# The Science of Marine Protected Areas

Third Edition: Mediterranean Sea

PISCO Partnership for Interdisciplinary Studies of Coastal Oceans

The **Partnership for Interdisciplinary Studies of Coastal Oceans** (PISCO, USA) and the **University of Nice Sophia Antipolis** (UNS, France) produced this booklet: The Science of Marine Protected Areas—Mediterranean Version. Core booklet content was developed in collaboration with COMPASS (www.compassonline.org). PISCO is a consortium of academic scientists at Oregon State University; University of California, Santa Barbara; University of California, Santa Cruz; and Stanford University. PISCO advances the understanding of coastal marine ecosystems and communicates scientific knowledge to diverse audiences.

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### Convening and Content Lead Authors

**Jane Lubchenco** (Oregon State University [OSU], USA), **Paolo Guidetti** (National Center for Scientific Research-University of Nice Sophia Antipolis [CNRS–UNS], France; National Interuniversity Consortium of Marine Sciences [CoNISMa], Italy), **Kirsten Grorud-Colvert** (OSU, USA), **Sylvaine Giakoumi** (CNRS-UNS, France; University of Queensland, Australia), **Steven Gaines** (University of California, Santa Barbara, USA), **Fiorenza Micheli** (Stanford University, USA), **Giuseppe Di Carlo** (World Wide Fund for Nature [WWF] Mediterranean, Italy).

### Science of Marine Protected Areas, Mediterranean Project Directors

**Sylvaine Giakoumi, Jeremiah Plass-Johnson** (CNRS–UNS, France)

### Science of Marine Protected Areas, Project Director

**Kirsten Grorud-Colvert** (OSU, USA)

### Mediterranean Project Assistant Directors

**Jessica Reimer** (OSU, USA), **Claudia Scianna** (CNRS–UNS, France)

### Mediterranean Advisory Committee

**T. Agardy** (Sound Seas, USA), **F. Bachet** (Côte Bleue MPA, France), **D. Cebrián** (Regional Activity Centre for Specially Protected Areas [RAC-SPA], Tunisia), **S. Chakour** (University of Jijel, Algeria), **J. Claudet** (CNRS, France), **M. Damanaki** (The Nature Conservancy, UK), **B. Daniel** (Agence des Aires Marines Protégées [AAMP], France), **S. Dujmovic** (Brijuni MPA, Croatia), **A. Di Franco** (CNRS–UNS, France), **S. El Asmi** (RAC-SPA, Tunisia), **M. Fouda** (Benha University, Egypt), **P. Francour** (CNRS–UNS, France), **J. A. García-Charton** (University of Murcia, Spain), **M. Gomei** (WWF Mediterranean, Italy), **H. Güçlüsoy** (Dokuz Eylül University, Turkey), **A. Jeudy de Grissac** (International Union for the Conservation of Nature [IUCN], Spain), **B. Meola** (Network of Marine Protected Area Managers in the Mediterranean [MedPAN], France), **F. Niccolini** (University of Pisa, Italy), **G. Notarbartolo di Sciara** (Tethys Research Institute, Italy), **S. Planes** (CNRS–University of Perpignan, France), **J. Plass-Johnson** (CNRS–UNS, France), **G. Prato** (WWF Mediterranean, Italy), **M. Portman** (Technion–Israel Institute of Technology), **C. Rais** (Okianos, Tunisia), **S. Ben Salem** (National Institute of Marine Sciences and Technologies, Tunisia), **N. Staglicic** (Institute of Oceanography and Fisheries, Croatia), **C. Webster** (MedPAN, France).

**Creative Director: Monica Pessino** (Ocean o' Graphics, University of California, Santa Barbara, USA)

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## Table of Contents

# Overview:

The ocean and seas are of great value. They provide important benefits to people including food, oxygen, economic opportunities, recreation, and cultural value. However, heavy uses of the ocean are eroding these benefits, sometimes at alarming rates.

Marine protected areas (MPAs) can be a powerful tool to protect, and possibly restore, the ability of ecosystems to provide these benefits. Globally, there are thousands of MPAs, though their collective area is small. What have we learned from these protected places? This booklet summarizes the latest science about MPAs, emphasizing the Mediterranean Sea.

There are many terms for MPAs, reflecting different levels of protection, history, governance, management authority, and more. In this booklet, we simplify these categories by focusing only on the degree of protection from extractive uses. We define MPAs and classify them as follows:

**Marine Protected Areas (MPAs)** are places in the sea designed to protect marine species and ecosystems, while sometimes allowing for sustainable uses of marine resources within their boundaries. An MPA can be 1) **partially protected**, where some uses are prohibited but some extractive activities are allowed and regulated, or 2) **fully protected**, where all extractive and destructive activities are forbidden, except as needed for scientific monitoring. Fully protected areas are also called **no-take areas**. A **multiple-use area** can combine partially and fully protected areas in different zones.

MPAs can help support livelihoods and preserve cultural values. Full protection from extractive activities usually leads to much greater long-term ecological, economic, and social benefits than only partial or no protection. Emerging evidence suggests that large, fully protected areas can provide resilience to climate change and other environmental threats.

Regardless of the level of protection, an MPA must have strong compliance and enforcement to successfully meet its goals.

MPAs can be an effective tool for conservation and management, but they cannot address all threats to marine life. Parallel actions are needed to make fishing and aquaculture sustainable, address climate change and ocean acidification, and reduce pollution from plastics, nutrients, and chemicals. Science shows what MPAs can provide and offers useful information for planning MPAs.

# what is a marine protected area?

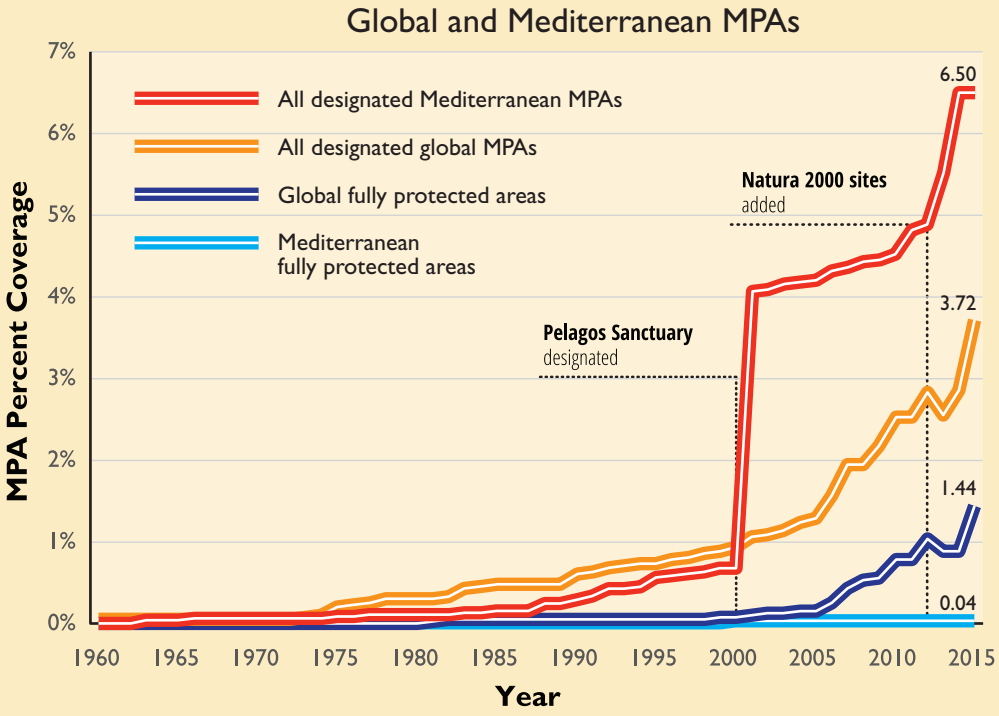
# MPAs Are Increasing Globally, but More Effective Protection is Needed

In 2015 there were more than 11,300 MPAs around the world. That sounds like a lot, but in reality MPAs cover only 3.7% of the oceans and seas, and fully protected MPAs cover only 1.4%. This represents considerable progress—a decade ago, only 0.2% was fully protected.

Governments have recognized the important role of MPAs in protecting biodiversity and sustaining livelihoods. The United Nations Sustainable Development Goal 14 and the Convention on Biological Diversity's Aichi Target 11 both call for protecting at least 10% of the oceans and seas in MPAs by 2020.

The goal to increase protection in the oceans and seas has led to many new MPAs, globally and in the Mediterranean Sea. Although a few of the new MPAs elsewhere are very large and fully protected, most MPAs, including in the Mediterranean, are small and only partially protected.

Adding up the area covered by new MPAs in the Mediterranean shows a 10-fold increase over the past 15 years. Unfortunately, many of these MPAs have not been implemented or are not enforced, and virtually none of the new MPAs are fully protected.




This figure shows the increase in coverage of all types of MPAs in the Mediterranean (red line) and globally (orange line) and the increase in coverage of fully protected areas in the Mediterranean (light blue line) and globally (blue line). Although 6.5% of the Mediterranean Sea has some protection, only 0.04% is fully protected. Black dotted lines show recent designations that cover a large area in the Mediterranean: the Pelagos Sanctuary (2000) and new Natura 2000 sites (2013).

The Mediterranean region faces challenges and opportunities for MPAs. It has a high density of people and supports 1/3 of the world's tourism. It is rich in ecological, historical, and cultural treasures, which are threatened by a long history of human use. In the Mediterranean Sea, fully protected areas cover only 0.04%, much less than the global 1.4%. Moreover, the average size of fully protected areas in the Mediterranean is only 5 km$^2$. Increasing the size of existing Mediterranean MPAs and the size of their fully protected areas is one way to provide ecological benefits while moving closer to achieving international conservation targets. However, for the goals to be met, all MPAs must be effectively implemented, enforced, and managed.



# MPAs in the Mediterranean Sea

The points on this map show Mediterranean MPAs that are either fully protected areas or multiple-use MPAs including at least one fully protected area.

## Where Are the Fully Protected Areas in the Mediterranean?

**Most Mediterranean countries have designated MPAs within their territorial waters.** Most Mediterranean MPAs are multiple-use areas including one or more fully protected areas as well as partially protected areas. Inside the fully protected area, no extractive activities are allowed, but some recreational activities such as swimming, boating, and diving may be permitted. Inside the partially protected areas, extractive activities such as regulated artisanal fishing can be allowed. The stated goal of these multiple-use MPAs is to protect biodiversity, preserve the socio-cultural heritage of the Mediterranean, and support sustainable local economies. Achieving these goals requires compliance, enforcement, and monitoring.

## Mediterranean MPA Facts

- **There are 1,140 designated MPAs that cover 6.5% of the Mediterranean Sea.**
- **Only 76 are fully protected. They cover 0.04% and their average size is small—only 5 km².**
- **The number of designated MPAs increased almost 3 times over the past 15 years, but fully protected MPAs increased less rapidly.**
- **The vast majority of designated Mediterranean MPAs are weakly enforced or only 'parks on paper', because they are not implemented or not managed at all.**

## Legal Framework

Mediterranean countries have legal obligations to protect the marine environment and to designate MPAs through various agreements, policies, and laws. Key international instruments include the Convention on Biological Diversity and the United Nations Sustainable Development Goals. The Barcelona Convention, with the Specially Protected Area and Biological Diversity Protocol, applies to the Mediterranean region. Across the EU, MPAs are also called for in directives such as the Marine Strategy Framework Directive and the Habitats and Birds Directives for implementation of the Natura 2000 network of sites at sea.

*References: 1, 2, 3, 4 and online 52*

# effects of MPAs inside their borders

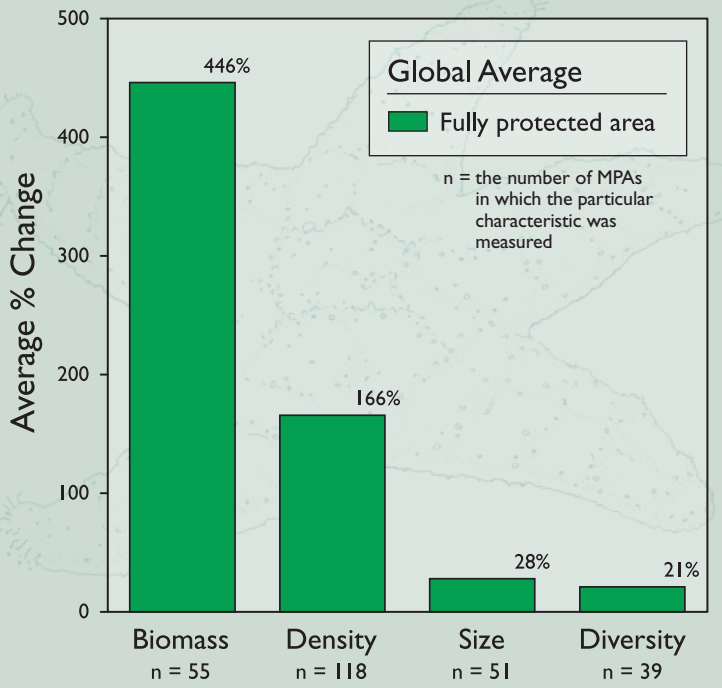
**One key goal of MPAs is to protect the abundance and diversity of marine life. Scientific research shows that fully protected, well-enforced, and appropriately sized MPAs almost always accomplish this goal. MPAs that are partially protected and enforced can show some biodiversity increases, but benefits are less than in fully protected areas.**

## More Fishes, Invertebrates, and Other Marine Life

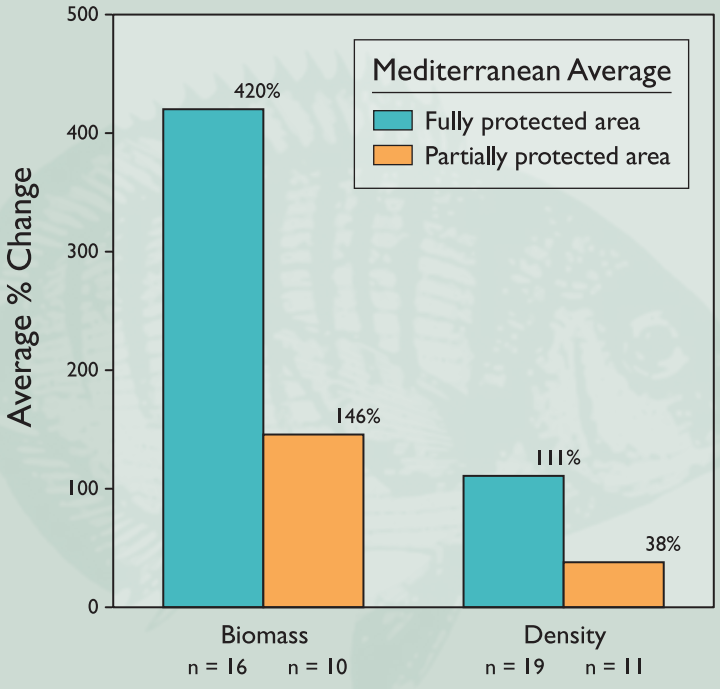
Scientists have studied more than 150 fully protected MPAs around the world and monitored biological changes inside their borders. A 2006 global review (see top graph) revealed that marine fishes, invertebrates, and seaweeds show significant average increases in biomass, density, size, and diversity inside fully protected areas compared to unprotected areas.

1. **Biomass,** or the total weight of animals and plants, increased an average of 446%.
2. **Density,** or the number of plants or animals in a given area, increased an average of 166%.
3. **Body size** of animals increased an average of 28%.
4. **Species diversity,** or the number of species, increased an average of 21%.

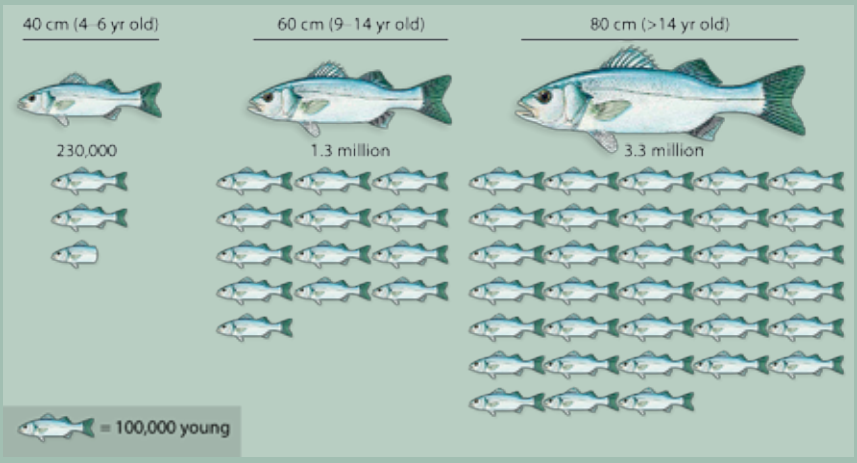
A new review of 25 MPAs in the Mediterranean Sea showed similar increases (see bottom graph). On average, species within fully protected areas showed greater responses to protection than they did in adjacent partially protected areas. Both fully and partially protected areas had more and larger fish than areas outside the MPAs. Heavily fished species, such as dusky groupers and seabreams, were most abundant and biggest in fully protected areas. Compared to unprotected areas, fish biomass was 420% greater in fully protected areas and 146% greater in partially protected areas. Fish density was 111% greater in fully protected areas and 38% greater in partially protected areas. Fully protected areas consistently showed the largest increases, but partial protection also had positive effects.




Average changes (green bars) in fishes, invertebrates, and seaweeds within fully protected MPAs around the world. *Data: Ref. 5*




Average change in fish biomass and density within fully protected areas (blue bars) and partially protected areas (orange bars) in Mediterranean MPAs. *Data: Giakoumi et al. in prep*




Average number of young produced by three different sizes of European seabass. *Data: Ref. 6*

## Bigger Animals Have More Young

Fishes and invertebrates grow bigger in fully protected areas. This effect of protection is extremely important because large individuals contribute much more to the next generation than smaller adults by producing disproportionately more offspring. For example, if a 40 cm European seabass is allowed to grow to 80 cm, it produces 14 times more young (see figure at left). Bigger animals in fully protected areas can produce far more young than their smaller neighbors in fished waters.

## Even Small MPAs Can Be Effective

Small MPAs by themselves cannot protect the number of individuals, species, and habitats typically protected by larger MPAs or by networks of many MPAs. However, global and Mediterranean scientific reviews both show that some species can benefit from even small, well-enforced and well-managed MPAs. For example, fish biomass has increased significantly in the 0.65 $km^2$ fully protected area of the French Cerbère-Banyuls MPA.

If managed well, small MPAs even near urban areas can produce important benefits. In the 0.3 $km^2$ Italian fully protected area at Miramare, abundance, size, and biomass of many commercially important species are much higher than in adjacent fished areas.

Small MPAs near urban areas, such as Miramare in Italy and the Larvotto Marine Reserve in the Principality of Monaco, are also valuable for educating the public about protection of the sea.

## Fast Facts

- Bigger adult fishes and invertebrates produce many more young than smaller adult animals.
- Many species increase in MPAs, particularly those that are fished outside. Some species decrease, such as the prey of previously fished predator species.
- MPAs help restore the natural range of ages and sizes for populations of many species.

## MPAs Can Restore Species Interactions

Inside fully protected MPAs, there tend to be large overall increases in biomass, density, size, and diversity for some fish and invertebrate species. However, other species inside fully protected areas may either decline or not change. In general, species subject to fishing in unprotected waters tend to increase in fully protected MPAs. A worldwide analysis found that 61% of fish species were more abundant inside fully protected MPAs than outside, while 39% of species declined following protection.

Some fish and invertebrate species become less abundant in an area after it is designated as a fully protected MPA. For example, prey species that increase when their predators are fished become less abundant when their predators are protected. In the fully protected Medes Islands MPA in Spain, for instance, increases in predatory fishes can lead to higher predation pressure on juvenile spiny lobsters.

Such increases in predators leading to decreases in prey inside MPAs have been seen in New Zealand, Australia, Chile, and the USA. Well-designed, fully protected areas restore many natural species interactions.

Larvotto Marine Reserve in the Principality of Monaco. *Photo: Kevin Sempé*

The education program "Respect the sea" at the Larvotto Marine Reserve, Monaco. *Photo: Patrice Francour*

*References: 5, 6, 7, 8, 9, 10*

## How Long Does It Take to See a Response?

Although some changes happen rapidly, it may be many years before the full effects of MPAs are evident. Some fishes, invertebrates, and plants may not change noticeably in abundance, body size, biomass, or diversity for some time. Several factors predictably influence the response time of species to MPAs:

- The level of MPA protection, compliance, and enforcement
- The availability of breeding adults
- How fast individual animals and plants grow
- The age at which animals and plants can reproduce
- The number of young produced and the availability of suitable habitats for juveniles
- Mobility during each life stage
- Interactions among species, such as predators and prey
- Human impacts prior to MPA establishment, such as the intensity of fishing or amount of seabed damage
- Ongoing impacts from climate change and regional pollution
- The habitats' and species' ability to recover after being impacted

## Species Grow and Mature at Different Rates

Marine organisms vary greatly in how fast they grow and the age at which they first reproduce (see figure below). These traits influence the response rate of each species after an MPA is established. Some species—such as the salema fish—grow and reproduce quickly, producing large numbers of offspring. These animals may multiply rapidly in an MPA, increasing greatly in abundance in just a few years. Other species—such as the dusky grouper—grow slowly and mature at an older age. These slow-growing species are particularly vulnerable to human impacts. They need long-term protection to recover inside MPAs.

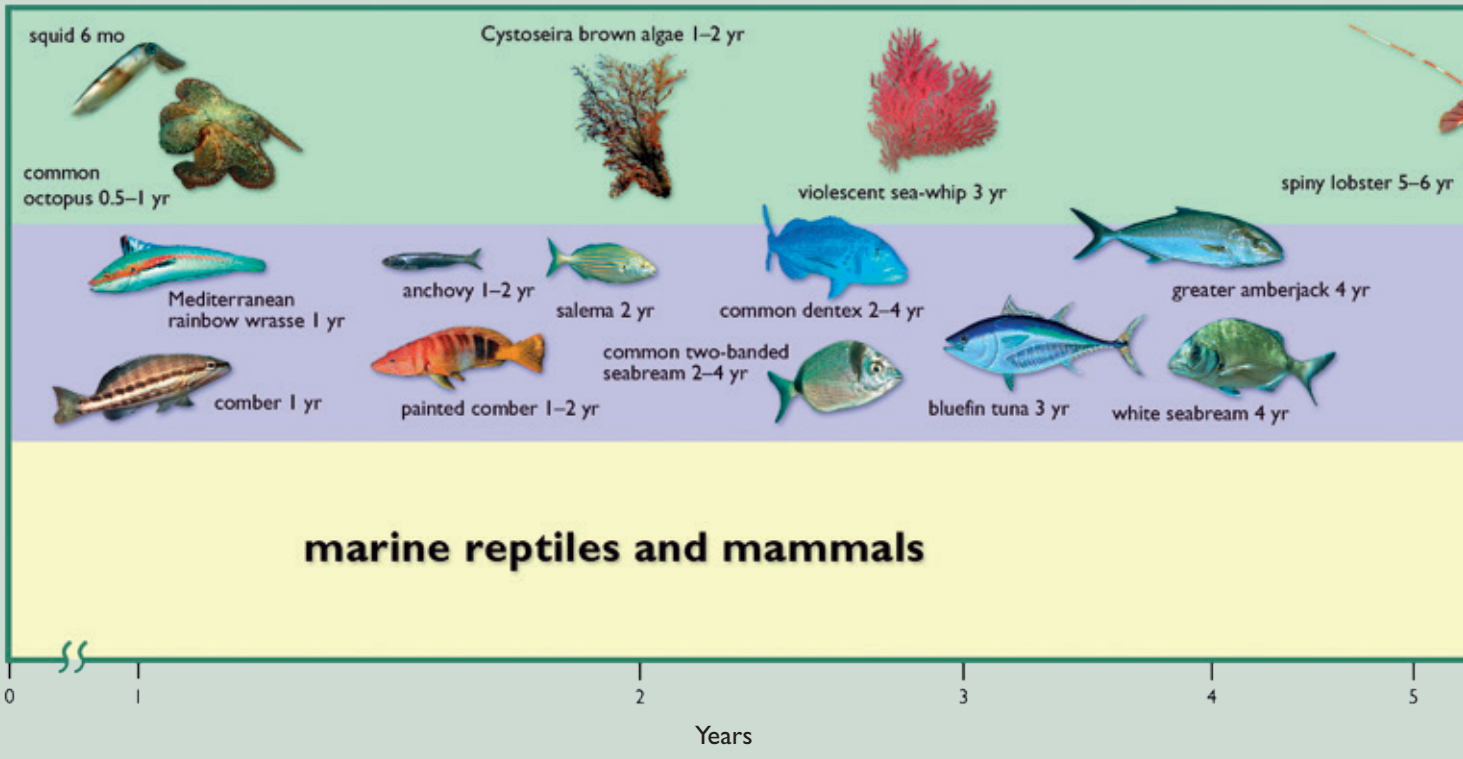
The Mediterranean slipper lobster is a slow-growing species that has been subject to intense harvesting. *Photo: Sylvaine Giakoumi*

### Fast Facts

- Inside MPAs, fast-growing fishes and invertebrates that mature quickly and produce many offspring are likely to increase most rapidly, sometimes within 1 to 4 years.
- Some ecological changes may not be evident in an MPA for years or even decades after an area is protected.
- Long-term protection is needed for slow-growing species to recover in MPAs.

*Photos:* Seaweed and Invertebrates: *Sylvaine Giakoumi, Egidio Trainito, Paolo Guidetti, Lorenzo Bramanti, Andromede.* Fish: *Patrick Louisy, Andromede, Egidio Trainito.* Marine reptiles and mammals: *MOm/P. Dendrinos, Richard Daniel*

## Age of Maturity for Selected Species



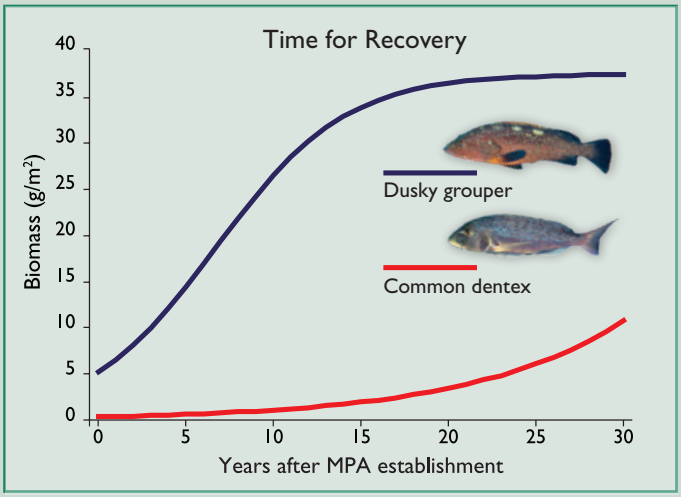
# Long-term Protection Is Needed for Full Recovery

Populations of some animals recover quickly following protection. Other long-lived animals can take decades to fully recover. In the fully protected area of Medes Islands MPA in Spain, two commercially important fishes—the dusky grouper and the common dentex—recovered at different rates (see figure at right).

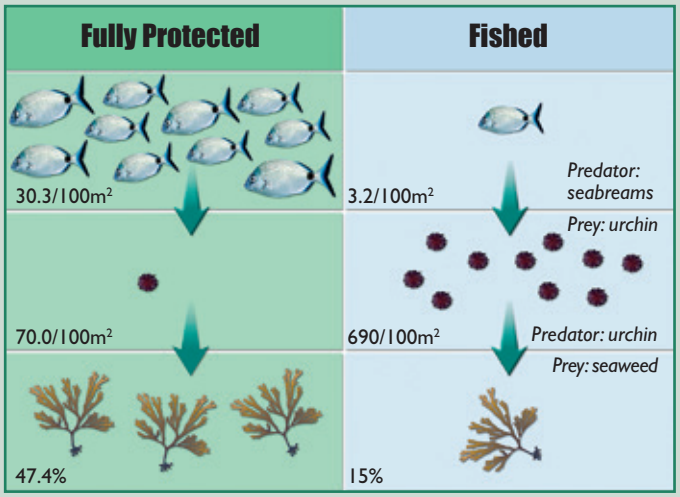
The abundance of dusky groupers increased for 15 years, stabilizing about 20 years after protection. The common dentex increased more slowly, but continually, and is still increasing 30 years after protection. These data show that continued protection is needed for full ecosystem recovery.

A review of fully protected MPAs in New Zealand, Australia, the USA, Kenya, and the Philippines found that species targeted by fishing generally responded within 5 years of protection. However, unfished species took longer—an average of 13 years—because they were not responding to the absence of fishing but rather to changing abundances of other species.

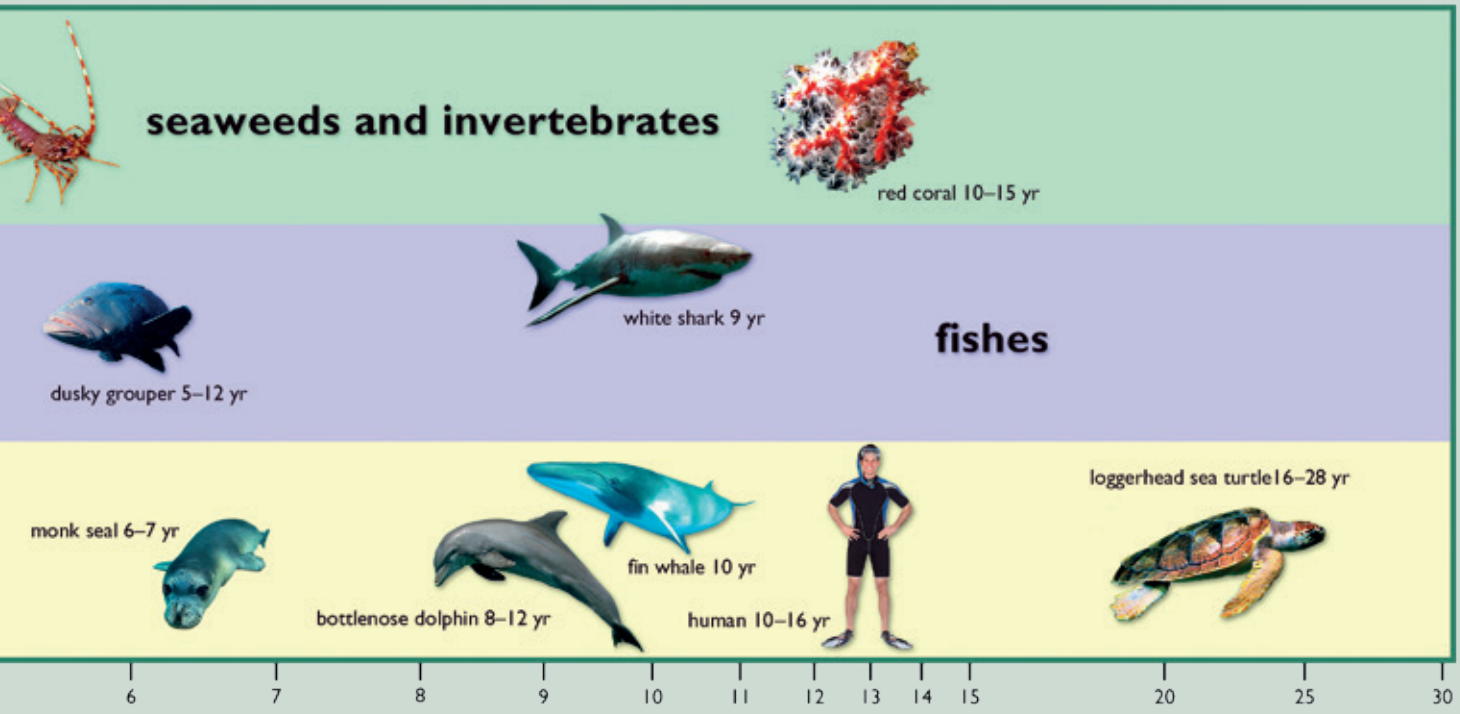
In the Mediterranean, commonly fished seabreams became larger and 2 to 10 times more abundant inside the fully protected area of the Torre Guaceto MPA. After 10 years, more and larger seabreams ate more and more sea urchins, and there were 10 times fewer sea urchins inside the fully protected area. This effect cascaded through the food web. With fewer sea urchins, there was 3 times more seaweed inside compared to outside the MPA. More seaweeds means more habitat for other species and their young, who use it as a nursery. Thus, over time, full protection is restoring many key interactions among species, but recovery may vary with temperature, habitat, and other factors.




Recovery of biomass for the common dentex (red line) and dusky grouper (blue line) in the Medes Islands MPA in Spain. *Data: Ref. 11*




In the fully protected area of Torre Guaceto MPA in Italy, there are abundant seabreams and low urchin numbers, enabling seaweeds to flourish. Outside the fully protected area, fewer seabreams mean there are too many urchins, which eat most of the algae. *Data: Ref. 12*

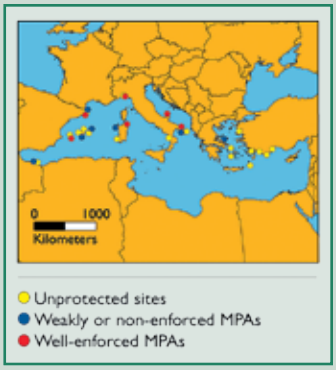



*References: 11, 12, 13*

# Case Study: MPAs Across the Mediterranean Sea

A common dentex in the Medes Islands MPA, Spain. *Photo: Josep Clotas*

Tavolara-Punta Coda Cavallo MPA, Italy. *Photo: Egidio Trainito-Tavolara MPA*




Sites surveyed across the Mediterranean Sea to compare enforcement and MPA effects. *Data: Ref. 16*

## Enforced MPAs Boost Fish Biomass

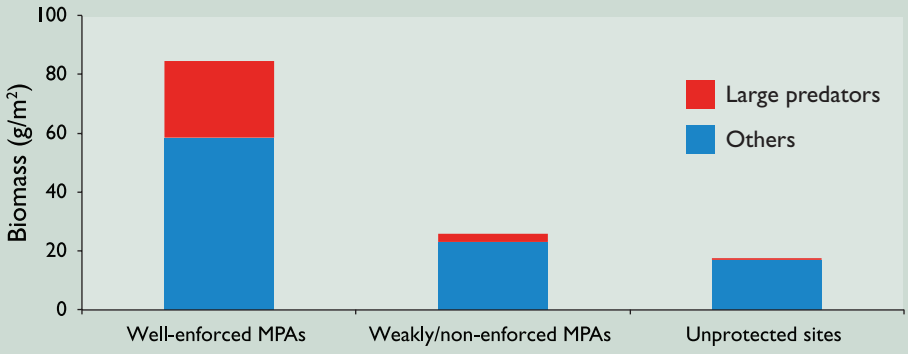
Marine resources have been intensively harvested from the Mediterranean Sea for millennia. Unsustainable use has led to the depletion of many resources, including fish stocks.

A study summarizing differences between MPAs and unprotected areas across the Mediterranean Sea (in Spain, Morocco, Italy, Greece, and Turkey) showed that fish biomass was much higher in fully protected areas, but only when the protected areas were well-enforced. In MPAs with effective and full protection the overall biomass of fish was higher, with relatively more predatory fishes. Conversely, there were no differences in fish biomass between weakly-enforced MPAs and unprotected areas. Local support, compliance, and enforcement reduce or stop illegal fishing, ensuring that MPAs truly work. MPAs cannot achieve the intended benefits without compliance and enforcement.

High levels of protection can also generate ecosystem benefits. In the well-enforced Tavolara-Punta Coda Cavallo MPA in Italy, fish density, size, and biomass of exploited species, such as the dusky grouper, were higher in fully protected areas than in adjacent fished areas. Invertebrates, such as the endangered and intensely harvested ribbed Mediterranean limpet, were larger in fully protected areas, especially in isolated locations. Other invertebrates, such as amphipods, are prey for numerous predators that benefit from protection. These invertebrates were less abundant within the fully protected areas compared to the adjacent fished sites.

### Lessons Learned

- Biomass of fish, especially commercially exploited species and large predators, increased in fully protected areas in Mediterranean MPAs.
- The benefits of MPAs can only occur when communities comply with legal restrictions, enforcement is effective, and MPAs are well-managed.
- When predators increase in MPAs, their prey tend to decrease.




Biomass of large predatory fishes (red bars) and other fishes (blue bars) by protection level. *Data: Ref. 16*

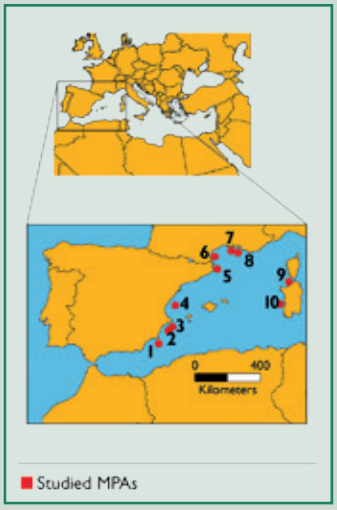
The endangered ribbed Mediterranean limpet. *Photo: Stefania Coppa*

*References: 16, 17, 18, 19*

# Case Study: MPAs in Spain, France, and Italy

A SCUBA diver observes coralligenous communities in Medes Islands MPA, Spain. *Photo: Josep Clotas*

A small-scale fisherman at Cabo de Palos-Islas Hormigas MPA (Murcia, Spain). *Photo: Miguel Lorenzi*




Location of the ten Mediterranean MPAs studied: 1=Cabo de Palos (Spain), 2=Tabarca (Spain), 3=San Antonio (Spain), 4=Columbretes (Spain), 5=Medes Islands (Spain), 6=Cerbère-Banyuls (France), 7=Cap Couronne (France), 8=Carry-le-Rouet (France), 9=Bouches de Bonifacio (France), 10=Sinis Mal di Ventre (Italy). *Data: Ref. 20*

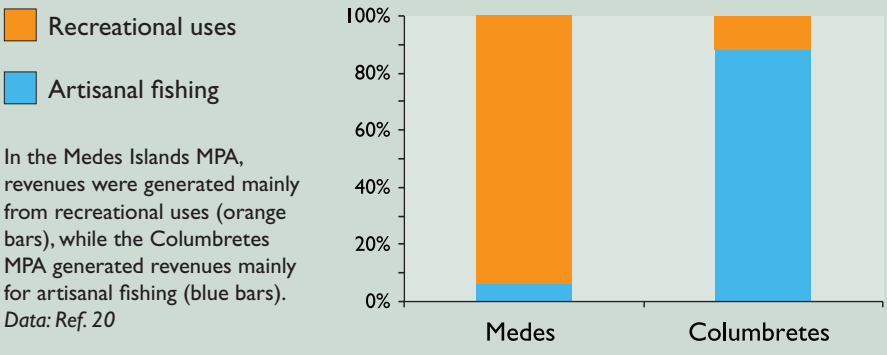
## MPAs Can Provide Economic and Social Benefits

*When MPAs are well-designed, enforced, and managed they can generate more revenue than their costs of management. Therefore, MPAs could bring a profit to local communities. A scientific study of 12 MPAs in Spain, France, and Italy (10 in the Mediterranean Sea) showed that the income generated by fishing and SCUBA diving in an MPA was 2.3 times greater on average than the MPA management costs. The increases in fishes, invertebrates, and marine plants in MPAs can result in important economic benefits for people. Ecosystems with more abundant, larger, and diverse organisms can offer better places for tourists like divers to visit. The establishment of well-designed MPAs can also enhance fisheries. Fished species that are protected in an MPA, especially in fully protected areas, can move outside and replenish adjacent areas. These MPA outcomes can increase the income and overall wellbeing of some people. However, the location and design of the MPA and the potential activities allowed will determine which groups of people benefit the most.*

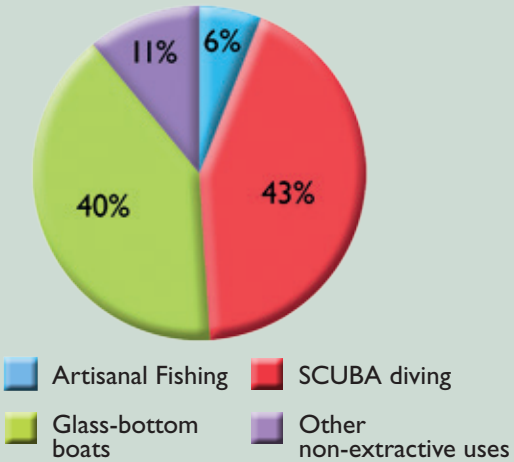
*In the Columbretes MPA in Spain, artisanal fishers receive most of the social and economic benefits. Fishing in the partially protected area surrounding the fully protected area yields higher catches of greater value. These benefits also support more jobs. In other MPAs, such as in the Medes Islands in Spain, the greatest economic benefits go to the tourism sector. This MPA, with a fully protected area less than 1 km², generates revenues of about 10 million euros annually. Almost 85% of these economic benefits are generated by SCUBA diving and glass-bottom boats. The recovery of marine life, especially large fishes, attracts thousands of tourists every year from all over the world. Similar results have been reported for other MPAs in Spain, France, and Italy.*

### Lessons Learned

- Well-enforced and well-managed MPAs can increase revenue and jobs in local communities.
- Across 12 MPAs, average income from fishing and diving was 2.3 times higher than the MPA management costs.




In the Medes Islands MPA, revenues were generated mainly from recreational uses (orange bars), while the Columbretes MPA generated revenues mainly for artisanal fishing (blue bars). *Data: Ref. 20*




The estimated revenue generated by the Medes Islands MPA based on different activities: artisanal fishing (blue), SCUBA diving (red), glass-bottom boats (green), and other non-extractive uses (purple). The greatest percentage of revenue was generated by non-extractive uses. *Data: Ref. 21*

*References: 20, 21, 22*

# effects of MPAs beyond their borders

*Increases in the number and size of fishes and invertebrates are most evident inside fully protected areas. However, some of these benefits may also connect MPAs with fished areas when eggs, larvae, and adults drift or move beyond MPA borders.*

### Fast Facts

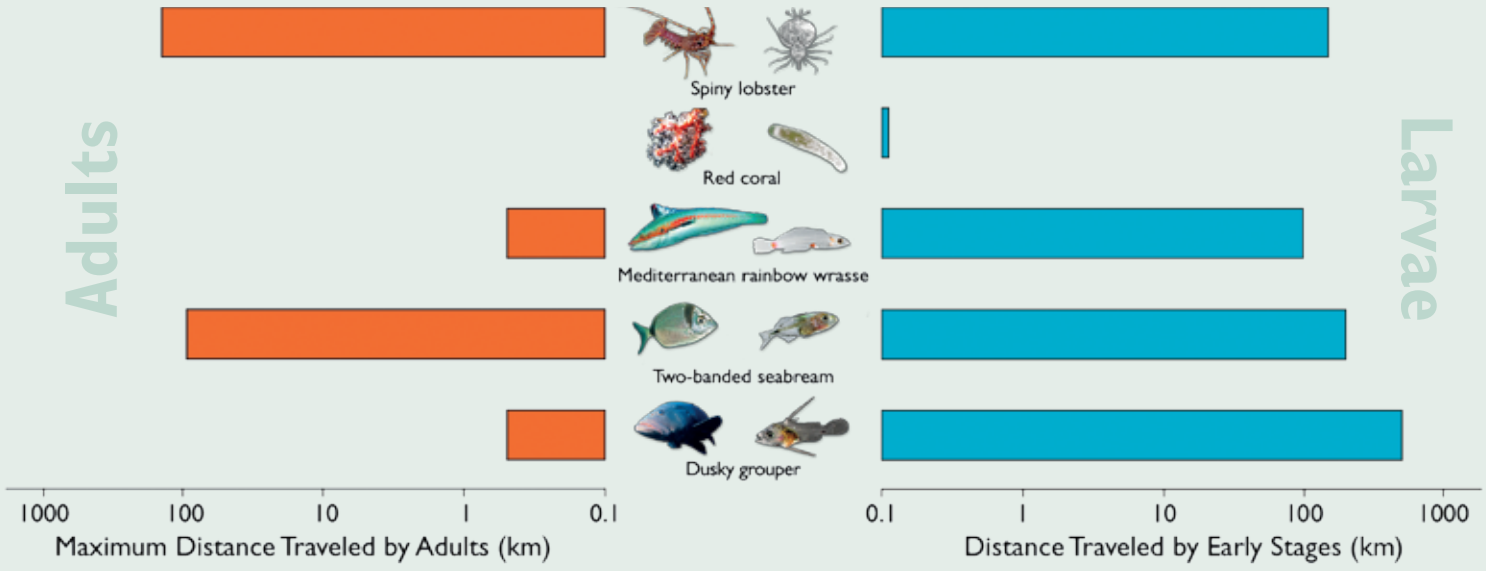
- Some adult animals move outside fully protected areas in a process called spillover.
- The early stages of some marine organisms can drift away from their parents in a process called dispersal.
- Both spillover and dispersal from fully protected areas can help replenish populations in fished areas.

## Spillover of Adults and Juveniles

As animals become more abundant inside a fully protected area and space becomes limited, some adults and juveniles may leave and move elsewhere. This process is called **spillover**. They also may leave because they need a different type of prey or habitat as they grow or reproduce. Spillover can help replenish fish and invertebrate populations in partially protected areas and outside MPAs, thereby enhancing local fisheries. Fishers often fish along the margins of fully protected areas to catch this spillover. Scientists use tagging and other techniques to document spillover by following animals that leave MPAs. Studies have shown spillover from fully protected areas in many locations around the world, including Spain, France, and Italy.

## Dispersal of Early Stages

Many fishes and invertebrates release large numbers of eggs into the water. After fertilization, eggs hatch into tiny larvae. These early stages (eggs and larvae) can stay in open waters for days or months, sometimes traveling far from their origin in a process called **dispersal**. Some eggs or larvae produced in an MPA may remain inside, while others may settle and grow into adults far away. Through this export of early life stages, fully protected areas can help replenish fished areas. Scientists use genetic data, life-cycle information, oceanographic models, and advanced tagging techniques to learn how many organisms stay inside MPAs, how many disperse from MPAs, and where they go.




The maximum distances that some adult marine animals travel ('spillover') from MPAs in the Mediterranean Sea (tagging studies). *Data: Ref. online 59, 60, 61, 62, 63*

The estimated distance at which eggs and larvae of marine animals that live in the Mediterranean can be exported. *Larval photos (top to bottom): Jose Iglesias, Eric Tambutté, Manuel Muntoni, Manuel Muntoni, Emília Cuhna (IPMA–EPPO). Data: Ref. online 62, 63, 64, 65, 66*

*References: 14, 15*

# Case Study: Columbretes, Spain and Torre Guaceto, Italy

Lobster fishing in the Columbretes MPA, Spain. *Photo: Sandra Mallol*

A spiny lobster in the Columbretes MPA, Spain. *Photo: David Diaz*


Location of the Columbretes MPA (middle map) and the Torre Guaceto MPA (lower map).

## Fully Protected MPAs Can Replenish Fished Areas

Scientific evidence shows that MPAs can help replenish neighboring fished areas. For example, protection of lobsters within the fully protected area of the Columbretes MPA in Spain led to higher lobster catches outside its borders. Lobsters from the MPA were caught up to 4 km beyond its border. This provides an important economic benefit for local artisanal fishers. They caught larger lobsters with higher commercial value after the MPA was implemented. Other species with high commercial value, such as the red scorpionfish, also moved from the fully protected area to surrounding fished areas. Similar patterns were observed in other MPAs in Spain, Italy, and France, where adult fishes increased in abundance and size in fully protected areas and spilled over to enhance catches in nearby fished waters.

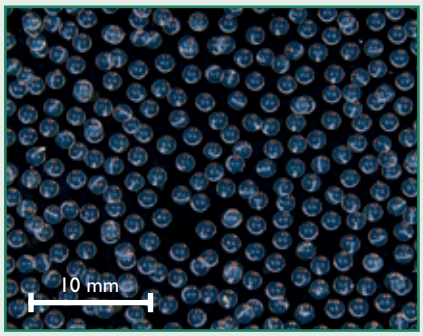
Fully protected areas can also support populations outside MPAs when eggs and larvae drift beyond MPA borders. For example, scientists studying the Torre Guaceto MPA in Italy found that the MPA is a productive source of fish eggs and larvae. The high number of large seabreams that inhabit the MPA produces large numbers of eggs and larvae, which replenish both the MPA and areas outside. Benefits are seen well beyond the MPA borders (more than 100 km).

Such data provide mounting evidence that MPAs with fully protected areas can benefit commercially important species by protecting larger individuals that produce more offspring and replenish fished areas outside MPAs.

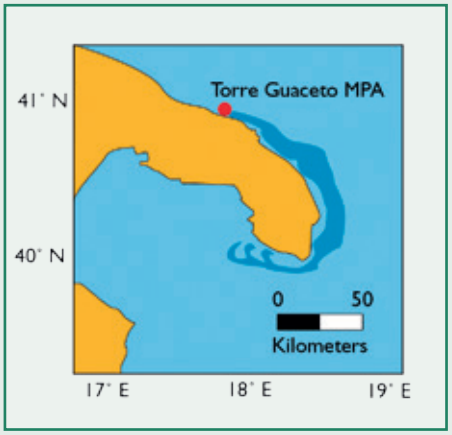
### Lessons Learned

- Over time, larger lobsters and commercially valuable fishes spilled over from the fully protected area of Columbretes MPA to increase catches in surrounding fished areas.
- Large seabreams in the fully protected area of the Torre Guaceto MPA produce eggs and larvae that disperse to fished areas more than 100 km away.

The tower at the Torre Guaceto MPA, built in 1531. *Photo: Area Marina Protetta Torre Guaceto*




Fish eggs. *Photo: Yiannis Issaris*




Biological tracking showed that seabream eggs and larvae dispersed (blue area) outside the Torre Guaceto fully protected area into fished areas. *Data: Ref. 25*

*References: 23, 24, 25, 26*

# scientific considerations for designing MPAs

**Humans rely on healthy marine ecosystems for livelihoods, education, and recreation. Studies show that if MPAs are designed with ecological, social, cultural, and economic factors in mind, they can achieve multiple benefits. A well-designed MPA balances trade-offs between the MPA size, the species and habitats it protects, and the benefits it provides.**

## The Best MPA Size for Species Depends on Where They Move

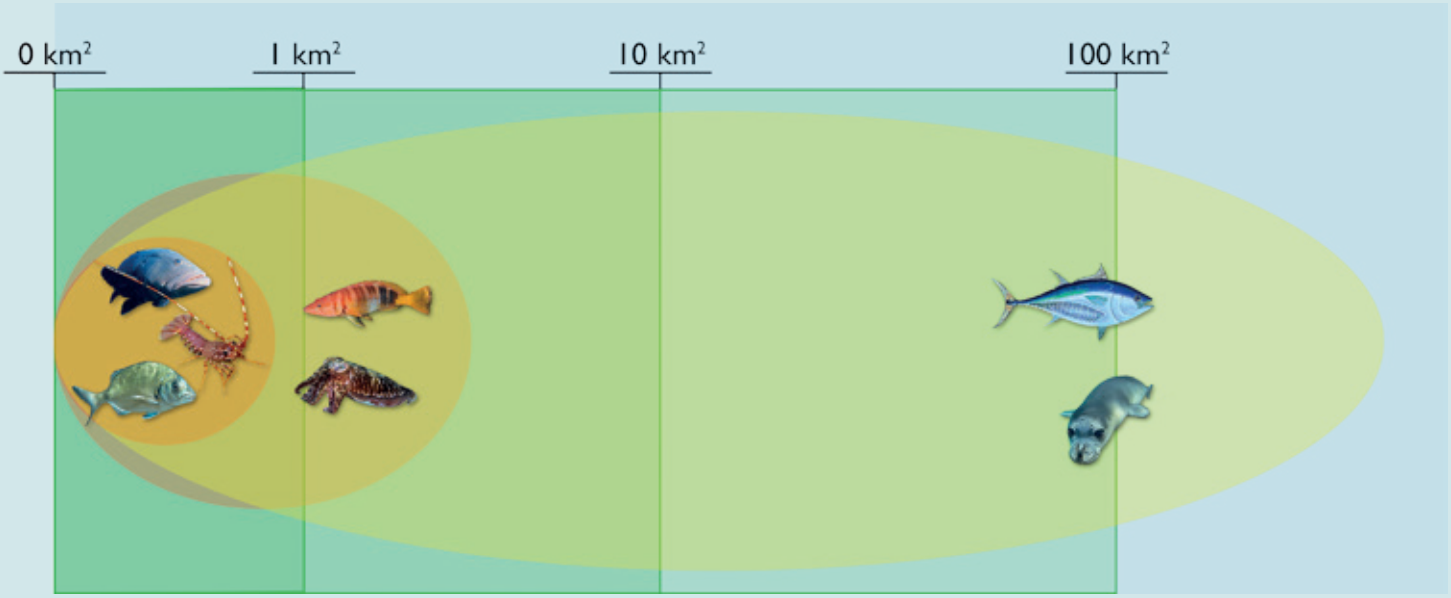
MPA size and level of protection both determine its effectiveness. MPA size is important because species differ in where they spend most of their time, which is called their home range. A small fully protected area can protect many individuals of species with small home ranges, but individuals of species with large home ranges are not well-protected (see graphic below). A species with a large home range will require a larger fully protected area to provide the same benefits. Scientific evidence shows that large and continuous fully protected areas protect more species and thereby restore more ecological interactions. For species that move less, a well-designed network of small or medium sized MPAs can accomplish the same goals as a single large MPA.

## Numbers, Sizes, Zoning, and Placement of MPAs Depend on the Goals

Successful MPA design depends on clearly stated goals. Balancing ecological, social, economic, recreational, and cultural goals can involve trade-offs in the number, size, zoning, and placement of MPAs and thus the benefits they provide. If conservation is the priority, then larger fully protected areas will achieve the goals for more species. If MPA size is constrained by the need to preserve access to fishing grounds, then a network of smaller MPAs can benefit some species. However, more mobile species will depend on effective fisheries management outside the MPAs to obtain conservation benefits.



### Size of Fully Protected Area




Although the home range size of most Mediterranean species is unknown, data on species with small home ranges, like dusky grouper (in the smallest orange circle above), show these can benefit from relatively small fully protected areas (< 1 km²). Other species with larger home ranges, such as the cuttlefish (medium circle above), need larger fully protected areas (between 1 and 10 km²). Species such as the monk seal and bluefin tuna can move over areas that are much larger. These species must depend on better management outside of MPAs to achieve conservation benefits. *Data: Di Franco et al. in prep, Ref. 3, 27, 28*


The two-banded seabream uses many habitats throughout its life. Open water, shallow protected bays with rocky and sandy patches, and rocky reefs with macroalgae are important for growth and survival during different life stages of this fish. *Art by Alberto Gennari*



## Design Considerations: Connectivity

Different habitats are connected to one another by the movement of species. Many fish and invertebrates move from one habitat to another at different points in their life. For example, juvenile stages of many species move between habitats, carried along by marine currents that transport eggs and larvae from rocky reefs to open water. Larvae then swim to sheltered bays. Full protection of a species requires consideration of the range of habitats it needs at different points in its life.

For example, the two-banded seabream—a highly valuable species for professional and recreational fisheries—uses many different habitats throughout its life. Adult seabreams thrive in rocky reefs and seagrass meadows. When they reproduce, they gather into schools to spawn. In the open water, eggs hatch into larvae and drift for up to 5 weeks. They become juveniles when they settle to shallow waters in sheltered bays containing rocky and sandy patches. About 6 months later, juveniles move deeper and start to grow into adults.

Many Mediterranean species require a range of habitats to thrive from birth to adulthood. MPAs that include those essential habitats will provide greater benefits. If a single, large MPA that encompasses all habitats is not feasible, a network of several small MPAs can be a viable alternative. Knowledge of habitat use, life cycles, dispersal, connectivity, and behavior is key for the effective design of MPAs or MPA networks. There is still much to learn about how species connect habitats in the Mediterranean.

### Fast Facts

- Many Mediterranean species need a range of habitats to thrive from birth to adulthood.
- Including multiple habitats in Mediterranean MPAs will enhance their effectiveness.
- MPA networks can be a useful alternative when it is not feasible to create MPAs large enough to encompass all important habitats.

The brown meagre is another fish that uses multiple habitats during its life.
*Photo: Patrice Francour*

*References: 25, 29, 30*

# Considerations for MPA Networks

Networks consist of multiple MPAs that are connected by the movement of juveniles or adults. Individually, each MPA can provide some conservation, economic, and social benefits. Collectively, the network can create significantly greater benefits, if it is well-designed. Scientific research on marine spatial planning has identified four design principles, labeled **CARE**, that enable these broader network benefits.

A **Connected** MPA network provides organisms multiple refuges in the network system if they leave the protection of a single MPA. These connections are especially important for young. Larvae produced in one MPA can drift beyond MPA borders, find safe haven, and replenish populations in another well-placed MPA.

An **Adequate** MPA network contains enough of each key habitat to ensure the persistence of targeted species through time. The amount of each habitat that is needed depends on the ecological characteristics of the species, the management rules in the MPAs, and the susceptibility to and frequency of disturbances (e.g., storms or oil spills) that threaten habitats and species.

A **Representative** MPA network seeks to protect the full range of habitats and biodiversity in the region. MPAs that are adequate for protecting a few species may be inadequate for other species that require different habitats or face different threats.

A cost **Efficient** MPA network is one that is connected, adequate, and representative while minimizing the costs to other human activities. Small adjustments to a conservation plan can often achieve similar conservation goals while preserving other activities that people value. Regulated fishing, diving, shipping, and other activities can still occur in and around a well-designed MPA network.

In the Mediterranean Sea, researchers used systematic conservation planning to propose designs for MPA networks in Greece and Israel. In 2008, the regional government of the Cyclades Archipelago in Greece worked with scientists to design a network of fully protected MPAs using **CARE** principles. Fishing and tourism are vital for the local economy, so candidate sites were selected with these activities in mind. The proposed network is designed to protect a representative and adequate amount of biodiversity, minimize negative impacts on fishing, and maximize benefits for tourism.

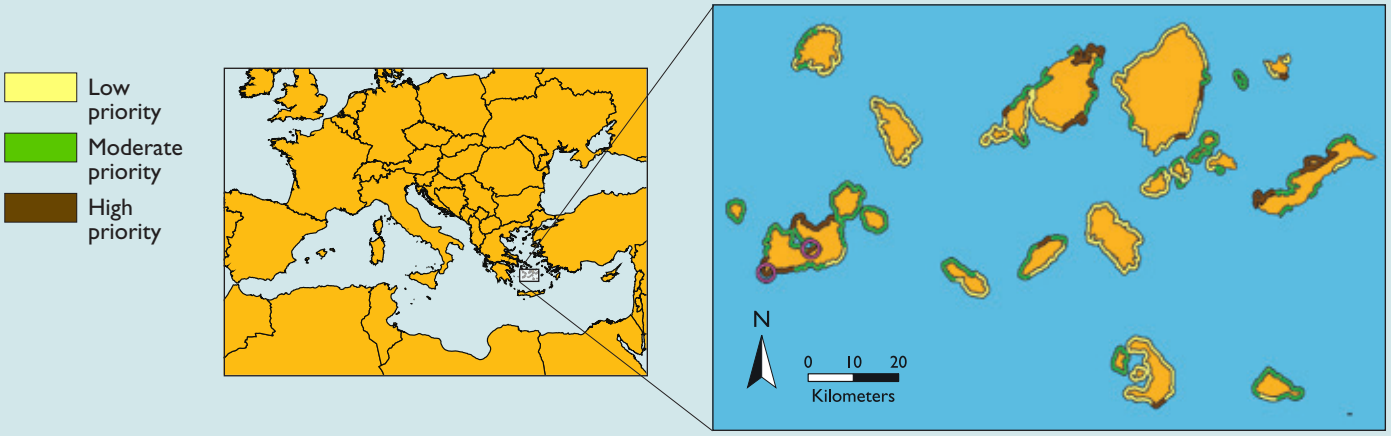
In Israel, the Israel Nature Parks Authority proposed six new MPAs, including extensions of existing MPAs closer to shore. If implemented, these MPAs will create a network to protect habitat for marine organisms while accounting for human activities such as commercial fishing, aquaculture, and shipping.

Mandrakia, a fishing village in Milos Island, Cyclades, Greece. *Photo: Louis-Marie Preau*

## Fast Facts

- Effective MPA networks must be connected, adequate, representative, and cost-efficient.
- Creating more and effective networks in the Mediterranean would greatly expand both ecological benefits and benefits to people.

**In the Mediterranean Sea, MPA networks have been proposed to encompass Ecologically and Biologically Significant Areas (EBSAs), which have been scientifically described by the Convention on Biological Diversity.**




Priority areas for conservation in the Cyclades Archipelago, Greece. Darker colors correspond to areas of higher priority. Purple circles indicate high priority areas that are Natura 2000 sites and were selected by fishers as high priority for conservation. *Data: Ref. 33*

*References: 31, 32, 33, 34*

# MPAs Can Help Address Regional and Global Challenges

## Large MPAs Can Protect Highly Mobile Species

Well-enforced, fully protected MPAs can lead to benefits for many species, even when the MPA is small. However, the protection of highly mobile species—such as monk seals, fin whales, common dolphins, basking sharks, and devil rays—requires large and well-enforced MPAs or MPA networks that include the coastal and open water habitats critical for breeding and feeding. For example, Mediterranean monk seals—one of the world's most endangered marine mammals—have been increasing where their habitat is protected, such as in Greece's large National Marine Park of Alonissos.

In the Mediterranean, establishing large MPAs may require transboundary regulations and agreements between different nations. The Pelagos Sanctuary for the conservation of Mediterranean marine mammals is an example of a large-scale, transboundary conservation effort among France, Monaco, and Italy. When the management plan is implemented and enforced, this sanctuary has the potential to produce significant ecological benefits for striped dolphins, fin whales, and other highly mobile species.


Map of the Pelagos Sanctuary in the northwest Mediterranean.

## MPAs Can Help Monitor and Mitigate Global Changes

The Mediterranean Sea faces many pressures, including heat waves and invasive species. Researchers documented that heat waves in 1994, 2003, and 2009 impacted seafloor organisms like sea fans, mollusks, and seagrasses. Invasive species such as the rabbitfish have moved into the Mediterranean Sea from the Red Sea. These voracious grazers feed on seaweeds and leave behind large barrens, reducing biodiversity and threatening the health of the ecosystem overall.

MPAs cannot address all global changes such as these, but they can decrease some impacts. They can also provide crucial reference areas for monitoring the impacts of many global and regional pressures. When fishing does not occur in an area, the influence of global changes such as invasive species can be separated from the direct impacts of fishing.

Healthy populations and ecosystems within fully protected MPAs are also more likely to resist disturbances associated with global changes and support species responding to climate change. In Mexico, scientists found that a fished mollusk showed resistance to a climatic disturbance inside a fully protected MPA but not in unprotected sites. As organisms increase their ranges due to temperature changes, networks of MPAs may offer an opportunity to protect species as their ranges shift. Overall, the role of MPAs in providing resilience to climate change and other global challenges is still poorly understood and more research is urgently needed.

### Fast Facts

- Highly mobile organisms such as marine mammals, sea birds, and sharks can benefit from large MPAs or networks of MPAs.
- Many pressures on marine ecosystems do not stop at MPA boundaries. Fully protected MPAs provide important references for monitoring changing ecosystems.
- Some ecosystems in fully protected MPAs can better resist climate change or recover from its impacts compared to unprotected sites.
- More research is needed to understand how healthy ecosystems in MPAs might respond to regional and global pressures.

Below, left to right: A large school of invasive rabbitfishes in a seagrass meadow in the Eastern Mediterranean. *Photo: Yiannis Issaris.* A Mediterranean monk seal in the Aegean Sea, Greece. *Photo: Panagiotis Dendrinos/MOm.* A fin whale in the Pelagos Sanctuary. *Photo: Simone Panigada-Tethys.*

*References: 35, 36, 37, 38, 39, 40, 41*

# people and MPA planning

## Engaging People in MPA Planning and Management

Establishing MPAs should involve collaboration among stakeholders with diverse backgrounds in resource use, marine policy, business, conservation, ocean recreation, and natural, cultural, and social sciences. The traditional knowledge of users should be combined with knowledge and data from scientists about habitats, species diversity and life cycles, and human uses, threats, and values. This information enables comprehensive, informed decisions about MPA planning and management.

In a study of the successes and failures of 27 MPAs in the Mediterranean and around the world, conservation scientists found that the participation of stakeholders was the most important factor for the success of these MPAs. The following three case studies show how stakeholders have engaged in MPA planning and management in diverse social and economic settings in the Mediterranean.

### Lessons Learned

- Engaging diverse stakeholders from the community in MPA planning processes is vital for the successful design, establishment, and management of MPAs.
- Support from local, national, and international governments is critical for long-term MPA success.
- Collaboration among managers across MPAs can make the process more efficient.
- Users who participate in MPA planning are more likely to support and comply with MPA rules.



## Case Study: Taza National Park, Algeria

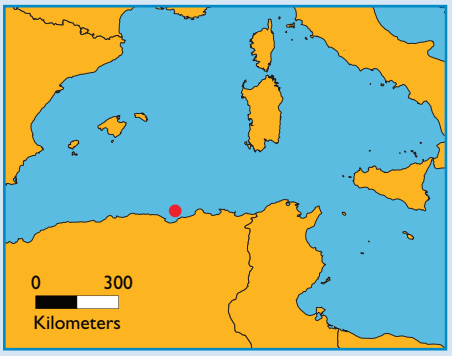
In 2009, the Taza National Park of Algeria began to plan the establishment of an MPA that extended from the existing land park into the sea.

An initial socio-economic assessment showed that fishers were skeptical about the benefits of the MPA for their community (see figure below). Therefore, the Park Authority launched a participatory, multi-stakeholder process to develop a plan that would create multiple-use zones in the MPA. NGOs, scientists, fishers, tourism operators, and local authorities all actively participated and helped identify the fully protected areas.

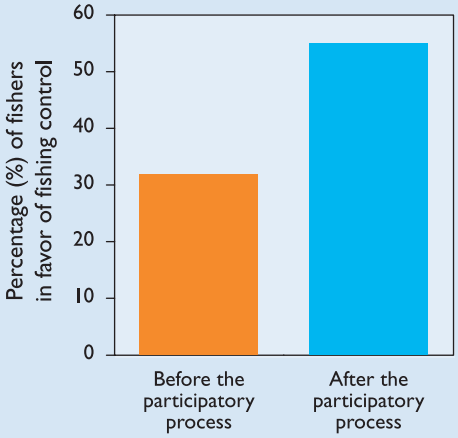
In 2012, the management plan was officially adopted by the government. The plan met the conservation, cultural, social, and economic objectives. The participatory process had created a strong sense of community ownership.

Because they were involved in the process, fishers were more supportive of the fishing regulations (see figure at right). Their participation was key to achieving compliance with the MPA regulations.

The MPA is now seen by many as an opportunity not only to protect species and habitats, but also to increase fishing revenues, enhance tourism, and improve the wellbeing of the local community.



Taza National Park, Algeria





Scientists interviewing fishers about fishing activity at Taza National Park. *Photo: Marina Gomei. Figure Data: Ref. 43*

# Case Study: MPAs in Croatia

Despite the old age of MPAs in Croatia, by 2008 their protection status and quality of management were low, and they lacked clear conservation objectives, management plans, and monitoring procedures.

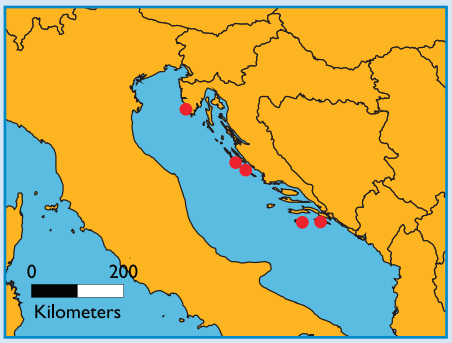
In 2008, the managers of five Croatian MPAs launched a process that brought together multiple stakeholders. The managers, scientists, and stakeholders collaborated to set clear conservation objectives and develop management plans and monitoring procedures.

MPA staff received training in planning and management and then engaged local stakeholders—such as fishers, tourism operators, and local administrations—to produce new management plans.

Involvement of managers from multiple MPAs facilitated joint learning, new relationships, and adoption of similar approaches. The outcomes were new regulations and standardized monitoring, evaluation, and business plans.

Local community engagement was key for ensuring support of MPA goals and the new zoning plans. Fishers' opinions on the effectiveness of fully protected areas also changed—more fishers supported the MPAs after they were involved in the planning process.

This coordinated effort also ensured strong political support and commitment at the national level. By 2014, all management plans were endorsed by the park management boards and the Ministry of the Environment.




The five Croatian MPAs. From north to south: Brijuni, Telašćica, Kornati, Mljet, Lastovo.

Stakeholder engagement workshop in Lastovo Archipelago MPA, Croatia. *Photo: Claudia Amico*

# Case Study: Côte Bleue Marine Park, France

The Côte Bleue MPA in France is a successful bottom-up initiative where artisanal fishers are engaged in its governance, promoting a high level of compliance and social acceptance of the MPA. The MPA staff, decision makers, scientists, divers, and fishers have worked together since the creation of the MPA in 1983.

Recent studies show that divers and artisanal and recreational fishers have positive perceptions of the MPA. These users believe that the MPA provides benefits to both the ecosystem and local fisheries, and that it has created positive relationships among stakeholders. Fishers support the actions of managers after participating in multiple communication, education, and engagement projects focused on the MPA.

Côte Bleue MPA is one of the few cases in the Mediterranean where baseline information on fish assemblages was collected prior to the establishment of the MPA. Scientists compared data collected before the MPA was implemented with data collected after. This comparison clearly showed that fish numbers had increased in response to protection, especially large-bodied, commercially important species like groupers.


Côte Bleue Marine Park, France

Interview with recreational fishers at Côte Bleue Marine Park. *Photo: Eric Charbonnel*

*References: 42, 43, 44, 45, 46*

# the long-term success of MPAs

## Bridging Short-term Costs to Gain Long-term Benefits

MPAs can produce a number of benefits, such as protection of biodiversity, enhanced local fisheries, and increased revenues from tourism. However, restricting access to some areas at sea may have negative impacts, at least initially, on users like fishers and divers. For example, creating an MPA with a fully protected area reduces the total area available for fishing. This can affect livelihoods and potentially increase fishing effort and impact in places where fishing is still allowed. Fishers might need to travel farther and spend more money to reach fishing grounds. In some cases, the benefits of MPAs may go to different people than those who bear the costs. Planning for and addressing these short-term losses is critical to achieve long-term benefits, gain support from users, and increase compliance. Globally, diverse strategies have been used to reduce short-term costs. Strategies include:

- ***Innovative activities like 'pesca-tourism'***
- ***New market strategies to increase the value of fisheries around MPAs, such as ecolabels for sustainable seafood***
- ***Investments by public or private partners who offset short-term costs for the protection of habitats and species***
- ***Allocating exclusive fishing rights to local fishers in partially protected zones or in areas surrounding MPAs***
- ***Promoting alternative livelihoods through training programs that help users learn new job skills and generate new income***

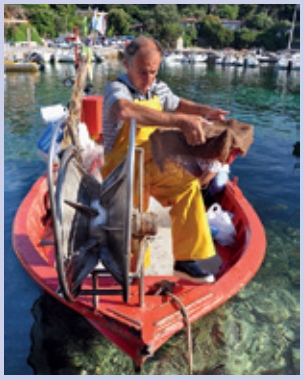
Short-term losses can be small compared to the long-term benefits of successful MPAs. When benefits accrue over the long term, they can be used to offset the earlier costs of the transition.

### Quick Summary

- MPAs can protect biodiversity, enhance fisheries, and increase tourism revenues over the long term.
- Reducing the impacts of short-term losses from MPA implementation can pave the way for long-term benefits.
- Many strategies involving public and private sectors can help reduce the short-term losses of MPAs.

Al Hoceima MPA, Morocco. *Photo: Marina Gomei*

## Rights-based Fisheries



Fisherman in Port-Cros, France. *Photo: Magali Mabari*

Allocating fishing rights to artisanal fishers is one promising path to local fisheries sustainability. Rights-based fisheries assign individuals or communities the right to fish exclusively in specific fishing grounds or the right to harvest a certain fraction of the total catch. Because their fishing rights are secured, fishers have stronger incentives to fish sustainably so that their fisheries will remain productive and profitable over time.

These long-term incentives can also influence who captures the potential benefits of spillover from MPAs. MPAs can enhance catch rates in their partially protected areas and along the MPA borders. If some fishers have exclusive access to these waters, they capture the fisheries benefits of the MPA. The value of MPAs to local fishers is thus enhanced with rights-based management. Secured fishing rights are not common in the Mediterranean. But Spain's fully protected MPAs, for example, are often surrounded by partially protected areas, where local fishers who were originally displaced by the fully protected area now have exclusive fishing rights. Evidence from around the world suggests that fishers commonly advocate for fully protected MPAs when they are allocated exclusive rights to a particular fishing ground nearby.

## MPA Benefits Increase Through Time

MPAs with good compliance and enforcement become more valuable through time. Fisheries benefits come from the protection of larger individuals that produce more offspring and swim into adjacent fished waters. Protection of large fish and rich habitats attracts tourists and divers, enhances fisheries, and supports cultural opportunities. One example is the Spanish Medes Island MPA. More than 20 years after its creation, this MPA generates over 10 million euros per year in fishery and tourism revenues. At Tavolara-Punta Coda Cavallo MPA in Italy, large fishes such as groupers and rich biodiversity attract more than 10,000 recreational divers each year, contributing more than 15 million euros in local annual revenue. The Port Cros MPA established in France in 1963 harbors more healthy and productive habitats that can better resist or recover from disturbances. Over the long-term, MPAs also preserve the cultural heritage of fishing and maritime communities, including their traditions of fishing, navigation, music, stories, recipes, and religious celebrations.

Mosaic of fishermen from the Early Roman Empire (27 B.C. to 395 A.D.) in the Archaelogical Museum, Sousse, Tunisia. *Photo: Paolo Guidetti*

## Elements that Sustain Long-term Benefits

**Compliance** and **Enforcement:** If users are engaged in the decisions that lead to new rules and in monitoring the outcomes, they will be more likely to cooperate and encourage others to support and comply with MPA rules. If voluntary compliance is insufficient, an MPA authority is needed to enforce the rules.

**Monitoring** and **Adaptive Management:** Tracking ecological, social, economic, and cultural changes makes it possible to evaluate progress toward goals inside and outside the MPA, and to adapt management through time. Monitoring can also provide information about impacts of activities outside the MPA, serving as a reference point for regulating fisheries. Scientists, MPA managers, fishers, and other users can collaborate on monitoring.

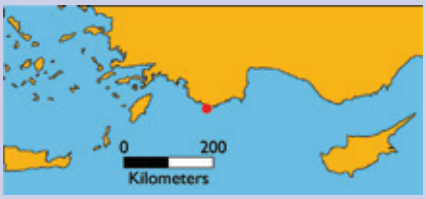
**Financial Support:** Long-term arrangements for funding, training, management, education, and enforcement are essential for the long-term success of an MPA. Some MPA benefits can be used to offset these costs.

**Continuing Education:** Stakeholders are interested in what managers learn about the impacts of MPAs. They should assist with and have access to monitoring information to see and take pride in the results.

Monitoring ecological changes in Mediterranean MPAs through interviews with fishers. Zakynthos Island, Greece. *Photo: Alexis Pey*

## Accounting for Long-term Benefits

Harbor in the Kaş-Kekova MPA, Turkey (left). *Photo: Claudia Amico.* Location of the Kaş-Kekova MPA, Turkey (center). Turkish fisherman (right). *Photo: Magali Mabari*




Before developing a new management plan, the managers of the Kaş-Kekova MPA in Turkey evaluated the costs and benefits of increasing or decreasing protection measures. This analysis accounted for potential changes over the next 20 years in commercial fishing, SCUBA diving, boat excursions, and the amount of carbon stored by healthy habitats in MPAs. These projections were evaluated based on different scenarios: MPA protection stayed the same, protection was increased, or protection was decreased. Increasing protection provided 30% greater benefits to the community by 2030, while decreasing the protection took away 24% of the value to the local community. Results from the evaluation provided strong support for increasing protection in the management plan, which was approved in 2015. The annual MPA budget needed to conduct the most critical conservation activities totaled about 90,000 euros per year. Increased MPA protection generated about 10 million euros per year, meaning the MPA cost less than 1% of the total revenue it generated. This case study shows that benefits of environmental protection in the long-term can vastly outweigh the costs if MPAs are properly designed and managed.

*References: 22, 42, 47, 48, 49, 50, 51*

# summary: MPAs contribute to ocean health

**MPAs have proven to be an effective tool to protect and manage marine biodiversity, especially when they contain well-enforced, fully protected areas and are organized into networks. MPAs are a smart investment to recover and maintain marine resources that provide benefits for people, today and in the future.**

This booklet summarizes the best global scientific information on MPAs as well as scientific results from research in many MPAs around the Mediterranean region. The conclusion is that small Mediterranean MPAs that are well-managed and well-enforced are already effectively recovering resources, sustaining fisheries, improving livelihoods, and promoting a sustainable tourism model. Opportunity exists to build on these successes beyond small scales.

## Scientific evidence shows that:

- Total MPA area is increasing globally and in the Mediterranean. While total MPA area in the Mediterranean is approaching international targets, the fully protected area only accounts for 0.04%.
- MPAs can be a powerful tool to achieve international targets, such as UN Sustainable Goal 14 and Aichi Target 11, to manage and protect marine and coastal ecosystems, increase resilience, reduce the impacts of fisheries, and promote local sustainable development.
- In fully protected areas, fish biomass increased over 400%, based on increases in numbers and sizes of fish.
- MPAs help restore the natural range of individual ages and sizes of many species, and they boost the recovery of top predators and heavily fished species (i.e. groupers, seabreams). These changes make these ecosystems more resilient to environmental changes and bring tangible fishery, biodiversity, and tourism benefits.
- In well-designed Mediterranean MPAs the income generated can be 2-3 times greater than the management costs.
- Compliance and enforcement are important for ensuring that MPAs work and produce benefits. The majority of MPAs in the Mediterranean today lack adequate enforcement. Many are only 'paper parks' without any real protection.
- Science shows how to design MPAs to balance trade-offs between protecting habitats and species, supporting local economies, and preserving social well-being. MPA design should account for the connectivity of habitats and ecosystems, leading to either single large MPAs or networks of smaller MPAs.
- Smaller MPAs protect fewer species—primarily those who do not move a lot. Larger MPAs or MPA networks are necessary to protect multiple habitats, benefit more species, and provide resilience in the face of environmental changes.
- The involvement of stakeholders and communities is key to the success of MPAs. Their engagement increases compliance, improves decision-making, reduces management efforts and costs, and ensures MPAs deliver benefits.
- These recommendations can help create a connected and efficiently managed network of Mediterranean MPAs by 2020, a goal set at the 2012 Forum of Mediterranean MPAs.

**The Mediterranean region could benefit from much more protection in MPAs.** Simply implementing and enforcing existing MPAs would be a good start. **Expanding fully protected areas** within existing MPAs could significantly enhance benefits. **Establishing more functional networks of MPAs** could greatly enhance the outcomes of individual MPAs. **Continued public education, monitoring, and awareness** of the changes facing the Mediterranean Sea will be essential for good results over the long term.

*Photos, top to bottom: Claudia Amico, Sandrine Ruitton*

# selected references and key terms

**Connectivity**—When MPAs are connected via the movement or dispersal of organisms.

**Compliance**—When people adhere to the rules and regulations of an MPA. People are more likely to adhere to rules when they are consulted and involved in the MPA planning process.

**Enforcement**—When the managing authority of an MPA makes sure the rules are followed and issues penalties to offenders.

**Fully protected area**—A marine area where all extractive activities are forbidden, except as needed for scientific monitoring. These areas can also be referred to as 'no-take areas' or 'marine reserves'.

**Marine protected area network**—A group of MPAs designed to meet objectives that single MPAs cannot achieve on their own. Networks of MPAs should be connected, adequate, representative, and cost-efficient.

**Multiple-use MPA**—An MPA that combines different zones that are fully or partially protected.

**Marine protected area (MPA)**—Places in the sea designed to protect marine species and ecosystems while sometimes allowing for sustainable uses of marine resources within their boundaries. MPAs can help support livelihoods and preserve cultural values.

**Partially protected area**—A marine area where some uses are prohibited but many activities are allowed and regulated.

**Stakeholder**—Anyone who has an interest in, or who is affected by, the establishment of an MPA.

These references contain information cited directly in *The Science of Marine Protected Areas—Mediterranean Version*. Additional cited references, and other information about MPA science in the Mediterranean, can be found at **www.piscoweb.org/science-mpas-med**.


## General

1. Lubchenco J, Grorud-Colvert K (2015) Science 15: 382–383
2. Day J, et al. (2012) *Guidelines for applying the IUCN protected area management categories to marine protected areas*. IUCN. 39 pages
3. MAPAMED dataset. MedPAN, UNEP/MAP/RAC/SPA. September 2016 release
4. Gabrié C, et al. (2012) *Status of Marine Protected Areas in the Mediterranean Sea*. MedPAN & CAR/ASP. 260 pages

## Effects of MPAs Inside Their Borders

5. Lester S, et al. (2009) Marine Ecology Progress Series 384: 33–46
6. Ergunden D, Turan C (2005) Pakistan Journal of Biological Sciences 8: 1584–1587
7. Claudet J, et al. (2011) Conservation Biology 25: 105–114
8. Guidetti P, et al. (2005) Journal of the Marine Biological Association of the United Kingdom 85: 247–255
9. Diaz D, et al. (2005) New Zealand Journal of Marine and Freshwater Research 39: 447–453
10. Micheli F, et al. (2004) Ecological Applications 14: 1709–1723
11. Garcia-Rubies A, et al. (2013) PLoS ONE 8: e73922
12. Guidetti P (2006) Ecological Applications 16: 963–976
13. Babcock RC, et al. (2010) Proceedings of the National Academy of Sciences 107: 18256–18261

## Effects of MPAs Beyond Their Borders

14. Grüss A, et al. (2011) Biological Conservation 144: 692–702
15. Cowen RK, Sponaugle S (2009) Annual Review of Marine Science 1: 443–466

## Case Studies: Impacts Inside and Outside

16. Sala E, et al. (2012) PLoS ONE 7: e32742
17. Di Franco A, et al. (2009) Marine Ecology Progress Series 387: 275–285
18. Ceccherelli G, et al. (2011) Journal of Coastal Research 27: 882–889
19. Sturaro N, et al. (2014) Marine Ecology Progress Series 506:175–192
20. Roncin N, et al. (2008) Journal for Nature Conservation 16: 256–270
21. Merino G, et al. (2009) ICES Journal of Marine Science 66:147–154
22. Sala E, et al. (2013) PLoS ONE 8: e58799
23. Goñi R, et al. (2006) Marine Ecology Progress Series 308: 207–219
24. Stobart B, et al. (2009) Marine Ecology Progress Series 384: 47–60
25. Di Franco A, et al. (2012) PLoS ONE 7: e31681
26. Harmelin-Vivien M, et al. (2008) Biological Conservation 141: 1829–1839

## Considerations for Designing MPAs

27. Adamantopoulou S, et al. (2011) Aquatic Mammals 37: 256–261
28. Cermeño P, et al. (2015) PLoS ONE 10: e0116638
29. Edgar GJ, et al. (2014) Nature 506: 216–220
30. Claudet J, et al. (2008) Ecology Letters 11: 481–489
31. Possingham H, et al. (2006) *Protected areas: Goals, limitations, and design*. In Principles of Conservation Biology 3rd ed. pp. 507–549
32. Grorud-Colvert K, et al. (2014) PLoS ONE 9: e102298
33. Giakoumi S, et al. (2011) Biological Conservation 144: 753–763
34. Portman M, et al. (2016) PLoS ONE 11: e0154473
35. Game ET, et al. (2009) Trends in Ecology and Evolution 24: 360–369
36. Notarbartolo di Sciara G, et al. (2008) Aquatic Conservation: Marine and Freshwater Ecosystems 18: 367–391
37. Karamanlidis A, et al. (2016) Biological Conservation 193: 71–79
38. Marbà N, et al. (2016) Frontiers in Marine Science 3: 1–3
39. Hobday A, et al. (2016) Progress in Oceanography 141: 227–238
40. Sala E, et al. (2011) PLoS ONE 6: e17356
41. Micheli F, et al. (2012) PLoS ONE 7: e40832

## Stakeholder Engagement and Long-term MPA Success

42. Giakoumi S, et al. *submitted*. Conservation Biology
43. Boubekri I, Borhane Djebar A (2016) Ocean and Coastal Management 130: 277–289
44. Gomei M, Di Carlo G (2012). *Making Marine Protected Areas Work—Lessons Learned in the Mediterranean*. WWF Mediterranean. 29 pages
45. Claudet J, et al. (2006) Biological Conservation 130: 349–369
46. Leleu K, et al. (2012) Marine Policy 36: 414–422
47. Ovando D, et al. (2016) Fish and Fisheries DOI: 10.1111/faf.12153
48. Barner A, et al. (2015) Oceanography 28: 252–263
49. Micheli F, Niccolini F (2013) Ecology and Society 18: 19
50. Pascual M, et al. (2016) Ocean and Coastal Management 133: 1–10
51. Başak E (2015). *Feasibility assessment of potential sustainable financing mechanisms for Kaş-Kekova SEPA, Turkey*. WWF Mediterranean. 52 pages

# The Science of Marine Protected Areas

**Marine protected areas (MPAs)** have been established around the world, including throughout the Mediterranean Sea. Scientific research shows that MPAs consistently produce ecological, economic, and social benefits when they include fully protected areas and are well-designed and well-managed.

This booklet summarizes the scientific evidence that shows effective MPAs can recover marine resources, sustain fisheries, improve local livelihoods, and promote sustainable tourism.

Some MPAs in the Mediterranean are already accomplishing these goals. However, many Mediterranean MPAs are not implemented or enforced, and only 0.04% of the Mediterranean Sea is in fully protected areas. This science summary shows how the region could benefit from more protection in MPAs.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For more information:
www.piscoweb.org/science-marine-reserves-project
www.piscoweb.org
pisco@piscoweb.org

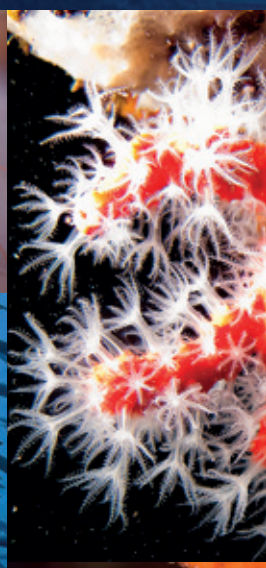
Science of Marine Reserves Project
PISCO
Oregon State University
Department of Integrative Biology
3029 Cordley Hall
Corvallis, OR 97331

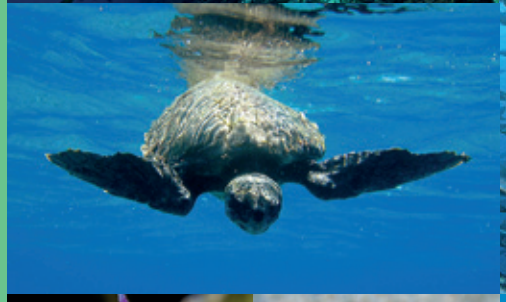
PISCO
University of California, Santa Barbara
Marine Science Institute
Santa Barbara, CA 93106-6150

ECOMERS
(FRE 3729 – CNRS & UNS)
University of Nice Sophia Antipolis
28 Avenue Valrose
Parc Valrose 06108
Nice, France





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