PHAROS4MPAS

SAFEGUARDING MARINE PROTECTED AREAS IN THE GROWING MEDITERRANEAN BLUE ECONOMY

RECOMMENDATIONS FOR LEISURE BOATING

Interreg Mediterranean
PHAROS4MPAs

Front cover: Moored boats above a *Posidonia* meadow in Cap de Creus Natural Park, Spain © Damsea / Shutterstock

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EXECUTIVE SUMMARY

The Mediterranean Sea is the most popular tourism destination in the world. Coastal and nautical tourism have followed the sector's growth trend with the development of many activities and affordable services which have opened the sea to millions of users. However, coastal population densities are driving water pollution, noise pollution and marine habitat destruction, and the nautical sector is adding to these shore-based pressures.

Leisure boating is one of the main nautical sectors. The Mediterranean Sea attracts all kinds of leisure boaters thanks to its climate and its landscape, and is well provided with marinas, manufacturing, refit and repair facilities. The Mediterranean also hosts half the global fleet of 'large yachts', vessels of more than 24 metres long.

While being practiced by many sea lovers, leisure boating has many detrimental impacts on the marine environment. This is especially the case in marine protected areas (MPAs), which attract recreational sea users in search of beautiful spots. Densities of five boats per hectare can sometimes be observed in crowded Mediterranean bays during the tourist season, a level clearly above the carrying capacity of some areas. While these densities relate to smaller vessels, the impacts of large yachts are even stronger. The most important environmental issue related to the sector is that it drives degradation of *Posidonia* meadows, with losses reaching an alarming 30% in some areas.

Public authorities have a significant role to play in mitigating the impacts of the sector on MPAs, and most importantly to put in place environmental monitoring programmes for recreational boating to track its ecological and socio-economic impacts along the national coastline and to define a recreational boating strategy at national coastline level.

In MPAs, a step-by-step approach is the best way to develop regulatory frameworks that promote eco-friendly boating. This would include, for instance, banning navigation and mooring by boats over 24m in length (e.g. superyachts), but also banning high-speed boats and old two-stroke motor engines and instead encouraging the use of eco-friendly alternatives, such as electric engines. Overnight stays also need to be controlled, or prohibited, if too many boats are present in the area or no mooring areas are available; entry permits should be required for MPAs with a limited number of permits issued each day according to the estimated carrying capacity of the area. Other steps include speed restrictions within the MPA, the creation of alternative routes to prevent collisions with cetaceans, and encouraging the use of non-toxic (ecological) antifouling paints and eco-friendly on-board cleaning products. In order to limit damage to marine habitats such as *Posidonia* meadows, anchoring bans associated with eco-mooring facilities installation represent a good way forward. These measures require effective monitoring of sensitive habitats, and in all cases zoning measures require careful control.

Last but not least, while the leisure boating industry works to align with the Recreational Craft Directive, more eco-designed products and services are needed, to drive more sustainable practices at sea. The role of education is also crucial, as leisure boating enthusiasts are often unaware of the effects they have on the marine environment. Awareness-raising programmes and updated boating courses and licenses are recommended to change leisure boaters' habits in future.

MOTOR BOATS DOMINATE THE MARINA AT SANTA MARGHERITA, GENOA, ITALY

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INTRODUCTION

From a global perspective, the northern shore of the Mediterranean Sea sees a high concentration of nautical activity. With many marinas along the northern coasts, there is even an overcapacity of leisure boats in some places, saturating scenic bays and island waters. The sector is growing economically, which also means there is a growing number of vessels in some sensitive areas. Facilities and technology have given many people access to the sea, keen to find beautiful, peaceful places such as marine protected areas (MPAs).

While the vast majority of leisure boats measure less than 24 metres, these places are also seeing an increasing number of large yachts (>24 metres long), which is like having floating hotels in fragile ecosystems. More than half of the world's largest yachts are in the Mediterranean, thanks to its seascapes, high quality marinas and leading manufacturers.

In areas with an average to high number of leisure boaters – and the related impacts such as noise, organic and chemical pollution, and most of all habitat destruction – the sector has become a real threat to marine biodiversity and habitat conservation, especially in the MPAs that are popular destinations for leisure boaters.

This report is based on results detailed in the *Capitalization Report on leisure boating in Mediterranean Marine Protected Areas*, developed as part of the PHAROS4MPAs project. The capitalization report provides extensive scientific evidence of the interactions between leisure boating and the marine environment in MPAs, as well as a set of research outputs and experiences (best practices) from Mediterranean case studies, EU projects, worldwide initiatives and other sources (international guidelines, scientific papers, technical reports etc.).

This report provides a brief but practical reference guide to current thinking on the subject for public authorities, MPA managers and the leisure boating sector. The aim, ultimately, is to help achieve the long-term sustainable use of marine ecosystems and environments.

The PHAROS4MPAs project explores how Mediterranean MPAs are affected by activities in the growing Blue Economy, and provides a set of practical recommendations for regional stakeholders on how the environmental impacts of key sectors can be prevented or minimized. Encouraging international collaboration across MPA networks and cooperation between state, industry and other actors, PHAROS4MPAs aims to enhance MPA management effectiveness and improve the conservation of marine ecosystems across the whole of the Mediterranean.

PHAROS4MPAs focuses on the following sectors of the Blue Economy:

- Maritime transport and industrial ports
- Cruise
- Leisure boating
- Offshore wind farms
- Aquaculture
- Recreational fisheries
- Small-scale fisheries

SPEEDBOAT, MALTA

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PART ONE
LEISURE BOATING:
BACKGROUND INFORMATION

1.1. THE LEISURE BOATING SECTOR IN THE MEDITERRANEAN

In 2017, southern Europe received about 270 million international visitors, or 20% of the world total [1]. With France, Spain and Italy among the top five world destinations, tourism is the biggest sector in the Mediterranean region in terms of gross value added (GVA) and employment. In addition, non-European Mediterranean countries are developing their tourism sectors, with international visitor numbers growing to 35 million in 2017 [2].

In some popular Mediterranean destinations the coastal and maritime tourism industry is reaching over-capacity, which brings socio-economic and environmental challenges that threaten its contribution to economic growth [3,4].

Coastal and maritime tourism employs more than 3.2 million people and generates an annual total of €183 billion in GVA[1]. Coastal tourism accounted for 40% of the GVA, 61% of the jobs and 24% of the profits of the European Union Blue Economy in 2016 [5,6]. It's expected to grow a further 2-3% by 2020 [7], particularly in the Mediterranean [8]. Maritime leisure activities have experienced strong growth in recent years, a trend that is expected to continue.

On 20 February 2014, the European Commission adopted a strategy on coastal and marine tourism which recognised the leisure boating sector as an important source of income for coastal and insular[2] economies. Specific data on the size, type and capacities of the marina industry in Europe is scarce [9], although it is widely recognised as a structural sector. The EU's nautical tourism sector creates up to 234,000 jobs and generates €28 billion in annual revenue, and 59% of its economic output comes from the Mediterranean [9]. European countries account for 20% of the total global turnover for nautical industries [10]. In this context, the Northern Mediterranean region generating around half of the sector's economic output and employment.

The latest Blue Plan report on the nautical sector [11] mentions a total of around 940 marinas with more than half in three countries: 253 in Italy, 191 in Spain and 124 in France[3]. Greece, Croatia and Turkey also possess a network of ports and marinas while the other Mediterranean countries have a lower capacity (Figure 3). In 2015, other new marina projects were also identified: 17 in Greece, 10 in Spain, 1 Malta and several in Italy and the Adriatic (exact number unknown). Berth demand is still growing, and is used to justify new marina projects. However, in some countries such as France, with a high density of marinas (averaging one every 14km), the potential for spatial expansion is now very limited by environmental protection legislation. On other coasts, the leisure boating sector continues to cause significant infrastructure development pressure.

The sector provides economic benefits that include jobs, investment and infrastructure in coastal areas [9]. Currently, the recreational boating industry generally creates one job for every four berths used in ports [11]. Based on approximately 400,000 berths in Mediterranean ports (Figure 3), 100,000 jobs could be tied to the recreational boating sector in coastal countries. The ICOMIA Recreational Boating Industry Statistics [10] gives a total turnover of €4,059 million for Spain, mainly due to the activity of service providers, and €3,437 million for Italy covered by the activity of boatbuilders. The positive economic impacts of leisure boating makes it a difficult activity to restrict, in particular in areas where it has been overdeveloped, such as the Côte d'Azur in France or the Ligurian coast in Italy [12].

[1] European Commission (2017). Coastal and maritime tourism. Retrieved June 2019, https://ec.europa.eu/maritimeaffairs/policy/coastal_tourism_en

[2] Tourism remains the first economic activity for islands like Cyprus, Malta, the Balearic Islands and Sicily.

[3] The French Riviera hosts 50% of the global fleet through six ports (Cannes, Golfe-Juan, Gallice in Antibes, Vauban in Antibes, Nice and Villefranche-Darse). More than 2,000 vessels recorded, mostly motor boats at an average size of 27 metres. Retrieved August 2019 from www.economie06.fr/ReadBinaryItem.asp?DocumentId=%2F%2F%-2FsidIv4%2Fdocuments%2Fplaisanceetyachting%2FEtudefilierenautiquealpesmaritimes2017

1.2. A SECTOR DOMINATED BY NUMEROUS SMALL VESSELS

Recreational boats of between 2.5-24m in length represent more than 90% of the total Mediterranean fleet of vessels. Recreational boat production in European Mediterranean countries shows an average annual growth rate of 10% from the 2008 crisis from which the European sectors has recovered[4]. Most of the leisure boat fleet (87%) is composed of motor boats, compared to 11% for sail boats and 2% for other types (inflatable boats, canoes etc.) [11]. This general segmentation occurs in all Mediterranean countries, although in some countries sailing boats are more popular than the overall average. Marina berths and mooring places are rare and/or expensive, and prices are correlated to boat size – this consideration partly drives the mainstream demand for small motorized units. The small motorized unit limits journeys to areas around the home marina. Marina density along the coast therefore constitutes an indicator of the regional distribution of the leisure boating intensity (Figure 1).

There is a wide variety of leisure boaters. The total number is unknown, but the number of marina berths gives an indication of how many there are in each country (Figure 3). At the Mediterranean basin level, there were around 400,000 berths in 2011 [13] and the number continues to increase according to the latest ICOMIA reports.

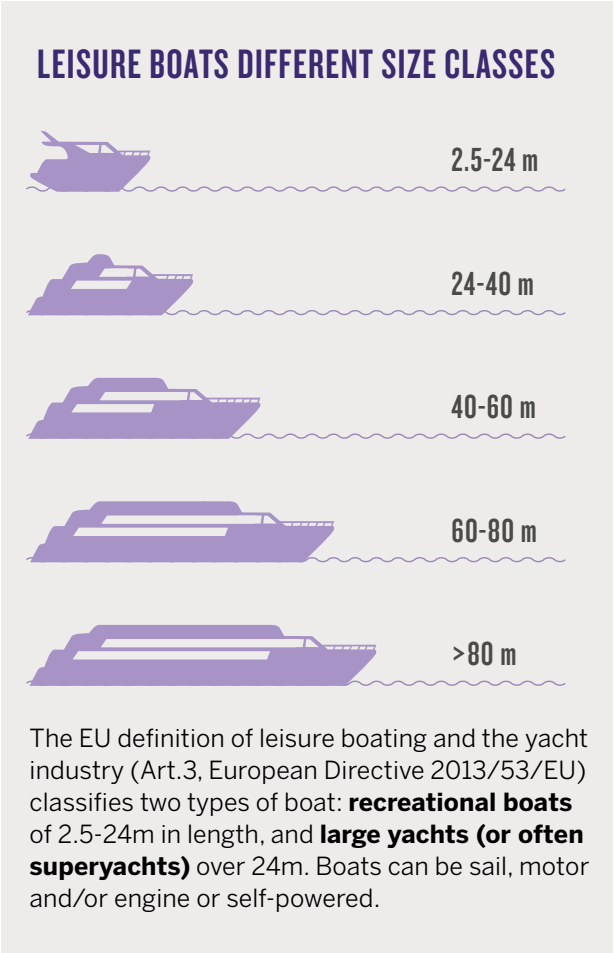


FIGURE 2. The different size classes in the leisure boating sector. They include recreational boats of 2.5- 24m, and recreational vessels over 24m long called large yachts.

[4] Eurostat, Sold production, exports and imports by PRODCOM list (NACE Rev. 2) - annual data with Proc Code 30121100, 30121200, 30121930. European commission. Retrived in June 2019 from https://ec.europa.eu/eurostat/web/prodcom/data/database

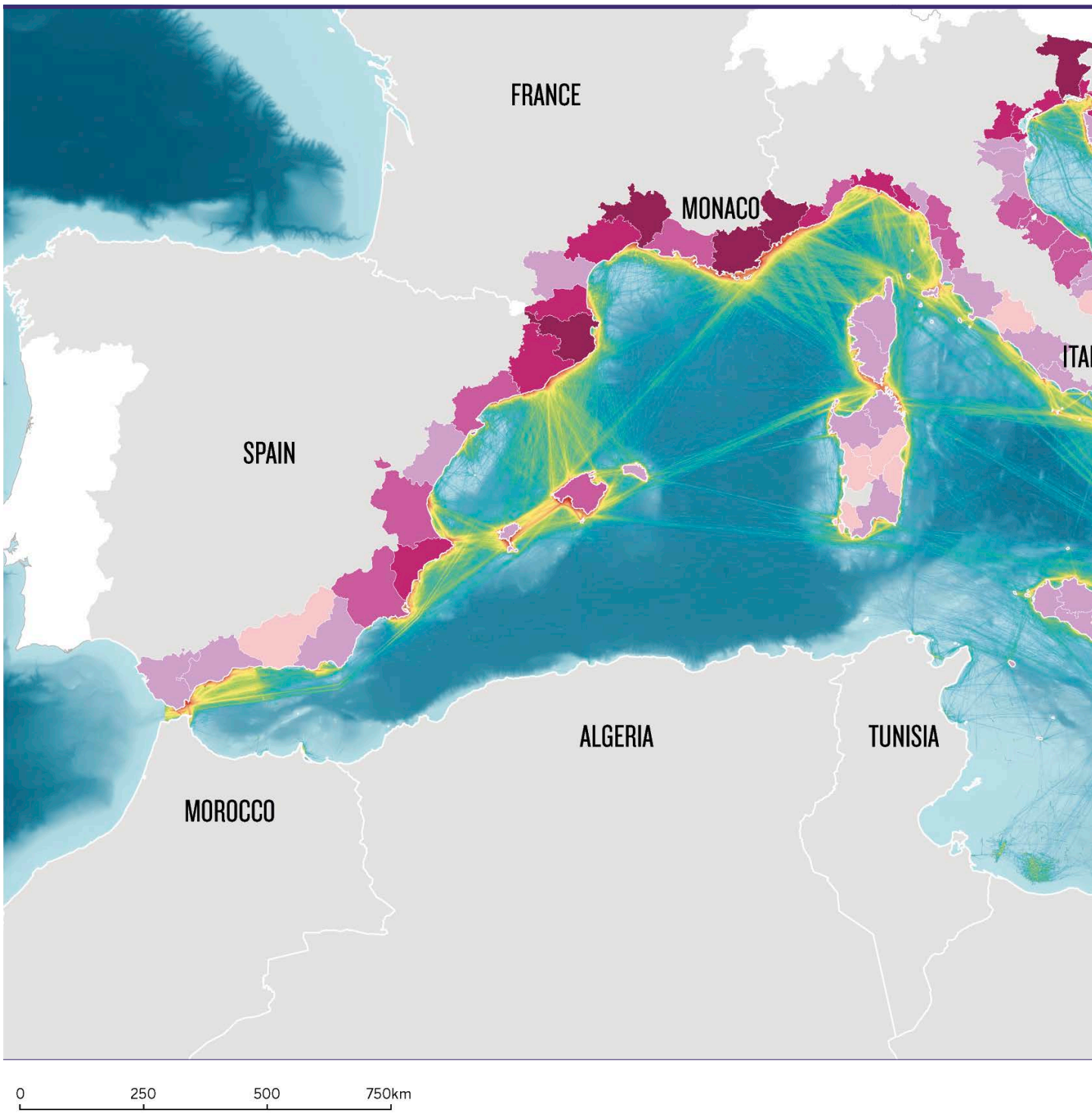
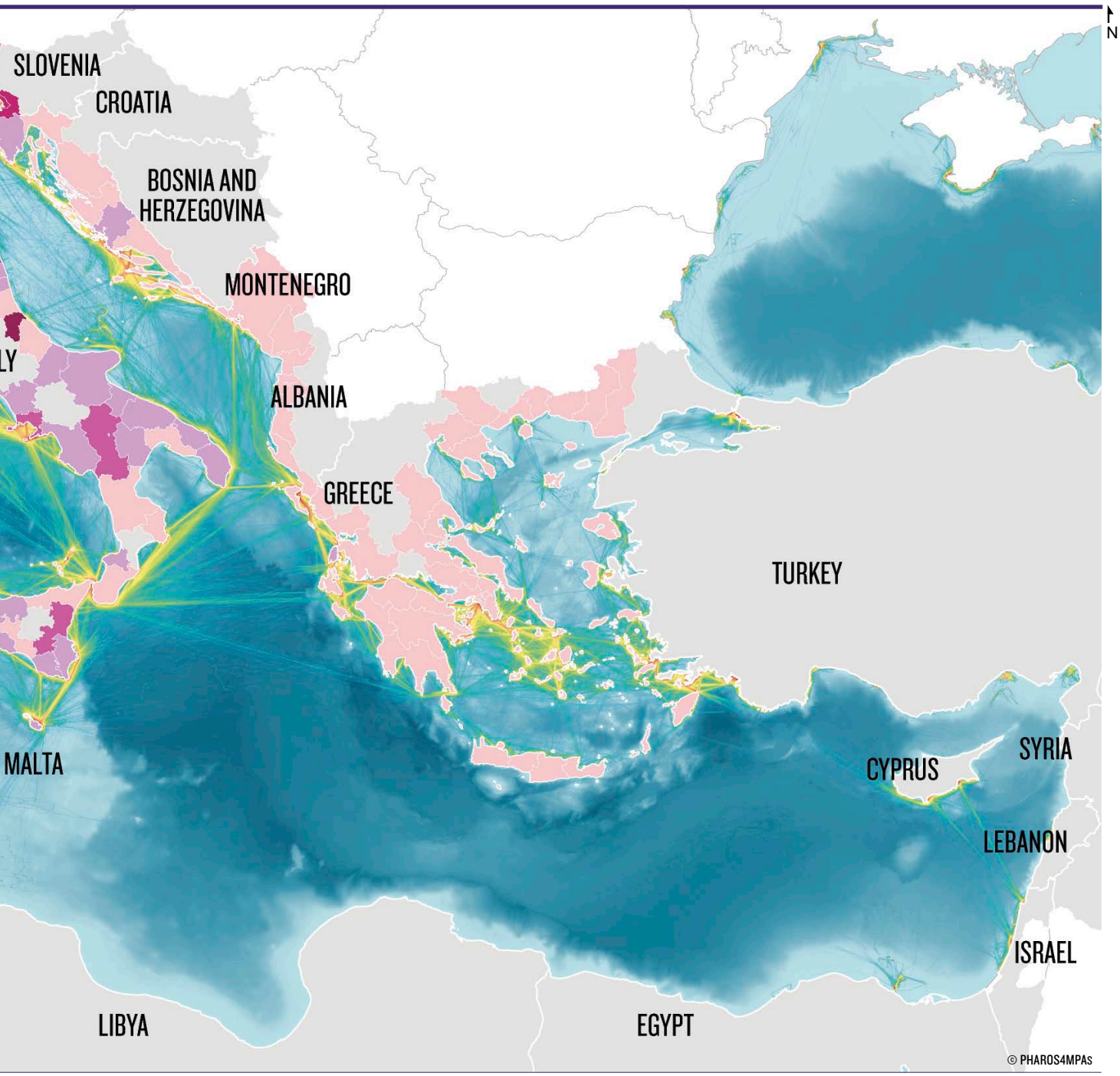


FIGURE I. Marina port capacity shown by number of moorings per km of coastline in EU countries (except Cyprus), and routes of sailing and pleasure craft using Automatic Identification System (AIS) signals (craft > 24m)



MARINA PORT CAPACITY IN MOORINGS PER KM OF COASTLINE

- <10
- 10-35
- 35-60
- 60-10
- >100

DENSITY OF VESSEL TRACKS BY AIS SIGNALS (in total hour of leisure boat presence per square km per year)

0 | 0.5 | 2 | 5 | 10 | 20 | ≥100 h

Number of mooring per km of coastline
SOURCE: European Environment Agency (2017)

Density of Vessels Tracks
SOURCE: EMODNET (2019)

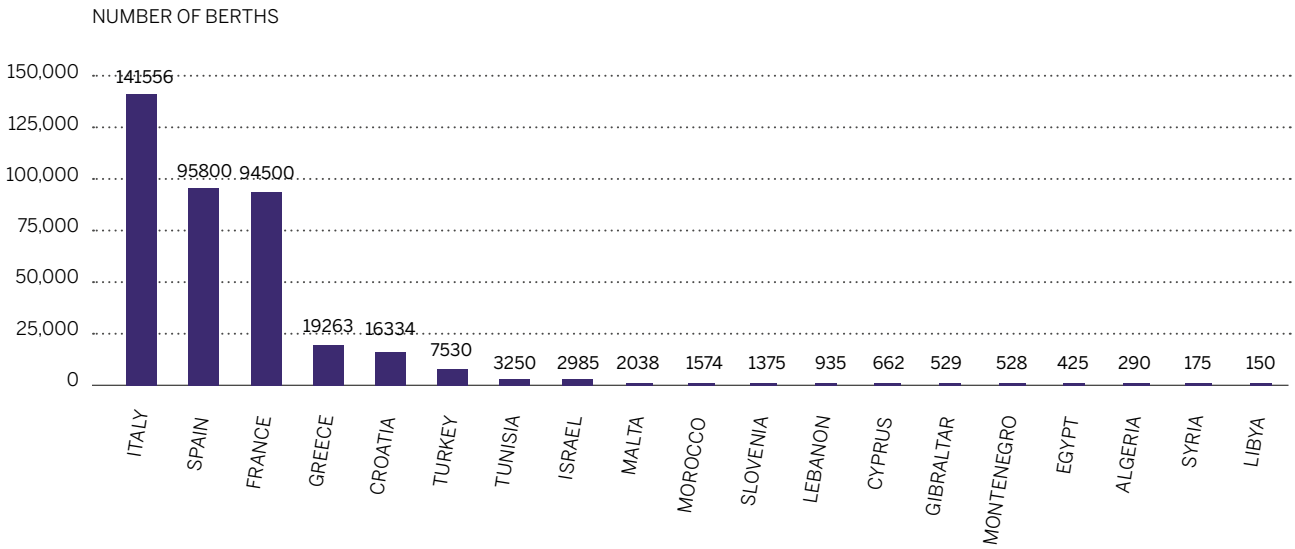


FIGURE 3. Illustration of the distribution of berths in Mediterranean marinas in 2010. Italy, Spain and France make up most of the capacity (SOURCE: BILLÉ AND LOWEZANIN, 2010)

1.3. THE SUPERYACHT SEGMENT

According to the European Boating Industry, 36 million European citizens regularly participate in recreational boating activities[5]. The craft used are either owned by the participants themselves or chartered (from businesses or directly from other boat-owners), with a preference for charter reflecting a trend of fewer boat owners and more rentals. The average age of European boaters is estimated to have increased from around 45 to 55 years over the last 10 years [14]. Contributory factors are thought to include the ageing of the EU's population overall and a decline in participation by younger people, in part due to increasing competition for leisure time from other recreational activities and family and work commitments.

Evidence shows that 50% of the global fleet of large yachts – also called superyachts – spends 8 months out of 12 in Mediterranean waters [15]. In terms of charter destination, 70% of large yacht charter contracts worldwide are for the Mediterranean (56% for the Western Mediterranean). The Superyacht Migration Report [16] gives a 3.5% average annual growth in large yacht presence within the Mediterranean Sea, with 37% of them below 40m, 47.5% from 40-60m, 13% from 60 -90m, and 2.5% of vessels more than 90m long.

The Côte d'Azur in France is the most popular destination for large yachts, as is reflected in Figure 1. In 2016, countries with the highest number of berths for superyachts included Monaco, Italy, Turkey, Spain, Croatia, France and Greece; while Montenegro, Cyprus, Egypt and Gibraltar, despite offering fewer berths, market a large part of their offer towards this particularly lucrative segment (Figure 4).

[5] European Boating Industry, fact and figures, retrieved on July 2019 from http://www.europeanboatingindustry.eu/facts-and-figures

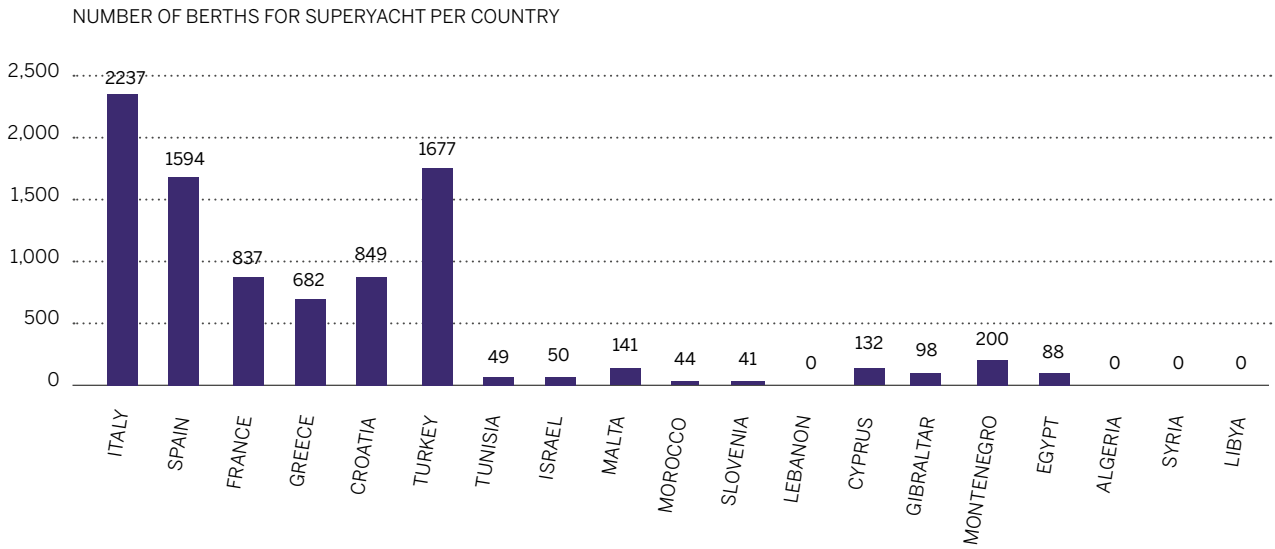


FIGURE 4. Superyacht berth distribution along the Mediterranean Sea. Countries are arranged by total number of berths (all lengths), from the maximum on the left (Italy) to the minimum on the right (Libya) according to Figure 3 (SOURCE: MODIFIED FROM DESSE ET AL. 2017) [6]

Although the number of large yachts is relatively limited, they make up an important share of the nautical economy in the region. Italy, Turkey and France represent half of the global market share. The Camper & Nicolson CNI Super Yachting Index estimates that the Italian industry holds approximately 20.5% of the global large yacht manufacturing market: 1,105 large yachts of the total fleet of 5,400 were built in Italy. France, Spain, Italy and Turkey dominate the refit and repair industry, accounting for half of global activity. The services offered to yachts by coastal cities generate a lot of income[7], many medium ports have turned part of their economy to the large Yacht segments in order to rehabilitate, redevelop the infrastructure facilities.

[6] Desse, M., Rodne Jeanty, J. Gherardi, M., Charrier, S. (2018) Le tourisme dans la Caraïbe, un moteur du développement territorial. IdeAs, 12

[7] About 10% of the yacht's value/year for insurance, fuel, dockage fees, maintenance, crew, etc. (BlueMed project, Retrieved June 2019 from http://www.bluemed-initiative.eu/the-project/)

KEY FACTS

With a current total of **305** million tourists in Mediterranean countries, coastal and nautical tourism sectors are continuously growing.

With more than **400,000** berths, the region's port facilities host one of the world's largest recreational boating and large yacht fleets. More than half of the world's superyachts are present in Mediterranean marinas during the summer.

The Côte d'Azur in France is one of the most popular destinations, followed by Italy's Ligurian coast.

FRANCE'S BAY OF SAINT TROPEZ, CLOSE TO THE MARINE NATURA 2000 SITE OF THE CORNICHE VAROISE, IS ONE OF THE MOST POPULAR PLACES FOR YACHTING IN THE MEDITERANEAN SEA

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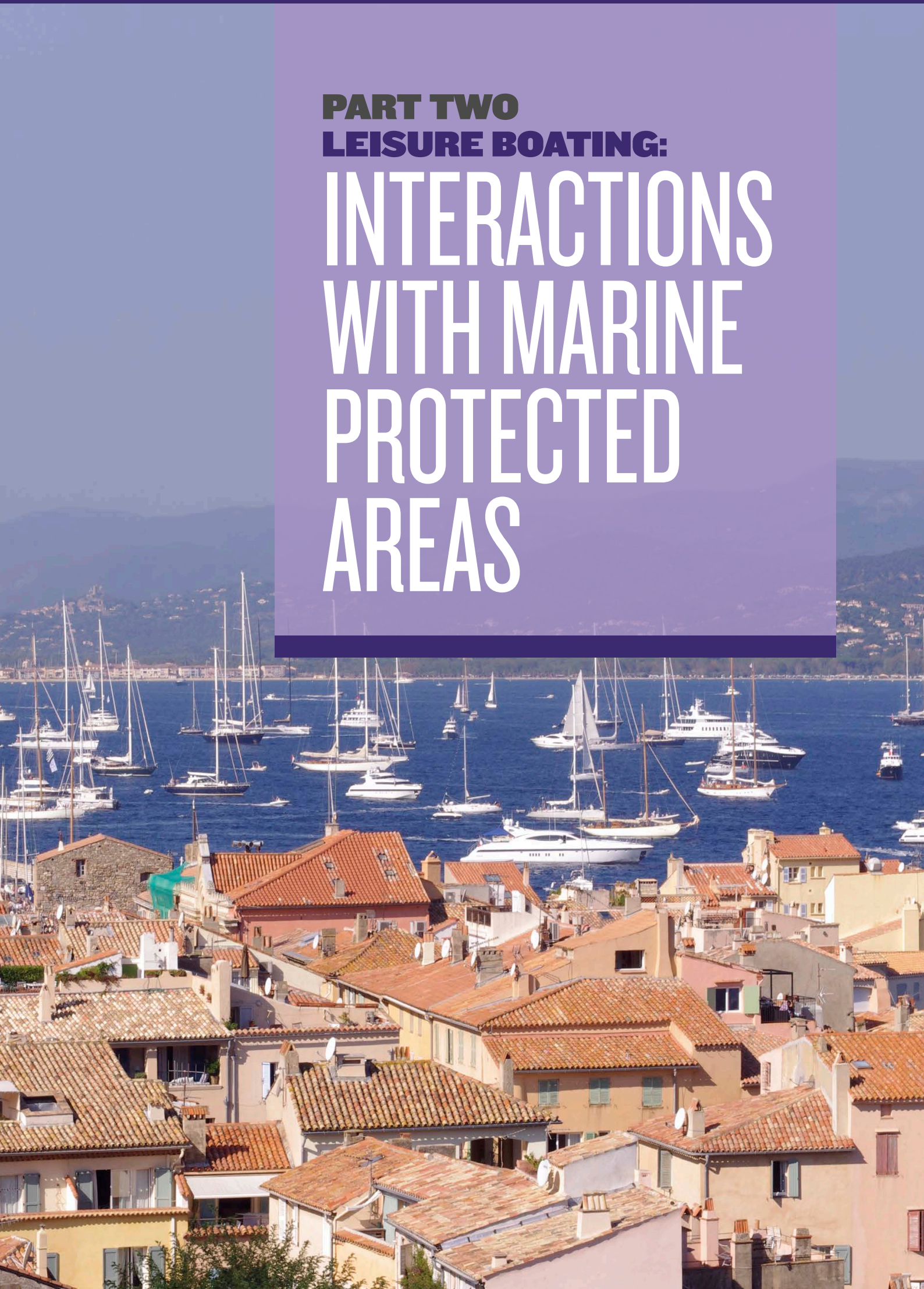
PART TWO
LEISURE BOATING:
INTERACTIONS WITH MARINE PROTECTED AREAS



Since the 1950s, the Contracting Parties to the Barcelona Convention have established a range of MPAs and other effective area-based conservation measures (OECMs). To date there are 1,231 MPAs and OECMs in the Mediterranean covering 179,798 km^2, which places a total of 7.14% of the sea under a legal designation [17]. The Convention on Biological Diversity (CBD) targets a 10% marine protection objective by 2020, known as the CBD Aichi target 11.

These sites are established at national level, at regional level (European or Mediterranean scale) or at international level under a wide variety of designations [17]. Marine Natura 2000 sites are considered as MPAs in some countries (e.g. France) while in other countries (e.g. Italy) they are not.

Figure 6 shows the number of MPAs and marine Natura 2000 sites created per year by level of designation (national, regional and international) and cumulative surface area covered from 1950 to 2016.

2.1. POTENTIAL COEXISTENCE OF LEISURE BOATING WITH THE DIFFERENT TYPES OF MPAS

MPAs play a significant role in protecting landscapes and seascapes. In total, 40% of *Posidonia* habitats are covered by MPAs and OECMs [18].

MPAs are often found in untouched or isolated places, and are usually associated with an image of wild marine paradises: as a result, their location and reputation attracts high numbers of tourists and leisure boaters in countries with a significant tourism industry. Surveys show high density figures in countries such as Spain, France and Italy, which often exceed the carrying capacity of marine sites. In a single creek of just 20 hectares in Cape de Creus marine reserve, Spain, there can be up to 90 boats in a day [19]. More than 350 leisure boats and more than 100 large yachts have been counted during one peak day in the Saint Tropez gulf, France [20]. The coasts of the Costa Brava, the Balearics, south Corsica, the Campanian and Pontino archipelagos as well as Croatia and northwest Greece are also very busy during the yachting season.

As is shown in Figure 5, leisure boaters' destinations usually overlap with ecologically significant areas, including MPAs and marine Natura 2000 sites. In fact, interactions between the leisure boating sector and MPAs are having strong and almost irreversible impacts. Increasing attention is now being paid to these impacts, raising the key question of whether and how far recreational boating should be allowed in such vulnerable locations, and how it can be better managed.

PORTOFINO MPA, ITALY: AN MPA UNDER PRESSURE

Within the MPAs in Liguria, yachting and boating pressure is huge. The Portofino Promontory and its municipalities (Camogli, Portofino and Santa Margherita Ligure) are at the centre of a heavily populated area: to the west, the port of Genoa has more than 5,000 recreational boats that can reach the Portofino MPA in less than two hours and to the east, the marinas of Rapallo, Chiavari, Lavagna and Sestri Levante provide a further 2,000 berths [21].

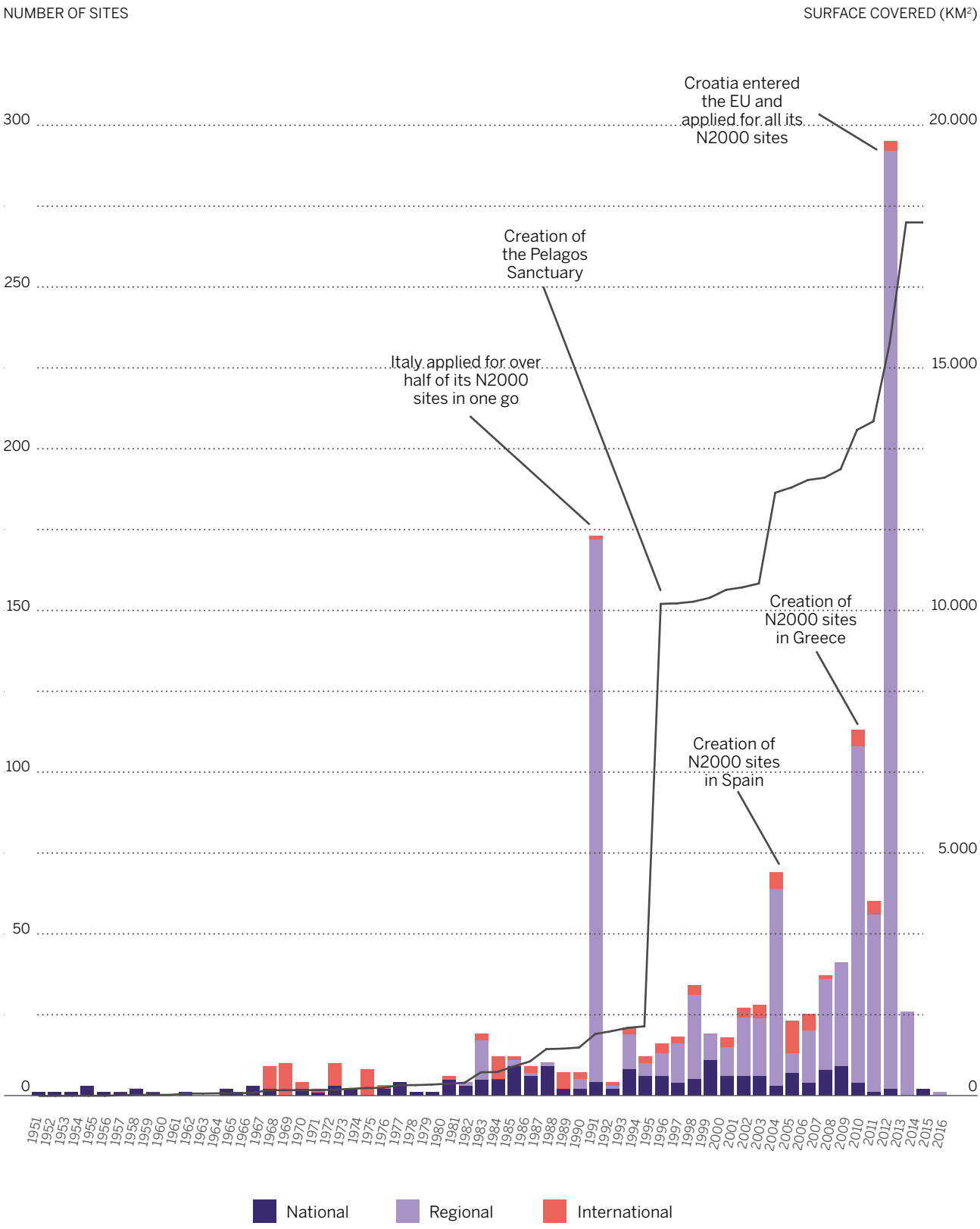


FIGURE 6. Number of MPAs and marine Natura 2000 sites created per year by type of designation (national, regional and international) and cumulative surface area from 1950 to 2016 (MedPAN, 2016)

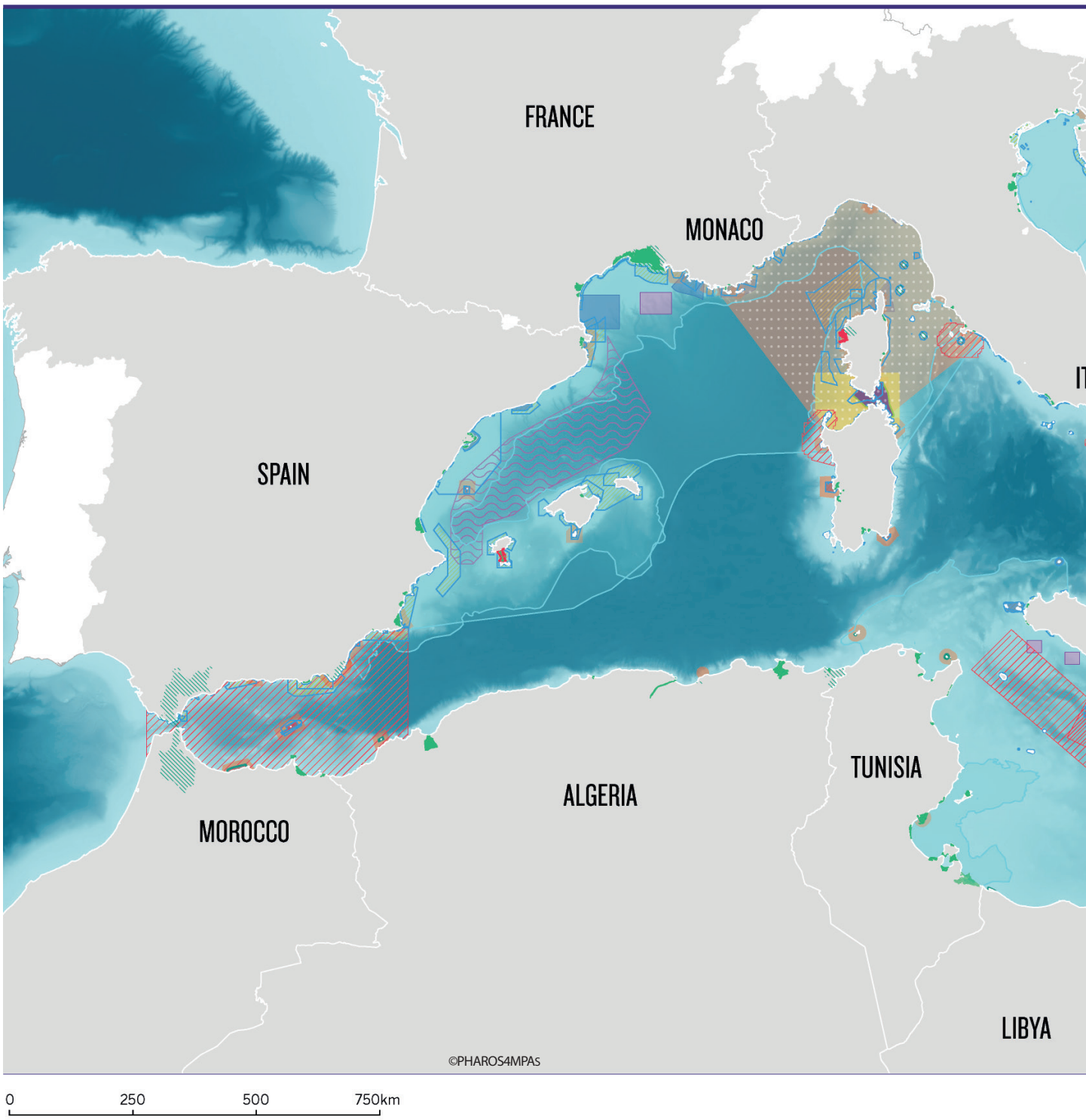
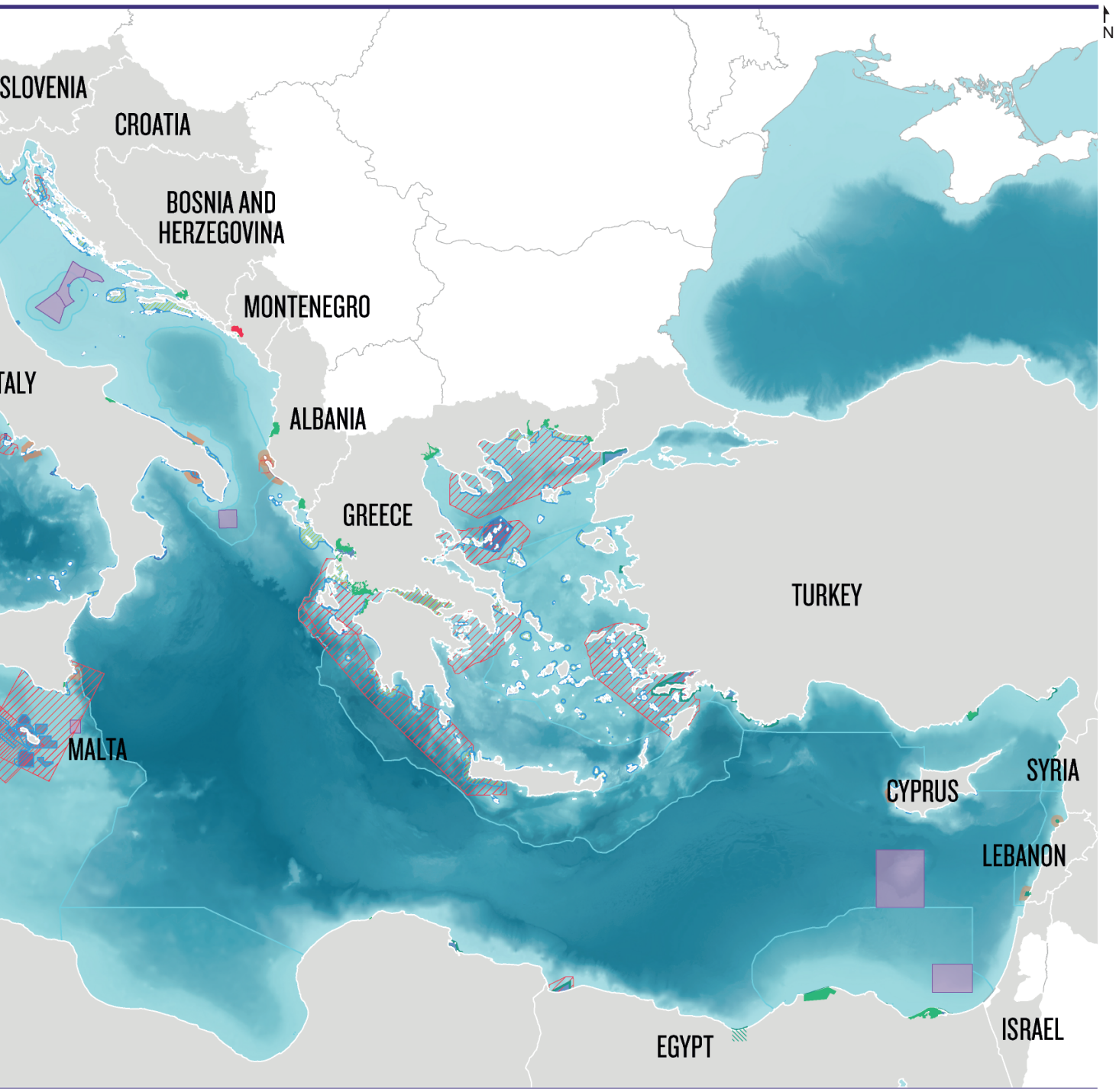


FIGURE 5. Different types of protected areas in the Mediterranean Sea



CONSERVATION AREAS

- National MPA
- Natura 2000 site
- Mediterranean Cetacean Migration Corridor
- Pelagos Sanctuary for Marine Mammals
- Specially Protected Areas of Mediterranean Importance
- International Marine Park of the Bonifacio Strait
- Fisheries Restricted Area (FRA)
- World Heritage Site
- UNESCO Biosphere Reserve
- RAMSAR site

AREAS OF CONSERVATION INTEREST

- Particulary Sensitive Sea Area (PSSA)
- Ecologically and Biologically Significant Areas
- Cetacean Critical Habitat (CCH)

SOURCE: MAPAMED, MedPAN & UNEP-MAP-SPA/RAC (2017)

2.2. INTERACTIONS BETWEEN LEISURE BOATING AND OTHER USERS

The increase in leisure boating can also be a source of conflicts with other users of the sea such as professional fishers.

Generally, the potential conflicts are directly proportional to the number of boats in the area. The social issues associated with a high rate of recreational boating include the potential for crowding, conflict, and dissatisfaction [21]. In addition, excessive overcrowding and overexploitation of natural resources are making this recreational activity less attractive [22].

Although there are no specific studies related to conflicts between leisure boaters and other stakeholders at sea, some indications are given by MPAs managers. In the Medes Islands, Spain, MPA managers report that conflicts occur with the scuba diving sector. Although there are clear regulations in Illes Medes regarding leisure boating, one of the main conflicts is between scuba divers and unlicensed boaters who hire leisure boats that do not require any navigation license or permit. Because of their lack of navigation experience, they do not have knowledge of the navigation rules and may moor on diving buoys or encroach on the minimum distance to divers' alpha flags. In other cases, large yachts and speedboats can be responsible for injuries or fatal accidents.

Recreational boating can also generate conflicts with other economic activities, such as aquaculture development – this is the case, for example, in MPAs on islands of the inner Ionian archipelago, Greece, such as Kalamos and Kastos. In these areas, leisure boaters have joined with other groups in opposing several aquaculture farm projects, putting them on the same side as local residents, environmental NGOs and others who enjoy using the sea for fishing, sailing, kayaking, walking, photography, nature conservation and tourism purposes [23,24].

THE DANGERS OF "NO LICENCE AND NO EXPERIENCE" BOAT RENTAL POLICIES

© JOSEP LLORET

Leisure boating might also disturb small-scale fisheries (SSF) and recreational fishers' activities by accidentally dragging and destroying fishing gears, in particular nets. Collisions between leisure boats and small-scale fishers' boats can also occur, and several fishers have lost their lives in this way in the past.

In addition, constructing or expanding marinas may face local opposition. This was the case in Sete[8], France, where citizens feared it would cause landscape destruction, cultural change and increased real estate prices.

[8] MidiLibre, press article, Retrieved September, 2019 from www.midilibre.fr/2019/03/02/sete-les-anti-marina-sont-dans-la-rue,8046321.php

KEY FACTS

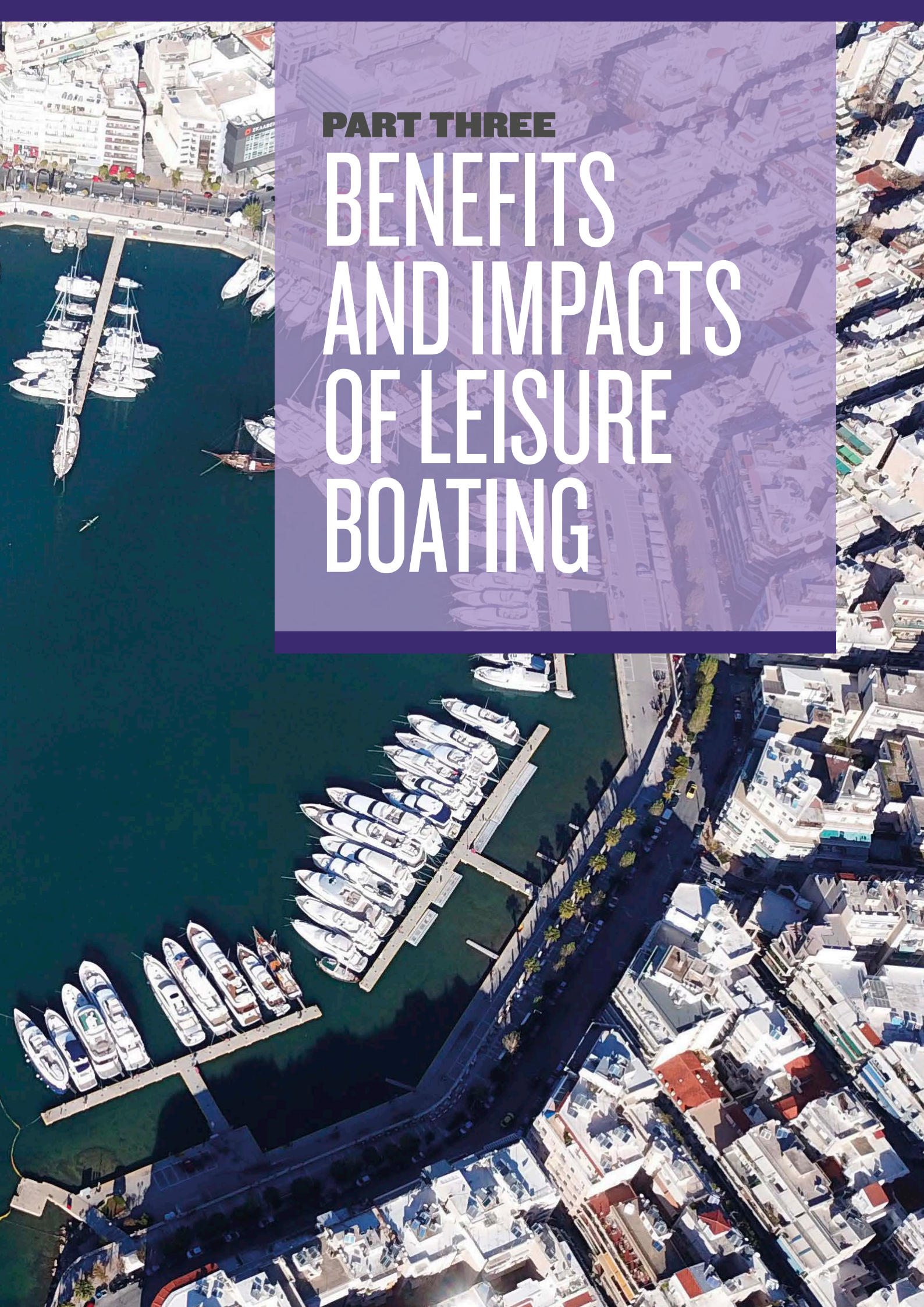
MPAs cover **7.14%** of the Mediterranean Sea surface area, but if we exclude the Pelagos Sanctuary the area covered by MPAs is less than **2%**. With the exception of this sanctuary, MPAs are mostly situated on the coast, and are particularly attractive destinations for leisure boaters.

MPAs play a significant role in protecting landscapes and seascapes. In total, **40%** of *Posidonia* habitats are covered by MPAs and OECMs.

In some MPAs the high concentration of leisure boaters (up to five boats per hectare) drives spatial conflicts with other stakeholders.

THE ICONIC ROUND-SHAPED ZEAS MARINA WITH BOATS DOCKED NEXT TO THE PORT OF PIRAEUS, ATTICA, GREECE

© AERIAL-MOTION / SHUTTERSTOCK



PART THREE

BENEFITS AND IMPACTS OF LEISURE BOATING

3.1. SOCIO-ECONOMIC BENEFITS

Leisure boaters generate economic activity beyond what they spend directly on boating. They spend money in the area they are visiting, for example on accommodation, food and beverages, cultural visits, shopping, etc. Moreover, a segment of leisure boaters are well known for their high net worth, hence many regions try to attract them to visit. This is the case, for example, in the Balearic Islands, where there has been an increase in rentals of crewed long yachts that carry a maximum of 12 passengers of high purchasing power, and who demand luxury products [25].

The recreational boating sector is particularly visible in rural and island communities, where economic development is a priority. The emergence of charter, rental and share schemes is driving increasing demand for refit and repair services, which provide additional economic activity in marinas. However, these socio-economic benefits can have social, ecological and economic impacts on coastal zones if they are not properly managed.

3.2. ECOLOGICAL IMPACTS

Anchoring is the largest impact that MPAs suffer from leisure boating [19,26,27,28]. However, other ecological impacts are also involved, in particular those associated with oil pollution, black and grey waters, the use of antifouling paints and the noise generated by vessels' engines.

3.2.1. ANCHORING IMPACTS

Depending on the type, shape and size of the anchor, the length and size of the chains, and the characteristics of the area where ships are moored, sensitive habitats such as *Posidonia* meadows[9], coralligenous assemblages and maërl bottoms can be heavily damaged [19,29]. These are some of

[9] *Posidonia* meadows do not regenerate easily when damaged, causing the area to become sandy / muddy, promoting the subsequent suspension of sediments and turbidity of the waters and the displacement of the natural fauna inhabitants.

LUXURY YACHTS MOORED IN THE HARBOUR AT HVAR, CROATIA

© SHUTTERSTOCK

the most productive and biodiverse habitats in the Mediterranean. Both seagrass beds (mainly *Posidonia oceanica* and *Cymodocea nodosa* meadows) and coralligenous assemblages are defined as priority natural habitats in Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora[10], and their protection is therefore a key conservation issue in EU waters. They are also considered a critical habitat at the scale of the whole Mediterranean basin.

Depending on their type, size and shape, anchors can damage fragile *Posidonia* meadows by tearing or crushing the plants when dropped. The anchor bares the rhizomes, abrades the matte, generates large dead matte areas and facilitates the colonization of alien species. In addition, if ships are not positioned well against the wave and wind conditions, anchors and chains may drag on the bottom, causing much greater damage.

Experiments conducted in Mediterranean MPAs such as Port-Cros, France, and Ustica Island, Italy, revealed that between 6 and 34 *Posidonia* shoots were destroyed during an anchoring cycle (lock-in and retrieval), depending on the anchor size [30,79]. A 50m yacht can destroy up to 1,500m^2 of *Posidonia* meadows in a single anchoring cycle[11].

The current decline in *Posidonia* meadows is alarming, and is taking place across the Mediterranean [31]: some 34% of *Posidonia* meadows have been lost in the last 50 years [32]. This is due to the cumulative effects of multiple local stressors, but the leisure boating sector has had a major influence [32].

Damage to *Posidonia* meadows is proportional to the size of the vessels anchoring on it: the larger the boat, the greater the damage [30]. Large vessels have bigger anchors, heavier chains and need to be more strongly stabilized when moored. While there are relatively few of them, large yachts are responsible for significant damage. Some large yacht hotspots in France have lost 30% of their meadows over five years [33]. Figure 7 illustrates mooring impacts in the *Posidonia* meadow in the Saint-Tropez bay.

BOAT ANCHOR DAMAGING *POSIDONIA* MEADOW

© F.BEAU / OBSERVATOIRE MARIN

The damage is greater when inexperienced boaters – typically those renting small boats without a navigation license, or boaters without ecological knowledge of the sea bed – try to anchor. To put this in perspective, 76% of boat users in Spain's Cape Creus MPA said they did not know which habitat types they anchored their vessels on [19].

Fixed moorings can also cause damage. Non-ecological mooring fields consist of a series of buoys chained to a concrete block deployed on the seabed, linked to a heavy chain, ropes and floats, where vessels are held in position. A study in Maddalena Archipelago National Park, Sardinia, Italy, showed that the seagrass meadows at traditional mooring fields appeared more fragmented [34]. The presence of either strong wave action or the misuse of moorings, dump weights can become dislodged and moved along the bottom, affecting surrounding areas of the meadow. The study concludes that traditional mooring fields and anchoring restrictions do not seem to have been an effective tool for seagrass protection [34].

[10] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora

[11] Citation of Frederic Villiers from the French Biodiversity Agency, Retrieved September 2019, from https://yatta.club/blog/2019/04/14/pleasure-threatens-posidonia-meadows/

Other habitats (e.g. coralligenous) and species such as the noble pen shell can also be destroyed. The species can be damaged, torn or crushed depending on the size, type and shape of the anchor. A study performed in Cabrera and Mallorca, Spain, found that in an area where anchoring was not permitted, the average density of noble pen shells was 7.9 individuals/100m^2 - this was a value significantly higher than for areas where anchoring was not forbidden, where the density was on average 1.7 individuals/100m^2 [35]. Noble pen shells' density and growth are related to anchoring pressure.

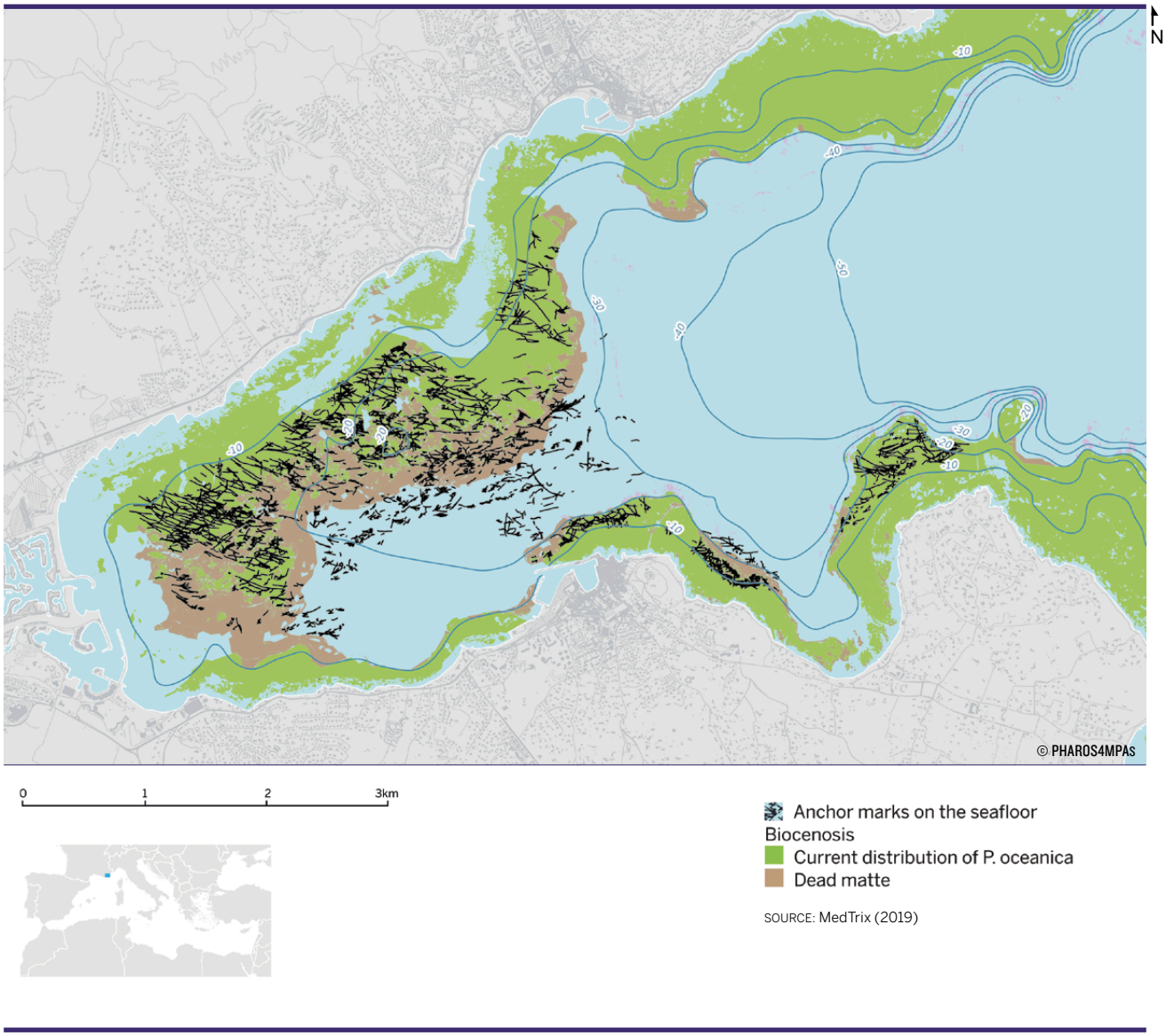


FIGURE 7. Map of *Posidonia* meadows and marks from anchoring in Saint-Tropez bay, France (SOURCE: MEDTRIX, 2019[12])

[12] DONIA marine maps: Habitats mapping - Retrieved September 2019 from www.medtrix.fr

3.2.2. IMPACTS RELATED TO MOTOR ENGINES

Fuel and oil leaks including those from bilge waters: Engine exhaust gases from vessels are cooled by means of spraying cold water into the exhaust stream. Unburnt or incompletely burnt fuel, particulates and traces of oil are collected by the water and find their way into the environment. In addition, bilge water (wastewater generated by the engine room) is likely to contain oil and other pollutants.

'Maritime' sources of marine hydrocarbon pollution caused by 'small craft' as defined by the International Maritime Organization (IMO) account for approximately 2% of total oil pollution at sea, including land-based sources [36]. However, if highly concentrated on a local scale, leisure boats can release a significant volume of oil. Moreover, refuelling in ports and marinas can cause small spills that are nevertheless highly polluting [37].

Fuel contains heavy metals and polycyclic aromatic hydrocarbons (PAHs). These are highly harmful to organisms and bioaccumulate and biomagnify throughout the trophic chain, finally reaching humans when they eat seafood [38]. PAHs may induce genetic and cell damage in living organisms, even at environmentally low concentrations [39,40,41].

THE PROBLEM OF OLD TWO-STROKE ENGINES

The old highly polluting two-stroke engines still used by many pleasure boats are one of the major sources of air and water pollution in coastal areas. The main cause of the high hydrocarbon emissions from two-stroke engines is the design of the motor. It is estimated that 20-30% of the fuel and the added oil that these two-strokes use is emitted unburned directly into the water. At low speeds up to 40% of the fuel entering a cylinder might escape unburned, while at the most efficient operating range 8% of the fuel is expelled as exhaust.

Air pollution: Hydrocarbon releases by motor engines of leisure boats, particularly from old two-stroke engines and high-speed boats, represent 0.56% of the total emissions caused by human activities. They generate air pollution, directly affect the marine environment by polluting water, and also contribute to climate change [37]. As the number of leisure boaters has been increasing since the year 2000 and is expected to continue to do so [42].

Sediment suspension: Navigating motor vessels with propeller engines over sandy or muddy bottoms may generate sediment suspension, contributing to the turbidity of the water. Higher speeds make sediment suspension worse, because higher engine power is needed. Increased turbidity may modify animals' behaviour by altering predation habits or by blocking sunlight, resulting in the loss of marine flora. Turbidity not only affects the transparency of water but also promotes eutrophication, which may cause the growth of blooms of toxic bacteria and the appearance of harmful algae due to the presence of more organic material to decompose [43,44]. These harmful organisms may pose a threat to the environment and to human health. Port dredging can also be a source of turbidity in surrounding waters.

Motor noise disturbance: Recreational motor boats and yachts in an MPA can cause recurring noise levels that affect marine fauna (including birds, fish and mammals), causing changes in their behaviour and even physiological effects [45]. This noise can be caused by the engines themselves or by the cavitation effect of the propellers. As the sound is transmitted further in water than in air, it can affect animals well beyond the boundaries of the MPA.

IMPACT ON DOLPHINS

Cumulative short-term responses to boats, either positive or negative, could have impacts on long-term dolphin survival [46]. By either approaching or avoiding boats, dolphins may reduce the time they would spend socializing, feeding or resting causing decreased energy acquisition and increased energy expenditure [46], potentially leading to lower individual fitness, reproductive success and thus a less viable population. The full extent of disturbance on a population will be differentially linked to resource availability and acquisition [46,47]. Dolphins inhabiting disturbed areas showed more moderate responses to noise disturbance, but some individuals were found to completely leave a disturbed area in favour of a non-disturbed area, as has been observed with bottlenose dolphins in the coastal waters of Croatia in the Cres-Lošinj archipelago (northern Adriatic) in response to seasonal increases in boat traffic [48,49].

Ship strikes on marine animals: Since there is no safe distance regulated for most marine animals (excluding cetaceans), they can be hit by vessels' hulls or get cut by their propellers [50]. Ship strikes are one of the causes of human-induced sea turtle mortality in the Mediterranean [51,52]: although not yet frequent, they are becoming increasingly common and should not be ignored [51]. Any types of cetacean can be injured or killed by speed boats and large yachts[13]. A failure to respect the distance between cetaceans and vessels is often the cause of collisions, because under certain circumstances cetaceans can perform sudden changes of course.

[13] Out of 24 fin whales killed by ship strikes, 2 (8.3%), were hit by large recreational yachts (from 15 to 80m long) [66].

3.2.3. IMPACTS FROM HARMFUL CLEANING/ANTIFOULING PRODUCTS

Many detergents used for cleaning ships' hulls are harmful to the marine environment and are not biodegradable. Some antifouling paints contain heavy metals and polycyclic aromatic hydrocarbons, which, as stated above, may bioaccumulate and biomagnify through the food chain, reaching humans when they eat seafood [38,53,50,54]. Copper is one of the toxic heavy metals contained in some antifouling paints, and can modify fish feeding and reproductive behaviours [55,56,57].

BOTTLENOSE DOLPHINS MEET A SAILING BOAT IN THE NATURAL MARINE PARK OF GULF OF LION, FRANCE

© MAXIME BRIOLAT / DÉCOUVERTE DU VIVANT

LARGE YACHTS IN MYKONOS HARBOR WITHOUT FACILITIES FOR WASTEWATER RELEASE, GREECE

© NEIL COOPER / FLICKR

3.2.4. IMPACTS FROM HUMAN WASTE

Human waste is a major threat in all the world's oceans and seas. The Mediterranean is no exception: as it is almost entirely landlocked, its waters have a low renewal rate (from 80 to 90 years), making our sea extremely sensitive to pollution. Seasonal population pressures are expected to increase in future [58]. Everyday human waste from leisure boating comes in three types: black water, grey water and marine litter. It accounts for a significant part of the total marine waste produced at sea.[14]

Black water: Black water is the term commonly used to describe toilet waste, which will often contain harmful bacteria and viruses. This water discharge from recreational craft is both a sanitary and an environmental issue in confined waters such as inland waterways, creeks and marinas [59]. Even if modern boats are supposed to be equipped with a holding tank,[15] these tanks are mostly emptied into the sea [60]. In addition, MARPOL regulations do not apply to yachts carrying more than 12 people. Furthermore, even when large yachts have black water treatment systems they are often unused [61]. Black water discharges can result in a decrease of available dissolved oxygen, and increase the potential for algal blooming. In addition, enterobacteria and viruses can be released into the sea and transferred to other organisms.

Grey water: Grey water comes from showers, baths, laundry, kitchens, dishwashers etc, not from toilets and urinals. This is not a major issue for smaller leisure craft, as most don't have such facilities on board. However, grey water can constitute 90% of the liquid waste generated on board cruise ships [62], with 340 litres of grey water per passenger per day. Annex IV to MARPOL addresses only fecal sewage (black water), although grey water also has a negative effect on the sea since nutrient input may lead to eutrophication [60]. In addition pollutants in grey water can contribute to adverse environmental effects such as shellfish contamination, algal blooms, hypoxic waters, the smothering of benthic biota (e.g. reef-building corals), mortality of filtering organisms and the introduction of invasive species [63,64,65].

Marine litter: Most of the waste produced on board a recreational craft is similar to the household waste found in any home. While environmental consciousness increases, this litter is still dropped in the sea by some recreational boat users, and it has become a serious pollution threat to MPAs [62]. A passenger at sea produces an average of 0.5 to 4 kilos of solid waste each day. Plastics – the main litter threat – can be decomposed by microorganisms or by the action of time, becoming micro-plastics which can be ingested by other organisms and bio accumulated through the trophic chain [67].

[14] Quadrienal report of the French Biodiversity Agency 'L'Environnement en France'

[15] Directive 2013/53 on recreational craft and personal watercraft: "Any toilet fitted in a recreational craft shall be connected solely to a holding tank system or water treatment system." Annex I, point 5.8

A POWERFUL ILLUMINATION FROM LARGE YACHTS IN THE PORTOFINO MARINE PARK, ITALY

© TICHR / SHUTTERSTOCK

3.2.5. OTHER IMPACTS

Artificial light emissions: Light pollution can affect marine organisms in many different ways and although this is an unassessed issue in the Mediterranean, high numbers of vessels moored near the coastline are likely to make it worse [68]. The lights from the boats, which have become more powerful over time, may disturb or modify the behaviour of marine fauna. Changes may include sea turtle hatchlings and adults swimming towards artificial lights even after reaching the water [69], difficulties finding suitable reproduction spaces and in hatchlings finding the sea [70], changed communications and relations (aposematism/ mimicry) between fish [71], and competition for resources between nocturnal and non-nocturnal fish.

Involuntary transport of exotic species: Shipping has been involved in the dispersal of numerous neritic (coastal) organisms, from micro-organisms and macrophytes to fish [72]. Leisure craft can transport alien species in their ballast water, as well as in anchors, as hull fouling or as solid ballast (i.e. with sand, rocks, soil, etc.). Otero [73] and Martinez-Lais [74] found surprisingly high numbers of non-indigenous species on vessels cruising Mediterranean waters, which further suggests that leisure boating presents a risk of spreading non-indigenous species. Ulman [75] revealed that Mediterranean marinas act as major hubs for the transfer of non-indigenous marine species, evidence that recreational boats are vectors for spreading them.

LEISURE BOATING IMPACTS	PRESSURE FROM PORTS/MARINAS	PRESSURE FROM VESSELS
Bioaccumulation through the trophic chain, genetic and cell damage in living organisms	Oily water runoff from roads Waste treatment sites	Oil leaks from engines
Global heating		Air pollution from engines
Marine flora loss, animal behaviour modifications	Sediment suspension from dredging	Sediment suspension from propellers
Marine flora loss, especially sensitive habitats (e.g. *Posidonia oceanica*)	Construction and development of new facilities	Action of anchors
Physiological effects, animal behavior changes	Construction and development of new facilities	Motor noise disturbance
Death and physical injuries of marine animals		Collision
Fish feeding disturbance and reproductive behaviour changes	Harmful cleaning/antifouling products at port	Harmful cleaning/antifouling products at sea
Decrease of available dissolved oxygen, algal blooms	Black waters released at port	Black waters released at sea
Shellfish contamination, algal blooms, hypoxic waters, smothering of benthic biota (e.g. reef-building corals), mortality of filtering organisms, invasive species introductions	Grey waters released at port	Grey waters released at sea
Physiological effects: diseases, injuries, death	Marine litter dropped at port	Marine litter dropped at sea
Problems with orientation/disorientation, attraction/repulsion, reproduction		Artificial light emissions
Disruption of trophic chains and habitats		Involuntary transport of exotic species

TABLE I. Leisure boating impacts and related pressures: low pressure in yellow, medium pressure in orange and high pressure in red. (PERS. COM. UNIVERSITY OF GIRONA-SEAHEALTH RESEARCH GROUP).

KEY FACTS

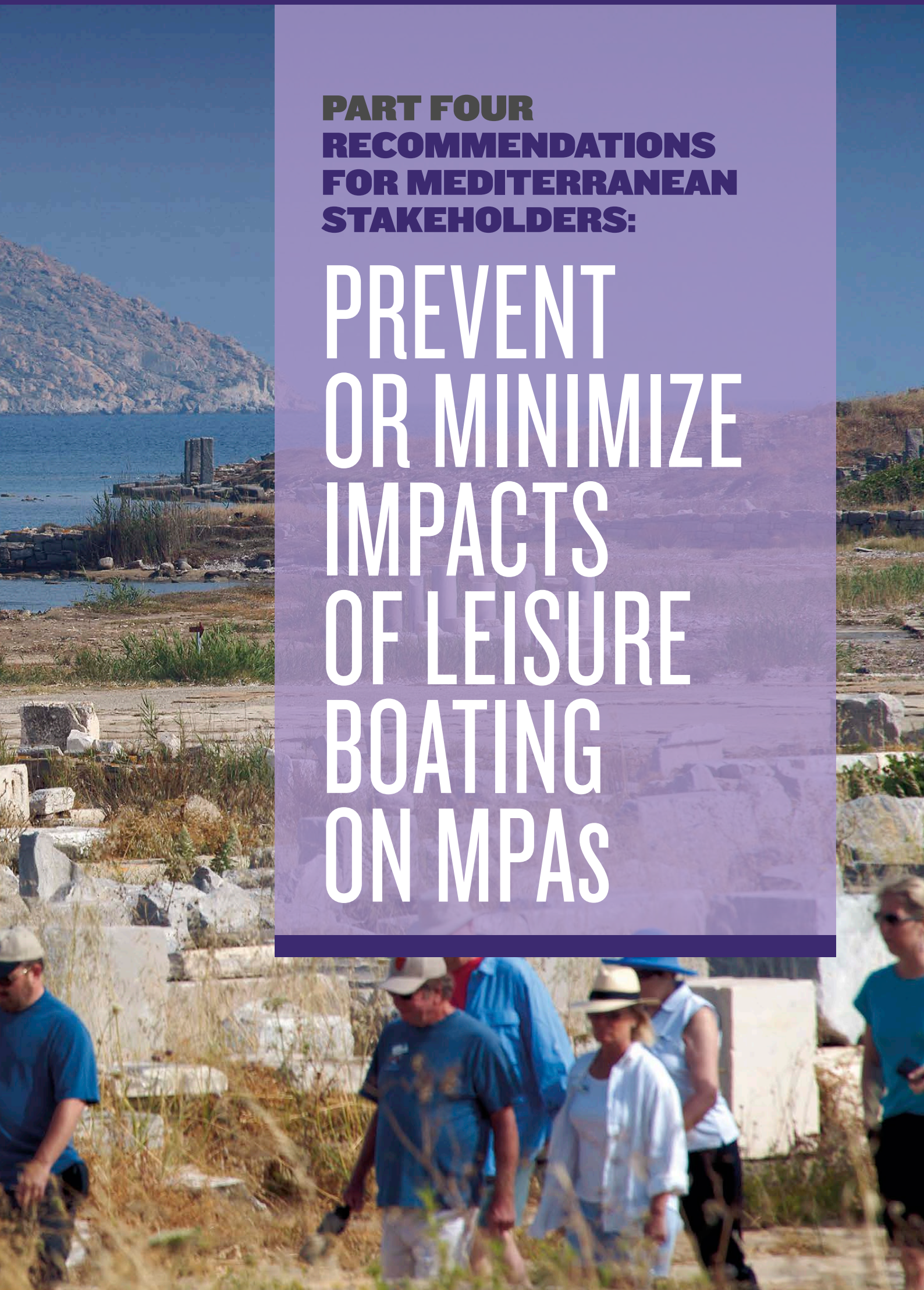
With one job for every four berths [II], the leisure boating sector is important to economies in port cities.

The leisure boating sector is responsible for the loss of **30%** of Mediterranean *Posidonia* meadows. Large yachts with large anchors are especially damaging.

All kinds of leisure craft can cause problems including the release of polluting products, discharges of sewage and the involuntary transport of exotic species.

A LARGE YACHT IN THE BAY OF DELIS, IN THE CENTRE OF A NATURA 2000 MARINE SITE, GREECE

© EUROPEAN BOATING INDUSTRY



PART FOUR RECOMMENDATIONS FOR MEDITERRANEAN STAKEHOLDERS:

PREVENT OR MINIMIZE IMPACTS OF LEISURE BOATING ON MPAs

This section gives an overview of recommendations for dealing with interactions between MPAs and leisure boating in the Mediterranean Sea.

Three different groups of stakeholders are included:

- Public authorities
- MPA managers
- Representatives of the leisure boating sector

4.1. PUBLIC AUTHORITIES

Along with the leisure boating sector itself, local and national public authorities are the actors who can do most to minimize the impacts of further sector development on the marine environment.

1. To provide a solid basis for management, public authorities should put in place environmental monitoring programmes for recreational boating to assess its spatial extent, socio-economic features and ecological impacts.

Defining sustainable management measures requires accurate ecological and socio-economic monitoring. Public authorities should implement monitoring plans to get an understanding of the leisure boating sector's pressure and impacts. They should also provide support for regular regional assessments of sensitive coastal habitats such as *Posidonia* meadows. The main monitoring parameters to be analysed include:

- Number and types of recreational boats berthing in marinas and use patterns (e.g. number of days' use per year);
- Visiting patterns in nearby MPAs (type of vessels visiting, behaviours etc) ;
- Anchoring patterns and impacts on fragile habitats such as *Posidonia* meadows;
- Presence of water and air pollutants in marinas and at sea;
- Invasive species coming from biofouling, anchors, etc.;
- Any other significant impacts, such as on the presence of marine fauna, especially cetaceans, and reported collisions.

This will help identify key issues, such as

- Areas at risk of high anchoring impacts;
- Trends in boating pressures (e.g. an increase of large yachts);
- The particular impacts of motor boats.

Depending on the findings, proactive management measures can be put in place.

POSIDONIA SHOOTS RIPPED FROM THE SEAFLOOR BY A MOTORBOAT ANCHOR

© GIP CALANQUES

REFIT, REPAIR AND WINTERING AREA IN THE ZAFER KIZILKAYA MPA, TURKEY

© MEDITERRANEAN CONSERVATION SOCIETY

2. Define a recreational boating spatial strategy at national coastline level

National recreational boating strategies must aim to ensure sustainable use of the sea and avoid potential negative impacts. MSP authorities have a crucial role to play. Depending on the findings from monitoring activities, proactive management measures can be put in place.

Maritime spatial planning and leisure boating

Recreational boating uses and occupation of the coastline are densely spread in many Mediterranean countries. In some countries, the mean distance between marinas is as little as 14km[16], which indicates the high density of coastal development artificializing shallow marine habitats and the potentially intensive use of the coastline for navigation and mooring.

Defining a vision at the whole coastline scale is necessary to understand the overall issues relating to the development of the sector. From an MSP perspective, issues may include:

- Limiting the number of marinas and their spatial development
- Handling spatial conflicts with other maritime uses and sectors
- Addressing the navigation and mooring requirements of the sector.

For all these issues, MSP authorities should adopt an ecosystem approach, taking into account sensitive habitats such as seagrass meadows and other relevant ecosystem functions, such as marine fauna migration corridors. The national and local carrying capacity of sensitive areas, including MPAs, should be taken into account.

The spatial development of recreational boating should address actual and potential conflicts with traditional uses such as small-scale fisheries, as well as other sectors which need space, and integrate these in maritime spatial plans. In this perspective, the application of the Maritime Spatial Planning Directive (Directive 2014/89/EU) covers a number of the issues we have discussed, and constitutes the principal approach to guide the spatial development of recreational boating.

Defining a strategic plan for marina development and operations

The increase of the number of marinas as well as the number of recreational boats in marinas should be limited according to the carrying capacity of the available coastline, particularly in popular marine areas. Ports also irreversibly destroy shallow marine habitats, which are the most productive ones. Boat-sharing schemes should be explored as a way to reduce the footprint of individual boat ownership.

[16] PERSEUS (2013) Preliminary identification of pressures of the coastal seas in socio-economic terms. Gap analysis and knowledge. Deliverable N° 2.2, Retrieved April 2019 from http://www.perseus-net.eu/site/content.php?artid=669

All marinas should operate with high environmental standards. At EU and global level, marinas' activities are subject to an increasingly specialized and detailed regulatory and legislative arsenal, including several directives and international texts regarding water management and quality. The international convention for the prevention of pollution from ships (MARPOL) was adopted by the IMO on 2 November 1973. Recreational boating is particularly concerned with annexes IV (prevention of pollution by sewage from ships) and V (prevention of pollution by garbage from ships). The Anti-fouling System Convention bans the use of anti-fouling systems containing harmful substances. At EU level, several directives are relevant, including:

- The European framework directive of 22 December 2000 on water protection and management (Directive 2000/60/EC)
- The International Convention for the Control and Management of Ships' Ballast Water and Sediments (IMO, 2004)
- The European Directive 'Strategy for the marine environment' (Directive 2008/56/EC)
- The European Directive on the Quality of Bathing Water (Directive 76/160/EEC)
- The European Directive 2008/105/EC setting environmental quality standards in the field of water policy
- The European Directive on port reception facilities for the delivery of waste from ships (2019/883/EU).

VOLUNTARY APPROACHES

The **iconic Blue Flag** is one of the world's most recognised voluntary eco-labels, and is awarded to beaches, marinas and sustainable boating tourism operators. In order to qualify for the Blue Flag, a series of stringent environmental, educational, safety and accessibility criteria must be met and maintained.

Clean Harbour Guidelines is a voluntary approach by marina managers in the south of France who are increasingly conscious of the need to commit to environmental management. It provides a step-by-step approach to ensure that these areas are properly managed with the necessary methods and tools. The 'Clean Harbour' approach was launched in the PACA region in 2001. Since then, 120 ports have joined the process. An official certification process was created to ensure the efficiency of this approach. Equipment used as a result of the action programme includes installations for the treatment of waste water from careening, household waste, sewage etc.

Sustainable port development should be considered. This approach facilitates a design in which the proactive utilization and/or provision of ecosystem services serves as part of the engineering solution. This can be achieved through optimizing dredging strategies, providing habitats for fish nurseries, etc.

Defining a mooring strategy

While national or European regulations apply to recreational craft (<24 m), the large yacht fleet is regulated by international obligations such as the IMO's MARPOL convention – although the adaption of the MARPOL annexes remains an issue for the sector. Commercial yachts are treated in the same way as cargo ships in international sailing[17]. In addition, most large yachts sail under flags of convenience which implies they're subject to foreign social and environmental rules. For national authorities, one measure could be to limit entry into their waters: they have the right to ban, limit numbers or impose minimum distances from shore in order to ease the impact of the superyacht sector. National authorities can also regulate the pressure from recreational craft by restricting numbers or access to sites.

Define no-mooring zones in sensitive habitats

Prohibitions on mooring with an anchor must be set up to protect sensitive habitats, such as *Posidonia* meadows and coralligenous bottoms. In 2019 French authorities imposed a mooring ban for any large yachts in sensitive areas, taking the activity some distance away from areas with sandy bottoms, with eco-friendly facilities installed in sites from which boats can't be excluded.

Planning mooring areas

Designing authorized mooring areas is another solution to reduce impacts on seagrass meadows and coralligenous assemblages. Many cities in several Mediterranean countries have set up mooring systems in their waters to providing leisure boaters with quality shelters that are nevertheless ecologically friendly [50].

[17] The British Large Yacht Code remains unfortunately to date the only regulation suited to these particular vessels.

SOME OF THE 30 MOORING BUOYS IN PORT MIOU BAY, THE ONLY ONE WITH MOORING EQUIPMENT IN THE NATIONAL MARINE PARK OF CALANQUES, FRANCE

© SHUTTERSTOCK

It is essential to install ecological mooring buoys [76]. Non-ecological (traditional) mooring systems should be replaced with ecological ones as soon as possible, following the correct protocols for their removal [77]. Installations should be prioritized on seagrass meadows, and correct management of the maintenance, fixing and signalling of these systems must be ensured. Traditional mooring systems must be avoided because, as has been shown in a study in Italy's La Maddalena Archipelago National Park [34], they can be even more destructive than letting ships moor with anchors on the bottom. By contrast, ecological moorings can represent a win-win solution both for the users and the marine environment.

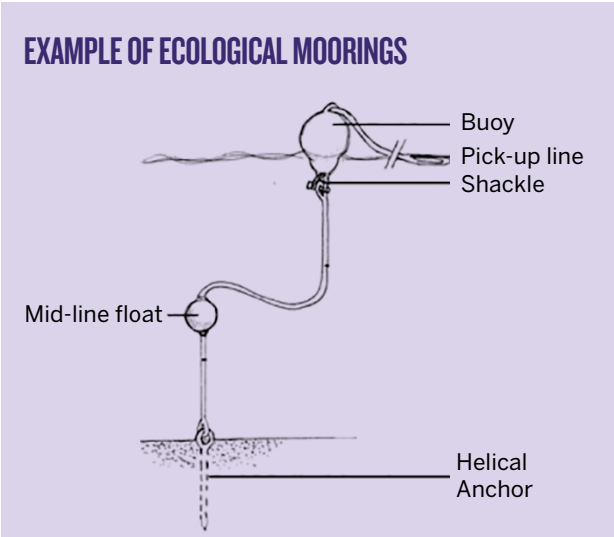


FIGURE 8. Example of ecological mooring (FRANCOUR, 2006)

If ecological mooring systems are not financially viable (they are more expensive than traditional moorings), a fee for the use of the buoys should be considered. If they still prove impossible to create, non-ecological moorings must be placed on sandy or muddy bottoms to avoid the seagrass meadows.

Dealing with pollution issues and other impacts from boats

National regulations should encourage and ultimately make compulsory the eco-friendly design, construction and maintenance of recreational boats and follow the guidelines of Directive 2013/53 on recreational craft and personal watercraft. This includes issues such as:

- Low consumption and clean propulsion and energy systems
- Safe handling of waste waters (grey and black) and solid waste
- Engine noise limitation
- Use of ecological anti-fouling paints[18]
- Use of ecological in-board cleaning products
- Recycling vessels when they reach the end of their lives.

[18] Ecological anti-fouling paints may help fight against bio-fouling, and thus may also reduce the transport of some invasive species.

BLACK WATER FACILITIES

© EUROPEAN BOATING INDUSTRY

Some EU Member States have national legislation limiting access to certain areas to recreational craft equipped with a sewage holding tank. Spain, for example, has introduced holding tank requirements prohibiting vessels from discharging untreated sewage within Spanish territorial waters (12 nautical miles); and since March 2010, Turkey has been enforcing restrictions on the discharge of both black and grey waste. However, there is still no consistency on this issue at European level, and there is no international convention requiring private pleasure craft to fit a holding tank.

Within the EU, the Marine Strategy Framework Directive (Directive 2008/56/EC) deals with noise pollution that can alter marine habitats, requiring actions to avoid or reduce such disturbance. More specifically, noise pollution from powered recreational craft is limited by the Recreational Craft Directive (2013/53/EU). Before placing craft on the market, all manufacturers must demonstrate by calculation or by testing in accordance with ISO 14509 standard that the craft does not exceed 67-75dB(A) depending on the rated engine power or 78dB(A) for twin engines.

Since 2017, the Recreational Craft Directive has regulated the environmental characteristics of boats with hull lengths between 2.5m and 24m with stricter exhaust limits for emissions from leisure boats including motor boats, sailing yachts and water scooters.

Limiting other impacts

Administrations should be aware of the need to implement speed restrictions and alternative routes for large yachts and recreational craft in order to avoid sensitive habitats, particularly marine mammals' key habitats. It is very important to define appropriate buffer zones around MPAs, and consider the impact of long-range sound propagation.

Awareness-raising and education

Public authorities have a role to play in education and should finance large campaigns, especially on the issue of sensitive habitats such as *Posidonia* meadows. In fact, sandy or muddy bottoms are more secure places for anchoring in any case, which means there are both safety and environmental protection arguments for awareness-raising of this kind. Bad behaviours should be regularly highlighted and condemned: advertisements in port can help to spread the information.

4.2. MPA MANAGERS

Leisure boating enthusiasts are particularly attracted towards MPAs, and this is very much the case in the Mediterranean. For many years, MPA managers have been addressing the issue and looking for sustainable management solutions. Good practices are already well established in many Mediterranean MPAs.

However, progress still needs to be made in dealing with issues beyond the direct control of managers, including the availability and usability of ports' reception facilities, boats' equipment for managing grey and black waters, and the increasing number of leisure boating practitioners.

4.2.1. ADOPTING A CO-MANAGEMENT APPROACH

A growing number of scientific publications show that taking a participatory approach to MPA management is effective and brings positive results. While co-management in its strictest sense is not always possible in MPAs governed by a management board, effective participatory management can still be achieved by establishing dedicated committees under the management board in which participants share decisions, responsibility and accountability.

In this context, leisure boaters need to be represented by representative bodies such as recreational boating associations in local marinas. Setting up participatory management structures will help deal with conflicts between leisure boaters and other sectors, and also pave the way for setting up sustainable management measures for leisure boating in MPAs.

A LARGE YACHT CLOSE TO THE MPA OF CINQUE TERRE, VIAREGGIO, ITALY

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4.2.2. MONITORING LEISURE BOATING PRESSURE AND IMPACTS

Monitoring is a key starting point for MPA managers, in order to quantify and identify the number and practices of leisure boaters, the impacts of their activities and the socio-economic benefits of the sector, as well as its development trends. It is also useful to ensure a correct and fair distribution of the MPA space between stakeholders. A comprehensive study of recreational boating requires various data: quantifying boats and flows (number of boats, type, size, age), monitoring their temporal course (periods of high frequentation, noise levels), spatializing frequentation (sea lanes and preferential destinations as well as home port) and characterizing practices (categories of users, motivations, perception of the activity and its environment).

Monitoring parameters for achieving these objectives are specified several publications, among which we can quote the MedPAN report on Visitor use observation and monitoring in Mediterranean marine protected areas [78].

Regular monitoring of the status of sensitive habitats should also be performed. *Posidonia* meadows are one of the best indicators of water quality and an essential habitat for many animals including fish and invertebrates, so the impact of moorings must be measured [79]. In addition, monitoring programmes to detect and report the presence or expansion of invasive species (algae, invertebrates and vertebrates) are useful. Several examples of how these species should be monitored can be found in the report *Monitoring Marine Invasive Species in Mediterranean Marine Protected Areas* [73].

MONITORING IN LIGURIA, ITALY

A study of Venturini [21] in Liguria, Italy, focused on the determining factors behind the use of marine space in an MPA by yachters. These included the distance of the MPA from port facilities, the presence of bays or areas protected from the wind and waves, the season, and the presence of restrictions and regulations for recreational boating. Through collaboration between geographically different MPAs in Liguria, a monitoring framework for recreational boating has been implemented: this has made it possible to create predictive models to communicate to users, in advance, what may be the most congested areas and encourage the correct use of the MPA. This predictive model will encourage effective management at the regional level, not just at the individual park level

4.2.3. DEFINING APPROPRIATE ZONING

An appropriate zoning plan for leisure boating will usually include two key elements: areas forbidden for anchoring, and authorized mooring areas (which may require specific equipment).

No-mooring areas

There should be prohibitions against anchoring on seagrass beds in MPAs. Large yachts should be completely forbidden inside small MPAs, and strictly regulated in larger ones. In the latter case, immediate action should be taken to forbid large yachts from mooring in waters shallow enough for *Posidonia* meadows (generally to a depth of 30m, but deeper in some pristine areas). This 30m limit could be relaxed for areas with less sensitive habitats, such as sandy bottoms. Prohibiting overnight stays should also be considered in order to decrease the number of larger vessels and reduce light pollution at night.

In particularly vulnerable or busy areas the largest yachts should be kept well away from MPA boundaries. This is already the case around the Scandola MPA in France, where the Maritime Prefect has established a buffer area in which navigation and mooring of vessels >500 UMS (~45m in length) is forbidden[19].

Establishing ecological mooring facilities

MPA managers should organize a certain number of ecological mooring buoy fields, depending on the results of monitoring studies. The number and location of these fields should reflect variables including the surface area of the MPA, its carrying capacity, the numbers and characteristics of visiting boats, and the vulnerability of the seabed.

For instance, the Egadi Islands MPA, Italy, has 14 authorized mooring areas throughout the archipelago, for sailboats up to 24m. It has also installed more than 150 buoys for mooring safely in the busiest bays to prevent anchor damage to the seabed. If ecological mooring systems appear financially prohibitive to instal (they are more expensive than common ones), it's worth considering charging a fee to use them. This would both subsidise their cost and help increase awareness among boaters regarding the ecological value of the site.

[19] UNESCO World Heritage site's obligation

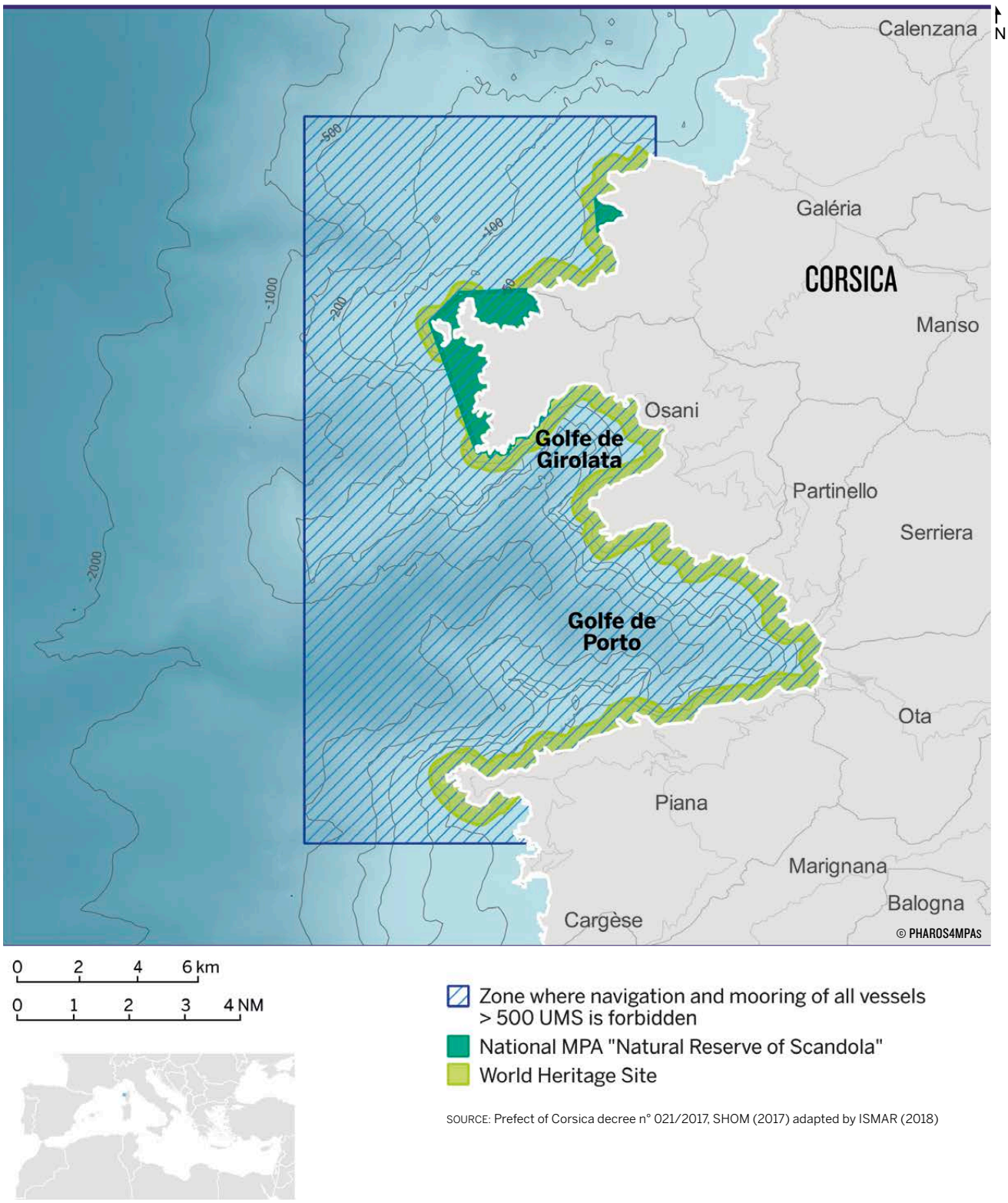

FIGURE 9. Navigation regulations in the Natural Reserve of Scandola, France

PORTOFINO MPA, ITALY: A GOOD EXAMPLE OF ZONING

A leisure boating carrying capacity study set a limit for recreational boats around a maximum of 220 [12]. Recreational boating is regulated depending on the levels of protection of the different zones of the MPA, in particular:

- Boats over 24m in length (large yachts or superyachts) are forbidden throughout the MPA
- Zone A is fully protected: no boats are allowed in it
- In Zone B there is a ban on anchoring: boats are only allowed to stop in seagrass-friendly mooring fields situated in San Fruttuoso (40 buoys, a fee must be paid) and in Cala degli Inglesi (15 free buoys)
- In Zone C generally anchoring is allowed, except in some areas of Zone C East reserved for bathing, and in two areas of Zone C West, one dedicated to the Tonnarella of Camogli (a traditional fishing technique) and the other at Punta Chiappa where a mooring field is placed (70 buoys, a fee must be paid).

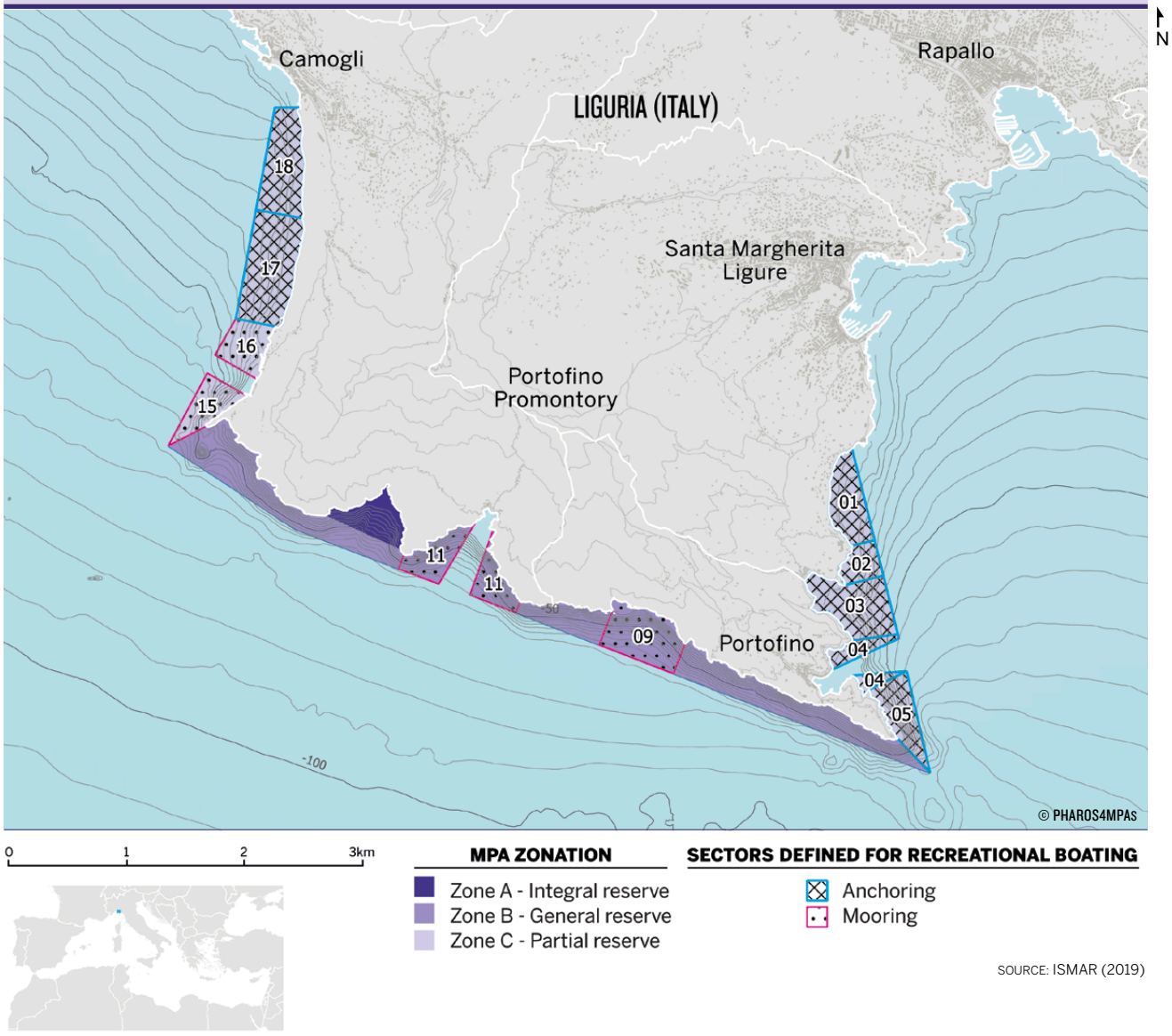

FIGURE 10. Distribution of mooring and anchoring sectors among the three zones of Portofino MPA, Italy

CAP D'AGDE MPA, FRANCE, HAS THE LARGEST ZONE OF ECOLOGICAL MOORINGS AT SEA IN THE LANGUEDOC-ROUSSILLON REGION KNOWN AS "BRESCOU." IT HAS BEEN OPERATING SINCE JULY 2014: 30 ECOLOGICAL MOORINGS FOR BOATS UP TO 17M WITHIN THE ANCHORAGE AREA OF 35 HECTARES ARE NOW AVAILABLE.

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4.2.4 SETTING REGULATIONS FOR MOTOR BOATS

The single most effective measure leisure boaters can take to reduce their emissions and related impacts is to reduce the speed of their vessels.

Speed restrictions are strongly recommended for MPAs that do not yet have them. This would cut down on excessive noise, pollution, impacts on marine animals and conflicts with other user groups (scuba divers, recreational fishermen, tour boats, etc.) and other leisure boaters. In Port-Cros national park, France, speed is limited to 12nds in the centre of the park. A 3nds speed limit also applies in specific zones, mostly rocky capes where boats can come very close to the shore in shallow areas. The most sensitive zones are fully protected by a ban on access. MPA managers should also consider banning high-speed craft and boats over 24 metres in length.

In some cases, MPA entry permits are the most effective way to limit the number of smaller craft and their related impacts. Spain's Cabrera National Park issues a maximum number of permits per day in line with the estimated carrying capacity of the site. Ideally, the permits should give priority to recreational boats that are fully equipped to avoid all discharges of waste at sea. Limiting access to craft with old two-stroke engines can also be considered.

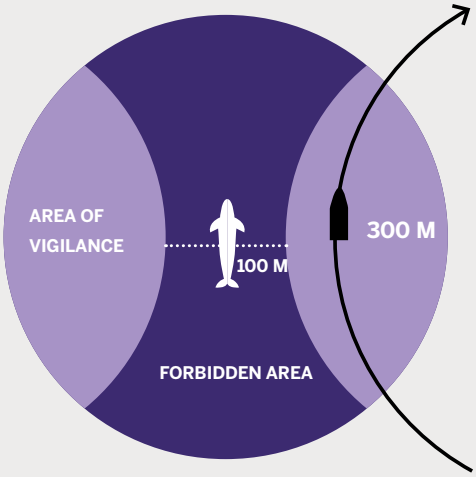
Eco-friendly engines, such as hybrid and hydrogen, electric engines and sailboats should be favoured in MPAs over more ecologically damaging vessels, cutting down on both pollution and excessive noise. Informative campaigns about the ecological impacts of motor engines should be launched to raise awareness among leisure boat users, encouraging good maintenance of engines, propellers and hulls in order to avoid malfunctions, pollution, excessive noise or cavitation effects, and strikes to marine fauna.

4.2.5. REGULATING ENCOUNTERS WITH MARINE MAMMALS

MPA managers must provide leisure boaters with recommendations on how to observe and enjoy the presence of marine mammals without harming or disturbing them. Several good practice codes[20] have been widely distributed in the Mediterranean. The code of conduct of the Pelagos Sanctuary, a large MPA in the Western Mediterranean dedicated to the protection of marine mammals, is a good example (Figure 11).

Setting up alternative routes to prevent strikes on cetaceans is also an effective way of reducing the impact of the bigger leisure boats on macro marine fauna.

[20] Retrived July 2019 from http://www.rac-spa.org/sites/default/files/doc_cetacean/watching.pdf



CODE OF CONDUCT FOR OBSERVING MARINE MAMMALS

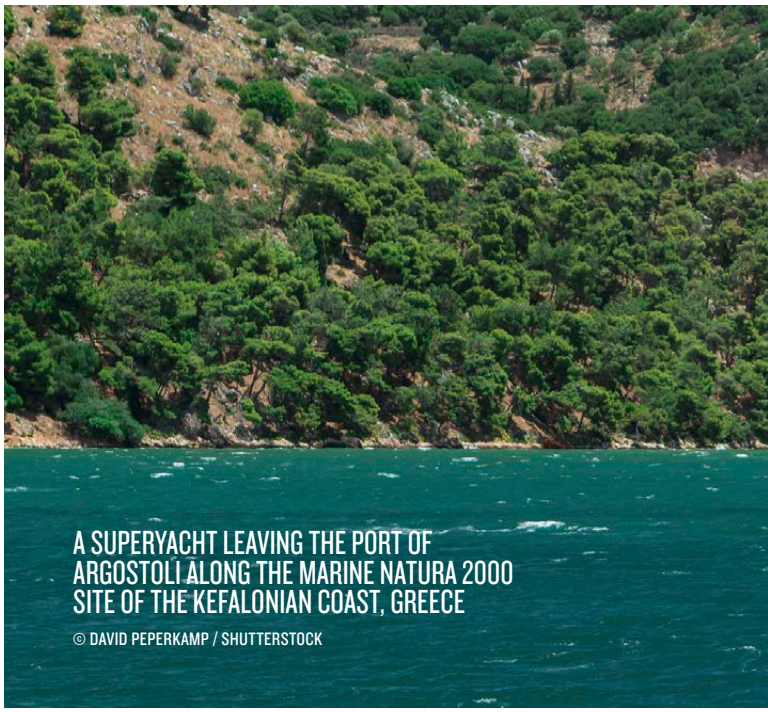
- Avoid whale-watching within the 5 nautical miles coastal strip
- Position the boat parallel to the animals
- Limit the boat speed to 5 knots and avoid sudden change of speed and/or direction
- Only one boat should be in the vigilance zone at a time and should not stay longer than 30 minutes (15 minutes if other boats are waiting)
- Immediately cease observing if the animals seem disturbed, agitated or stressed
- Redouble your distance of approach if you notice the presence of new-born animals
- Do not attempt to touch, feed or swim with a cetacean

Observing cetaceans can be a source of disturbance for them if done without sufficient care. Contact operators in a sustainable way.

The handing of stranded marine mammals is a matter for a competent structure, trained people well aware of the health risks, as well as the scientific interest linked to these episodes.

FIGURE II. Code of Conduct for observing marine mammals in the Pelagos Sanctuary[21]
(SOURCE: PELAGOS SANCTUARY, ACCOBAMS)

[21] Retrived June 2019 from https://www.sanctuaire-pelagos.org/en/raising-awareness/code-of-good-conduct



A SUPERYACHT LEAVING THE PORT OF ARGOSTOLI ALONG THE MARINE NATURA 2000 SITE OF THE KEFALONIAN COAST, GREECE

© DAVID PEPERKAMP / SHUTTERSTOCK

4.2.6. COMBINING EDUCATION, CONTROL AND ENFORCEMENT

Surveillance targeting leisure boating is needed in order to prevent illegal activities such as anchoring on *Posidonia* meadows. Considering the general inobservance of restrictions on anchoring, local surveillance remains a critical measure. This will be more effective if spatial regulations issued by the MPA are widely publicized in navigation maps and other channels including the MPA zoning map. For large yachts, using AIS data is a possibility for enforcing areas forbidden to navigation and anchoring.

Effective dissemination of recommendations to mitigate the impacts of leisure boating is essential for changing behaviours and ensuring the enforcement of MPA regulations. MPA managers should design smart and effective awareness-raising strategies – these could include collaborating with leisure boaters' associations and rental boat stakeholders, holding discussions with leisure boaters, attending local and national boat shows, launching information campaigns, producing brochures and flyers, etc.

Several MPAs have already produced information brochures and leaflets for leisure boaters. User questionnaires and surveys can help in tailoring the messages to suit particular leisure boating communities. Responsible leisure boating courses, particularly for motor boats, can also include material to encourage users to follow good environmental practice on waste management, animal feeding[22] and handling/removal, and light emission. Some smartphone applications are also under development in order to relocate and distribute leisure boating pressure, either by showing *Posidonia* meadows[23] on interactive maps or by producing predictive models of congested areas.

BLUE BOAT INITIATIVE

Operation Blue Boat involves the Port-Cros National Park (France) and local boating companies (sellers, rental companies, maintenance etc). Its aim is to make professionals aware of the actions of the National Park and to keep them informed of navigation regulations in the area, while formalizing their commitment by signing a convention. This includes four criteria: black water management, anti-rejection of fuel, motorization and awareness of good sailing practices. Currently, 16 companies are engaged in a partnership with the National Park. With an estimated 120,000 pleasure boats carrying nearly 500,000 people between Toulon and Saint-Tropez each year, special attention is being paid to the preservation of the quality of the marine environment and how boaters can best coexist with other users at sea.

[22] In some MPAs, such as in Illes Medes-Montgrí MPA, is interdicted to discard food within 12 miles of coast in order to avoid coastal fauna to feed from these discards and alter its feeding habitats (AMP Illes Medes, 2011).

[23] Project Donia, retrieved September 2019 from https://ec.europa.eu/environment/ecoap/node/259_it

THE PORT-CROS HARBOR IN THE PORT-CROS NATIONAL PARK, FRANCE

© CHRISTEL GÉRARDIN

4.3. LEISURE BOATING INDUSTRY

The leisure boating industry has a major role to play in finding solutions to mitigate its impacts. It must comply with the requirements of the Recreational Craft Directive, which includes regulations implemented through international ISO standards on accidental discharge of pollutants, waste discharge, exhaust emissions and noise emissions. In addition, the industry is moving towards further reducing its environmental impact through initiatives including the introduction of circular economy principles, lower-emission engines and sustainable methods of antifouling. The following developments can strongly reduce the impact of the sector on the marine environment:

- **Noise:** A sound level below 80 dB is strongly recommended to avoid noise disturbance of marine fauna (in line with the requirements for noise emission levels in the essential requirements of the Recreational Craft Directive 2013/53). Promoting the use of four-stroke engines, which are less polluting and quieter than the old two-stroke engines, will make a positive difference [50].
- **Liquid waste:** On-board treatment systems are currently too large to be installed on smaller boats. The boating industry should accelerate the development goals of the EU Waterborne Technology Platform's Strategic Research Agenda.
- **Eco-friendly engines:** Effort should be invested in the development and wider use of new filters, new batteries, less polluting fuel and hybrid and electric-powered engines. Combining electric engines with sailing boats with solar panels may offer a particularly ecologically friendly way of boating.
- **Ecological antifouling paints:** Among eco-friendly antifouling paints available in the market there are many that are copper-free which offer multi-season performance. There are also low-density copper technology antifoulings, self-polishing, water-based ablative paints and other technologies that reduce the release of heavy metals by as much as 90%.
- **Boat end-of-life:** Free or cheap recycling solutions should be provided to boaters. A working group chaired by the European Commission with the European Boating Industry is currently working on the topic of end-of-life boats. France is one of the first countries in the world to offer free recycling for leisure boats. Ecoboat Recycling is a good example[24].
- **Eco-friendly inboard cleaning products:** The sector should provide a list of the most efficient and environmentally friendly cleaning products including information on cleaning performance, toxicity and biodegradability[25,26].

THE ECONAV NETWORK (FRANCE)

The French Biodiversity Agency has set up a long-term partnership named ECONAV that brings together a network of actors – businesses, research and training organizations, public authorities, NGOs and individuals – involved in the sustainable development of maritime activities. It aims to promote technical and social innovations and good practices, advising stakeholders and piloting actions to make eco-navigation the foundation of tomorrow's navigation, in particular in MPAs.

www.econav.org

[24] Retrieved August 2019 from https://www.ecoboat-recycling.com/

[25] Retrieved August 2019 from http://www.boatus.org/findings/47/

[26] Retrieved August 2019 from www.sailorsforthesea.org/programs/green-boating-guide/non-toxic-cleaning-products

ACRONYMS

CBD	Convention on Biological Diversity
Db(A)	Decibel 'A' weighting, sound measurement corrected to account for human hearing
GVA	Gross Value Added
EU	European Union
EC	European Commission
IMO	International Maritime Organization
ISO	International Standard Organization
MARPOL	International convention for the prevention of pollution from ships
MPAs	Marine Protected Areas
OECMs	Other Effective area-based Conservation Measures
MSP	Maritime Spatial Planning
PACA	Region of Provence Alpes Côte d'Azur, France
PAHs	Polycyclic Aromatic Hydrocarbons
SSF	Small-Scale Fisheries
UMS	Universal Measurement System

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THE PHAROS4MPAs PROJECT IN NUMBERS

7.14% of the Mediterranean Sea is under some form of **protection,** 1,231 MPAs and OECMs covering **179,798** km^2

With **€395** bn Gross Marine Product (GMP) the Mediterranean Sea economy is the **5th largest** in the region

7
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