



ORAL PRESENTATIONS



CLIMATE CHANGE



SEAWATER WARMING AT THE NORTHERN REACH FOR SOUTHERN SPECIES: APPRAISAL, MONITORING AND NEW RECORDS IN THE GULF OF GENOA

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One of the predicted effects of global warming is the poleward range expansion of plant and animal species, both on land and in the sea. In the world ocean, evidence of this phenomenon is accumulating especially for warm-temperate areas: major examples are known from California, Australia, the NE Atlantic, and the Mediterranean. In the Mediterranean Sea, in particular, seawater warming has even more dramatic effects, as it offers further scope to the spread of tropical species coming from the Red Sea through the Suez Canal (a man-made seaway) or from the Atlantic through the Straits of Gibraltar (a natural seaway). The concurrent temperature increase and abundance of tropical species is leading to the so-called 'tropicalisation' of the Mediterranean Sea, which is particularly obvious in the south-eastern sectors of the basin. At the same time, the colder north-western sectors of the basin have been said to undergo a process of 'meridionalisation', that is the arrival of native warm-water species previously restricted to the southern sectors. The Gulf of Genoa (Ligurian Sea) is the north-western reach for southern species of whatever origin in the Mediterranean. The relative occurrences of both tropical aliens and warm-water natives has been monitored between 2009 and 2015 in shallow (0 to a few metres depth) rocky reefs at Genoa, and compared with the trend in air and sea surface temperatures. A total of 19 southern species (10 natives and 9 aliens) was found. While temperature has kept on increasing for the whole period, with 2014 and 2015 being the warmest years since at least 1950, the number of native warm-water species increased linearly, that of tropical alien species increased exponentially. Among the alien species, the SW Atlantic sponge *Paraleucilla magna*, the Red Sea polychaete *Branchiomma luctuosum*, and the amphi-American and amphi-Atlantic crab *Percnon gibbesi* are new records for the Ligurian Sea, whereas a juvenile of the Indo-Pacific fish *Fistularia commersonii* has been found for the first time, suggesting the establishment of the species in the area.



REGIONAL CLIMATE AND PATTERNS OF PHYTOPLANKTON SUCCESSION IN THE OPEN BLACK SEA

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According to reanalysis model (NOAA) the winter sea air temperature (SAT) in the central areas of the western and eastern cyclonic gyres in the Black Sea showed an increase during the last 60 years. Simultaneously, the frequency of cold winters with the February SAT less than the multi-annual mean decreased. The same tendency was observed in the sea surface temperature during the last 35 years. Observations of satellite derived chlorophyll a (Chl) over the last 18 years showed a different pattern of the winter-spring phytoplankton dynamics. The classical spring bloom was observed only after the cold winters, whereas after the regular winters the maximum Chl occurred in December with the following gradual decrease to summer. Field measurements of nutrient concentration during several years showed that due to disproportion in nutritional elements in the upward flow to euphotic zone during winter, the inorganic nitrogen (N) exhausted primarily during the winter-spring proliferation of phytoplankton. As a result of that, after winters the relatively high concentration of inorganic phosphorus (P) exists in the photic zone. The highest P remained after the coldest winters. At the same time, after coldest winters the N:P ratio was as low as 2, whereas after regular winters it varied from 5 to 36. This nutritional disproportion and low N occurred after cold winters are favorable for coccolithophores which regular annual maximum observed in May-June. Dynamics of concentration of particular inorganic carbon, which is good tracer of coccolithophores, derived from satellite images showed that in cold and regular winters the pattern of the bloom dynamics is different. Intensive bloom of coccolithophores followed only cold winters. Thus, the intense winter convection defines the certain pattern of seasonal succession with the pronounced spring bloom in March, subsequent low Chl in April and bloom of coccolithophores in May-June. With the warming of regional climate and decrease in frequency of the cold winters such case occurred more and more rarely. Further warming might lead to total disappearance of the cold winters and consequently the spring blooms, which can affect the other trophic levels of the ecosystem.



SEA TEMPERATURE RISE AND PHYTOPLANKTON COMPOSITION (1987-2013) IN THE SYLT-RØMØ BIGHT, NORTH SEA; GERMANY

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Sea surface temperature in the Sylt Rømø Bight (SRB) shows an exceptional high annual rise of 0,03°C over the last half century. Since 1987 microplankton composition (>700 species) in the SRB was monitored on a weekly basis (ca. 1300 samples) within the semi-quantitative SYLT ROADS time series. The plankton data set is accompanied by a full set of hydrochemical parameters.

Based on this enormous amount of data the paper aims at the description of the overall behavior of important diatom, dinoflagellate as well as prymnesiophyte members of the planktonic community during this time of environmental change.



THE EVOLUTIONARY CHALLENGE OF RED CORAL FACING CLIMATE CHANGE: INSIGHTS FROM GENOMIC AND TRANSCRIPTOMIC DATA

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Mediterranean octocorals have been impacted by mortality events linked with thermal anomalies. This raises the question of the adaptation of these organisms in a context of global warming. The observation of differential responses to thermal stress between species and populations raises the question of the evolution of thermotolerance. We choose to study this in the red coral *Corallium rubrum* with a comparative approach between populations experiencing different thermal regimes in the NW Mediterranean (different depths and regions). This species has been impacted by mortality events and previous studies had demonstrated contrasted thermotolerance levels between populations living at different depths on the basis of necrosis levels, polyp activities or expression of candidate genes. Here we used an integrative approach to better understand the origin of these differences in adaptive abilities. Using a population genomic approach (RAD-sequencing) we tested the occurrence of genetic x environment associations which would correspond to adaptation to these thermal habitats. The results confirm the strong genetic structure of this species and populations. We identified several loci potentially linked to local adaptation. This should have important consequences on its evolution at the metapopulation level. We also analyze the transcriptomic response of red coral to thermal stress in experimental conditions with a comparison between colonies from different depths. The obtained results will be useful to better understand the physiological mechanisms underlying the stress response of this species. The integration of genomic and transcriptomic data will be useful to understand the evolutionary drivers of the response to thermal stress and the adaptive potential of this species in a climate change context.



IT'S GETTING HOT IN HERE! ARE HEATWAVES A DRIVER OF CHANGE IN INTERTIDAL MUDFLAT COMMUNITIES?

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The frequency and intensity of extreme climate events are increasing as a result of global climate change, however marine climate change experimental studies have largely assessed gradual sea warming and ocean acidification impacts on marine organisms and not impacts of extreme events. This study aims to fill the gap in knowledge on the impacts of heatwaves on marine communities, using intertidal mudflats as a study system. Intertidal mudflats are protected in Europe and the associated macroinvertebrate communities are a vital component of the coastal system. Mudflat habitats are already characterized by vast fluctuations in temperature associated with tides, time of day, and season. While temperature refuge may be found by some macroinvertebrates via burrowing into the sediment, locally collected field temperature data indicate that temperature variation is quite pronounced even in the upper few centimeters of the sediment. This has implications for the vulnerability of mudflat macroinvertebrates, particularly of surface dwelling and shallow burrowers, to extreme heat events during periods of low tide emersion. Summer heatwave events were simulated in an outdoor mesocosm system to investigate the effects on the survival and physiology of two ecologically and commercially valuable species, *Alitta virens* (king ragworm) and *Cerastoderma edule* (the common cockle). Measures of physiological condition included the condition index, measured for *C. edule*, and an analysis of total energy reserves (total carbohydrates, proteins, and lipids) for both species. Additionally, whole community samples were subjected to a simulated heatwave event. Community composition in heated and control samples was compared to identify heatwave 'winners' and 'losers' and the functional traits they exhibit, which has implications for ecosystem functioning. An assessment of the success of this novel system for simulating heatwave events in intertidal systems will be made along with a presentation of the physiological condition and community composition results from the single species and community trials, respectively.



SIGNS OF POPULATION EXPLOSION IN THE BALTIC CLAM *MACOMA BALTHICA* FROM NORTH-WESTERN WHITE SEA

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Populations of boreal marine invertebrates and fishes in the subarctic seas, i.e. northern part of their distribution ranges, often demonstrate lower growth rates and recruitment in opposite to populations from temperate latitudes. *Macoma balthica* is one of dominant species in the White Sea soft-bottom intertidal communities. This study examined the changes in abundance, individual growth rates and shell shape characteristics of *M. balthica* from 1992 till 2015 in NW White Sea, the Kandalaksha bay. Mean density of adult individuals increased in 1998-99 from 350 to more than 4000 ind.*m⁻², and later remained more than 5 times higher as compared to pre-1998 values. This change matches the recent dramatic warming of the Arctic. We found strong dissimilarity between the individual growth rates of *Macoma* during cold (1990-1999) and warm (2000-2015) periods. During last warm period, individuals grew faster in first two years after recruitment, but slowly in all subsequent years (2-way ANOVA with factors “growth rate at age”: F=5.36, p=0.02 and “period”: F=8.16, p=0.005). Cold-period mollusks also had significantly flattened shells, a characteristic usually being interpreted as adaptive to fast burrowing performance during low tides. Patterns of long-term variability of recruitment and growth rates in *Macoma* are strikingly similar to those in Atlantic cod *Gadus morhua* and other boreal marine invertebrates and fishes (Pörtner et al., 2001). While North Sea populations of this species complex suffer from a warming climate (Beukema et al., 2009), subarctic White Sea populations, living at conditions closer to lower temperature and salinity tolerance limits, can benefit from raised temperatures. Finally, White Sea is inhabited by a hybrid “swarm” between Atlantic *M. balthica rubra* and Pacific *M. b. balthica*. While no direct evidence for a hybrid advantage in *Macoma* has been yet presented so far (Strelkov et al., 2007), hybrid taxa were earlier suggested to be effective colonizers of marginal habitats. The study was partly supported by the grant 16-34-00682 provided by RFBR.



ASSESSMENT OF CLIMATE CHANGE IMPACT ON SIZE STRUCTURE OF BENTHIC COMMUNITIES

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Body size is a fundamental biological unit that is closely coupled to key ecological properties and processes. Decline in organisms' body-size has been recently predicted to be "the third universal response to global warming" (alongside changes in phenology and distribution of species) in both aquatic and terrestrial systems. Some results from pelagic studies (of zooplankton and ichthiofauna) confirm that hypothesis. Increasing temperature results in higher abundance of smaller organisms, associated with warmer water masses or in higher proportion of juveniles vs. adults. As the climate changes the most significantly at the polar regions we aimed to present the first assessment of Benthic Biomass Size Spectra in both Arctic and lower latitude/warmer locations and determine possible future effects of global warming on arctic benthic ecosystems. The study was conducted in 6 Norwegian fiords representing a wide geographical range and different temperature regimes - from 60°N up to 80°N (Raunefjorden, Ballsfjorden, Ullsfjorden, Hornsund fiord, Kongsfjorden and Rijpfjorden). We hypothesize that the decreasing temperature along the latitudinal gradient is reflected in the organism size, here analyzed at the community level. At each location we collected three macrobenthic samples using van Veen grab, acquired hydrological settings and collected sediments for geochemical analyses (grain size, organic matter descriptors). All macrobenthic organisms were identified and measured using microscope-based Image Analyses System. Using volumetric formulas we calculated the biovolume of each organism. For each location we plotted the Abundance Spectra and Normalized Biomass Size Spectra. Individual biomass values were used to estimate the secondary production. The variability in size structures and functioning (production) of the studied communities were related to the environmental settings. The results are used to predict the possible climate warming related environmental changes on the benthic communities in Arctic coastal waters. Preliminary we conclude that direct impact of temperature on benthic communities size structure is of lower importance contrary to input of fresh organic matter that positively stimulates macrofaunal biomass. Primary production is directly related to the climate changes so in regions of its rapid changes the benthic size structure will be also influenced.



EFFECTS OF STORMS ON HABITAT HETEROGENEITY AND BETA DIVERSITY IN MARINE SOFT-SEDIMENTS

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Storms can result in strong modifications in coastal soft-sediments, with powerful waves increasing erosive processes and changing the habitat features. Climate change projections highlight that storms might have their frequency and intensity increased in the near future. Thus, it is necessary to understand ecological responses to severe storms in order to avoid or mitigate harmful effects on coastal ecosystems. Here, we combine hydrographic, sediment and biological data to test a set of hypothesis and predictions about the ecological impacts of storms on macrobenthic assemblages inhabiting intertidal soft-sediments of Araçá Bay, a sheltered tidal flat in Southeast Brazil. We found that storms reduced species richness, abundance and biomass of macrobenthic assemblages. We also found that β diversity is higher after storms; however, local contribution to β diversity is lower, indicating that areas within the bay are less unique in their biological composition. Overall, our results suggest that storms may affect biodiversity and ecosystem services of coastal soft-sediment ecosystems. Future studies should test our hypothesis and predictions in different areas in order to advance the knowledge of how future climate change will impact coastal ecosystems.



STRUCTURAL AND TROPHIC RESPONSE OF BENTHIC MACROINVERTEBRATE COMMUNITY TO LOW pH IN A NATURALLY ACIDIFIED SHALLOW ECOSYSTEM

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Ocean acidification is a global phenomenon caused by the decrease in ocean pH as a direct effect of the uptake of carbon dioxide from the atmosphere. Decreased pH and consequent alterations in carbonate chemistry is expected to negatively affect a broad variety of marine organisms. Naturally acidified ecosystems such as shallow submarine volcanic CO₂ vents are increasingly being investigated as they offer great potential for studying the effects of low pH on marine organisms and ecosystems. The aim of this work was to examine community and trophic structure of motile benthic macroinvertebrate community associated to macrophyte in seagrass (*Cymodocea nodosa*) meadows in a site close to the vents (weakly acidified) and in a control site (normal pH conditions) at Vulcano Island (Italy). Samples were collected in spring using an airlift sampler on 30x30 cm quadrats. Higher abundance and nutritional quality (low C/N ratio and high nitrogen content) of macrophytes was detected close to the vent. These changes, however, did not translate to higher macrophyte consumption by herbivores and detritivores. The associated motile invertebrate community close to the vent showed a loss of diversity (reduction of calcifying gastropods and dominance of relatively few polychaete and amphipod species). Community-wide metrics investigated through stable isotopes ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) revealed a trophic simplification as reflected by the lower trophic positions, shorter food web, and reduced trophic diversity. The dominance of primary producers and herbivores/detritivores and the loss of carnivore species suggest a dual trophic cascade effect on food web structure, involving a marked bottom-up effect and a reduced top-down control. The findings of this study bring light to the changes that occur in the organization of benthic communities in CO₂ vents. Particularly, the overall structural and trophic simplification of motile fauna community associated to macrophytes makes these systems comparable to unstable and stressed ecosystems, while the expected enhancement of macrophyte contribution to upper trophic levels under ocean acidification was not detected.



EFFECTS OF STORMWATER PULSES ON MARINE ECOSYSTEMS IN CURRENT AND PROJECTED CLIMATES

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Climate change models predict increased frequency of extreme precipitation events. In situ experimental research is needed to help inform prediction of the consequences of this change, for example due to increased frequency of pulses of stormwater into coastal ecosystems. Using establishing and mature assemblages on hard substrata, we tested the effect of stormwater (a mixture of copper, nutrients and freshwater), and frequency of simulated pulses of stormwater, on biodiversity, assemblage structure and ecosystem functioning. Stormwater had a negative effect on community attributes and functioning of establishing assemblages, and the biomass and functioning of mature assemblages. Establishing assemblages showed no lasting effect of stormwater after a two month respite from pulses. The clearance rate of mature assemblages subjected to stormwater pulses was not initially impacted, but after two months respite, it was significantly lower than controls. Increased frequency of stormwater pulses altered establishing assemblage structure, and decreased the rate of community respiration and biomass of the mature assemblages. The results of this study may help inform management and conservation of ecologically and commercially important species by characterising the effects of pollutants under alternative scenarios of change.



AN ASSESSMENT OF SEABIRD INFLUENCE ON ARCTIC COASTAL BENTHIC COMMUNITIES

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It is well recognized that Arctic seabirds exert a 'top-down effect' on vast marine areas as consumers of plankton and fish, and locally provide significant nutrient enrichment to the terrestrial ecosystems. However, next to nothing is known about the fate of bird-derived nutrients that return to the marine environment and potentially concentrate in the relatively small coastal area immediately adjacent to large coastal colonies ('bottom-up effect'). To attempt to assess the influence of this potential nutrient enrichment of the coastal benthic community, samples of pelagic and sedimentary particulate organic matter (POM and SOM, respectively), macroalgae, algivorous snails and mainly algivorous sea urchins, and predatory/scavenging hermit crabs and whelks were collected at two Arctic localities (Spitsbergen), (1) below a mixed colony of guillemots and kittiwakes, and (2) in an adjacent geomorphologically similar location not influenced by the seabird colony. Higher nitrogen stable isotope ratio ($\delta^{15}\text{N}$) was found in POM, hermit crabs, and whelks sampled below the colony than away from it. However, there was no ornithogenic enrichment in macroalgae or the two herbivores. SOM taken from the zone of dense kelp forest did also not differ isotopically between the two areas, while sediments from outside the kelp zone showed the ornithogenic impact near the colony. The lack of differences between the colony and control area in the food chains based on benthic primary production might result from the timing of an intensive growth period in macroalgae in late winter/early spring, when there is little or no runoff from the land, and/or ornithogenic nutrients being directly incorporated by phytoplankton (confirmed by the signal in POM). Hermit crabs and whelks seemed to be more dependent on detritus derived from food chains originating from pelagic producers. Our results indicate that seabirds in the Arctic may fertilize coastal benthic communities through pelagic-benthic coupling, while having no direct impact on bottom primary production. Since progressive eutrophication of Arctic seas is one of the likely phenomena driven by climate change, recognition of ornithogenic fertilization effects on marine coastal area may shed a light on what may happen within the local food webs in the climate change scenario.



THE IMPACT OF THE OXYGEN MINIMUM ZONE ON THE VERTICAL DISTRIBUTION AND ABUNDANCE OF GELATINOUS MACROZOOPLANKTON IN THE EASTERN TROPICAL ATLANTIC

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One of the consequences of climate change is a global decline in the oceanic dissolved oxygen concentration. Mesopelagic oxygen minimum zones (OMZs) occur naturally in all oceans, but the consequences of their recent expansion for the pelagic fauna remain largely unknown. While OMZ expansion may result in habitat reduction of oxygen demanding species, it may result in habitat expansion for species capable to tolerate low oxygen levels. The mesopelagic zone is the habitat of large and diverse populations of gelatinous organisms which cannot be sampled adequately by nets. Gelatinous organisms typically have low metabolic rates and their potential resilience towards low oxygen levels may enable them to live in OMZs, and cope with OMZ expansion. To test this hypothesis, abundance and distribution of representative members of the gelatinous community of the eastern tropical Atlantic (Cape Verde Area) were correlated with dissolved oxygen concentrations.

We performed pelagic video surveys in the eastern tropical Atlantic at stations with an OMZ of different intensity, during day and night. The surveys were carried out using a newly developed towed, optical observation instrument (PELAGIOS) which collects video of pelagic organisms (>1 cm) and continuously measures temperature, depth and oxygen. Video transects were made at 20, 50, and 100 m depth followed by a stepwise recording every 100 m down to a maximum depth of 1000 m.

The surveyed stations had the OMZ core between 300 and 500 m depth. Overall, the measured oxygen concentrations ranged from almost saturated levels in surface waters (>220 $\mu\text{mol}/\text{kg}$) down to a minimum of 30 $\mu\text{mol}/\text{kg}$ within the core of the OMZ. Our video surveys provided one of the first *in situ* video observations of the large pelagic (>1 cm) fauna in the eastern tropical Atlantic and revealed a diverse gelatinous community including ctenophores, medusozoans and thaliaceans. Abundant genera among them were *Solmissus*, *Lilyopsis*, *Beroe* and *Atolla*. The preliminary analysis of our data showed a strong vertical zonation with a shift of species composition with changing oxygen concentrations, depth, daytime and sampling location. These relations will be discussed in the context of a future ocean scenario with expanded mesopelagic OMZs.



BOTTOM LIFE OF PLANKTON IN TWO ARCTIC FJORDS

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Two glaciated fjords on Spitsbergen (Hornsund 77°N) and Kongsfjorden (79°N) were studied for the occurrence of macroplankton (mostly euphausiids, hyperiids, chaetognaths) with the use of drop down camera. The underwater imagery demonstrate that closer to the glacier front, where turbid and freshwater occurs, most of macroplankters leave the upper water column and descends to the bottom (about 100m depth). Concentrations of macroplankton in the immediate vicinity of the sediment reach over 500 specimens per m² -what corresponds to the biomass of 10g C/m³. Such concentrations of macroplankton are of prime interest for fish, seals and other carnivores. Conditions in the near bottom waters are in many respects better than in the upper water column -better oxygenated, cold, fully saline and transparent waters with rich food deposited on the seabed surface (sinking pelagic microplankton). We suggest that this phenomenon is related to the increase of glacier melt and fresh water discharge intensity.



TROPHIC ECOLOGY OF THE ORANGETHICK FLYING SQUID *STHENOTEUTHIS PTEROPUS* (STEENSTRUP, 1855) (CEPHALOPODA: OMMASTREPHIDAE) IN THE EASTERN TROPICAL ATLANTIC

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In the eastern tropical Atlantic, the orangethick flying squid *Sthenoteuthis pteropus* is an opportunistic short living carnivore and among the fastest growing squids. This species is one of the dominant members of the epipelagic nekton community and due to their ability to live in environments with low oxygen concentrations and high plasticity, they may be able to cope with a changing ocean. So far our understanding of their trophic ecology is limited. Our study attempted to better understand its role in the pelagic food web of the eastern tropical Atlantic by investigating its feeding habits.

We examined 110 specimens of the orangethick flying squid *Sthenoteuthis pteropus*, ranging from 155 to 475 mm (dorsal mantle length), that were caught by hand jigging in the eastern tropical Atlantic in 2015. Besides body mass and size, factors such as sex, maturity stages and stomach fullness were determined. Stomach contents of all individuals were analyzed as well. To estimate the current trophic position of the squid in the food web, stable isotopes ($\delta^{13}\text{C}$; $\delta^{15}\text{N}$) were measured from mantle tissue samples of 30 squids. We also analyzed stable isotopes of gladius samples taken at 10 and 20 mm increments to track possible ontogenetic changes in the squid's diet (n=5).

Preliminary results on the trophic ecology of *Sthenoteuthis pteropus* are in line with the feeding habits that have been shown for many other oceanic squids. *S. pteropus* feeds on abundant members of the oceanic micronekton such as myctophid fishes (e.g. *Electrona risso*, *Ceratoscopelus warmingii* and *Hygophum hygomii*) and flying fishes (*Exocoetus obtusirostris*). Exoskeletons of amphipods, decapods and other crustaceans were also found in smaller squid specimens and this is likely part of an ontogenetic transition from crustacean prey to fish and cephalopod prey. This transition will be studied using the results of the stable isotope analysis, which are still in progress.



EFFECT OF MOLLUSC INVASION AND CLIMATE CHANGE ON LONG-TERM CHANGES OF PRIMARY PRODUCTION IN THE LAGOONS OF THE BALTIC SEA

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The Curonian Lagoon and Vistula Lagoon are of the largest lagoons in Europe. The researches (chlorophyll, primary production, nutrients, benthos, etc) were carried out monthly at 20 stations. The database includes 3400 stations for the period from 1991 to 2015. Eutrophication and algae blooms are most important problems. Climate warming combined with other factors (slow-flow exchange, high nutrients concentrations in silt, shallow depths) caused ongoing eutrophication and algae blooms in these lagoons.

The Curonian Lagoon may be characterized as hypertrophic water body. Hyperbloom of Cyanobacteria (average for June-October Chl>100 µg/l) were observed during 4 years in 1990s and 9 years in 2000s. Primary production in 2000s and 2010s (490 and 560 gC·m⁻²·year⁻¹) is 2 times higher in 2010s, than in 1970s. Harmful algal blooms (chlorophyll to 700-3400 µg/l) result in deterioration of the water chemical parameters, death of fish and pollution with toxins.

Also, effects of climate change and eutrophication have been observed in Vistula Lagoon. Mean annual temperature increased by 1.2°C for 40 years, and water warming combined with other factors created conditions for algae “blooms” in 1995-2010. Primary production in 2000s and 2010s (415 and 460 gC·m⁻²·year⁻¹) is considerable higher, than in the middle of 1970s (300 gC·m⁻²·year⁻¹). However, brackish water which corresponds to the “critical salinity” (4-6‰) prevented harmful algal hyperblooms. Great changes have taken place in the Vistula Lagoon ecosystem in the 2010s after the invasion of the North American filter-feeding bivalve *Rangia cuneata*. The benthic biomass increased by 20 times (to 650 g/m²), and chlorophyll decreased by 2 times (20 g/m³) in 2011-2014. The phytoplankton assimilation numbers as an indicator of the rate of photosynthesis increased by 2-3 times (to 300-400 mgC·mgChl⁻¹·day⁻¹). Invasion filter-feeding mollusks significantly improved water quality but primary production remained on long-term hypertrophic level, which creates favorable conditions for the other trophic groups (zooplankton, benthos, fish).

If global warming continues, it can be expected to remain long-term trend of increasing primary production and eutrophication in the Vistula and the Curonian Lagoon. In the Curonian Lagoon it will stimulate harmful algal blooms. In the Vistula Lagoon intensive development of filter-feeding mollusks will prevent harmful algal blooms and promote the conservation ecological state at possible levels.



INDICATORS



THE SEAGRASS OF VASILIKO BAY, A LOST CASE?

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Vasiliko bay, in southern Cyprus, is affected by multiple and mounting anthropogenic pressures. There are many fish farms at ~1-3 km from the shore; these are expanding and contribute significantly to organic loading. The coastline has already been modified by three ports and the country's largest power station, cement factory and military naval base which have altered the hydrodynamics of the bay and contributed to chemical and thermal pollution. A major new oil terminal has recently been constructed in the bay, following the discovery of Leviathan field gas reserves.

Here we present the first scientific surveys of *Posidonia oceanica* meadows in Vasiliko bay. The meadows were mapped with a combination of high resolution aerial imagery and side scan sonar and the seagrass was monitored in 2012 and again in 2013 at 30 stations spread across the bay. In addition, four 50 m long transects (three near fish farms and one at a Reference site) were set-up at to monitor the lower depth limit of the meadows according to Med *Posidonia* project guidelines. We found that an extensive ancient seagrass meadow covered most of the sand in the bay at ~10-30 m depth as well as harder limestone substrata in the shallows. Dead matte is now abundant as the seagrass meadows are regressing, particularly at their lower depth limits and near fish farms that previously operated over the meadows. We found that between 2012 and 2013 some of the live seagrass meadow in the eastern part of the bay was dredged to construct a marine jetty. In the western part of the bay, heavy seagrass epiphytic cover, lower leaf surface area and lower shoot densities are thought to be due to fish farm operations.

Despite on-going regression of seagrass habitat in southern Cyprus, *P. oceanica* still forms extensive live meadows that provide the habitat for other important species, so it is not too late to protect what is left.



MAPPING OF SEAGRASS MEADOWS IN GREECE (IONIAN AND AEGEAN SEAS, EASTERN MEDITERRANEAN)

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In the framework of the Mediterranean Fisheries Regulation (1967/2006), an extensive seagrass mapping project was conducted along the Greek coastline. The aim of the project was the production of a baseline map with seagrass meadows distribution throughout the Greek coastal areas using the grid of 1kmx1km provided by the European Environmental Agency (EEA 2013).

The mapping of seagrasses was based on the combined use of satellite images, side-scan sonar images, in situ observations by scuba diving and underwater boat-towed cameras. The input of mapping results on the grid of 1 km x 1 km was based on the use of four classes (class 1: 0-5%, class 2: >5-25%, class 3: >25-35%, class 4: >35%) of cell cover. In total 31,744 cells were evaluated. At class 1 were classified 26,088 cells. Most of them (18,525 cells) was considered as a subclass of class 1 (class 0: 0% = absence). At class 2 were classified 2,506 cells. At class 3 were classified 873 cells, while 2,277 cells were classified at the greater than 35% of coverage (class 4).

According to the mapping results, *Posidonia oceanica* meadows are present practically almost everywhere along the Greek coasts (~16,500 km), except in areas near estuaries, enclosed gulfs, or shallow and sheltered bays where the more eurythermal and euryhaline marine Angiosperms, *Cymodocea nodosa* and *Zostera noltei* are present. The most extensive (class 4) meadows of *P. Oceanica* were located in the Ionian Sea (780 cells), followed by the North Aegean Sea (680 cells).

An evaluation of 1) the total seagrass distributional range and 2) their coverage area, was attempted based on a conventional percentage of coverage for each of the four classes (2.5%, 15%, 30% and 67.5%, respectively). The total seagrass distributional range was estimated at 31,744 km². Based on the conventional percentage of each class and the number of the cells classified at each of the four classes, the total surface of seagrasses in the Greek coasts was estimated at 2,364 km². This value of seagrass total extent area is higher than the values found in the literature but lower than the values obtained through modeling processes.



TESTING OF THE ZOOPLANKTON MEAN SIZE AND TOTAL STOCK (MSTS) INDICATOR IN THE SOUTHERN BALTIC SEA

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Results on mesozooplankton community structure dynamics provide valuable information on understanding of ecosystem functioning, changes in pelagic food webs, and contribute to the assessment of Good Environmental Status as defined in the EU Marine Strategy Framework Directive (MSFD).

The zooplankton Mean Size and Total Stock (MSTS) is a Baltic Marine Environment Protection Commission (HELCOM) core indicator primarily relevant for food webs (MSFD criterion 4.3: abundance/distribution of key trophic groups/species) with secondary link to biodiversity (MSFD criterion 1.6: habitat condition). MSTS indicates that the investigated pelagic food web structure is or is not optimal for energy transfer from primary producers (phytoplankton) to fish.

MSTS indicator was applied to test changes in the pelagic food web structure in the southern Baltic Sea. This core indicator appears to be very useful for this role: it considers the zooplankton mean size change as a consequence of an increase of small taxa biomass (along with an increasing eutrophication) and especially a decrease in abundance of larger copepods (due to the impact of hydrological conditions' change as well as predatory pressure of small pelagic fish). MSTS indicator provides estimates of the feeding conditions for sprat, herring and cod larvae and the grazing pressure on phytoplankton.

MSTS is strongly linked to two anthropogenic pressures listed in the MSFD Annex III, Table 2: selective extraction of species and nutrient and organic matter enrichment.

Data that are the Polish contribution to the HELCOM COMBINE Programme were used for indicator testing. In most of the cases, samples were taken 5 times per year using the WP-2 net. The longest data series (since 1979) were collected at deepwater stations whereas those taken at more coastal ones started within the last twenty years. Considering the different length of presented data, two alternative strategies for setting reference conditions had to be applied: (i) for coastal stations the long term mean and the corresponding variance was calculated based on the entire dataset and (ii) for the open-water stations the reference periods were defined based on chlorophyll *a* concentrations and weight-at-age of clupeid fish.



CURRENT DEVELOPMENT ON MULTIMETRIC FISH INDEX FOR ASSESSING ECOLOGICAL QUALITY OF POLISH COASTAL AND TRANSITIONAL WATERS

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Fish assemblages are considered indicators of aquatic ecosystem quality. The status of these biological communities indirectly presents the condition of the environment because the organisms react to shifts in anthropogenic pressures. Due to the Water Framework Directive requirements, all member states of the European Union are obligated to assess the quality of transitional waters using fish as one of the Biological Quality Elements.

The aim of this study was to develop a fish-based Multimetric Index for an evaluation of the ecological status of Polish transitional waters. Acquisition of additional information on fish in coastal waters and applied statistical approaches give opportunities for the development of a consistent assessment system for both water types.

Fish data were collected in the years 2011 and 2013-2016 along the Polish coast using gillnets and bottom trawls. Based on information about catches we calculated 20 candidate fish metrics, that may describe community ecological status. To test metric response to pressures and relevance for assessing the quality of water bodies, we used regression-based models and multivariate analysis. The sampling methods and environmental factors were considered in modeling. We used the Baltic Sea Impact Index (BSII) as a proxy of human disturbances in the studied areas. Data on depth, surface water temperature, bottom water temperature, salinity and water transparency, as well as information on sampling season and gear type were included.

We combined in a Multimetric Index selected non-redundant metrics, which showed significant correlation with BSII. Previously fitted models were applied to predict metrics values in different levels of anthropogenic impact and bootstrap simulation results were further used for class thresholds assignation. We adopted a system of 5-grades scoring to obtain final Index values. Regression methods were used to test Multimetric Index response to pressures.

The assessing tool developed during the presented study gathers variable information about fish community health into a single score and discriminates well between the sites that show different levels of anthropogenic pressure. The index can be properly used as an approach for evaluation of ecological quality of the highly impacted Polish coastal and transitional waters.



A COMPARISON AMONG CORALLIGENOUS-BASED INDICES FOR THE ASSESSMENT OF THE MARINE ECOLOGICAL QUALITY

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Mediterranean coastal areas host the endemic biogenic reefs commonly known as “coralligenous”. They develop in dim-light conditions from about 20 m down to 120 m depth, shaped by bioconstructors, mainly represented by coralline algae, and erosive processes acted by borer organisms and physical abrasion. This dynamic equilibrium creates a morphologically complex calcareous substrate where highly diverse benthic assemblages develop, offering shelter and food to a rich community of vagile invertebrates and fishes. Hence, coralligenous reefs are real hotspots of biodiversity, affected by several anthropogenic and natural pressures that threaten their structure and functioning. Despite the undeniable need to conserve coralligenous habitats, their extreme spatial variability and the operational restrictions imposed by scuba diving at depths where they usually develop limited the number of studies aimed at assessing their health status. Only recently, some coralligenous-based indices to evaluate marine ecological quality have been proposed. The Coralligenous Assemblage Index (CAI - Deter *et al.*, 2012), the Ecological Status of Coralligenous Assemblages (ESCA - Cecchi *et al.*, 2014) index, the COralligenous Assessment by ReefScape Estimate (COARSE - Gatti *et al.*, 2015) index and the Index-Cor (Sartoretto *et al.*, 2014) were compared among each other and against some classical univariate indices (e.g. the Shannon diversity Index) in 21 sites along the southern coasts of France.

The four coralligenous-based indices are built on different approaches and combining various metrics. The CAI and ESCA indices are both based on photographic sampling and image analysis; on the contrary, the COARSE index is based on direct *in situ* observations, while the Index-Cor integrates photos and direct observations. Image analysis methods differ among CAI, ESCA and Index-Cor. The metrics considered by the indices vary from the simple abundance of some taxa/groups, to the sensitivity of species to different pressures, to structural and functional metrics.

Results showed that the four indices are not always concordant in indicating the ecological quality of coralligenous habitats and coastal waters, some metrics being more sensitive than others to the increasing pressure levels.



ECOLOGICAL QUALITY STATUS OF VASILIKO BAY (CYPRUS, EASTERN MEDITERRANEAN SEA), AN AREA INFLUENCED BY VARIOUS ANTHROPOGENIC ACTIVITIES

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The assessment of benthic macrofauna community structure, including the application of biodiversity and biotic indices, has proved to be a useful tool to evaluate the ecological status of coastal habitats and identify environmental degradation patterns, especially in human-stressed areas.

In the island of Cyprus, Vasiliko bay (south coasts) is influenced by various anthropogenic activities, such as aquaculture, industrial facilities, port installations and tourism; with more energy plants intended to be constructed in the near future. Despite its multi-sectoral activity, the monitoring of ecological quality status has been limited only at local sites. In 2013, the first large-scale survey of benthic macrofauna communities was carried out as part of a research project, aiming at assessing the ecological status of the area based on zoobenthos, as the most appropriate biological quality element for coastal waters.

Benthic macrofauna replicated samples (3 per station) were collected with a Van-Veen grab (surface of 0.1 m²) from 42 stations interspersed in the bay, at depths ranging from 4 to 60 m. Each sample was sieved (0.5 mm mesh), sorted and identified to species level, where possible. Sediment geochemical parameters, including grain size, organic matter content and chemical pollutant concentrations (acid volatile sulphide, mercury, iron, hexachlorobenzene, hexachlorobutadiene), were estimated from samples concurrently collected from the same stations. Average abundances, biodiversity and biotic indices (including BENTIX, AMBI, M-AMBI, BQI-Family and MEDOCC) were calculated and represented in maps using ArcGIS software (interpolation method, nearest neighbour algorithm) to visually identify patterns of environmental degradation. Finally biotic indices were correlated to abiotic values and known anthropogenic pressures, in order to assess their agreement and performance in estimating the ecological quality status of the area. Though a general agreement in the applied biotic indices has been observed, BENTIX was identified as the most sensitive index, successfully detecting ecological disturbances in Vasiliko bay. This outcome conforms to the findings of relevant studies from the eastern Mediterranean Sea.



A METHODOLOGICAL APPROACH AND ASSESSMENT OF ECOLOGICAL STATUS IN HELLENIC COASTAL WATERS: RESULTS FROM THE '2012-2015' MONITORING CYCLE

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A decision tree methodology is applied to assess the ecological status of the Hellenic coastal water bodies based on data obtained from the four years' (2012-2015) monitoring of water quality in the Hellenic coastal waters within the Water Framework Directive (WFD). The assessment is also compatible with the needs of the Marine Strategy Framework Directive (MSFD) for assessing the environmental status of water bodies. Based on a risk based approach, the monitoring network was designed to include 50 surveillance monitoring stations, which were sampled during a single year of monitoring covering 1-3 sampling periods and 30 operational monitoring stations, which were sampled every year covering 4-9 sampling periods during the four years of monitoring. Results on hydro-morphological, physicochemical and biological elements are presented. The chemical status was evaluated based on measurements of heavy metals in water. The evaluation of the biological quality was based on the use of metrics developed for phytoplankton biomass, benthic macroinvertebrates and macroalgae. The ecological status of each station was assessed through the average indicators' values throughout the monitoring, while the spatial assessment on the level of water bodies was based on the use of 'assessment areas' units and the one out - all out principle. Results on the integrative status of the water bodies were validated by correlating classification results with a pressure index assessing multiple pressures on the coast and environmental parameters in water column and sediment. The majority of stations (50 out of 80 stations) accounting for over 70% of coastline length or water body surface were assessed as in good or high quality status. In comparison to the baseline classification, results validated the risk status of the majority (60%) of operational stations, while a percentage of 15% of stations should change risk status category and monitoring type (operational or surveillance). Benthos was found to be the element with the closest agreement with the integrated final status having an increased weighting in the decision tree. All indicators used correlated with water and sediment parameters and the overall assessment was successfully coupled with the pressures on the coast.



STEREOM MICROSTRUCTURE OF TEETH IN BRITTLE STARS: 3D RECONSTRUCTION AND QUANTIFICATIONS USING SYNCHROTRON MICROCOMPUTED TOMOGRAPHY DATA

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In brittle stars (Ophiuroidea, Echinodermata), dietary differences and feeding mechanisms are, among others, reflected in a variety of morphologically different teeth. These are modified calcite stereom ossicles, typically arranged in vertical series of one or more rows along the inner sides of the jaws. Despite a wide range of known feeding modes, detailed morphological descriptions of the microstructure of teeth are scarce and their actual functioning when manipulating or handling food is largely unknown. Nonetheless, knowledge on the role, the function and the mechanical properties of teeth is highly relevant, because the teeth ultimately represent the final manipulating structures prior to food intake and digestion and therefore shed light on the animal's role in local food chains. Here we present first results on 3D reconstructions from high resolution X-ray synchrotron microComputed Tomography (μ CT) data as an advanced non-invasive tool for morphological visualization of complex three-dimensional structures such as the calcite stereom teeth in brittle stars. We use the concept of ambient occlusion for the segmentation of the intrapore space and the stereom classification. Presently, we focus on different infaunally living and deposit-feeding amphiid species known to possess so called 'compound teeth'. In these, the proximal area of the tooth is loosely fenestrated, but the distal part as well as proximally located insertion and fixation hunches (i.e. where the tooth is inserted into the dental plate) are of solid imperforate calcite. In addition, we provide quantifications from the reconstructions for architectural properties of the teeth for standardized comparisons, such as porosity, amount and relation of fenestrated and imperforate calcite and gradients of porosity within a tooth from basal to distal. The results will allow for intra (- and inter) specific comparisons of different species with respect to their known feeding modes and life styles. Overall, the results will lead to a better understanding of the significance of structural differences in teeth of brittle stars, their overall feeding ecology and, ultimately, their roles in different marine benthic ecosystems.



LONG-TERM EFFECTS OF AQUACULTURE ON A REFERENCE MACROFAUNAL COMMUNITY (CEPHALONIA, IONIAN SEA)

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The assessment of the Ecological Quality Status of European marine waters is of increasing interest due to recent policy requirements associated with the Water Framework Directive (WFD, 2000/60/EC) and the Marine Strategy Framework Directive (MSFD, 2008/56/EC). In this context, the establishment of reference values concerning benthic communities in local scale is crucial. Thus, aquaculture cumulative effects on the benthic ecosystem were studied in a sheltered bay (Cephalonia, Ionian Sea) where a large fish farm operated since 1982. A comprehensive dataset was used to assess the long term changes caused by the operation of the fish farm in the area that was used as a reference location in previous scientific projects. The comparison of the macrofaunal community showed small differences between sampling periods regarding species abundance and species composition. Nevertheless, the decrease in Lumbrineridae and Nephtyidae abundances combined with the increase in Cirratulidae abundance implied changes in ecosystem functioning, such as a decrease in bioturbation processes. This type of shift is important for the degradation and burial of organic matter in benthic ecosystem and it may result in a decline of the ecological quality status in the area.



EMODnet BIOLOGY: ALLOWING EASY COUPLING AND VISUALISATION OF INDICATOR SPECIES AND THEIR DOCUMENTED DISTRIBUTION

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The importance to describe species distribution patterns and their underlying processes is essential in determining the current status and predicting the future evolution of marine ecosystems. Until now, the lack of an integrated, standardized system serving this biological information has hampered these large scale functional analyses. Within the Biological Lot of the European Marine Observation and Data Network (EMODnet Biology) - and linked with the European Life Watch project - the first steps have been taken to associate the taxonomy and distribution of marine species with their ecological and biological information, with a specific focus on the importance of marine species to society. This is expressed in a thorough documentation of traits such as the protection status species have in legal frameworks (IUCN, CITES), whether a species is introduced or invasive, of fisheries or aquaculture interest (FAO), harmful, or used as an ecological indicator (MSFD). Through the EMODnet Biology Data Portal, such information can now be queried and downloaded. This Portal is combining the World Register of Marine Species (WoRMS) and the European Ocean Biogeographic Information System (EurOBIS) for respectively taxonomy & traits and distribution information. Through the EMODnet Portal, it becomes possible to combine both these data systems and to allow for more complex searches which were previously not easily executable. Next to the freely accessible online EMODnet Biology Data Portal where the selected data can be visualized and further fine-tuned, online tools are being prepared to easily link data from WoRMS and EurOBIS with species traits within the European Life Watch project. In the long run, services will be offered to the scientific community, building support to answer specific ecological questions which are currently hard or nearly impossible to address due to a lack of accessibility, availability, standardization and linking of data.



ASSESSING SENSITIVITY OF MARINE AND COASTAL HABITATS: THE MARESA APPROACH

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Understanding the sensitivity of coastal and marine features to the effects of human activities is essential to underpin management of the marine environment. It is also a vital component of a number of indicators being developed for the marine environment, particularly in support of the Marine Strategy Framework Directive. Defining sensitivity and assessing the sensitivity of habitats can be challenging and a number of approaches have been developed. The Marine Evidence-based Sensitivity Assessment (MarESA) methodology is the latest iteration of sensitivity assessment in the UK, built on prior approaches developed by MarLIN and UK Statutory Nature Conservation Bodies. A brief outline of prior approaches is first presented along with an overview of the main types of assessment; clarification of terminology; data requirements and key limitations. The MarESA approach is then discussed along with key findings. MarESA updates the MarLIN sensitivity assessment database with MarESA assessments addressing the defined list of pressures resulting from human activities produced by the OSPAR Intergovernmental Correspondence Group on Cumulative Effects (ICG-C) (OSPAR, 2011). The creation of a database of sensitivity assessments represents a significant investment and provides an open access resource for marine researchers and managers. Recent examples of the use of sensitivity assessments to support marine planning will be described and potential future application discussed. Examples include identification of priority pressures resulting from human activities on a subregional sea basis; the development of risk assessment tools for specific activities (anchoring and mooring) in Marine Protected Areas; and core indicators proposed to assess the achievement of Good Environmental Status under the Marine Strategy Framework Directive.



BENTHIC HABITAT HOMOGENIZATION AND COMMUNITIES' CONDITION INDICATORS OF ANTHROPOGENIC PRESSURE

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Habitat heterogeneity is considered an important driver of taxonomic and functional diversity. Habitat homogenization is often considered to occur after a broad-scale, high-intensity impact that removes or catastrophically alters habitats. However, several chronic anthropogenic activities of lower intensity can impact the structures and key species contributing in habitat heterogeneity of soft sediments. In order to investigate homogenization of benthic habitats as an effect of anthropogenic pressures, a macrofauna dataset of 80 stations around Greek coasts, sampled in the framework of the WFD monitoring network during 2012-2015 was used. The stations were assigned to categories according to (a) EUNIS classification habitats, (b) four 'ecotypes' based on depth and sediment type, (c) two impact groups based on the BENTIX index. Communities' structure was investigated by univariate α -diversity indices (S, N, H', J) and habitat homogenization by multivariate similarity analyses and β -diversity.

In total, 28631 individuals belonging to 931 species were identified. The most abundant taxa were the Polychaetes (69.3%), followed by Crustaceans (12.7%), Molluscs (11.3%), Varia phyla (4.8%) and Echinoderms (2%). From the 80 stations, 50 were estimated to be non-impacted (High and Good ecological quality) and 30 were impacted (Moderate, Poor and Bad). BIOENV showed that benthic communities' distribution was best related to depth, sediment type and ecological status. Most habitats and respective 'ecotypes' included stations of both impact categories. ANOVA of α -diversity indices indicated a statistically significant drop of H' and J in the case of impacted infralittoral sands compared to the corresponding non-impacted habitats.

Multivariate Bray-Curtis similarity showed that there is low similarity in the total dataset, but similarity between habitats increased within the impacted stations group (ANOSIM $R=0.232$, compared to $R=0.423$ in the non-impacted group). In addition, β -diversity per ecotype was always higher in the non-impacted group, indicating also signs of habitat homogenization under human pressure. This effect demonstrated by both similarity analysis and β -diversity was more pronounced in the case of the most heterogeneous habitats (sandy or mixed sediments) compared to muddy ones, due to their lower resilience to disturbance.



ASSESSING BENTHIC IMPACT FROM FISHERIES: EUROPEAN WIDE COLLABORATION IN AN ICES ADVICE PROCESS

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Member countries and Regional Sea Conventions (RSCs) are developing indicators of impacts on benthic habitats from anthropogenic activities for MSFD purposes (D1 biodiversity and D6 seafloor integrity). EU projects are also developing approaches across European seas (including the Mediterranean and Black Sea). Fishing pressure is being considered as part of this need. As part of this process ICES has provided bottom fishing pressure maps using VMS and logbook data for the North-East Atlantic (OSPAR) and the Baltic Sea (HELCOM). The next challenge is to develop an indicator to interpret what these fishing pressure maps mean in terms of impact on benthic habitats and their utility in management. ICES has thus assigned sensitivity scoring to habitats, mapped habitat sensitivity and overlaying pressure to evaluate impact at a regional scale. Early progress on producing such impact maps has also been made in EU projects such as BENTHIS, RSCs and ICES working groups. In a recent workshop ICES has facilitated the exchange of "principles and good practices" across regions and interest groups (e.g. EEA, OSPAR, HELCOM, the fishing industry, as well as experts from Baltic Sea, North Sea, and Mediterranean countries). Using this input an overall evaluation of the methods available at the regional scale has been produced, aimed at tangible use of these types of indicators to evaluate the state of the seabed in relation to fishing pressure. This ICES advice to the EU will feed into ongoing efforts within the Common Implementation (CIS) of the MSFD.



MORE SMALL PREDATORS - INDICATING EFFECTIVE FISHING REGULATIONS OR ENHANCED PREDATOR RELEASE? A CASE STUDY IN THE MPA KORNATI NATIONAL PARK, CROATIA

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Trammel-net fish surveys in the Croatian Adriatic between 1993 and 2009 identified increases in abundance of four meso-predator species, hypothesized to be indicators of positive effects from fisheries regulations implemented within those years. An alternative explanation is that ongoing harvest of large predatory species continues to release these populations of indicators. We tested these two hypotheses by comparing fish population densities inside and outside MPAs and no-take areas. If fishing restrictions are responsible for increase in indicator species then 1. densities of indicators should be uniformly higher in more fisheries-restricted zones. If fishing restrictions increase top predators, which then reduce the populations of meso-predators, then 2. densities of predators should increase, and their potential prey decrease, in response to fisheries restrictions.

We performed trammel-net surveys at four sites, three within and one outside the Kornati National Park, Croatia in 2009, 2013, 2014 and 2015. We matched the trammel specifications, including habitat and depth, of the 1993-2009 survey. The four indicator species reached highest abundances at different locations. *Symphodus tinca* peaked within the no-take zone, *Pagellus erythrinus* at a less protected site within the MPA, and *Mullus surmuletus* and *Scorpaena porcus* peaked outside the MPA with no significant differences across MPA sites. This contradicts hypothesis 1. Hypothesis 2 can be addressed by comparing *Scorpaena* species, which are trophically connected. Two *Scorpeana* species co-inhabited the site with *Scorpaena porcus*. The larger *S. scrofa* significantly increased in abundance from 2009 to 2015 within the MPA with significantly higher abundances in the no-take zone for all year/site combinations. The smaller *S. notata* showed no significant changes across MPA sites and displayed negative trends within the no-take zone. In less protected MPA sites, *S. porcus* and *S. notata* displayed opposite abundance trends: positive for the larger *S. porcus* and negative for the smaller *S. notata*. These results support hypothesis 2. We conclude that increases in meso-predators is not evidence for the general success of fishing regulations, but of relatively higher vulnerability of large predators to fishing, and subsequent predator release. This work was supported by the Croatian National Science Foundation under the project COREBIO (3107).



APPLYING ECOSYSTEM AND RISK-BASED APPROACHES TOWARDS AN INTEGRATED ASSESSMENT OF BENTHIC HABITATS COMMUNITIES AT A REGIONAL SEAS SCALE

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The Marine Strategy Framework Directive (MSFD) aims to implement an integrated ecosystem-based and a risk-based approach, to manage of the anthropogenic pressures on the marine environment within European Union waters. Reporting on the MSFD by Member States is facilitated using 11 'Descriptors', made up of numerous indicators which help quantify the state, pressure or impact on components of the marine environment. Unfortunately this process has led to overlaps between indicators under the different descriptors, which have consequently been criticised for double counting and poor coherence. In addition, there are many unknowns about the marine environment including the extent and condition of benthic habitats and the effect of cumulative pressures and impacts on benthic habitats from anthropogenic activities. Such knowledge gaps can make it difficult to set baselines required for monitoring and assessment processes under the MSFD.

Through work developed within the European funded EcAprHA project in conjunction with the development of indicators within OSPAR's regional seas convention, we propose an integrated cyclical approach to assess the state of the seabed and benthic communities with the use of best available evidence at a sub-regional scale but applicable to all MSFD regions. This method integrates indicators relating biodiversity (D1), seafloor integrity (D6) and potentially food web (D4) descriptors in a cyclical process, with transversal implications on other descriptors depending on the pressure types to be assessed (e.g. fisheries activities, eutrophication, hydrological changes, etc). Through this integrated cyclical process, multi-metric indices are used to assess changes in the condition of the seabed and its communities at a site scale to provide quantitative feedback to set thresholds, seafloor disturbance levels and habitat sensitivity assessments at a sub-regional scale. This method not only integrates biodiversity and seafloor integrity related indicators, but also provides a mechanism to strengthen and improve confidence in indicator assessment, where prior information is missing or expert judgement is used. This integrated cyclical approach to assess the state of the seabed is an innovative method, based on actual monitoring and assessment methods.



THE ROLE OF ECOSYSTEM FUNCTIONS AND ECOSYSTEM SERVICES IN THE PROTECTION OF PROTECTED AREAS

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Marine ecosystems play an increasing role in the provision of essential services to human societies. In the last decades, however, intense anthropogenic pressure caused serious threats to ecosystems, leading to habitat degradation, worsening environmental quality, and thereby increasing the risk of collapse of ecosystem functions, with potentially related loss of ecosystem services.

In the Eco Potential project the environmental quality status of Protected Areas (PAs) will be assessed by a series of indicators based on (changes in) ecosystem functions and ecosystem services, and their drivers of changes, across a broad range of biogeographic settings and environmental conditions. The PAs under study have different protection levels, in order to be able to define generalities for the requirements of current and future novel PAs.

The results of a survey on the weighted importance of various ecological, environmental, and socio-economic indicators for ecosystem functions, ecosystem services, and drivers of change, partly according to the CICES system (provisioning, regulating, cultural, supporting) will be presented, based on the findings for marine PAs (Wadden Sea, Dutch Delta, Curonian lagoon, Camargue) in comparison with terrestrial PAs (Gran Paradiso, Kalkalpen, Sierra Nevada, Peneda-Gerês, Samaria).

In marine PAs most important were abiotic environmental indicators (including habitat heterogeneity, salinity, raw materials) (59%). Ecological indicators (including primary and secondary production, biodiversity, connectivity, food provision, nutrient cycling) were less important (34%), whereas in terrestrial Protected Areas ecological indicators were most important (49%). Socio-economic and cultural indicators (including fisheries, recreational activities, land-use) were least important (marine 7%, terrestrial 19%).

Most important indicators for threats in marine and terrestrial PAs include change of species composition, (over)exploitation, area reduction, system deterioration, and disturbance.

The results will support the assessment of essential ecosystem services and functions in PAs, and drivers of change, that may set management strategies and policy options for current and (the identification of) novel PAs. Thereby this study will help to optimize the process to underpin changes to be made in future and existing PAs, to define modifications in PAs boundaries and extent, to prevent potential obstacles, or to initiate remedial action.



OPEN SESSION



THE SMALL-SCALE TRAP FISHERY IN THE SOUTH-EASTERN AEGEAN SEA: SPATIO-TEMPORAL DISTRIBUTION PATTERNS OF *PLESIONIKA NARVAL* (FABRICIUS, 1787)

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Spatio-temporal distribution patterns of shrimps are important to successful fisheries management. In the south-eastern Aegean Sea (Dodecanese Islands), an important small-scale trap fishery is performed for the narwal shrimp, *Plesionika narval*. Temporal and spatial variation in catch per unit effort (CPUE), sex ratio and contribution of ovigerous females were monthly during an annual cycle (2014 to 2015) at three depth intervals (A: 0-30, B: 70-90 and C: 150-170) studied. A total of 17743 shrimps were collected, sex determined and carapace length and weight was measured. General additive models (GAM) were used to study spatiotemporal variations in CPUE. Catch per Unit Effort (CPUE) increased during the summer period, May to July, strongly correlated to increased sea surface temperatures (SST) and formation of thermocline. No significant difference in CPUE could be determined for depth but CPUE varied between localities. Sex ratio showed a significant difference between depths, with increased presence of males with increasing depths at all seasons, a pattern that was even more evident during the main summer fishery period, May to August. The overall sex ratio of the sampled population was estimated to be 67% for females and 33% for males. The percentage contribution of ovigerous females to the total shrimp abundance was high from March to September but decreased with increasing depth. Seasonal variation of ovigerous individuals among females were almost identical at the three depths investigated with main dominance (>80%) from May to October. To study spatial and temporal variations in sizes of *P. narval*, mean values and length frequency distribution *S* were used. Males were generally found to be smaller than females. Size of the narwal shrimp increased from April to July. For both males and females, larger sizes were observed with increasing depth.



PROJECT INDEXMED: ORIGINAL SOLUTIONS TO MANAGE THE HETEROGENEITY OF MARINE ECOLOGY DATA IN THE MEDITERRANEAN SEA

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Concerning studies about biodiversity and socio-ecological systems (SES), the data production in the coastal and marine area is expensive and still has a low level of automation. Long time series and/or large spatial areas studies are difficult to conduct, and when it is necessary to involve several observers, the robustness and reproducibility of the observation is more difficult to obtain.

In a production framework of multi-source data, equivalence of observation systems and their inter-calibration become crucial. Multi-disciplinary or trans-disciplinary integrative approaches become necessary in the study of systems where output of each discipline is discontinuous, imprecise and poorly distributed. Yet all variables (biotic, abiotic, anthropogenic and natural pressures, felt and rendered services, societal image...) of these systems interact over time and at each spatial scale.

A better overall understanding of the balance of SES and their influence on biodiversity will be permitted by constructing and testing co-interpretation methods of analyses of these heterogeneous data. Data mining methods must be able to bring new perspectives to the disciplinary researches that finally examine interrelated objects (environmental chemistry, genomics, transcriptomics, metabolomics, population ecology / landscape, socio-ecological systems).

The IndexMed consortium aims to identify and overcome the scientific barriers related to data quality and heterogeneity. The use of graph-based model allows us to consider them, despite their differences, at a similar level, and improves decision support using emerging data mining methods (collaborative clustering, machine learning, mining graphs, knowledge representation, etc).

Keywords: interdisciplinarity, data qualification, standards, data dictionary, thesaurus, ontologies, inter-calibration, decentralized information system, integrated coastal management



CIGESMED PROJECT: EVIDENCE-BASED MANAGEMENT FOR CORALLIGENOUS HABITATS IN THE MEDITERRANEAN SEA

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Coralligenous is one the main Mediterranean hard bottom seascape generating structural complexity and biodiversity. It provides goods and services to several sectors. Pollution, anchors, trawling and diver frequentation may cause its degradation, whilst traditional fishing as well as angling mainly affect target species. Coralligenous may also be susceptible to turbidity and invasive alien species. These habitats, which are of great ecological, socio-economic and patrimonial importance, are also under the pressures caused by the global warming.

CIGESMED's (2013-2016) goal is to understand the links and consequences of natural and anthropogenic pressures to the functioning of these habitats and to define and maintain their Good Environmental Status (GES) in the Mediterranean Sea. This project gathers scientists from France, Greece and Turkey, working in ten marine ecology laboratories. A Committee of External Advisors, meeting at an annual basis, and aiming at providing advice on all aspects of the execution of the project is helping the scientific steering committee and is ensuring CIGESMED to reach its objectives. Coralligenous specific indices have been constructed and collectively tested in the NW Mediterranean, in different parts of the Mediterranean Sea. Protocols have also been designed for the implementation of a Citizen Science network. Different types of tested monitoring protocols have produced large and heterogeneous data sets; new tools and methods for management, analysis and for data representation have been developed and made available under open source formats.

CIGESMED outcome will be an integrative assessment of the GES, in compliance with Marine Strategy Framework Directive. The main output include: a new definition of coralligenous, a short list of species to be managed, insights for innovative bioindicators including the use of molecular tools, the implementation of an international citizen science network and specific website dedicated to coralligenous monitoring and finally, a decentralized information system.

Keywords: biogenic habitats, monitoring, observable biodiversity, standardized protocols, bioindication, large ecological data sets, decentralized information system, Marine Strategy Framework Directive, Photoquad software, scientific diving



ARE LARGE-BODIED SERRANIDS POPULATIONS DECREASING IN THE PACIFIC COAST OF THE SOUTHERN BAJA CALIFORNIA PENINSULA?

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Serranids of the genus *Mycteroperca* and *Epinephelus* are important targets of commercial and recreational fisheries in the Pacific off the Baja California peninsula and within the Gulf of California. Serranids are particularly vulnerable to overfishing due to their large adult size, longevity, high habitat affinity, the formation of spawning aggregations and because many species are protogynous hermaphrodites. Hence, targeted fishing of large-sized fishes can lead to a lower fertilization rates and decreased recruitment, and a sharp decrease in population size. Worldwide, many species serranids have suffered population collapses due to overfishing of the larger-sized individuals.

There is little information regarding the current and past population size and exploitation level of *Mycteroperca* sp. and *Epinephelus* sp. in the Magdalena Bay (MAB) region, a productive coastal area located in the Pacific off the Baja California Peninsula. This study aims to evaluate the past and current status of serranids through 1) the analysis of fishery data and the review of historical documents, 2) interviews with fishermen of different generations to characterize current and past fishing practices and the perceptions regarding the local population's characteristics and 3) visual censuses to estimate current density, the size-distribution of specific species and document the presence of spawning aggregations.

Data analyzed indicate an overall decrease in the abundance of some species of large sized groupers. Analysis of the official catch records, catch volumes of these species increased by 225% between 2001 and 2013, probably due to increased fishing effort (further fishing places and more time spent fishing) and a higher number of catch reports registered by CONAPESCA in MAB. Interviews of local fishermen indicated that there was a 30% decrease in the estimated maximum size captured over the past four decades. Changes in population abundance over time and the maximum size captured were not perceived equally by the three generations of fishermen interviewed; fishermen ≥ 55 years of age described a greater decline in abundance. The lack of ecological studies in BMA and the importance of groupers to the ecosystem make necessary the implementation of appropriate management measures for their preservation and sustainable exploitation.



ESTIMATING THE CONTRIBUTION OF SINGLE NURSERY AREAS TO THE OVERALL HERRING (*CLUPEA HARENGUS*) POPULATION IN THE WESTERN BALTIC SEA BY OTOLITH CHEMISTRY

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For many fish species, coastal areas are ecologically important by providing essential spawning and nursery habitats. However these habitats are often highly impacted by multiple anthropogenic threats. Western Baltic populations of Atlantic herring (*Clupea harengus*) are an economically and ecologically important component of the Baltic Sea ecosystem. Herring shows a distinct homing behavior returning to particular spawning grounds every year during spring. Attributed to early life stage mortality, herring recruitment decreased in the western Baltic Sea during the past two decades. Since major drivers and stressors for herring reproduction are potentially introduced on the local scale of spawning and nursery grounds, the knowledge of the contribution of different nurseries to population dynamics is essential but challenging to investigate.

We used elemental fingerprinting in herring otoliths to detect differences in the chemical composition based on varying water chemistry in particular spawning areas. Cluster analysis revealed a distinct chemical separation between juvenile herring caught in the vicinity of the Island of Ruegen (south-western Baltic Sea) and other potential nursery areas further west in the Baltic Sea. Element concentrations of i.e. copper, lithium, arsenic and mercury differed significantly among areas, indicating that otolith chemistry is a suitable means to identify the origin of herring offspring and therefore the contribution of particular nursery areas.

Further analyses of trace elements in otoliths from a random sample of adult herring will prove the ratio of individuals that originated in a certain nursery area. Otolith chemistry is considered a valuable tool for evaluating the contribution of different spawning areas to the adult population which could lead towards a more directed management of important spawning grounds and nursery areas.



USING MOLLUSCAN DEATH ASSEMBLAGES TO UNCOVER THE ECOLOGICAL HISTORY OF MARINE HABITATS - A CASE STUDY FROM THE NORTHERN ADRIATIC SEA

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The shallow northern Adriatic Sea was formed at the end of the last glaciation by the rising sea level. Since historical times, it has been strongly influenced by human activities (e.g. fishing, coastal development, pollution, eutrophication), making it one of the most degraded marine ecosystems worldwide. Our study reconstructs environmental changes and anthropogenic impacts since the onset of the Holocene transgression using down-core changes in molluscan death assemblages as indicators for ecological shifts. The sediment cores were taken at three stations (Brijuni Islands, Croatia; off Piran, Slovenia; off Venice, Italy), each representative of specific sediment and nutrient conditions and degrees of habitat exploitation. The cores were 1.5 m long and had diameters of 90 or 160 mm. For the molluscan shell analyses, sediment subsamples were examined for species composition, abundance and taxonomic similarity. In total, 98,700 shells were investigated and 113 bivalve and 178 gastropod species recorded.

Sedimentation rates derived from ²¹⁰Pb dating are very low, between 0.15 cm/yr at Brijuni and 0.25 cm/yr at Piran station. The dating of bivalve shells (*Lucinella divaricata*, *Timoclea ovata* and *Gouldia minima*) with ¹⁴C calibrated amino-acid racemisation revealed that the cores at all three stations cover at least 6000 to 8000 years. Time averaging is high, especially in the lower core layers of Piran station, probably due to strong bioturbation. Molluscan assemblages show significant interregional differences that correlate with grain size, nutrient concentration and the occurrence of organic pollutants and heavy metals. Down-core changes in molluscan communities are also conspicuous in all cores. They partly reflect long-term changes in water depth, vegetation cover or grain size distribution caused by natural fluctuations of environmental conditions over the past millennia. In the uppermost core layers, however, these changes can be interpreted as indicators of anthropogenic impacts.



EFFECTS OF BENTHIC SUBSTRATE COMPLEXITY ON EGG MORTALITY OF ATLANTIC HERRING (*CLUPEA HARENGUS*) IN THE BALTIC SEA

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Western Baltic herring (*Clupea harengus*) annually migrate into shallow coastal areas for mating and spawning. They attach their demersal eggs to benthic substrates, mainly submerged vegetation. Despite the severe decline of aquatic plants over the last decades, herring regularly return to the Greifswalder Bodden, a major spawning area of this stock. This strong spawning site fidelity renders the stock vulnerable against environmental changes and habitat alterations. In the studied system, eutrophication resulted in an increased water turbidity followed by a degradation of macrophyte habitats in water depth below 4 m. Additionally, increasing coastal modification and commercial utilization of coastal zones introduces artificial structures such as harbor walls and wave-breakers. It is assumed that herring spawning behavior is non-selective in respect of spawning substrates. However, little information is available on the effects of different substrates on egg development.

Hypothesizing that the character of spawning substrate affects the development of herring eggs, we defined potential natural and artificial spawning units. Those were incubated in laboratory and field experiments to analyze the embryonic development. The results indicated that especially substrates with a complex, multidimensional structure increased the hatching success. Based on this findings, we conducted further experiments to examine a correlation between the structural complexity of a substrate and the mortality rate of attached eggs. To compensate for any physiological effects of different substrate materials artificial plants of differing complexity but same material were used as spawning substrates to investigate relation among substrate structure and egg development. The analysis revealed that artificial plants with a laminar structure resulted in a higher egg mortality rate than complex, multi-dimensionally structured plants.

The results of this study indicate that complex benthic structures such as beds of macro algae and seagrass meadows provide essential functions as spawning substrate for herring in the Baltic Sea. To increase our knowledge on substrate requirements for herring reproduction is essential to evaluate consequences of environmental changes and anthropogenic alteration on coastal spawning grounds and their effects on population dynamics. This is a basis for effective management of coastal habitats and thus a foundation for resilient herring stocks.



FISH POPULATION ASSESSMENT IN THE EASTERN ADRIATIC SEA: BAITED, REMOTE, UNDERWATER VIDEO (BRUV) VERSUS TRAMMEL NET SAMPLING

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Development of non-destructive, fisheries-independent methods of fish population assessment, behavioural ecology, and habitat choice are a conservation priority within the European Union. In this paper we evaluated (1) the suitability of two alternative methods for fish population assessment: trammel net sampling and non-destructive BRUV (Baited Remote Underwater Video), and (2) the potential to cross-calibrate the methods based on a set of shared species with high catch probabilities within the eastern Adriatic Sea (Croatia). A statistical power analysis concluded that BRUV can be conducted with sufficient sample size to perceive small changes in fish population size with high power, and therefore can be used as a sentinel monitoring method. We found that fish species detected by both methods amounted to almost a third of the number of species in each method's catch, and that 90% of these species are candidates for cross-calibration. 74% of the species at BRUV and 50% at trammel had occurrence probabilities above 10%, a reasonable threshold allowing stock assessment of these species. The sampled and predicted total species richness, extrapolated from the species accumulation curves, was almost identical across methods. We conclude that cross-calibrating the two methods and eventual replacement of the trammel method with non-destructive BRUV is a feasible goal in the eastern Adriatic Sea. The most needed areas of improvement currently are optimization of night-sampling methods and development of more effective strategies of attracting sedentary species within three-dimensional habitat cover. This work has been supported under the Croatian Science Foundation under the project COREBIO (3107).



COMPARISON OF TRAWL FISHERIES EFFECT ON CHONDRICHTHYANS BETWEEN GOKCEADA ISLAND (NORTH EASTERN AEGEAN SEA) AND AROUND ISKENDERUN BAY (NORTH EASTERN LEVANTINE SEA)

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In this study, we evaluated biomass and abundance data according to spatial and temporal factors focusing on Chondrichthyan species in different fishing areas from the Eastern Mediterranean Sea. The 149 hauls were performed by commercial trawlers between June 2014 and September 2015 in depths of 30-400 m. Totally, 159 fish species were identified in the study, 22 of them belonging to shark and batoid groups. The average abundance of Chondrichthyan species constituted 1.47% of the total catch. The frequency of these species was calculated as 62.26 in all hauls. The small spotted catshark, *Scyliorhinus canicula*, was the most abundant species among the sharks in both areas (80 N/km² in Iskenderun Bay, 233 N/km² in Gokceada Island), while the thornback ray *Raja clavata*, (71 N/km² in Iskenderun Bay, 17 N/km² in Gokceada Island) was the most abundant species among batoids. Also, some rare species such as *Leucaja naevus*, *Raja radula*, *Dipturus batis* and *Squatina oculata* were obtained from the Gokceada Island. *Mustelus mustelus*, *Squalus acanthias* (in both studying areas) and *Dasyatis pastinaca* (in the Iskenderun Bay) show a declined trend in comparison with previous studies.



LONG-TERM MONITORING OF THE ANTARCTIC COASTAL BENTHOS WITH NON-DESTRUCTIVE TECHNIQUES: THE ICE-LAPSE PROJECT AT TERRA NOVA BAY (ROSS SEA, ANTARCTICA)

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SCUBA-based benthic monitoring programs in extreme and logistically challenging underwater environments necessarily have to be as efficient and rapid as possible, in order to minimize bottom time. At the same time, they have to guarantee useful results with the minimum impact for benthic communities.

The case of Antarctic benthos dynamics' and spatial patterns' analysis is an emblematic example of this kind of research challenge, requiring a time- and cost- effective sampling method, due to the logistical difficulties of field activities in such inhospitable place and the extremely reduced bottom time allowed for divers operating at -1.8°C .

Within the PNRA (Italian National Antarctic Research Program) project ICE-LAPSE (PNRA 2013/AZ1.16), a network of permanent monitoring stations was created for the study of Antarctic benthos at Terra Nova Bay (Ross Sea) by using novel technologies and a non-destructive approach, based on video and photographic sampling methods. The collected data will be of fundamental importance in establishing a reference baseline for this area to measure future changes and study the benthos dynamics in the short and long-term.

All sampling activities of the project took place in November-December 2015 and, in the specific, these were: i) HD video recording along fixed transects in order to start a monitoring program of TNB macrobenthos; ii) Short-term study (24-48h) of benthos dynamics by using time-lapse video recording; iii) Placement of a long-term, time-lapse video recording system to study the benthos dynamics for one year; iv) Placement of ARMS (Autonomous Reef Monitoring Systems) structures to study settlement; v) Placement of probes for environmental parameters (T, salinity, light intensity).

The elaboration of images from the video transects enabled the study of Antarctic macrobenthos dynamics at the local scale with a 'seascape' approach, focusing on the distributional patterns of key species such as the scallop *Adamussium colbecki*, the sponge *Mycale acerata*, and the regular sea urchin *Sterechinus neumayeri*. Preliminary analyses showed the great potential of photogrammetric techniques in obtaining 3D models of the sea bottom and of conspicuous species such as massive sponges with an unprecedented level of detail.

The technology developed in this monitoring program, due to its non-destructive nature and relatively low cost, can be of wider application to other coastal sites where logistical constraints allow a short bottom time and few or no repeated dives.



CROSS-HABITAT INVESTIGATION OF BENTHIC MACROFAUNAL COMMUNITIES AND NUTRIENT RECYCLING

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Coastal zones are important for many ecosystem functions, such as primary production and nutrient recycling, as well as in maintaining a high biodiversity. Heterogeneous coastal ecosystems act as nutrient filters between land and the open-sea, but the processes and context-dependency related to such a filter function have not been well quantified. For example, the activity of benthic macrofauna, through bioturbation, bioirrigation and feeding, affects sediment biogeochemistry and the processes of nutrient retention and transformation at the sediment-water interface. However, not many studies have explored these relationships on a larger scale across habitat types.

We conducted a large-scale field survey in the northern Baltic Sea; intact sediment cores were collected from 18 sites along a gradient from fine to coarse sediments, including variation in organic matter input and vegetation coverage. The sediment cores were incubated for measurement of oxygen and nutrient fluxes prior to sieving to quantify the benthic macrofauna. The results showed a large variation and context-dependency in the measured fluxes between habitats, as well as in the macrofaunal communities. Exploring the variability in the relationships between habitats, macrofauna and nutrient cycling increases our understanding of biodiversity-ecosystem functioning in the coastal zones with a mosaic of habitats.



METACOMMUNITY STRUCTURE OF BEACH MACROINVERTEBRATES: CONTRASTS BETWEEN DISPERSAL MODE AND HABITAT SPECIALIZATION

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Understanding patterns and mechanisms of variation in the structure of communities across spatial scales is a fundamental challenge in ecology. We examined the role of local environmental and spatial processes in structuring benthic communities on 21 shallow soft-sediment sites in a beach network using a metacommunity ecology approach. We found that both processes contributed to a varying degree to the structure of the local communities suggesting that the interplay of environmental filters and dispersal related mechanisms played key roles in determining abundance patterns. We further categorized all the benthic invertebrate taxa from the beach communities according to their dispersal mode (i.e., passive vs. active) and habitat specialization (generalist vs. specialist) to obtain further information on metacommunity dynamics. We found that passive dispersers responded to a combination of environmental and spatial processes, while active dispersers were environmentally mediated. We also found that habitat generalists responded primarily to spatial factors, while habitat specialists only responded to local environmental filtering. Our findings emphasize the complexity of natural benthic ecosystems, and the need to use different categories of species traits as an approach to make accurate predictions about dynamics in metacommunity studies. Our study highlighted the sensitivity of beach macroinvertebrates to eutrophication proxies (e.g., submerged vegetation cover, organic matter or turbidity). Beaches play a fundamental role in the functioning of coastal zones, and eutrophication is a significant stressor in coastal ecosystems. A better understanding of the role of the environmental spatial processes of beach metacommunities will help us to improve our ecological understanding of the coastal zones, and prioritize management actions to cope with pervasive environmental stressors.



REPRODUCTIVE BIOLOGY OF *PLESIONIKA NARVAL* IN THE DODECANESE ISLANDS, SE AEGEAN SEA

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Plesionika narval is a widespread species of the Pandalidae family, of particular high economic importance for small-scale shrimp trap fisheries in the Dodecanese Islands (SE Aegean Sea). Understanding of its biology and reproduction are crucial for stock management. Reproductive biology aspects were studied through data collected during monthly experimental surveys with baited shrimps traps (November 2014 - October 2015), carried out in the study area, at a depth range 10-150 m. A total of 3436 individuals within the size range of 6.46- 20.20 mm carapace length (CL), were preserved in 10% formalin and analyzed. Overall, mean female size ($CL_f = 13.83$ mm) was significantly higher than mean male size ($CL_m = 12.19$ mm) (ANOVA, $F=555.67$, $p<0.05$), while the mean size of ovigerous females ($CL_{OV} = 14.30$ mm) was higher than that of non-ovigerous females ($CL_{Non-OV} = 12.19$ mm) (ANOVA, $F=138.81$, $p<0.05$). Ovigerous females were observed throughout the study period; however, monthly proportions revealed that the April to October was the main reproductive period of the species in the area. The smallest size of ovigerous females was 9.79 mm in CL, attributed to mesh size used (12 mm). The largest size of ovigerous female was 20.20 mm in CL and was collected in October. The sex ratio showed a clear predominance of females in the shallow depth zone (10-25 m). Immature females (stage I gonads), were found from November to March. Mature females (stage IV gonads) were found all year round, exhibiting higher percentages in March (37.95%), June (38.04%), July (37.71%) and September (44.23%), indicating that *P. narval* has continuous reproductive activity. Gonadosomatic index (GSI) obtained its highest mean \pm SE values (peak of spawning) in May (1.90 ± 0.24), June (2.04 ± 0.20) and September (2.39 ± 0.21), indicating two peaks in the spawning season thus revealing its main reproduction period from April to October. Size at first maturity (CL_{50}) was estimated from 1981 female individuals and was $CL_{50} = 11.7$ mm in CL. The present work was funded by the European Fisheries Fund, PLESIONIKA MANAGE project, co-financed by the Greek Ministry of Rural Development and Food and the EU, OPF 2007-2013.

Keywords: pandalid shrimps, sex ratio, gonadosomatic index, Eastern Mediterranean Sea



FISH BEHAVIOR FROM UNDERWATER OBSERVATIONS IN THE BOTTOM TRAWL CODEND FROM THE AEGEAN SEA

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Information on fish behavior is important for selectivity studies. In the present work bottom-trawl selectivity experiments using different codend meshes (40 mm diamond mesh-used in the past in the Mediterranean, 40 mm square-currently used, and 50 mm diamond mesh-potential future use) have been studied to describe fish behavior inside and outside the codend. The covered codend method was used. Cameras were placed in the inner and outer area of the codend to record net condition and fishes escaping through the codend to the cover as well as individuals remaining in the codend. In total, the videos from 45 hauls were analyzed. Information related to species identification, swimming activity, direction of motion and condition were recorded. *Engraulis encrasicolus*, *Sardina pilchardus*, *Mullus barbatus*, *Mullus surmuletus*, *Trachurus spp.*, *Spicara smaris* and *Boops boops* remained very actively swimming for the duration of the one-hour experimental trawling periods. They also tried to escape in an upward direction, passed through the codend and remained actively swimming between the codend and the cover. However, other species such as *Merluccius merluccius* and *Lophius budegassa* did not seem to be very active in the trawl and many times were observed to be moribund. *Raja* species also remained mostly close to the bottom of the trawl. Differences in fish behavior and the number of fish species identified between the different codends were also examined.



SEASONAL VERTICAL STRATEGIES IN A HIGH ARCTIC COASTAL ZOOPLANKTON COMMUNITY

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We studied the larger (>1000 μm) size fraction of zooplankton in an Arctic coastal water community in Billefjorden, Svalbard (78°40' N) in order to describe seasonal vertical distributions of the dominant taxa in relation to environmental variability. *Calanus* spp. numerically dominated the herbivores. *Aglantha digitale*, *Mertensia ovum*, *Beroë cucumis*, and *Parasagitta elegans* were the dominant carnivores. Omnivores and detritivores were numerically less important. Descent to a deeper region of the water column (>100 m) between August and October, and ascent to the shallower region (<100 m) between November and May was the dominant seasonal vertical strategy in this zooplankton community. In contrast to other groups, *P. elegans* was not found to have pronounced vertical migrations. Seasonal vertical strategies of most species could be described in association with the availability of their main food source. The seasonal vertical strategy of later developmental stages of *Calanus* spp. was inversely associated with fluorescence, indicating that they descended from the shallower region while it was still relatively productive, and ascended before the primary production had started to increase. Strong similarities between the vertical strategies of secondary consumer *M. ovum* and *Calanus* spp., and tertiary consumer *B. cucumis* and *M. ovum* indicated that these carnivores seasonally followed their prey through the water column. We conclude that seasonal vertical migrations were a widespread trait in the high-Arctic community studied, and predator-prey interactions seemed particularly central in shaping the associations between the seasonal vertical strategies of adjacent trophic levels.



TAXONOMIC VS FUNCTIONAL PATTERNS ACROSS EUROPEAN MARINE BENTHIC HABITATS: USING RESEARCH INFRASTRUCTURES (LIFEWATCH, ESFRI) IN LARGE-SCALE ECOLOGY

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In the framework of EMBOS (European Marine Biodiversity Observatory System) project, soft-bottom communities from marine and transitional ecosystems were sampled from twenty-eight marine sites along the European coastline, using jointly-agreed and harmonised protocols, tools and indicators. The dataset was subsequently used to test a number of hypotheses, by comparing taxonomic to functional patterns across different biogeographical regions sampled and using a variety of multivariate and univariate analyses. The LifeWatch Research Infrastructure (European Strategy Forum on Research Infrastructures) was used to manage and analyze the data. The results of the study indicate that patterns derived from matrices with taxonomic and functional data are similar but not identical. In addition, both taxonomic and functional sufficiency concepts seem to be supported by the data used. Furthermore, the Atlantic Ocean and Mediterranean Sea share a similar pattern of trait representativeness while in the Baltic Sea the pattern differs due to its short geological history and the extreme nature of its habitats. It is concluded that taxonomic and functional approaches result in complementary patterns and thus they should be applied in concert to achieve improved management of marine areas.



MERCURY SPECIATION IN VARIOUS TISSUES OF TWO DEMERSAL PREDATORS FROM THE NORTH AEGEAN SEA: EFFECTS OF SEX, MATURITY CONDITION AND BODY LENGTH

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Sharks as long-lived, apex predators represent good bioindicators of the extent of mercury contamination in the marine ecosystems. This study examined total mercury (Hg) concentrations in the muscle, liver, gills and gonads of 469 small-spotted catsharks (*Scyliorhinus canicula*) and 208 longnose spurdogs (*Squalus blainville*), captured accidentally by commercial fishing vessels in the North Aegean Sea (off Skyros and Psara Islands) during an 8-year period. Mercury quantifications were carried out by cold vapour atomic absorption spectrometry (CVAAS) with stannous chloride as reducing agent. Preferential Hg bioaccumulation occurred in muscle tissue in both species, following the order: muscle > liver > gills > gonads. Sex seemed to play an important role in differentiating Hg levels only in *S. blainville*. On the contrary, maturity condition affected Hg levels in both species, with mature individuals having a significantly higher Hg content than immature ones in most of the tissues. The between-species comparison showed a significantly higher Hg content in *S. blainville* in all of the tissues examined, except liver. Body-length dependent accumulation of Hg was observed in both species, regardless of the tissue. From a regulatory point of view, in 67.7 and 88.8% individuals of *S. canicula* and *S. blainville*, respectively, Hg exceeded the European Commission regulatory threshold of 1 mg/kg w.w. The estimated weekly intake of Hg (EWI) exceeded the provisional tolerable weekly intake (PTWI) and the recommended reference dose (RfD) in both species. Mercury hazard index (HI) exceeded the safe limit of 1 in both *S. canicula* and *S. blainville* (1.92 and 4.14, respectively). The maximum possible consumption of the studied species (MPCF per week for a mean body weight of 70 kg) was 0.25 kg for *S. canicula* and 0.11 kg for *S. blainville*. In light of these findings, it appears that the regular consumption of *S. canicula* and *S. blainville* from the North Aegean Sea should be discouraged and mercury levels should be regularly evaluated for these species.

Keywords: mercury, metal body distribution, multi-factorial effect, risk assessment, sharks, Mediterranean Sea



SEASONAL CHANGES IN MACROZOOBENTHIC COMMUNITIES IN SHALLOW COASTAL HABITATS

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Coastal zones encompass a wide variety of different habitats that support a high biodiversity and are therefore important areas for the maintenance of ecosystem functions, such as primary production and nutrient cycling. Coastal areas of the Baltic Sea are exposed to large differences in temperature and light due to changes in season. This is reflected in the differences in community composition throughout the year. To gain a broader understanding of the coastal macrozoobenthic community, rather than doing a snapshot-study at one time point, we conducted sampling bimonthly throughout one year. We chose three shallow coastal stations representing three different macrozoobenthic habitat types, mainly reflected in differences in grain size. From each station at every time point we took four sediment cores and characterized the surrounding environment to gain an understanding of the seasonal changes in not only the macrozoobenthic community, but also in the surrounding habitat. From our cores we retrieved data on the occurrence of different species of macrozoobenthos and we also measured oxygen and nutrient fluxes to obtain information on the current status of nutrient cycling processes taking place at the sediment surface. In our results we describe the seasonal changes in macrozoobenthic community composition and discuss the effects of these changes on the functionality of the system, including differences in the effect of macrozoobenthic activity on oxygen and nutrient fluxes over season.



TEMPORAL VARIATIONS (2004-2015) IN EPIBENTHIC MEGAFUNAL COMMUNITIES FROM THE ARCTIC DEEP-SEA OBSERVATORY HAUSGARTEN

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Established in the Fram Strait in 1999, the LTER (Long-Term Ecological Research) observatory HAUSGARTEN enables us to study the composition of Arctic epibenthic megafaunal communities through the analysis of seafloor photographs. This, in combination with annual sampling campaigns, which have yielded data on faunal, bacterial, biogeochemical and geological properties, as well as on hydrography and vertical export, allows us to identify drivers of temporal variations in megafaunal abundances, diversity and community structure.

Here, we present the first time series results from a northern and the southernmost station of the observatory (N3 and S3, ~2500 m depth) from 2004 to 2015, obtained via the analysis of images acquired by a towed camera (Ocean Floor Observation System). We assess variability in megafaunal densities, species composition and diversity as well as biotic and abiotic factors, which may cause the patterns observed. Both stations display significant differences in megafaunal abundances, diversity and abiotic factors with N3 in particular seeing a significant increase in megafaunal abundance from 12.08 (± 0.39) ind./m² in 2004 to 35.21 (± 0.97) ind./m² in 2007, alongside a ten-fold increase in (drop)-stones. At S3, megafaunal densities peaked in 2015 (22.74 \pm 0.61 ind./m²) showing a significantly increasing trend since 2004 (12.44 \pm 0.32 ind./m²).

Holothurians showed particularly striking temporal differences: densities of the small sea cucumber *Elpidia heckeri* increased significantly from 0.31 ind./m² (2004) to 3.74 ind./m² (2015) at S3, coinciding with a significant, sustained increase in chloroplastic pigment equivalent, phospholipid and readily soluble protein quantities in the sediment. Initially entirely absent from N3 in 2004, densities of the larger holothurian *Kolga hyalina* peaked in 2007 (5.87 ind./m²) and decreased continuously since then, mirroring a decrease in particulate organic carbon concentrations. Overall diversity (γ) increased significantly at both stations over the course of the study, however, with varying contributions of α and β diversities.

Our results highlight the importance of time-series studies as the community composition is characterised by a continuous change, taking approximately three years to fully diverge. This indicates that epibenthic communities from the deep seafloor are reactive and dynamic, with no “null” community state, and to monitor them over is crucial in understanding natural and anthropogenic impacts in an area exposed to the effects of climate change.



USING POPULATION GENETIC DATA TO ESTIMATE POPULATION CONNECTIVITY AND COLONISATION HISTORY. THE CASE OF SEA BELT KELP *SACCHARINA LATISSIMA*

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Kelp species form important parts of coastal ecosystems worldwide, providing primary production and 3D structure. Worldwide, kelps are increasingly harvested and farmed. Knowledge on population connectivity in kelp is important for management and protection of its natural populations. We studied the northern hemisphere temperate to arctic taxon *Saccharina latissima*. The study was achieved based on ten newly developed polymorphic microsatellite DNA markers and COI (cytochrome-c-oxidase I) DNA sequences, and carrying out coalescent simulations with molecular clock calibrations. This has yielded important novel insights into levels of connectivity among European populations of sea belt, as well as into the colonisation history of the taxon around the northern hemisphere.



ASSESSMENT OF PROTECTED AREAS IN THE MEDITERRANEAN: INTRODUCING A FISHERIES PERSPECTIVE

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Networks of Marine Protected Areas (MPAs) are recognized worldwide as an important tool for biodiversity and ecosystem conservation, and are currently adopted by all the EU marine and maritime policies. According to Article 13 of MSFD, spatial protection at EU level should be addressed to coherent and representative MPA networks that adequately cover the diversity of species, habitats and ecosystems. In the present study preliminary results from the MPAs Challenge of the EMODnet Med Sea Checkpoint, aiming to analyze the existing network in the Mediterranean, are presented.

One of the most important deficiencies in assessing the efficiency for the Mediterranean MPAs is the lack of knowledge of the conservation measures adopted by each protected area especially in terms of fishing activities. As a first step to address this shortcoming we added Fisheries Restricted Areas (FRAs) to the list of the protection initiatives. We built a comprehensive list of protection initiatives combining the databases from different sources and a geodatabase of habitats and species distributions.

Preliminary results on MPAs networks' adequacy showed that despite the large number of protected areas established in the Mediterranean (781 according to our database), the majority are small coastal sites that cover 6% (3.4% without the large marine mammals' sanctuary, Pelagos) of the total area of the Sea. Only the 0.15% of the Mediterranean Sea constitutes no-take zones, where the use of all fishing gears is prohibited. The median size of the protected areas is 5 km², a value that highlights the existence of multiple small parks. These are generally located close to the shore and most of the times are part of larger terrestrial protected areas. Representativity analyses on key habitats and vulnerable species indicated that 17% of Posidonia meadows, 20% of transitional waters and 13% of coralligenous formations overlap with protected areas other than FRAs; Only 0.86% of Posidonia meadows, 1.57% of transitional waters and 0.43% of coralligenous formations overlap with FRAs for all gear types highlighting the lack of areas closed to fishing pressure. 62% of Posidonia meadows, 15% of transitional waters and 0% of coralligenous formations overlap with FRAs for bottom trawling, one of the most destructive gears for bottom habitats.



MARINE INVASIONS



ALIEN AND NATIVE FISH IN GILL NETS AT RHODES, EASTERN MEDITERRANEAN (2014-2015)

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Fish catch composition in gill net operations from Rhodes Island (Aegean Sea, Greece) was qualitatively and quantitatively analyzed. Samplings were performed with a hired professional fishing vessel from December 2014 to May 2015, at 5-35 m of depth, over two fishing grounds in the east coast of the island (Faliraki and Kolimbia), where sandy to muddy sand and rocky substrata occurred along with *Cystoseira* sp. and *Posidonia oceanica* beds. A number of 21 samplings produced a total biomass of 183 kg comprising 1072 fish individuals.

The overall species identified were 49, belonging to 25 families, the richest being Sparidae with 14 species and Serranidae with 4 species. Native species were 43 while alien species were 6, all Lessepsian migrants: *Siganus luridus*, *Siganus rivulatus*, *Sargocentron rubrum*, *Fistularia commersonii*, *Lagocephalus scelaratus* and *Sphyræna flavicauda*.

Within the native species *Sparisoma cretense* showed the highest frequency of occurrence in nets (81%) followed by *Scorpaena scrofa* (76%), *Mullus surmuletus* (67%), *Serranus cabrilla* (57%) and *Pagrus pagrus* (52%). Significantly high was the frequency of occurrence of the alien *S. luridus*, *S. rivulatus*, *S. rubrum* and *F. commersonii* (95%, 76%, 71% and 57% respectively), while it was low for *L. scelaratus* (10%) and *S. flavicauda* (5%).

The number of alien fish specimens was 320 (29.9% total abundance) (overall ratio alien/native abundance 0.43), their biomass 48.3 kg (26.37% of total biomass) (overall ratio alien/native biomass 0.36), with the two siganids dominant among aliens (72.8% of total alien specimens and the 71.8% of their total biomass). The native *S. cretense* prevailed in terms of abundance (30% of total specimens) and biomass (27.4% of the total biomass), followed by the two alien siganids, with 22% of total specimens and 19% of total biomass. Ratio alien/native species per sampling ranged from 0.13 to 1.5, whereas the ratio alien/native abundance ranged from 0.06 to 2.88 and the ratio alien/native biomass was from 0.08 to 3.34.

The present work gives a substantial contribute in filling scattered information on coastal fish assemblages in an eastern Mediterranean region heavily impacted by biological invasions.



EFFECTS ON THE MARINE PLANKTONIC FOOD WEB BY THE INVASIVE CLADOCERAN *PENILIA AVIROSTRIS*

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The cladoceran *Penilia avirostris*, a zooplankton originally distributed in tropical and subtropical marine areas around the world, is now occurring regularly in the North Sea and adjacent Scandinavian waters. The effects on the pelagic ecosystem by this species have only to a very small extent been investigated. The results presented here show that resting eggs occur in sediments, which makes *P. avirostris* an established species on the Swedish west coast, and not only transported there each summer by currents. Moreover, the hatching of resting eggs is strongly temperature dependent, with a hatching time of about 30 days at normal summer temperature in sediments at about 10-20 m depth. Experiments comparing grazing activity of *P. avirostris* with the grazing by native copepods (*Acartia* sp.), shows that *P. avirostris* consume phytoplankton at rates comparable to, or even higher than the copepods. *P. avirostris* also consumes food items down to 2-3 μm in size. Copepods usually do not eat food items as small as this. This makes *P. avirostris* potentially both competing with copepods for food, but also that this species compete with ciliates for smaller food particles. This would short-cut the microbial loop, with implications for the food-web transfer of organic carbon.



INTRODUCED CRAB PUSHES COASTAL ECOSYSTEM FROM BOTTOM-UP TO TOP-DOWN CONTROL AND GLIDES BENTHIC AND PELAGIC BASELINES

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It is theoretically simple to test the intensity of bottom-up and top-down mechanisms, but difficult in practice because in situ predator-prey interactions operate on large spatial scales lying far beyond the reach of adequate manipulative research. Crabs are the key predators in coastal food webs, and through bioturbation, grazing and predation, they modulate the availability of resources for multiple trophic levels. The North American mud crab *Rhithropanopeus harrisii* was recently introduced to the Baltic Sea where it has since become the first crab species with permanent reproducing populations across the entire Baltic Sea area. Here we take advantage of this unique opportunity to test the ecological implications of adding a novel interaction - crab predation - to an ecosystem. Using 'before-and-after' field observations, complemented with a census of crab population and manipulative field experiments, we tested the impacts of the invasive crab on nutrient availability, benthic macrophyte, invertebrate, and pelagic communities. Within 2-3 years of *R. harrisii*'s arrival, the mud crab has colonized the whole bay area followed by notable decline in the richness and biomass of benthic invertebrates in soft bottom habitats but not in mixed bottom habitats. Moreover, areas infested by the mud crab were characterized by higher availability of pelagic nutrients and phytoplankton biomass. Experiments showed the observed decline in benthic invertebrates and increase in microalgae was consistent with crab activity and largely independent from background nutrient availability. Our study demonstrates not only how an inclusion of a novel predator in an ecosystem can trigger strong top-down control on lower trophic levels, but also how top-down forces can reallocate bottom-up effects among aquatic habitats through increasing overall nutrient availability and phytoplankton production in pelagic environments.



BALLAST WATERS AS AN IMPORTANT VECTOR FOR THE TRANSFER OF AQUATIC ORGANISMS [PORT BASELINE SURVEY IN THE PORT OF KOPER, SLOVENIA (ADRIATIC SEA)]

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Ballast waters are an important vector for the transfer of Harmful Aquatic Organisms and Pathogens (HAOP) and Non-indigenous Species (NIS). Many organisms loaded on board survive ballasting operations and longer voyages. For the efficient ballast water control and management system, which would track NIS introductions and identify threats for ballast water receiving ports, Port Baseline Surveys (PBS) are to be conducted in ports to compile a list of native species and NIS. These PBSs comprise the sampling of benthic organisms on hard and soft bottoms, plankton and fish community. In the frame of the IPA Project BALMAS (Ballast water management system for Adriatic Sea protection) a PBS in the Port of Koper (Slovenia) was performed. In phytoplankton samples 15 dinoflagellate species (mostly belonging to genera *Dinophysis* and *Alexandrium*) and one diatom genus (*Pseudo-nitzschia*) were recognized as potentially harmful. Few species (*Dactyliosolen phuketensis*, *Lithodesmium undulatum*, *Pseudoguinardia recta*, *Meuneria membranacea*) were detected for the first time in Slovenian waters. Cysts of five potentially harmful dinoflagellates were present in the port sediments: *Alexandrium minutum/tamutum*, *Alexandrium tamarense/catenella*, *Gonyaulax spinifera*, *Lingulodinium polyedrum* and *Protoceratium reticulatum*. The abundance of microbial pathogens in seawater and sediments was higher at the sampling site in the vicinity of treated wastewater discharge; however no *Vibrio cholerae* was detected. Among zooplankton, certain species related to the process of tropicalisation, such as *Muggiaea atlantica*, were identified. Moreover, the first finding of the copepod *Pseudodiaptomus marinus* in Slovenian waters was related to the bioinvasion, and was possibly introduced by ships. In macrofouling samples five NIS were determined: cirripeds *Balanus trigonus* and *Amphibalanus amphitrite*, the bivalve *Crassostrea gigas*, the amphipod *Monocorophium sextonae* and the red algae *Asparagopsis armata* (*Falkenbergia rufolanosa* phase). Among benthic infauna three NIS were identified: bivalves *Arcuatula senhousia* and *Anadara transversa*, and the polychaete *Ficopomatus enigmaticus*. During the sampling of the fish community one NIS gastropod, *Bursatella leachii*, was caught. Lastly, with the selective sampling on hard substrates in the lagoon of the Škocjanskizatok Nature Reserve (near the Port of Koper), one non indigenous cirriped, *Amphibalanus eburneus*, was found, as well.



THE ENIGMA OF SMALL CRAB *BRACHYNOTUS SEXDENTATUS* RISSO, 1827 (CRUSTACEA BRACHYURA VARUNIDAE) IN THE BLACK SEA - AZOV BASIN

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A varunid crab *Brachynotus sexdentatus* was reported as a common and abundant species in the Sea of Azov in the 1930 - 1940s. Since then, its population has virtually disappeared or at least strongly declined in this basin. This coincided with the appearance and spread of a non-indigenous crab species *Rhithropanopeus harrisi*. At the same time *B. sexdentatus* was rarely (virtually never) reported in the northern Black Sea in the last five decades. During our target search of this species (2011 - 2015) we failed to find it in the Taman Bay (Sea of Azov) where it lived in the XX century and where *R. harrisi* is now abundant. However, it occurs along the Caucasian and Crimean coast of the Black Sea where *R. harrisi* is absent. It is found in particular habitats (shallow areas with sandy - shelly substrates) where it maintains a clearly hiding habit. Morphological characteristics, sexual dimorphism and size structure of the Black Sea population of *B. sexdentatus* have been described. *Heterograpsus lucasi ponticus* Czerniavsky, 1884 is confirmed to be a junior synonym of *B. sexdentatus*. Molecular bar coding indicated that the Black Sea specimens have the same haplotype of the mitochondrial cytochrome oxidase gene I as the Mediterranean specimens. *B. sexdentatus* has generally similar habitat preferences and life traits as *R. harrisi*, but attain somewhat smaller size and has relatively smaller chelae with lesser mechanical advantage. Thus, it is possible that *R. harrisi* might have over-competed *B. sexdentatus* in the Sea of Azov, but alternative explanation of the enigmatic spatio-temporal pattern of the latter species have to be also considered.



IS REGIONAL MARINE TRAFFIC A THREAT FOR THE INTRODUCTION OF NEW SPECIES VIA BALLAST WATER DISCHARGE?

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Ballast waters are one of the most important vectors for the introduction of non-indigenous species, also for phytoplankton where several harmful and toxic species can be found. In the frame of IPA Project BALMAS (Ballast water management system for Adriatic Sea protection) ballast waters were sampled on board ten vessels in the Port of Koper (Slovenia). Vessels were chosen to provide ballast waters from different donor ports, all in the Mediterranean Sea. Phytoplankton analyses of different accuracy levels were conducted: i) indicative test of ballast waters with portable PAM instrument to estimate the number of phytoplankton cells; ii) epifluorescence microscopy of FDA stained samples to count the viable cells; and iii) inverted microscopy of fixed samples for taxonomic identification of species. Results of fluorescence measurement with PAM showed that only a minor number of vessels would have been compliant with the 10 cells/ml threshold set by the D-2 standard of Ballast Water Management Convention for organisms between 10 and 50 μm in minimum dimension. Similarly, also detailed analysis on viability of FDA stained cells showed that ballast water from the majority of vessels had >10 cells/ml, although there was not a good correlation between PAM results and stained cells counts. Most commonly observed diatoms in live stained samples were *Skeletonema costatum* s.l. and *Pseudonitzschia* spp., but a number of other viable cells were also observed in different ballast waters (naviculoid diatoms, *Chaetoceros* spp., *Ditylum brightwellii*, *Thalassionema* spp., ebridean flagellates, different dinoflagellates and undetermined nanoflagellates). Detailed analyses of fixed samples revealed a diverse phytoplankton community in ballast water, especially rich in diatoms. Prevailing diatom species were the same as observed in stained samples and which regularly occur in Slovenian waters. Besides these, two diatom species *Lithodesmium undulatum* and *Dactylisolen phuketensis* were observed for the first time almost synchronously in sea water samples of the Port of Koper and in some ballast water samples. Their parallel occurrence should be discussed in the light of possible spreading between the Mediterranean ports via ballast waters.



FACTORS CONTROLLING LONG-TERM CHANGES OF MACROZOOBENTHOS: LESSONS FROM THREE MONITORING SITES IN THE EASTERN GULF OF FINLAND

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Analysis of 30-years (1985-2014) benthic data series from three monitoring sites demonstrated the considerable variations in structure and abundance of macrozoobenthos. The bottom macrofauna at the study sites was very poor and consisted of only a few species. At the beginning of the study period macrozoobenthos was strongly dominated by glacial relict crustaceans: isopods *Saduria entomon* and amphipods *Monoporeia affinis*. In 2000s this uniquely simple benthic community was enriched with introduction of non-indigenous annelid species: tubificid oligochaetes *Tubificoides pseudogaster* and spionid polychaetes *Marenzelleria arctica*. The observed changes in macrozoobenthos abundance and biomass can be classified into three types which were related to influence of different factors. (1) The interannual and site-specific variations were related to the cyclic (with period equal to 6-7 years) oscillations of local populations of crustaceans. These oscillations were connected with intraspecific competition for limited food resources and the action of the mechanism of density dependent regulation. (2) The more long-term and large-scale changes were triggered by periodical hypoxic events leading to mass mortality of benthic organisms and subsequent recovery succession. Immediate causes of these events were variations of hydrographic conditions in the Baltic Sea controlled by large-scale climatic factors. (3) The most significant changes were related to biological invasions of annelid species especially *Marenzelleria arctica*. Introduction of these hypoxic-tolerant polychaetes mitigated the negative effects of oxygen depletion on benthic communities. In contrast to the reversible population cycles and climate-driven variations invasion-induced changes can be characterized as irreversible regime shifts resulting in formation of new alternative communities. This shift is in line with the concept of continuing postglacial succession of the Baltic Sea. The results suggest that factors controlling temporal changes in macrobenthic communities differed with scale. Factors important at the short-time scale, such as intraspecific competition, are of no significance in controlling of the long-term tendencies.



MACROBENTHIC FAUNA ASSOCIATED WITH THE INVASIVE ALIEN SPECIES *BRACHIDONTES PHARAONIS* (MOLLUSCA: BIVALVIA) IN THE LEVANTINE SEA

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The invasive alien mytilid species, *Brachidontes pharaonis*, dominates the medio-littoral and upper-infralittoral zones of the Levantine Sea. It forms a biogenic habitat in the area and host a number of alien and native species. Three-replicated samples of *Brachidontes pharaonis* were taken by a quadrat of 20x20 cm in dimension at 7 stations along the Levantine coast of Turkey in September 2005. Examinations of samples yielded 189 macrobenthic invertebrate species and 23407 specimens belonging to 13 taxonomic groups. Polychaeta accounted for up to 48% of the total number of species, whereas Mollusca comprised 46% of the total number of individuals. The dominant species in the habitat were *Stenothoe dollfusi* (12%), *Spirobranchus kraussi* (10%), *Mytilaster minimus* (7%) and *Elasmopus pocillimanus* (12%). The species with the highest frequency values were *Pseudonereis anomala*, *Phascolosoma stephensoni* and *E. pocillimanus*. The highest faunal density and the biomass (wet weight) in the habitat were estimated as 72550 ind.m² and 19178 g.m², respectively. The species number in samples changed between 14 and 47 species in the area. The mean diversity index values ranged from 1.72 to 2.27, and the mean evenness index values from 0.37 to 0.62. In the investigated area, two faunal assemblages were encountered, and the species responsible for the dissimilarity of the assemblages were *E. pocillimanus*, *Syllis prolifera* and *Stenothoe dollfusi*. The environmental variables best explaining variation in zoobenthic community structures were salinity, dissolved oxygen and nitrogen in the water column. This study was financially supported by TUBITAK (project no: 104Y065).



PLASTIC TRAITS OF THE INVASIVE MUSSEL *XENOSTROBUS SECURES* IN RESPONSE TO THE PRESENCE OF THE PREDATORY DOGWHELK *NUCELLA LAPILLUS*

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The ability of the invasive mussel *Xenostrobus securis* to activate defence mechanisms in response to the presence of a novel predatory dogwhelk *Nucella lapillus* was explored using field and laboratory-based approaches to evaluate the importance of the origin of individuals in relation to their ecological memory. Mussels were obtained from two populations characterized by different levels of predation pressure (high and low) and by different environmental conditions in the Ría de Vigo (NW Iberian Peninsula). In the field, the responses of mussels in a cage-transplant experiment were clearly asymmetrical, as only individuals caged with dogwhelks at the high-predation site developed phenotypical changes in protective tissues, such as stronger byssal attachment, thicker shells and heavier posterior adductor muscle. No such responses were observed in mussels held in cages without dogwhelks at the high-predation site. In mussels transferred to the low-predation site and held in cages without dogwhelks, only an increase in the weight of the posterior adductor muscle was observed. By contrast, shell growth was faster in mussels held in cages without dogwhelks at the high predation site, which suggests that mussels were only able to allocate energy to shell growth when other energy-demanding responses were not activated. Nevertheless, in mussels transferred to the high-predation site, the soft tissue weight also increased significantly regardless the presence of predators. *X. securis* transferred to the high-predation site was able to activate inducible morphological defence mechanisms without any detrimental effect on soft tissue growth.

To evaluate the role of temperature on the mussel phenotypic responses, mussels from both populations were exposed to water temperatures of 13 and 18°C, in the presence/absence of dogwhelks. Mussels originally from the low-predation site probably did not respond to the presence of predators because they had not learned to identify any specific cues from a predator that does not occur naturally in their habitat. At 18°C, mussels secreted stronger byssal threads regardless of their origin, while induced poorer condition and thinner shells as well as more rapid gametogenesis, particularly in the presence of dogwhelks.

In summary, the invasive brackish-water *X. securis* appears to be highly capable of activating mechanisms to survive in marine environments. Its ability to activate anti-predator defence mechanisms may significantly decrease mortality by predators and indirectly contribute to the success of the species improving survival and fitness. Outer zones of Galician rias with an oceanic-influence and where predation pressure is higher may promote rather than limit the success of the invader with potentially important consequences for the native community.



ENERGETIC DEMAND OF THE INVASIVE CRAB *HEMIGRAPUSUS SANGUINEUS* AND THE NATIVE *CARCINUS MAENAS* AT HELGOLAND, NORTH SEA

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Biological invasions can entail major threats to marine biodiversity. Non-indigenous species may induce changes in community structure and ecosystem functioning, thereby affecting ecosystem services and human economic interest and health. Decapod brachyuran crabs are among the most invasive marine animal taxa. The originally European species *Carcinus maenas* and the Asian shore crab *Hemigrapsus sanguineus* invaded different coastal areas around the world. While their invasion history and ecology has been thoroughly investigated, physiological properties of *H. sanguineus* are virtually unknown.

The aim of this study was to compare the metabolic energy demand of both crab species and - based on these data - to assess their potential dietary impact on the ecosystem. Respiration measurements were conducted with a flow-through system covering a temperature range naturally experienced by these crabs (5, 10, 15 and 20 °C). Both species were analyzed on the island of Helgoland in April, June and August 2015.

A general linear mixed-effects model (LMM) was applied to test for the effects of species, temperature, biomass and sex on respiration rates. Overall rates increased with temperature but decreased with the mass of the crabs. Respiration rates did not differ significantly between sexes in both species.

From the full model, two separated LMMs were created for either species. They allowed establishing species-specific equations for the prediction of respiration rates y (nmol d⁻¹ g⁻¹) for a crab of any given mass x_{Mass} (g) at any given ambient temperature x_{Temp} (°C):

$$\ln y = 10.39 + (-0.34 * \ln x_{\text{Mass}}) + (0.06 * x_{\text{Temp}}) \text{ for } C. \textit{maenas}$$

and

$$\ln y = 10.42 + (-0.39 * \ln x_{\text{Mass}}) + (0.08 * x_{\text{Temp}}) \text{ for } H. \textit{sanguineus}.$$

The mass-specific respiration rates of *C. maenas* and *H. sanguineus* were quite similar. By applying the diet-dependent respiratory quotient, oxygen uptake may be used to calculate carbon uptake and metabolic energy demand either for single crabs or for entire populations of a given area.

On the population level, the metabolic energy demand and thus ecosystem impact of both species depend primarily on their abundance in the field and, less so on their dietary preferences.

Keywords: *Hemigrapsus sanguineus*, *Carcinus maenas*, respiration, carbon uptake, metabolic energy demand



PHOSPHORUS EXCRETION BY NEWLY ESTABLISHED BENTHIC SPECIES: POTENTIAL IMPACTS FOR NUTRIENT FLUX IN THE EASTERN GULF OF FINLAND

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The structure of zoobenthos of the Gulf of Finland (Baltic Sea) has changed dramatically during several decades because of several invasive species of polychaetes *Marenzelleria* (mainly *M. arctica*), oligochaete *Tubificoides pseudogaster* and gammaridean crustaceans (*Pontogammarus robustoides*, *Gammarus tigrinus*, *Gmelinoides fasciatus*, *Chelicorophium curvispinum*) have established. In 2014, biomass of *Marenzelleria* spp. averaged 19 gm^{-2} (34% of the total biomass) in deep and 6 gm^{-2} (>40%) for invasive amphipods in the coastal zone. The native Baltic species, such as the mollusk *Macoma baltica*, the isopod *Saduria entomon* comprised 37% and 22%. Despite the fact that waste water is purified and nutrient loads from the land sources to the Gulf were reduced notably during last decades, we have still observed intensive summer cyanobacterial bloom in the open Gulf, indicating a high level of bioavailable phosphorus in the ecosystem. As known, benthic activities together with oxygen conditions in the bottom sediments may influence on the form and amount of soluble reactive phosphorus (SRP) that are mobilized from sediments to pore water and subsequently released to the overlying water stimulating eutrophication. This article focuses on effect of benthic macrofauna on SPR dynamics in the Gulf with relation to recent shift in biotic communities due to invasive species dominance. We tested for differences in SPR excretion and bioirrigation activity of both invasive and native species dominants, combining measurements of excretion and phosphorus flux rates from natural bottom sediments during research cruise 2015 at the catamaran *Centaurus-II*. We found the significant differences in SRP flux rate between sites depending on sediment characteristics, and biomass and functional role (ability to bioturbate the sediments) of dominating species presented in benthic community. Also, the phosphorus excretion rates differed between mass classes within a taxon and between taxa, with invasive *Marenzelleria* and gammarids generally having greater excretion rates than native mussels and crustaceans. We developed equations for nutrient excretion versa soft-tissue dry weight for different taxa allowing estimation of their contribution to total nutrient fluxes from the sediment to water. The increased phosphorus flux from new polychaetes and amphipods may facilitate cyanobacterial growth, especially in well-mixed shallow areas of the gulf.



STRUCTURALLY COMPLEX NATIVE AND INVASIVE HABITAT ENGINEERS SUPPORT SIMILAR COMMUNITIES

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The Pacific oyster, *Crassostrea gigas*, is a non-native aquaculture species which has established extensive wild populations outside its native distribution. *C. gigas* has colonized rocky shores as well as soft sediment environments and has been shown to affect the diversity and composition of these ecosystems. It is feared that *C. gigas* capacity as a habitat engineer may lead to a reduction in β -diversity by promoting rocky shore assemblages in soft sediments. Therefore we tested for effects of the presence of the invasive *C. gigas* on native assemblages by comparing them directly to assemblages associated with a similar, but declining native habitat engineer, the European oyster, *Ostrea edulis*. Presence of both oyster species was manipulated in intertidal and subtidal habitats at horizontal and vertical orientations. After 12 months, species diversity and benthic assemblage structure between assemblages with *C. gigas* and *O. edulis* were similar, but differed between subtidal and intertidal habitats and orientation, suggesting that both oyster species are functionally similar in terms of biodiversity facilitation. These findings support evidence, that non-native species could play an important role in maintaining biodiversity in systems with declining populations of native species.



SEPARATE AND INTERACTIVE EFFECTS OF NON-INDIGENOUS SPECIES ON NATIVE COMMUNITIES: THE TWO AGGRESSIVE NOVEL BENTHIC PREDATORS IN THE BALTIC SEA

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The number of non-indigenous aquatic species (NIS) has rapidly increased globally. The majority of published evidence on the NIS effects to local communities is single species studies in which the interactive effects of NIS are not considered. Two novel benthic predators, the round goby (*Neogobius melanostomus*) and the North American mud crab (*Rhithropanopeus harrisi*) have shown strong potential to impact local ecosystems in the Baltic Sea range. Since these two species are rapidly increasing both their range and abundance, they are expected to have both separate and interactive effects on the native communities. A laboratory experiment, investigating the effect on the two species on local benthic invertebrate communities (*Gammarus* spp., *Mytilus trossulus*, *Macoma balthica*, and *Theodoxus fluviatilis*) in varying environmental conditions, was carried out in the Northeastern Baltic Sea during autumn 2015.

Both predators separately and interactively impacted the studied invertebrate community. Communities with both predators diverged the most from the rest of treatments and such pattern was stronger at higher temperatures. Among invertebrate species mobile gammarids were consumed more than other species. Crabs consumed less gammarids at lower temperature than at high temperature; however, the predation of round goby on gammarids was high and independent of water temperature. Providing the fast expansion and increase in abundance of both species and the previous weak dominance of such functional trait in the area, these invasions are expected to severely impact benthic invertebrate communities in very near future. The magnitude of impact is likely stronger in areas where the ranges of these two species overlap.



CUMULATIVE IMPACTS OF ALIEN SPECIES ON THE MARINE NATURA SITES OF GREECE

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Our aim was to assess the cumulative impacts of alien species on the marine ecosystems of the Greek Natura-2000 network of protected areas, and analyze the spatial patterns of impact. The estimation of cumulative impacts was based on the CIMPAL index (Cumulative IMPacts of invasive ALien species). According to CIMPAL, cumulative impact scores were estimated on the basis of the distributions of invasive alien species and marine habitats, and both the reported magnitude of ecological impacts and the strength of such evidence. The methodology was applied in all marine areas of NATURA-2000 sites in Greece. The extent of each habitat at each Natura site was based on the official habitat mapping of the sites. Data on the presence/absence of all invasive marine alien species at each Natura site was retrieved from the European Alien Species Information Network (EASIN). The spatial patterns of impact were based on Generalized Additive Modelling of the CIMPAL index in relation to the area of each site, its longitude and latitude. The CIMPAL index increased with area due to the increased richness of both alien species and habitats with area. No significant pattern in relation to longitude or latitude was revealed. The analysis also allowed the estimation of the relative importance of alien species on cumulative impacts across the Greek Natura-2000 sites and allowed their prioritization for management actions. The application of the CIMPAL index in the Greek Natura-2000 marine sites provided a baseline that can be built upon with future improved information (such as estimates of the alien species abundance at each site instead of presence/absence data).



THE MANY FACES OF *ULVA COMPRESSA*

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Concomitant with the fact that species of the cosmopolitan order Ulvales are often dominant in European marine and brackish shallow water environments some representatives are also characteristic foulers and known for their ability to form massive blooms, so called green tides. These characteristics - associated with an opportunistic strategy - support their introduction into new ecosystems, where they have a high potential to affect algal diversity and ecosystem services. Due to the extremely variable and overlapping morphology of Ulvales the taxonomic identification of genetically distinct species was largely hampered until recently. As a consequence cryptic or alien species are often not recognized, while different phenotypes of the same species are regarded as distinct taxa. An impressive example is *Ulva compressa* Linneus 1753. Our genetic study of the biodiversity of Ulvales at the North Sea and Baltic Sea coasts of the German state of Schleswig-Holstein - using the markers *tufA*, *rbcL* and ITS - revealed that the species is abundantly present in both sea areas. However, only in the North Sea we detected morphologies reminiscent to the branched tubular type material, while *U. compressa* at Baltic Sea coasts indiscriminately exhibited a very distinct morphology of sheet-like thalli that were mostly unattached. This drifting form was so far probably confused with *Ulva lactuca*, a morphologically similar species that - based on our survey - is absent from the German Baltic Sea coast. The drifting form of *U. compressa* was also frequently detected in the Wadden Sea, but not on the island of Helgoland. It could be considered as invasive, as it may form green tides in some locations, covering stands of other algae in the Baltic Sea and causing sediment anoxia in the Wadden Sea. *U. compressa* Linnaeus 1753 from Germany is also conspecific with the type strain of the model organism *U. mutabilis* Föyn 1958, which was originally collected at Faro in Portugal. This could not only be demonstrated through genetic investigation, but also through interbreeding experiments. Both species exhibit the same life cycle stages, are inclined to show the same morphological mutation patterns during cultivation and can be treated as same species.



BALMAS (BALLAST WATER MANAGEMENT SYSTEM FOR ADRIATIC SEA PROTECTION) IPA PROJECT: DATA ON MACROZOOBENTHOS COMMUNITY OF BARI HARBOUR (ADRIATIC SEA, ITALY)

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The general objective of *BALLast water Management system for Adriatic Sea protection* (BALMAS) IPA Project is to establish a common cross-border system, which will link all researchers, experts and responsible national authorities from Adriatic countries in order to avoid unwanted risks to the environment from the transfer of Harmful Aquatic Organisms and Pathogens (HAOP). This can be achieved through control and management of ships' ballast water and sediment. Further, long-term effective Ballast Water Management (BWM) in the Adriatic will be set at the cross-border level utilizing this project's related knowledge and technology. One of the objectives of the BALMAS project is the realization of Port Baseline Surveys (PBS) in the biggest ports of the Adriatic Sea, including the port of Bari, Italy. PBSs are used to develop an overview of native species and non-indigenous species (NIS) present in the ports. This overview will be the basis for developing a list of HAOP which will be used as a baseline for tracking new introductions. Surveys of biota include sampling of several different groups of organisms: hard substrate and soft bottom benthos, plankton and fish. Sampling protocol is based on CRIMP protocol, which is successfully applied in tropic and temperate marine environment, becoming a guideline for ballast water sampling and risk assessment. Regarding macrozoobenthos community of Bari harbour, the sampling strategy followed the BALMAS PBS Protocol, developed in the framework of the project on the basis of the CRIMP protocol. Two surveys have been carried out, in Spring and Autumn 2014. Three sites in the inner part of the port have been sampled in each survey by scuba divers. The benthic fauna was analyzed both in terms of abundance and richness. The total list of macrozoobenthos species found during the two campaigns comprises 226 soft-bottom taxa and 184 hard-bottom taxa. Totally, we counted 2 NIS (1 Polychaeta and 1 Mollusca) and 1 probable NIS (Polychaeta) for soft-bottom; 11 NIS (3 Polychaeta, 4 Crustacea, 1 Mollusca, 2 Bryozoa, 1 Tunicata) for hard-bottom. Additional future analyses will be desirable in order to unravel some ecological and taxonomic issues still open.



ECOLOGICAL NICHE DIFFERENTIATION BETWEEN NATIVE AND ALIEN CARIDEAN SHRIMPS IN THE NORTHERN BALTIC SEA

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Due to harsh environment the caridean shrimps are represented only by three species in the north-eastern Baltic Sea. Among them two are native to the region (*Crangon crangon* and *Palaemon adspersus*) and the third (*Palaemon elegans*) is naturalized alien species recently invaded the Baltic Sea. In order to quantify the distribution ranges of native and invasive shrimps and compare their realized niches targeted field studies were performed in 2001-2015. The analysis of outlying mean index (OMI) showed that the niche space of the invasive *P. elegans* was narrower than that of the native *P. adspersus*. Based on the canonical correspondence analysis (CCA), there was a clear separation of habitat occupancy between native and invasive shrimp species along the studied abiotic and biotic environmental gradients: the habitats of *P. elegans* were related to lower salinity and higher eutrophication level compared to the habitats of *P. adspersus*; *P. adspersus* was strongly associated with perennial brown alga *Fucus vesiculosus* while *P. elegans* was associated with filamentous green algae. Under controlled experimental conditions the invasive species preferred hard bottom habitats while the native species was equally observed in vegetated soft/hard and unvegetated hard bottom habitats. The estimated niche overlap between the native and invasive shrimps suggests the existence of interspecific competition among shrimp species; nevertheless, the native congener of the invader has broader environmental niche space and thereby possesses the capacity to escape this potential interference competition. On the other hand, by virtue of distinct habitat specialization the invasive species is capable of colonizing new habitats previously devoid of shrimps and thereby adding functional diversity to the coastal ecosystems of the Baltic Sea.



FURTHER EVIDENCE OF THE ATLANTIC PRESENCE IN THE CENTRAL MEDITERRANEAN OF *ACANTHURUS MONROVIAE* AND OF *ABUDEFDUF HOEFLERI* WITHIN MALTESE COASTAL WATERS

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The Lessepsian phenomenon, involving the ingression of allochthonous marine species of thermophilic affinity into the Mediterranean via the Suez Canal, has, in recent years, attracted considerable media and scientific attention. Concomitant with such an influx, however, is a second and less-publicised influx of new marine species, native of the eastern Atlantic, into the Mediterranean, through the Straits of Gibraltar. The second cohort of newcomers is considered as range-expanders, rather than allochthonous species and, by virtue of their Central Mediterranean location, the Maltese Islands witness the arrival of both streams of newcomers. The present study documents the first substantiated occurrence of *Acanthurus monroviae* (the Monrovia surgeonfish) in Maltese waters, with a single previous report of the species from the same waters not being backed up by caught specimens or by photos. The same species has to date only been reported from the western half of the Mediterranean, with the exception of one record from Israel. This study also documents the establishment of *Abudefduf hoefleri* (African surgeonfish) within Maltese waters, which is not considered to be a range-expanding species due to the lack of any records of the species from the western half of the Mediterranean. The species, also native of waters off the western flank of Africa down to Angola, was first recorded as a single individual from Maltese waters way back in 2014 and is not known from any other Mediterranean location. In April 2016, small shoals of the species were observed by spear fishermen, with a number of individuals from at least three different Maltese coastal localities being caught simultaneously, suggesting that the same species might be potentially established within the same waters. Such observations further reinforce the call for the establishment of a transboundary observatory for marine alien species in this part of the Mediterranean. Possible drivers of the continued eastern Atlantic influx into the Mediterranean are discussed within this study.



TRANSITIONAL WATERS



INTERMEDIATE PREDATORS AND EUTROPHICATION: ARE STICKLEBACKS TOP-DOWN DRIVERS OR BOTTOM-UP PASSENGERS?

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Following declines in top predatory fish, mesopredators such as sticklebacks have become increasingly abundant in some areas of the Baltic Sea. The increase in mesopredator abundance can cause important shifts in the trophic network, by feeding on mesograzers and thus facilitating macroalgal blooms. In this study, we sampled fish populations using a beach seine across the Finnish Archipelago Sea to determine the spatial and seasonal variation in mesopredator abundance, and the most important environmental factors explaining fish assemblage structure and function. Sticklebacks dominated the fish community in shallow coastal areas, but while we predicted that sticklebacks would be most associated with highly eutrophicated areas in the middle archipelago, we found the opposite. Both three-spined and nine-spined sticklebacks were most abundant in outer archipelago sites and positively correlated with high Secchi depth, low filamentous algal cover, and high macrovegetation cover. No juveniles were found within the middle archipelago, implying that sticklebacks have, since the 1970-80s, shifted their breeding grounds to less eutrophicated sites. Using tethering experiments in a seagrass landscape, we found that three-spined sticklebacks exert a strong, but transient predation pressure on seagrass mesograzers. The temporal pattern revealed that survival odds for both amphipods and isopods were lowest in June and increased towards the end of the season. Predation pressure also varied in space, with lowest mesograzers survival in bare sand and highest at seagrass edge and interior locations, while larger mesograzers body size also played a role in increasing survival. While sticklebacks have been considered as both contributing to and benefiting from increased eutrophication in the Baltic Sea, we instead suggest that these changing environmental conditions may have an adverse affect on sticklebacks, leading them to shift their breeding grounds and spatial distribution, with potentially unexpected cascading effects in eelgrass food webs.



USE OF BENTHIC MACROPHYTE METRICS TO ASSESS COASTAL LAGOONS DEGREE OF CONSERVATION: A CASE STUDY OF EAST MACEDONIA & THRACE NATIONAL PARK, GREECE

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East Macedonia & Thrace National Park includes two Natura 2000 Sites, “Nestos Delta and Keramoti lagoons” (GR1150010) and “Lakes and Lagoons Thrace” (GR1130009), consisting of 15 major lagoons with salinities ranged from 3.1 to 45.2. Twenty (20) sites, located at least two in each 10x10 km reference grid, in 10 lagoons were selected to satisfy Habitats Directive (92/43/EU) requirements, i.e. assessment of the Degree of Conservation (DC) at three spatial scales (sampling station, reference grid, site Natura 2000). Key abiotic factors were measured in the field (temperature, salinity, pH, dissolved oxygen, light attenuation coefficient) and water samples were collected for chemical analysis (total dissolved inorganic nitrogen, P-PO₄, water column chl- α and suspended solids) and the EII stress index was calculated. Seventy (70) random samples in total (n=1-5) of benthic macrophytes were collected using box-corer (17x17 cm) during the hot period (June-September) 2013-2014. In the laboratory, the samples were sorted, and taxa were identified to species and functional group levels. The surface covered by each taxon in vertical projection was quantified as a coverage (%). Twenty-six species, of which 4 belonged to angiosperms and 22 to macroalgae (10 Chlorophyta, 9 Rhodophyta, 1 Ochrophyta, 2 Cyanobacteria) were identified in total. The most abundant species for coastal lagoons with salinity >5 were *Ruppia cirrhosa*, Cyanobacteria, *Gracilaria bursa-pastoris*, and *Ulva olivascens*, and for coastal lagoons with salinity <5 were *Potamogeton pectinatum*, *P. crispus* and *Ceratophyllum* sp. While DC of four sampling stations with salinity <5 based on expert judgment, DC of rest sampling stations with salinity >5 was estimated by MATECS methodology. It is based on the deviation (%) of weighted and summed structural [total coverage (%), species richness, Shannon-Weiner (H') index, Pielou (J') index, multivariate analysis (MDS, Cluster)] and functional [ESG IA, IB, IC coverage's (%), ESG IIA, IIB coverage's (%), Ecological Evaluation Index (EEI-c)] metrics mean values from reference conditions metrics (ranges from 0 to 1). The DC for sampling sites ranged from 0.2 (C) to 0.831 (A). The DC was unsatisfactory-sufficient (2 grids A, 1 B, 3 unknown) for GR1150010 and unsatisfactory-bad (1 grid B, 4 C, 1 unknown) for GR1130009.



RESPONSE OF PHYTOPLANKTON TO A DYSTROPHIC EVENT IN PAPAS LAGOON (ARAXOS CAP, WESTERN GREECE)

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Papas lagoon is of particular economic importance due to the significant production of fish and shellfish. This ecosystem suffers historically from frequent dystrophic crises due to its eutrophic character. We studied the composition of phytoplankton species from March 2012 to March 2013, the progress of an eutrophic phenomenon led to last dystrophic crisis in July 2012, and then during ecosystem restoration. In total 45 different phytoplankton organisms are recognized, of which at least ten classified as toxic. The abundance of phytoplankton organisms gradually increased since March 2012, reaching the maximum values in August, i.e. a month after the outbreak of dystrophic crisis. The Shannon-Wiener diversity index values generally fluctuated at low levels, from 0.5 to 2.9 with the maximum levels in the summer and less in winter. Diatoms dominate in the early spring, but gradually fully replaced by the dinoflagellates. About a month before the outbreak of dystrophic event occurred many toxic species of dinoflagellates i.e. *Prorocentrum minimum*, *Katodinium glaucum*, *Karlodinium* sp., *Scrippsiella* sp., *Alexandrium minutum*, *Dinophysis* sp., together with the potentially toxic dinoflagellate *Akashiwo sanguine* and *Ceratium* sp. Immediately after the outbreak of the dystrophic crisis and throughout the coming period, diatoms reappeared. But until the middle of autumn is worth mentioning the presence of several toxic dinoflagellates, as well as the toxic *Chatonella marina* (Heterokontophyta).



BIOGEOGRAPHICAL PATTERNS OF BIODIVERSITY ORGANISATION IN TRANSITIONAL WATER ECOSYSTEMS

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Transitional water ecosystems are habitat islands in the coastal landscape. They are colonised by just few purely transitional water species and by many marine and freshwater species.

Here, we address how the different species pool interact determining organisation of biodiversity in transitional water ecosystems. The study is based on a meta-analysis of published data.

In the paper we test the following hypothesis: 1. merging large species pool in small habitat islands, biodiversity of transitional water has a among ecosystem component larger than the within ecosystem one; 2. Relative importance of among and within ecosystem biodiversity components is invariant at a biogeographical scale; but, 3. tidal range induced connectivity of transitional water along the coastline determines an higher homogeneity among species composition of different transitional water ecosystems.

Hypotheses have been tested on benthic macroinvertebrates and fish guilds of different biogeographical regions.

Results show that species composition similarity among transitional water ecosystems is consistently low, even between neighbouring ecosystems, with a lower average similarity in macroinvertebrate guilds than in fish ones. Therefore, biodiversity in transitional water ecosystems is mainly due at every biogeographical region by among ecosystem components. These patterns are invariant comparing different biogeographical regions, even though similarity in the taxonomic composition of transitional water guilds is higher in meso-tidal conditions than in micro-tidal ones.

Results suggest lottery competition as the underlying mechanisms determining biodiversity organisation in transitional water ecosystems.



CROSS-COMMUNITY SCALING RELATIONSHIPS: DESCRIBE ENERGY FLOWS ALONG BOTH VERTICAL AND HORIZONTAL GUILD ORGANIZATION IN MEDITERRANEAN LAGOONS

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Body size and temperature dependency of individual metabolism has been scaled up to population, community and ecosystem levels addressing body size patterns, energy flows and ecosystem processes. Body size patterns have been described as body size and density relationships at population and species levels (Local or Global Size Density Relationships, LSDR and GSDR, respectively) and at guild and community levels (Cross Community Scaling Relationships, CCSR).

In fact, intercepts of CCSRs are estimates of the average energy flowing through the guilds, while slopes, incorporates additional size dependencies of resource exploitation and conversion efficiencies. Therefore, CCSR are expressions of ecosystem properties, describing trophic transfer efficiency at the community level and allow addressing energy partitioning among guilds sharing similar trophic resources and energy flow across trophic levels.

The main objective of the study is to analyze the significance of Cross Community Scaling Relationships, where, have been tested the following hypotheses: i. If CCSR shape varies comparing trophic levels, ii. If differences in energy flow between trophic levels are large enough to be maintained also within ecosystems at the habitat level, and iii. If CCSR discriminate the amount of energy flowing across different guilds occurring at the same trophic level.

These hypotheses were tested on benthic macro-invertebrate guilds of fifteen lagoon ecosystems in the Mediterranean and Black Sea. The study presented few implementations of CCSR on benthic macro-invertebrate guilds of the Mediterranean and Black Sea lagoons, addressing their adequacy in describing energy flows among guilds at same or different trophic levels.