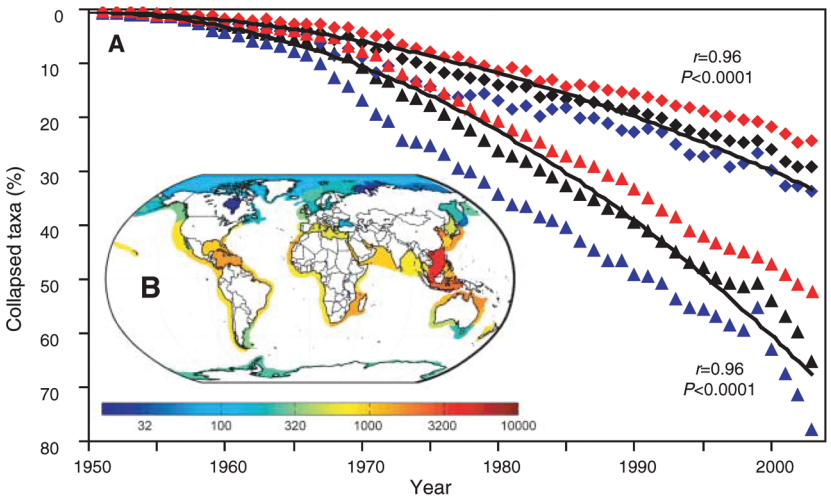
ΕΘΝΙΚΟ ΘΑΛΑΣΣΙΟ ΠΑΡΚΟ ΖΑΚΥΝΘΟΥ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΩΝ ΤΗΣ ΘΑΛΑΣΣΑΣ ΤΟΥ ΠΑΝΕΠΙΣΤΗΜΙΟΥ ΑΙΓΑΙΟΥ

NATIONAL MARINE PARK OF ZAKYNTHOS
DEPARTMENT OF MARINE SCIENCES OF THE UNIVERSITY OF THE AEGEAN

# MARINE PROTECTED AREAS, BIODIVERSITY CONSERVATION AND FISHERIES MANAGEMENT

### The current status of marine ecosystems

The size and extent of human impacts on the marine ecosystems is enormous and continues to grow. The populations of many species have experienced steep declines worldwide, as a result of over-exploitation by fisheries. What's more, the exploited species are a small fraction of the species that are affected by fisheries. Additionally, rates of marine habitat fragmentation, degradation and loss are comparable to those on land. A large proportion of the Mediterranean coastal and marine habitats has been degraded or entirely disappeared, while fishing and especially trawling are known to have large scale effects across the whole Mediterranean basin. There is clearly a need to protect the complete range of marine biodiversity and habitats and not just the species we fish. A promising management tool to achieve this end is the establishment of networks of Marine Protected Areas, also known as MPAs.




*A. Collapsed fish and invertebrate taxa over the past 50 years from large marine areas worldwide. B. World color-coded map, indicating total fish species richness (Source: Worm et al., 2006)*

### MPAs: a promising management tool

Place-based management is an approach that aims to the temporary or permanent protection of certain places from a defined set of threats. Place-based management can be effectively achieved through MPAs. An MPA is a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values. Marine Reserves (no-take areas) are a special type of MPAs that are fully and permanently protected from activities that remove organisms. However, several alternative ecotourism activities, such as swimming, boating, snorkeling and scuba-diving, are sometimes allowed to take place within Marine Reserves. The beneficial impacts of MPAs are well documented in the published findings of several studies that have been carried out around the world. When protection measures are properly designed and effectively

enforced, MPAs and particularly Marine Reserves, have been proved to increase the biomass, abundance, size and diversity of marine biota found within or sometimes even beyond their boundaries. At the same time they constitute areas for the establishment of new recreational and cultural opportunities, as well as education and research.

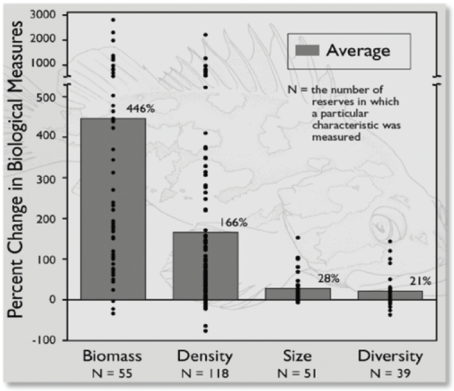
Management of marine systems by means of MPAs has a relatively short history and as a consequence, only a small fraction of the marine ecosystems gets some form of protection by means of MPAs. As of 2010, only 1.17% of coastal ecosystems is protected in 5878 MPAs and 0.1% in Marine Reserves worldwide. In the Mediterranean Sea, there are currently 237 MPAs and 50 Marine Reserves covering only 4% of its surface. Most of the existing MPAs and Marine Reserves are small in size.

## 2. MARINE PROTECTED AREAS AND THEIR EFFECTS ON BIODIVERSITY AND FISHERIES

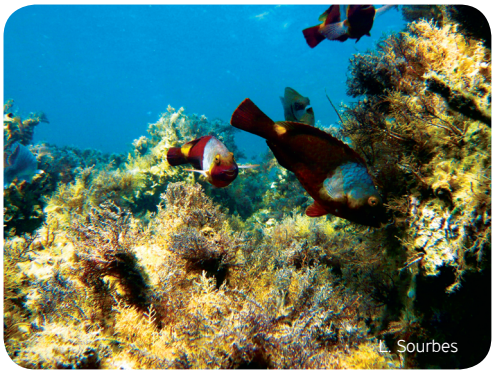
### Benefits of MPAs on the marine biota

There is plenty of evidence on the beneficial impact of MPAs, especially of marine reserves, on aggregate measures of the status of the biotic communities inside their borders, such as abundance, biomass, diversity and size of the organisms. In a review of 89 studies of Marine Reserves of varying sizes around the world, it was reported that inside the reserves, on average, abundance doubled, biomass almost tripled and size of animals and diversity increased by 20 - 30%. Although small reserves did have positive effects, large reserves are needed for absolute increases in numbers and diversity.

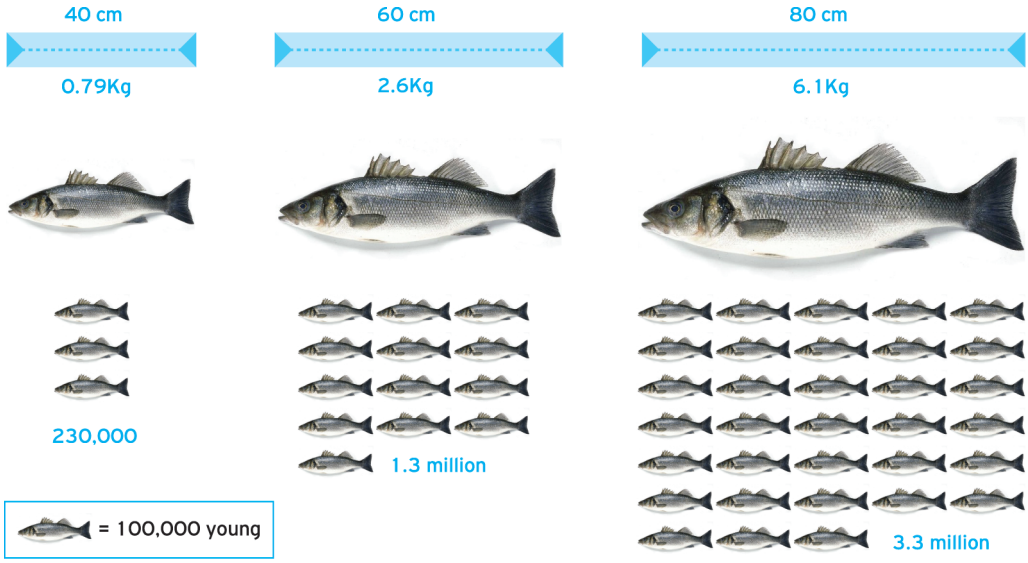
An increase in animal body size is often correlated to increased fecundity: Bigger fish produce much more offspring than smaller ones. MPAs can help restore the natural size and age distribution of many species.




*Average changes in fishes, invertebrates and seaweeds within marine reserves around the world (Source: Partnership for Interdisciplinary Studies of Coastal Oceans, 2011).*


L. Sourbes


D. Poursanidis




*Average number of young produced by three different sizes of European seabass (Source: modified from Partnership for Interdisciplinary Studies of Coastal Oceans, 2011).*

### Changes due to MPAs vary across species

The magnitude of changes inside MPAs vary across species: The heavily exploited species respond quickly and their recovery is often impressive. For instance, it has been shown that in MPAs that have been effectively managed for a period of at least five years, there were rapid increases in the biomass of exploited fishes that reached three to five times within five years. What's more, the increases were sustained for decades in the oldest protected areas. However, it is also possible to observe decreases in the populations of some species, as an effect of the trophic interactions between species. For example, the increases in the populations of the exploited predator species above a certain threshold level may lead to decreases in prey species.


C. Dimitriadis

### MPAs replenish fished areas

One of the main mechanisms through which MPAs can enhance fisheries is the emigration of fish outside the MPA boundaries. As abundance and biomass of adult fish increases inside the MPAs, competition for space, reproduction, and food resources, force fish to move to nearby areas and fishing grounds through a process known as the spill-over effect. The spill-over effect varies among species and MPAs, and depends on several factors, such as mobility of species, larvae dispersal, connectivity of habitats and fishing intensity outside the MPA.

### How fast do MPA effects become apparent?

It takes time for the beneficial effects of MPAs to become apparent. How fast populations inside an MPA will recover depends on several factors:

- Breeding adults present inside the MPA may produce young that will quickly enhance the MPA populations.
- Species grow and mature at different rates and produce young in different numbers. Long-lived animals may take decades to fully recover.
- Effects on unfished species take longer to appear, for example due to the negative effects on their populations of predator-prey interactions.
- Potential source populations outside the MPA should be available at the appropriate distances.
- The protected habitats' innate capacity to recover.
- Levels of human impacts before the establishment of the MPA and levels of human impacts outside the MPA. Also, the level of protection enforcement in the MPA.

## 3. WHAT MAKES AN MPA DESIGN EFFECTIVE?

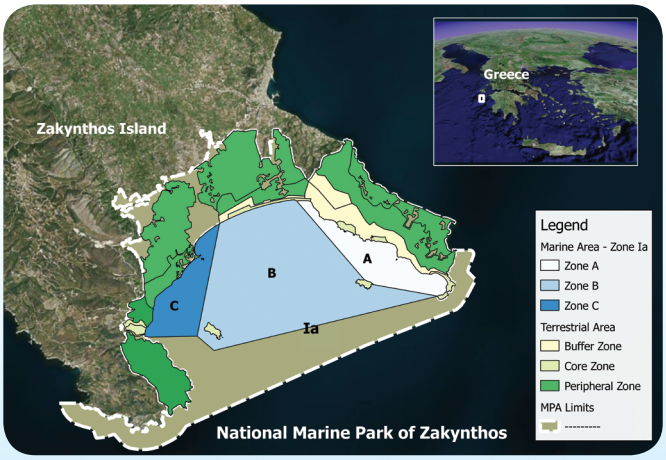
### Protection goals should be clearly defined

The design of MPAs depends on the management goals. For example, MPAs could aim on the conservation of threatened species and habitats or the enhancement of fisheries by the protection of critical habitats such as spawning grounds.

D. Poursanidis

## The importance of the level of protection

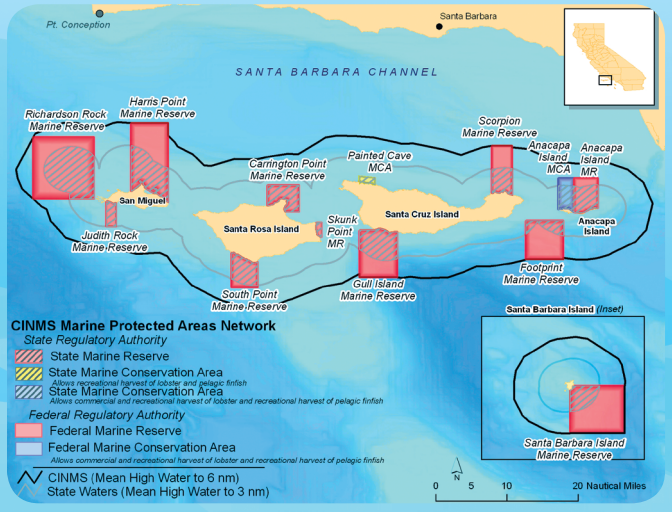
The benefits of MPAs are proportional to the level of protection, as partially protected areas offer only a fraction of the benefits that Marine Reserves do. Partially protected areas can thus be improved by either increasing protection levels or at least creating zones of full protection inside them.




*Zoning scheme in the MPA of the National Marine Park of Zakynthos (Source: Dimitriadis et al., 2013)*

## There is a need for networks of MPAs

Ecological theory predicts that larger MPAs host more habitats, more species and larger populations than smaller ones. However, a better alternative is the establishment of MPA networks that consist of a number of small- to medium-sized MPAs that encompass important habitats and are located close enough to function as a network. A well designed Network of MPAs will effectively accommodate species migration and larval dispersal. Networks of MPAs can incorporate both areas of partial protection and no-take areas. Replicate MPAs and Marine Reserves for the same habitat will provide insurance against catastrophes.




*The network of MPAs within the nearshore waters of the Channel Islands National Marine Sanctuary (USA) (Source: http://channelislands.noaa.gov).*

## Location and size of MPAs

The following should be considered when deciding on the size and placement of MPAs in an MPA network:

- Individual MPAs should be large enough to provide enough space for the movements of adults.
- The spacing of MPAs should allow effective larval dispersal.
- All the important species and habitats in the region should be protected, including critical habitats such as spawning grounds.
- Location of existing human activities in relation to the socio-economic costs and benefits provided by the MPAs.
- Exposure to human impacts that cannot be confronted by MPAs, such as marine pollution.

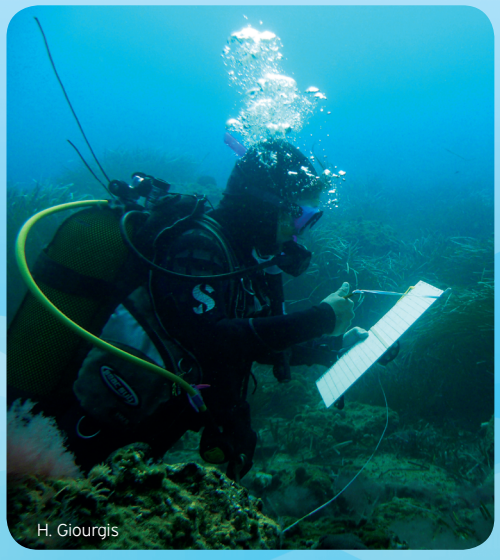
## The importance of socio-economic factors

The balance between socio-economic costs and benefits influences the planning and success of MPAs. Several prerequisites are involved for a successful outcome:

- Supportive legislation and institutions and long-term, sustainable funding.
- Comprehensive information on the patterns of the existing human activities.
- Explicit informing of the local communities about aims, restrictions, costs and benefits of MPA establishment, which is expected to result in high local community participation in planning and enforcement.
- Fair sharing of economic benefits among the involved social groups.
- It is true that local fishing communities often fear the short-term economic losses due to the establishment of MPAs. However, in a current review it has been shown that the economic value of MPAs (enhanced fisheries in the surrounding areas plus new alternative eco-friendly tourism activities within the MPAs) may often exceed the value of local fisheries prior to protection.

## Scientific monitoring is essential

Ecological monitoring of the individual protected areas and monitoring of the socio-economic changes in the local communities are essential in order to assess whether management objectives are being achieved, or whether changes in management plans are needed. Moreover, Marine Reserves in particular provide reference areas for the development of management tools and scientific research.

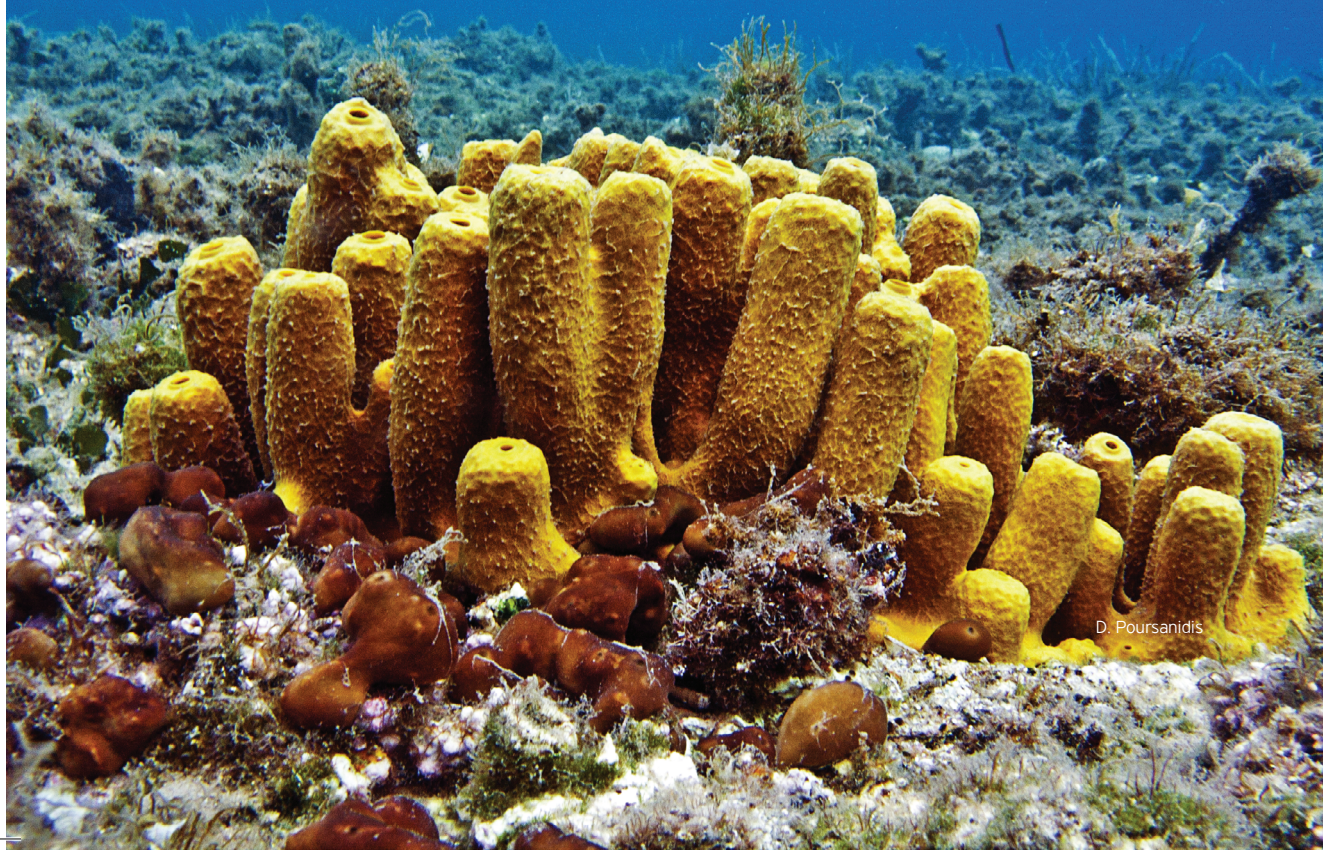

H. Giourgis


V. Lekkas

# 4. MEDPAN NORTH PROJECT

The Network of Mediterranean Marine Protected Areas Managers (MEDPAN network) brings together 21 countries and more than 200 MPA's along the Mediterranean coasts. Under this framework, the MedPAN North project (co-funded by the European Regional Development Fund) included 12 partners from 6 European countries bordering the Mediterranean (France, Greece, Italy, Malta, Slovenia and Spain). The aim of the MedPAN North project was to improve Marine Protected Areas (MPA) management effectiveness, including the marine Natura 2000 sites, and to contribute to the establishment of a network of MPAs, fulfilling international commitments, and particularly European commitments in this area. Sustainable management of fisheries in MPAs is an important component of the MedPAN North project actions, in which the National Marine Park of Zakynthos (N.M.P.Z), with the collaboration of Dept. of Marine Sciences (University of the Aegean, Greece), has been involved.


MEDPAN NORTH PROJECT PARTNERS
MPA'S IN THE MEDITERRANEAN



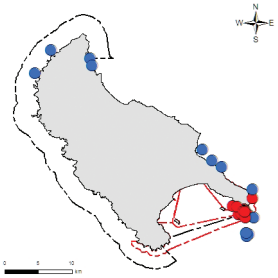
D. Poursanidis

## 5. THE CASE STUDY OF THE NATIONAL MARINE PARK OF ZAKYNTHOS

The action «Management Measures for Artisanal Fisheries in the Marine Protected Area of the National Marine Park of Zakynthos», aimed to the assessment of the state of the fish stocks and the artisanal fisheries of Zakynthos in relation to the operation of the MPA of the N.M.P.Z., in the framework of the EU funded MedPAN North Project.

01

02



**Methodological Approach**

Given that fisheries activities and fish stock conservation is a complex issue encompassing both ecological and socioeconomic aspects, we adopted several methodological approaches (Recreational Fishing, trawlers and purse seiners are permanently banned from the MPA).

Inside (red symbols - area A and green symbols - area B) and outside (blue symbols – area C) the MPA of N.M.P.Z. were carried out:

**01.** Visual census of the fish populations with scuba diving
**02.** On board sampling of the commercial artisanal fisheries with trammel nets
**03.** Questionnaire surveys and interviews with artisanal fishermen
**04.** Collection of data related to fisheries from the local authorities

M. Sini

I. Fournari - Konstantinidou

## MAIN RESULTS

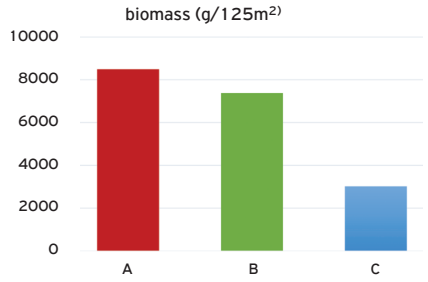
### Results of the Visual Census - Fish species

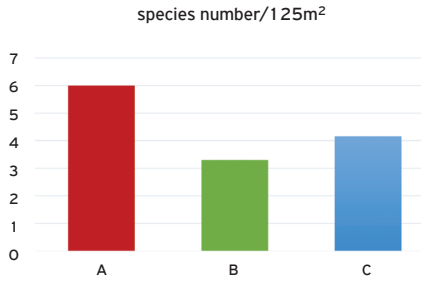
• A total of 33 fish species were observed

• A significantly higher species number, total abundance and biomass were observed in the protected areas A and B in comparison with the unprotected area C

• Overall response of the fish populations to the protection within the N.M.P.Z. was positive, especially pertaining to the biomass, although response of the individual species was found to vary

• In general, abundance and biomass of the fish populations, especially of the carnivorous species and the apex predators, was relatively low in all areas examined, particularly in the *Posidonia oceanica* sea grass meadows



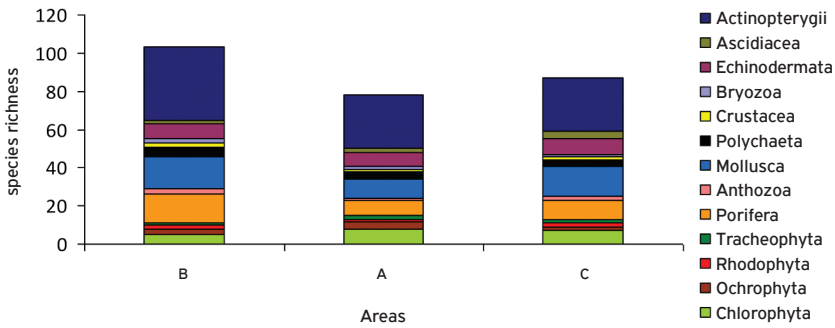





### Results of the Visual Census - Biodiversity

• In total 134 species belonging to 4 taxonomic groups of Marine Flora and 9 of Marine Fauna were recorded Area B presented the highest species richness (103), followed by areas C (87) and A (78)

• 27 vulnerable and protected species by international, EU or national legislation were recorded

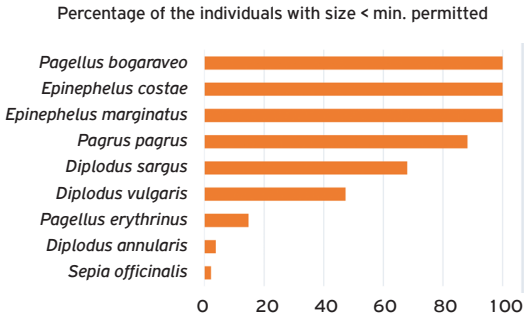


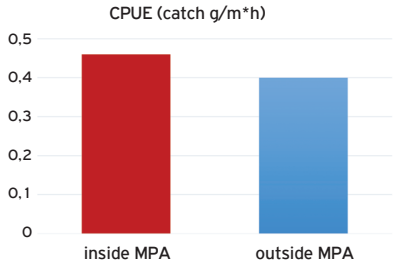
## Results of the on-board sampling in commercial Artisanal Fisheries

• A total of 57 species of fish and marine invertebrates were collected

Species number, catch per unit effort (CPUE) and income per unit effort (IPUE) were not significantly higher inside the MPA

• In 24 species (almost 50% of the total number), 76 - 100% of the fished individuals had a body length smaller than the species body length at maturity (Lm). In 7 species, a significant part of the fished individuals had body sizes smaller than the minimum permitted according to the fisheries legislation in Greece



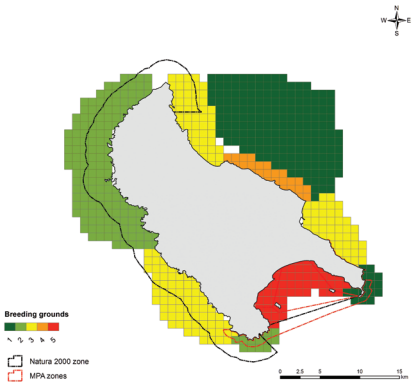

## Results of the questionnaire surveys and interviews with fishermen

• Willingness of fishermen to participate to the research varied considerably. The lack of understanding of the benefits associated with the sustainable MPA management in the long term as well as MPA enforcement issues were detected from interviews with fishermen

• The most frequently employed fishing gears are nets and long lines

• A reduction trend in fishing yields and fish size was recognized by all fishermen involved in the research

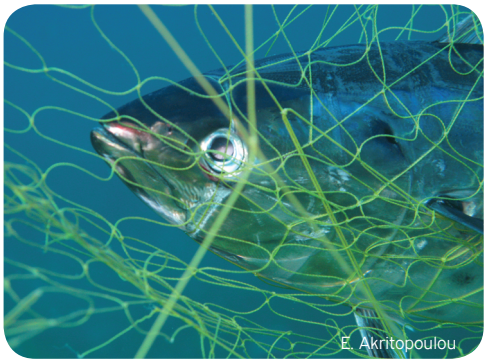
• Fishermen recognized that the MPA of NMPZ is one of the most important breeding and spawning grounds in Zakynthos Island




## Relational Database and Geo-database

For the needs of the project a descriptive and a geographic database were designed

In total, 11 tables were constructed, 10 regarding biodiversity information on the algae, higher plants and animals and one on the environmental parameters, such as depth, sea temperature, sea salinity, etc.The database biodiversity-related tables contained a total of 751 records.



## Main Conclusions and Management Implications

**1.** The observed overexploitation status of fish stocks in all studied areas, and the lack of a marine reserve effect, indicate that current management measures are not sufficient in maintaining fish stocks at a sustainable level, whilst compromising ecosystem health and fishermen profits. These findings may be related to the fact that the MPA was designed mainly for the protection of the sea turtle *Caretta caretta*.

**2.** The MPA zoning system requires several modifications, including the establishment of a year-round no-take zone which will exclude all types of fishing activity and will encompass marine features of special importance (e.g. critical habitats for fish reproduction).

**3.** In order to enhance the reduced fish biomass (especially of the apex predators, which have a high commercial value), nets with a mesh size smaller than 28 mm should be banned. This will allow a sufficient proportion of fish populations to reach reproductive maturity, and may ultimately have a considerable effect even in areas located outside the MPA, through dispersal processes.

**4.** Fisheries regulation (e.g. maximum catches, fishing gear restrictions, number of fishing vessels operating in the MPA) alongside with improved surveillance and monitoring of fishing gears and fisheries landings, should be applied in the MPA.

**5.** Given that the MPA is actively enforcing fisheries restrictions since only 2005, several years more, or even decades are required for the management benefits on fish stocks to become evident. Thus, management actions and protection measures should continue to be consistently enforced in the future. Moreover, long term monitoring schemes will allow evaluation and improvement of applied regulations through the process of adaptive management.

**6.** The active participation and cooperation of the local community and stakeholders in the management decisions is of fundamental importance and should be further enhanced, whereas fishermen should be actively involved in the decision-making, safeguarding and governance of the MPA through active participation.

**7.** Educational and awareness raising campaigns, aiming to improve current practices, attitudes and perceptions regarding the marine environment and the potential positive effects of MPAs as management tools may enhance the participation of the local community. Promotion of the positive effects that MPAs can bring about to fish stocks and subsequently to fishing yields and incomes in the long term, could possibly lead fishermen to support and further comply with fishing regulations within the MPA.

**8.** Given that recreational fisheries (including spearfishing) can further compromise the sustainability of the already reduced fish stocks (overlap of target species with high commercial value by artisanal and recreational fisheries), it is strongly recommended that all forms of recreational fishing must remain excluded from the MPA of NMPZ, since professional activities are more important than recreational ones.

**9.** Continuous monitoring of the MPA is necessary to ensure appropriate evaluation of management measures through time. Future monitoring plans should combine several methodological approaches (similar to those applied in the present study) that will be repeatedly applied at regular time intervals, in order to effectively evaluate the ecological status of species and habitats. The active participation of fishermen in the monitoring process (e.g. keeping up fisheries records and logbooks) would significantly enhance evaluation processes and improve management actions.

## 6. GOOD PRACTICES FOR SUSTAINABLE SMALL SCALE ARTISANAL FISHERIES

**1.** Deployment of fishing gears (nets and long-lines) for long time-periods (more than a night) should be avoided.
**2.** Use of nets with a small mesh size (<28mm) is not a viable practice, since the catches are consisting of small-sized, immature individuals (with low commercial value) which have not produced offspring (no replenishment of the fish stocks).
**3.** Priority or Protected types of Habitats (e.g. Posidonia meadows, Coralligenous reefs), which are adversely affected by fishing gears, should be excluded from fishing grounds.
**4.** Discards (i.e. fished species without a commercial interest) such as Crabs, Sea Stars, Urhins, Molluscs should be carefully detached from the fishing gear and quickly thrown back to the sea.
**5.** There should be a proper and frequent maintenance of the fishing vessel for oil leakage in order to avoid sea pollution.
**6.** The sea bottom is already a 'trash bin'; do not throw garbage and old/damaged nets and long-lines into the sea.


V. Lekkas

*Calappa granulata*


pescaenautica.it

*Tonna galea*


V. Lekkas

*Dardanus arossor*


Fournari - Konstantinidou

*Ophidiaster ophidianus*


V. Gerovasileiou


E. Akritopoulou

## MINIMUM SIZE OF REPRODUCTION MATURITY (LM)

**Dusky grouper** •
*Epinephelus marginatus*
Lm=58.7cm | Age of Lm: 6.7
C.S.: Threatened

**White sea bream**
*Diplodus sargus*
Lm=29.5cm | Age of Lm: 5.1
C.S.: Unknown

**Common dentex**
*Dentex dentex*
Lm=44.8cm | Age of Lm: 6.3
C.S.: Unknown

**Red porgy**
*Pagrus pagrus*
Lm=32.8cm | Age of Lm: 3.9
C.S.: Threatened

**Amberjack**
*Seriola dumerili*
Lm= 70.2cm | Age of Lm: 2.4
C.S.: Unknown

**Red Scorpion fish**
*Scorpaena scrofa*
Lm=31.6cm | Age of Lm: 8.2
C.S.: Unknown

**Striped red mullet**
*Mullus surmuletus*
Lm=18.7 | Age of Lm: 3.4
C.S.: Unknown

**Pandora**
*Pagellus erythrinus*
Lm=18.2cm | Age of Lm: 3
C.S.: Unknown

**Little tunny** •
*Euthynnus alletteratus*
Lm=89.2cm | Age of Lm: 3.2
C.S.: Least concern

**European hake**
*Merluccius merluccius*
Lm=43cm | Age of Lm: 4.5
C.S.: Unknown

**Striped seabream**
*Lithognathus mormyrus*
Lm=22.1cm | Age of Lm:2.9
C.S.: Unknown

**Brown wrasse**
*Labrus merula*
Lm=25cm | Age of Lm: 3.1
C.S.: Least concern

### MINIMUM PERMITTED CATCH SIZE

| | | |
|---|---|---|
| **Dusky grouper** | *Epiphelus marginatus* | 45 cm |
| **Goldblotch grouper** | *Epiphenus costae* | 45cm |
| **European hake** | *Merluccius merluccius* | 20cm |
| **Pandora** | *Pagellus erythrinus* | 15cm |
| **Red porgy** | *Pagrus pagrus* | 18cm |
| **Stripped rd muller** | *Mullus surmuletus* | 11cm |
| **White sea bream** | *Diplodus sargus* | 23cm |
| **Sea bass** | *Dicentrachus labrax* | 25cm |
| **Two banded sea bream** | *Diplodus vulgaris* | 18cm |
| **Blackspot seam bream** | *Pagellus bogaraveo* | 33cm |
| **Octopus** | *Octopus vulgaris* | 500gr |
| **Common cuttlefish** | *Sepia officinalis* | 20cm* |
| **Lobster** | *Palinurus sp* | 9cm** |
| **Stripped sea bream** | *Lithognathus mormyrus* | 20cm |

• Protected species from National and International law

**Lm:** Minimum size of reproduction in centimeters (source: Life history tool – www.fishbase.org)
**Age of Lm:** Minimum of age for reproduction maturity in years
**C.S. :** Conservation Status (IUCN)

* Mantle length | * *Carapace length

COUNCIL REGULATION (EC) No 1967/2006

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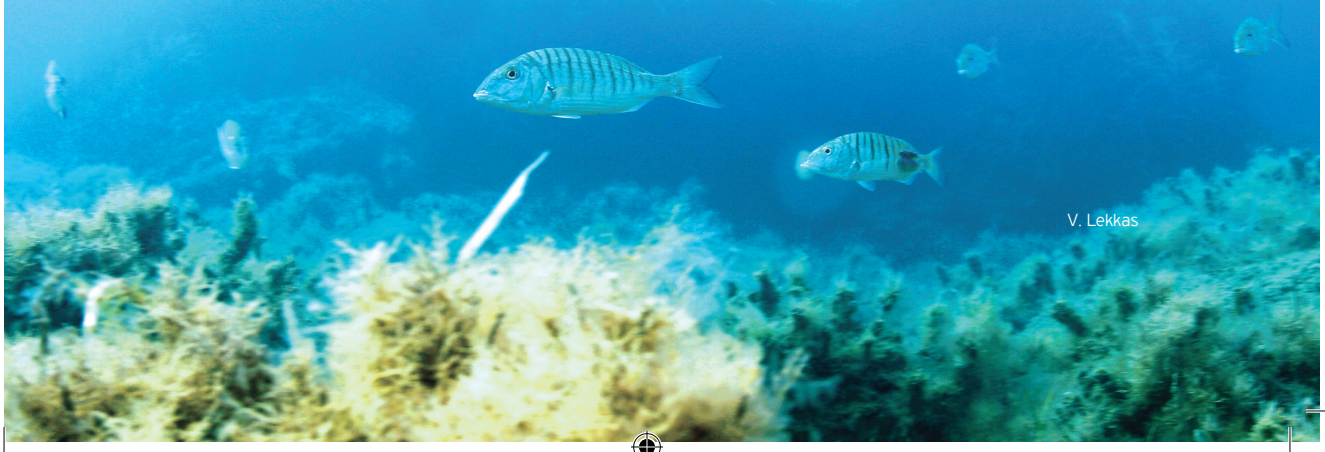

V. Lekkas

## Contact

Ministry of Environment, Energy and Climatic Change - N.M.P.Z.,
El. Venizelou 1-Zakynthos 29100, Tel. 2695029870

NATIONAL MARINE PARK OF ZAKYNTHOS: **www.nmp-zak.org**
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