LIVING MEDITERRANEAN REPORT

MONITORING SPECIES TRENDS TO SECURE ONE OF THE MAJOR BIODIVERSITY HOTSPOTS

Tour du Valat

MedWet

Mediterranean Wetlands Observatory

IUCN

ZSL INSTITUTE OF ZOOLOGY

WWF

MedPAN

Centro Ecologia Aplicada "Prof. Baeta Neves"

Tour du Valat (TdV): Founded in 1954 by Luc Hoffmann, the TdV is a research institute which aims at better understanding wetlands in order to better manage them. In order to accomplish this task the TdV has developed research and integrated management programs to better inform public policies, to influence the effective management of wetlands and to facilitate the discourse between users, natural site managers and scientists.

Mediterranean Wetlands Initiative (MedWet): Established in 1971, MedWet is an initiative of 27 of the Mediterranean and peri-Mediterranean countries that are Parties to the Convention on Wetlands (Ramsar, Iran, 1971). MedWet's mission is to ensure and support the effective conservation of the functions and values of Mediterranean wetlands and the sustainable use of their resources and services

Mediterranean Wetland Observatory (MWO): Coordinated by the TdV, the MWO was established in 2008 in collaboration with MedWet as a multi-partner project to act as a wetland management tool for the countries involved in the MedWet Initiative. The ultimate aim of this project is to improve the conservation and the rational use of wetlands by informing the general public and political deciders.

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SUMMARY

We are living in exciting, if somewhat discouraging, times for our planet. We face unprecedented global challenges that are a clear consequence of our actions, with temperatures rising and biodiversity collapsing. We have the necessary tools to protect our environment, however time is running out. The decisions we make now will be pivotal in determining the future of every species on earth as well as our own.

The Mediterranean basin, a region of the world where natural resources have ensured the prosperity of human societies for millennia, must also face these new challenges. The future appears even more uncertain here than the global average due to the combination of more rapid climate change and stronger anthropogenic drivers of environmental degradation, as revealed in two recent reports, the State of the Environment and Development in the Mediterranean 2020 [1] and the First Mediterranean Assessment Report of experts on climate change [2]. The Living Mediterranean Report sheds light on the fate of one of the other major features of the Mediterranean basin: its extraordinary biodiversity, which has earned it recognition as the world's second largest biodiversity hotspot.

We conducted in-depth research to gather abundance records of more than 80,000 animal populations, belonging to 775 vertebrate species (birds, fishes, mammals, reptiles and amphibians), i.e. 26% of all species in these taxonomic groups present in the Mediterranean hotspot. This is probably the best-documented database on animal population trends available for the Mediterranean, with a volume of data comparable to that used to produce the Global Living Planet Index (Living Planet Report) [3]. This impressive amount of data makes it possible to calculate an average abundance change index, representative of the region's biodiversity, and to monitor its trend since 1993 which corresponds to the year following the Earth Summit in Rio where most nations made major commitments to biodiversity conservation.

Sadly, nearly 30 years later the results have failed to meet expectations. The index shows a 20% average drop in vertebrate population abundance monitored in the region between 1993 and 2016. The declines recorded are even more dramatic for species living in marine (-52%) and freshwater (-28%) ecosystems, i.e. at sea, both offshore and on our coasts, and in our wetlands and rivers. Based on the incredible amount of information provided by naturalist experts through the IUCN Red List of Ecosystems, we can point to unsustainable practices threatening the survival of many species in these environments: overfishing (including by-catch), proliferation of dams on rivers, over-abstraction of water resources, pollution and loss of natural wetlands induced by intensive agriculture and aquaculture practices.

Despite these worrying declines, there is some encouraging news from terrestrial ecosystems (forests, shrublands, grasslands, rocky areas and farmlands) where an increase in its index was observed. However, this positive trend must be interpreted with great caution as less data was collected for this ecosystem when compared to the other two biomes and some regions had less available data, notably in the South and East. There are definite increases, such as in several large mammal or forest bird populations, partly due to decades of conservation actions to strengthen their populations or protect their habitats. But the IUCN Red List also reveals that species in terrestrial ecosystems are more threatened than average, with one in four species at risk of extinction. The intensification of agricultural practices, which is leading to the loss of the biodiversity rich traditional Mediterranean agro-pastoral environments, is one of the main threats.

No matter their ecosystem, most species are experiencing the effects of climate change head-on with an increase in the magnitude of these effects expected in the coming decades. A significant proportion of the species in the Mediterranean basin are endemic and have restricted ranges, meaning that they are particularly vulnerable to the degradation of environmental conditions. The climate emergency and the biodiversity crisis must therefore be considered simultaneously when looking for solutions.

Despite a general downward trend in biodiversity in the Mediterranean basin, several measures and initiatives have saved numerous species from extinction and even made them flourish again. To move from small-scale increases to widespread biodiversity recovery, governments must ensure environmentally responsible governance, sustainable socio-economic models, and regulate the sustainable use of resources. Promoting nature-based solutions is crucial to mitigating the serious effects of climate change in the region. The protection of ecosystem functionality and biodiversity conservation are also critical to our own health, and in reducing risks of epidemic outbreaks.

Finding long-term sustainable solutions is our duty and responsibility, for the wellbeing of all humankind. If we are to succeed policy makers, scientists, civil society, businesses and local communities must share the same vision.

MARINE | Port-Cross National Park marine protected area.
© P. Le Nost

MARINE | Posidonia grass meadows.
© P. Le Nost

TERRESTRIAL | High Atlas mountain range, Morocco.
© iStockphoto.com/C. Meurer

TERRESTRIAL | Cedar forest in the Al Shouf Cedar Nature Reserve, Lebanon.
© iStockphoto.com/F. Camhi

THE MEDITERRANEAN HOTSPOT: A VERY COMPLEX AND BIODIVERSITY RICH REGION

The Mediterranean is one of the most geologically, biologically, and culturally complex regions in the world and the only example of a large sea surrounded by three continents (Africa, Europe and Asia).
It is one of the 36 recognised biodiversity hotspots in the world, defined as bio-geographical regions that contain a high rate of endemic species, found nowhere else in the world, and where natural ecosystems have been seriously degraded, resulting in a sensitive area to biodiversity [4].

With a range of 2 million square kilometres the Mediterranean is the second largest of these biodiversity hotspots. This vast area is geographically diverse, with its extensive coastal areas, numerous archipelagos and islands, as well as flat and mountainous terrain [5]. This geographical richness supports a variety of climates and more than 120 habitats, as defined by the International Union for Conservation of Nature (IUCN) Red List (RL) world classification in terrestrial, freshwater and marine biomes.

Figure 1.
Map of the Mediterranean basin with the biodiversity hotspot highlighted.

TERRESTRIAL | Olive trees in Patrimonio, Corsica.
© iStockphoto.com/S. Cesareo

FRESHWATER | Lake Prespa, Albania.
© J. Jalbert-TdV

MARINE | FRESHWATER | TERRESTRIAL | The Gediz Delta, Turkey.
© Helio-Van Ingen

LIVING PLANET INDEX FOR THE MEDITERRANEAN HOTSPOT

In the Mediterranean basin, one of the world cradles of agriculture and of different civilizations, the landscapes and associated biodiversity have been shaped by human activity for thousands of years[6]. Ecological change resulting from human activity is not new, however the scale and rate at which current human actions are affecting the environment of the Mediterranean basin is having severe consequences on biogeochemical cycles (carbon and nitrogen cycles), net primary production, as well as patterns of biodiversity in space and time[7].

Measuring the ecological changes and their impacts on biodiversity is a complex task. No single method can completely capture all the intricacies of life on Earth with its never-ending fluctuations, some natural and some due to human activity. Indicators are the primary tool in assessing the changes in biodiversity; they provide a snapshot of how and why biodiversity is changing. This helps us decide where we need to focus our conservation efforts and tells us if the results of our efforts are successful or not.

The Living Planet Index (LPI) is recognized as one of the best-established indicators of the state of global biodiversity[8,9]. Developed and updated by the Zoological Society of London (ZSL), in cooperation with the World Wide Fund for Nature (WWF), the LPI helps to detect changes in population abundance over time.

BOX 1 • MEASURING TRENDS IN BIODIVERSITY: THE LPI AND ITS APPLICATIONS

The Living Planet Index was one of the global indicators used to monitor progress towards the Aichi Biodiversity Targets agreed by the Convention on Biological Diversity's (CBD) in 2010 (SCBD 2010). It tracks trends in abundance of a large number of populations of vertebrate species in much the same way that a stock market index tracks the value of a set of shares. Using a method developed by the ZSL and WWF, trends in populations of vertebrate species are aggregated to produce the different Living Planet Indices [10–12]. These can focus on different subsets of the data, for example on different regions, hotspots, biomes or species groups.

In addition to the global index produced every two years for WWF's Living Planet Report, the LPI has been used to show trends in the abundance of Arctic migratory birds [13], marine species [14], species in protected areas [15], reptiles [16] and forest specialists [17]. The collaboration with Tour du Valat goes back more than a decade, when the first LPI for Mediterranean wetlands was published [18].

THE LIVING PLANET INDEX FOR ALL THE MEDITERRANEAN SPECIES SHOWS **A NEGATIVE TREND** WITH AN AVERAGE DECREASE OF

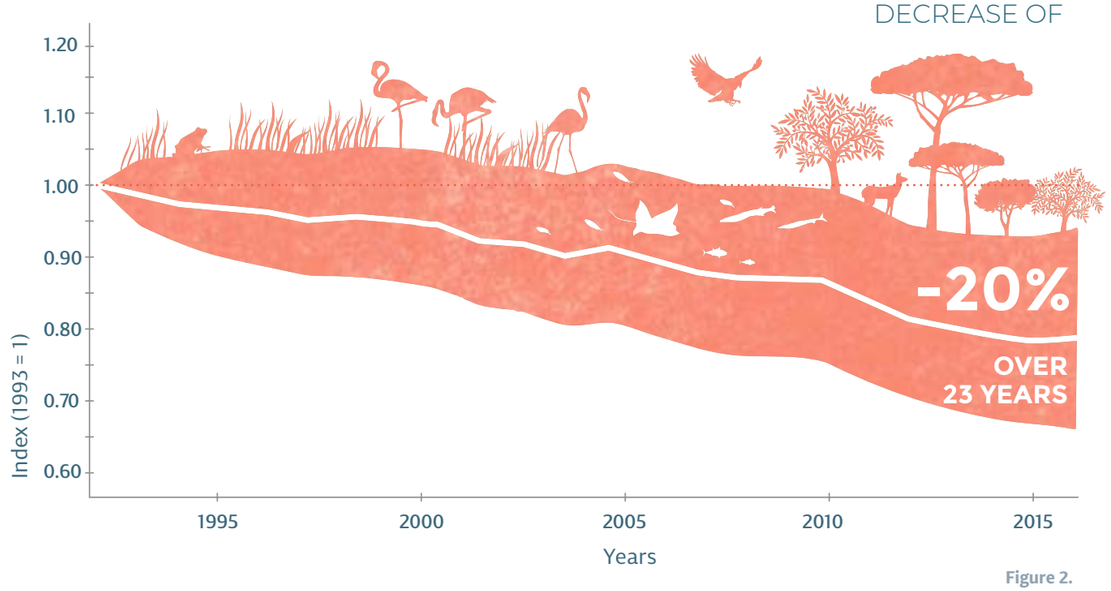


Figure 2.
Mediterranean Living Planet Index
(Weighted by species per biome)

The Living Planet Index for all the Mediterranean species shows a negative trend with an average decrease of 20% between 1993 and 2016 (Figure 2). The index begins the year after the 1992 Earth Summit held in Rio where the global community met and agreed to engage in efforts to tackle biodiversity loss. Yet, despite these commitments, biodiversity has continued to decline in the Mediterranean basin.

Extensive work was done to search for and gather monitoring data on vertebrate species in the Mediterranean hotspot. In total the dataset is comprised of 80,483 populations of 775 species, which represent 26% of all vertebrate species present in the hotspot. The populations were grouped into different taxonomic groups (namely mammals, birds, reptiles, amphibians and fishes) and biomes (terrestrial, freshwater, and marine). This allowed the Mediterranean LPI to be weighted by the proportion of each taxonomic group by biome so as to give a more accurate representation of all the species in the hotspot with the available data. For example, fish are more prevalent in marine biomes than other taxonomic groups and were therefore attributed more weight. This is to prevent taxonomic groups for which there is more data from overshadowing other groups for which there is less available data. For more details on the methodology adopted, it is possible to consult the online annex accessible via the following link:
https://tourduvalat.org/en/download/33154/

BIODIVERSITY IS DECLINING AT DIFFERENT RATES IN DIFFERENT BIOMES

The result of the Mediterranean LPI was split into freshwater, marine and terrestrial indices to show how trends vary in different ecosystems (Figures 3-5). Each species was associated with a single biome with only the taxa being weighted within each biome.

The populations of freshwater species decreased by 28% on average. All the different taxonomic groups show sharp declines in their population, except waterbirds.

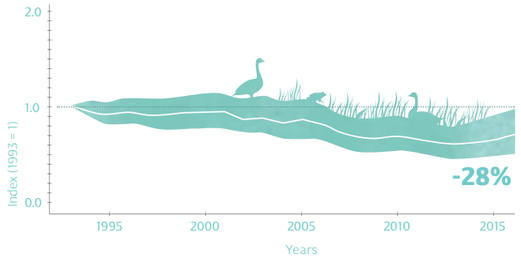


Figure 3. Mediterranean Freshwater LPI of 59,848 populations of 201 species (Weighted by taxa)

Populations of marine species decreased by 52% on average, mostly due to the decline of fish populations both at sea and in coastal wetlands, whereas seabirds are stable and sea turtles are on the increase.

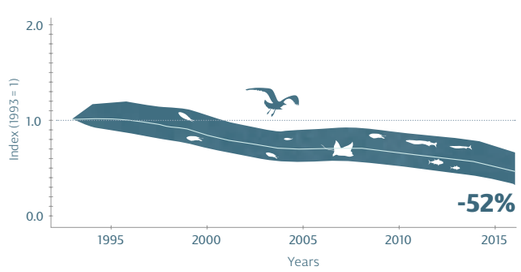


Figure 4. Mediterranean Marine LPI of 16,437 populations of 284 species (Weighted by taxa)

Populations in terrestrial ecosystems increased by 46% on average. This positive trend is mainly driven by the recovery of forest and mountain birds and mammals, including raptors or ungulates. However, many species, such as farmland birds and bats, did not increase over the same period. We obtained less data for the terrestrial biome than for the others, and most of the data originated from Western Europe (61%), additional data on other terrestrial taxa and on populations of the southern and eastern Mediterranean regions is needed to have a more reliable view of the overall trend.

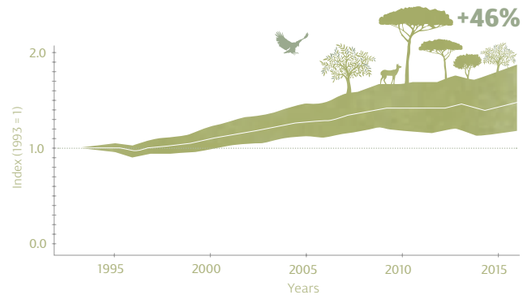


Figure 5. Mediterranean Terrestrial LPI of 4,198 populations of 290 species (Weighted by taxa)

ZOOMING IN ON MEDITERRANEAN ENDEMIC SPECIES

Endemic species are native to one geographic location and cannot be found anywhere else in the world. As an example, of the more than 7,300 vertebrate, invertebrate and plant species examined in the Mediterranean IUCN Red List, almost 2,700 - or 37% - are endemic to the hotspot. This high rate of endemism distinguishes the Mediterranean basin from neighbouring biogeographical regions.
The information from the Red List helps to identify some alarming results among the endemic populations (Figure 6), with a 37% average decrease in abundance in vertebrate endemic species, endemic amphibian populations being the most greatly affected. Mediterranean countries have a responsibility to conserve these unique species. If they disappear in the Mediterranean, they will disappear forever.

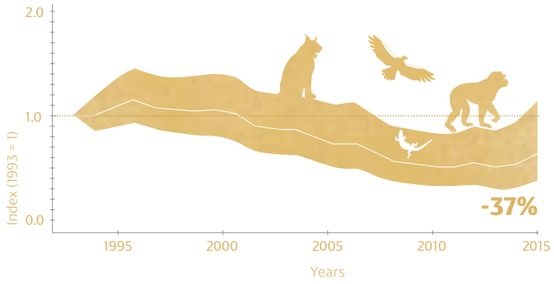


Figure 6. Trends of 531 endemic vertebrate populations (weighted by taxa) in the Mediterranean, representing 63 endemic species.

For example, the Iberian lynx (*Lynx pardinus*) is a wild cat endemic to the Iberian Peninsula and classified as Endangered by the IUCN. Habitat loss, poaching and, mainly, the dramatic decrease of the populations of the wild European rabbit, its main prey, due to diseases, has brought the Iberian lynx to the brink of extinction in 2002, with less than 100 individuals remaining in the wild. Since then, conservation efforts mainly maintaining and enhancing the wild rabbit populations and the release of captivity-bred lynxes through successful reintroduction programs have helped to increase their population size. In Portugal, for example, captivity bred Iberian lynxes are being released into sustainable managed hunting areas where hunters and game managers committed to the conservation of the Lynx, and promote abundant and healthy rabbit populations through good habitat management practices [19].

POPULATION TRENDS ARE CONTRASTED AMONG THE DIFFERENT VERTEBRATE GROUPS

A closer look at the LPI of different taxonomic groups shows differing trends. Birds show a positive trend with a 30% average increase since 1993, while fish show a significant negative trend with a 52% LPI decrease. Amphibians demonstrate negative trends and mammals positive trends, however both taxonomic groups have wide confidence intervals which means there is more uncertainty surrounding the final index value. Reptile populations show a stable trend, however the underrepresentation of this group in the dataset as well as a large confidence interval which includes the baseline makes it difficult to assess the exact trend.

The data gathered corresponds to 68% of bird species, 29% of amphibians, 27% of mammals, 15% of fish and 11% of reptiles present in the Mediterranean, and was equalised with a weighting process.

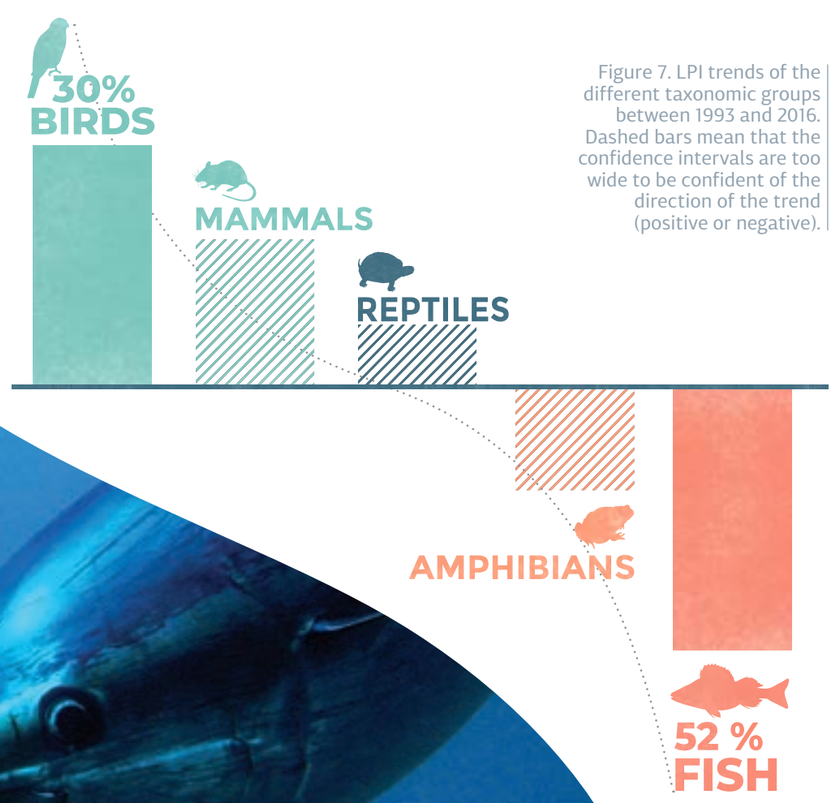


Figure 7. LPI trends of the different taxonomic groups between 1993 and 2016. Dashed bars mean that the confidence intervals are too wide to be confident of the direction of the trend (positive or negative).

Bluefin tuna
© iStockphoto.com/ A. Sutandio

Peregrine falcon
© iStockphoto. com/J.A. Huerta

While some positive LPI trends are observed, over 300 species out of the 775 included in our dataset are on the decline. Marine and freshwater fish are the most heavily impacted taxa. Marine fish populations in particular have experienced the greatest decline since the 90s, with overfishing endangering species such as the Bluefin tuna (*Thunnus thynnus*). From the mid-90s to 2007, 50,000 to 61,000 tonnes of Bluefin tuna were being fished every year, bringing the species on the verge of collapse with a 90% decline in adult biomass [20,21]. Monitoring the populations of Bluefin tuna has helped to sound the alarm and build regulatory frameworks. In 2006 a recovery plan limiting the total allowable catches was introduced and reinforced by the International Commission for the Conservation of Atlantic Tunas (ICCAT) which has allowed stocks to improve over the past decade.

Bird populations are the only group to show positive trends, in part thanks to the protection measures established by the European Bird Directive and the work of some NGOs. Achieving these increases was no small task, as both individuals and associations put all their effort into changing and implementing laws to prevent bird populations from decreasing further than the very low levels they had reached in the 1990s due to habitats loss, unsustainable hunting and the use of pesticides in agriculture such as DDT.

One species particularly affected by pesticides was the Peregrine falcon (*Falco peregrinus*). 1,000 pairs were present in France during the 1940s, but when organochlorine compounds started being used in the 1960s, this number was reduced to only 122 pairs [22]. A ban on organochlorine pesticides in Europe in the 1980s helped bring back Peregrine falcons from near-extinction and the species is now listed as Least Concern on the IUCN Red List. These bans and protection measures not only saved bird populations but also helped fish and amphibians, which had been affected by the pesticides carried in the water. This positive general trend and this particular example should not make us forget that many threats have grown over the same period and led to the massive decline of certain groups of species, such as the common farmland birds in Europe [23].

Widespread efforts of conservation across all Mediterranean countries are needed to help preserve the remaining wildlife and to prevent biodiversity from decreasing further. One of the needed actions is to ensure proper monitoring of all taxa. Our work highlights the lack of data in some areas, as much of the information gathered originates from the northern Mediterranean countries: further data collection is necessary in other regions to have a complete picture of the state of populations in the hotspot. Additional monitoring data is especially needed for amphibians, as well as terrestrial mammals and reptiles, for which there is less recorded information.

Furthermore, in order to effectively put in place these conservation measures for all taxa, we must address the root of this loss in biodiversity; the fact that these negative trends are primarily the result of human actions. Our overexploitation of resources and the lack of regulations have pushed the natural world to its limits and now pose a threat to the survival of our ecosystems and ourselves.

THE IUCN RED LIST OF THREATENED SPECIES IN THE MEDITERRANEAN HOTSPOT

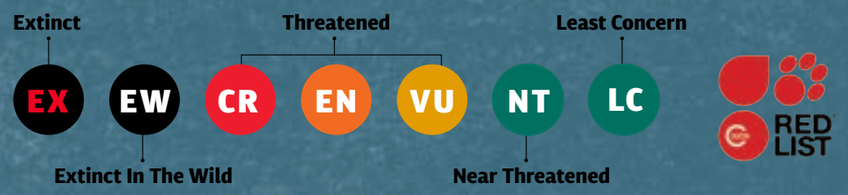
Like the Living Planet Index, the IUCN Red List is another critical indicator of biodiversity and a key tool in preventing the extinction of species. Using the IUCN Red List for species of the Mediterranean Basin Biodiversity Hotspot, it is possible to identify the declining general trends of species and habitat conservation status as well as the main threats to Mediterranean species.

Used in tandem, the Living Planet Index and the IUCN Red List complement each other, helping to create a clearer picture of the state of biodiversity.

BOX 2 • THE RED LIST OF THE IUCN

The International Union for Conservation of Nature's Red List of Threatened Species is an indicator of the health of the world's biodiversity. By measuring the risk of taxa extinction, it is a powerful tool to inform and catalyse action for biodiversity conservation and policy change, critical to protecting biodiversity. It provides information about range, population size, habitat and ecology, use and/or trade, threats, and conservation actions that will help inform conservation decisions.

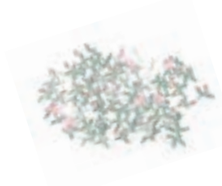
The IUCN Red List is used as a guide to revise the annexes of some important international agreements, such as the Convention on International Trade in Endangered Species (CITES) and the Convention on Migratory Species (CMS). In addition, data from The IUCN Red List is used to calculate the Red List Index (RLI), which is one of the biodiversity indicators used by the Convention on Biological Diversity (CBD) to monitor progress towards achieving the targets set out in the Strategic Plan for Biodiversity 2011-2020. The IUCN Red List also provides data for the indicators needed to measure progress towards the achievement of the United Nations Sustainable Development Goals (SDGs), particularly Goal 15: Life on Land.



Currently, there are more than 134,000 species on The IUCN Red List, with more than 37,000 species threatened with extinction.

7363 Mediterranean species from the IUCN Red List were examined including:

PLANTS



2,250 species
(50% endemic)
30% threatened

MAMMALS

300 species
(13% endemic)
20% threatened

BIRDS

500 species
(10% endemic)
12% threatened

AMPHIBIANS

100 species
(50% endemic)
30% threatened

REPTILES

300 species
(40% endemic)
23% threatened

FISH

550 freshwater species
(47% endemic)
44% threatened

1,300 marine species
(9% endemic)
9% threatened

INVERTEBRATES

2,100 species
(47% endemic)
31% threatened

This is but a small sample, invertebrates are a highly diverse group, but little is known on their number. Only insects are estimated at 150,000 species in the hotspot [24].

These species were allocated to the biomes where they live: freshwater, marine and terrestrial. To get an idea of the biodiversity of each biome, we considered each species that develops part of its life in the respective biome. Therefore, an amphibian species was considered in both an aquatic and a terrestrial biome.

FRESHWATER

Freshwater biomes include coastal and inland wetlands.

36% of species are threatened
(2225 species
41% are endemic)

MARINE

Marine biomes encompass the whole range from coastal to pelagic ecosystems.

12% of species are threatened
(1556 species
10% are endemic)

TERRESTRIAL

Terrestrial biomes are comprised of mountains, forests, grasslands and farmlands.

25% of species are threatened
(3672 species
45% are endemic)

THE DIRECT DRIVERS TO BIODIVERSITY LOSS IN THE MEDITERRANEAN

The loss of biodiversity is being exacerbated by the pressures and stresses exerted by human actions. The anthropogenic activities or processes that impact and actively contribute to the destruction of ecosystems and the decline in biodiversity are known as direct drivers of biodiversity loss. The major direct drivers were grouped and adapted from the IUCN threats classification scheme (version 3.2; IUCN, 2020) to fit with the Mediterranean context.

Leads to the direct destruction of habitats for species and generates pollution due to an excess of nutrients and pesticides.

Destroys, fragments or reduces the quality of available habitats for species and increases both air and water pollution.

Reduces the populations of species that are hunted, fished or harvested for human consumption and prevents their regeneration. Includes species that are killed unintentionally such as by-catch in fisheries.

Species introduced by man, intentionally or accidentally, that negatively impact the native species.

Alters ecosystems, blocks species from travelling, and reduces water availability.

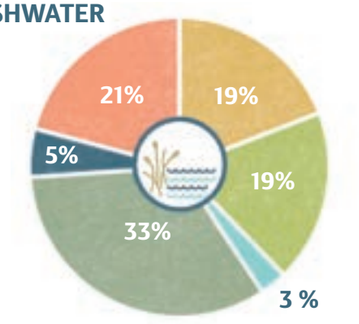
Modifies habitats, forces species to migrate, and makes conditions harsher for the species that cannot adapt or move.

Figure 8. The different major direct drivers of biodiversity loss in the Mediterranean

THE THREATS TO SPECIES ARE NOT THE SAME BETWEEN THE DIFFERENT BIOMES

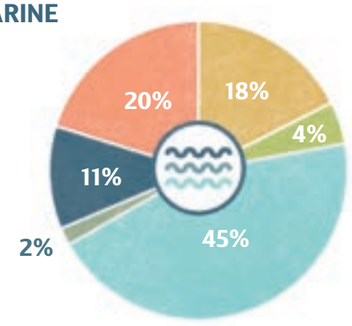
The direct threats to the Mediterranean biodiversity were analysed for each biome; freshwater, marine and terrestrial.

FRESHWATER



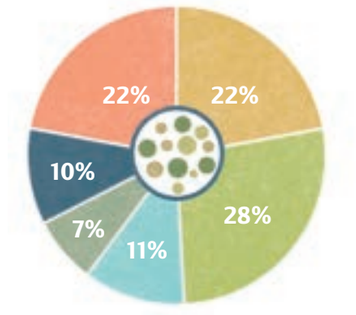
The main threats to freshwater biodiversity are dams and water abstraction. These direct drivers increase the fragmentation of rivers and aquatic ecosystems, preventing species from reaching areas previously accessible, and limiting available water sources downstream. The other important threats are climate change, urbanisation and agriculture as they lead to wetland conversion and water pollution.

MARINE



Marine biomes are under serious threat from overfishing (including by-catch) with almost half of the species affected by this direct driver. This depletion of fish stocks may disrupt the food chain in the seas. Climate change and urban development are also seriously threatening species living on the coast.

TERRESTRIAL



Intensive agriculture is the main threat to terrestrial biomes, replacing traditional agro-systems. It requires high levels of inputs and leaves less room for wild species. Like in the other biomes, climate change and urbanisation are also significant threats to Mediterranean terrestrial species.

Figure 9. Relative importance of Direct Drivers in biodiversity loss per biome (terrestrial, marine and freshwater) in the Mediterranean hotspot. The colours of the sections correspond to the colours of the direct drivers on the opposite page.

HOW DO THESE DIRECT PRESSURES AFFECT SPECIES?
SOME MEDITERRANEAN EXAMPLES

The Great bustard

INTENSIVE AGRICULTURE

Widely recognised as a major cause of declining farmland bird population, intensive agriculture leads to loss of cover, monocultures and the massive use of chemicals such as fertilizers, herbicides and insecticides that reduce food resources [25].
The Great bustard (*Otis tarda*), is particularly impacted by the wide-scale ploughing of grasslands. This heavy flying bird, originally inhabiting the steppe, was previously doing very well in traditional and diverse agricultural land surrounded by extensively grazed meadows. Alongside infrastructure development, hunting and feral dogs are also significant threats to this species.

Drusian spring minnow

CLIMATE CHANGE

Freshwater fish species face harsh climate change challenges: dry inland waters, fluctuating water levels and, above all, rising water temperatures will affect numerous species in the future. With current trends, fish stocks are expected to decline, and more species of fish will become extinct [26]. The recent LPI for migratory species at the world level states a 76% decline in less than 50 years [27].
The Drusian spring minnow (*Pseudophoxinus drusensis*) is a freshwater fish endemic to the northern part of the Jordan River in Israel and Syria, currently identified as Endangered. Its population has crashed at the end of 1990s after a severe drought and has not recovered yet. The species is also threatened by high water abstraction and pollution, and the introduction of invasive fish species.

Orontes spined loach

DAMS AND WATER ABSTRACTION

Most Mediterranean rivers experienced a significant reduction in their flow from approximately 25% to 70% between 1960 and 2000 [28]. This excessive water abstraction combined with the disconnection of flow provoked by dams seriously affects fish and invertebrates.
Orontes spined loach (*Cobitis levantina*) is an endemic fish of very few rivers of Lebanon, Turkey and the Syrian Arab Republic. Massive water abstraction has reduced its distribution area to just five locations highly threatened with water pollution. It is currently classified as an Endangered species.

Angel shark

OVER EXPLOITATION

For fish, the levels of fishing effort determine a general overexploitation status of commercial stocks with more than 90% of the stock assessed out of safe biological limits [29].
The Angel shark (*Squatina squatina*), is a bottom-dwelling cartilaginous fish, found at depths of 150m on sandy seabeds. It was common throughout much of the Mediterranean Sea until benthic trawling efforts increased in both intensity and efficiency. Highly susceptible to bycatch in trawls, angel shark populations have declined so much in the last 50 years that they are now very close to extinction and the species is assessed as Critically Endangered [30].

Monk Seal

URBANISATION

Urbanisation and consequent habitat loss is a cause of decline for many species. The world's rarest seal, the Mediterranean monk seal (*Monachus monachus*), is comprised of only of a few hundreds of individuals living in isolated subpopulations in the Aegean Sea, the archipelago of Madeira and the Cabo Blanco (Mauritania) where they are threatened by residential and touristic development.
Classified as Endangered the Mediterranean monk seals are very sensitive to human contact. This is why they have shifted their breeding areas from open beaches to caves that are less accessible for humans. However conditions in these caves are harsher and less than half of the pups survive past 4 months [31]. Interactions with fisheries through deliberate killing or entanglement in fishing gears are still major threats for the species.

BOX 3: CLIMATE CHANGE

Climate change in particular is a direct driver growing in importance in the Mediterranean. It not only threatens the resilience of ecosystems but also the wellbeing of all the people living in the region. According to the First Mediterranean Assessment Report, temperatures in the Mediterranean are increasing 20% faster than the global average and are expected to rise by 2.2°C by 2040. Along with this increase in temperature, rainfall will likely decrease by 10 to 30% in most regions, leading to drier climates with greater risks of mega fires [2]. Water shortages will increase the need for water abstraction to maintain the irrigation of agricultural lands, putting even greater strains on freshwater ecosystems.

The productivity and distribution of marine life will be impacted by the rise in sea temperatures along with the increase in seawater acidification, further weakening the resilience of marine ecosystems and reducing the available resources which are already suffering from overexploitation. Sea levels will continue to rise; the First Mediterranean Assessment Report predicts a global sea-level rise of 37 to 90 cm by 2100 [2]. This will heavily impact coastal ecosystems (notably wetlands) but also human populations who in the Mediterranean often live close to the coast.

These events are expected to have important economic impacts, from the damage caused to infrastructure, to the diminishing touristic activity in heavily affected regions. The yields of crops will also likely decrease in lands with drier climates and more extreme weather events. This may lead to food shortages, conflicts over resources and migrations out of the most severely affected regions, with already disadvantaged populations being even more vulnerable to these changes.

Climate change will lead to warmer and drier environments, with heat waves and temperature extremes increasing in duration and intensity which in turn will make some regions more susceptible to wildfires. Proper management and planning is needed to anticipate this risk and limit the damages to both humans and the environment.
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Partially submerged church in the village of Alassa near the Kouris dam in Cyprus. The entire village was evacuated and flooded to allow for the construction of the dam in 1984.
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INDIRECT DRIVERS IN THE MEDITERRANEAN

While direct drivers are responsible for the degradation of ecosystems and biodiversity loss, the underlying causes of these changes are known as indirect drivers. These indirect drivers interact with direct drivers and each other, influencing the rate at which ecosystems are degraded. Indirect drivers include governance, demographics trends, sociocultural trends, economic growth as well as technological development.

In the Mediterranean region, demographic trends, sociocultural trends as well as a lack of appropriate governance are the overarching fundamental factors that have a strong negative impact on the state of biodiversity. The Mediterranean is experiencing very high demographic pressures by residents and tourists. The ecological footprint of human activity in the region is almost twice the world average, with particularly high pressure on water resources [32]. There is therefore an urgent need of improved governance frameworks to regulate the degradation of nature and to protect the environment [33,34].

Governance is the way a government, business, or a network manages human activities in a social system (a country, a city, an industry etc.). With the right approach and a greater emphasis on sustainability, governance can be key to reducing our impact on the environment. However progress has been slow, partly due to challenges such as:

BOX 4:
GOVERNANCE CHALLENGES

Differences in levels of development and living standards between countries, affect investments in sustainability.

Lack of effective science-policy interface and knowledge-exchange processes that take into consideration the diversity of the Mediterranean region (beyond one-size-fits-it-all approach).

Differences between environmental regulations (especially between EU and non-EU countries).

Lack of cross-sectoral policy to operationalize integrated resources management and secure a healthy environment.

Lack of inclusive governance, with the contribution of civil society.

Lack of communication between health institutions and environmental institutions.

Source: UNEP/MAP, Plan Bleu, Circle of Mediterranean Parliamentarians for Sustainable development in the Mediterranean.

DEMOGRAPHIC AND SOCIOCULTURAL CHALLENGES

More than five hundred million inhabitants live in the regions bordering the Mediterranean, and this number is expected to increase by an additional 182 million by 2050 [1]. Urbanisation has increased significantly in most of the Mediterranean countries over the past decades, with 70% of the population living in urban areas. The Mediterranean basin also receives 360 million tourists per year, representing 27% of the world's tourism. All these trends are causing continuous urbanisation and land degradation , especially along the coast [35]. With increased human population densities comes higher demands in resources, food, land, infrastructure, energy and this generates even greater amounts of waste and pollution. The Ecological Footprint already exceeds the region's biocapacity by more than 150%, running an ecological deficit [7]. There will be even greater demands for water, with more than a third of the inhabitants already considered water poor, and this number is expected to increase. In addition, densely populated areas with very high exchange rates of both goods and people may foster the spread of pathogens.

Economic growth is the increased production of goods and services in a country. Depending on the way the economic activity is organised in a country, economic growth can be an indirect driver of biodiversity loss leading to greater consumption of natural resources and putting even more stress on biodiversity. In the Mediterranean, the economy is still driven by rapid growth in polluting sectors including coastal mass tourism, transportation relying on fossil fuels, and intensive agriculture consuming large amounts of fertilizer, pesticides and water [1]. The inequalities in distribution of resources and wealth, both within and between countries, can lead to social conflict and instability which can also disrupt ecosystems [36]. Mediterranean high-income countries generate significant environmental spillover effects by exporting a large amount of pollution, waste and other negative externalities, thus limiting other countries' ability to achieve sustainable development [1]. However economic growth derived from innovative sectors within the green, blue and circular economy could be much less damaging to biodiversity and allow countries to invest more in nature conservation.

Technological development is another indirect driver that can both positively and negatively impact biodiversity. New technological advancements can help provide sustainable solutions to biodiversity conservation, for example, more efficient methods of harnessing solar and wind power to produce cleaner energy reduces the need for fossil fuels that contribute to climate change. However, some advancements can facilitate the degradation of ecosystems or amplify the overexploitation of resources. One such example is the development of more powerful fishing vessels since the 1990s. More sophisticated gear has given fisheries access to deeper waters and has played a major role in the depletion of deep sea stocks.

Overcrowded beach in Salou, Spain.
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IMPORTANCE OF BIODIVERSITY TO OUR HEALTH

BOX 5. HUMAN HEALTH AND ECOSYSTEMS HEALTH

THE ONE HEALTH APPROACH

The COVID-19 pandemic crisis that we are presently living in is a new reminder of how closely our health is intertwined with the health of ecosystems and wildlife. The pandemic is just one example of the terrible effects biodiversity loss can have and further emphasizes the need to protect and monitor areas such as the Mediterranean hotspot.

Habitat fragmentation and the expansion of industrial farming are increasing contact between humans and other animals, potentially increasing the chances of the emergence and spread of zoonotic diseases. The Mediterranean conditions of high-density populations, constant movement of people and commercial products can also facilitate the dispersion of these infectious diseases

Healthy ecosystems and biodiversity conservation help to limit disease impacts in both wildlife and human populations. Contact with nature also contributes to protect our immune system and mental health (to learn more see for example [37,38].

"Biodiversity and Nature are the foundation of our food, clean water and energy. They are at the heart not only of our survival, but also of our cultures, identities and enjoyment of life. The best available evidence, gathered by the world's leading experts, points us now to a single conclusion: we must act to halt and reverse the unsustainable use of nature- or risk not only the future we want, but even the lives we currently lead"

(Sir Robert Watson, IPBES).

Ringing a young Eurasian spoonbill (*Platalea leucorodia*) with a field-readable tag. Tagging and tracking different species is an important step in protecting wildlife. It allows us to track their movement, better understand their behaviour and implement regulations better adapted to their needs.
© *Zeppelin*

BENDING THE CURVE OF BIODIVERSITY LOSS

Preventing the further loss of biodiversity is essential for both the health of the planet and our own. If we aim to reverse these negative trends and bend the curve of biodiversity loss we must start taking action and working together. This is not an insurmountable task and fortunately there are already multiple successful cases of conservation programmes that can be used as examples to help better protect other species in the future.

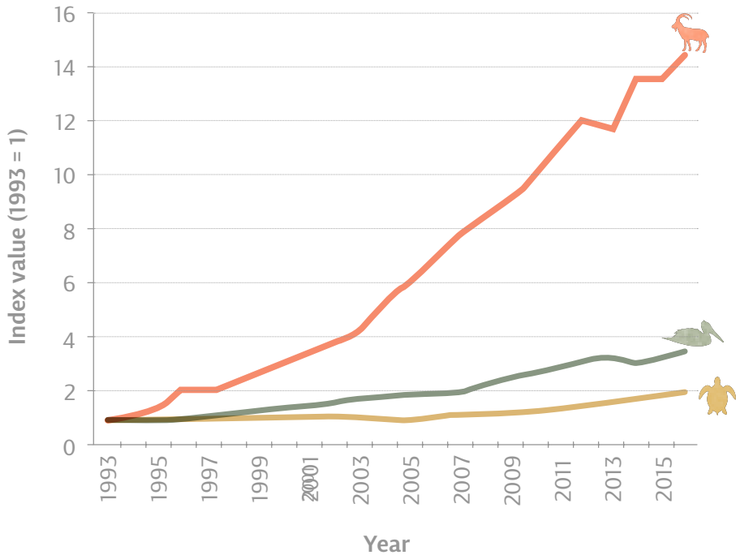
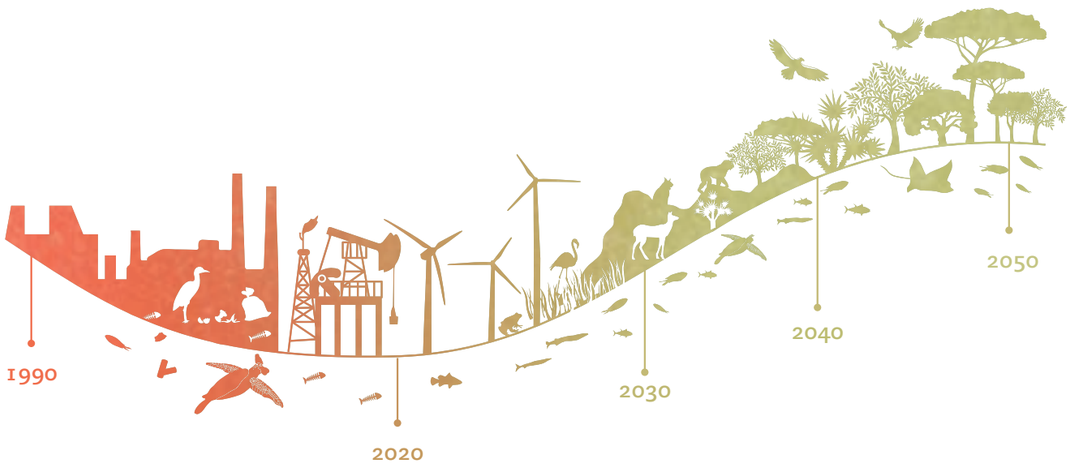


Figure 10. Increasing population trends of the Loggerhead turtle (*Caretta caretta*), the Dalmatian Pelican (*Pelecanus crispus*) and the Alpine ibex (*Capra ibex*).



GOOD NEWS: INCREASING TRENDS THANKS TO CONSERVATION PROGRAMMES

© *Thomas Galewski*

THE DALMATIAN PELICAN (*Pelecanus crispus*):

Conservation measures such as surveillance of breeding colonies, dismantling of dangerous powerlines and provisions of breeding platforms in Europe, especially in Greece, have helped to increase populations and the species has been donwlisted from Vulnerable to Near Threatened. However Dalmatian pelicans are still susceptible to threats and populations could decline rapidly if precautions are no longer taken [39].

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THE LOGGERHEAD TURTLE (*Caretta caretta*):

Almost all Mediterranean countries, including those with major nesting and foraging habitats for Loggerheads and Green Turtles, are signatories to international conventions for the conservation of species including sea turtles and have national laws for the protection of sea turtles, as well as fisheries agreements. Furthermore, many countries have sea turtles conservation projects run by governmental bodies or NGOs. Special attention has been given to the protection of major nesting sites and as a result, the Mediterranean population of Loggerhead Turtles is one of the few healthy populations of this species.

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THE ALPINE IBEX (*Capra ibex*):

Prized by poachers, the Alpine ibex was on the verge of extinction at the end of the Second World War with only 416 individuals left in the world [40].

Protection from poaching in the Gran Paradiso National Park (Italy) helped save the species and successful reintroductions have allowed populations to increase throughout the European Alps. There are now more than 50,000 mature individuals and the species is listed as Least Concern [41].

WHAT CAN WE DO FOR OUR HOTSPOT?

MONITORING BIODIVERSITY STATE, THREATS AND THEIR SCOPE

In order to better protect this amazing Mediterranean hotspot there must be transparent and constantly updated information on the state of biodiversity so that better adapted conservation strategies can be designed within and beyond territorial land and waters.
National, regional and global analysis can profit from the Red List, the Mediterranean LPI database and models as good proxies to identify the state of biodiversity.
However, additional efforts are needed to complete the information on the status, threats and protection needs of species, especially for plants and invertebrates, as well as for marine species as a whole. Monitoring programmes are also needed to acquire a general understanding of the Mediterranean biodiversity, especially for amphibians, reptiles and mammals, as well as populations living outside protected areas including agricultural lands. Furthermore, monitoring programs in the southern and eastern Mediterranean have to be implemented and/or reinforced so that the state of biodiversity can clearly be assessed in those regions. The inclusion of participatory monitoring in these programmes would greatly assist in these efforts.
It is easier to protect what we know, therefore environmental research and education is essential to prevent species loss and improve the state of ecosystems.

WE NEED TO WORK TOGETHER TO SUCCEED

Policy makers, scientists, the civil society, businesses and local communities need to work together to succeed. The good news is that we have the tools to evaluate current trends and to propose target solutions. The most urgent task right now is to find good ways to unify governments and people to put these solutions into practice to protect our planet.

The Covid-19 pandemic, the climate emergency and the ecological crisis we face today compels us to address the root causes of these disorders. This can start with firmer engagements between the environmental and health institutions, in order to promote an effective “One Health” approach and to reach the 2030 goals. This includes a 50% reduction of the negative ecological footprint of production and consumption, the protection of 30% of both marine and terrestrial areas, and the restoration of degraded land. We need the full commitment and financial support of governments, international funding agencies and the private sector, especially those that are currently having a negative impact on biodiversity. Civil society and local communities should be fully involved in the implementation of conservation actions to ensure their long-term success. Finally, it is crucial to support science-policy interface organisations, at different spatial scales, to identify the most appropriate solutions and measure their effectiveness once implemented.

Lake Skadar National Park located on the border of Albania and Montenegro.
© Jean Jalbert

BOX 6. SOLUTIONS FOR FRESHWATER ECOSYSTEMS

Wetland restoration is strategic for biodiversity conservation in the Mediterranean hotspot but also as a Nature-based Solution to mitigate and adapt to climate change. It also provides water and soil regulating services and is important for recreation, education and for improving peoples’ health.
By protecting wetlands, which cover only 2-3% of the basin's surface, we support more than 30% of vertebrate species, more than 40% of endemic species and 36% of threatened species in the hotspot.
Protecting wetlands is also protecting our livelihoods. They have the capacity to build adaptive barriers or new path openers for smooth water spread in case of storms, they sequester important carbon amounts, and provide food and resources when they are healthy and functional [35].

Our recommendations are:

- Foster wetland conservation and restoration.
- Ensure that dams are designed and managed to limit their impact on biodiversity.
- Change agricultural practices in order to reduce pollutants runoff and water abstraction.
- Implement integrated management mechanisms such as the Integrated River Basin Management and the Integrated Water Resources Management.

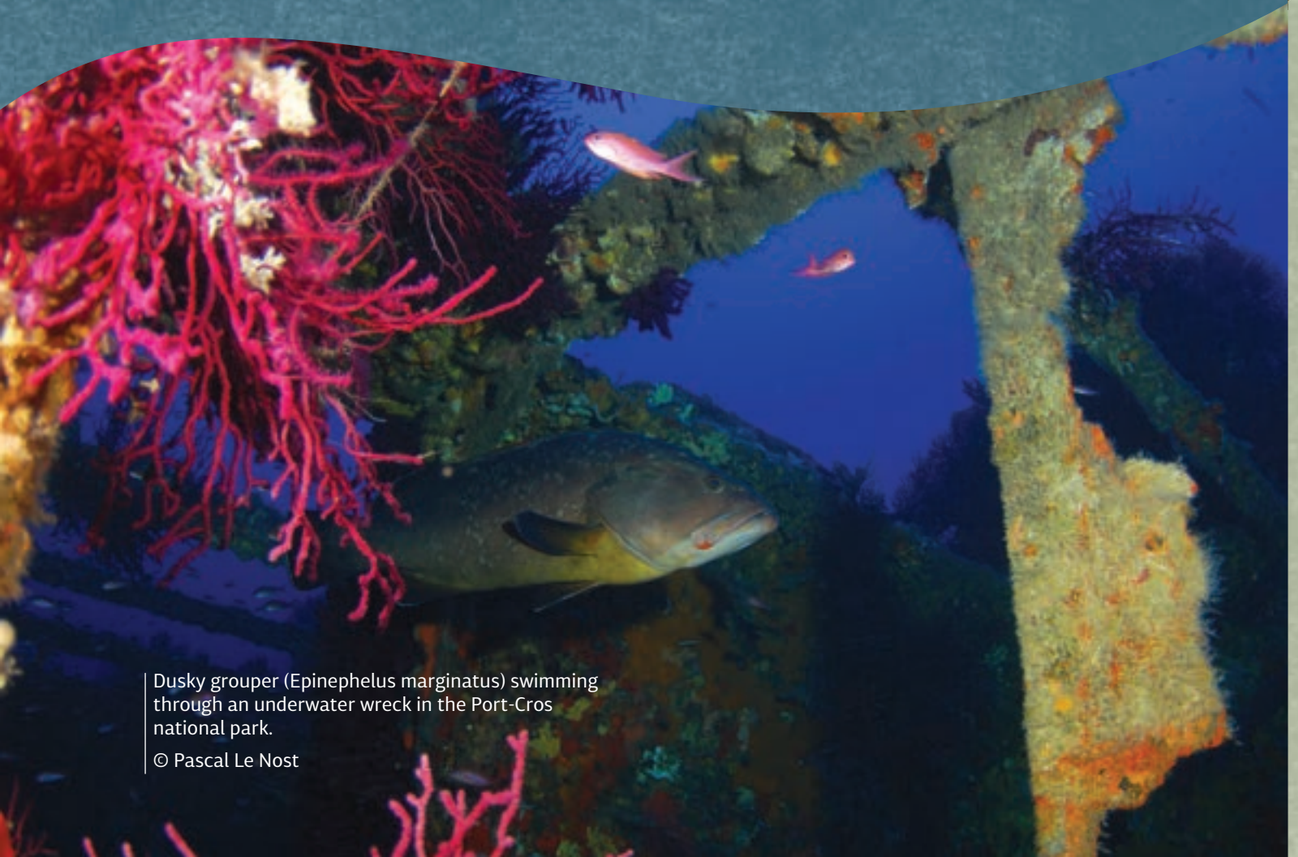
BOX 7. SOLUTIONS FOR MARINE ECOSYSTEMS

For all Marine Protected Areas (MPA), active management, enforcement and stakeholder inclusiveness are needed to reach conservation objectives. In the current context of widespread ecosystem degradation and climate change, effectively protected MPAs are essential to preserve, conserve and restore our oceans.

Benefits of fully protected areas in the Mediterranean are widely reported, from spillover to much greater effectiveness in recoveries when compared to partially protected areas, or as climate change sentinel sites. Investing in MPA capacity development will result in high returns on investment for both people and nature.

Our recommendations are:

- Ensure effective management and sustainable financing of existing MPAs.
- Increase the number and area coverage of fully protected areas within existing MPAs to provide ecological and socio-economic benefits. Ideally 30% of the sea should be protected.
- Place greater emphasis on network based approaches for mobile species that do not know any border and require MPAs to collaborate beyond the local level. This allows data sharing and thus, the possibility to take timely and adaptive management decisions at site level, whilst contributing to an integrated management strategy for these species.



Dusky grouper (Epinephelus marginatus) swimming through an underwater wreck in the Port-Cros national park.

© Pascal Le Nost

Traditional orchard plantation in the Kingdom of Morocco.

© Coralie Hermeloup

BOX 8. SOLUTIONS FOR TERRESTRIAL ECOSYSTEMS

The Mediterranean region is a biodiversity hotspot and a cradle of human civilizations. Throughout history, human pressures have altered the Mediterranean ecosystems. This long-lasting relationship between ecosystems and land-use practices have degraded ecosystems in some cases but in other cases contributed to create cultural landscapes of high biodiversity value. The success of preserving this hotspot in years to come relies on the ability to address biodiversity conservation goals while responding to human socio-economic needs.

Our recommendations are:

- Improve land management. In several areas of the Mediterranean the lack of sustainable management or outright land abandonment are correlated with threats (e.g. wildfires) and loss of landscape diversity. Conservation measures including restoration of degraded ecosystems are urgently required.
- Better integrate land-uses. Proper planning and integration of agro-industrial farming and other land use practices to minimize effects on biodiversity.
- Promote sustainable and wise use of forests and other terrestrial resources both within and outside protected areas.
- Extend the network of protected areas to all Key Biodiversity Areas and other sites remarkable for their biodiversity (such as Ancient Forests) and ensure that effective management and conservation measures are implemented.

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