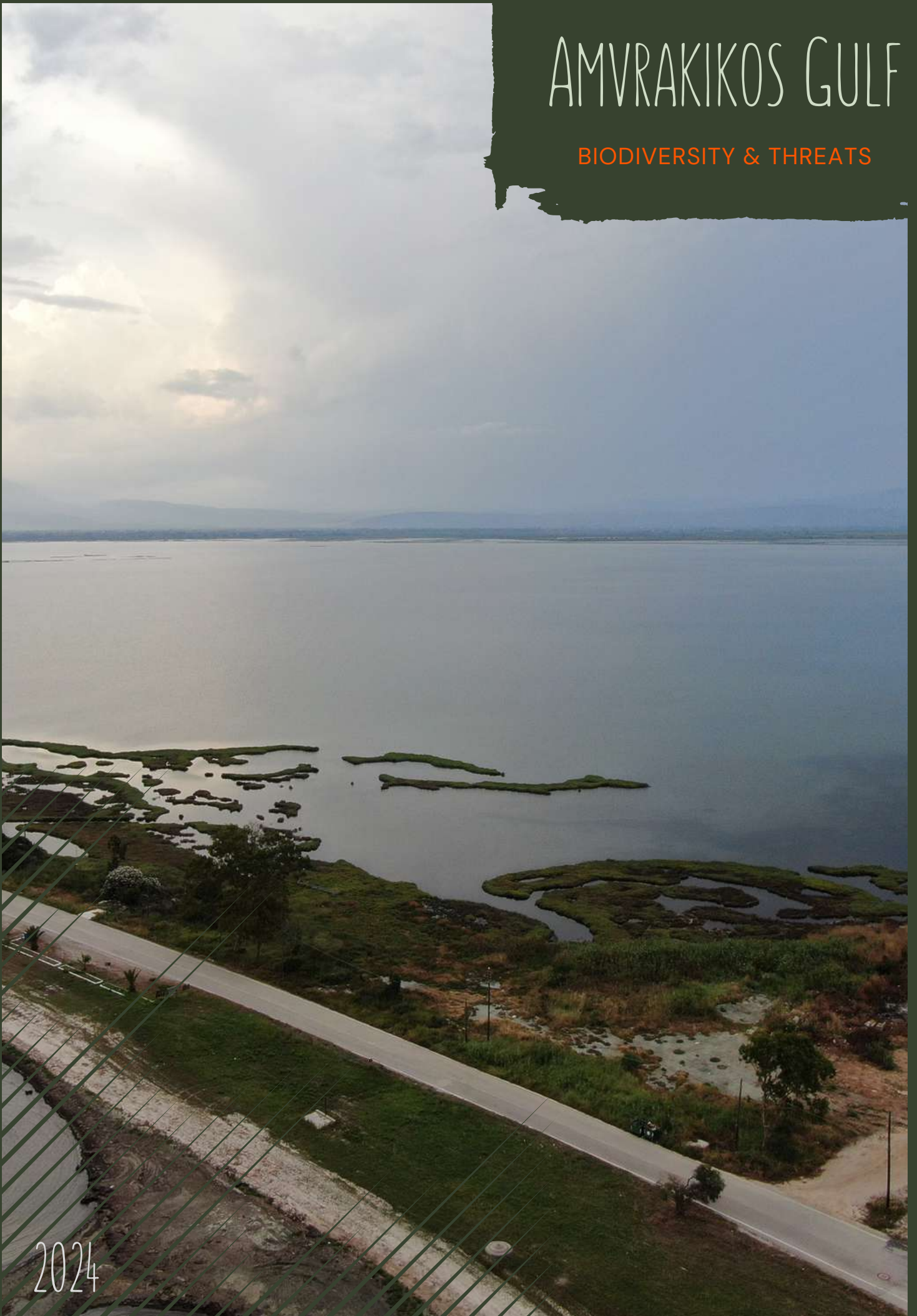


# AMVRAKIKOS GULF

BIODIVERSITY & THREATS



2024



## Proposed citation

Giovas, I., Gonzalvo, J., Ciprian, M., Gaentlich, M., Gavriel, E., Konstas, S., Kordopatis, P., Koutsikopoulos, C., Mavrogiorgos, D., Moutopoulos, D.K., Panagopoulou, A., Papatheodorou, Ramfos, A. Amvrakikos Gulf: Biodiversity and threats. Project "Contributing to the effective management of the Amvrakikos Gulf National Park", Greece 2023.

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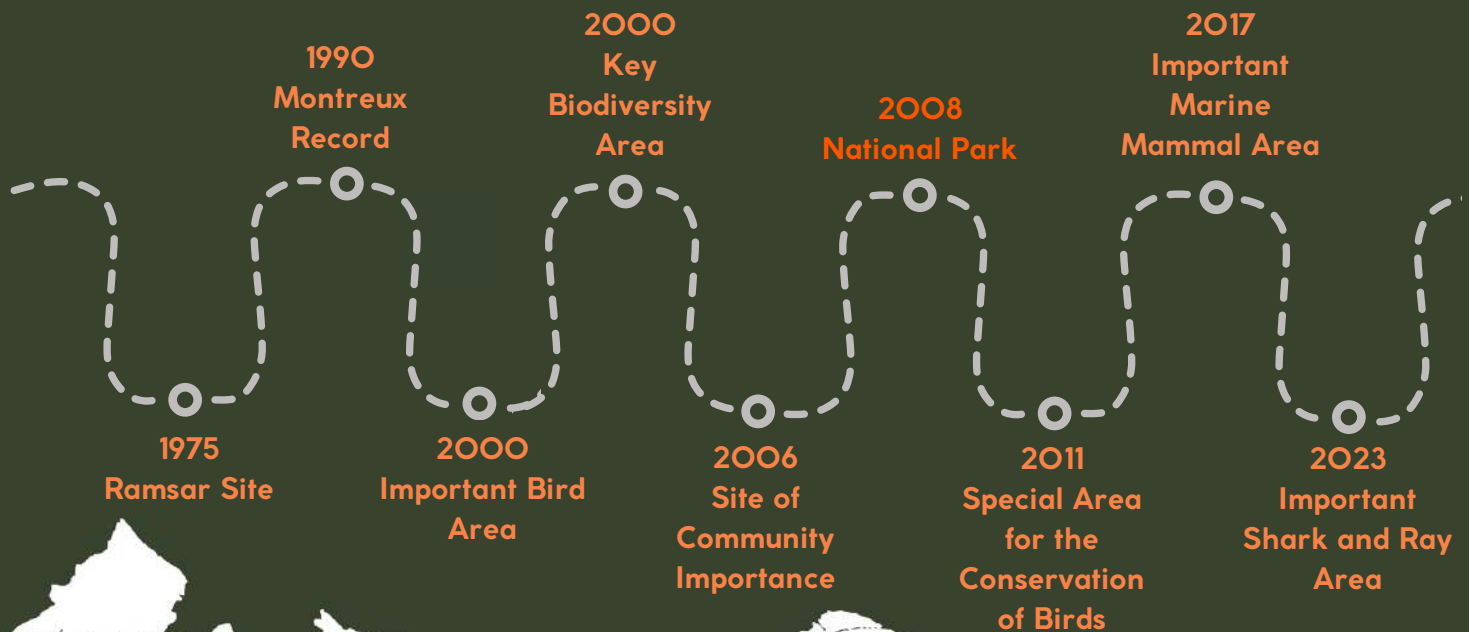
Acknowledgements



# The Importance of Amvrakikos Gulf

Amvrakikos Gulf is one of the most important ecosystems in Greece with a special ecological value both nationally and internationally. The north side is part of the Ramsar Network since 1975, while several development projects in the 1980s affected the ecological character of this wetland site and resulted in the inclusion of the site in the Montreux Record in 1990. It was only in 2008 that the Amvrakikos Wetlands National Park was founded (Government Gazette 123/D'/21-O3-2008).

In 2006 the Gulf and the wetlands were confirmed as a Site of Community Importance (SCI- GR 2110001) and in 2011 the lagoons of the north coast were designated as a Special Area for Conservation for Birds (SPA-GR2110004) under national Law (3937/31-3-11/OJ 60 A). In addition, Amvrakikos Gulf has been delineated as an Important Bird Area, an Important Marine Mammal Area and more recently as an Important Shark and Ray Area. Finally, the North part has been identified as a Key Biodiversity Area but an expansion is required at the borders of the National Park.



BOTTLENOSE

150

DOLPHINS

MAIN THREATS

POLLUTION

HABITAT DEGRADATION

COASTAL DEVELOPMENT

UN-REGULATED DOLPHIN-WATCHING



DOLPHINS

# Dolphins of Amvrakikos

## The Critically Endangered Bottlenose Dolphin Gulf of Amvrakikos Subpopulation

The semi-enclosed Amvrakikos Gulf, where the bottlenose dolphin (*Tursiops truncatus*) is the only cetacean species present, hosts one of the highest observed densities for this species in the Mediterranean Sea. Bottlenose dolphins in the Gulf show high levels of year-round site fidelity. Nevertheless, there is indication of some degree of emigration. Three dolphins photo-identified in the Gulf and regularly observed in the area between 2003 and 2008, were subsequently found outside the Gulf and as far south as the Gulf of Corinth. Moreover, longer-distance movements by another two individuals, encompassing roughly 1,000 km across the Ionian and Adriatic Seas, were recently reported. None of these “dolphin scouts” were ever observed again in the Amvrakikos Gulf.

Based on genetic analyses, the Amvrakikos Bottlenose Dolphins forms a distinct subpopulation isolated from neighbouring conspecifics, with low levels of genetic diversity. Dolphin population estimates in the Gulf, based on photo-identification effort collected between 2006-2022, manifested a slight declining trend and showed that only about 140 dolphins presently inhabit the Gulf.

Fishers working in the Gulf unanimously report predation and damage to their nets by dolphins; nevertheless, although occasional dolphin incidental captures (i.e., bycatch) happen, the occurrence of intentional killing of dolphins by fishermen as a form of retaliation was never reported in recent years. Human disturbance caused by the un-regulated development of dolphin-watching activities in the Gulf by operators consistently ignoring basic guidelines of respectful whale-watching operations (e.g., <sup>1</sup>ACCOBAMS, IWC) is also cause of concern.

Dolphins are exposed to high levels of pollution in Amvrakikos Gulf, mostly derived from local agriculture (i.e., pesticides), which poses a real toxicological problem for them. All the above-mentioned factors, together with the continued deterioration of the Gulf’s water quality and the observation of dolphins in poor health status, leads to the worrying inference that dolphin decline will continue in the foreseeable future. The bottlenose dolphin subpopulation of Amvrakikos Gulf, listed as Critically Endangered by the IUCN Red List, and the increasingly fragile ecosystem they live in, are in urgent need of effective management interventions to address the causes of such deterioration.



<sup>1</sup>Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area ACCOBAMS “Guidelines for Commercial Cetacean-Watching in the ACCOBAMS Area”. Find more here: [https://www.accobams.org/wp-content/uploads/2018/09/GL\\_commercial\\_cetacean-watching.pdf](https://www.accobams.org/wp-content/uploads/2018/09/GL_commercial_cetacean-watching.pdf)

International Whaling Commission IWC “General Principles for Whale Watching” <https://iwc.int/private/downloads/RQjCOUOPdaiCUdz3vUu99g/IWC68-General-Principles-for-WW.pdf>



BIRD  
>300  
SPECIES

## MAIN THREATS

HABITAT DEGRADATION  
DISTURBANCE  
ILLEGAL HUNTING ACTIVITIES



BIRD FAUNA

# Birds of Amvrakikos

---

The largest Greek wetland, hosting ca. 16% of the total wintering waterbirds of Greece and one of the oldest Dalmatian Pelican colonies.

The wetland complex of Amvrakikos gulf is one of the most important wetlands in southern Europe. It is a Ramsar wetland of international importance, which means that in Amvrakikos we find waterbirds in such high numbers that classify their populations important on an international level. Amvrakikos gulf is classified as a Special Protected Area (SPA), part of the Natura 2000 network, for thirty four birds species (we present some them below in **bold**).

In Amvrakikos we find the most extensive reedbeds and saltmarshes in Greece. The Rodia reedbed, located in the north-west part of Amvrakikos is the largest in the country (ca 30 sq. km) and hosts a breeding population of the Near Threatened **Ferruginous Duck** (*Aythya nyroca*), the Eurasian Bittern (*Botaurus stellaris*) as well as important heron colonies.

Amvrakikos contains the largest lagoon system in Greece. These lagoons are the breeding habitat of one the oldest colonies of **Dalmatian Pelican** (*Pelecanus crispus*), for which HOS implemented its first ever long-term monitoring and wardening programme in the area in 1984. Conflicts between the Dalmatian Pelicans and the local fishermen have decreased over the years due to the long term communication and dissemination efforts of NGOs as well as the local Management Authority. Overhead electricity transmission wires pose a threat for the species, and a number of fatalities are recorded each year due collision.

The area is one of the most important wetlands in Greece for breeding, migratory and wintering waterbirds, waders, raptors and passerines. Some species of global conservation concern, recorded in the area, are the Pygmy Cormorant, the White-tailed Sea-eagle, the

Eastern Imperial Eagle, the **Greater spotted Eagle**, the Lesser Kestrel and the Great Snipe. Significant nesting species include the **Little Egret**, the **Squacco Heron**, the **Black-crowned Night Heron**, the Purple Heron, the **Little Bittern**, the **Glossy Ibis**, the **Eurasian Spoonbill**, the **White Stork**, the **Black-winged Stilt**, the **Eurasian Stone-curlew**, the Collared Pratincole, the Common Tern, the **Little Tern**, the **Sandwich Tern** and the **Gull-billed Tern**.

Wintering species, recorded in large numbers in Amvrakikos, include the **Great Cormorant**, the **Great White Egret**, the Greater Flamingo, the **Eurasian Spoonbill**, the Shelduck, the **Eurasian Wigeon**, the Gadwall, the **Common Teal**, the **Northern Pintail**, the **Northern Shoveler**, the **Common Pochard**, the Red-breasted Merganser, the **Eurasian Coot**, the Great Crested Grebe, the **Black-necked Grebe**, the Dunlin, the **Common Redshank**, the Northern Lapwing, as well as Black and Red Kites.

Hunting and illegal hunting pose a great threat for the birds of Amvrakikos. Illegal hunting is widespread in the area and hunting is allowed within core areas of Amvrakikos despite the continuous efforts of HOS to stop it. The wetland is vast and effective patrolling is practically absent. As a result, illegal hunting activities are unfortunately a common sight that results in significant disturbance for the waterbirds.





SEA TURTLE

2

SPECIES

MAIN THREATS

INCIDENTAL CAPTURE IN FISHING GEAR



SEA TURTLES

# Sea turtles in Amvrakikos

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## An **important foraging area** for adult and juvenile loggerhead turtles

Sea turtles are marine reptiles that use diverse terrestrial and marine habitats, and undergo migrations spanning thousands of kilometers. Three species of turtle can be found in Greece: The leatherback (*Dermochelys coriacea*), a rare but frequent visitor from the Atlantic Ocean, the green (*Chelonia mydas*) and the loggerhead (*Caretta caretta*), which is the only species nesting in Greece.

Turtles are enigmatic species and there is not enough available information related to their lives at sea. Amvrakikos Gulf is one of the few marine sites in Greece that have been confirmed as important foraging areas for adult and juvenile loggerhead turtles. Thanks to ARCHELON's long-term monitoring project dating back to the early 2000's, where approximately 200 individuals are captured and tagged annually, we now know more about the turtles occupying the area. We have found that they show a preference for the nutrient-rich shallow waters adjacent to several lagoons bordering the Gulf, especially close to the mouths of the rivers Louros and Arachthos. Recent studies using satellite telemetry, genetics and the return of external flipper tags have shown that Amvrakikos Gulf is a site of regional importance for loggerhead turtles, since it is home to individuals from several nesting rookeries (Zakynthos, Kyparissia Bay, Rethymno, Kefalonia, Turkey, Libya). More recently, the regular presence of green turtles was also confirmed.

Incidental capture in fishing gear is one of the threats having the highest impact on sea turtles occupying Amvrakikos. The Gulf is intensely fished, mostly using set nets, bottom long lines and traps. Captures in fishing gear are incidental and are considered bycatch (i.e. the unintended capture of non-target species), however these have a negative impact. E.g., if bycaught turtles are unable to reach the surface to breathe, they may drown, reaching mortality rates as high as 80%. Further, ingestion of hooks and fishing lines can be lethal. Finally, a very small portion of fishers in the area have been reported to intentionally kill or injure bycaught sea turtles, mostly in retaliation for damages caused to their fishing gear. This is an understandable – even if highly unfair – reaction on the part of fishers, who already experience significant reductions in their catch because of overfishing resulting in loss of income to them and their families. Fishing however, is a traditional activity within the Gulf dating back to the 7th century BC, and fishers possess ecological knowledge of the uniqueness of Amvrakikos and have a deep connection with it. As a result, collaboration with local fishers is key to the long-term protection of sea turtles occupying Amvrakikos Gulf.





SHARK & RAY

10

SPECIES

## MAIN THREATS

INCIDENTAL CAPTURE IN FISHING GEAR

HABITAT DEGRADATION

POLLUTION

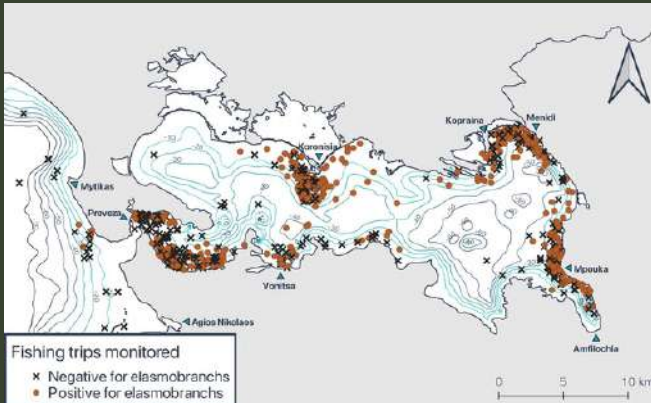


SHARKS & RAYS



# The importance of Amvrakikos Gulf for sharks and rays

An **important nursery area** for sharks and rays in the Mediterranean



Map of Amvrakikos Gulf with trips monitored within the By Elasmocatch Project, marked with orange and X symbols. Orange symbols represent fishing trips with elasmobranchs caught, while X symbols represent fishing trips with no elasmobranchs caught.

The Amvrakikos Gulf, a semi-enclosed gulf in the north-west Greece, communicating with the Ionian Sea through the Preveza Channel. The area has never been studied systematically in terms of elasmobranchs, but in the last 5 years records of endangered sharks and rays species were reported by citizen science.

Since February 2022, iSea focused its research on the gulf, through the By Elasmocatch Project. During almost 2 years of monitoring, it has been proven that the area supports a rich biodiversity of elasmobranch species, among these 8 species of rays and 2 of sharks. In particular the Critically Endangered Spiny Butterfly Ray (*Gymnura altavela*) and Duck Bill Eagle Ray (*Aetomylaeus bovinus*); the Endangered Sandbar Shark (*Carcharhinus plumbeus*); the Vulnerable Common Stingray (*Dasyatis pastinaca*), Eagle Ray (*Myliobatis aquila*) and Smooth-hound Shark (*Mustelus mustelus*);

the Least Concerned Ocellate Torpedo Ray (*Torpedo torpedo*) and Marbled Torpedo Ray (*Torpedo marmorata*) and the Data Deficient Brown Stingray (*Bathytoshia lata*) and Tortonese's Stingray (*Dasyatis tortonesei*).

The area has been confirmed as a nursery area for 3 species (*A. bovinus*, *G. altavela*, *M. mustelus*), but newborns and young of the year for all the species has been recorded during the By Elasmocatch project and Citizen Science. Further data need to be collected to understand the use of space and the connectivity with the Ionian Sea.

The different species are interacting with the fishing activities all year around, being both targeted and bycaught. During the research carried out within the By Elasmocatch Project, it has been proven that most individuals are caught when they are still immature, thus resulting in possible negative effects on the conservation of the populations of the different species in the future. It has been proven that the size of caught individuals depends on the type of gear used, in particular, trammel nets tend to catch smaller sizes with respect to gillnets and demersal longlines targeting large-size smooth-hound sharks. Moreover, Smoothhound-targeted fishery is generally carried out in periods that are of particular vulnerability for the species, for instance during their pregnancy.





DOMINANT

8

SPECIES

MAIN THREATS

ILLEGAL FISHING

HYPOXIA/ANOXIA

POLLUTION



MEGABENTHOS



# The megabenthic community of Amvrakikos

## A unique marine community in the Mediterranean



*P. lividus* urchins in a 20x20cm frame

Amvrakikos is a fjord-like mesotrophic coastal gulf with a highly productive brackish surface layer (0 – 20m) and a deeper hypoxic or even anoxic layer. The mega benthic community in Amvrakikos is characterized by the dominant presence of few species which form very dense aggregations, rarely seen in other coastal waters of the Mediterranean. These dominant species typically exhibit calcareous bodies and primarily function as filter-feeders, thereby reinforcing the connection between the pelagic and benthic realms.

Since 2017, the University of Patras' marine biology research team has devoted attention to this understudied yet unique macro-invertebrate community within the Amvrakikos gulf. More recently, they've expanded their focus through the 'K. Karatheodoris' scholarships for PhD students and the Operational Program for Fisheries and Maritime 2014 – 2020. Preliminary findings have revealed an overabundance of small-sized individuals of the edible purple sea urchin *Paracentrotus lividus*, reaching densities of up to 200 ind/m<sup>2</sup>.

Additionally, seasonal occurrences of mussel spat (*Mytilus* sp.) on the intertidal zone from April to August, dense populations of the murex gastropod *Hexaplex trunculus*, extensive populations of Noah's Ark bivalve *Arca noae* on hard substrates, and a significant presence of the endangered pillow coral *Cladocora caespitosa* in various sizes, have been observed. Certain areas of the gulf also harbor extremely dense populations of brittle stars and sea anemones while sea cucumber populations seem to shrink due to illegal fishing. Equally noteworthy is the existence of one of the last remaining populations of the endemic fan mussel *Pinna nobilis*, which appears to have survived the mass mortality events between 2016 and 2019 that nearly decimated populations across the entire Mediterranean.

Quantifying the population dynamics of this unique community is expected to elucidate its role in pelagic-benthic coupling and its capacity as a carbon sink, owing to the substantial absorption of CO<sub>2</sub> for shell construction. Furthermore, it aims to raise public awareness regarding the protection of the most sensitive and endangered species that possibly rely on the Amvrakikos Gulf as their last sanctuary, facing threats such as illegal fishing, pollution, and the expanding hypoxic layer.





SQ. KILOMETERS

>3.5

OF RHODOLITH BEDS

MAIN THREATS

FISH FARMS

HYPOXIA

RODOLITH BEDS

# Rhodolith Beds (Maërl)

## Essential and unique habitats

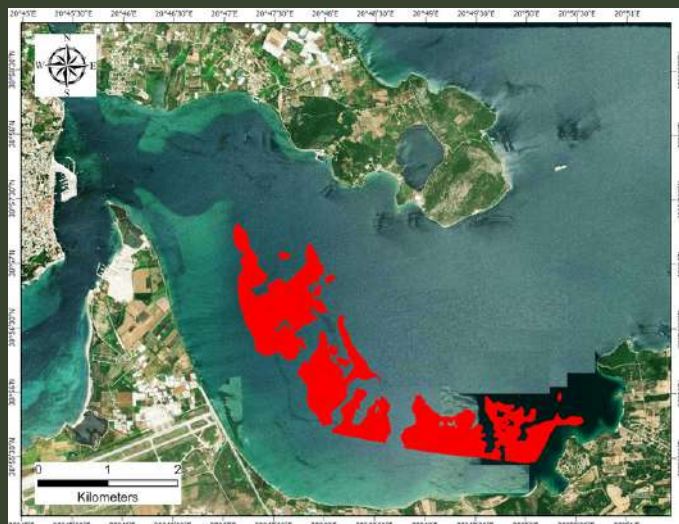
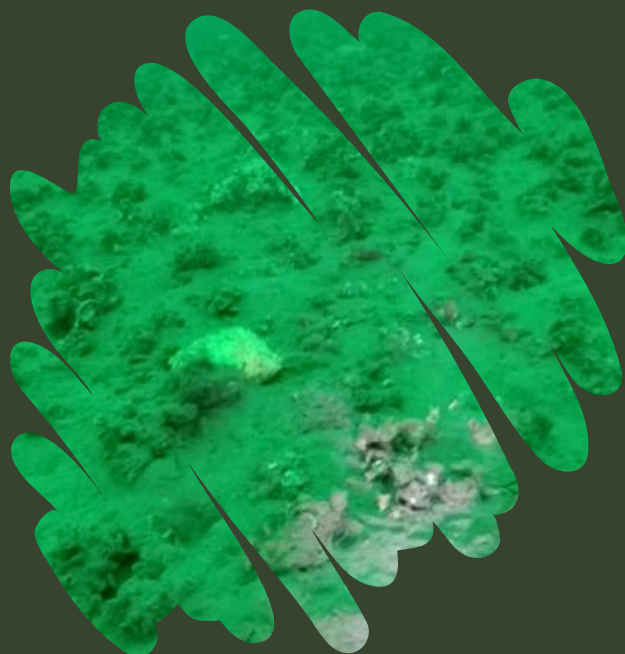


Fig. 1. Map showing the rhodoliths bed (red) at the Preveza Gulf.

Rhodolith is a specific morphotype of hard coralligenous formation that resembles small, branching nodules or pebbles of red, purple or pink colour. Rhodoliths are biogenic aggregations of photosynthetic algae species; such are *Lithothamnion corallioides* and *Phymatolithon calcareum*. They form and grow in a layered fashion, as they assimilate calcium carbonate from the surrounding water and develop in sizes ranging from a few millimeters to some centimeters. This is typically a slow process, and their growth rate is very low (0.4 to 1 mm/y). A seafloor that is characterized by high abundance of rhodoliths is referred to as a rhodolith bed. Rhodoliths are mostly found in muddy and sandy seafloors and have been recorded in shallow environments worldwide, like the Gulf of Mexico, Brazil, the Mediterranean Sea, the Great Barrier Reef, Malaysia and the Galapagos. While rhodolith beds are found in very shallow areas in tropical waters, in the Mediterranean Sea they form in the mesophotic zone (between 30-100 m depth) because of the elevated percentage of irradiance (photosynthetically available radiation, PAR) reaching the seafloor.

More specifically, in the Aegean Sea the existing information suggests that these ecosystems are mainly found in waters deeper than 40 m, in the Cyclades plateau. Rhodoliths and rhodolith beds offer important ecological services since serve as blue carbon by sequestering atmospheric CO<sub>2</sub> and storing it. They are also a vital part of the marine ecosystem as they act as breeding and feeding ground and provide shelter for a great number of marine species of fishes, invertebrates, crustaceans and mollusks. Rhodoliths and coralligenous formations have low resilience and, consequently, they are very susceptible to anthropogenic activities such as dredging/fishing, anchoring, environmental pollution and the indirect effects of invasive species. Moreover, the impacts of climate change, particularly those related to acidification, might substantially threaten the coralligenous formations.

A systematic marine remote sensing survey accompanied with ground truthing using side scan sonar, multibeam and R.O.V showed an extensive field of rhodoliths at the southwestern part of Preveza Gulf (fig 1). The rhodolith bed consists of big-sized (20-30cm) rhodoliths of high spatial density and has been developed in soft seabed consisting of sandy mud. The bed was found in depths between 10 and 25 m covering an area more than 3.5 km<sup>2</sup> (fig. 1). The knowledge of species compositions, dominant morphologies, proportion of living thalli and natural and anthropogenic pressures is essential for the protection and management of this very important ecosystem found in the entrance of a ecologically sensitive Gulf like that of Amvrakikos.

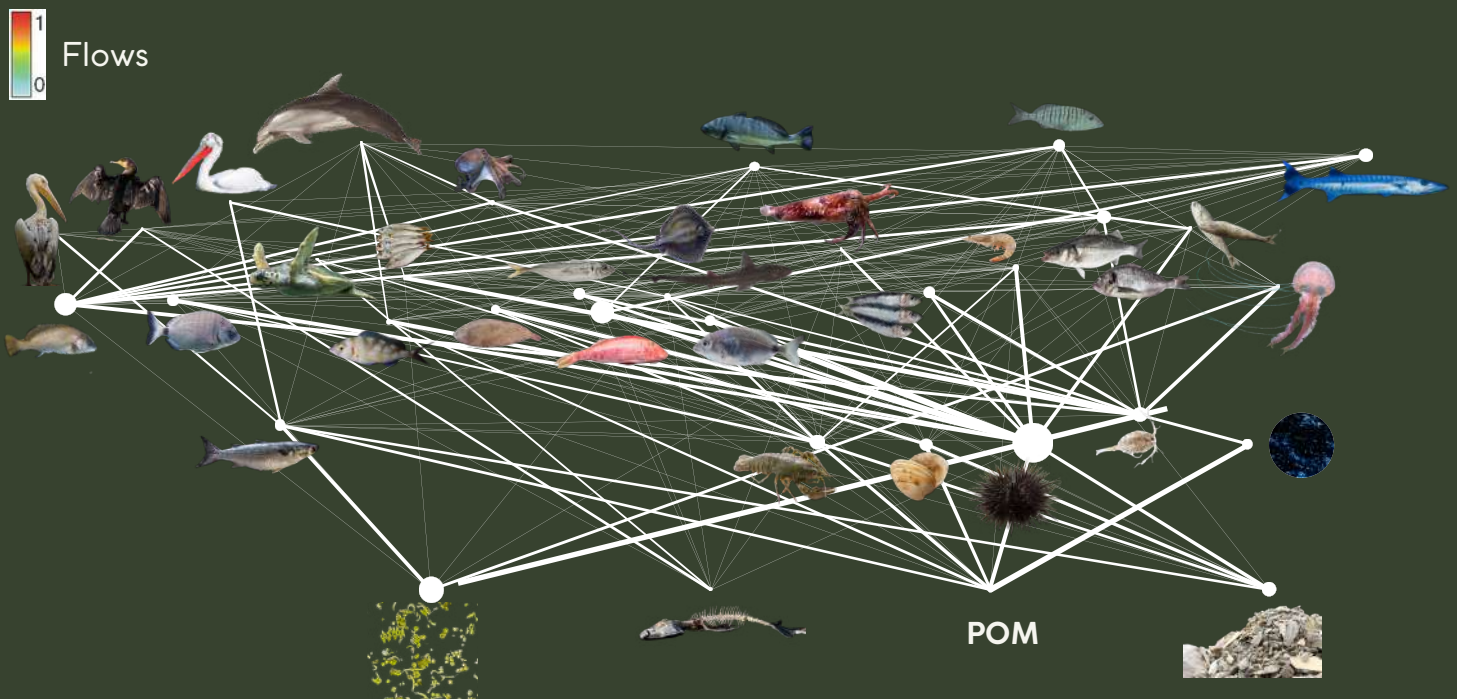




# The trophic web of the Gulf

An **eutrophic marine ecosystem** that requires attention

Amvrakikos Gulf represents an ideal “natural laboratory” for implementing an ecosystem modeling, due to its small size, its semi-enclosed morphology, its richness of charismatic megafauna, and its provision of several goods and services. In addition, such a model may be of relevance to other world ecosystems facing similar conditions and challenges. The overall aim of this modeling approach is to support the planning and implementation of the MSFD, which requires the assessment of all European marine ecosystems and associated pressures and the achievement of a “Good Environmental Status” (GENS) by 2030.



Presently, one food web model has been built for the whole Amvrakikos Gulf ecosystem representing the 1980–2013 period (Piroddi et al. 2016). The model was constructed to 1) investigate the dynamics (1980–2013) of marine resources considering the effect of changes in river runoff, development of fish farming, and dynamics of fisheries as the major anthropogenic drivers affecting the system; and 2) assess structural and functional changes of the Gulf using model-derived indicators (e.g. composite biomass and trophic-based indices and ecosystem-scale biodiversity). Results indicated that the strongest drivers in the Amvrakikos food web were changes in nutrients and organic matter mostly from the loads of two local rivers. Trends in ecological indicators highlighted a degradation of the demersal compartments of the food web and relative stability of the pelagic ones mainly due to high eutrophication levels. The well-known degradation of the Gulf of Amvrakikos, which has been particularly severe in the last 20 years, calls for action to preserve this increasingly endangered ecosystem. The current study serves as a tool for evaluating the health of the Amvrakikos ecosystem and for creating future management plans for the gulf.



SMALL SCALE

280

FISHING VESSELS

MAIN TARGET SPECIES



EUROPEAN PILCHARD



RED MULLET



CARAMOTE PRAWN



GREY MULLET



FISHERIES

# FISHERIES IN THE GULF

**An area of traditional high dependent fisheries through a multi-species low intense small-scale fishery.**

Commercial fisheries operating in the study area include only small-scale fisheries working mainly with set nets (i.e., trammel and gill nets). According to the Royal Fishing Law 23.3/8-4-53 trawling and purse-seining have been prohibited within the Gulf all year round since 1953.

Despite the traditional importance of fishery in Amvrakikos Gulf, limited information on the official historical fisheries data is available. This makes it almost impossible to thoroughly compare the current situation with the past. It is of particular importance the lack of data from the 80s to the present day when major changes occurred in the Amvrakikos ecosystem. The data available both from the statistical service and from the wholesale fish market of Preveza cover a much larger operational area than that of the gulf and they are not considered reliable in order to characterize fisheries production trends in Amvrakikos. Although some historical information from the Preveza fisheries office is accessible, it does not necessarily reflect the overall characteristics in the Amvrakikos Gulf.

During the 1980s there was a large increase in the number of both professional and recreational fishers operating in the gulf. Important fishing ports, both in terms of the number of fishing vessels and the number of professional small-scale fishers, are Preveza, Koronesia, Salahoura, Menidi, Amfilochia and the wider area of Vonitsa. Currently the active fishing fleet includes approximately 200 fishing vessels exclusively inside the Gulf and targeting mainly *Sardina pilchardus*, *Mullus barbatus*, *Penaeus kerathurus*, *Sepia officinalis*, *Mugilidae* and *Solea spp.*, whereas species such as *Merluccius merluccius*, *Diplodus annularis*, *Lithognathus mormyrus*, *Spicara maena* that exhibited a considerable contribution 30 age, they have significantly reduced at recent period (Koutsikopoulos et al., 2008, Piroddi et al., 2016).

Regarding the technical characteristics of the fishing fleet operating in the Amvrakikos Gulf, it is evident the low GT/Overall length ratio (0,20), which is at least 50% lower than the Greek mean value, demonstrating the unique characteristic of the area fleet, which is highly adapted to the specific characteristics of the gulf (fished in shallow waters, short distances, lagoons, enclosed gulf). The small-scale fleet is also characterized by low-cost fishing vessel, equipped only with sounder (80%), whereas only 10% have an instrument other than the sounder.

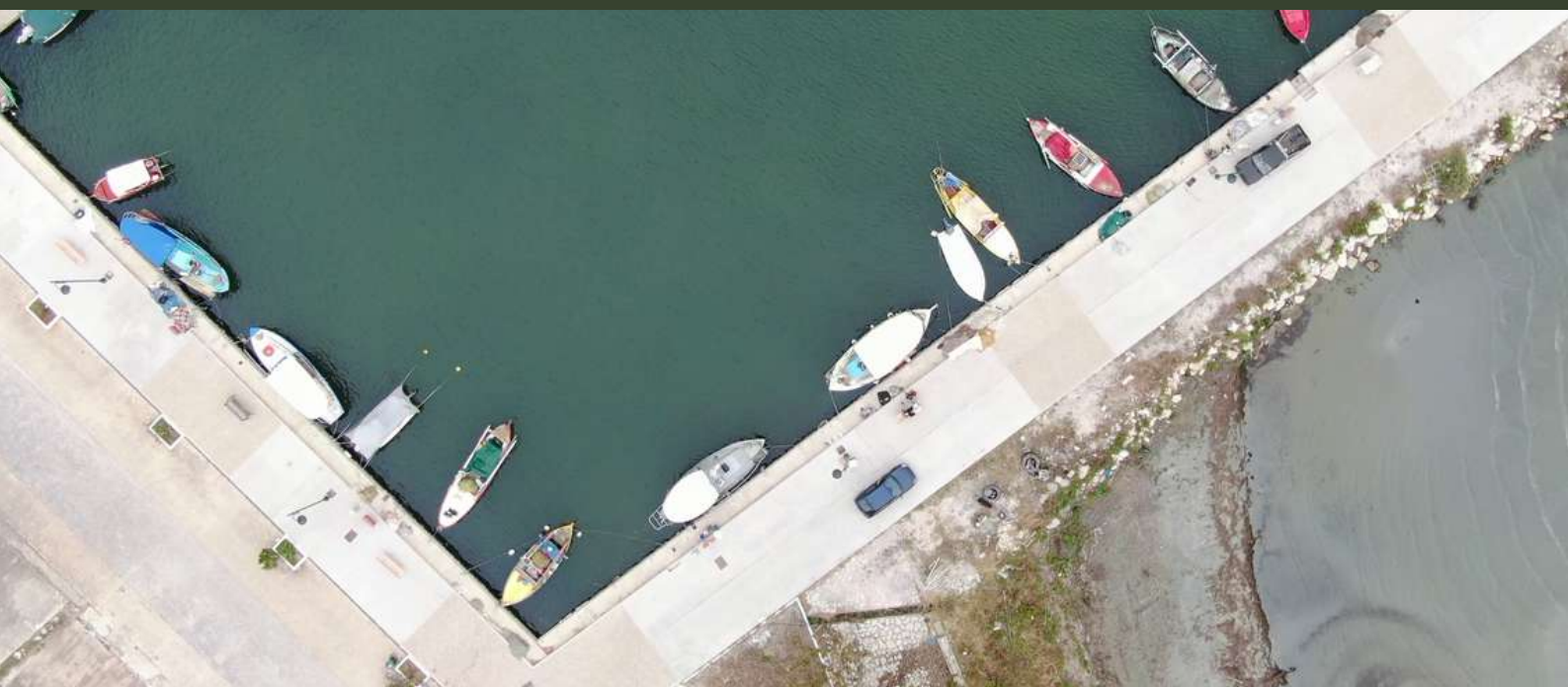
An enhancing to the above factor is that the fact that the mean age of the fishing vessels is rising, with the majority of the fleet (6–9 m) being older than 35 years, linked too with the age of the fishers. Trends of the fisheries landings inside the Gulf appeared to be rather stable throughout the recent period, at concerns for the species such as *Sardina pilchardus*, whereas *Mullus barbatus* depicted a negative trend, and while *Penaeus kerathurus* fluctuated across several years. Concerns about the possibility of the environmental degradation of the Gulf influenced the abundance trends of the above-mentioned fish species has been raised during the last 20 years by many studies (Koutsikopoulos et al., 2008, Piroddi et al., 2016).







# THREATS



# IN AMVRAKIKOS GULF





# THREATS

A fragile ecosystem, facing **multiple threats**.

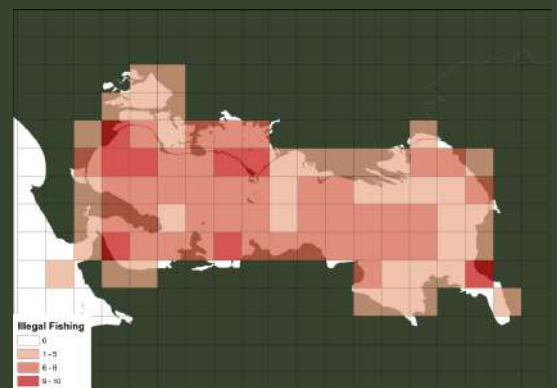
The semi-enclosed nature of the Amvrakikos Gulf results in water quality being strongly affected by the input of organic matter and pollutants, notably from the Louros and the Arachthos rivers, which transport runoff from agriculture, livestock and sewage discharges from coastal towns and villages, and intensive fish farming. Pollution, together with the limited physical connection of Amvrakikos with the Ionian Sea, have led to the degradation of the water quality and the development of hypoxic conditions in the Gulf. As a consequence, at least three massive farmed-fish mortality events have occurred in the eastern and western parts of the Gulf since 1992.

Despite being protected by national, European, and international legislation, the health of this increasingly fragile ecosystem and the rich biodiversity dependent on it, is cause of concern. Moreover, the local small-scale fishery, which comprise roughly 300 professional boats, suffer from on-going illegal practices by 'clandestine' bottom trawlers and by some amateur fishers, whose activity has an impact not only in the ecosystem but also in the local economy. The unregulated development of dolphin-watching activities in the Gulf in recent years, by operators not applying any guidelines of respectful whale-watching operations, are a source of disturbance to the critically endangered subpopulation of bottlenose dolphins of the Gulf of Amvrakikos.

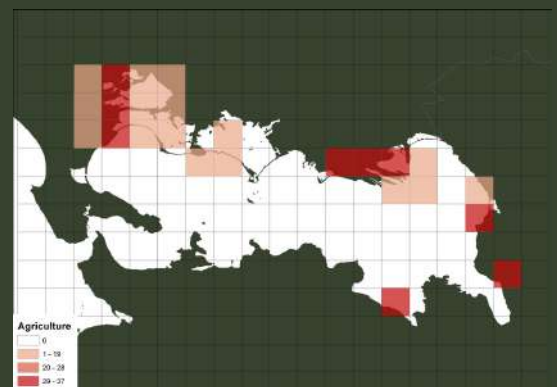
# 88

Questionnaires by  
local stakeholders

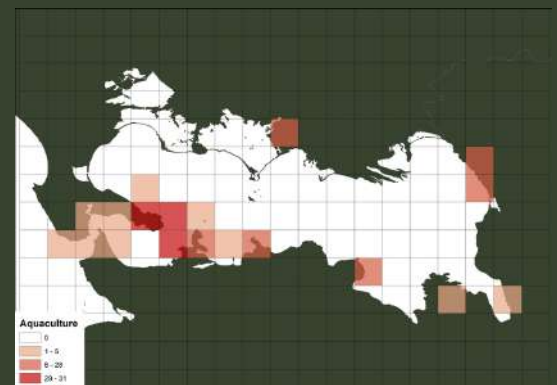
A. Illegal fishing



B. Agriculture



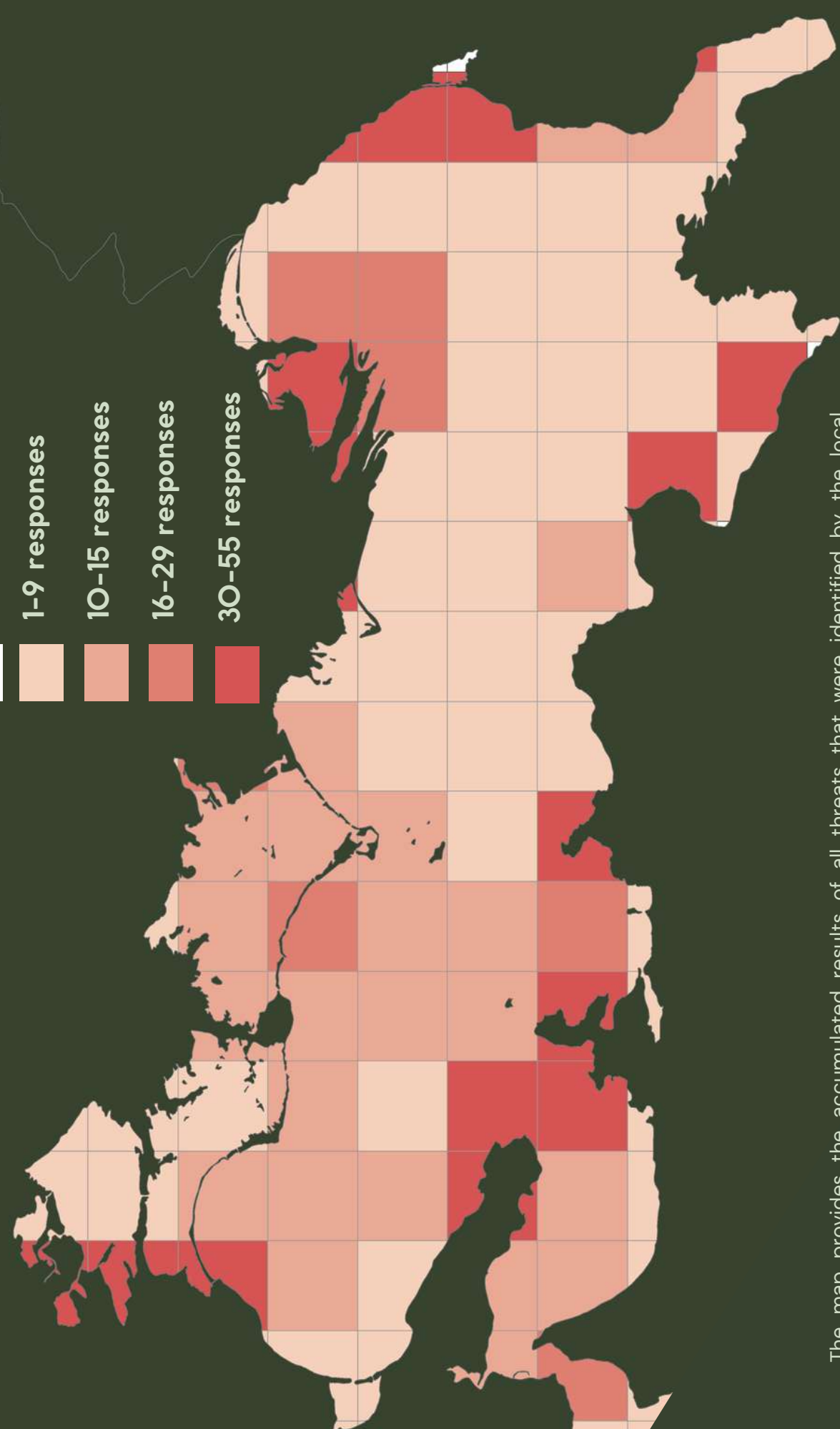
C. Aquaculture



In the context of the project "Contributing to the effective management of the Amvrakikos Gulf National Park" 88 questionnaires were collected from local stakeholders for understanding and recording the local ecological knowledge regarding the threats in the area and locate their spatial distribution. For this work, we provided maps and a list of 10 different threats to the respondents. They had to score its threats and provide the spatial distribution of the threats scored as the most significant for the area. The maps above provide the accumulated results of all responses for the 3 most significant threats as identified by the local community of Amvrakikos.

# THREATS

Accumulative pressures  
(Total number of  
questionnaires: 88)



The map provides the accumulated results of all threats that were identified by the local community of Amvrakikos.



# HYPOXIA/ ANOXIA

## Hypoxia in the **only Mediterranean** "fjord"

Amvrakikos Gulf is a semi-enclosed embayment of the Mediterranean Sea and belongs to the growing list of "dead zones" around the world. The Gulf is connected to the Ionian Sea by a narrow, shallow sill and is characterized by a fjord-like oceanographic regime. At the entrance of the Gulf over the sill, there is a brackish water outflow in the surface water and a saline water inflow close to the seafloor. In the gulf, the water column shows a well-stratified two-layer structure, made up of an oxygenated surface layer and a seasonal hypoxic/anoxic bottom layer that are separated by a strong pycnocline. The dysoxic/anoxic interface was found at water depth ranging from 25 to 35 m. Underneath the anoxic waters, a black silt layer and a white mat cover the seafloor (Fig. 2).



Fig. 2 ROV photos showing microbial shrinkage cracks in mats covering the seafloor at the deep (65m) eastern basin of Amvrakikos Gulf. Note isolated lenticular, curved, spindle-shaped, and triradiate shrinkage cracks.

These dysoxic/anoxic conditions appear to have been developed the last 20 to 30 years and are linked to the excessive use of fertilizers, intensive fish farming and domestic effluents. It is estimated that an area of 217.5 km<sup>2</sup> (50%) of the total 411.4km<sup>2</sup> of the seafloor of the Gulf is under hypoxia and 2.9 ×10<sup>9</sup>m<sup>3</sup> (28.5%) of the total 7.4×10<sup>9</sup> m<sup>3</sup> of the water mass are seasonal hypoxic (Fig. 3).

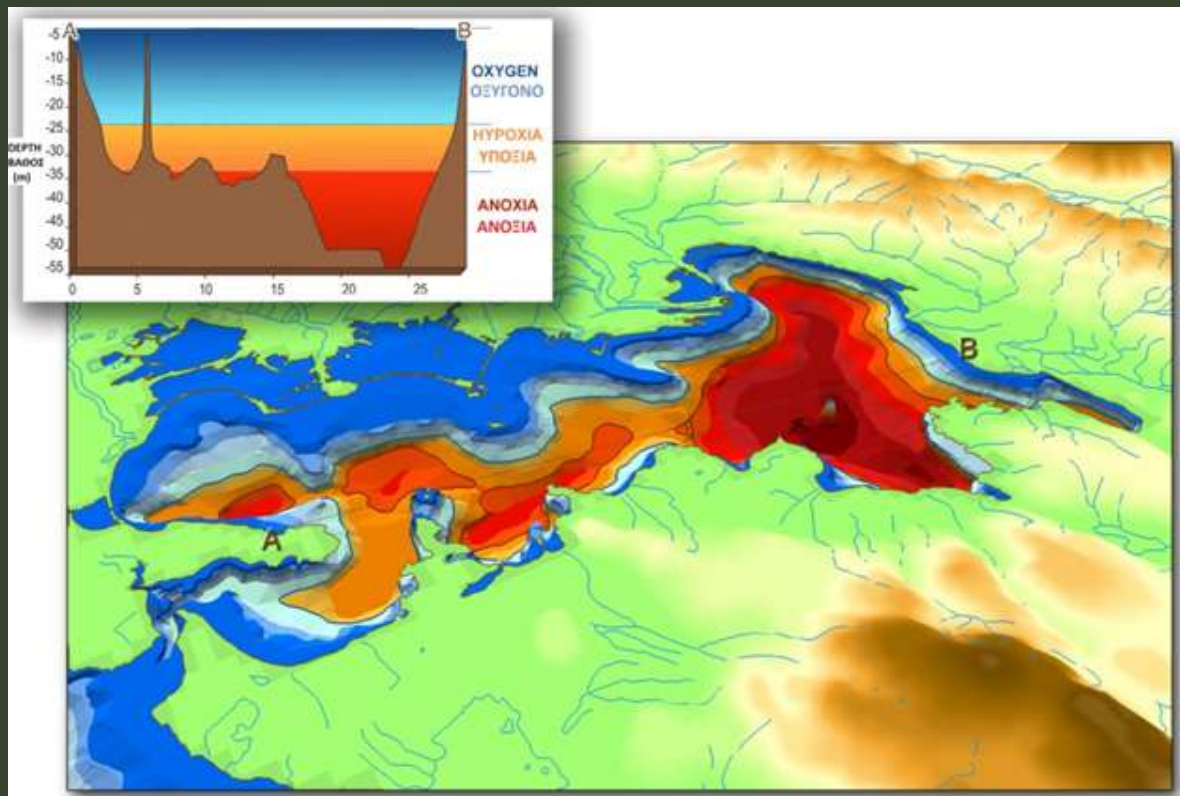


Fig. 3: 3D representation of Amvrakikos Gulf showing the extent of the hypoxic/anoxic regime in the seafloor and the water column.

# AMVRAKIKOS ALLIANCE



## Our vision

*“Our vision is to highlight the unique ecological value and the natural and cultural heritage of the Amvrakikos Gulf National Park, for effectively manage, restore, preserve and protect its unique ecosystems and biodiversity together with the local community”*

## Our common goals

- Have access to improved and updated scientific information with regard to the protected species and habitats
- Collaborate and promote the sustainable use of the natural resources of the area

**Amvrakikos Alliance will contribute to the effective management and protection of the Amvrakikos Gulf and its unique ecosystems and biodiversity through:**

1. Carrying out monitoring activities on species and human based activities in the area and informing all stakeholders about their findings as appropriate
2. Promoting the sustainable use of the area's natural resources
3. Strengthening the collaboration between the signatories for achieving the aforementioned goals
4. Encouraging and facilitating the collaboration among all stakeholders of the area

## Our aim

Our aim is to contribute to the effective management of the Amvrakikos Gulf National Park and assist the work of its responsible Management Agency by creating a long-term partnership among different stakeholders operating in the Amvrakikos Gulf, via a variety of actions that include research, outreach and more.

PARTNERS

7



# THE PARTNERS



## iSea

iSea is a Not for Profit Non-Governmental Organisation founded in March 2016, in Greece, aiming to preserve aquatic ecosystems. It consists of a group of young scientists with experience in conservation research and management. To achieve its goals, iSea utilizes different tools, such as scientific research, advocacy, environmental education and awareness of different stakeholder groups.



## Tethys

Since 1991, the Ionian Dolphin Project, run by Tethys Research Institute, and Italian NGO funded in 1986, aims to ensure the long-term viability of marine mammals living in coastal waters of the eastern Ionian Sea. In 2001 we started to study the bottlenose dolphins of the Gulf of Amvrakikos. Our research is documenting how the local dolphin community interacts with its environment and how human activities may influence its conservation status.



## HOS

The Hellenic Ornithological Society / BirdLife Greece aims to protect wild birds and their habitat in Greece. Since 1982, HOS has strived to ensure that humans and birds can share a common future. The work of HOS includes conservation and research actions, public awareness and education activities as well as direct action on urgent issues of environmental law breach. The HOS has been a partner of BirdLife International since 1994, thus contributing to the largest conservation network in the world.



## ARCHELON

ARCHELON, the Sea Turtle Protection Society of Greece aims to protect sea turtles and their habitats in Greece and to raise awareness about the threats and dangers for their survival. For 40+ years, ARCHELON runs conservation projects on the main loggerhead nesting sites in Greece. ARCHELON also operates a Sea Turtle Rescue Centre in Glyfada, Attica, rehabilitating injured and sick sea turtles. ARCHELON is active in Amvrakikos Gulf since 2002.

# THE PARTNERS



## Oceanus Lab

Oceanus-Lab was founded in 1990, in the Department of Geology of the University of Patras and has been established as the most complete center for research and education in the field of Marine Sciences, in Greece. Its objectives are the monitoring, mapping and preservation of the Greek and Mediterranean marine natural and cultural heritage, while it focuses on the training of young scientists and public awareness.



## Fisheries and Aquaculture Dept

The Department is part of the School of Agricultural Sciences of the University of Patras. The agricultural sciences are at the center of great challenges of the modern world linked to the urgent need for producing and exploiting more and better quality of food with a sustainable manner for the natural resources and the environment.



**BLUE MARINE  
FOUNDATION**



## BMF

UK based charity Blue Marine is dedicated to restoring the ocean to health by tackling overfishing, one of the world's biggest environmental problems. This dynamic charity is working all over the world to protect huge areas of ocean and restore marine biodiversity. In the coming decade Blue Marine aims to see at least 30 per cent of the ocean protected, and the other 70 per cent sustainably managed.



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# Acknowledgements

The authors would like to thank the local community in Amvrakikos Gulf that supported the project by participating in the events and replying to the questionnaire.

In addition, a special thank you to the Management Unit of Acheloos Valley and Amvrakikos Gulf Protected Areas that facilitated the work of the Alliance in the gulf.

We would finally like to thank the Municipality of Nikolaos Skoufa and the Management of the Kopraina Environmental Education Station, as well as the Coast Guard Stations of Preveza and Amphilochia for their support.

Special thanks are due to the volunteers and field leaders of all organisations who have been tirelessly working in Amvrakikos Gulf, collecting valuable data.





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