APRIL 2024

MARMARA SEA

A RESTORATION ROADMAP

Bluescapes Alliance

Dünya Mirası Adalar

ABOUT

This document presents an executive summary of the **"Marmara Sea: A Restoration Blueprint,"** a watershed-scale restoration plan to conserve at least 30% of the Marmara Sea watershed's ecosystems and natural areas by 2030. Developed through a sixteen-month process from fall 2022 to spring 2024, this blueprint was shaped by invaluable input from diverse stakeholders, including marine biologists, civil engineers, urban planners, legal experts, policymakers, students, and engaged community members.

This document lays out a holistic roadmap for revitalizing the Marmara Sea's marine environment, broader hydrological systems, safeguarding its rich biodiversity, and ensuring its long-term sustainability as a shared natural resource. This comprehensive initiative was made possible through generous funding from the **National Geographic Society**.

Through collaborative efforts, cartography and data visualization, field research, and a shared commitment to environmental stewardship, the "Marmara Sea: A Restoration Blueprint" represents a community-based approach towards reclaiming the health and resilience of this extraordinary body of water for generations to come. All photographs, unless otherwise credited, were taken by **Sera Tolgay** during the fieldwork. All maps and text were compiled by **Sera Tolgay.**

I would like to thank my NGS Program Officer Sven Andres and Claire McNulty Executive Director, Europe & Middle East (Western Asia) at NGS for their guidance and support throughout the project. I would also like to thank Bursa Su Kollektifi's Caner Gökbayrak, wildlife photographer and Karacabey Belediyesi municipal officer Alper Tüydeş, Volkan Narcı from Deniz Yaşamını Koruma Derneği, Serdar Güven from İznik Belgesel Sinemacılar Derneği, lawyer Tunç Lokum leading the Ergene Deep Discharge Lawsuit, Özgür Aksu with the Marmara Yaşasın, historian Hüseyin Irmak with Kağıthane Belediyesi, and Derya Tolgay from Dünya Mirası Adalar Ekoloji ve Kültür Derneği in the Princes Islands Archipelago for their invaluable insights and feedback in making this a collective vision for the future of the Marmara Sea.

With support from:

EXECUTIVE SUMMARY

MARMARA SEA

A BRIDGE BETWEEN CONTINENTS

The Sea of Marmara stands as a bridge between continents, offering a unique migration corridor and marine habitat that supports the movement of a range of species, in the water, on land, and in the air. This region is shaped by the complex interplay of tectonic forces within the Alpide belt that stretches from the Atlantic to the Himalayas. Anatolia continues to be shaped by the convergence of the African and Eurasian plates, with the Anatolian Plate moving westward, placing Marmara in one of the most seismically active areas globally, and shaping the region's diverse landscapes that owe their form to these tectonic activities.

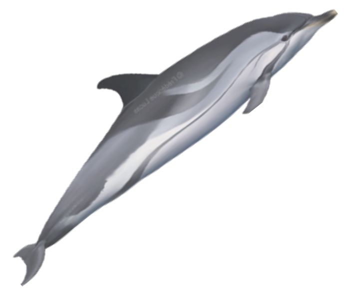
The Sea of Marmara provides a pivotal route for myriad migrating bird species traveling from Eastern Europe to Africa each year. It's here that approximately 400,000 storks, 200,000 raptors, and tens of thousands of passerines and waterfowl navigate through the skies in spring and fall, including notable species like the Greater Spotted Eagle (Aquila clanga), and the iconic White (Ciconia ciconia) and Black Storks (Ciconia nigra).

In addition to feathered travelers, the Sea of Marmara's waters play host to a diverse array of marine mammals, serving as a critical habitat for species such as the Short-beaked Common Dolphin (Delphinus delphis), the Harbour Porpoise (Phocoena phocoena), Common Bottlenose and the Striped Dolphin (Stenella coeruleoalba), underscoring the area's ecological significance connecting the Mediterranean with the Black Sea.

The Sea of Marmara's role as a bridge between continents goes beyond mere geography; it is a vital conduit for the annual ebb and flow of migratory species, linking habitats, and enabling the survival and diversity of species across borders. Its preservation is essential not only for the species it supports but also for maintaining the ecological balance and biodiversity of the wider region.

Short-beaked common dolphin
Delphinus delphis

White Stork
Ciconia ciconia



Striped dolphin
Stenella coeruleoalba

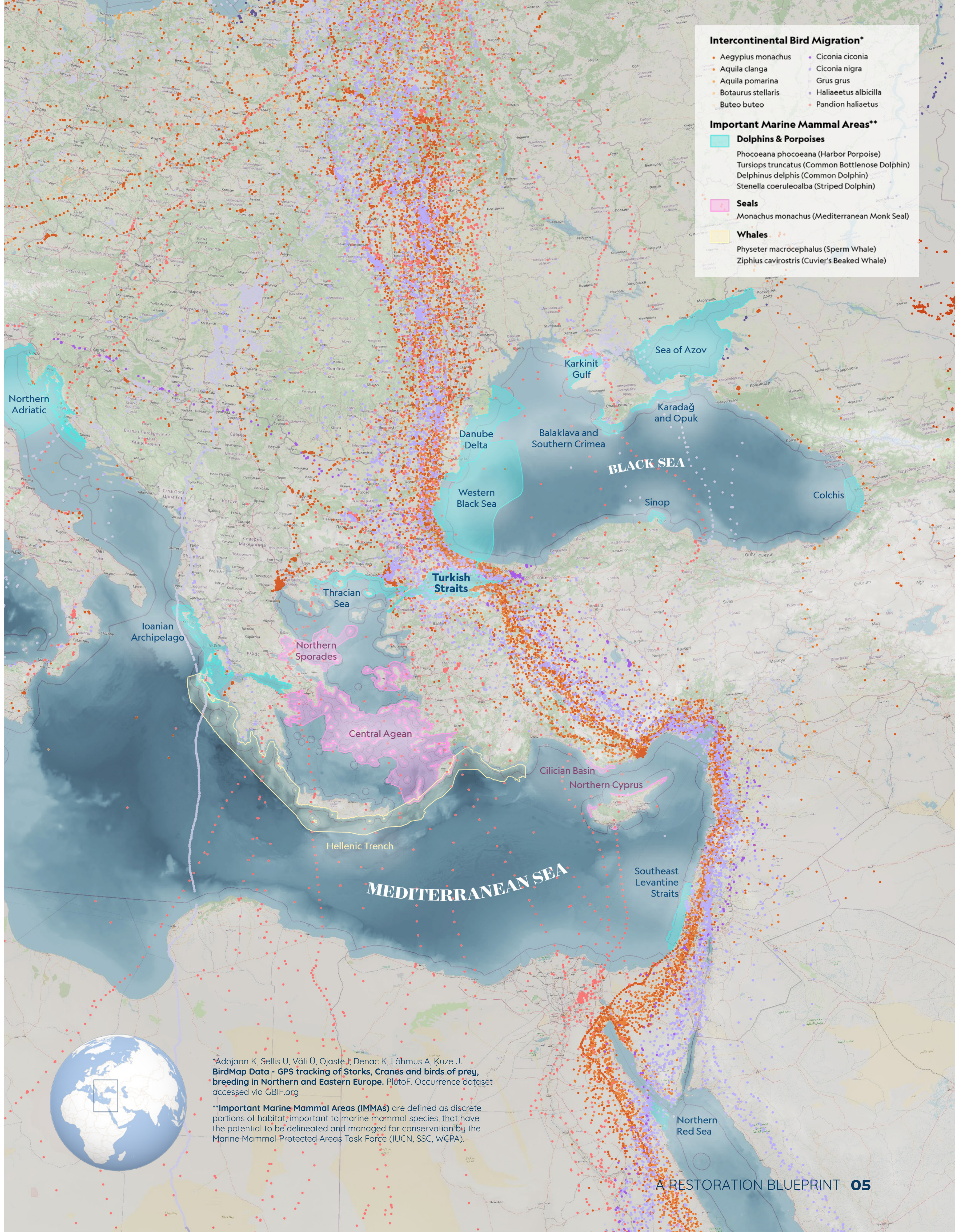
Eurasian bittern
Botaurus stellaris

Harbor Porpoise
Phocoena phocoena

Osprey
Pandion haliaetus

Common bottlenose dolphin
Tursiops truncatus

Greater Spotted Eagle
Aquila clanga



*Adojaan K, Sellis U, Väli Ü, Ojaste I, Denac K, Lõhmus A, Ķuze J. **BirdMap Data - GPS tracking of Storks, Cranes and birds of prey, breeding in Northern and Eastern Europe.** PlutoF. Occurrence dataset accessed via GBIF.org

****Important Marine Mammal Areas (IMMAs)** are defined as discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation by the Marine Mammal Protected Areas Task Force (IUCN, SSC, WCPA).

MARMARA SEA

SHAPED BY TECTONIC FORCES & WATER

The Sea of Marmara, nestled between the continents of Europe and Asia, is an inland sea shaped by both tectonic forces and hydrological processes over millions of years. Around 12 million years ago during the Miocene epoch, the collision and movement of the Eurasian and Anatolian plates led to the formation of the **North Anatolian Fault**, which created a pull-apart basin, resulting in the stretching and thinning of the Earth's crust. As the crust stretched apart, it created a depression with a maximum depth of 1.35 km that gradually filled with water from the Mediterranean Sea to the south and the Black Sea to the north, forming the Sea of Marmara as we know it today. This **inland sea**, characterized by its unique hydrological and geological features, serves as a vital link between the Black Sea and the Aegean Sea, supporting regional and inter-continental biodiversity with its network of alluvial floodplains, coastal wetlands and freshwater habitats.

The Marmara Sea was originally called *"Propontis"* by the Greeks, from "Pro" meaning before and "Pontus," the Black Sea. After the islands around the Propontis became a mining district for marble, the name gradually changed to **"Marmara"** from the word *"Marmaraon"* meaning marble in Greek. The island of Marmara, in the middle of the sea still contains extensive marble quarries mined to this day.

THE MUCILAGE CRISIS

In the summer of 2021, the Sea of Marmara faced an unprecedented environmental crisis as vast swathes of mucilage, or "sea snot," engulfed its waters. This mucilage, composed of organic matter, algae, and bacteria, spread rapidly across the sea's surface, forming thick blankets that choked its ecosystems. The crisis drew global attention to the deteriorating health of the Sea of Marmara and raised concerns about its long-term ecological viability.

The 2015 algae bloom event seen here captured by NASA's Landsat 8 sattelite, while noteworthy, was eclipsed by the severity of the outbreak in 2021, which was reported to have reached critical levels never before seen. In 2021, the "sea snot" covered vast areas of the Marmara Sea, extending to depths and impacting the seabed.

Several factors contributed to the emergence of the mucilage crisis. Chief among them were wastewater discharge, nutrient pollution, and high water temperatures. Wastewater discharge, agricultural runoff, and industrial pollution through decades of “deep discharge” into the Sea of Marmara, an inland sea, introduced excessive nutrients, such as nitrogen and phosphorus, into the sea, fueling the growth of algae and phytoplankton.

As these microscopic organisms proliferated, they formed dense blooms, depleting oxygen levels in the water and creating an environment conducive to the formation of mucilage. One of the most significant impacts was the depletion of dissolved oxygen levels in the Sea of Marmara. As the mucilage decomposed, it consumed oxygen, leading to hypoxic, or low-oxygen, conditions in the water. This reduction in oxygen levels threatened the survival of marine life, particularly fish and other oxygen-dependent organisms, and contributed to the formation of dead zones within the sea. It smothered marine habitats, such as seagrass beds and coral reefs, depriving organisms of essential resources and habitats. The accumulation of mucilage on the sea floor hindered nutrient cycling and disrupted the food chain, potentially leading to cascading effects throughout the marine ecosystem.

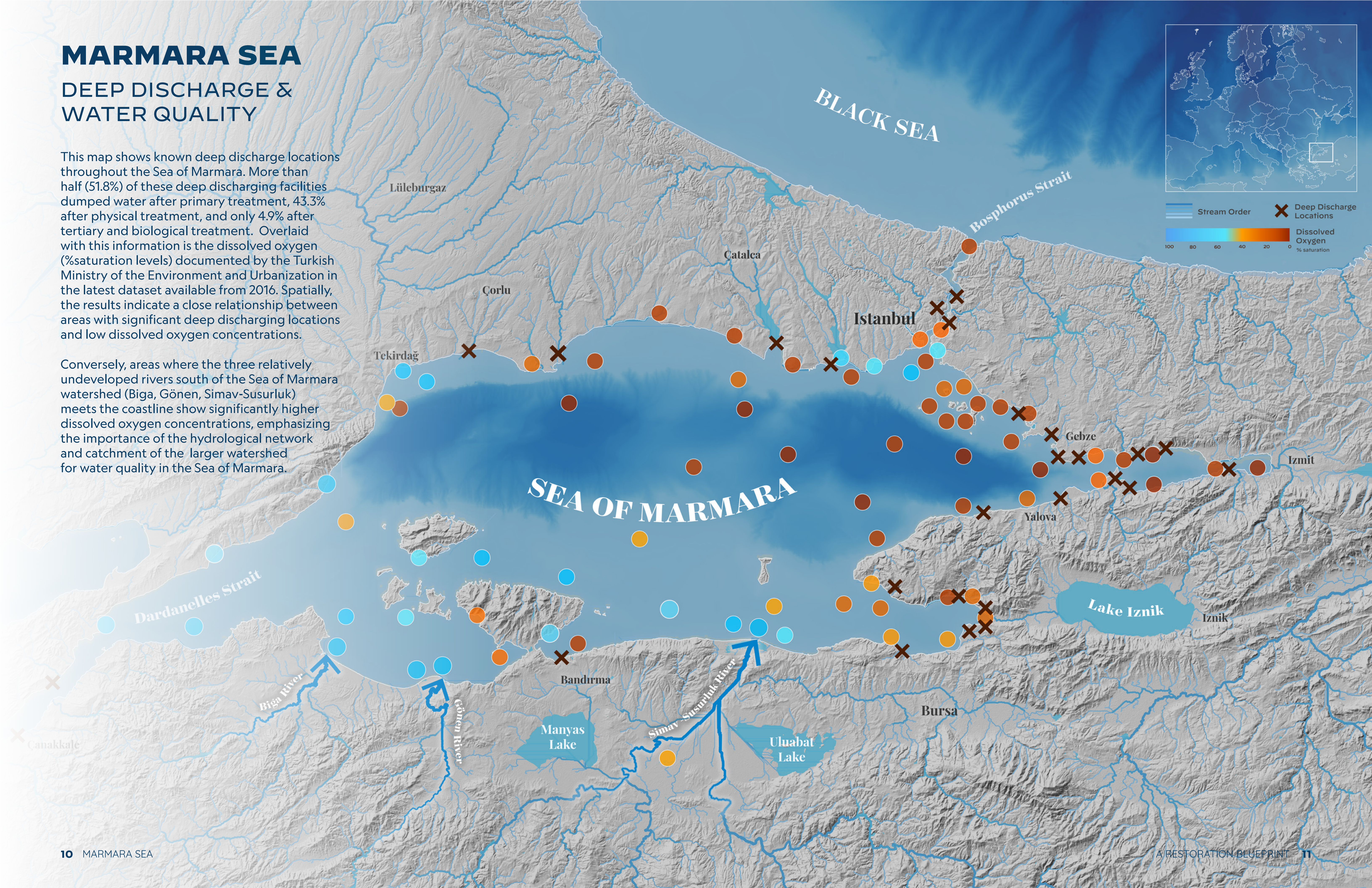
NASA Earth Observatory. (2015, August 14). Blooms in the Sea of Marmara. NASA Earth Observatory. https://earthobservatory.nasa.gov/images/85947/blooms-in-the-sea-of-marmara

MARMARA SEA

DEEP DISCHARGE & WATER QUALITY

This map shows known deep discharge locations throughout the Sea of Marmara. More than half (51.8%) of these deep discharging facilities dumped water after primary treatment, 43.3% after physical treatment, and only 4.9% after tertiary and biological treatment. Overlaid with this information is the dissolved oxygen (%saturation levels) documented by the Turkish Ministry of the Environment and Urbanization in the latest dataset available from 2016. Spatially, the results indicate a close relationship between areas with significant deep discharging locations and low dissolved oxygen concentrations.

Conversely, areas where the three relatively undeveloped rivers south of the Sea of Marmara watershed (Biga, Gönen, Simav-Susurluk) meets the coastline show significantly higher dissolved oxygen concentrations, emphasizing the importance of the hydrological network and catchment of the larger watershed for water quality in the Sea of Marmara.



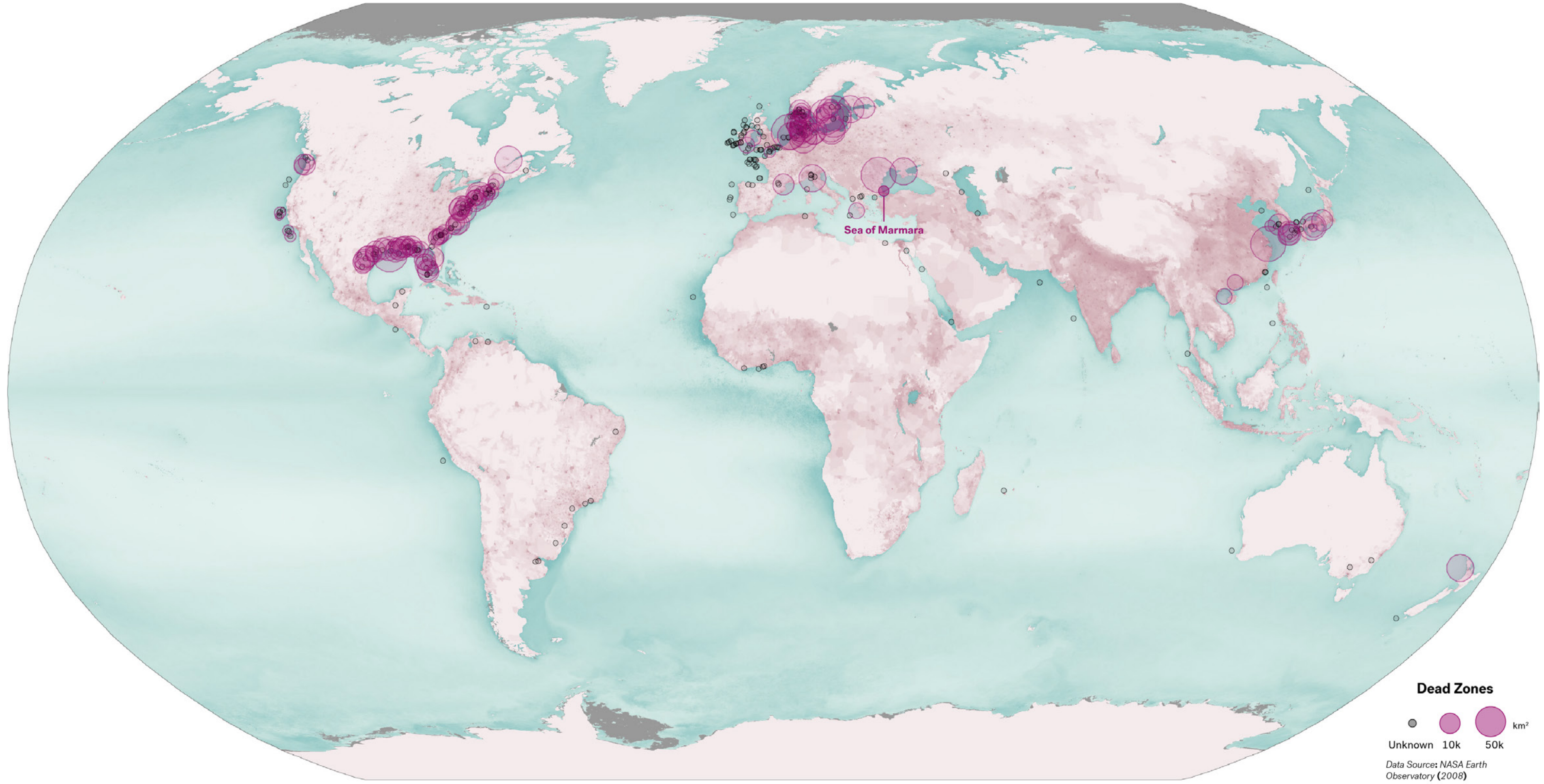
HOW DID WE GET HERE?

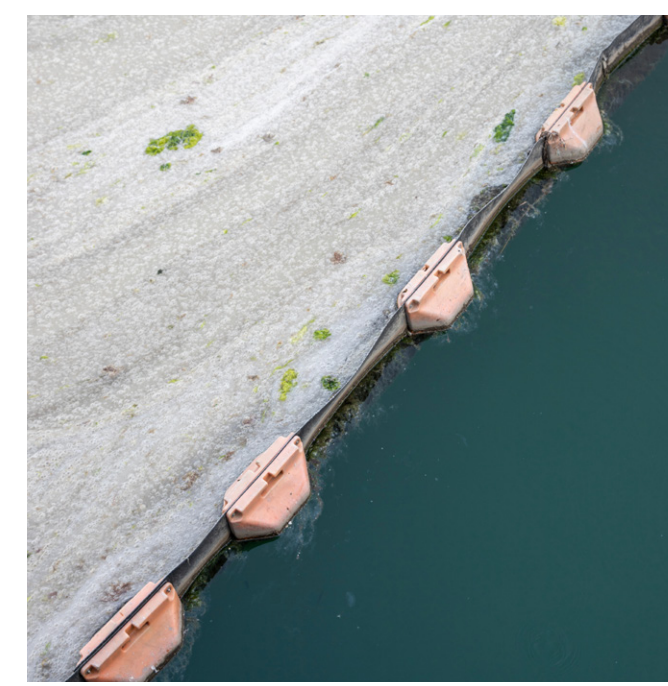
DEAD ZONES
A GLOBAL PROBLEM

The mucilage crisis in the Sea of Marmara bears striking similarities to other dead zones around the world, such as those found in the Gulf of Mexico and the Baltic Sea. In all cases, nutrient pollution, exacerbated by human activities, fuels the growth of algae and phytoplankton, leading to oxygen depletion and the formation of dead zones. These dead zones pose significant threats to marine biodiversity, fisheries, and coastal economies, highlighting the urgent need for concerted efforts to address the underlying causes of nutrient pollution and mitigate its impacts on marine ecosystems worldwide.

There are over 400 dead zones around the world, according to a 2008 study, with a significant increase from previous assessments.[1] "Dead zones" are deadly: Few or no organisms can survive in their oxygen-depleted, or hypoxic, waters. Often located in coastal areas near metropolitan areas (and even lakes and ponds), dead zones become oceanic deserts, devoid of aquatic biodiversity. Phytoplankton require sunlight to grow, so they float near the surface of the ocean, where they can soak up available sunlight. They also love nutrients, especially nitrogen and phosphorus. Luckily for phytoplankton in coastal areas, humans provide superfluous nitrogen and phosphorus. Phytoplankton use the nutrients to grow and reproduce—and scientists can see the huge blooms via satellite images.

When water approaches two parts per million or less of oxygen—considered low-oxygen conditions—anything mobile, like crabs, snails, and fish, will try to move away. However, marine organisms that are not able to move, particularly sea grass meadows and coral species endemic to the Sea of Marmara were severely impacted by the last algae bloom event in the summer of 2021.





1. Diaz, R.J., & Rosenberg, R. (2008). Spreading dead zones and consequences for marine ecosystems. Science, 321(5891), 926-929. doi:10.1126/science.1156401

MARMARA SEA

IN 2002 (LANDSAT 5)

MARMARA SEA
IN 2022 (LANDSAT 8)

Imagine you could see the "greenness" of plants from high above, as if you were a bird soaring over the landscape. Using NASA's Landsat sattelite imagery, that's what NDVI (Normalized Difference Vegetation Index) allows us to do. By measuring how plants reflect certain wavelengths of light differently than bare ground or water, NDVI gives us a glimpse into the health and density of vegetation. Lush, vibrant forests and crops appear vividly green. In this case the false color image also integrates other visible light bands (red and green) to show urban areas in purple and agricultural areas in different shades of pink. Comparisons over time suggest growing urbanization and reduction in protected green areas at an alarming rate.

LAND USE CHANGE OVER TIME

& WATERSHED HEALTH

There is a strong relationship between land use change and the health of watersheds. Land use change, such as urbanization, deforestation, agricultural expansion, and industrial development, can have significant impacts on the overall health and functioning of watersheds.

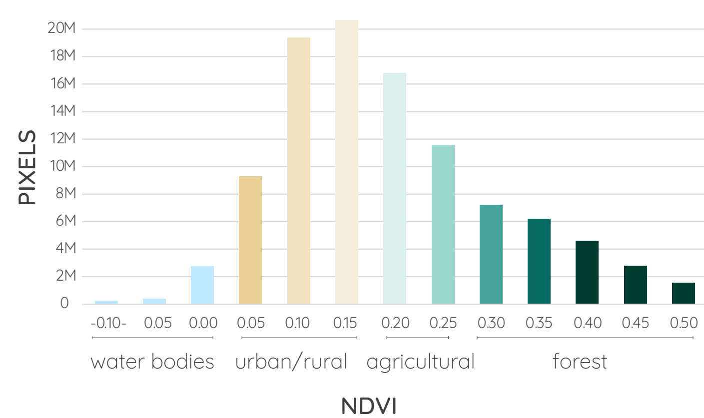
Water Quality: Land uses such as agriculture, construction, and urban development, can contribute to increased sediment loads, nutrient pollution, and the introduction of contaminants (pesticides, heavy metals, etc.) into water bodies within the watershed. This can degrade water quality and harm aquatic life. Over the last two decades, satellite images show that forest cover and protected areas were reduced from accounting for 15.75% (about 12,000 square kilometers) of the Marmara Sea watershed to 6.5% (4,950 square kilometers).

Hydrology and Water Quantity: Land use changes that involve the removal of vegetation or the creation of impervious surfaces (e.g., buildings, roads) can alter the natural water cycle within a watershed. This can lead to increased surface runoff, reduced groundwater recharge, and changes in the timing and magnitude of peak flows, potentially increasing the risk of flooding or water scarcity. In the last two decades, urban footprints in the Sea of Marmara has increased significantly, particularly in the cities of Istanbul, Bursa and Izmit. Region-wide, urban areas grew from 27.7% to 38.4% of the region.

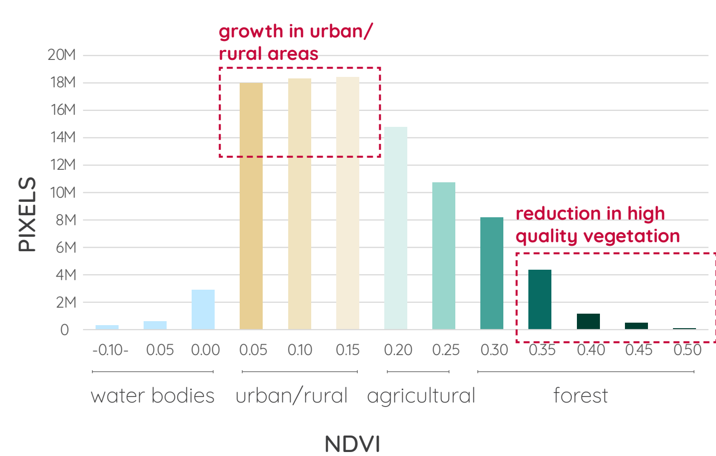
More importantly, alterations to land cover, such as deforestation, wetland drainage, or stream channelization, can result in the loss or fragmentation of important habitats for aquatic and terrestrial species within the watershed. This can negatively impact biodiversity and disrupt ecological processes, impacting watershed health and hydrological connectivity.

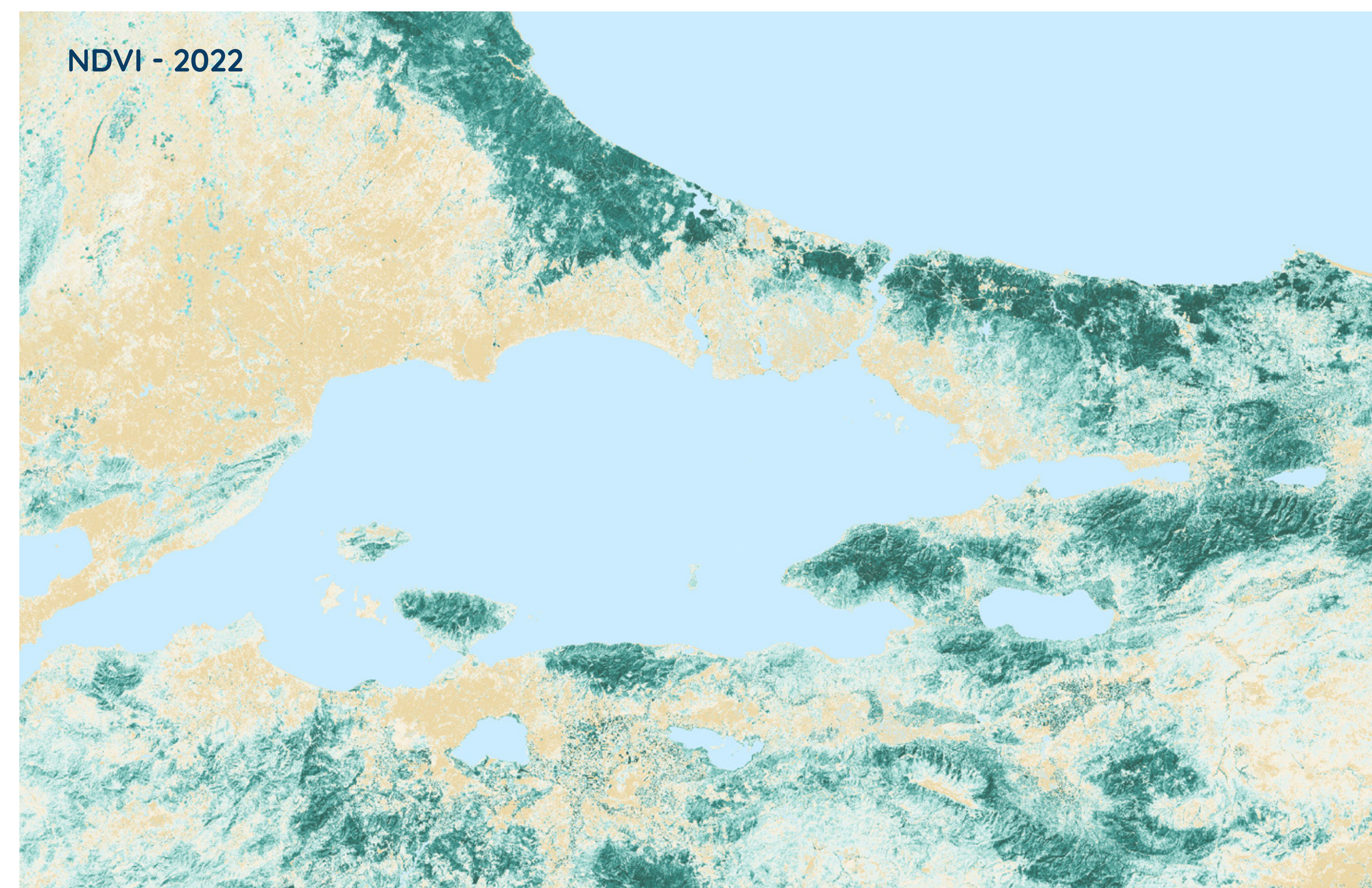
What is NDVI (Normalized Difference Vegetation Index) ?
Remote sensing allows us to understand the world beyond what our eyes can see. NDVI is a widely used remote sensing index that provides a measure of vegetation health. The NDVI is derived from the difference between the maximum absorption of radiation in the red band (caused by chlorophyll pigments) and the maximum reflectance in the near-infrared band (resulting from the internal leaf structure of healthy vegetation). Values close to 1 represent dense, healthy vegetation cover. Values around 0 represent bare soil or non-vegetated areas. Negative values can represent water bodies, clouds, or snow.

NDVI - 2002



NDVI - 2022





A WATERSHED APPROACH FOR RESTORATION

WHAT IS A WATERSHED?

A watershed is an area of land that channels rainfall and snowmelt from mountains and forests to creeks, streams, and rivers, and eventually to outflow points like reservoirs, bays, or the ocean. Every stream and river has an upstream watershed that feeds into it. Watersheds come in all shapes and sizes, from just a few acres draining into a stream to millions of acres channeling water into a major river system. The boundaries of a watershed are defined by the highest points of elevation, such as ridges or hills, which separate it from adjacent watersheds. The Sea of Marmara is made up of smaller watersheds like the Nilufer River and Karacabey estuary, which is separated from Lake Iznik's watershed.

Watershed-scale planning is crucial for conservation efforts aimed at improving water quality, which is influenced by activities and land uses throughout the entire watershed, not just in the immediate vicinity of a water body. Pollutants, sediments, and contaminants can enter waterways from various sources across the watershed, making a comprehensive, upstream-to-downstream approach necessary.

Effective water quality management requires considering the interconnections between terrestrial ecosystems, surface water, and groundwater within the watershed boundaries. Watershed-scale planning allows us to identify and prioritize critical areas for conservation, restoration, or management interventions that will have the greatest impact on overall water quality. It also facilitates collaboration and coordination among multiple stakeholders, agencies, and communities within the watershed, ensuring a consistent and integrated approach to water quality improvement efforts.

RESTORING 30% BY 2030

Preserving **30% of ecosystems and natural areas by 2030** can significantly contribute to restoring a watershed like the Sea of Marmara, which has been declared a dead zone due to severe pollution and environmental degradation. Designating all remaining forests and coastal habitats in the watershed as protected areas, such as national parks or marine reserves, can help the region reach 25%. This map shows **a list of critical habitat areas** that provide sanctuaries for threatened species, allowing them to recover and thrive. These areas need to be protected, restored and adaptively managed by 2030 to reach this 30% goal.

PRESERVING FLOODPLAIN FORESTS AND DUNES

Karacabey is one of three protected floodplain forests in the Sea of Marmara, currently at risk from increasingly polluted runoff and development pressures. Karacabey floodplain forest and Kocaçay Delta sustains various plant species, including ash and alder trees, loddon and water lilies, and flowering rush. Waterfowl, including flamingos, black storks and herons, can be sighted among the wetland's abundance of water, amid their annual migration through Türkiye.

The floodplains are fundamental parts of this estuarine ecosystem, buffered by a dune ecosystem from the Sea of Marmara with a distinct plant palette that supports a local population of herders and beekeepers who rely on lavender plants in the dunes as their source of honey.

KARACABEY FLOODPLAIN FOREST

40.390001 ° N, 28.461055 ° E

STRATEGY 1

PRESERVE & IMPROVE HYDROLOGICAL CONNECTIVITY OF COASTAL WETLANDS

Preserving floodplain forests and coastal wetlands plays a crucial role in enhancing water quality and facilitating ecological rehabilitation in a dead zone like the Sea of Marmara, where aquatic environments suffer from severe oxygen depletion due to excess nutrients. These ecosystems serve as natural filters, trapping pollutants and sediments before they reach open waters, in turn significantly reducing the influx of nutrients that contribute to dead zones. Furthermore, they provide critical habitats for a wide range of species, such as soaring birds like the white stork, who undertake their journey between March and May in spring, and from August to October in the fall. These coastal wetlands also act as nurseries for many marine organisms. Their preservation and restoration can help dead zones return to more balanced and vibrant aquatic ecosystems.

These four sub-strategies can be instrumental for preserving and improving the hydrological connectivity of coastal wetlands like the Karacabey Floodplain Forest:

1. RESTORE NATURAL WATER FLOWS

Restore natural water flow patterns to and from coastal wetlands by removing barriers (e.g., dams, levees, roads, culverts) that disrupt connectivity. This can help maintain the ecological balance, enhance sediment and nutrient capture, and support the life cycles of aquatic and semi-aquatic species.

2. ESTABLISH RIPARIAN BUFFER ZONES

Create and enforce riparian buffer zones along waterways leading to and from coastal wetlands. These buffers, consisting of native vegetation, can filter runoff, reducing sediment, nutrient, and pollutant loads into wetlands while also providing habitat connectivity.

3. REPLANT NATIVE TREE SPECIES

Implement a robust management plan to support native species and control invasive species that threaten the health and hydrological functionality of coastal wetlands. By prioritizing native vegetation and controlling invasive species, these areas can better perform their natural functions, including water filtration and providing habitat. A recent study compared how much organic carbon and nitrogen are stored in the soil in the native forests of the Karacabey floodplain with commercial plantations of poplar and stone pine trees. The study found that the native forests of alder, ash and oak trees store a significant more of these elements.

- Native trees (per acre): 237.6 Mg C for alder, 167.1 Mg C for ash, and 141.7 Mg C for oak
- Introduced Trees (per acre): 109 Mg C ha-1 for poplar and 68.1 Mg C ha-1 for stone pine

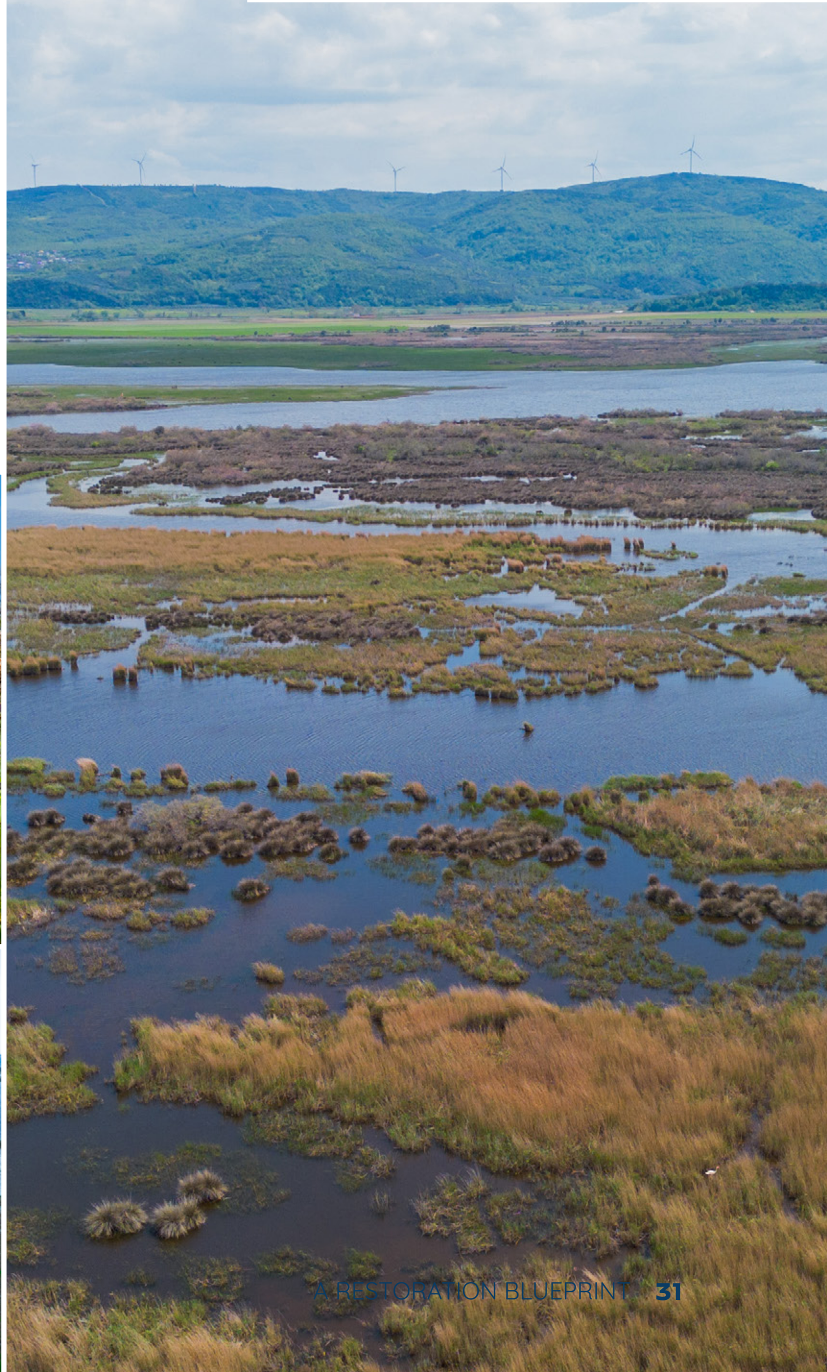
4. "RE-WET" FORMER WETLANDS FROM AGRICULTURAL LANDS

Restoring agricultural lands that were formerly wetlands and are now experiencing issues with high water levels and salinity back to their natural wetland state is an essential component of enhancing ecological resilience and hydrological connectivity. Portions of the Karacabey were converted to agricultural areas, which are are now faced with the dual challenges of unproductive farming due to waterlogging and salinity, and the loss of valuable wetland ecosystems. By restoring these lands to their natural state, we can reestablish their ecological functions, such as biodiversity support, water purification, flood mitigation, and carbon sequestration, contributing significantly to the resilience and health of coastal and riparian landscapes.





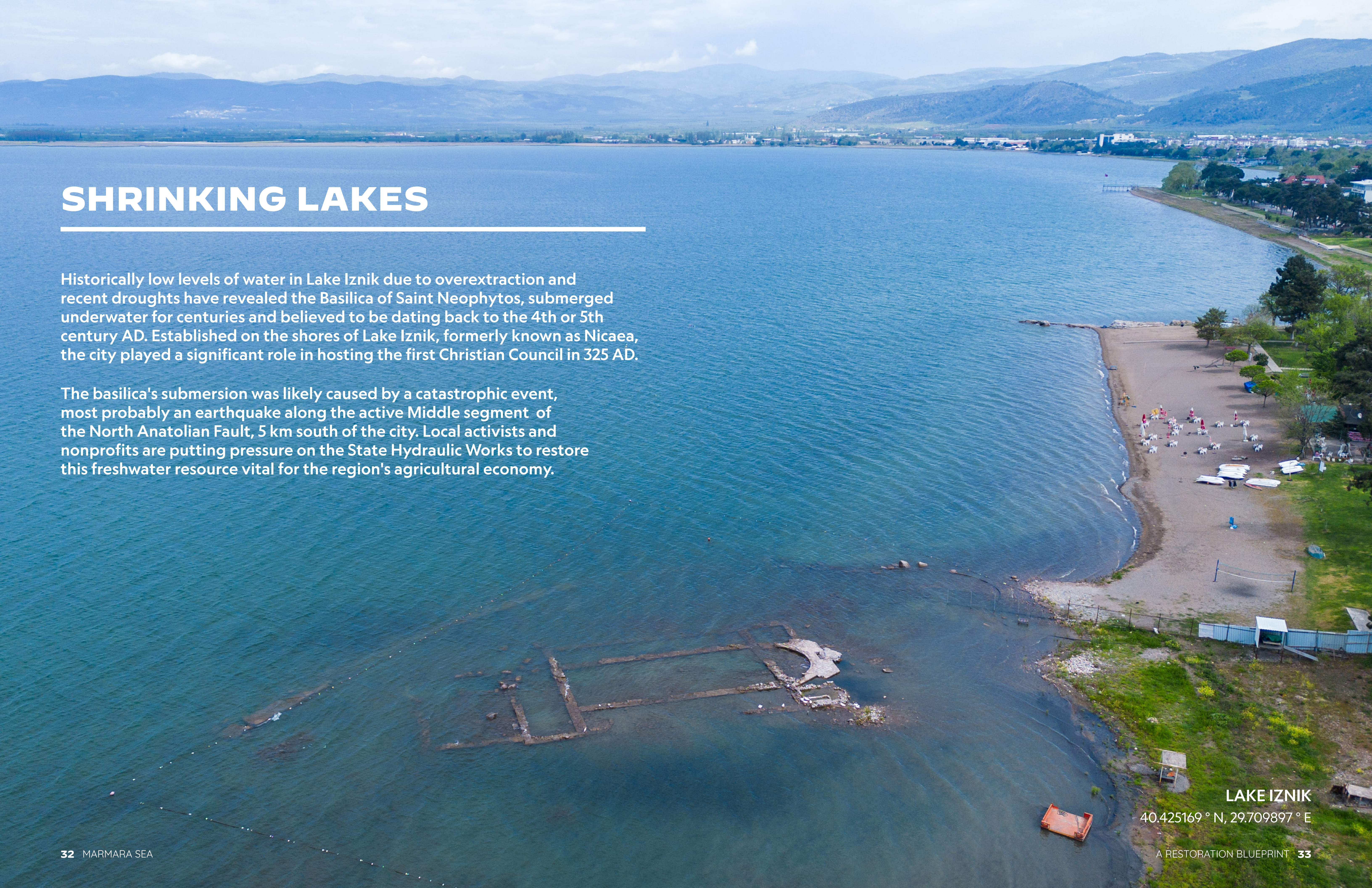




SHRINKING LAKES

Historically low levels of water in Lake Iznik due to overextraction and recent droughts have revealed the Basilica of Saint Neophytos, submerged underwater for centuries and believed to be dating back to the 4th or 5th century AD. Established on the shores of Lake Iznik, formerly known as Nicaea, the city played a significant role in hosting the first Christian Council in 325 AD.

The basilica's submersion was likely caused by a catastrophic event, most probably an earthquake along the active Middle segment of the North Anatolian Fault, 5 km south of the city. Local activists and nonprofits are putting pressure on the State Hydraulic Works to restore this freshwater resource vital for the region's agricultural economy.



LAKE IZNIK
40.425169 ° N, 29.709897 ° E

STRATEGY 2

CONSERVE WATER & REDUCE OVEREXTRACTION TO REDUCE DROUGHT RISK

Water conservation is critical in regions like the Sea of Marmara, characterized by erratic rainfall patterns, including periods of drought. Such variability in precipitation, coupled with extensive reliance on singular freshwater sources like Lake Iznik—which is experiencing shrinkage—exacerbates the vulnerability of local communities, agriculture, and ecosystems to water scarcity. In fact, the drop in water levels by about 5 meters led to the discovery of an **ancient basilica** submerged in Lake Iznik, which sheds light on the city's rich history and the influence of tectonic forces on its development.

Established on the shores of Lake Iznik, formerly known as Nicaea, the city played a significant role in hosting the first Christian Council in 325 AD. According to researchers and archeologists, the basilica's submersion was likely caused by an earthquake, evidenced by the damage observed on the city's archaeological remains. The region surrounding Lake Iznik is situated only 5 kilometers north of the active Middle segment of the North Anatolian Fault, which has been responsible for significant tectonic activity, including six large earthquakes (Mw>7) in the past 2500 years, as documented by historical texts and archaeological studies. Researchers are in the process of uncovering the timing of the basilica's demise, potentially linked to liquefaction and ground destabilization during seismic events.

This complex interplay between tectonic forces, climate change, and human activity in Lake Iznik complicates the fate of communities in the region that rely on the lake as a source of water for local agriculture. The main culprits are large fertilizer industries downstream in the Bay of Gemlik that are using this water source for free. Conserving water and reducing over-extraction are critical strategies to mitigate drought risk, ensuring a sustainable water supply for both current and future generations, and maintaining the ecological balance of local environments.

1. IMPLEMENT WATER-SAVING TECHNOLOGIES IN AGRICULTURE

Agriculture is often the largest consumer of water in drought-prone areas. Adopting water-efficient irrigation technologies such as drip or sprinkler systems can significantly reduce water use. Additionally, practices like mulching and selecting drought-resistant crop varieties can improve soil moisture retention, decreasing the need for irrigation.

2. PROMOTE URBAN WATER CONSERVATION MEASURES

In urban areas, water conservation can be encouraged through the use of low-flow fixtures in homes and businesses, rainwater harvesting systems, and recycling wastewater. Public awareness campaigns can educate residents about the importance of reducing water consumption and provide tips for doing so in daily life.

3. ENHANCE NATURAL WATER RETENTION IN THE LANDSCAPE

Restoring and protecting natural landscapes such as forests, wetlands, and grasslands can enhance groundwater recharge and reduce runoff. This includes reforestation efforts, wetland restoration, and the implementation of green infrastructure in urban settings, such as green roofs and permeable pavements, which help absorb rainwater.

4. REGULATE AND MONITOR WATER EXTRACTION FROM FERTILIZER INDUSTRY

Developing strict regulations on water extraction, especially for industrial use downstream by large fertilizer factories is crucial to prevent overuse and depletion of water resources. Implementing a permit system for water extraction and encouraging the use of metering can help manage and monitor water use more effectively. Additionally, setting extraction limits based on the sustainable yield of water sources can ensure that water use does not exceed the replenishment rate of these sources.






RESERVOIRS AND THE URBAN PERIPHERY

As the metropolitan area of Istanbul grows, many reservoirs and river corridors areas are at risk and in close proximity to quarries, mining, industry and construction, particularly with proposed development projects along the Canal Istanbul project. As reservoirs level drop, recently below 10% capacity in Alibey Reservoir in the summer of 2023, there is growing concern about sustaining the city's growing need for freshwater.

ALIBEY RESERVOIR
41.121374 ° N, 28.900139 ° E

STRATEGY 3

IMPLEMENT WATER-SENSITIVE LAND USE PLANNING AROUND RESERVOIRS AND RIVERS

This Preserving the areas surrounding key reservoirs and creating buffers and reforesting river corridors are critical actions for maintaining water quality, ensuring the availability of freshwater resources, and enhancing ecological resilience. These practices help in minimizing pollution runoff into water bodies, controlling erosion, promoting groundwater recharge, and providing habitat for a wide range of species. Moreover, they act as natural filtration systems, improving the quality of water that enters our reservoirs and, by extension, the water available for human consumption, agriculture, and industry.

1. ESTABLISH PROTECTIVE BUFFER ZONES

Create buffer zones around reservoirs and along river corridors, where specific land use practices are regulated or restricted. These buffers, composed of native vegetation, act as barriers that filter pollutants, sediments, and nutrients before they reach water bodies. They also provide critical wildlife habitat and migration corridors, enhancing biodiversity. Similarly, encourage and support the adoption of sustainable agriculture practices within watersheds that feed into reservoirs. This can include the use of cover crops, reduced tillage, and integrated pest management to minimize runoff of pesticides and fertilizers. Providing incentives such as subsidies, technical assistance, or access to sustainable farming certifications can motivate farmers to adopt these practices.

2. PROHIBIT MINING AND QUARRIES NEAR RESERVOIRS

Develop and implement land use plans that prioritize water sensitivity around reservoirs. This may involve zoning regulations that restrict or prohibit certain land uses in sensitive areas, such as mining and quarrying, while promoting activities that support water quality and conservation, such as agriculture, forestry, and recreation.

3. IMPLEMENT RIPARIAN AND WATERSHED REFORESTATION PROJECTS

Initiate and support reforestation and afforestation projects within the watersheds of key reservoirs and along river corridors. Planting native trees and vegetation helps stabilize soil, reduce erosion, and increase rainwater infiltration, which replenishes groundwater supplies. Forested watersheds also serve as carbon sinks, contributing to climate change mitigation efforts.

4. CREATE LARGE PUBLIC PARKS ALONG MAJOR RIVER CORRIDORS

Create and manage riparian corridors as urban parks by identifying suitable sites, particularly along alluvial floodplains throughout Istanbul in the seismically active region. To the extent possible, encourage homeowners to relocate from these areas of high damage risk by engaging stakeholders, assessing environmental conditions, designing and planning, educating and engaging the public. Educate the public about the ecological importance of riparian corridors and the benefits of urban parks through interpretive signage, guided tours, educational programs, and community events. Encourage community involvement in stewardship activities and volunteer opportunities.

OLD GROWTH FORESTS & HISTORIC WATERWORKS

The Belgrade Forest is one of the last protected old growth forests and parks open to the public in Istanbul, home to more than a dozen historic dam structures built in the Byzantine era, and expanded by Ottoman Sultans, that still provide freshwater to the city to this day.

BELGRADE FOREST
41.191307 ° N, 28.987705 ° E

STRATEGY 4

PRESERVE ALL EXISTING OLD GROWTH FORESTS IN THE MARMARA REGION

Trees, Macropores & Healthy Watersheds

Re-establishing old growth forests like the Belgrade Forest is an exceptionally challenging endeavor due to the unique and complex ecological characteristics that develop over centuries. Old growth forests are distinguished by their ancient trees, varied tree sizes and species, dead wood in various stages of decay, and the unique microhabitats they provide. These forests play a critical role in maintaining ecological balance, supporting biodiversity, sequestering carbon, and regulating hydrological cycles. Once disturbed or destroyed, the intricate ecosystem of an old growth forest cannot be quickly or easily restored, as the ecological processes and diversity take hundreds of years to develop naturally. They also play a significant role in climate regulation by storing vast amounts of carbon, both in the living biomass and within the soil.

Having soils with more macropores, thanks to trees, earthworms, and other factors, can help water management. Macropores allow for faster water infiltration, reducing surface runoff, managing heavy rainfall events, reducing erosion and recharging groundwater more efficiently. Soils with more macropores drain better, reducing waterlogging and improving conditions for root growth. They also contribute to the overall porosity of the soil, and this stored water can be available for plant uptake over time, enhancing drought resilience. Macropores can facilitate the downward movement of nutrients into deeper soil layers, making them available to plant roots that penetrate deeply into the soil. The activities of organisms that create macropores also help in organic matter decomposition, nutrient cycling, and maintaining soil structure. Improved infiltration and water storage capacity make these soils more resilient to the impacts of climate change, such as more intense and frequent rainstorms or periods of drought. Soils enriched with macropores offer several advantages for water management, including better infiltration, drainage, water storage, and ecosystem support.

1. STRICT PROTECTION MEASURES

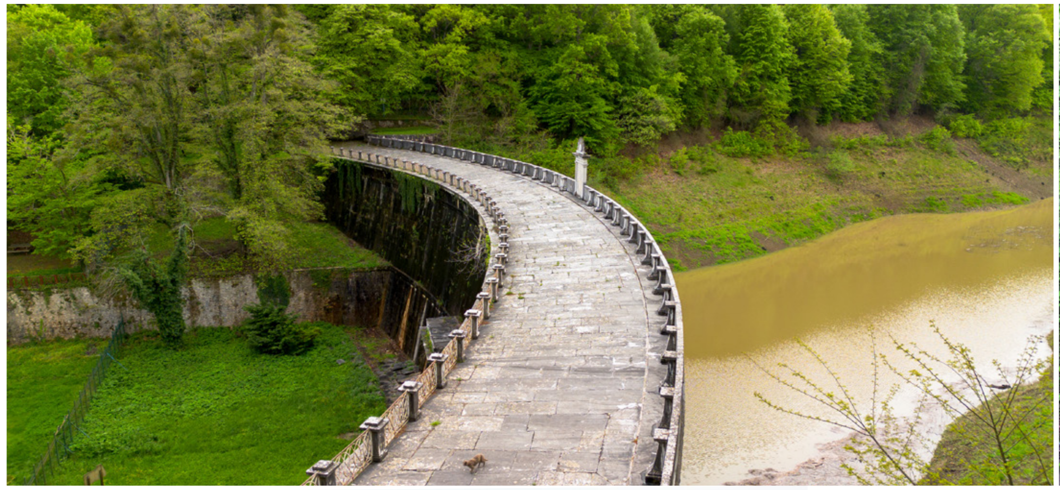
Enforce strict protection measures to safeguard existing old growth forests from logging, mining, and other extractive activities. This involves legal protections, such as designating these areas as national parks or conservation reserves, and enforcing regulations to prevent unauthorized exploitation or development. Limit human access and activities within old growth forests and create buffer zones around these forests to further reduce the impact of human activities, focusing on maintaining the natural ecological processes and minimizing disturbances that can lead to invasive species introduction or increased vulnerability to diseases and pests.

2. ECOLOGICAL MONITORING AND RESEARCH

Implement a comprehensive ecological monitoring program to track the health of old growth forests, identifying any signs of stress or degradation early. Research into the unique ecological processes of these forests can inform management practices that support their health and resilience, facilitating adaptive management strategies in response to emerging threats or changing environmental conditions.

3. RESTORATE ADJACENT LANDS

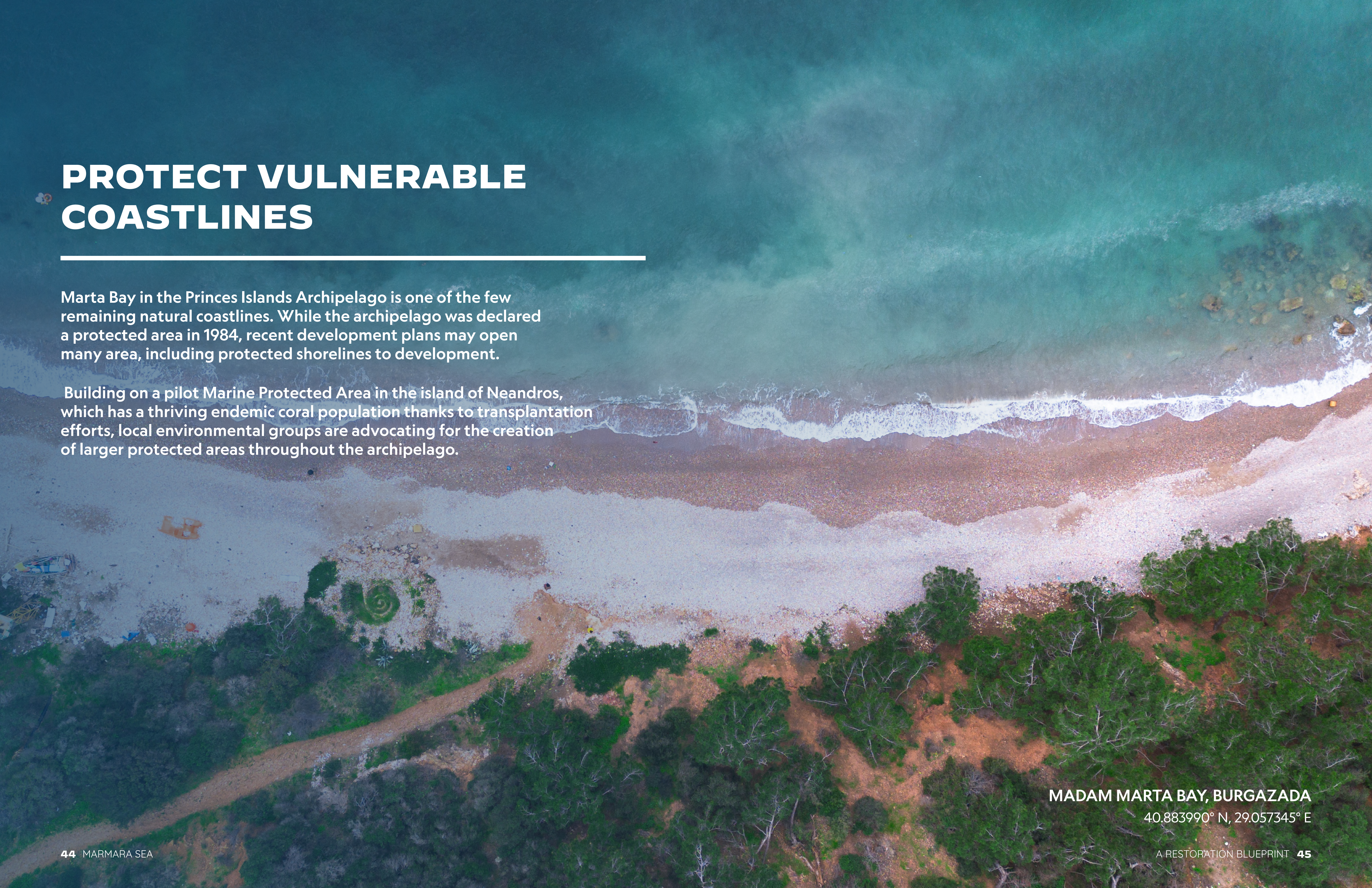
Engage in the restoration of ecosystems adjacent to old growth forests to expand habitats and increase ecological connectivity. This can include reforestation projects and the restoration of degraded lands to create buffer zones that enhance the overall resilience of the watershed. Restoration efforts should prioritize native species and aim to mimic the natural forest structure and composition to support wildlife movement and ecological processes.



PROTECT VULNERABLE COASTLINES

Marta Bay in the Princes Islands Archipelago is one of the few remaining natural coastlines. While the archipelago was declared a protected area in 1984, recent development plans may open many area, including protected shorelines to development.

Building on a pilot Marine Protected Area in the island of Neandros, which has a thriving endemic coral population thanks to transplantation efforts, local environmental groups are advocating for the creation of larger protected areas throughout the archipelago.



MADAM MARTA BAY, BURGAZADA
40.883990° N, 29.057345° E

STRATEGY 5

ESTABLISH MARINE PROTECTED AREAS THAT ARE CONNECTED AND THRIVING

Marine Protected Areas (MPAs), like the island of Neandros in the Princes Islands Archipelago, provide a refuge for marine biodiversity, conserve critical habitats, and help replenish overfished populations. They serve as natural laboratories for scientific research and can be integral in adapting to and mitigating the impacts of climate change by preserving areas that are crucial for species adaptation. MPAs also play a significant role in sustaining fisheries and supporting the livelihoods and cultural traditions of coastal communities.

Natural shorelines are critical for the ecological dynamics of coastal areas. They provide essential habitats for marine life, including nurseries for fish and invertebrates, feeding grounds, and refuge from predators. Additionally, natural shorelines offer protection against erosion, buffer against storm surges, and filter pollutants. Preserving and restoring natural shorelines within and around MPAs enhances biodiversity and the resilience of coastal ecosystems to climate change.

1. INCORPORATE INDICATOR SPECIES IN MPAS AND ADAPTIVE MANAGEMENT

Indicator species, organisms that reflect the health of the ecosystem, can be pivotal in establishing and managing MPAs. These species, like sea grass meadows, can provide valuable insights into the overall health of marine ecosystems, signaling the effectiveness of conservation measures and highlighting areas that may require additional protection or restoration efforts. Monitoring changes in the populations and health of indicator species can help managers adapt. Use scientific research and monitoring data to inform the adaptive management of MPAs. This includes regular assessments of marine populations, habitats, and environmental conditions within and around MPAs. Data on indicator species, habitat health, and the effectiveness of conservation measures can guide adjustments to management strategies, ensuring MPAs remain effective in the face of changing conditions.

2. IMPLEMENT ECOLOGICAL CORRIDORS

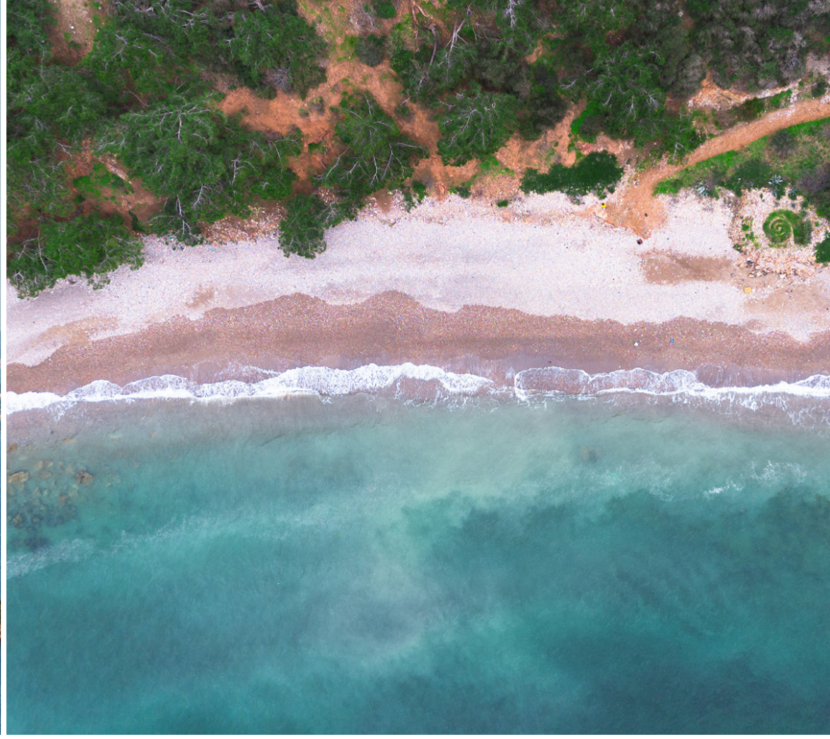
Create ecological corridors between MPAs to facilitate the movement of species. These corridors, by connecting isolated protected areas, can enhance the resilience of marine populations to environmental changes and human impacts, ensuring the sustainability of marine biodiversity.

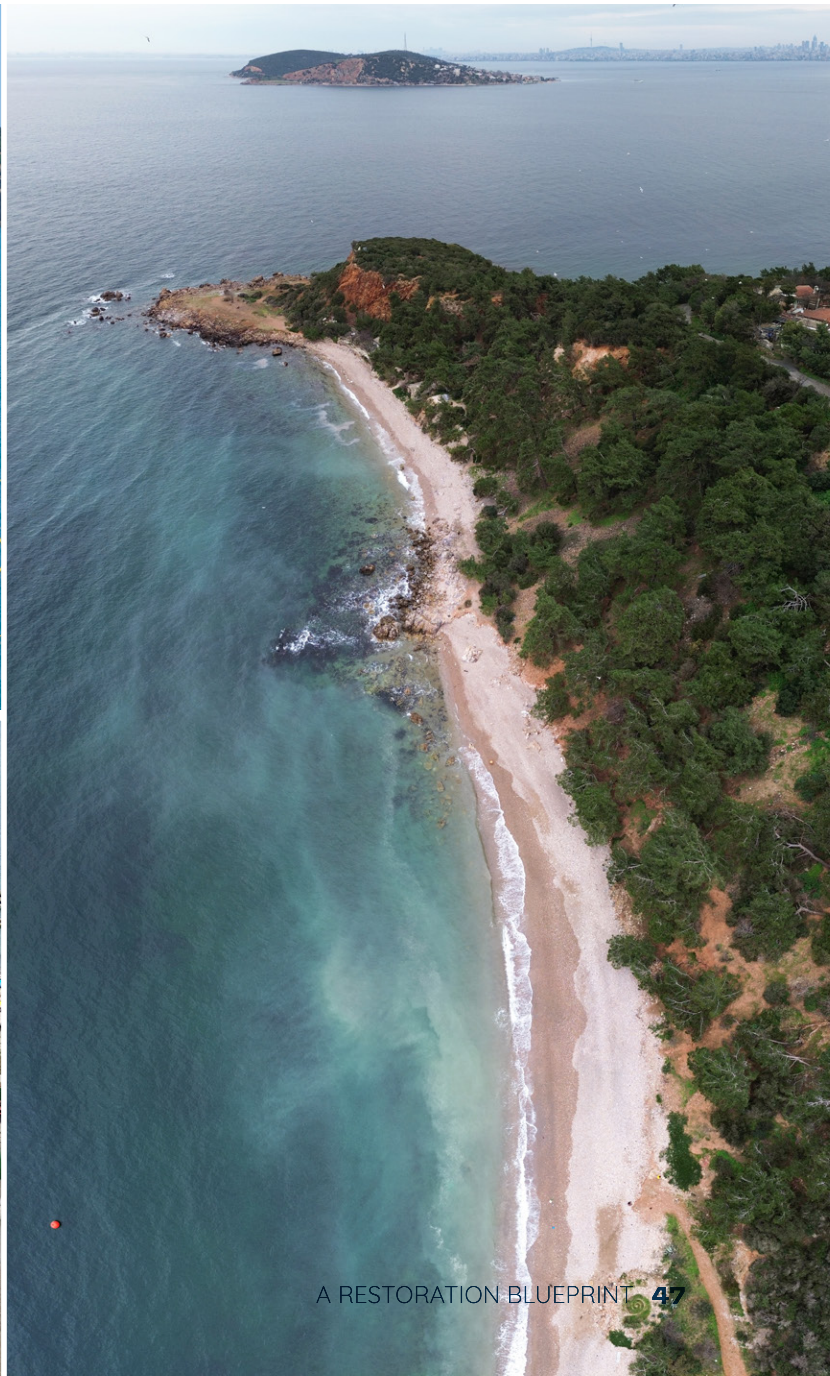
3. SEED ROCKY COASTAL HABITATS WITH MUSSELS

Reseed rocky coastal habitats, especially those affected by higher nutrient loads, with bivalves such as oysters or mussels. These species are efficient at denitrification, removing excess nutrients from the water and improving water quality. This process also supports the creation of complex habitats that enhance biodiversity and provide services such as shoreline stabilization and carbon sequestration.

4. COMMUNITY ENGAGEMENT AND CO-MANAGEMENT

Involve local communities, fishers, and other stakeholders in the planning, establishment, and management of MPAs. This co-management approach can ensure the MPAs meet both conservation and local socio-economic needs, increasing compliance and the effectiveness of protection measures.

IMPORTANCE OF INDICATOR SPECIES

SEA GRASS MEADOWS

Sea grass meadows *Posidonia oceanica* serve as a key indicator species for Marine Protected Areas (MPAs) due to their sensitivity to changes in water quality and the ecosystem services they provide. Using drones and anecdotal evidence from divers, we mapped shallow sandy coastal areas around the Princes Islands, up to 10 meters of depth, that are known to have extensive sea grass meadows. However, unprotected coastlines with high levels of water transportation and shoreline construction showed signs of decline. Research suggests that sediment loading from coastal land use mismanagement and elevated turbidity can reduce seabed light levels and impact seagrass productivity and meadow health.[2] Incorporating sea grass meadows into the management of MPAs in the Prince's Islands will be an important strategy for the archipelago's biodiversity.

1. BASELINE SURVEYS AND CONTINUOUS MONITORING

Building on this preliminary mapping, comprehensive surveys to establish the current health, extent, and biodiversity of sea grass meadows within and adjacent to the MPA can provide a baseline against which changes can be measured. Continuous monitoring to track the health and coverage of sea grass meadows over time should assess indicators such as the density of sea grass, the presence of new shoots, and signs of stress or degradation.

2. WATER QUALITY MANAGEMENT

These indicators used to measure the health of sea grass meadows can also be used as a measure of water quality within the MPA. Sea grasses require clear, clean water for photosynthesis and growth, so declines in their health can indicate deteriorating water quality. Measures to improve water quality might include controlling runoff from land, reducing sedimentation, and implementing stricter regulations on pollutants.

Targeted Actions: Based on monitoring data, if a decline in sea grass health is detected, targeted actions can be taken to address the specific causes of water quality degradation affecting the meadows.

3. HABITAT PROTECTION AND RESTORATION

Physical Protections: Implement measures to protect sea grass meadows from physical damage due to anchoring, trawling, or other disruptive activities. This can include the installation of mooring buoys to prevent anchoring in key areas and enforcing no-go zones for certain types of fishing gear.

Restoration Projects: In areas where sea grass meadows have been damaged or destroyed, undertake restoration projects. This can involve reseeding areas with sea grass or installing structures that stabilize sediments and facilitate natural recolonization.

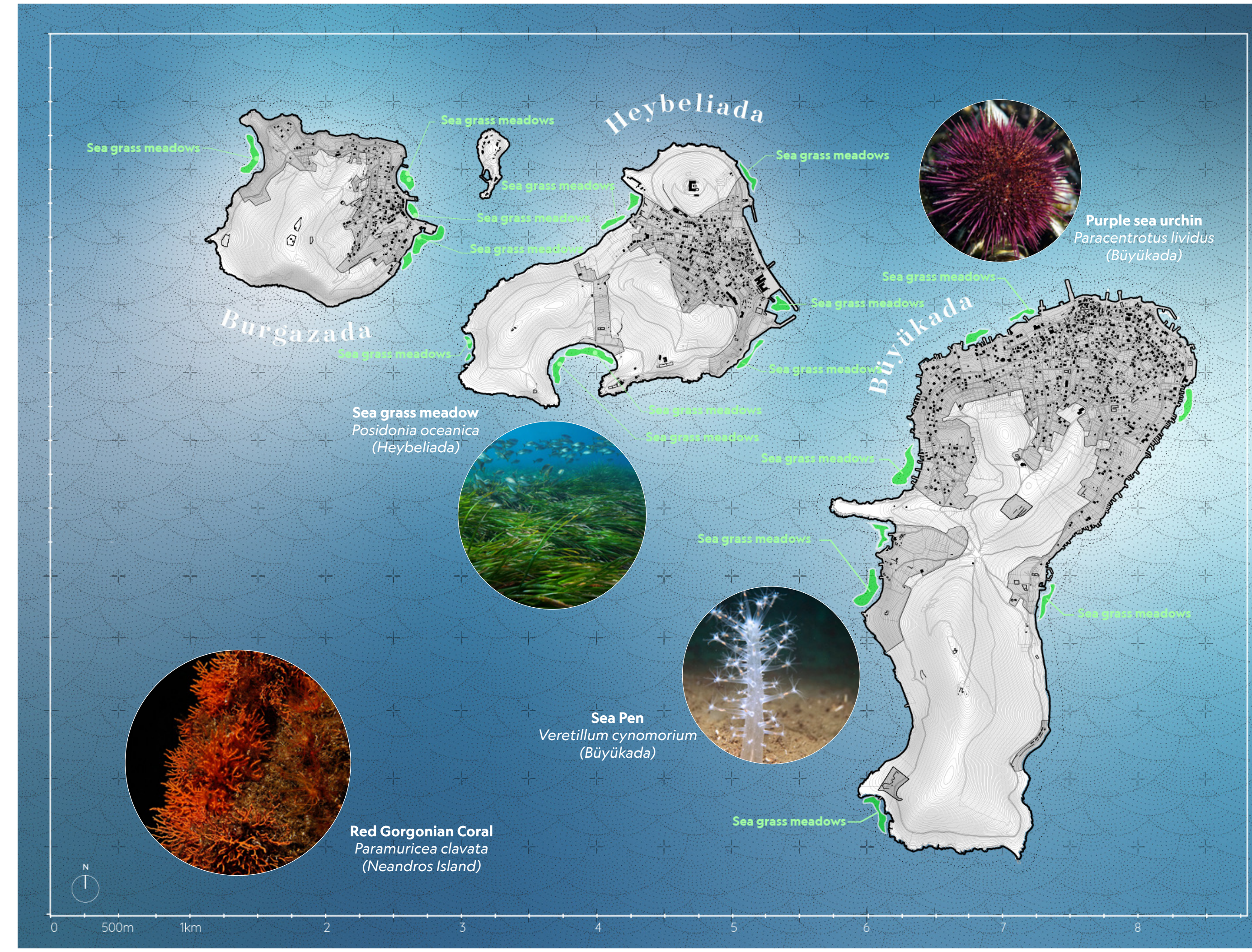
4. INTEGRATED MANAGEMENT PLANS

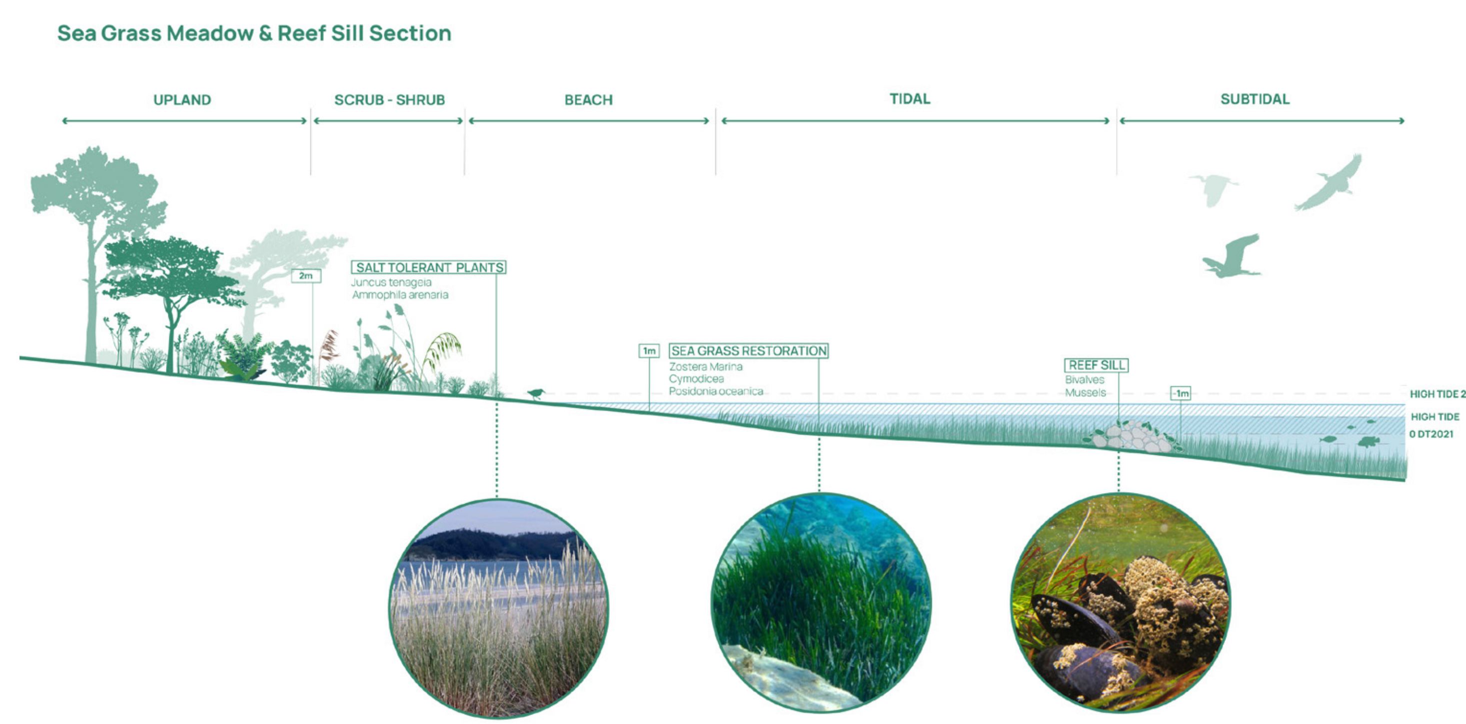
Comprehensive Strategies: Develop and implement integrated management plans for MPAs that specifically include objectives for the conservation and restoration of sea grass meadows. This involves considering the meadows in zoning decisions, threat mitigation strategies, and in the design of visitor management plans to reduce human impacts.

Stakeholder Involvement: Engage stakeholders, including local communities, fishermen, and recreational users, in the conservation of sea grass meadows. Education and outreach programs can raise awareness of the importance of sea grasses and promote behaviors that minimize harm to these vital habitats.

This approach not only benefits the biodiversity within the MPA but also enhances the overall ecological health and resilience of the marine environment.

2. Thrush, S. F., Hewitt, J. E., Cummings, V. J., Norkko, A., Chiantore, M., ... & Asnaghi, V. (2018). Mapping the Global Footprint of Fish Farming. Frontiers in Marine Science, 5, 462. https://doi.org/10.3389/fmars.2018.00462





Location Map and Representative Section of Sea Grass Meadows in the Princes Islands.
Data Source: Fieldwork and remote sensing analysis by project team. Map design by Sera Tolgay and Daniel Marshall
Photos: Coral Transplantation at Neandros Island via (Deniz Yaşamını Koruma Derneği, Volkan Narcı), purple starfish on mussels, Sea pen (Veretillum cynomorium), Sea grass meadows in the Sea of Marmara via Adobe and Sera Tolgay

NEXT STEPS

REALIZING THE VISION

This Framework for the Future represents a bold, community-driven vision for the revitalization of the Marmara Sea and its surrounding watersheds. The goals and supporting objectives outlined in this plan arose directly from an extensive engagement process with diverse stakeholders, ensuring that it reflects the shared values and priorities of the region.

Achieving this vision will require sustained commitment, collaboration, and strategic action. To that end, this initiative has catalyzed the founding of the **BLUESCAPES ALLIANCE**, a new NGO based in the Princes Islands Archipelago. This organization will spearhead efforts to realize the strategies proposed in this plan through research, advocacy, and on-the-ground implementation with other community partner focused on the following priority areas:

- **Advocate for Wastewater Treatment Upgrades:** Lobbying authorities to build additional wastewater treatment capacity and discontinue the deep discharge of untreated effluents into the Sea of Marmara, a practice that has severely compromised water quality and marine habitats.
- **Enact a 30% by 2030 Watershed Restoration Plan:** Working closely with the Marmara Municipalities Union to develop and enact a comprehensive watershed restoration plan that safeguards upstream tributaries, rivers, and their surrounding ecosystems, recognizing their integral role in the health of the larger marine environment.
- **Prioritize Protection of Vulnerable Areas:** Identifying and prioritizing the protection of areas most at risk from climate-related hazards such as sea-level rise, stormwater flooding, and geological hazards in this earthquake-prone region with areas vulnerable to liquefaction, ensuring the long-term resilience of coastal communities and natural habitats.
- **Implement Nature-Based Infrastructure Projects:** Designing and constructing pilot projects that demonstrate the role of nature-based solutions in restoring coastal habitats, shorelines, and providing critical ecosystem services such as flood mitigation, water quality improvements and erosion control.

The **BLUESCAPES ALLIANCE** will continuously engage the community, policymakers, and key stakeholders to drive tangible progress toward these objectives. Through evidence-based research, policy advocacy, and the implementation of innovative, sustainable practices, this organization will work to safeguard the Marmara Sea's future as a thriving, resilient ecosystem that benefits both human and natural communities.

Established through this collaborative process, the **BLUESCAPES ALLIANCE** will ensure that the **"Marmara Sea: A Restoration Roadmap"** aims to be a catalyst for transformative change starting with this decisive decade, and pave the way to restore and safeguard a healthy watershed and marine environment for generations to come.


Bluescapes
Alliance