PERSEUS

POLICY-ORIENTED MARINE ENVIRONMENTAL RESEARCH IN THE SOUTHERN EUROPEAN SEAS

Preliminary report on assessment of pressures and processes in the sub-regions of the Med and BS

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Contents

Executive summary / Abstract

This report presents the rationales and experiments conducted in the different sub-regions of the Mediterranean and Black Seas, aiming at addressing different components of MSFD descriptors and individual indicators. The selected study areas presented were chosen on the basis of specific processes and pressures representative of the major SES sub-basins. The seven study areas were (1) the Strait of Gibraltar and Alboran Sea, (2) the Gulf of Lions and Ligurian Sea, (3) the Adriatic and Ionian Seas, (4) the Levantine Sea, (5) the Aegean Sea, (6) the Turkish Straits System and Marmara Sea, and (7) the western Black Sea.

Descriptors / **Sites**	D1 Biological diversity	D2 Non-indigenous species	D3 Populations of commer-cially exploited fish and shellfish	D5 Human-induced eutrophi-cation	D6 Sea floor integrity	D7 Permanent alteration of hydrological conditions	D8 Concentrati on of contaminan ts	D10 Properties and quantities of marine litter
Gibraltar Strait & Alboran Sea	■	■	■	■				
Gulf of Lions and Ligurian sea	■		■			■	■	■
Adriatic and Ionian Sea	■	■		■		■	■	
Levantine Basin	■	■		■			■	
Aegean Sea	■			■	■	■	■	
Turkisk straits Marmara Sea	■	■		■			■	
Black Sea		■	■	■				

The experimental work or process modeling addressed the (sole or combined) impacts of natural and human-made pressures on a component of the marine ecosystem. The natural pressures considered are the exchange fluxes at straits, the hydro-meteorological variability, the dense water formation, and the atmospheric deposition. The human pressures taken into consideration are the overfishing, the introduction of contaminants, and the introduction of alien species. The key issues deal with (i) the effects of alteration of hydrological conditions on biogeochemistry, planktonic ecosystem abundance, composition and structure, ii) the improvement of satellite-derived primary productivity, (iii) the mapping of biodiversity, (iv) the expansion of non-indigenous species and fish population, and (v) the accumulation of contaminants in deep-sea sediments.

28 cruises were conducted to date. The analysis of data and the process-oriented modeling are in progress.

Scope

The following report provides a preliminary report on the advancement of the dedicated studies conducted in seven sub-regions of the Mediterranean and Black Sea. We used information provided by task 1.1 on the data and knowledge gaps on pressures and impacts considered as major threats to the good environmental status of the open sea marine ecosystems. The report presents for each studied region the rationale regarding the selected pressures and processes that are investigated, the specific MFSD descriptors addressed, a description of the activities conducted to date, and the expected outcomes. A list of the cruises carried out to date is itemized. Fieldwork and process modelling will be coordinated with WP3 (in situ observation), WP4 (modeling), and WP5 (MSFD demonstration). The results of this task will contribute to the definition of the overall strategy for long-term monitoring (done by WP3) as well as assisting in formulating adaptive policies (in WP6).

1. Rationales and activities conducted for different sub-regions of the Mediterranean and Black Seas

1.1. ALBOREX: Alboran Sea – Strait of Gibraltar Experiment

1.1.1. Effect of inter-basin and coastal-ocean exchanges of material fluxes.

Participants

CSIC-ICMAN (resp.), IEO

Rationale

The Alboran Sea plays a crucial role in the overall Mediterranean dynamics, acting as its interface with the Atlantic Ocean. Inter-basin and shelf-slope fluxes of elements influence the biochemistry and the lower trophic level productivity in the Strait of Gibraltar, along the Atlantic jet, and in the Alboran Sea.

MSFD Descriptors

Descriptor 1 Biological diversity

Descriptor 5 Human-induced eutrophication

Detail contribution

Criteria 5.1 Nutrients level

Activity performed

A SAMI-pH and a SAMI-CO2 were deployed in order to continuously record the temporal variation of both variables in the Mediterranean water. Every three months the line has been recovered for battery replacement, maintenance and data collection. With the maintenance of the mooring and the sampling of the GIFT station, we performed a total of 7 oceanographic cruises during 2012 and 2013.

We performed a comprehensive recompilation of nutrient and plankton (abundance and taxonomic composition) data obtained from research cruises carried out in the north-western Alboran Sea from 1994 to 2010. Additionally, meteorological data and satellite images provided by MODIS-Aqua for 2002-2010 have been gathered and analysed. A preliminary detailed model of distribution of nutrients, chlorophyll a and plankton in the northern-Alboran sea is being assessed.

Expected Outcomes

We plan to estimate the role of the plankton in modulating the vertical and horizontal flows of organic C and N in different hydrological areas of the western Alboran Sea with the future activity of an oceanography cruise in July 2014 (IEO resp.). Also, the mooring and the GIFT station sampling will continue the data base of the only oceanographic time-series whose maintenance is carried out by Spanish and Moroccan PERSEUS partners.

1.1.2. Estimation of the inter-basin transfer of non-indigenous species through the Strait of Gibraltar.

Participants
CSIC-ICMAN (resp.), INRH

Rationale
Non-indigenous species, and particularly the gelatinous zooplankton, which includes animals from different groups (cnidaria, ctenophore, salpas), are an excellent target to study the inter-basin exchanges variability through the Strait of Gibraltar.

MSFD Descriptors

Descriptor 1 Biological diversity. Quality and occurrence of habitats. Distribution and abundance of species

Descriptor 2 Non-indigenous species

Detail contribution
Criteria 2.1 Abundance and state characterization of non-indigenous species

Activity performed
We compiled data from local, regional and national level of sightings of non-indigenous species at both sides of the Strait of Gibraltar. During ALBOREX experiment, we have focus in two case studies of a non-indigenous species entering through the Strait of Gibraltar: Portuguese Man-of-War (*Physalia physalis*) and *Rhizostoma luteum.* We performed field sampling, size spectra, genetic analysis of the organisms, plus environmental variables to study the connection of the organisms with the climatic/oceanographic conditions.

Expected Outcomes
We expect to advance in the understanding of species transfer, based not only in field data, but also using modeling tools. In this sense, and in particular with the pleustonic Portuguese Man-of-War, we hope to be able to efectively model the arrival with the real observations, combining a ROMS based numerical simulation forced with realistic winds (ASCAT) and heat fluxes from ERA-Iterim, together with an Individual Based Model (IBM) simulations.

References
Prieto L., Armani A., Macias D. (2013). Recent strandings of the giant jellyfish Rhizostoma luteum Quoy and Gaimard, 1827 on the Atlantic and Mediterranean coasts. Marine Biology, doi: 10.1007/s00227-013-2293-6.

Prieto L., Navarro G. (2013). Avistamientos de medusas en el litoral Andaluz. Grupo Oceanografía de Ecosistemas (Cádiz), 36pp. http://www.marinera-medex.eu/index.php?option=311&file=Prieto_Navarro_2013.pdf

1.1.3. Estimation of the deep outflow from the Mediterranean to the world ocean, for chemicals such as macronutrients or anthropogenic carbon, whose contribution to the sea is modified by SES riparian countries.

Participants
CSIC-ICMAN (resp.), INRH

Rationale
The Mediterranean Sea shows a peculiar anomaly in its nutrient pattern compared to the global ocean, as there is decrease in nutrient concentration from west to east. This feature has been attributed to the anti-estuarine circulation at the Strait of Gibraltar, where an eastward flow of Atlantic nutrient-poor surface waters is compensated by a westward countercurrent of Mediterranean nutrient-rich deep waters. This water exchange has been suggested as the ultimate cause for the oligotrophy of the Mediterranean basin, even though only a few studies have accurately examined the magnitude of the nutrient flux through the Strait of Gibraltar. In order to confirm or discard this assumption, we assessed nutrients distribution in the region and applied a two-layer model of water mass exchange to accurately calculate nutrient transport between the Mediterranean Sea and the North Atlantic.

MSFD Descriptors
Descriptor 5 Human-induced eutrophication

Detail contribution
Criteria 5.1 Nutrients level

- Indicator 5.1.1 Nutrients concentration in the water column
- Indicator 5.1.2 Nutrient ratios

Activity performed
Data were collected at 8 stations distributed in two perpendicular sections: one that goes along the longitudinal axis of the Strait and constitute the GIFT and a perpendicular section that was also sampled for intercalibration purposes. Sampling was conducted during 15 campaigns that were carried out between May 2005 and October 2008. Water transport of the Mediterranean outflow was also measured during the study period.

Expected Outcomes
The first outcome is new and accurate values of the exchange of nutrients through the Strait of Gibraltar. Also, that phosphate is in excess with respect to nitrate in the Atlantic jet entering through Gibraltar. Finally, than external nitrogen enriched inputs are responsible for the non Redfieldian behaviour found in the Mediterranean.

References
Huertas IE, AF. Rios, J. García-Lafuente, G. Navarro, A. Makaoui, A. Sánchez-Román, S. Rodríguez-Gálvez, A. Orbi, J. Ruiz, FF. Perez (2012). Atlantic forcing of the Mediterranean oligotrophy. *Global Biogeochemical Cycles, 26, GB2022.* doi:10.1029/2011GB004167.

1.1.4. Effects of environmentally-induced (Atlantic jet of the Alboran Sea) enrichment processes on mid-trophic levels of the pelagic food web.

Participants

CSIC (resp.), IEO

Rationale

The Strait of Gibraltar replenishes the Mediterranean with Atlantic waters through an intense eastward current known as the Atlantic Jet (AJ). The AJ fertilizes the southwestern Mediterranean and is considered to be the ultimate factor responsible for the comparatively high fish production of this region.

MSFD Descriptors

Descriptor 3 Populations of commercially exploited fish and shellfish

Detail contribution

Criteria 3.1 Level of pressure of the fishing activity

Activity performed

We performed an analysis of the available historical catches and catch per unit effort (CPUE) of anchovy, together with a long series of surface currents, kinetic energy and chlorophyll concentration in the Alboran Sea.

Expected Outcomes

Anchovy recruitment in the region is inhibited by the advection and dispersion of larvae and post-larvae during periods of strong advection by the AJ. The inhibitory impact of kinetic energy on anchovy landings is not a transient but rather a persistent state of the system. An exceptional combination of events creates an outbreak of this species in the Alboran Sea. These events depend on the Mediterranean-Atlantic exchange of water masses and, therefore, are highly sensitive to climate changes that are projected, though not always negatively, for fish landings.

References

J. Ruiz, D. Macias, MM. Rincón, A. Pascual, IA. Catalán, G. Navarro (2013). Recruiting at the Edge: Kinetic Energy Inhibits Anchovy Populations in the Western Mediterranean. PLoS ONE 8(2): e55523. doi:10.1371/journal.pone.0055523

1.2. LIONEX: Western Mediterranean Sea Experiment - Gulf of Lions

1.2.1 Effects of deep water formation processes on basin hydrology and planktonic ecosystem abundance, composition and structure

Participants
UPS-LA (resp.), CNRS-CEFREM

Rationale
Preliminary studies suggested the fundamental role of dense water formation, especially open-sea convection, on the functioning of the planktonic ecosystem in the northwestern Mediterranean, but they remained quite speculative regarding the biogeochemistry because no coherent set of observations (needed to check the model) was available.

MSFD Descriptors addressed
Descriptor 1 Biological diversity; Quality and occurrence of habitats; Distribution and abundance of species
Descriptor 7 Permanent alteration of hydrological conditions

Detail contribution
Criteria 1.1 Species distribution
- Indicator 1.1.1 Distribution ranges
- Indicator 1.1.2 Distributional pattern
- Indicator 1.1.2 Area covered

Criteria 1.2 Population size
- Indicator 1.2.1 Population abundance and/or biomass

Activity performed
An annual monitoring of hydrology, biogeochemistry and plankton has been performed in the Gulf of Lion and Ligurian Sea from September 2012 to September 2013 using multiples platforms (ships, gliders, profiling floats, moorings, satellites). A bottom-reaching open-sea convection event has been evidenced in the Gulf of Lion during the winter 2013. An accurate physical simulation has been achieved, thus enabling to assess the biogeochemical model using the new data set and improve it.

Expected Outcomes
We expect that this study will allow understanding how dense water formation or its absence could impact the ecosystem in terms of planktonic diversity and trophic regimes. The transfer of particulate organic matter to deep environments will be also addressed. We will also allow characterizing spatially the regions locally or remotely impacted by deep water formation in terms of biodiversity and change in hydrological and biogeochemical properties (seasonal mixing, renewal of intermediate and bottom waters). We also expect to understand how dense water formation and (sub) mesoscale structures impact the ecosystem in terms of planktonic diversity and trophic regimes.

1.2.2 Effects of deep water formation processes on the level of pressure of fishing activity and the population dynamics of the commercial deep-sea shrimp *Aristeus antennatus*

Participants
CSIC-ICM (resp.)

Rationale
Previous studies have indicated that dense shelf water cascading influences the shrimp fisheries by flushing the population during strong cascading events and provoking a temporary collapse of the landings.

MSFD Descriptors addressed
Descriptor 3 Population of commercially exploited fished and shell-fishes

Detail contribution
Criteria 3.1 Level of pressure of the fishing activity
- Indicator 3.1.2 Ratio between catch and biomass

Criteria 3.3 Population age and size distribution
- Indicator 3.3.1 Proportion of fish larger than the mean size of the first sexual maturation

Activity performed
A monitoring of the landings of shrimps has been conducted in the different ports of the Catalan fishing ports (Roses, Palamós, Blanes, Arenys de Mar, and Vilanova i la Geltrú.
A ratio between catch and biomass, as well as indexes (population age, population size distribution, proportion of individuals larger than the mean size of the sexual maturation) has been inferred.

Expected Outcomes
We expect to advance in the understanding of the effects of dense shelf water cascading events on the population dynamics, understand the probable role of convection in the recruitment, and improve the recent pilot regulation that applies to the fishing grounds.

1.2.3 Effects of deep water formation processes on the transfer of trace metals to the basin and accumulation of contaminants in deep-sea sediments.

Participants
CNRS-CEFREM (resp.), ICM-CSIC, UB

Rationale
Dense shelf water cascading influences the export of organic matter and pollutants from the coastal zone to the deep environments. Recent observations also emphasize the potential role of open sea convection in the remobilization of deep sediment and the spreading of particulate contaminants throughout the deep basin. A deepening of our knowledge on the inputs, export from the coastal zone, and dispersal into the basin is needed to assess the levels and the origins of the contamination of the deep sediments.

MSFD Descriptors addressed
Descriptor 8 Concentration of contaminants

Detail contribution
Criteria 8.1 Concentration of contaminants measured in the relevant matrix: atmospheric particles, water, and sediment

Activity performed
An annual monitoring of atmospheric, river, slope and deep basins particulate fluxes and composition in metallic trace elements has been conducted between December 2011 and December 2012.
A massive deep water formation both on the Gulf of Lions' shelf and basin during the winter 2012 has been evidenced. Their interplay resulted in the formation of a new bottom water (Durrieu de Madron et al., 2013), that likely spread the particulate elements in suspension throughout the northwestern Mediterranean basin.

Expected Outcomes
Assess the levels of metallic contamination in different marine compartments and decipher the role of dense water formation on the spreading of contaminated sediments.

References
Durrieu de Madron X., L. Houpert, P. Puig, A. Sanchez-Vidal, P. Testor, A. Bosse, C. Estournel, S. Somot, F. Bourrin, M.N Bouin , M. Beauverger, L. Beguery, A. Calafat, M. Canals, L. Coppola, D. Dausse, F. D'Ortenzio, J. Font, S. Heussner, S. Kunesch, D. Lefevre, H. Le Goff, J. Martín, L. Mortier, A. Palanques, P. Raimbault (2013) Interaction of dense dense shelf water cascading and open-sea convection in the Northwestern Mediterranean during winter 2012. Geophysical Research Letters, 40, 1379-1385, doi:10.1002/grl.50331.

1.2.4 Effect of dense shelf water cascading in the composition, spatial distribution and source of litter in submarine canyons

Participants
UB (resp.)

Rationale
Submarines canyons close to the Catalan shore are very effective to trap dense shelf water overflowing the shelf edge and cascading down the slope during winter. Canyon's heads form major conduits for the transport of particulate matter from the coastal zone and are also major sites both for professional and recreational fishing activities. A study on the properties (composition, spatial distribution, and source) of marine litter in submarine canyons influenced by dense shelf water cascading was needed to assess potential impact on these sensitive ecosystems.

MSFD Descriptors addressed
Descriptor 10 Properties and quantities of marine litter

Detail contribution
Criteria 10.1 Characteristics of litter in the marine and coastal environment

- Indicator 10.1.2 Trends in litter in water column and on the sea floor

Activity performed
Surveys with Remotely Operated Vehicle (ROV) were performed in 2011 along the axis and the flanks of three submarines canyons off the Catalan coast (Cap de Creus, La Fonera, Blanes). Video records were analyzed to quantify the number items, their type, their size, and their apparent weight.

Expected Outcomes
We plan to assess the nature, distribution, origin and dispersal processes of large marine litter in these environments.

1.3. ADREX: Adriatic and Ionian Seas Experiment

1.3.1 Effect of the circulation on the Ionian Sea hydrology and ecosystem dynamics

Participants
OGS (Resp.), CNR, NIB

Rationale
Associated with the Ionian cyclonic or anticyclonic upper-layer circulation regulated by the BiOS (Adriatic-Ionian Bimodal Oscillating System) mechanism, the alternate advection of saltier water from the Aegean/Levantine basis or fresher water of Atlantic origin from the Western Mediterranean modifies the Ionian thermohaline properties and the geographical location where the effective upward transfer of nutrients can occur. Accordingly, the food web structure could exhibit a spatial differentiation: a “classic” type (phytoplankton – copepods – predators) in the area of active nutrients supply, and a microbial loop structure in the more oligotrophic waters, alternated on decadal scale. Although this was observed in the Ionian Sea, this issue needs further investigations.

MSFD Descriptors addressed
Descriptor 1 Biological diversity is maintained
Descriptor 7 Permanent alteration of hydrological conditions

Detail contribution
Criteria 1.1 Species distribution.
Criteria 1.2 Population size.
Criteria 1.7 Ecosystem structure.
Criteria 7.1 Spatial characterization of permanent alteration.
Criteria 7.2 Impact of permanent hydrographical changes.

Activity performed
Two west-east sections in the Ionian and one section across the Otranto Strait were investigated during the oceanographic campaign ADREX-2014 on February 2014. Dataset includes extended physical, biogeochemical and biological parameters. In addition, autonomous platform (Argo and Bio-Argo floats, satellites) were deployed and/or are currently in use in order to monitor the hydrological conditions of the Ionian Sea at finer time/space resolution. In selected stations investigations on primary and prokariotic carbon production, and on plankton species composition were performed.

Expected Outcomes
The study related to this part of the ADREX task aims at exploring the effects of the regional circulation regime on the phytoplankton dynamics and structure, with implications on the food web organization, on pelagic resources, and on the CO_2 equilibrium between atmosphere and ocean. Particular attention will be put on the impact of open sea dynamics on the mixed layer depth, the nutricline depth and the deep chlorophyll maximum, considered as key interfaces for the ecosystem dynamics. The relative abundance of diatoms and coccolithophores, considered as proxy of different trophic regimes and different carbon pump mechanisms will be addressed. Secondary level species composition typical of main water masses of the studied area will be assess.

1.3.2. Climate and BiOS effects on the Adriatic hydrology

Participants
OGS (Resp.), IOF

Rationale
The Adriatic Sea is connected with the Ionian Sea through the Otranto Strait (about 80 km wide, 800 m deep). What happens in the Ionian is reflected in the South Adriatic. Both advection and dynamics exert their natural pressure on the thermohaline and biogeochemical characteristics of the South Adriatic. The BiOS (Adriatic-Ionian Bimodal Oscillating System) determines the preconditioning for the open-ocean convection in the South Adriatic, but the heat fluxes driven by the climate play sometimes a predominant role. On the opposite end of the basin, in the North Adriatic, the thermohaline cell is feed by new dense waters generated by shelf processes. This water represents a potential conveyor for the longitudinal transfer of anthropogenic pressure originated in the northern sub-basin.

MSFD Descriptors addressed
Descriptor 7 Permanent alteration of hydrological conditions

Detail contribution
Criteria 7.1 Spatial characterization of permanent alteration.

Activity performed
Monitoring of the Bari-Dubrovnik transect across the South Adriatic were performed on March 2013 (ADREX-2013) and February 2014 (ADREX-2014). Another section including the two main depressions in the Central Adriatic (Pomo Pits) were investigated. Dataset includes extended physical and biogeochemical parameters. In addition, autonomous platform (gliders, Argo and Bio-Argo floats, satellites) were deployed and/or are currently in use in order to monitor the hydrological conditions and the winter convective process in the South Adriatic at finer time/space resolution.

Expected Outcomes
The BDT is historically considered a proxy of the BiOS dynamics, since the mixing/convection in the South Adriatic integrates the thermohaline and biogeochemical variability due to the advective transport from the Ionian across the Otranto Strait. In addition, the deepest part of the south Adriatic Pit (from 800 to 1200 m depth) represents the memory of the Adriatic dense water production system, that includes the entire Adriatic Sea. Recently, two opposite winter conditions occurred in the area: in 2012, winter was very severe and generated exceptional dense waters, more than 1.030 kg/m^3 in the northern basin, recognizable from the present thermohaline characteristics of deep waters in the Pomo and South Adriatic Pits. Conversely, winter 2014 was very mild and the lack of new dense water production was particularly noticeable. We consider these events very useful in order (i) to assess the capability of the Adriatic system in transferring longitudinally anthropogenic pressure generated in the northern sub-basin; (ii) to understand the role of atmospheric forcing in interacting with the internal oceanic processes at the base of the BiOS mechanism. A case study relates the premature inversion of the Ionian circulation (from cyclonic to anticyclonic) occurred in 2012 with the exceptional dense water produced in the Adriatic. The activity performed in the frame of this task will contribute in assessing the sensitiveness of the BiOS to the climatic condition of the area.

1.3.3. Effect of dense water formation on the Adriatic biogeochemistry and ecosystem dynamics

Participants
OGS (Resp.), CNR, IOF, NIB

Rationale
The amount of nutrients advected into the Adriatic from the Ionian depends from the dynamics at the northeastern border of the Ionian Sea, the source area for the water advected through the Otranto Strait into the South Adriatic. Phytoplankton bloom timing, strength and duration were firstly ascribed to the interannual variability of open-ocean convection. Recently, it has been shown that the BiOS affects the salt and nutrient import from the Ionian to the South Adriatic, changing its buoyancy and nutrient reservoir, that can play a role in the phytoplankton dynamics of the area. To these variability patterns correspond a remarkable differentiation in phytoplankton species composition. However, the impact of the BiOS on the plankton dynamics and phenology is not trivial, since salinity and nutrient levels in South Adriatic are out-of-phase.

MSFD Descriptors addressed
Descriptor 1 Biological diversity
Descriptor 7 Permanent alteration of hydrological conditions

Detail contribution
Criteria 1.1 Species distribution
Criteria 1.2 Population size
Criteria 1.7 Ecosystem structure
Criteria 7.1 Spatial characterization of permanent alteration
Criteria 7.2 Impact of permanent hydrographical changes

Activity performed
Monitoring of the BDT across the South Adriatic were performed on March 2013 (ADREX-2013) and February 2014 (ADREX-2014). Dataset includes extended biogeochemical and biological parameters. In selected stations investigations on primary and prokariotic carbon production, and on plankton species composition were performed. In addition, autonomous platform (gliders, Argo and Bio-Argo floats, E2M3A Observatory, satellites) were deployed and/or are currently in use in order to monitor the hydrological conditions of the South Adriatic basin at finer time/space resolution.

Expected Outcomes
This activity will contribute to better understand how the variability in the intensity and occurrence of mixing/convection in the South Adriatic impact on the phytoplankton community. The availability of data provided by autonomous platforms will allow to investigate which exogenous factors drive phytoplankton dynamics, and to evaluate which species/taxa are involved, possibly identifying species assemblages characterising specific physical conditions. Novel results are expected on the impact of physical and biogeochemical forcings on the plankton community structure, with possible implications for the marine carbon cycle in the context of the climate change impact in the Mediterranean basin.

1.3.4. Effect of dense water formation on the Adriatic carbon system chemistry

Participant
CNR-ISMAR/TS (Resp.), OGS

Rationale
In the central Mediterranean region (Adriatic and Ionian Seas) dense water formation represents the main natural process able to drive CO_2 fluxes, seawater carbon chemistry changes and transfer of pressures at basin scale. Particular concern was therefore reserved to the super dense water produced in winter 2012 observed during ADREX 2014 campaign at the bottom of Pomo and South Adriatic Pits, as we expect a possible transfer of natural and anthropogenic signals from the North to the South Adriatic, and to the Ionian basins.

MSFD Descriptors addressed
Descriptor 1 Biological diversity
Descriptor 7 Permanent alteration of hydrological conditions

Detail contribution
Criteria 1.6 Habitat conditions.
Criteria 7.1 Spatial characterization of permanent alterations.
Criteria 7.2 Impact of permanent hydrographical changes.

Activity performed
Survey to gather pH_T, total alkalinity and derived carbonate system parameters data (DIC, pCO_2, carbonate and bicarbonate ion concentrations, calcite and aragonite saturation states) has been performed in February 2014 (ADREX cruise).

Expected Outcomes
We expect our studies will provide:

- a synoptic description of inorganic carbon system properties of the dense waters at basin scale (from the central Adriatic to the South Adriatic pits and the Ionian basin through the Otranto Strait);
- general description of the acidification levels in the Ionian and Adriatic seas;
- an estimate of temporal changes (if any) between present data and those collected in 2008 and in 2011;
- to understand how dense water formation (or its absence) impact on bottom waters acidification and on their calcite/aragonite saturation states;
- a better understanding of the mechanisms involved in transferring the carbonate system properties to bottom environment.

1.3.5. Effect of dense water formation on the Adriatic microbial carbon flux

Participants
CNR-IAMC (Resp.), OGS

Rationale
Previous studies have indicated that dense water formation influences the efficiency of C transfer to the trophic chain mediated by microorganisms. Open scientific questions to be addressed are: (i) how will dense water formation processes alter marine ecosystem dynamics and C cycling? (ii) will there be any feedback between altered marine trophic structure, and the efficiency of the biological pump? (iii) what is the role of enzyme activities in nutrient regeneration? Answers to these questions are crucial to improve understanding of the fundamental control mechanisms of the carbon cycle and thus to enable the prediction of the ecosystem's responses to human impacts like eutrophication and increasing atmospheric CO_2 concentration.

MSFD Descriptors addressed
Descriptor 1. Biological diversity
Descriptor 5. Human-induced eutrophication

Detail contribution
Criteria 1.6 Habitat condition.
Criteria 5.2 Direct effects of nutrient enrichment.
Criteria 5.3 Indirect effects of nutrient enrichment.

Activity performed
During ADREX-2014, waters from different depths, at selected stations in the Ionian and Adriatic Seas were sampled for the analyses of following parameters: prokaryotic abundance and biomass, rates of enzymatic activities, microbial community respiration, surface and under water scalar irradiance, chlorophyll *a* and phaeopigments concentration, viral abundance, continuous surface fluorescence, turbidity and temperature.

Expected Outcomes
An improvement of current understanding of the effects of dense shelf water cascading events on the abundance and functioning of microbial ecosystem is expected. The circulatory dynamics related to BiOS probably affects the efficiency of the biological carbon pump and the rates of carbon sequestration. So, the process of the decomposition of organic matter during its transfer through the water column to deep environments will also be addressed.

1.3.6. Effect of the BiOS mechanism on the Adriatic biodiversity

Participants
OGS (Resp.), CNR, IOF, NIB

Rationale
During the period 1961–2005, in several areas of the eastern Adriatic, changes in phyto- and zooplankton abundance and community structure, as well as in the quantitative and qualitative composition of the Adriatic ichthyofauna, have been documented and ascribed to natural and man-induced processes. Changes in the organism abundance and in the biodiversity patterns are related to, and could perhaps be partly associated with, the circulation changes in the EMed during the last 20 years and the modification of the water masses entering the South Adriatic. From the records presented in the table below, it follows that the presence of Atlantic and WMed species in the Adriatic is concomitant with the anticyclonic phase and thus with advection of AW into the Adriatic. On the other hand, records of Lessepsian organisms originating from tropical and/or temperate areas coincide with the cyclonic phase that advects EMed waters into the Adriatic, blocking the AW intrusion.

MSFD Descriptors addressed
Descriptor 1 Biological diversity
Descriptor 2 Non-indigenous species

Detail contribution
Criteria 1.1 Species distribution.
Criteria 1.2 Population size.
Criteria 1.7 Ecosystem structure.
Criteria 2.1 Abundance and state characterization of non-indigenous species.

Activity performed
Historical and more recent observations will be revisited in the light of the BiOS mechanism. We will extend this kind of analysis to the past, encompassing the entire 20th century. During ADREX-2014, special attention was dedicated to phytoplankton and mesozooplankton sampling in order to investigate the presence of particular species in concomitance with specific water masses (for example, coccolithophore Gephyrocapsa oceanica as tracer of water of Atlantic/Western Mediterranean origin).

Expected Outcomes
The results reported in the previous table suffer from the uncertainties typical of this kind of observation, and consequently they have to be taken into consideration with a certain caution. Nevertheless, they represent a key to the interpretation of the decadal natural variability in biodiversity and its effect on the local ecosystems reported in the literature during the last three decades. The results from this activity will be useful in setting the possible range of natural variability of the ecosystem, that represents a baseline for the maintaining of the good environmental state.

Date	Organism (type)	Upper layer Ionian circulation	Remarks
1982	Schedophilus medusophagus (fish)	?	Present in the WMed. Reported in the central Adriatic (Onofri, 1986).
end of 1980's	Copepod community (mesozooplankton)	reversal from cyclonic to anticyclonic	Changes of the entire copepod community in the Gulf of Trieste (Conversi et al., 2009)
1993	Desmopterus papilio (gastropode)	anticyclonic	Common in the Atlantic and found in the open South Adriatic, off Dubrovnik (Batistić et al., 2004)
1993	Pelagobia longicirrata (polychete)	anticyclonic	Common in the tropical Atlantic and found in the open South Adriatic (Batistić et al., 2004)
1995	Muggiaea atlantica (hydrozoan)	anticyclonic	Typical of the Wmed. It was reported for the first time in 1995 in the coastal southeastern (Gamulin and Krsinic, 2000), and central Adriatic (Batistić, 2007), then invaded the north Adriatic (Kršinić and Njire, 2001)
end of 1990's	Total copepod, in particular Paracalanus parvus (mesozooplankton)	reversal from anticyclonic to cyclonic	Changes in the abundance of some species (Conversi et al., 2009)
2002	Siganus rivulatus (fish)	cyclonic	Lessepsian migrator, recorded in the south Adriatic (Dulčić and Pallaoro, 2004)
2006	Fistularia commersonni (fish)	cyclonic	Lessepsian migrator, caught off the coastal waters in south Adriatic (Dulčić et al., 2007)
2006	Thysanoteuthis rhombus (cephalopode)	cyclonic	Considered a "slow swimmer" (Marčić et al., 2008), it was introduced in the North Adriatic probably from the Levantine basin
2007	Therapon teraps (fish)	cyclonic	Lessepsian migrator. Captured off Piran,, Slovenia (Lipej et al., 2008)

Table from Civitarese et al., 2010

1.3.7. North-south transfer of sediment and pollutants along the western Adriatic margin.

Participants
CNR-ISMAR/BO (Resp.), CNR-IRSA, OGS

Rationale
ADREX focuses also on the role of North Adriatic Dense Water (NAdDW) spreading along the western Adriatic margin in transferring sediments and pollutants to the deep basin. NAdDW moves southward along the Italian continental shelf, sinking in the Southern Adriatic basin through massive and intense cascading events. These phenomena control the water mass mixing, the deep ocean ventilation, the formation of complex erosive and depositional bedforms and affect the lateral export of sediments. The western Adriatic margin receives large inputs of organic matter from both terrestrial and marine sources and potentially sequesters a significant fraction of organic carbon in his seabed. The Bari Canyon represents a preferential pathway on which the sediment is transferred from the shelf into deep basin. It is necessary to increase our knowledge on the export from the coastal zone, and dispersal into the basin to assess the levels and the origins of the contamination of the deep sediments.

MSFD Descriptors addressed
Descriptor 8 Concentrations of contaminants

Detail contribution
Criteria 8.1. Concentration of contaminants measured in the relevant matrix.

Activity performed
In April 2013 we collected two gravity cores and five sediment surface samples in the South Adriatic basin. The samples were collected in the mud waves field named A, north of Gondola slide (mean water depth 550 m), in sites characterized by active sedimentation. Additional samples were collected in November 2013 (four cores and eight surficial samples in the shelf deposit from Ancona to Bari) and February 2014 (one core in the Po prodelta). The sediment samples were sectioned in sub-samples for determinations of water content, grain size composition, organic matter (Corg, N_{tot}, carbon stable isotopes), trace metals, organo-chlorine compounds, Polycyclic Aromatic Hydrocarbons, bacterial abundance, bacterial carbon production, and ommunity respiration rate. Natural radionuclides measurements (^{14}C, ^{210}Pb) will be used to calculate sediment accumulation and biomixing rates.

Expected Outcomes
Asses fluxes and inventories of contaminants in dated sediment cores of selected sites along the western Adriatic continental shelf in order to distinguish present conditions from pristine states of the basin.

1.4. LEVEX: Levantine Sea Experiment

1.4.1 Improvement of planktonic primary productivity estimate

Participants
IOLR (resp.)

Rationale
Primary productivity may be measured by in situ techniques, but also estimated by exploitation of information derived from satellite-carried optical sensors. The obvious advantage of using satellite-carried sensors is the extensive areal coverage and frequency of information acquisition, however, the indirect nature of the measurement requires parameterization and calibration of the models used for interpretation of optical measurements in terms of biological variables. It is to say that regional adaptation of successful models is a must prior reliable application, and such adaptation is necessarily based of work performed on-board boats. The existing data base on primary productivity in the pelagic waters of eastern Mediterranean is small, and is even smaller as much as coastal waters are considered. Therefore, LEVEX aims to further develop a remote-sensing methodology for accurate and reliable estimation of primary productivity in the eastern Mediterranean using optical information available from satellite-carried sensors and in-situ measurements.

MSFD Descriptors addressed
Descriptor 5 Human-induced eutrophication

Detail contribution
Criteria 5.2 Direct effects of nutrient enrichment

- Indicator 5.2.1 Chlorophyll concentration in the water column
- Indicator 5.2.2 Water transparency related to increase in suspended algae

Activity performed
Data was collected during four multi-disciplinary cruises (see table 2.4) for the following variables will be measured: (a) chlorophyll *a* at surface, (b) measure primary productivity by the well-established ^{14}C-radiotracer method, in simulator located on-board, and c) reflectance spectra and light attenuation (in two cruises). I*n situ* measured variables by a submersible probe (CTD, light, Chlorophyll a) and water collection (Chlorophyll a, phytoplankton biomass).

Expected Outcomes
Use of remote-sensed ocean color data to assess phytoplanktonic primary production and synoptic Chla distribution; Enhancing the existing data base and baseline levels on primary productivity, bacterial productivity, phytoplankton biomass in the pelagic waters of eastern Mediterranean (Levantine basin).

1.4.2 Quantification of Atmospheric contaminant fluxes and inputs into the Levantine Basin

Participants

UoC (Resp.), METU, IOLR

Rationale

Atmospheric inputs of the macro and micro nutrients to the coastal and open ocean have now been recognised as one of the major external sources. A much better observational data on the nutrient/trace metals atmospheric inputs to the Mediterranean is needed as no coordinated network of stations is operating. To address this gap existing stations operated by UoC, METU and IOLR were used for the assessment of atmospheric fluxes (nutrients and metals) in the Levantine basin and related atmospheric and aerosol-seawater interaction processes.

MSFD Descriptors addressed

Descriptor 8 Concentrations of contaminants
Descriptor 5 Human-induced eutrophication

Detail contribution

Criteria 5.2 Direct effects of nutrients enrichment

Activity performed

An aerosol sampling and analysis of archived and new samples, collected at existing stations operated by UoC (Finokalia), METU (Erdemli) and IOLR (Tel Shikmona, TS), was used for the assessment of atmospheric fluxes (nutrients and metals) and nutrient speciation. At TS analyses of nutrients in rainwater samples were performed for the years 2008 – 2011. Annual weighted mean average concentrations and fluxes were calculated. In addition, the annual dry fluxes of particulate trace elements were calculated based on the analyses of approximately 40 filters/year (2008-2011). At Finokalia, P speciation was analysed on a total of 27 rain events were collected during two years (2008-2009). Preliminary results show that the two years average percentage contribution of wet deposition DOP, CP and DRP to total dissolved P deposition was estimated at 69%, 6% and 24%, respectively. In addition, the dry deposition fluxes of P species during the dry season (April-September) in 2008-2009 were measured. At Erdemli nutrients were analysed on two-stage aerosol samples and their relative fluxes were calculated. In addition, atmospheric versus riverine nutrient input were performed by METU for the northern Levantine basin.

Expected Outcomes

Assess the magnitude of atmospheric dry and wet nutrient fluxes to the Levantine basin, and their species composition.

1.4.3 Monitoring biodiversity by barcoding

Participants
IOLR (resp.), METU

Rationale
The Levantine Sea is one of the most oligotrophic areas of the Mediterranean and at the same time is the primary receptor of non-indigenous species (NIS) through the Suez canal (Lessepsian migrators). There is an urgent need for a reliable database of marine organisms in the Levantine, as a taxonomy tool for aquatic biodiversity. Moreover, such a database and the supporting methodologies should allow the Levant researchers to develop a fast species identification system, improving the capacity to identify, monitor, and manage aquatic biodiversity, with profound societal and economic benefits and for better governance of the Levant sites. It also raises the possibility of identifying the vectors of zoonotic diseases in the marine habitats, as well as the disease organisms themselves.

MSFD Descriptors addressed
Descriptor 1 Biological diversity
Descriptor 2 Non-indigenous species

Detail contribution
Criteria 2.1 Abundance and characterisation of non-indegenous species

Activity performed
Several species were collected from the Levantine deep and coastal areas and processed as follow: collection with depicted coordinates of the sampling, traditional identification when feasible, sampling of tissue for DNA extraction, digital photographing, PCR to amplify the barcode DNA fragments and DNA sequencing. When possible, at least 5 specimens are taken from each species to elucidate polymorphism. At present several barcode species, of around 360 were run, divided into:
Bivalvia - ~20, Algae – 30, Annelida – 23, Tunicates – 30, Bryozoa – 10, Cnidaria – 4, Crustacea - 39, Echinodermata – 3, Gastropdoa – 10, Sponges – 34, Fishes - >150.

Expected Outcomes
Establishment of a barcoding database of the eastern Mediterranean. Developing a modern generic taxonomic tool, the “Barcoding of life.”, based on a species-specific DNA sequence database to contain the majority of Levantine basin species and enable fast and accurate identification of invasive species. New monitoring tool for “ensuring the long-term abundance of the species”.

1.4.4 Estimation of sedimentation rates. Assessment of contaminant level trends in sediments

Participants
ENEA (Resp.), IOLR

Rationale
The reconstruction of the pattern of anthropogenic pressures in the Levantine basin during the last century can be performed through the analysis of sediment cores. To assess the potential accumulation of pollutants to the seabed in decadal scale sedimentation rates should be known, while almost no data exists for the Levantine basin.

MSFD Descriptors addressed
Descriptor 8 Concentrations of contaminants

Detail contribution
Criteria 8.1 Concentration of contaminants in sediment

Activity performed
Five sediment cores were sampled along two transects, one at the south and second at the north, representing both, different distances from land-base sources of pollution (East-West component) and from the Nile delta (South-North component). The approximately 25 cm long cores were sub-sampled with Perspex tubes (7.5 cm diameter) from an Ocean Instruments model BX 700 Al Box corer (surface area of 0.062 m2 and effective penetration of 40 cm) and were sliced on board in layers 0.5 – 1 cm thick. The samples were freeze-dried, homogenized and analyzed by gamma spectrometry. Radiometric analyses are performed by Gamma spectrometry. All samples are stored for at least 22 days, thus insuring that the short-lived daughter products of 222Rn have grown into secular equilibrium with 226Ra. Each sealed sample is counted for 2 - 3 days on HPGe detectors, in a carbon fibre window.
Preliminary results of the measurements of 210Pbxs and 137Cs were already obtained.

Expected Outcomes
Assessment of the sedimentation and mixing rates at the continental slope and deep Levantine basin.

1.5. AEGEX: Aegean Sea Experiment

1.5.1 Improvement of satellite products for chlorophyll-a and primary production

Participants
HCMR (Resp.)

Rationale
AEGEX aims at covering data gaps and better understanding of major processes in the North and South Aegean Sea. Marine optics data and associated biogeochemical data will be used to address the problem of poor performance of satellite estimates of chl-α and primary productivity.

MSFD Descriptors
Descriptor 1 Biological diversity
Descriptor 5 Human induced eutrophication

Detail contribution
Criteria 1.6 Habitat condition
- Indicator 1.6.3 Physical, hydrological and chemical conditions

Criteria 5.2 Direct effects of nutrient enrichment
- Indicator 5.2.1 Chlorophyll concentration in the water column
- Indicator 5.2.2 Water transparency related to increase in suspended algae

The marine optics work could be beneficial on a number of levels because when combined with some of the other biogeochemical measurements it could aid our understanding of a) phytoplankton abundance, distribution and seasonal variability in the oligotrophic Aegean/Eastern Mediterranean; b) could contribute to an increase in accuracy of remote sensing products for the area through ocean colour validation and algorithm development work using the AEGEX data; c) could thus improve the monitoring of phytoplankton, the marine ecosystems, biogeochemical modelling and historical trend analysis for the Aegean which is in direct support of the MSFD implementation.

Activity performed
We conducted the South and North Aegean Sea Experiments in May and October 2013. Previous studies conducted in the region during past decades provide a good background on major biogeochemical processes, however outlining several gaps in data and knowledge. As part of these gaps is associated with the detailed knowledge of optical properties of the Aegean Sea, a targeted work was undertaken and a suite of optical sensors was used to measure radiance, irradiance, absorption, fluorescence and other inherent optical properties of seawater, for the first time in the region.
A total of 7 stations were visited in a N-S section in the S. Aegean, along a coastal-offshore transect north of the island of Crete. CTD casts and optical measurements were performed in all 7 stations while biochemical sampling and primary production experiments were performed in part of the stations (4 and 3, respectively). Similarly, a total of 14 stations were occupied in a N-S transect north of Limnos Isl. passing over the deepest sector of the north Aegean trough. CTD/optics casts, water samples were obtained, and in situ primary production experiments were conducted.

Expected Outcomes
Contribute to the improvement of satellite-derived chl-α and primary productivity products in the oligotrophic Eastern Mediterranean.

1.5.2 Understanding the combined effects of dense water formation and cascading in deep Eastern Mediterranean basins

Participants
HCMR (Resp.)

Rationale
The process of dense water formation on the continental shelf and the subsequent cascading into deep basins has been identified as a major process controlling the biogeochemistry of the Mediterranean Sea. Major changes in the thermohaline circulation of the Eastern Mediterranean have been recorded in the 1980s (EMT). The hydrographical conditions are severely affected by the Black Sea Water inflow and its variability. Dense water formation and cascading from the Aegean Sea is a major process regulating biogeochemical cycles. As continuous monitoring of such processes in not in place, we seek to bring together existing and new data to better understand the evolution of this process since the 1980s.

MSFD Descriptors
Descriptor 7 Alteration of hydrographical conditions

Detail contribution
Criteria 7.1 Spatial characterization of permanent alterations

Activity performed
Cruises in the South and North Aegean Sea, associated with long-term monitoring stations of the Poseidon network.

Expected Outcomes
Better understand hydrological processes and their impact of the biogeochemistry of the Eastern Mediterranean Sea.

1.5.3 Sediment record of contaminants in the Eastern Mediterranean

Participants
HCMR (resp.)

Rationale
Sediments are well-known repositories of anthropogenic substances, both organic and inorganic. The E. Mediterranean Sea, and in particular the North Aegean Sea, has been influenced by human activities during past decades. The region is affected by pollutant inputs from intense merchant shipping/oil transportation, atmospheric inputs as well as considerable amounts of freshwater/sediment inputs from a number of rivers discharging various organic and inorganic contaminants. Exchange flows with the Sea of Marmara through the Dardanelles Straits which acts as a conduit between the Aegean Sea and the Black Sea along with dense water formation and cascading are major processes controlling their vertical/ lateral export and final accumulation in sediments. We aim at recording present and past contaminant levels and trends addressing MSFD Descriptor 8.

MSFD Descriptors
Descriptor 8 Concentrations of contaminants

Detail contribution
Criteria 8.1 Concentration of contaminants measured in suspended particles and sediment).

Activity performed
During the AEGEX group oceanographic cruise conducted on October 2013 in the North Aegean Sea, undisturbed sediment samples were collected at 8 stations of the study area at a sampling step of 1cm penetrating to a depth of 5 cm. Also, high volume filtering (~20 l water samples) was conducted at 7 stations of the study area.

Expected Outcomes
Investigate distribution patterns of particle-associated organic pollutants (petroleum hydrocarbons) in order to assess their occurrence and major sources along with factors and water column processes controlling their vertical/ lateral export and accumulation in sediments. The study of organic (petroleum hydrocarbons, organochloride compounds) and inorganic (metals) pollutants in sediments, in order to report present and past contaminant levels, evaluate the type and degree of pollution and relate contaminant levels to biological effects, and to infer information regarding the occurrence, sources, preservation and major processes controlling their distribution over the past few decades.

1.5.4 Benthic community conditions

Participants
HCMR (resp.)

Rationale
Through the AEGEX experiment benthic macrofauna species composition and abundance, diversity and species richness, ratios of opportunistic-sensitive species, biomass size structure, biological traits analysis (BTA), feeding groups and habitat specific species will be analyzed.

MSFD Descriptors
Descriptor 6 Sea floor integrity

Detail contribution
Criteria 6.2 Condition of benthic community

- 6.2.1 Presence of particularly sensitive and/or tolerant species
- 6.2.2: Indices assessing species diversity and richness and the proportion of opportunistic to sensitive species
- 6.2.3: Proportion of biomass or the number of individuals above a specified length/size
- 6.2.4 Parameters describing the size spectrum of benthic communities

Specifically indicators 6.2.1 and 6.2.2 will be assessed through the application of biotic-sensitivity indices (Bentix index) and diversity indices (Shannon and Species richness). Indicators 6.2.3. and 6.2.4. will be assessed through the application of size distribution index (ISD).
The condition of benthic communities (status) is a criterion of the Sea-floor integrity descriptor however its indicators also respond to some criteria of the Biodiversity Descriptor concerning the benthic communities such as: species distribution (1.1), population size (1.2) and population condition (1.3). Nevertheless, it is recommended that different elements-criteria should be split among overlapping Descriptors and the status of the benthic communities adhere to D6 while the value of specific species to D1.

Activity performed
Surface sediment sampling in the North Aegean Sea (5 stations). Similar experiment to be conducted in the South Aegean Sea.

Expected Outcomes
Evaluation and Integration of all four indicators will assess the criterion 6.2. of benthic community condition under the Descriptors of Sea floor Integrity.

1.6. MAREX: Turkish Straits System – Marmara Sea Experiment

1.6.1 Human-induced eutrophication on the Marmara Sea

Participants
METU (resp.), IU-IMSM, IU-Faculty of Fisheries

Rationale
The two-layer flow regime in the Turkish Straits System (TSS, including Istanbul (Bosphorus), Canakkale (Dardanelles) and Marmara Sea) allows exchanges of brackish and salty waters between the SW Black Sea and Aegean Sea with their associated chemical properties. Naturally the Marmara upper layer ecosystem of about 15-20m is dominated by the brackish waters of Black Sea. The salty Mediterranean waters occupy the Marmara the Marmara deep basin. The sharp pycnocline confines wind-induced mixing to the Marmara upper layer, which significantly restricts ventilation in the salty lower layer. No decadal change has been reported on the fresh water input to the Black Sea in recent decades and thus in the water fluxes in the Bosphorus. In recent decades, however, the increased nutrient loads of the major river (mainly Danube) discharges to the Black Sea has lead to introduce more nutrient inputs to the Marmara Sea via the Bosphorus surface flow, leading to drastic changes in both the chemical fluxes in TSS and the Marmara ecosystem. The first estimates of the nutrient and organic matter exchange fluxes between these adjacent seas were carried out in the 1990's. The increased inputs and consequent POM production in the Marmara have limited algal production to the upper layer (10-15 m) and enhanced POM export to the Marmara sub halocline waters, resulting in the formation of suboxic conditions (<50 μM) and lower nitrate/phosphate (N/P: 8-10) molar ratios than the Redfield ratio of 16 in the salty lower layer.

This study aims to evaluate long-term data sets of nutrients, Organic Carbon (POC, TOC) obtained seasonally by METU-IMS (Erdemli) and IU-IMSM (Istanbul) researchers at the Bosporus exits from the late 1880's to 2013 and to assess the seasonal/annual chemical exchanges between the SW Black Sea and Marmara. The MAREX conducted in June 2013 also aims to further understand major processes dominating the processes in TSS, and pressures and impacts of human-induced eutrophication on the Marmara two-layer ecosystem. Specifically, in addition to chemical parameters to estimate fluxes in the straits, eutrophication indicators, contaminants in the surface sediments and benthic fauna at selected sites were sampled to compare with the previous data sets.

MSFD Descriptors Addressed
Descriptor 1 Biological diversity
Descriptor 2 Non-Indigenous species introduced by human
Descriptor 5 Human-induced Eutrophication levels in the Marmara Sea Descriptor 6: Sea-floor integrity: benthic fauna at selected locations
Descriptor 8 Concentration of contaminants:

Detail contribution
Criteria 1.1 Species distribution: distributional range and area covered by benthic species
Criteria 1.2 Population size: population abundance and/or biomass
- Indicator 2.1 Abundance and state characterisation of non-indigenous species, in particular invasive species

Criteria 5.1,2. Pressures (fluxes); state (nutrients and DIN/P/Si ratios in the upper layer, biomass); direct effects (losses in biodiversity, ecosystem degradation, harmful

Criteria 6.2 Condition of benthic community

- Multi-metric indexes assessing benthic community condition and functionally, such as species diversity and richness, proportion of opportunistic to sensitive species
- Criteria 8.1 Concentration of contaminants; heavy mtals and PAHs in surface sediments

Activity performed

METU-IMS team carried out a cruise in June 2013 in the Sea of Marmara, Istanbul and Canakkale Straits to document the physical and bio-chemical processes controlling the two-layer ecosystem and nutrient fluxes during the spring bloom period. For this goal, more than 90 stations were visited in the TSS. *In situ* CTD profiles were obtained, nutrient and oxygen data were determined in the water column to understand surface flow pattern of the less saline Black Sea surface waters, spatial and vertical distributions over the basin and provide data for exchange fluxes in the Straits. Phyto- and zoo-plankton samples were taken for analysis. Primary production and chemoautotrophic productions were measured at 3 stations to assess the effects of the Black Sea inputs and land-based discharges on the Marmara ecosystem. Moreover, chemical and biological data have been collected monthly since August 2012 in the Bosphorus surface layer to assess temporal variations in the nutrient concentrations and biomass abundance of Black Sea inflow feeding the Marmara upper layer ecosystem. Also, Aerosol sampling was performed during the cruise in 2013 (6 samples were collected).

Expected Outcomes

Annual/seasonal chemical exchange fluxes between the Marmara and Black Seas through the Bosphorus (Istanbul) Strait has been calculated based long-term data sets of nutrients, Organic Carbon (POC, TOC) obtained seasonally by the METU-IMS (Erdemli) and IU-IMSM (Istanbul) at the Bosporus exits from the late 1980's to 2013.
These seasonal fluxes are the essential inputs for modeling studies in these seas and assessing sustainable GES targets.
Impacts of human induced eutrophication will be assessed using new and old data sets of nutrients, Chl-a and oxygen deficiency in the bottom waters. Stilling areas of non-indigenous species will be derived from the observations and general surface circulation patterns over the Marmara basin.

1.7. BSEX: Black Sea Experiment

1.7.1 Eutrophication and its implications on the ecosystem/food web current state

Participants
METU (resp.), SIO-RAS, IO-BAS, IBSS, MHI

Rationale
Starting from the early 1970s, the entire Black Sea basin was heavily enriched by nutrients as evident by an increase of nitrate concentration in the chemocline layer from its background values of 2-3 mmol m^{-3} to 6-9 mmol m^{-3}. The impact of eutrophication was also clearly evident in an order of magnitude increase in summer phytoplankton biomass within the northwestern shelf and a five-fold increase in the inner basin. The deterioration of the food web by eutrophication as well as overfishing promoted the appearance of opportunistic and gelatinous species as dominant factors within the food web which were able to share rich food resources with planktivorous fish. Today there is a clear need to understand the affect of changes in riverine and atmospheric nutrients inputs on the ecosystem.

MSFD Descriptors
Descriptor 5 Human induced eutrophication

Detail contribution
Criteria 5.1 Nutrients level
- Indicator 5.1.1 Nutrients concentration in the water column
- Indicator 5.1.2 Nutrient ratios

Criteria 5.2 Direct effects of nutrient enrichment
- Indicator 5.2.1 Chlorophyll concentration in the water column)
- Indicator 5.2.2 Water transparency related to increase in suspended algae
- Indicator 5.2.4 Species shift in floristic composition such as diatom to flagellate ratio, benthic to pelagic shifts

Criteria 5.3 Indirect effects of nutrient enrichment
- Indicator 5.3.2 Dissolved oxygen, i.e. changes due to increased organic matter decomposition and size of the area concerned

Activity performed
Cruises were carried out during the summer of 2013 to measure the level of nutrients and oxygen and the ratios (silica, nitrogen and phosphorus) and distribution of phytoplankton, zooplankton and impact of gelatinous zooplankton is observed in the western Black Sea, south western Black Sea, the north-eastern Black Sea and the Sevastopol Bay.

Expected Outcomes
We expect to update the understanding on the nutrient levels more importantly the ratios of different nutrients and their impact on the phytoplankton, zooplankton, jellyfish concentration and distribution. Also to update the understanding on the processes controlling the main chemical features in the oxic/anoxic transition zone.

1.7.2 Temporal levels of concentration of invasive ctenophores and their impact on native zooplankton and especially on fish

Participants
SIO-RAS (resp.), METU, IO-BAS, IBSS.

Rationale
The deterioration of the food web by eutrophication and overfishing promoted the appearance of opportunistic and gelatinous species as dominant factors within the food web which were able to share rich food resources with planktivorous fish. Among these species, the jellyfish medusae Aurelia aurita was the most dominant one during the 1980s and the ctenophore *Mnemiopsis leidyi* was dominant after the end of 1980 following its accidental introduction into the Black Sea. It is of paramount importance to update temporal levels in the concentration of invasive ctenophores and their impact on native zooplankton and especially on fish.

MSFD Descriptors
Descriptor 2 Non-indegenous species

Detail contribution
Descriptor 2.1 Abundance and state characterisation of non-indigenous species

- Indicator 2.1.1 Trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non-indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species
- Indicator 2.2 Environmental impact of invasive non-indigenous species

Activity performed
Cruises were carried out during the summer of 2013 to measure the level biomass and distribution of gelatinous macroplankton in the western Black Sea, south western Black Sea, the north-eastern Black Sea and the Sevastopol Bay.
To answer the question on the potential mechanisms of effects of excretion and mucus release of Mnemiopsis leidyi and Beroe ovata in the Black Sea such as on low trophic levels of ecosystems– microplankton (bacteria, ciliates, heterotrophic flagellates), phytoplankton, mesozooplankton and hydrochemical parameters of environment. These sets of experiments are performed in aquariums and mesocosms in the coastal areas of the Black Sea.

Expected Outcomes
Updated information on the trends in abundance, temporal occurrence and spatial distribution of gelatinous macroplankton. Better understanding of the current impact level of gelatinous ctenophores on the other levels of the food-web.

1.7.3 Anchovy Spawning areas

Participants
METU (Resp.), SIO-RAS IO-BAS, IBSS

Rationale
In the Back Sea, still it is not clear where the most abundant fish, anchovy, spawn.

MSFD Descriptors
Descriptor 3 Populations of commercially explited fish and shellfish

Detail contribution
Descriptor 3.2 Reproductive capacity of the stock

- Indicator 3.2.1 Spawning Stock Biomass
- Indicator 3.2.2 Biomass indices

Activity performed
In the summer 2013 expedition the distribution of local anchovy population, egg and larvae are investigated at the southern Black Sea. Abundance of small pelagic fish sprat (*Sprattus sprattus*) and anchovy (*Engraulis encrasicholus*) is studied as components of the pelagic food web at the Bulgarian coast. Ichtyoplanton abundance is measured at the north-eastern coat of the Black Sea.

Expected Outcomes
Clarification of modern spawning areas by sampling eggs and larvae of anchovy during the peak spawning seasons.

2. Summary of the field cruises

2.1. ALBOREX: Alboran Sea – Strait of Gibraltar Experiment

Cruise	Vessel	Date	Site	Responsible	Objectives
GIFT0212	R/V Garcia del Cid	27-28 February 2012	Strait of Gibraltar	CSIC	Gibraltar Fixed Time Series sampling
GIFT0612	R/V Sarmiento de Gamboa	8 June 2012	Strait of Gibraltar	CSIC	Mooring line recovery
INGRES3-5 / STOCA 201208	R/V Coornide de Savedra	6 August 2012	Strait of Gibraltar	CSIC	Mooring line deployment
INGRES3-6 / STOCA 201210	R/V Ramon Margaleff	29 October 2012	Strait of Gibraltar	CSIC	Mooring line recovery and deployment
FICARAM	R/V Hespérides	19-20 May 2013	Strait of Gibraltar	CSIC	Gibraltar Fixed Time Series sampling
INGRES3-8/STOCA 2013	R/V Angeles Alvariño	6-8 June 2013	Strait of Gibraltar	CSIC	Mooring line recovery and deployment
INGRES39/STOCA 201309	R/V Angeles Alvariño	26 Sep, 2 Oct 2013	Strait of Gibraltar	CSIC	Mooring line recovery and deployment

2.2. LIONEX: Western Mediterranean Sea Experiment - Gulf of Lions

Cruise	Vessel	Date	Site	Responsible	Objectives
DEWEX1	R/V Suroit	1-22 February 2013	Ligurian Sea, Gulf of Lions	CNRS	Effects of deep water formation processes on basin hydrology and pelagic ecosystems
DEWEX2	R/V Suroit	4-26 February 2013	Ligurian Sea, Gulf of Lions	CNRS	Effects of deep water formation processes on basin hydrology and pelagic ecosystems
CAP DE CREUS 0612	R/V Lluerna	27 June 2012	Gulf of Lions	UB	Recovery and re-deployment of mooring line (Cap de Creus Canyon station)
DOSMARES-MED-3	R/V Garcia Del Cid	5-8 October 2012	Gulf of Lions	UB / CSIC	Deployment of mooring line (MINORCA station)
CAP DE CREUS 1212	R/V Lluerna	19 December 2012	Gulf of Lions	UB	Recovery and re-deployment of mooring line (Cap de Creus Canyon station)
CAP DE CREUS 0613	R/V Lluerna	27 June 2013	Gulf of Lions	UB	Recovery of mooring line (Cap de Creus Canyon station)
FOFA-2	R/V Garcia del Cid	27-29 July 2012	Northern Catalan continental rise	CSIC-IEO	Mooring lines recovery

MINORCA RECOVERY	R/V Europe	October-November 2013	Gulf of Lions	UB	Recovery of mooring line (MINORCA station)
CAP DE CREUS 1113	R/V Lluerna	October-November 2013	Gulf of Lions	UB	Recovery and re-deployment of mooring line (Cap de Creus Canyon station)

2.3. ADREX: Adriatic and Ionian Seas Experiment

Cruise	Vessel	Date	Site	Responsible	Objectives
ADREX2013 MedGES	R/V OGS-Explora	21-26 March 2013	Adriatic	OGS	Pressure of BiOS on the biogeochemistry and biology of the South Adriatic
ADREX-2014	R/V OGS-Explora	5-21 Feb. 2014	Adriatic, Ionian	OGS	Natural and anthropogenic pressure on the hydrology, biogeochemistry and biology of the Adriatic and Ionian Seas

2.4. LEVEX: Levantine Sea Experiment

Cruise	Vessel	Date	Site	Responsible	Objectives
HAIFA SECTION	R/V Shikmona	28-29 October 2012	Levantine basin	IOLR in collaboration with ENEA	Physical and chemical characterization of the water column; Surface water reflectance; Shipboard aerosol sample collection
CYBO	R/V Shikmona	30-31 October 2012	Levantine basin	IOLR OC-UCY	Surface water reflectance; Shipboard aerosol sample collection
BSGAS02	R/V Shikmona	June-July 2013	Levantine basin	IOLR in collaboration with ENEA	Seabed contamination and radionuclides/sedimentation rates in the open sea

2.5. AEGEX: Aegean Sea Experiment

Cruise	Vessel	Date	Site	Responsible	Objectives
AEGEX1	R/V PHYLIA	May 2013	South Aegean	HCMR	Light properties/primary productivity and remote sensing Effects of deep water formation processes on basin hydrology and pelagic

					ecosystems Transfer of anthropogenic signals/contaminants
AEGEX2	R/V AEGAEO	October 2013	North Aegean	HCMR	Light properties/primary productivity and remote sensing Effects of deep water formation processes on basin hydrology and pelagic ecosystems Transfer of anthropogenic signals/contaminants

2.6. MAREX: Turkish Straits System – Marmara Sea Experiment

Cruise	Vessel	Date	Site	Responsible	Objectives
IMS-METU-2013_TSS	R/V Bilim	17-25 June 2013	Sea of Marmara, Istanbul, and Canakkale Straits	METU	Study of pressures and impacts on the Marmara ecosystem and major processes dominating the two-layer ecosystem in the TSS

2.7. BSEX: Black Sea Experiment

Cruise	Vessel	Date	Site	Responsible	Objectives
IMS-METU-2013_BSEX	R/V Bilim	July 2013	SW Black Sea	METU	Study the level of eutrophication and distribution of phytoplankton, zooplankton, anchovy eggs and larvae and impact of gelatinous zooplankton.
IO-BAS	R/V Akademik	summer-autumn 2013 (5 cruises – June, July, August, September, November)	NW Black Sea Varna Bay across the shelf to the open sea	IO-BAS	Functioning of lowe food web (phyto-zooplankton) Linked with WP2
IBSS	R/V Professor Vodyanitsky	May – June 2013	Crimea and NW Black Sea	IBSS	Impact of gelatinous zooplankton on mesozooplankton
IBSS	MB Vyazemsky	January – December 2013	Sevastopol Bay and adjacent shelf	IBSS	Impact of ctenophore Mnemiopsis leidyi on zooplankton commubity