers and students but also the specialization of all the divers that want to improve their knowledge and collaborate in different fields of the marine sciences such as biology, ecology, geology and oceanography.
The School has organized 24 annual Training Course for Scientific Diver and a number of stage, workshops and field works and studies in the Mediterranean and tropical seas. A certificate of participation and an international "Scientific Diver" certification (C.M.A.S.-I.S.S.D.) have been issued to the participants of the annual training course. The A.C.D.S.I.S.S.D. "Anna Proietti Zolla" is recognized by the World Underwater Federation (C.M.A.S.) and UNESCO. In 2011 has become Organizational Member of the American Academy of Underwater Sciences (AAUS).

SCIENTIFIC DIVING TRAINING FOR ITALIAN MARINE BIOLOGISTS AND NATURALISTS

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In Italy, as in other countries, there is a growing need for adequate training on the methodologies of underwater scientific research within the training of marine biologists and naturalists. Unfortunately, the universities that provide this type of training among its courses are still few. In Italy, the best examples are those offered by the Polytechnic University of Marche, since 2006, and the University of Bologna, since 2010, for MSc in Marine Biology. Both courses include lectures, laboratory exercises and underwater experiences for a total of 6 ECTS. Topics covered include both destructive (direct sampling) and non-destructive (visual census) methods and experimental (manipulation) approaches, the use of specific equipments, as well safety at work. Diving activities are always focused on non-destructive methods and drive the students inside benthos exploration following an experimental hypothesis to be tested and discussed at the end of the course. These courses have a minimum of 6 scientific dives and can offer just a fast and first impression on what scientific diving is, not sufficient, to achieve the standards of the European Scientific Diver (ESD) defined by the European Scientific Diving Panel. Individual training should be completed during internships and theses and/or specific additional courses.

ESDTN - EUROPEAN SCIENTIFIC DIVING TRAINING NETWORK: A PROPOSAL FOR THE MARIE CURIE INITIAL TRAINING NETWORKS (FP7-PEOPLE-2012-ITN) CALL

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Since 50's the scientific diving community has endeavoured to promote safe, effective diving through self-imposed training and education programs. In the last few decades in some countries the Government recognised peculiarity and requirements of scientific diving. In the year 2008, the European Science Foundation adopted the Marine Board European Scientific Diving Panel (ESDP). The main objectives of the ESDP are: i) to encourage international mobility in the European scientific diving community through the implementation of a support framework; ii) to promote safety in scientific diving across Europe; iii) to advance underwater scientific excellence in Europe.
Within the ESDP framework, the proposed ESDTN project will focus on the training of early-stage researchers (ESRs) in the development and application of innovative underwater scientific methods and approaches in the fields of biology, experimental ecology, cartography and human impact assessment. A limited number of experienced researchers (ERs) will be recruited to collaborate in research activities and complete their formation. ESRs and ERs will be trained to apply a range of underwater scientific methods, from measurements to manipulative field experiments, sharing competences from different fields and

improving their skills. Each ESR should develop a 3-years research program in a specific scientific field increasing knowledge in natural and/or anthropogenic marine processes or developing new underwater methodologies or instruments. The trans-national joint research-training network will be based on European universities with well established research and training experience in these fields, which can provide high-quality education and a mutually recognised PhD certificate. Associated partners will include national and international organizations and a number of small-medium enterprises (SMEs), which can provide research and complementary training and secondment opportunities.

PHYPODE - A MARIE CURIE INITIAL TRAINING NETWORK ADDRESSING PHYSIOPATHOLOGY OF DECOMPRESSION

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The Marie Curie Initial Training Network (ITN) action within the 7th framework program of the EU aims to improve early-stage researchers' career prospects in both the public and private sectors, thereby making research careers more attractive to young people.
The aim of the PHYPODE ITN project is to advance understanding of the decompression phenomena by uniting academic and industrial partners on an international scale to provide a collaborative training and research programme. More specifically, the PHYPODE project will:
- Develop an educational and research framework for the cross-fertilization of research activities concerning the physiopathology of decompression;
- Provide young researchers with the opportunity to: share research techniques and resources, benefit from the knowledge of international scientists in this field, take advantage of a program of research promoting strong interactions between industry, medical centres and academia, participate in international networking events concerning the domain, undertake secondments in industry/clinical and laboratory contexts;
- Widen the career prospects of researchers by enabling them to embrace the entire chain of research activities; from fundamental research for pathophysiological understanding of decompression, to applied research in industry for the management of decompression.
To achieve this training & research programme, the academic partners, international not-for-profit associations, hyperbaric medical centres and industrial partners of the PHYPODE project have formed an international

consortium. Project coordinator is Dr. Guerrero, ORPHY, Brest, France.
The objectives of the consortium are underpinned by close collaboration between the members to leverage complementary expertise and construct a common program of education and research.
PHYPODE began in January 2011 and will finish in 4 years at the end of 2014. It is funded by the European Community as a Marie Curie FP7-PEOPLE-2010-Initial Training Network program. Further information are available at http://www.phypode.org/

SCIENTIFIC DIVING AS IMPORTANT TOOL FOR A SUSTAINABLE AQUATIC RESEARCH

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The Biological Institute Helgoland (BAH)/ Alfred-Wegener-Institute (AWI) for Polar and Marine Research is located 60 km off the German coastline. Helgoland is well known as a unique hard bottom nature reserve comprising a total subsurface area of about 40 km^2 in the southern North Sea.
The scientific focus of the BAH lies on the understanding of processes affecting the integrity of fragile coasts i.e. with respect to climate change and anthropogenic impacts. For this, the BAH provides a variaty of services for scientists and students of universities and institutes all over Europe. Services include full equippet wet- and dry-laboratories, basins for the cultivation of living biota, lecture rooms, accomodation as well as biota sampling and shipping.
Besides conducting front-end aquatic science, the AWI-Center for Scientific Diving holds an essential role in the in-house commitment to perform a conservation oriented underwater research. By applying diver supported selective sampling, the destructive impact of science on the marine environment is significantly minimised compared to ship supported methods like dredges or otter-trawls.
A new project within this context focus on the temporal and spatial occurence of marine biota which are often ordered from other reserach institutions throug the BAH biota shipping service. Using standarized biota assessment protocols for all SCUBA sampling missions combined with permanent monitoring stations sampled quaterly, a diver supported long-term monitoring will be established. Published in an open source data base, these data shall be used for a comparative analysis with other marine stations and diver supported programs in Europe.

SCIENTIFIC DIVING TECHNIQUES IN HAZARDOUS ENVIRONMENTS

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The vast variety of underwater conditions requires different and specific procedures to assure the safety of divers involved in research and to achieve scientifically valid results.
Hereby we present some case studies related to scientific diving performed in potentially hazardous environments such as caves, deep diving, below ice and very low visibility.
Studying flooded caves allows for the gathering of important geological, hydrological and plaeclimatological information, however overhead and restricted environments, darkness, potential low visibility and limited escape routes represent some of the challenges that must be carefully addressed in planning the underwater tasks.
Ice diving couples an overhead environment with extremely cold water and, sometimes, poor visibility. The icy conditions, both below and above water, will not only affect the performance of both the diver and diving equipment but also the sampling procedures and use of underwater instruments.
Very low visibility is often encountered in specific environments such as silty bottoms, rivers, river estuaries, wreck interiors, harbour areas or tannic waters. These conditions could present a potential hazard for the divers, such as increased entanglement hazards, and could interfere with the scientific study of such environments.
Specific techniques and diving procedures were developed to operate in the different scenarios and to collect the necessary data.
Despite the challenging conditions, it was possible to conduct safe and reliable scientific diving in all of the presented situations once a proper methodology was developed.

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