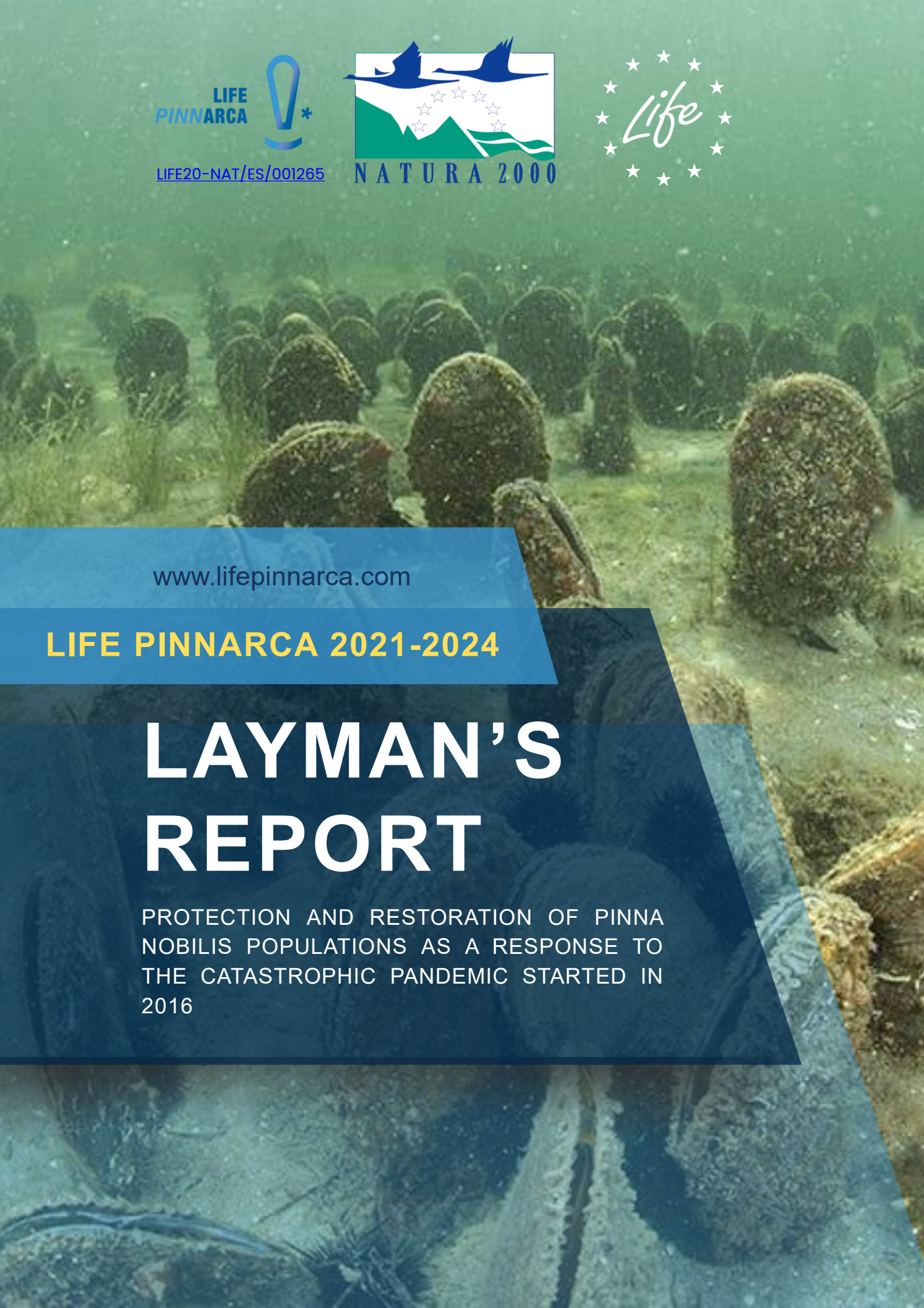

LIFE PINNARCA

LIFE20-NAT/ES/001265

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LIFE PINNARCA 2021-2024

LAYMAN'S REPORT

PROTECTION AND RESTORATION OF PINNA NOBILIS POPULATIONS AS A RESPONSE TO THE CATASTROPHIC PANDEMIC STARTED IN 2016

Photo: Mathieu Foulquie

CONTEXT

The Mediterranean **endemic bivalve** *Pinna nobilis* (commonly known as pen shell or fan mussel) is the largest bivalve of the Mediterranean Sea (**more than 1 m of shell length**). It is also one of the fastest growing bivalves (up to 15 cm in one year when young), and oldest (up to **50 years old**). Fan mussels live in a vertical position with the anterior third of the shell buried in the sediment, and the broad posterior end exposed to the currents. The large shell becomes a **microcosmos for hundreds of marine species**. A single individual can **filter thousands of litters of water per day**, increasing water quality. Until late 2016, millions of individuals thrived in Mediterranean coasts, forming patchy populations. However, fan mussel populations have been **devastated by a die-off** very likely associated to the protozoan *Haplosporidium pinnae*, favoured by a subjacent picornavirus infection that has affected the entire Mediterranean Sea. Prevalence and subsequent **mortality have reached almost 100% (>99.999%)** in affected populations. This fact, together with the characteristic biology of fan mussels, could, eventually, lead to the extinction of the species, which would represent an **unprecedented process in the Mediterranean Sea**.

P. nobilis is considered **"in danger of extinction"** in Spanish coasts (BOE-A-2019-8317) and as **"Critically Endangered"** by International Union for Conservation of Nature (IUCN) Red List.

LIFE PINNARCA PROJECT

PROJECT OBJETIVES:

The **main objective** of LIFE Pinnarca is **preventing the extinction of *Pinna nobilis* at the short-medium term**. The disease affecting the fan mussels has devastated nearly all populations, leaving only a **few scattered** potentially **resistant individuals** and a **few populations** of **non-resistant** individuals in reservoirs (e.g. **coastal lagoons, deltas**). Left alone, the few resistant individuals will perish without leaving any offspring, whereas the populations in reservoirs will slowly decay, being unable to regenerate due to loss of connectivity among them. The present project proposes carrying out urgent measures within the framework of an **international collaborative consortium of experts** in the field that enables the application of coherent trans-boundary measures.

LIFE PINNARCA PROJECT

PROJECT OBJETIVES:

The project focus on three main objectives

1. **Increasing awareness** to a global scale, in order to reduce the possibility of vandalism and illegal collection of the remaining fan mussels, but also to call for broad public collaboration.

2. **Gathering all existing information** on the remaining populations and resistant individuals and include it into a data-base integrated within the LIFE Pinnarca webpage. This will provide a more informed background to other countries planning mitigation and recovery actions, so their effectiveness can be fostered.

3. **Developing active recovery actions** focused both on the resistant individuals and on the remaining non-resistant populations, in order to increase the probabilities of recovery of the species.

ACTION AREAS

The project is developed in selected areas that host habitats appropriate for *Pinna nobilis* populations, most of them included in **Natura 2000 Network**, including from healthy *Posidonia oceanica* meadows to enclosed bays, coastal lagoons or deltas with gentle hydrodynamic conditions or deeper maërl beds, with optimum substrate and conditions for maintaining fan mussels. These areas also hosted dense fan mussel populations before the MME and had some permanent monitoring stations that were **periodically surveyed**. Using previous information increase the probability of finding resistant fan mussels.

Shallow and deep census have been conducted to explore the presence of survivor fan mussels.

Larvae collectors have been installed in key locations where the probability of transportation of larvae by the currents is higher.

PARTNERS

The project partners are:

•Universidad Católica de Valencia, Instituto de Investigación en Medio Ambiente y Ciencia Marina, Spain (Coordinator).
•Agencia Estatal Centro Superior de Investigaciones Científicas, Spain:
- Instituto Español de Oceanografía, Centre Oceanogràfic de Balears, Spain.
- Instituto Mediterráneo de Estudios Avanzados, Univesitat de les Illes Balears, Spain.
•Ecologistas en Acción Región de Murcia, Spain.
•Institut Océanographique Paul Ricard, France.
•Institut de Recerca i Tecnologia Agroalimentàries, la Ràpita, Spain.
•Panepistimio Aigaiou, University of The Aegean – Research Unit, Greece.
•Universidad de Alicante, Spain.
•Università degli Studi di Napoli Federico II – Dipartimento di Biologia, Italy.

PREPARATORY ACTIONS

Planning correction measures

Report with suggested correction measures that could be implemented Spain, France, Italy and Greece. The report includes the current situation of the species and recommendations about specific actions that can improve the conservation of individuals in the long-term.

Location of optimum sites

The **identification of optimal sites to perform conservation actions** is of high importance to reach successful reintroductions/reinforcements in *Pinna nobilis* populations. Two kinds of situations for *P. nobilis* have been taken into account: reservoir areas (free of pathogen), and areas in the Mediterranean open sea (ideal for resistant individuals). In the first case, and based in updated knowledge, optimal sites have been explored taking into account environmental conditions that prevent the spread of the pathogen (e.g. salinity) but that are compatible with the survival of *P. nobilis* (dissolved oxygen, temperature, additional impacts,…). On the other hand, further optimal sites have been also prospected in the Mediterranean open sea aiming to find suitable places to host *P. nobilis* resistant individuals (previous knowledge of high densities, MPAs).

Photo: Ilenija Sudulić

ACTIONS (I)

Installation of larvae collectors

The objective of this action was to place larval collectors designed to **collect fan mussel larvae** that settle directly from the pelagic stage unto the mesh of the collectors, which will indicate larval availability and potential recruitment in the benthos. When recruits are obtained, it was possible to **work with them in captivity maintenance** (Action C7) **and repopulation** of study areas which are free of the parasite and considered as adequate for reintroduction.

The collectors were installed before the breeding season (April-May) and collected after the breeding season (October-November).

Exhaustive shallow and deep area census

In areas where the die-off has already decimated the populations, it is of utmost interest to **search for possible survivors**, which could be **resistant to the disease**. The partners conducted underwater census of shallow (<30 m depth) and deep (between 30 and 50 m) areas to evaluate the prevalence of mortality episodes and the occurrence of resistant survivors or hybrids (*P. nobilis*/*P. rudis*).

ACTIONS (II)

Translocation of individuals

In areas affected by *H. pinnae*, the few **survivors are scattered hundreds of km** among them, which prevents their reproduction. Additionally, many individuals live at risk in the reservoirs, and **their longevity could be more than doubled just by translocating them to nearby safer areas**. The slow decay of the populations in the reservoirs without the possibility of natural repopulation in the following years and decades, would extinguish them at medium term.

We propose an **alternative connectivity mechanism**, through the translocation of individuals, until new options (e.g. artificial reproduction of resistant individuals) are put into play. Also, some individuals could be reimplanted in areas optimal for the survival of fan mussels, but that had not been colonized by the species before the occurrence of the MME, **increasing the number of reservoirs.**

ACTIONS (III)

Comparative genomics

Samples of fan mussel tissues have been treated for subsequent DNA analyses. This concerns tissues obtained from individuals of different Mediterranean locations, the close-related and resistant, *P. rudis*, and few resistant hybrids of nobilis-rudis that have been detected since the epizootie. Genotyping of *P. nobilis* individuals gives clues on the **genetic structure of populations** for further conservation actions such as to ensure the genetic diversity of the species.

This action also aims at identifying loci putatively involved in the disease resistance by (1) comparing a group of healthy/resistant individuals with a group of a posteriori sick/dead individuals and (2) comparing the genome of *P. nobilis* with the phylogenetically related mussel, which is known to be resistant to the parasite.

Tissue samples

ACTIONS (IV)

Actions for environmental improvement in fan mussel sanctuary areas

The objective of this action is increasing the survival and **reducing the threats of fan mussel populations in the remaining reservoirs where *P. nobilis* survive**. The reservoirs occupy areas heavily subjected to anthropogenic impacts such as pollution, fishing, recreational activities, etc. Different actions will be implemented in each country in the main sanctuaries observed.

Tank maintenance of healthy individuals

Two replicate actions have been carried out at the marine station of IMEDMAR-UCV and the installations of Murcia Aquarium. The individuals were be maintained during the entire project in captivity. The objective of the action was to **develop culture protocols to maximize the possibilities of captive reproduction**, while ensuring the long-term survival of stabled individuals. Once reproduction in captivity is achieved, it will be possible to apply the same methodologies learned, to the few resistant individuals, to produce seed with a higher potential of being resistant to the disease.

ACTIONS (V)

Treatment assays and analysis

The individuals were be analyzed for the tolerance to environmental variables and also for their response to the infection and treatment of the disease. This action will help to **save individuals from affected populations**. It has been observed that cold temperatures <14ºC slow down the infection and dispersion capacity of *H. pinnae* and that extreme salinities (as those observed in coastal lagoons and Deltas) could prevent infection by the protozoan. Furthermore, some haplosporidians do not withstand extreme low temperatures, which eventually kill them. **Treatments of low temperatures and extreme salinities** will be assayed in infected individuals to try to cure them in indoor facilities.

MONITORING OF THE IMPACT OF THE PROJECT ACTIONS

This action aims to periodically assess the impact of the project's activities, particularly the conservation actions and the communication strategy, to ensure that the objectives are being met. To achieve this, the following tasks will be carried out:

1. **Monitoring Indicators**: Environmental, technical, and dissemination indicators as outlined in the "LIFE 2020 Key Project Level Indicators" table.

2. **Verification References**: Monitoring based on regular status reports from partners, direct contact, and visits to the project sites.

3. **Reports**: Periodic monitoring reports and a final conclusions report, accompanied by the final version of the indicators table.

Regarding the economic impact, the project evaluates how its actions contribute to socio-economic development through conservation efforts and stakeholder collaboration. The Social Return on Investment (SROI) method was applied to measure the social, environmental, and economic value generated per euro invested. Indicators include increased conservation proposals, stakeholder engagement, and funding opportunities. Evidence is collected to distinguish project-driven outcomes from unrelated changes.

PUBLIC AWARENESS AND DISSEMINATION OF RESULTS

Dissemination actions

The activities included in this action aim at providing information about the project and its results at European level.

Transferability of the project results

Establish a "specific strategy for the transfer of results" that goes beyond the dissemination action proposed in the project Action E1 and that will ensure the impact of the project, at the European level, specifically in Mediterranean Sea.

LIFE PINNARCA PROJECT

RESULTS OF IMPLEMENTED ACTIONS (I):

This section includes the implementation of the conservation actions and their monitoring (including the Follow up of juvenile and resistant individuals, the Follow up of Mar Menor sanctuary population, the Follow up of the effectiveness of sediment fences, the Monitoring and evaluation of the impact of the project actions and the Development of a socioeconomic impact study).

LIFE PINNARCA project has found that despite the situation of *Pinna nobilis* is critical, **there are** still **reservoirs in coastal lagoons in Spain, France, Italy and Greece**. Some of them show recruitment (e.g. Thau Lagoon, Kaloni and Amvrakikos Gulfs) **adding up to more than 5000 identified alive individuals**.

However, **these are the most impacted areas due to anthropic actions and global change**, and concrete conservation and protection measures must be implemented.

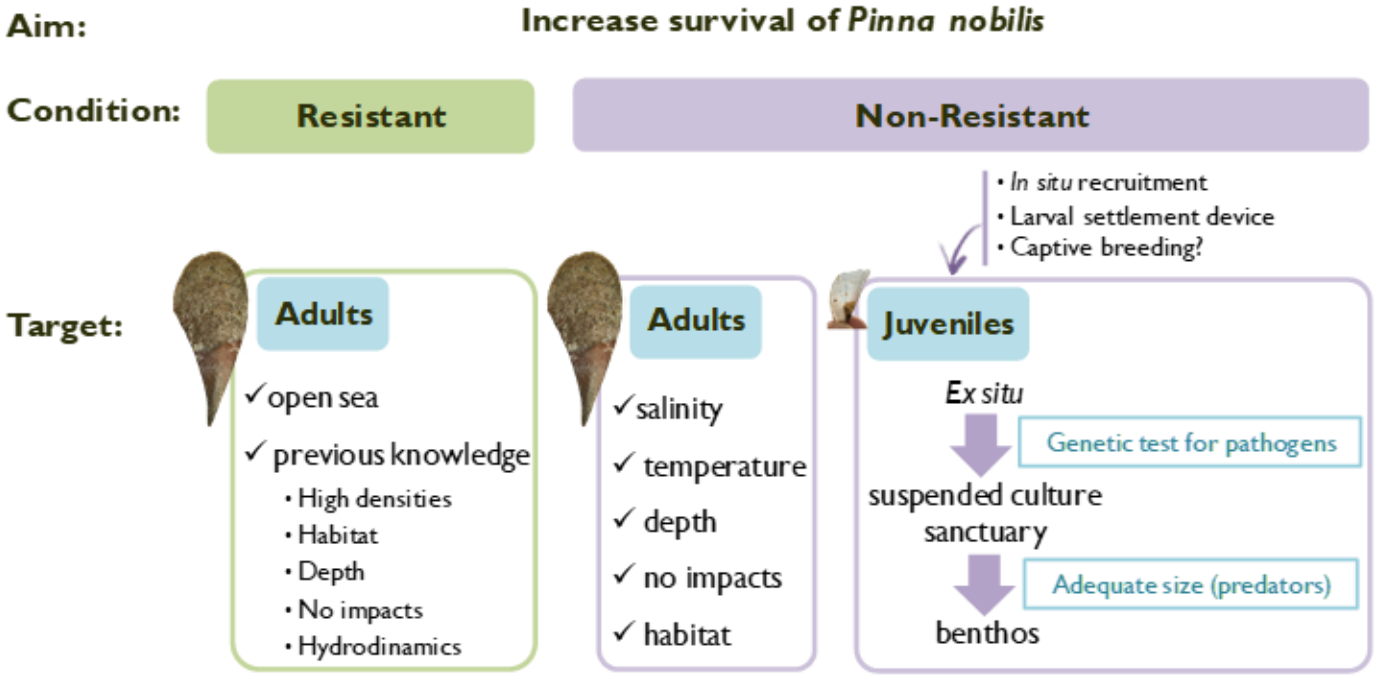
For more details, the documents developed within the framework of the project can be consulted at: https://www.lifepinnarca.com/

RESULTS OF IMPLEMENTED ACTIONS (II):

Report with suggested correction measures and location of optimum sites

During this action several reports were developed by all participants in the action related to the presence and status of *Pinna nobilis* populations in the different locations around the Mediterranean Sea and a report with the areas in the Spanish Mediterranean waters where survivors are alive. At the end of the action, the result was the development of a report with suggested correction measures.

Regarding to **optimal sites for resistant *P. nobilis*** individuals, in Spain, Cabrera National Park has been selected as the most optimal site to host resistant specimens.



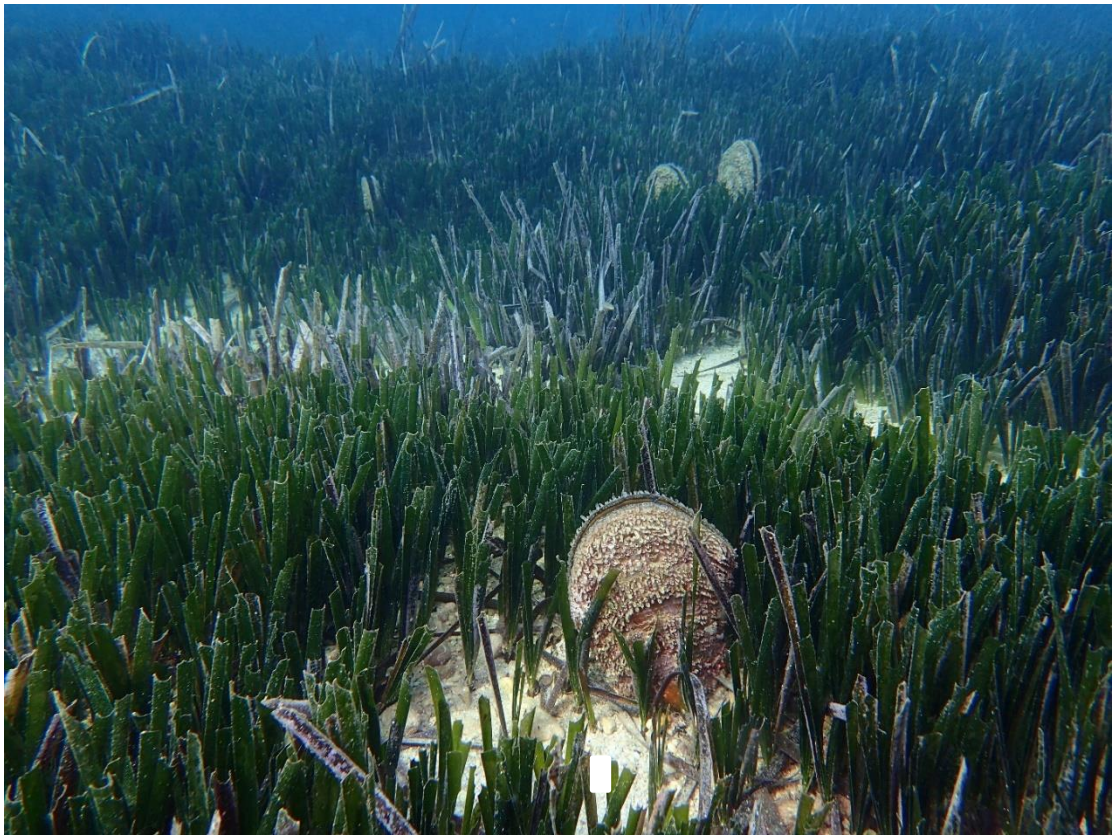
	Mediterranean Sea (Resistant)		Sanctuary (non-Resistant)	
Indicator	**Minimal criteria**	**Undesired criteria**	**Minimal criteria**	**Undesired criteria**
Dense populations	*>4 ind./100 m^2	*<2 ind./100 m2	>4 ind./100 m^2	-
Demography	*Positive, 0 or > -0.1 yr^{-1}	*< -0.2 yr^{-1}	Positive, 0 or > -0.1 yr^{-1}	-
Salinity	23-42	≤11 / ≥42	23-36.5 / 39.7-44.5	≤11 / 36.5–39.7 / ≥ 44.5
Temperature	8.5-26ºC	<8.5ºC/>26ºC	8.5-30 ºC	<8.5ºC/>30ºC
Hydrodinamics	< 9 Newton	45 Newton	< 9 Newton	45 Newton
Pressures	no anthropogenic pressures	pressures causing impacts	no anthropogenic pressures	pressures causing impacts

*Based on previous knowledge

RESULTS OF IMPLEMENTED ACTIONS (III):

In France, Brusc lagoon and the surrounding area of Les Embiez and the private basins with dense Cymodocea seagrass meadow could serve as a sentinel area for translocation. The Côte Agathoise MPA (Gulf of Lion) can also be considered an optimal site for the open sea, which is historically known to have hosted dense *P. nobilis* population.

Regarding **the reservoirs**, at Ebro Delta Fangar Bay display the lowest salinities and confer the highest protection to remaining individuals. However, in the monitored sites from Alfacs Bay a gradient of mortality has been observed with lower rates close to the Trabucador Sand Bar. In the Mar Menor lagoon, eighteen different variables have been used to model potential survival zones in collaboration with INUAMA and the Aquarium of the University of Murcia. Estany des Ponts (Balearic Islands) has been found to have the conditions to become a new reservoir and is the only area found as potential new reservoir to introduce fan mussels so far. In France, Diana pond (Corsica) and **Thau lagoon** (Occitan Coast) can be considered optimal sites. Alive populations have been found also in Urbinu lagoon (Corsica) and Grazel lagoon (Occitan coast) which can be considered potentially optimal sites too. In the Lagoon of Venice while up to 30% survival rate was observed inside the lagoon where *H. pinnae* was detected. Two (**Gulfs of Amvrakikos and Kalloni** in Lesvos Island) of the eleven surveyed sites in Greece can be considered “optimal” although only Amvrakikos is considered “pathogen free”. Both gulfs host alive and recruiting *P. nobilis* populations.



RESULTS OF IMPLEMENTED ACTIONS (IV)

Installation of larvae collectors

Very **few juveniles (27) have been found in larvae collectors**, most of them correspond to local recruitment within the reservoirs such as Amvrakikos Gulf and Thau Lagoon. Only a few have recruited in open waters, probably coming from the reservoirs. This suggest the **absence of "hidden" open water populations in the Mediterranean Sea** and that the future **conservation efforts have to be focused on the populations surviving in the reservoirs**.

Oyster farms from Thau lagoon have been found to be an excellent substrate for the recruitment of *P. nobilis* juveniles and numerous individuals are being found every year.

***Thau lagoon** : P. nobilis recruits in oysters farming areas*

Up: November 2022
Down: October 2024

RESULTS OF IMPLEMENTED ACTIONS (V)

Exhaustive shallow and deep area census

5.487 new individuals have been found alive and **living in reservoirs that were previously undetected** in Spain, France Italy and Greece. Models indicate the presence of 107.487 alive individuals living mostly concentrated in three reservoirs: Ebro Delta (2.827 individuals), Thau Lagoon (22.805 individuals) and Amvrakikos Gulf (80.549 individuals). **No surviving population has been found either in shallow or deep areas (up to 50 m depth) in open waters**.

Amvrakikos Gulf (Greece)

RESULTS OF IMPLEMENTED ACTIONS (VI)

Translocation of individuals

The success of translocations has been constrained by accelerating impacts derived from climate change and anthropic actions, such as excessive warming of sea water, killing both translocated and untranslocated individuals in kalloni Gulf (Greece), drought enabling the entry and survival of *H. pinnae* in Delta del Ebro and vandalism in Amvrakikos Gulf.

The survival of translocated individuals ranged between 0% (due to heatwaves and vandalism in Kalloni and Amvrakikos Gulfs respectively) and 94% in Amvrakikos Gulf.

Actions are now focused in reducing vandalism and increase the resilience of the populations in the reservoirs by working with the managers to reduce external impacts (specially those from direct anthropic origin.

Delta del Ebro

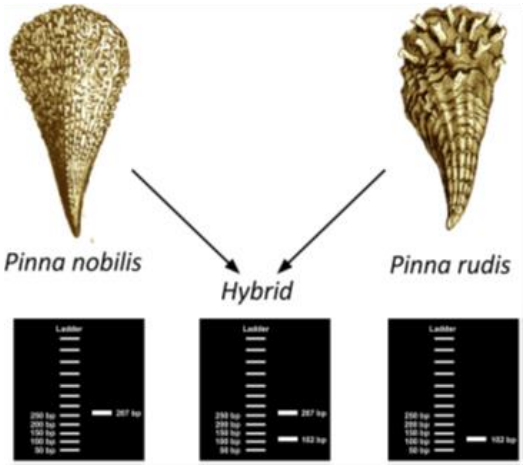
RESULTS OF IMPLEMENTED ACTIONS (VII)

Comparative genomics

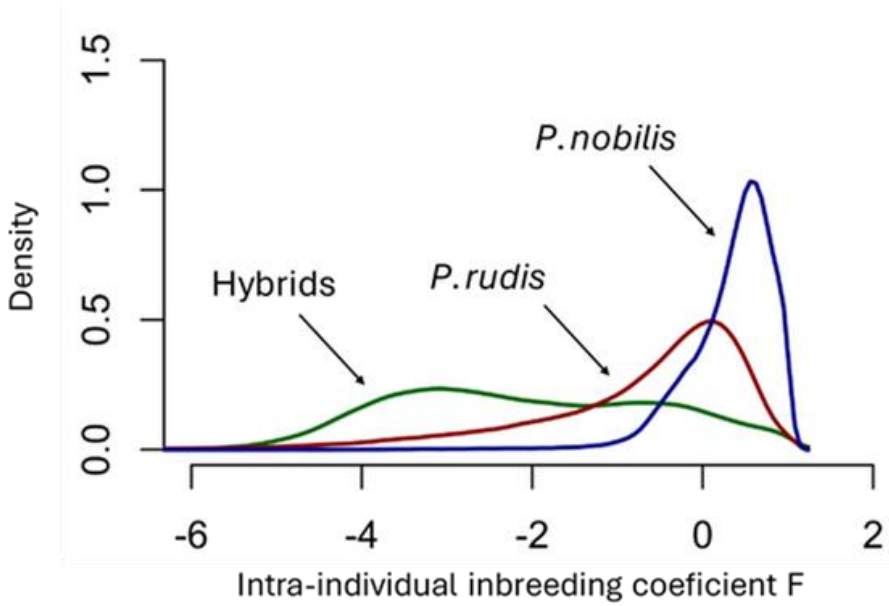
Genomic analysis and pathogen detection. Following the discovery of viral infection (PnPV) in the immune cells of Individuals of Catalonia (Alfacs Bay), same diagnostic was performed in Fangar Bay, Venice Lagoon and Faro Lake (Sicily). **All the areas and individuals resulted 100% positive to the infection**.

Samples of individuals of *Pinna nobilis* resistant, non resistant and hybrids have been analysed for resistance. **Analyses on sampled« resistant » and « sensitive » *P. nobilis*, *P. rudis* and hybrids *P. nobilis* x *P. rudis* have shown to exist potential SNP biomarkers in TLR genes to distinguish between resistant and sensitive individuals.**

Analysis of introgression of P. *rudis* into *P. nobilis* at the genome scale has shown that hybridization between the two species occurred in the past and that they share some genes.



Left: Catanese et al. 2024
Down: Analysis of introgression of P. rudis into P. nobilis at the genome scale

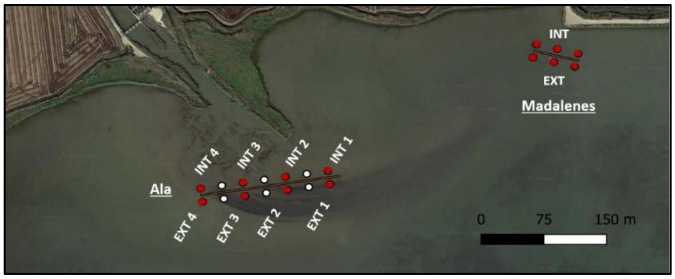


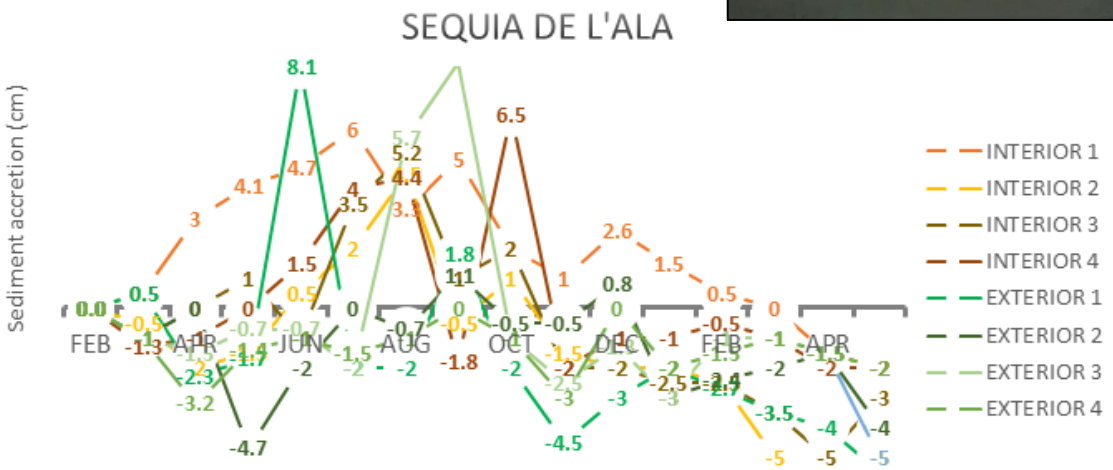
RESULTS OF IMPLEMENTED ACTIONS (VIII)

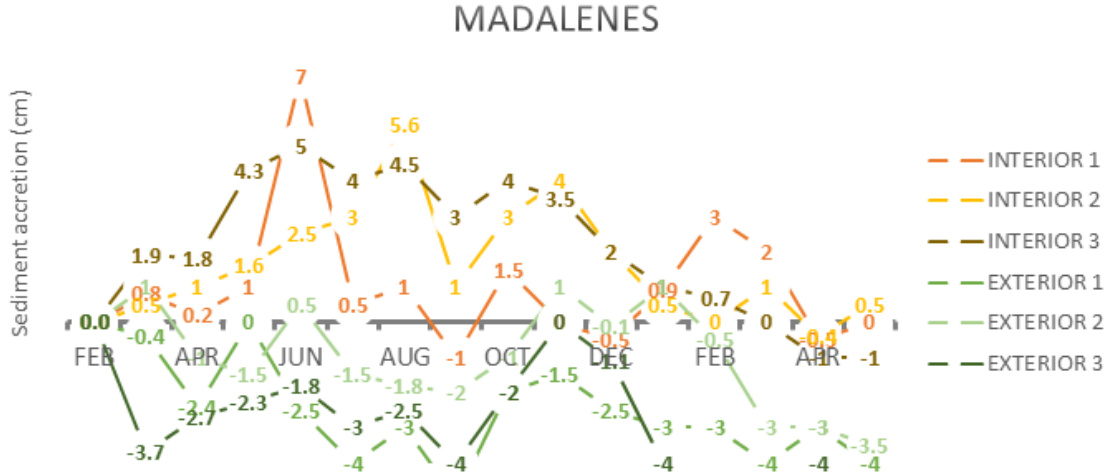
Actions for environmental improvement in fan mussel sanctuary areas

In Ebro Delta, fences were installed near two of the channels discharging towards a natural population to improve its habitat and water quality and favor the local recruitment. **The fences are able to filter the irrigation water coming from the canal**, reducing sediment accretion. When irrigation canals are open (April to November), differences in turbidity values between interior and exterior side can be seen, especially at Madalenes fence. The fence seems effective in buffer changes in salinity due to freshwater discharges.

At the moment, **a first exclusion area was approved in April 2024** by the Spanish Government (MITECO) (of ca. 40 ha), and a second area is also being negotiated in Alfacs Bay of Delta del Ebro.



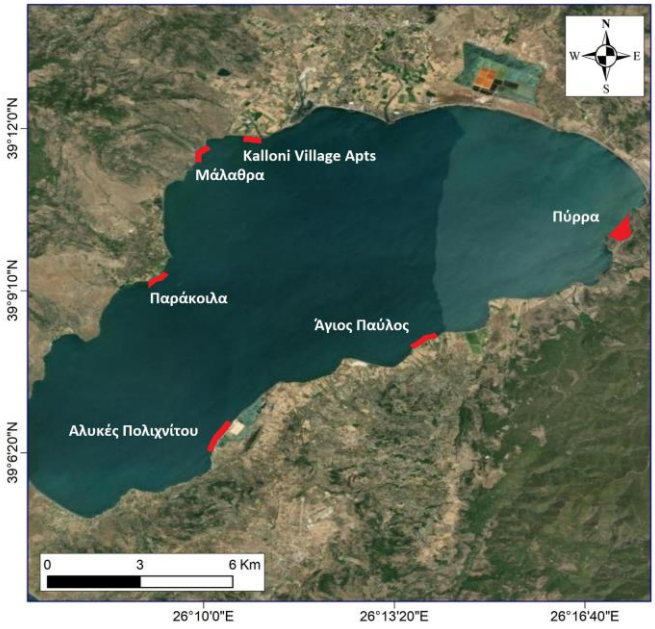


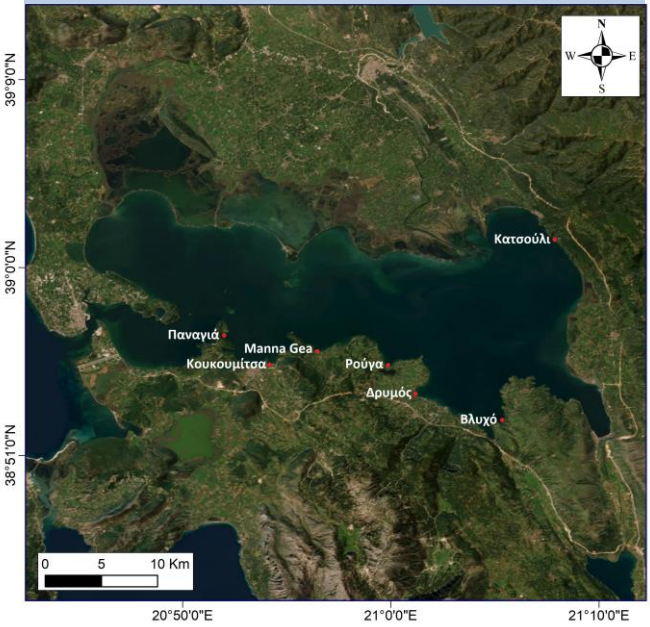


RESULTS OF IMPLEMENTED ACTIONS (IX)

During the project, **13 new MPAs have been proposed in Greece, 6 in Kalloni Gulf and 7 in Amvrakikos Gulf**.

Left: Kalloni Gulf
Right: Amvrakikos Gulf



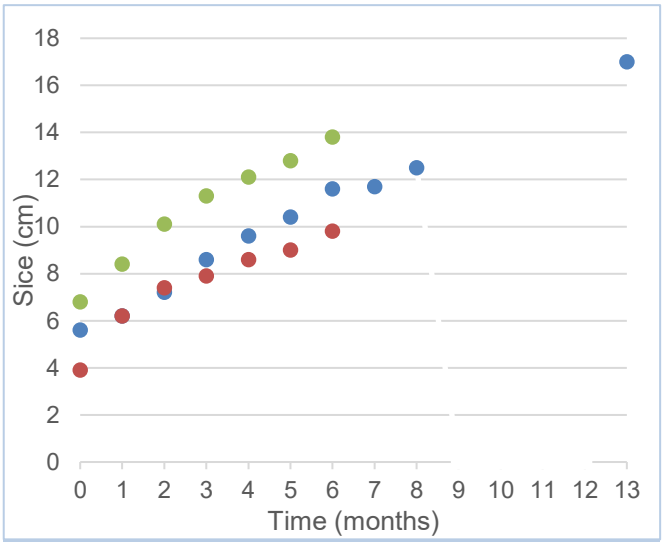


In Diana Lagoon, **shoreline cleaning actions**, **including the removal of ancient, dislodged floating aquaculture farms** stranded on the banks (especially in the southern part of the lagoon) is being implemented.

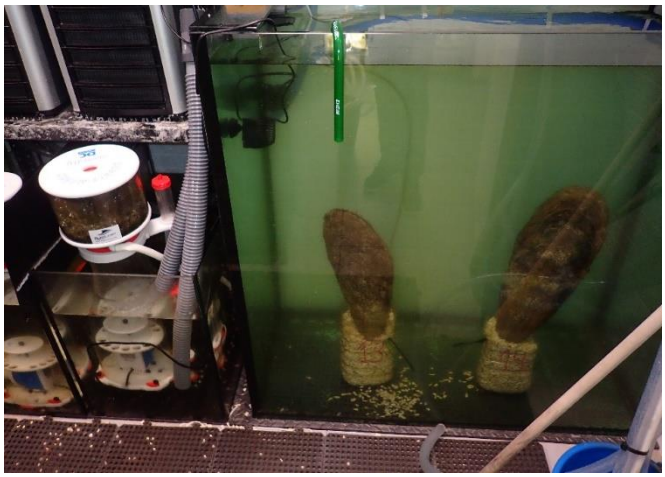
RESULTS OF IMPLEMENTED ACTIONS (X)

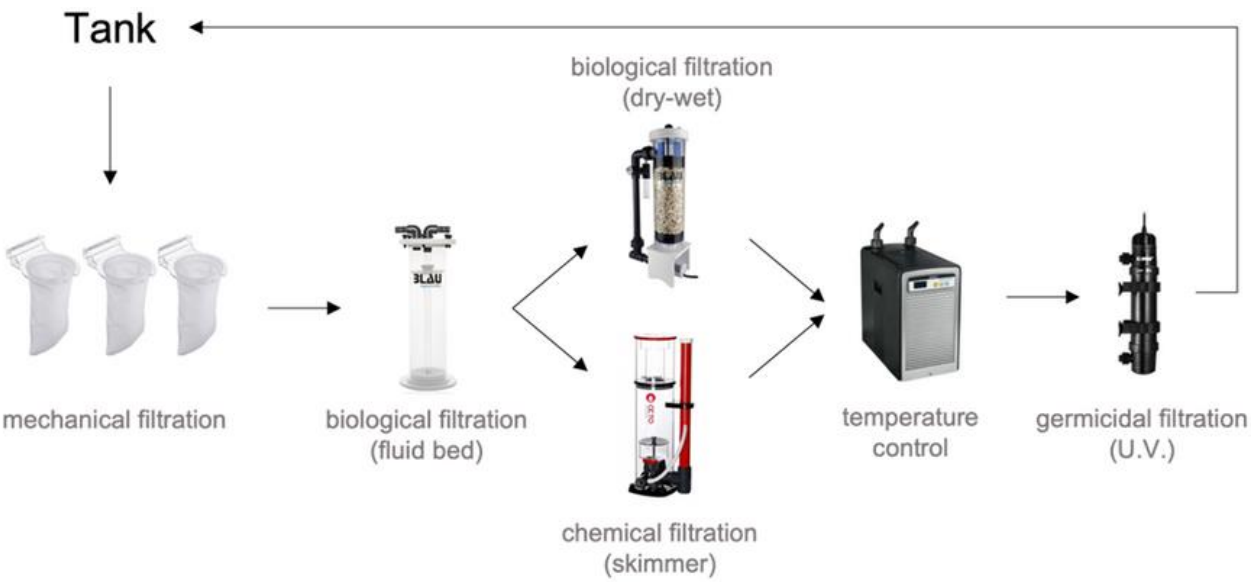
Tank maintenance of healthy individuals

A protocol has been written to describe the best conditions to maintain fan mussels in captivity, both in open and closed circuits. The conditions enable maintenance of individuals for longer periods expanding to more than 3 years. **Juveniles have been grown from 3.5 cm to more than 20 cm after two years in tanks for the first time.**



Growth of the three juvenile fan mussels retrieved from collector in October 2022





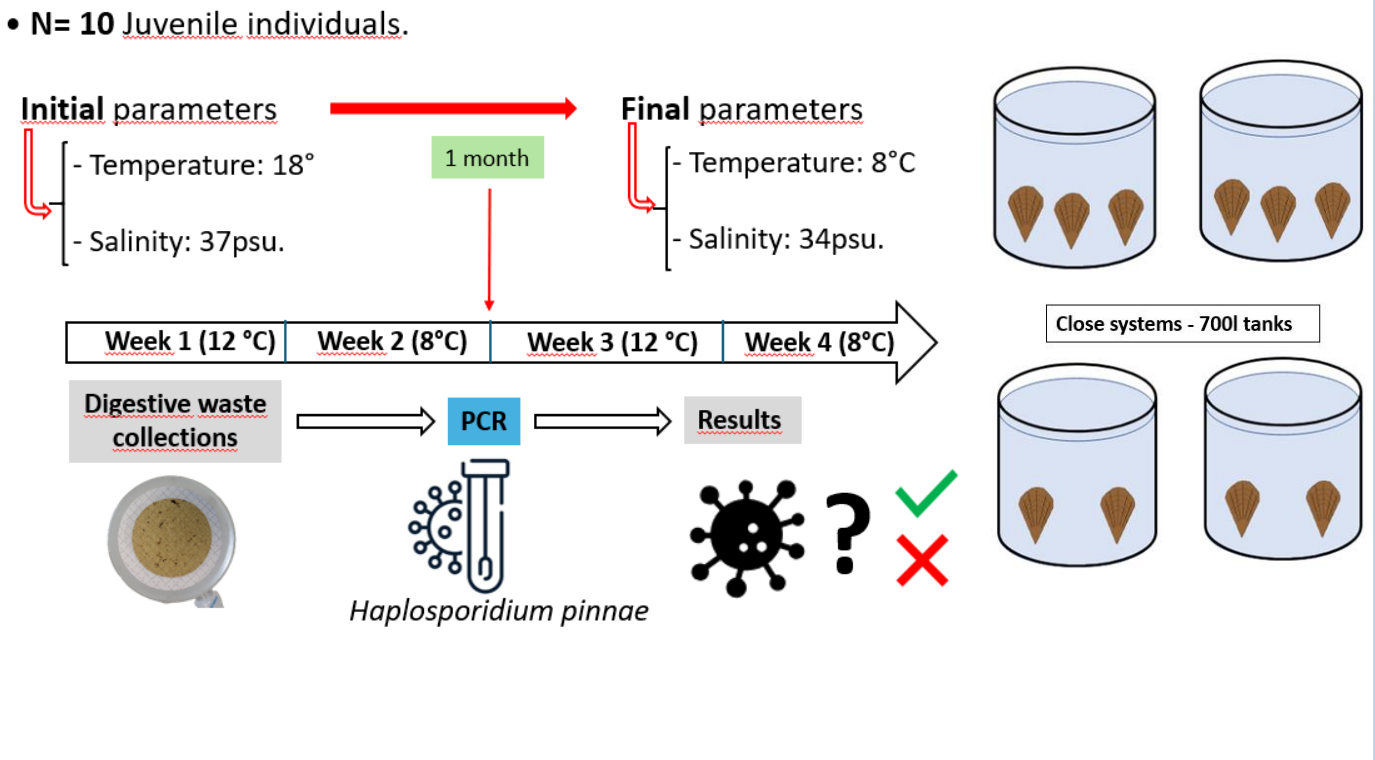
RESULTS OF IMPLEMENTED ACTIONS (XI)

Treatment assays and analysis

A treatment was applied to 10 juvenile *Pinna nobilis* individuals. They were placed in 700L closed-circuit aquaria with known initial salinity and temperature conditions (18°C and 37 psu). The treatment focused on gradually reducing these parameters in the tanks. Separate phases of low salinity (34 psu) and low temperature (8°C) were conducted over several consecutive weeks. **The concentration of the parasite decreased, but once the individuals were re-exposed to higher temperatures (18°C), the concentration of the disease returned to initial values.**

Therapeutic treatment including phytotherapy in individuals that had been previously subjected to the low-temperature treatments was conducted. Herbal medicine products contain bioactive compounds with various biological effects, such as immunostimulants, growth promoters, and curative agents for several pathogens like protozoa, bacteria, and viruses. The experimental phase was carried out at the IMEDMAR-UCV facilities during April and May 2024.

Salinity and temperatura treatment



RESULTS OF IMPLEMENTED ACTIONS (XII)

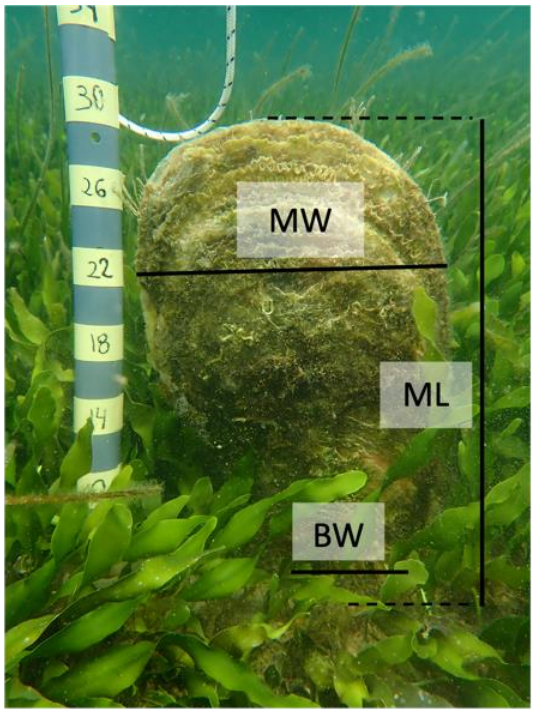
Follow up of Mar Menor sanctuary population

Plots were monitored from September 2022 to September 2024 to obtain information on population trends (density, development and growth, mortality rates, etc.) and epibionts description. In each plot, we also collected data on some environmental variables (temperature, salinity, dissolved oxygen, etc.), sediment characteristics (granulometry, redox potential, pH, etc.) and the main benthic macrophytes, obtaining information on the number of species, cover, canopy height and density of the seagrass *Cymodocea nodosa*.

Density of living individuals (living individuals/100 m2) in each locality at the different sampling times.

Locality	2022		2023		2024	
	May-June	September	May-June	September	May-June	September
PC	0.37	0.34	0.31	0.21	0.18	0.13
P	0.81	0.71	0.52	0.42	0.24	0.2
PG	0.48	0.45	0.44	0.38	0.32	0.3

Cleaning of individuals and measurements used to study sizes to study growth rates. Maximum width (MW), base width (BW) and maximum length (ML).



Dissemination actions and Transferability of the project results

During the project, numerous transfer and dissemination activities have been carried out:

SROI RESULTS

Input	Total investment	2.249.322 €
Economic impact of the project actions	Scientific Publications	119.045 €
	Filtration of Individuals	909.475 €
	Funding Obtained thanks to the LIFE PINNARCA	47.100 €
	Protected Areas	22.054 €
	Employment	650.000 €
	Volunteers	24.300 €
	Media Coverage	8.360 €
	Awareness and Sensitization	962.946 €
SROI ratio		1,2196

The final SROI value was 1,2196. This indicates that **for every euro invested in the LIFE PINNARCA project, a social return of 1,2196 has been generated in terms of social, economic, and environmental benefits** (2.745.968€ in total). Additionally, it is important to highlight that the economic quantification of the actions and objectives achieved within the framework of the LIFE PINNARCA project is a complex process, as the monetization of certain ecological goods and services presents significant challenges. The benefits provided by healthy ecosystems, where populations of *Pinna nobilis* are thriving, are far broader than those captured in this report. **These benefits not only have a positive impact during the duration of the project, but they also extend into the distant future, exponentially increasing both ecological and monetary gains**. In this sense, the true magnitude and scope of the actions carried out by this project far exceed any investment made, further reinforcing the need to continue these conservation efforts to ensure the future of the species and its preservation.

LIFE PINNARCA PROJECT

PUBLIC AWARENESS AND DISSEMINATION OF RESULTS

16 scientific publications in JCR Q1 and Q2 journals

Estuarine, Coastal and Shelf Science

Demographic regulation processes in *Pinna nobilis* population subunits: Implications for restocking

Laura Claramonte, Elvira Álvarez, Manuel Hidalgo, Salud Deudero, Maite Vázquez-Luis

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Highlights

- *Pinna nobilis* shows phenotypic variation in nearby subpopulations.
- There are differences in demographic stochasticity and adaptation to contrasting environments.
- Buffering effect of a large population with many adult individuals of many size classes is of great importance.
- Cabrera National Park is a suitable site for a future *Pinna nobilis* reintroduction program.

Marine Environmental Research

Sink-source connectivity for restocking of *Pinna nobilis* in the western Mediterranean Sea

A. Ferrio-Rodríguez, D. March, B. Mourre, I.E. Hendriks, M. Vázquez-Luis

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Highlights

- The endemic Mediterranean pen shell faces extinction due to an infectious disease.
- Conservation of the species depends on the identification of restocking areas.
- Six key repopulation areas were pinpointed by using a mixture of techniques.
- This network can support sustainable populations in the Western

PUBLIC AWARENESS AND DISSEMINATION OF RESULTS

More than 48000 humans directly influenced by the project thanks to 75 newspaper/magazine publications, 8 videos/broadcast, 5 poster/information boards, 5 events (including 2 international workshops and an international congress).

Indicator	Quantity
Public Administration	> 45
Associations	> 50
Scientific and Technical Community	> 50
Other Entities and Groups	> 25

Number of specialized activities in transfer of results	98

LIFE PINNARCA PROJECT

PUBLIC AWARENESS AND DISSEMINATION OF RESULTS

Public Administration	Associations	Scientific and Technical Community	Other Entities and Groups
National	**National**	**National**	**National**
Environment Resources Agency (ERA) Ministry of Malta Greek Ministry of Environment & Energy - Natural Environment and Biodiversity Greek Ministry of Maritime Affairs & Insular Policy - Department of Fisheries Control Greek Ministry of Rural Development & Food - Fisheries Institute for Environment and Nature, Ministry of Economy and Sustainable Development of Croatia Ministerio de Agricultura, Pesca y Alimentación of Spain Natural Environment and Forest Management from Balearic Regional Government Principality of Monaco Protected natural resources-protection and safeguarding of marine and coastal habitat Public Institution Sea and Karst, Croatia SPA/RAC Tunisia - Specially Protected Areas/Regional Activity Centre Steering Committee for the Natura 2000 site France Subdirección General de Biodiversidad Terrestre y Marina (MITECO) TRAGSA *"Empresa de transformación agraria sociedad anonima"* TRAGSATEC Public Company VAERSA Public Company	Assoziacione Professionale Agricola (AcliTerra) *Asociación* SUBMON Cabrera National Park Balearic Calanques National Park President Cilento National Park Côte agathoise Marine Protected Area FNE - France Nature Environment Fundació Fisabio (Fundación para el Fomento de la Investigación Sanitaria y Biomédica de la Comunitat Valenciana (Fisabio)) *Fundación* CONAMA Fundation IMC – International Marine Center Greek Natural Environment & Climate Change Agency - NECCA National Eau et Milieux aquatiques de France Nature Environment (FNE) SeoBirdLife The Geotechnical Chamber of Greece - GEOTEE Triton Research Union des Océanographes de France (UOF) Vallo di Diano and Alburni National Park (PNCVDA)	Aquarium Pula Ltd. Croatia CESM (Centro Studi Ecosistemi Mediterranei). CNR-IAS National Research Council, Italy Croatian Veterinary Institute Zagreb Hellenic Centre of Marine Research IMC International Marine Centre, Italy Institut Supérieur de Biotechnologie de Sidi Thabet, Tunisia Institute for Environment and Nature of Zagreb Institute of Anthropic Impact and Sustainability in marine environment (IAS) – National Research Council (CNR) Institute of Marine Sciences, Venice, Italy *Instituto de Acuicultura de Torre de la Sal* (IATS) - CSIC *Instituto de Ciencias del Mar* (ICM) CSIC Istituto Zooprofilattico di Portici - IZS Istituto Zooprofilattico Sperimentale delle Venezie - IZSve IUCN - *Union Internacional para la Conservación* Japan Fisheries Research and Education Agency Lycée de la mer Paul Bousquet Marine Biology Station Piran (Slovenia) Marine ecology engineer in the ECOSEAS laboratory, CNRS Mediterranean Institute of Oceanology, Marseille, France National Council of Researches, Institute of Marine Sciences, Napoli Oceanográfic de Valencia Oceanographic Center of the Balearic Islands (IEO-CSIC) Oceanographic Institute of Monaco Scientific Center of Monaco	Pact for the Mar Menor ComBio Fédération officielle de plongée sous, marine FFESSM EDF France Energy Fondazione Federico II of Palermo Foundation VEOLIA France *Fundación Azul Marino* Hippocampus INFOSA - *Salina Marina*, Cataluña, Spain *Instituto de Ecología Litoral* Monaco Yacht Club *Observadores del Mar* Office français de la biodiversité - OFB, France PLAN BLEU *Posidonia Ecosports* SOS Mar Menor, Spain The Observatory Sustainable Development Goal for the Mediterranean (SDG4MED) Triton Submarines WWF ITALY MIRAMARE AMP | SHORELINE SOC. COOP
Regional	**Regional**	**Regional**	**Regional**
Calp City Council of Spain City Council Torrevieja City representative of Six-Fours-Les-Plages Coast Guard of Kalloni Gulf Coast Guard Station of Gera Gulf Conselleria de Agricultura, Pesca, Desarrollo, Rural, Emergencia Climática y Transición Ecológica, GVA *Conselleria de Medio Ambiente, Infraestructuras y Territorio, Valencian Community, Spain* Direcció General de Medi Natural i d'Avaluació, Generalitat Valenciana Direction départementale des territoires et de la mer de l'Hérault Direction Régionale de l'Environnement, de l'Aménagement et du Logement Occitanie Directorate of Agricultural Affairs, North Aegean Directorate of Agricultural Economy and Fisheries - North Aegean Fisheries Department Environment and Territory from Balearic Regional Government Environment and Water Agency of Andalusia Environment Department of Alcudia City Council Environment of Palma City Council Generalitat Valenciana Coastguard Ibiza Town Hall La Région Occitaniae Marseillan City Council Murcia Fisheries and Aquaculture Service, Department Livestock Fisheries and Aquaculture Murcia Natural Heritage and Climate Change Natural Environment of Murcia Office Environnement de la Corse Port Authority of Mytilene Public Institution Natura Histrica Regional governor - Directorate of Environment, North Aegean Region Service of wildlife, Generalitat Valenciana Species Protection Service, Department of Environment Baleares Species Protection Service, from Balearic Regional Government	A.S.L Azienda Sanitaria Locale Albufera Natural Park ARPA Liguria Environmental Protection Ag. *Asociación Cultural Ars Creatio* *Asociación Marítima Estrella Polar* Assemblea Regionale Siciliana Association *Cabo de Palos* Association Française de Limnologie AVRAMAR fishfarms Cepralmar - centre d'étude pour la promotion des activités lagunaires et maritimes Comité régional de conchyliculture de Méditerranée (CRCM) Comité Régional des Cultures Marines Occitanie Comité Régional des Pêches Maritimes et des Elevages Marins Occitanie *El click verde* FEDEAS - *Fund. Española De Activ. Sub-acuáticas* Comunidad Valenciana Fishermen guild of Calpe Fishermen's Association of Mytilene Fishermen's Association of Western Lesvos Fishermen's Guild of San Pedro del Pinatar France Bleu Provence *Fundación Barcelona Zoo* Japonaise Océanographie - Académicien Président Société Franco l'Académie des Sciences Lettres et Arts de Marseille Lycée de la mer Paul Bousquet Mar Menor Office Marina Owners' Association Marine Explorers Society "20.000 leagues" Monaco Foundation Oikosferiki - Environmental Consulting Company *Parque Natural de Serra Gelada - Benidorm, Alicante* PROMAR - *Asociación defensa de la Fauna Marina* Syndicat Mixte Bassin de Thau (SMBT)	Universidad de Valencia - CIDE/SAMA ,Spain Universidad Miguel Hernández, Spain Universidad Politécnica de Valencia, Spain Università di Messina, Italy University - SETU (South East Technological) Ireland University Aix-Marseille - Institute of Biosciences and Biotechnologies – CEA University Aix-Marseille , IMBE (Institute of Biodiversity and Marine and Continental Ecology) University Bandirma Onyedi Eylül , Turkey University of Acibadem , Turkey University of Aix-Marseille , Mediterranean Institute of Oceanology, France University of Antipolis , France University of Athens - Agricultural , Greece University of Florida (USA) - Medina Aquarius Underwater Habitat University of Genoa, Italy University of Genova / Ramoge , Italy University of Klaipeda , Lithuania University of Malta, Malta University of Mauritius, Mauritius University of Montenegro, Institute of Marine Biology University of Murcia - Aquarium, Spain University of Sassari, Italy University of the Aegean, Greece University of Toulon, France University of Tripoli, Tunisia University of Tunis El Manar , Tunisia University of Tunis, Tunisia University of Western Macedonia, Greece University of Zadar, Croatia University of Zagreb - Faculty of Science, Croatia University of Vanvitelli, Italy	Galpemur- Local action group for fisheries in the Murcia Región Juan Carlos I Nautical School Réglon PACA Thau lagoon Oyster farmer

FUTURE CHALLENGES

For effective conservation of *Pinna nobilis*, the main challenges are:

•Improve conservation status of reservoirs to preserve the remaining populations.

•Increase awareness and reduce direct impacts and vandalism.

•Improve the legislation and creation of protocols to transport fan mussels within and among countries. Creation of an international Biosecurity Program to ensure the security of translocation of individuals among the remaining reservoirs to speed up the process.

•Monitoring and further experimentation on the disease and genetic associated factors.

•Improvement of the conditions of the individuals maintained in indoor facilities (nutritional and environmental aspects), it is necessary to complete a treatment to facilitate the reproduction of the individuals that reduces the load of the pathogens and enables the development of safe maturation and spawning procedures.

•Close the reproductive cycle of *P. nobilis* in captivity.