



## SPECIAL EDITION: POSIDONIA: THE ENDEMIC FOREST OF THE MEDITERRANEAN

In response to the need for biodiversity protection, and particularly for sensitive habitats in the Mediterranean, as well as France's international and European environmental obligations and maritime safety challenges, the 'Préfecture Maritime' decided in April 2019 to strengthen regulations on anchoring and stop vessels.

Beyond enhancing maritime safety, which is increasingly threatened by the proliferation of sea activities, these measures also address the need to protect marine habitats such as Posidonia meadows, which are suffering increasing degradation due to the rapid rise in the number and size of vessels.

Since then, a series of prefectoral orders have been developed through extensive **stakeholder consultation**: the concepts of stopping and anchoring in French inland waters and the territorial sea of the Mediterranean were defined in the 2019 'framework' order; Anchoring of vessels over 45 metres and yachts over 80 metres is now restricted to designated mandatory zones, particularly in vulnerable coastal areas; Anchoring of vessels over 20/24 metres is regulated by so-called 'local' orders developed in each département in collaboration with other government departments and various socio-economic partners.

In addition, **the duration of anchoring is now limited to 72 hours for all vessels.**

This system is now complete, with the signing of the West Corsica order in the summer of 2024, bringing the total to 17 orders covering the entire coastline. It is beginning to bear fruit, given the results of recent summer seasons.

- The **control chain** - involving in particular the French Navy's semaphore chain, the support centre for marine environment control (CACEM) and State action at sea units - is fully operational and effective. This is evidenced by the number of inspections conducted following reports from the semaphore stations.
- All actors in the chain unanimously report improved awareness of regulations among sea users.
- Positive outcomes of these regulations include **a significant reduction in pressure on Posidonia meadows**, despite an increasing number of anchoring activities.

**Vice-admiral Christophe Lucas,**  
Maritime Prefect for the Mediterranean



### 1 *Posidonia oceanica*, Key Mediterranean ecosystem

- Engineering species
- A multi-service protected species
- Where are the Posidonia meadows?
- Multiple Observations of Spontaneous Posidonia Meadow Recolonization
- Cartographic Atlas for Posidonia Meadow Monitoring

### 2 Knowledge and monitoring of anthropogenic pressures

- What Threatens Posidonia Meadows in France?
- Anchoring of large vessels: what are the impacts?
- Tightening regulations on anchoring, a major conservation tool
- How can we better understand small-scale yachting?
- Illegal mooring: recognizing ecological damage

### 3 Management and restoration: project monitoring

- REPIC: 3,800 m<sup>2</sup> of seagrass meadow restored
- DONIA App, a significant increase in users (>75,000)
- DONIA Manager, tracking and managing activities
- DONIA Mooring, second season of operation for yachting mooring buoys



## POSIDONIA OCEANICA, MEDITERRANEAN GODDESS

Posidonia (*Posidonia oceanica* (L.) Delile) derives its name from Poseidon, the god of the seas and oceans in Greek mythology. It is a flowering plant found only in the Mediterranean Sea (an endemic species). It is legally protected in many Mediterranean countries, including France, where the seagrass meadows it forms cover 34% of the seabed along the mainland coast and 66% around Corsica, at depths of 0 to 40 meters. Despite protection measures, Posidonia meadows are threatened by human activities, even though they provide numerous goods and ecosystem services. Across the Mediterranean basin, 10% of their surface area has been lost over the last 100 years. In France, the loss of goods and benefits is estimated to exceed four billion euros annually.

Vessels anchoring is a source of physical damage to sensitive marine habitats such as Posidonia meadows. AIS (Automatic ship Identification System) data can be used to estimate the pressure exerted on Mediterranean coastal marine habitats. Researchers at Andromède Océanologie have analyzed this AIS data in order to locate and quantify areas under anchoring pressure from pleasure craft and to assess the effectiveness of anchoring regulations.

### Identity card

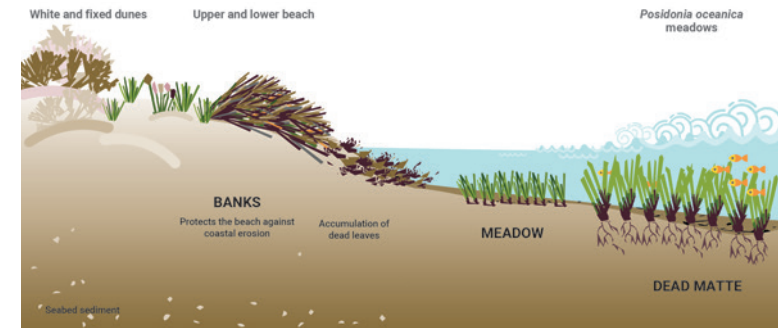
- **Name:** *Posidonia oceanica*
- **Taxonomic group :**  
Angiosperm (flowering plant)
- **Habitat:** Mediterranean coastline,  
0 to 40 meters deep
- **Size:** leaves 20-80 cm in length



*Posidonia* consists of bundles of leaves, rhizomes (creeping stems generally buried in the sediment) and roots.

### ENGINEERING SPECIES

*Posidonia* consists of bundles of **leaves**, **rhizomes** (creeping stems generally buried in the sediment) and roots. The horizontal growth of rhizomes is slow (a few cm per year). The tangle of rhizomes, roots, scales (deciduous leaf sheaths) and sediment trapped in crevices forms **the matte**. The matte plays an important role in **anchoring the meadow** and **stabilizing the seabed**.



The plant loses its leaves, primarily in autumn. These leaves can be washed ashore by current, forming thick **banks** on the beach, sometimes several meters thick. These banks provide **breeding** and **feeding** grounds for many terrestrial species. In the depths of the sea, leaves can also accumulate as litter. This organic matter produced along the coast is directly shared with both the beaches and the deeper seabed.



The *Posidonia* meadow is home to 20-25% of the Mediterranean's known plant and animal species. 1: School of picarels (*Spicara smaris*) above a meadow; 2: Gametes emitted by a holothurian at the edge of the meadow. © Laurent Ballesta

*Posidonia* forms underwater plant meadows often referred to simply as "**meadows**". A pivotal ecosystem, the *Posidonia* meadow plays **crucial ecological and economic roles**.

The economic value of underwater meadows is significant. According to a study by Costanza et al. (1997), their value is:

- 3 times greater than that of coral reefs,
- 10 times greater than that of tropical forests.

## Posidonia: an endemic and protected species

The *Posidonia* genus includes eight species in Australia, but only one in the Mediterranean: *Posidonia oceanica*.

Various laws and regulations have long protected this **endemic** species:

- The French **Nature Protection** Act of July 1976
- The **Littoral law** of January 1986
- The decree of July 19, 1988, listing **protected marine plant species**
- The European Habitats Directive (1992), the Bern Convention (1979) and the Barcelona Protocol (1995).

However in practice, *Posidonia* meadows were often destroyed by boats anchoring with impunity.

A significant shift came with Order no. **123/2019**, which introduced stricter anchoring regulations. Vessels over 24 meters in length are now **prohibited from anchoring in the *Posidonia* meadows**.

**Although the meadows are better protected today, the loss of surface area lost and the ecosystem services they provide remains significant.**

In the Mediterranean basin, *Posidonia* meadows have already lost 10% of their surface area over the last 100 years

In France, certain regions in the South have seen losses of up to **30%** in just a few years

## A MULTI-SERVICE PROTECTED SPECIES

*Posidonia oceanica* enjoys legal protection in many Mediterranean countries, including France, as it plays an essential role in the ecological functioning of the Mediterranean and in human well-being.

### *Posidonia oceanica* enjoys legal protection

An increasing number of EU directives and international conventions now refer to *Posidonia* meadows and directly protect the species itself or the habitat it forms.

### *Posidonia's* irreplaceable ecological roles

Scientists have identified **25 key ecological roles** provided by *Posidonia oceanica*, including :

- **Oxygen production**, earning the nickname "the lungs of the Mediterranean".
- **Carbon storage**, effectively removing carbon from the atmosphere
- **Water purification** through natural filtration
- Providing **habitats** for thousands of species
- **Contribution to the nutrient cycle** within marine ecosystems
- **Stabilization** of the seabed and prevention of sediment displacement
- Coastal **erosion control** through its root systems

...

Like coralligenous reefs or the Amazon rainforest, *Posidonia oceanica* meadows host an extraordinary concentration of biodiversity.



The meadow provide essential ecosystem services: fish supply, rich biodiversity, water clarity and purification, protection against coastal erosion, carbon sinks.

The term "**blue carbon**" refers to **carbon permanently captured** (sequestered) by **coastal marine ecosystems**, including mangroves, salt marshes and seagrass meadows.

By capturing and storing atmospheric carbon, these ecosystems help slow climate change.

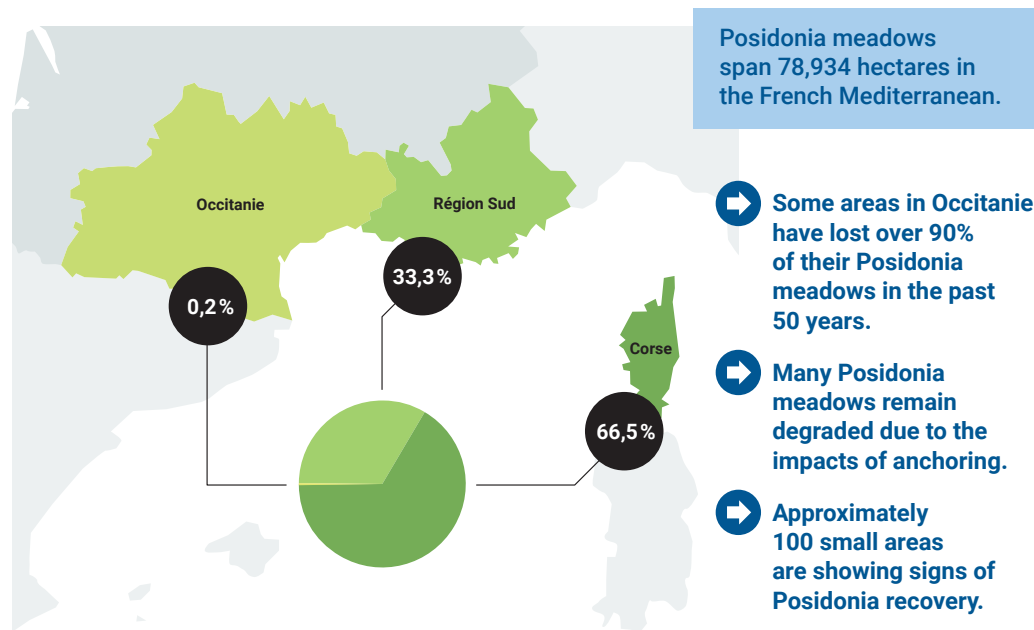
**Among the 64 species forming seagrass meadows, *Posidonia oceanica* is the most effective in carbon sequestration.**



*Posidonia*  
Meadows  
© Laurent  
Ballesta

## WHERE ARE THE POSIDONIA MEADOWS?

Since 2014, the location of Posidonia meadows in the **French Mediterranean** has been mapped along the entire coastline. Primarily found at **depths between 0 and 40 meters**, these meadows cover **78,934 hectares** (equivalent to 7.5 times the size of Paris). However, their **distribution varies significantly between regions** due to local factors such as turbidity, light availability, and seabed topology.



Coverage of Seabed (0–40 meters).  
The percentage of seabed covered by Posidonia meadows varies by region in the French Mediterranean.

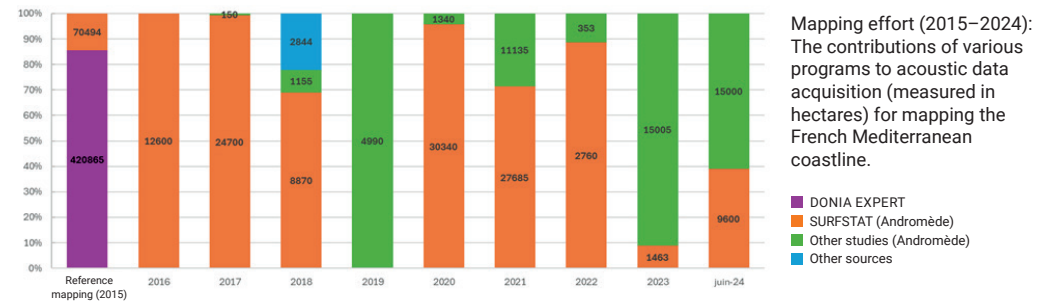


### A surface-based monitoring network for marine habitats

The **SURFSTAT monitoring network** provides **regular updates** (every 3–6 years) to a continuous map of marine biocenosis between 0 and 60 meters along the French Mediterranean coast. This mapping effort **estimates habitat fragmentation and connectivity**, especially for Posidonia meadows as well as other compositional and configurational variables that serve as spatial indicators of **coastal water quality**.

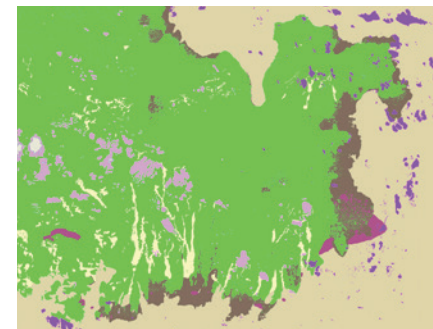
## A significant mapping effort

Continuous updates to marine habitat maps have been underway since the first publication of a **comprehensive map** of French Mediterranean marine biocenosis in 2014. Each year, **tens of thousands of hectares** of sonar data are collected. SURFSTAT therefore represents a crucial step toward **large-scale monitoring**, particularly for sensitive habitats like Posidonia.



## Recent map updates

Two recent mapping campaigns were conducted in the **Southern Region (2020–2022)** and **Corsica (2021–2023)**. A total of **46,150 hectares of Posidonia meadows** were updated based on **60,855 hectares of sonar mosaics**. **Thousands of direct underwater observations** and camera surveys were conducted to validate the data. These updates refined the understanding of the lower (deep) limits of the meadows, the coverage rate of Posidonia and areas showing degradation or recovery.



### Where to View the Updated Meadow Maps

The new 1:10,000 scale maps are available:

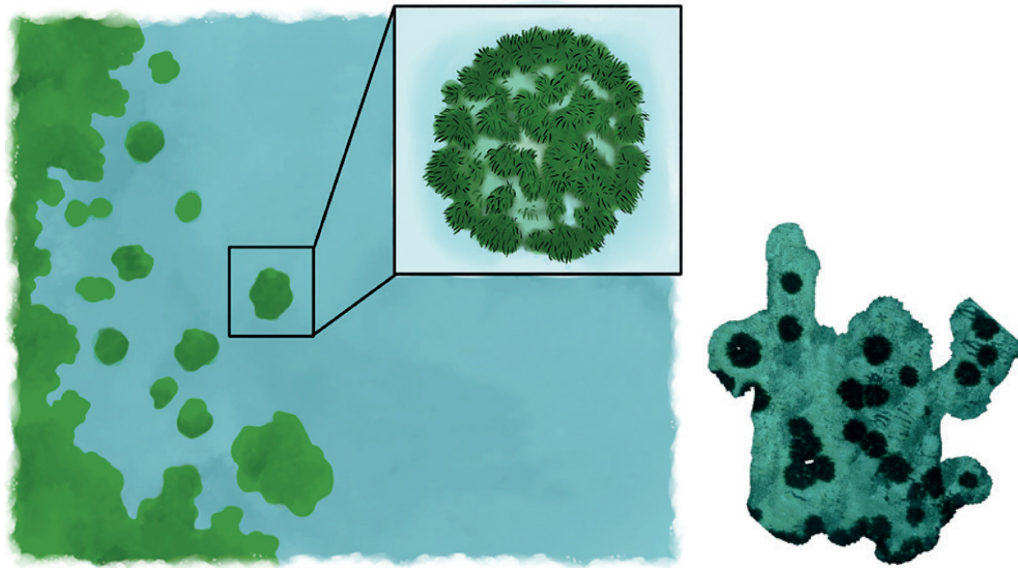
- Online: On the MEDTRIX platform (projects SURFSTAT, DONIA, and DONIA EXPERT), accessible free of charge.
- Mobile: Via the Donia® mobile app.
- Website: [www.donia.fr](http://www.donia.fr)



### MULTIPLE OBSERVATIONS OF SPONTANEOUS POSIDONIA MEADOW RECOLONIZATION

The biocenosis map for the southern region (SURFSTAT 2020–2021) was updated using over 30,000 hectares of sonar data and 5,000 dive observations. This update revealed **thousands of rounded patches** of meadow in **116 areas** between **Marseille and Menton**, at depths ranging from **5 to 35 meters**. These recolonization zones, consisting of rounded patches, cover varying surface areas from **767 m<sup>2</sup> to 44 hectares**.

Thanks to this recent cartographic data, the total area of expanding Posidonia meadows in the southern region is estimated at approximately **276 hectares**.



These natural recolonization patches often feature a central zone with lower leaf shoot density compared to their edges. The number of plagiotropic (horizontal) shoots—an indicator of an expanding meadow—is higher than that of orthotropic (vertical) shoots (Illustrations: Aline Faure).



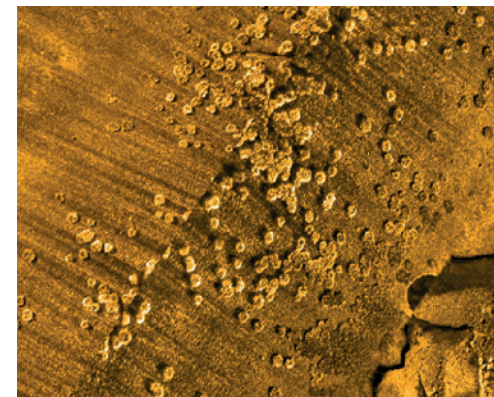
For more information about this phenomenon, visit the **RECOVERY** project page on the MEDTRIX website ([www.medtrix.fr](http://www.medtrix.fr)).

### The Marseilles roadstead and its 10,000 patches of spontaneous Posidonia recolonization

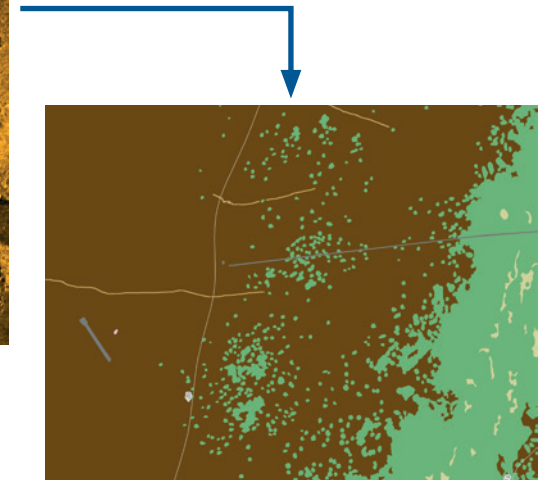
In the Marseilles roadstead, biocenosis maps dated back to 2003, 2007, and 2012, depending on the area. These maps were updated in 2023 through a sonar acquisition campaign conducted by Andromède Océanologie as part of the SURFSTAT monitoring network.

Interpretation of the sonar surveys identified **nearly 10,000 rounded features**. These signs of spontaneous regrowth indicate **a significant improvement in the health** of the Posidonia meadows in the Marseilles roadstead.

All patches were observed at depths of approximately 10 to 25 meters, covering a total area of 60 hectares—**60 hectares of expanding Posidonia meadows!**



Example of Sonar Mosaic  
The image on the left illustrates a sonar mosaic used to update the biocenosis map for Marseille in 2023. Dead matte appears in brown, while Posidonia meadows are shown in green.



### How Are Posidonia Meadows Monitored?

The **ecological monitoring** of Posidonia meadows (growth, dynamics) has been conducted since **2011** as part of the **TEMPO** network. This program covers **53 sites** located at a depth of -15 meters and **73 sites** at the lower limit of the meadows (the deepest local extension boundary).

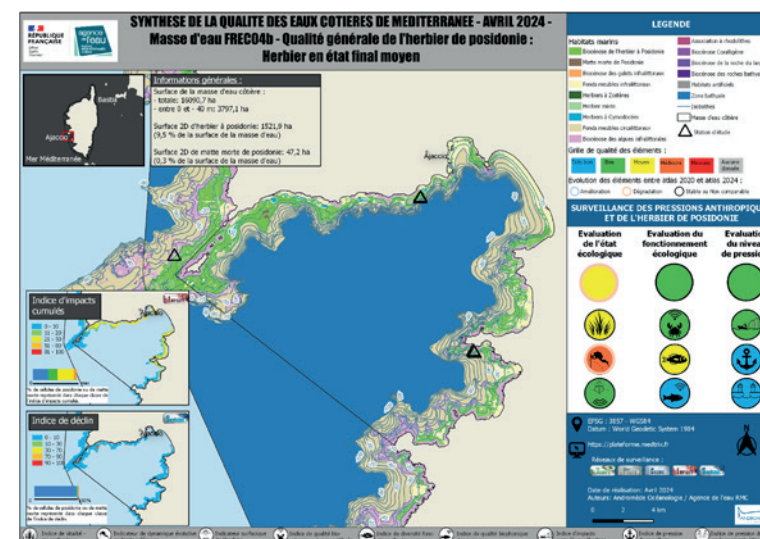
The **PISCIS** network provides information on the **ecological function** of this habitat. Created in **2015**, it focuses on monitoring **fish populations**.

Data collected **annually** through these monitoring systems are used to assess the health of Mediterranean Posidonia meadows and meet regulatory requirements.

### CARTOGRAPHIC ATLAS FOR POSIDONIA MEADOW MONITORING

Data from monitoring networks are integrated to evaluate the overall status of Posidonia meadows. Recent data (2020–2023) collected from **173 Posidonia meadow stations** have been compiled into a **cartographic atlas** (2024 edition). This atlas includes an assessment of **the meadow's ecological status**, its **ecological functions**, and the **pressures** exerted on it. The evaluations rely on various indicators and provide an assessment of the meadow's condition for each coastal water body through 44 maps (ATLAS Project).

- ➔ The good ecological status of Posidonia meadows has been achieved in 73% of water bodies.
- ➔ 70% of the study stations show meadows with **very high vitality** and a **stable or progressively improving dynamic**.
- ➔ Posidonia meadows exhibit minimal decline and strong cohesion in over 60% of the water bodies.



Example map from the 2024 Atlas. The map illustrates the general quality of Posidonia meadows within the FREC04b water body.



According to the 2024 Atlas, the quality of Posidonia meadows is very well-preserved (good overall condition) in areas such as the zone between Cap de l'Estérel and Cap de Brégançon, the eastern tip of Corsica, and the Corsican eastern plain.



The health of this ecosystem is summarized by the coastal water body in the Cartographic Atlas of Biological Monitoring and Water Quality in the French Mediterranean (2024 edition). © Laurent Ballesta

## WHAT THREATENS POSIDONIA MEADOWS IN FRANCE?

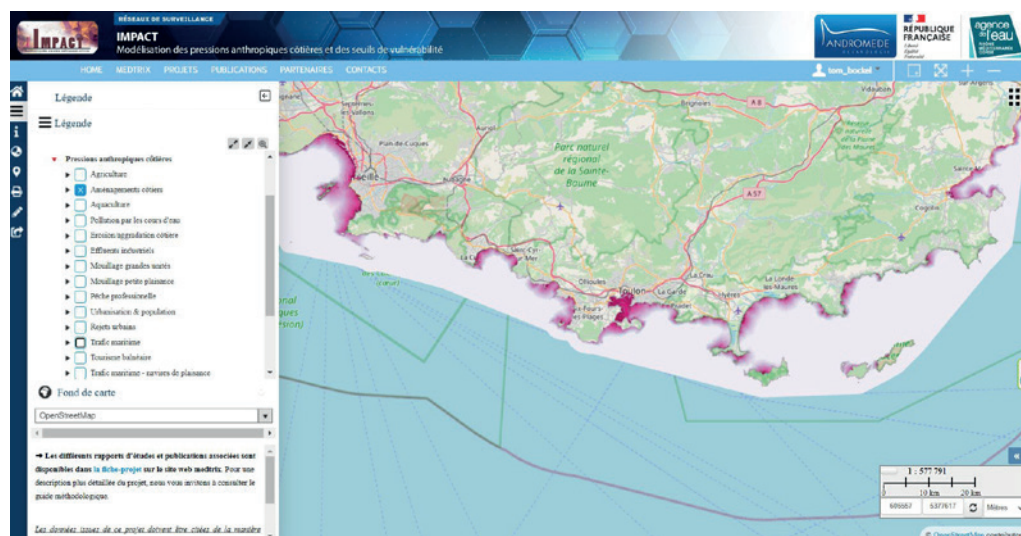
Posidonia's ecological preferences (shallow, clear waters with weak currents) and its **very slow growth rate** (a few centimeters per year) make it **highly vulnerable to human activities and associated pressures**.

Mediterranean Posidonia meadows are subject to various **physical impacts**, including coastal developments, trawling, anchoring, turbidity, erosion, and beach nourishment, among others.

## How are threats addressed?

The **IMPACT project** provides spatial models for **13 anthropogenic pressures** (human activities), including: Urbanization/population, coastal infrastructure, anchoring by small boats, anchoring by large vessels, coastal erosion/aggradation, agriculture, industrial effluents, aquaculture, non-trawl professional fishing, beach tourism, maritime traffic, pollution from rivers, urban wastewater discharge.

IMPACT enhances understanding of the **links between human pressures and the health of coastal ecosystems**.



Maps of the various anthropogenic pressures are available on the Medtrix and Seanoe platforms.

## FOCUS ON TWO MAJOR PRESSURES

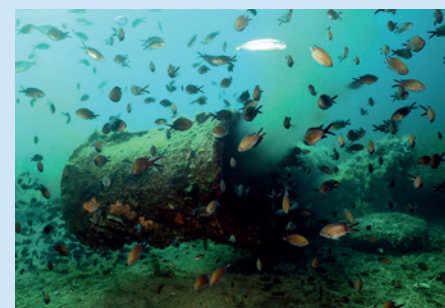
### ► Urban wastewater discharges

The lack of wastewater treatment in coastal areas has historically contributed to the degradation of Posidonia meadows by reducing water clarity and increasing sedimentation. However, since wastewater treatment systems were introduced, has Posidonia shown signs of recovery?

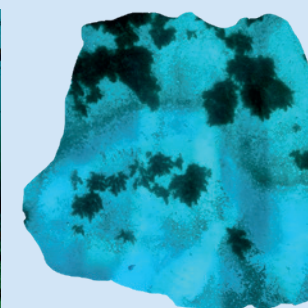
The answer is yes! With the combined effect of rising temperatures and improvements in local environments, **enhanced wastewater treatment has contributed to observed recoveries at the lower limits of the meadows**.

Following a 1991 European directive, French wastewater treatment systems were modernized in the early 2010s with the introduction of biological treatment for organic matter (Bockel et al., 2024b).

By 2024, the benefits of these improvements are evident in data from the **TEMPO network**. Photogrammetry surveys have revealed particularly notable recoveries **in the Occitanie and southern regions of France**.



Marine biodiversity near the La Londe-Maures outfall discharge (left)



Meadow regrowth near a marine discharge at Cap Sicié monitored by TEMPO (right)

### ► Boat anchoring

**Boat anchoring** causes significant physical damage to sensitive marine habitats like Posidonia meadows.



Watch the video:  
[www.youtube.com/watch?v=ui\\_Z0389jD0](https://www.youtube.com/watch?v=ui_Z0389jD0)

Anchoring in Posidonia meadows.  
© Laurent Ballesta



## ANCHORING OF LARGE VESSELS: WHAT ARE THE IMPACTS?

### Large yachts: What are the impacts on Posidonia meadows?

The impact on Posidonia meadows occurs in three main phases:

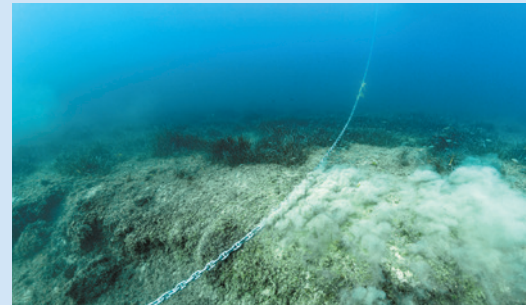
- The anchor falls into the meadow and drags along the seabed before catching on the substrate.
- The chain rubs against the seabed as the vessel swings, tearing up leaf clusters.
- Rhizomes, or even large blocks of matte, are uprooted when the anchor is lifted.



Direct impact  
during  
anchoring

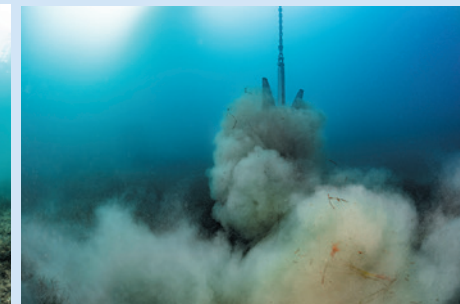
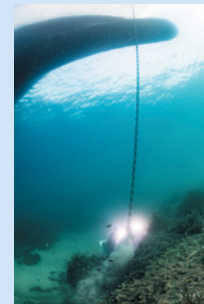


The anchors of large vessels not only uproot the meadow on the surface but also tear out the roots in blocks of matte, preventing any possibility of regrowth.



Chain dragging

The dragging of the chain causes extensive damage, including the removal of meadow patches during anchor retrieval.



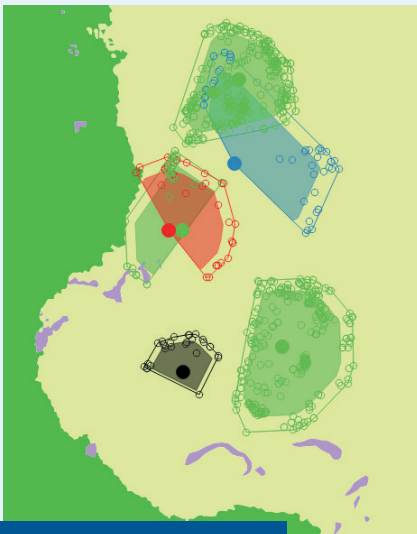
The larger the vessel, the more likely it is to damage marine habitats during anchoring.



After a boat anchors, visible scars—caused by the anchor and chain—remain in the meadow as large, wide tracks. These scars can persist for decades.



Anchored recreational boats



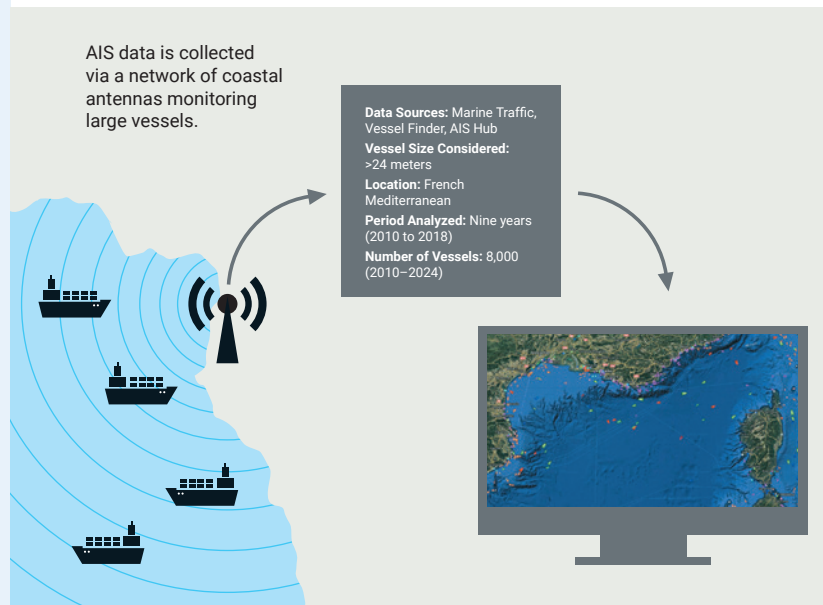
The positions of anchorages are calculated using a specific methodology (Deter et al., 2017)

To prevent conflicts over resource use and better manage the impacts caused by ship anchoring, it is essential to locate, quantify, and monitor the areas under this pressure.

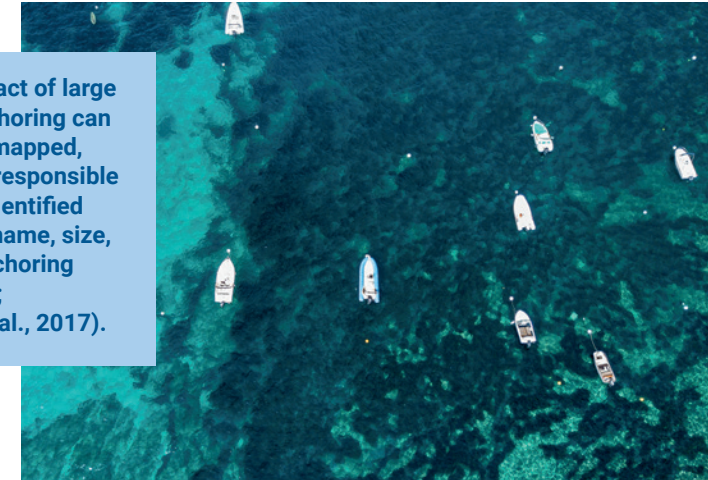
### How to quantify and map anchoring pressure?

**AIS** is a mandatory navigation safety system implemented since late 2004. It applies to vessels over 300 gross tons operating in international waters, vessels over 500 gross tons not in international waters, and all passenger-carrying commercial vessels regardless of size (International Marine Organization, 2016).

**AIS data can be used to pinpoint ship anchoring locations.**

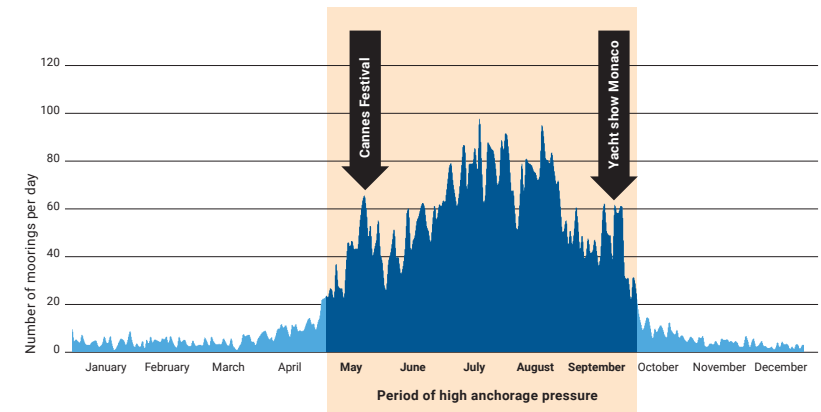


The impact of large ship anchoring can now be mapped, and the responsible vessel identified (vessel name, size, date, anchoring duration; Deter et al., 2017).



### When is anchoring pressure highest?

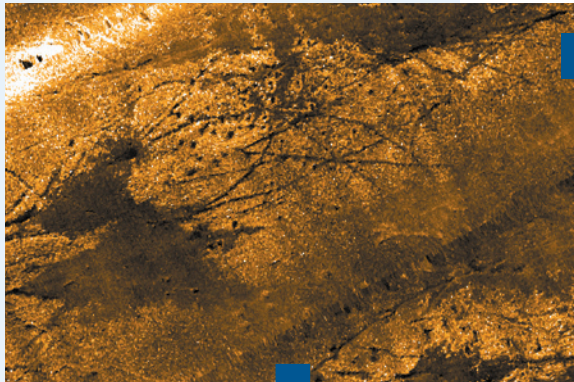
- From May to late September
- During local events or festivals
- On weekends (Friday to Sunday)
- Meal times (12 pm and 8 pm)



Temporal distribution of anchoring pressure

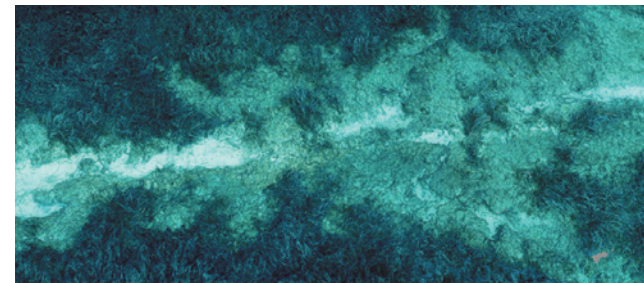
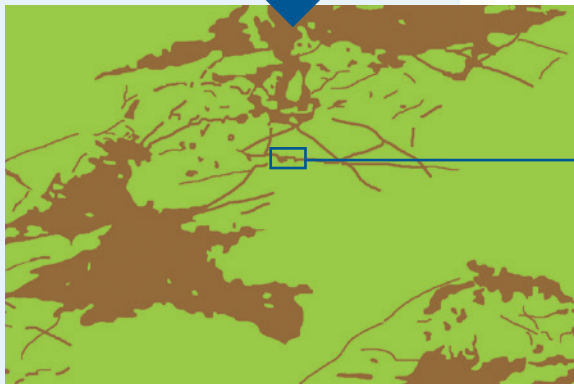
### How to monitor anchoring pressure over time?

The ongoing update of Posidonia meadow maps allows for the identification of **anchoring scars** within the meadows. By combining this information with AIS data, it is possible to link damaged or dead meadows to the vessels responsible. **All large vessels (over 24 meters long) that anchor in Posidonia meadows contribute to the destruction of this protected species.** These ships can be easily identified and located.



Mapping the impact of anchoring

Scars in the meadow north of Sant'Amanza Bay (Corsica) are visible in side-scan sonar images (top left), habitat maps (bottom left), and orthophotography from photogrammetry (right).



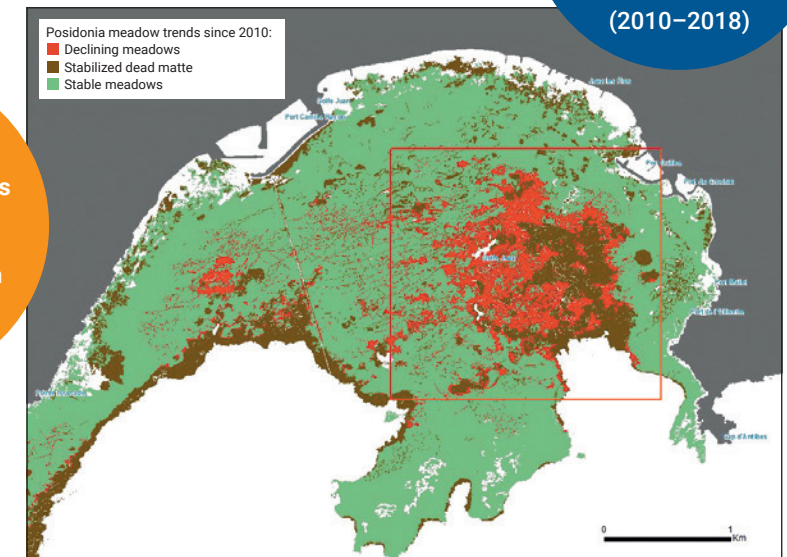
Sonar data map anchoring impacts, which are confirmed by diving observations revealing anchoring scars in the live meadows.

**24%**  
of anchoring incidents occur in Posidonia meadows, mostly by vessels ranging from 40 to 60 meters in length

### This alarming situation led to new regulations

Analysis of AIS data from 75,379 anchoring events (2010–2018) showed exponential damage to Posidonia meadows (Source: Monitoring Logbook No. 6).

**+449%**  
annual increase in anchoring by vessels between 24 and 60 meters (2010–2018)



In Golfe Juan, over 225 hectares of Posidonia were lost between 2006 and 2018



A prefectural order introduced in 2019 prohibits anchoring in Posidonia meadows for vessels larger than 24 meters, marking a significant regulatory shift.

<https://www.premar-mediterranee.gouv.fr/uploads/mediterranee/arretes/eec503812bac663e9c5536c6d5a59ee1.pdf>

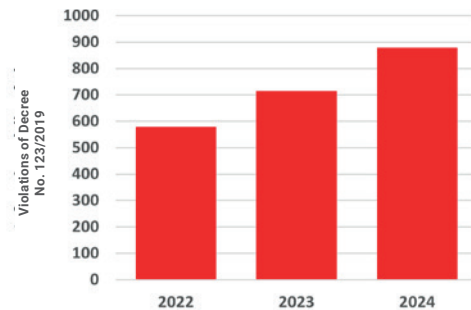
## TIGHTENING REGULATIONS ON ANCHORING, A MAJOR CONSERVATION TOOL

### Two recent decrees published

In France, a first prefectural decree strengthened the protection of Posidonia meadows. **Decree No. 155/2016 (now repealed and replaced by Decree No. 157/2024)** targets **large vessels** (pleasure craft over 80 m or other vessels over 45 m). It requires captains of these ships to request authorization from the semaphore before anchoring. This authorization is granted based on predefined seabed maps and preferential anchoring zones.

As awareness of the threat grew, in 2019, the State decided to **completely prohibit anchoring in Posidonia meadows for any vessel larger than 24 m** (locally, 20 m in some departments). Framework **Decree No. 123/2019** has been implemented through 17 prefectural decrees issued between 2020 and 2023 across the Mediterranean coastline.

### How is compliance monitored?



Number of violations of Decree No. 123/2019 by year based on AIS data

**Significant monitoring of regulations is conducted by State services** (150 verbal reports in 2024, 115 in 2023, 119 in 2022).

However, violations persist and are increasing. Although repeat offenses should incur a highly dissuasive fine, the penalty amount is still under discussion, with a legal precedent expected by the end of 2024.

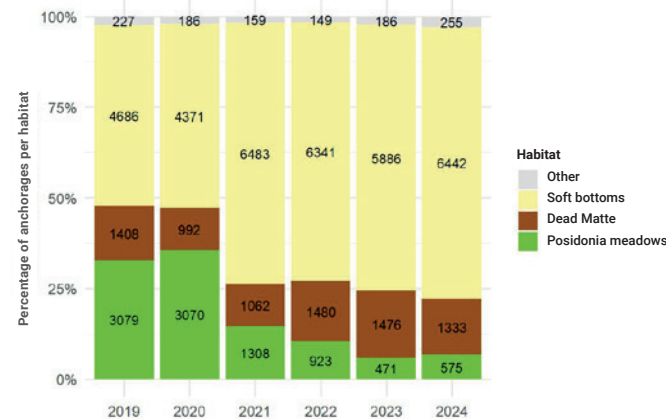
<https://medtrix.fr/cahier-de-surveillance-6/>

These encouraging figures highlight the need to continue **protection, monitoring, and enforcement** efforts.

While recent regulatory changes address the anchoring issue, they are not entirely satisfactory because **vessels under 24 m** (or 20 m in some areas) **are excluded**. Smaller vessels are harder to count and locate but are far more numerous. Their cumulative impact is currently under evaluation.

### What are the effects of the regulations on behavior?

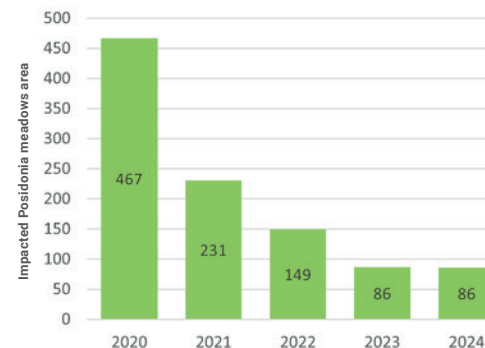
This new regulation has been a success, leading to a **reduction of over 20% in anchoring within Posidonia meadows** by pleasure craft over 24 m since 2021.



Number of anchoring events in Posidonia meadows by habitat and year for vessels >24 m (updated from Bockel et al., 2023)

**20% fewer anchoring events in meadows (since 2021)**

The **surface area affected** by pleasure craft >24 m decreased from **over 450 hectares in 2020 to less than 100 hectares in 2024**.



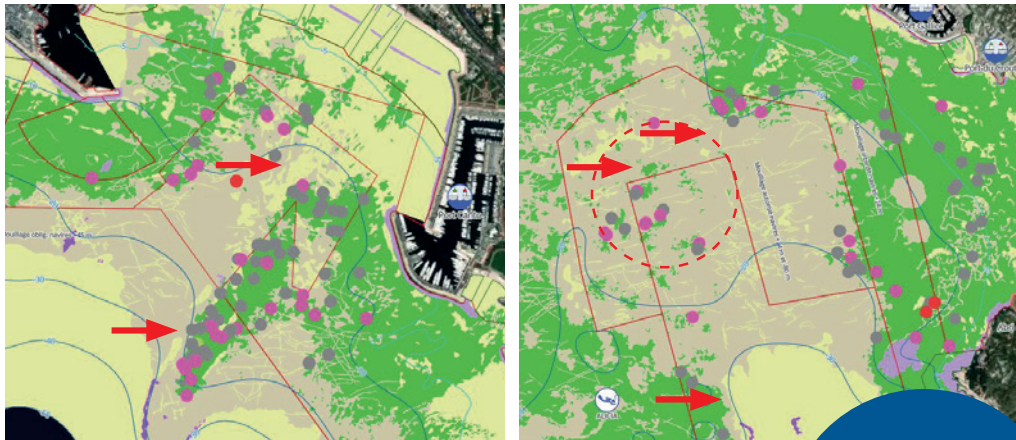
Total area of Posidonia meadows impacted by anchoring from vessels >24 m

**80% reduction in impacted meadow area (2020–2024)**

### A regulation still open for improvement

Under Decree No. 123/2019, some Posidonia meadows are located within authorized anchoring zones for large vessels, meaning they are destined for destruction in the short term, as seen in Cannes.

The rate of destruction is even higher for meadows in deeper mandatory anchoring zones **for large vessels**. For example, in Antibes (Golfe Juan), **5,000 m<sup>2</sup> of Posidonia meadows** remain under pressure from large vessels due to this zoning regulation.



The regulation's limitations are evident in areas like Cannes (left) and Antibes (Golfe Juan), where large swaths of meadows (green) are left vulnerable to destruction (red arrows) within authorized anchoring zones. Source of habitat maps: Donia Expert.

**5,000 m<sup>2</sup>**  
of Posidonia meadows  
remain under pressure  
from large vessels



High-pressure zones (red circles) of large yachts anchoring in Posidonia meadows where they are known and mapped (Bockel et al., 2024 - in preparation).

### Is there a spillover effect to foreign waters for yachts?

Despite stricter regulations, the number of vessels anchoring in Corsica remains stable, while the numbers are increasing in the South Region of France, as well as in the Balearic Islands and northern Sardinia, which have also adopted stricter regulations.

**There is currently no evidence of a spillover effect from French regulations pushing the impact of large yachts to foreign waters.**



Yachts in Monaco's port ([www.monacoyachtshow.com](http://www.monacoyachtshow.com))

### What about other Mediterranean countries?

Only a few Mediterranean countries have legislated on anchoring regulations to date, and **anchoring by large vessels in Posidonia meadows is prohibited only in France and the Balearic Islands.**

An ongoing, unprecedented Mediterranean-wide study (Bockel et al.) has identified areas of very high anchoring pressure on Posidonia meadows. This study provides **critical priorities for conservation actions.**



## HOW CAN WE BETTER UNDERSTAND SMALL-SCALE YACHTING?

### What pressure?

**Small boats** (<12 m) make up the vast majority of recreational boating activity. It is estimated that they anchor about **40% of the time in Posidonia meadows**. Without AIS tracking, these boats are harder to study. To address this, **new automated tools** have been developed, utilizing Artificial Intelligence and imaging data (Bockel et al., 2024, submitted to Ocean and Coastal Management).

### What impact?

Anchoring by small boats affects Posidonia meadows, but **the severity of the damage and the meadow's resilience to this impact remain poorly documented** (Francour et al., 1999; Ceccherelli et al., 2007; Bockel et al., 2024, submitted to *Ocean and Coastal Management*). The maneuvering technique, anchor chain, and type of anchor used also significantly influence the pressure exerted during anchoring.

### What management?

The **Mediterranean anchoring management strategy** for both small and large recreational vessels is currently being developed by the Interregional Mediterranean Sea Directorate.



Automatic detection of anchored boats in images:

- Fixed camera (top) (Source: STARESO)
- Very high-resolution Pléiades satellite imagery (bottom) (Source: University of Montpellier)

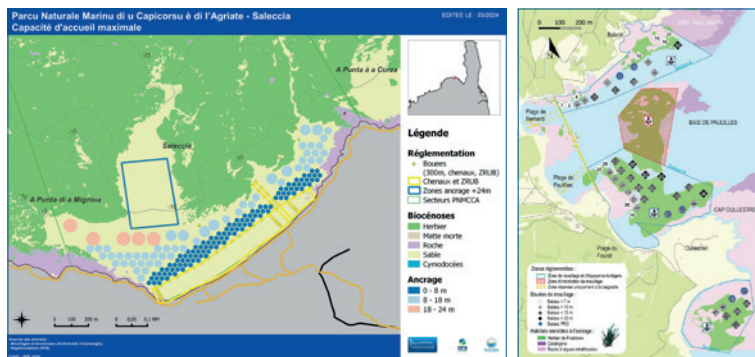
The precision of vessel detection is **81% with fixed cameras**, and **91% with very high-resolution satellite imagery\***

\* For all vessel sizes starting from 5 m



The calculation of **anchorage site capacity**, combined with **adequate monitoring of visitation**, now allows for **anchoring management tailored to local specifics**. This management may include: limiting visitation (temporally and/or spatially), stricter anchoring regulations in certain zones, requiring the use of specific tools (e.g., floating anchors, anchoring assistance apps), and/or installing eco-friendly mooring buoys.

Small boats (<12 m) anchor approximately **40%** of the time in Posidonia meadows



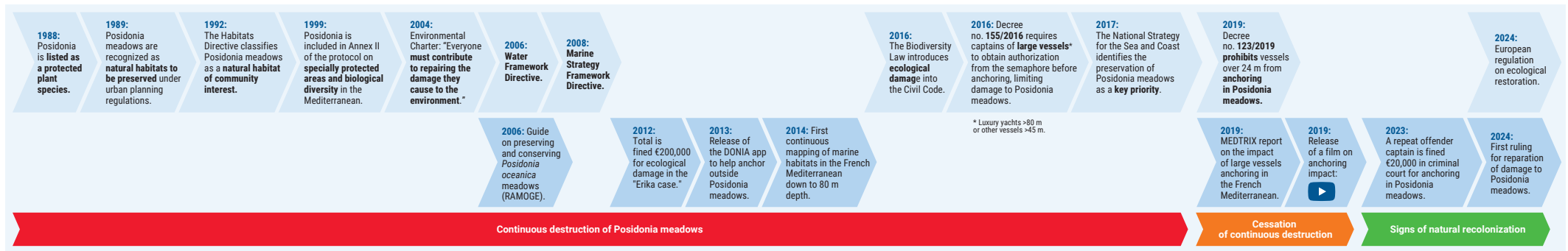
Automated tool for calculating maximum anchorage capacity in Saleccia Bay (Source: Andromède Océanologie and the Cap Corse and Agriate Marine Natural Park, 2024)

Example of a mooring zone with light facilities in Paulilles Bay (Source: [www.ledepartement66.fr](http://www.ledepartement66.fr))

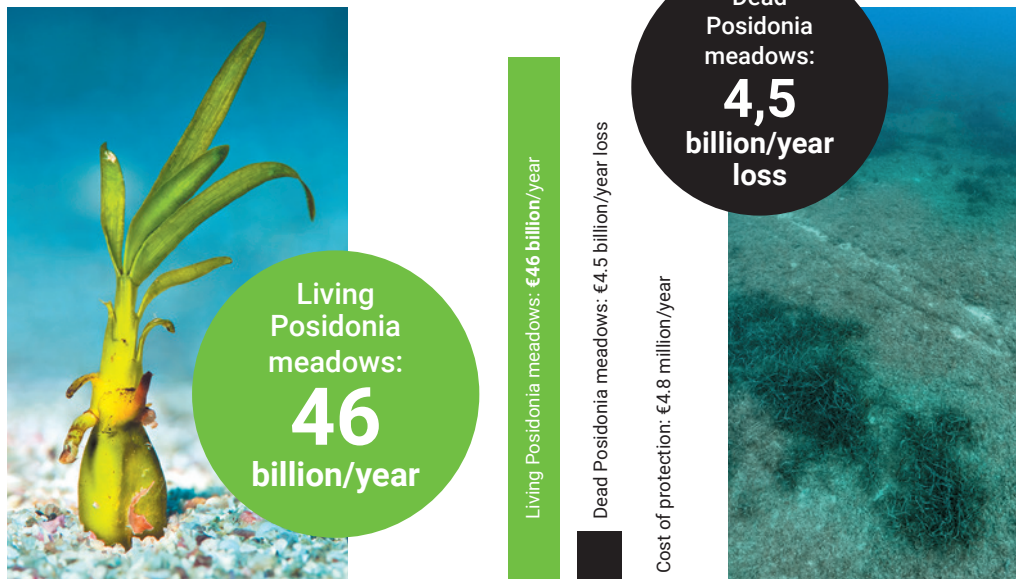
## ILLEGAL MOORING: RECOGNIZING ECOLOGICAL DAMAGE

Over the past two decades, a legal framework has been established to protect ecosystems from the impacts of human pressure. In September 2023, **France Nature Environnement (FNE)** requested, for the first time, that the Maritime Court recognize ecological damage and proposed that reparations be used to restore degraded Posidonia meadows caused by anchoring and to manage these sites. **Assessing the ecological damage to Posidonia meadows remains a challenge for the coming years.**

**Ecological damage is defined as "a significant harm to the elements or functions of ecosystems or to the collective benefits derived by humans from the environment" (Article 1247 of the Civil Code).**



Key figures from 2019: Services provided by Posidonia in France



## Two methods of estimation for ecological damage

### ➔ Restoration costs

Based on existing Posidonia restoration projects, this method estimates the costs of restoration operations in relation to the areas of Posidonia meadows that have been destroyed.

### ➔ Average ecosystem value of Posidonia

This method assesses either the value of ecosystem services provided by recently destroyed Posidonia meadows or the natural investment necessary to establish and maintain these ecosystem services. **Posidonia meadows are one of the ecosystems with the highest economic value globally.** Since Posidonia regrows very slowly (only a few centimeters per year under optimal conditions), the ecological damage must be considered over several years.

Economic value of coral reefs



x 3 =

Economic value of tropical forests



x 10 =

**Economic value of underwater meadows**

The idea of "ecosystem services" emerged in the 1990s. Understanding and knowing ecosystems allow societies to sustain and maintain their vital functions.

### Ecological restoration: Definitions

**Ecological restoration** was defined by the Society of Ecological Restoration (SER) in 2004 as the process of aiding the recovery of an ecosystem that has been degraded, damaged, or destroyed.

According to Atkinson and Bonser (2020), the process or action, which operates on an essential and fundamental basis of non-degradation, can be subdivided into three successive levels:

- **Natural restoration** (or commonly referred to as "passive restoration"): This involves reducing pressures to a threshold that allows ecosystems to regain resilience.
- **Assisted restoration:** This occurs following the previous step or combines with it by introducing interventions on the abiotic environment.
- **Reconstruction restoration:** This combines the two previous types of restoration by significantly reintroducing fauna and flora while potentially mimicking the dynamics of natural succession.



The project is supported by both public and private institutions ([https://medtrix.fr/portfolio\\_page/repic/](https://medtrix.fr/portfolio_page/repic/))

## REPIC: 3,800 M<sup>2</sup> OF SEAGRASS MEADOW RESTORED

### A non-destructive seagrass restoration program

Initiated in 2019, **REPIC** (REstaurer la Posidonie Impactée par l'anCrage) aims to **replant fragments of *Posidonia oceanica* seagrass** in areas previously impacted by anchoring, thereby **fostering the restoration of this remarkable ecosystem**.

The program uses a **non-invasive harvesting method that minimizes damage to seagrass meadows**. This involves collecting floating seagrass clusters torn loose by anchors during the summer season (or naturally broken) and **replanting them underwater in areas of dead matte (former seagrass beds)** using specially designed, **biodegradable metal staples**.



© Laurent Ballesta

The first R&D phase of the project (2019–2023) focused on refining restoration criteria to improve the survival rate and growth of transplanted fragments, as well as developing effective monitoring methods to track the success of the restoration efforts.

After five years of scientific monitoring, the project has moved into its **operational phase**, with a target goal of **1,500 m<sup>2</sup> of seagrass re-established per year**.



Illustration of replanting a fragment torn loose by an anchor using a biodegradable metal staple (© Aline Faure).

### Objectives

Aid in restoring existing seagrass meadows and reclaim areas destroyed by anchoring, mitigate the effects of climate change and its consequences and promote the adoption of the Nature Restoration Regulation.

**Where:** Golfe-Juan, Beaulieu-sur-Mer, and Villefranche-sur-Mer

**When:** Every year since 2019

### Key figures (2019–2024):

- **273,500 seagrass clusters replanted**
- **3,800 m<sup>2</sup> re-established** (2,000 m<sup>2</sup> between 2019–2023, 1,800 m<sup>2</sup> in 2024)
- **876 hours of scientific diving**

The REPIC program has been incorporated into the **Guidelines for the Active Restoration of *Posidonia oceanica***, produced by the "Mediterranean Posidonia Network" and led by the working group "Restoration of Posidonia."

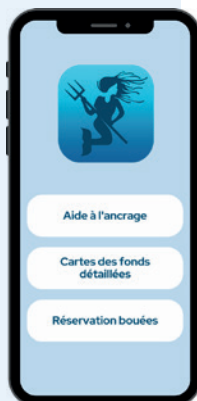


More than one in four  
boaters drop anchor in  
Posidonia meadows  
along the Alpes-Maritimes  
and Var coasts.  
With DONIA, users  
help preserve  
this sensitive habitat.

**DONIA:**  
An app for  
all vessels,  
regardless  
of size

The DONIA application  
is available for free  
on Apple Store  
and Google Play.

<https://donia.fr/>



Between  
2018 and 2024,  
**200 hectares**  
of *Posidonia oceanica*  
have been preserved due  
to this behavioral shift  
facilitated by  
the app

## DONIA APP, A SIGNIFICANT INCREASE IN USERS (>75,000)

Although it is true that **ship anchors have caused significant damage** to the seabed, especially to **Posidonia seagrass meadows** in the Mediterranean, this **impact can be mitigated** through **appropriate regulations** and **accessible anchoring assistance tools**. **Changing behaviors** by raising awareness and offering tools to avoid anchoring in Posidonia is essential.

### DONIA: The free app that guides anchoring away from Posidonia

Over five years, the number of DONIA users has increased by **15 times!** Research shows that **DONIA users anchor less in Posidonia meadows** compared to other boaters.



DONIA is an app designed to guide boat anchoring to protect fragile seagrass meadows  
(© Aline Faure).

## DONIA MANAGER, TRACKING AND MANAGING ACTIVITIES

DONIA Manager is a **specialized tool for maritime professionals** that provides maps showing fragile ecosystems and regulated anchoring zones.

It offers real-time information to allow active management of boating activities.

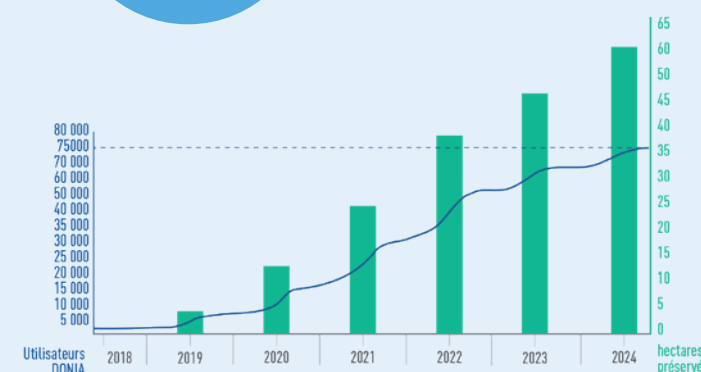


**DONIA  
Manager:**  
The professional's  
tool for managing  
and protecting  
fragile  
ecosystems

Key Features of DONIA Manager:

- **Real-time data:**  
Instant information enables better management of boating activities.
- **Historical analysis:**  
The historical module allows users to monitor and analyze the impact of navigation and anchoring on Posidonia over time.
- **Spatial and temporal queries:**  
Users can perform searches to view anchoring locations by time period, vessel type, or specific areas.

<https://donia.fr/manager/login>



The graph demonstrates a correlation between: Increased number of DONIA users (in blue) and increased areas of Posidonia preserved (in green). This preservation is based on anchoring patterns of DONIA users outside Posidonia meadows.

The benefits of using DONIA MOORING are that it prevents damage to Posidonia seagrass meadows and it supports ongoing restoration efforts

## DONIA MOORING, SECOND SEASON OF OPERATION FOR YACHTING MOORING BUOYS

It is not enough to prohibit access to large vessels to preserve Posidonia meadows, **alternatives must be provided**.

### DONIA MOORING: Reservable mooring buoys via the DONIA application

The DONIA mooring buoys offer an alternative to traditional anchoring during calm weather. Designed to withstand up to 17 tons of force—equivalent to the tension exerted by a 70-meter yacht in 50 km/h winds.

These mooring systems allow **yachts to stay close to the coast without dropping their anchors, thereby respecting areas where anchoring is prohibited**.

### Ten mooring buoys installed between Cannes, Golfe-Juan and Beaulieu-sur-Mer

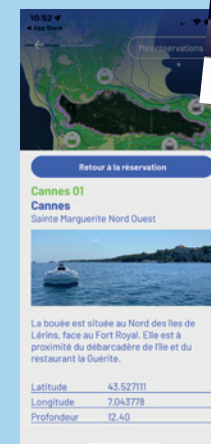
Since 2022, ten DONIA mooring buoys have been installed. These buoys are **innovative, autonomous, equipped with a patented automatic locking system**. The mooring buoys are accessed through the DONIA app using a reservation module (paid service). They allow yachts between 24 and 70 meters to moor securely and calmly close to the coast without negatively impacting shallow coastal seabeds.



Location of Donia Mooring buoys



DONIA MOORING 2023: The innovative solution combines modern technology, ecological preservation, and user convenience for sustainable boating. © Laurent Ballesta





# MEDTRIX MONITORING LOGBOOK SPECIAL EDITION: POSIDONIA MEADOWS

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