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BEST PRACTICES AND MANAGEMENT MEASURES OF THE BLUE CRABS IN THE MEDITERRANEAN

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I. EU policies framework on invasive species management

At international level, there are several major international conventions on biodiversity that take account of the problem of invasive alien species:

- the **Convention on Biological Diversity** requires each contracting party to "prevent the introduction of, control or eradicate alien species that threaten ecosystems, habitats or species". The new post-2020 strategic framework currently being negotiated includes a target for reducing the introduction of invasive alien species.
- the **Convention on the Conservation of European Wildlife and Natural Habitats**, or **Bern Convention**, makes numerous recommendations concerning invasive alien species. It also establishes a European strategy on invasive alien species. The obliges its parties to strictly control the introduction of exotic species, or to manage and eliminate those that have already been introduced.
- the **Convention on Wetlands, or Ramsar Convention**, requires parties to take measures to identify, eradicate and control invasive alien species on their territory.

At European level, several regulatory frameworks are tackling the problem of invasive species, including blue crabs:

- The **Marine Strategy Framework Directive (MSFD)** is the main European tool for maintaining healthy, productive and resilient marine ecosystems. This directive (n°2008/56/CE) recognizes that the introduction of exotic species endangers European biodiversity and calls on member states to include these species in the description of "good ecological status".
- The **Marine Strategy Framework Directive (WFD)** (n°2008/56/EC) recognizes that the introduction of exotic species endangers European biodiversity and calls on member states to include these species in the description of "good environmental status".
- **Regulation on the use of alien and locally absent species in aquaculture**. The aim of this regulation (n°708/2007) is to ensure that Member States take all appropriate measures to avoid any harmful effects on biodiversity resulting from the introduction or transfer of aquatic organisms or species for aquaculture purposes, as well as the spread of these species in the wild.
- **The European regulation on the prevention and management of the introduction and spread of invasive alien species**. Adopted on October 22, 2014, Regulation n°1143/2014 aims to prevent, reduce and mitigate the adverse effects on biodiversity of the introduction and spread of invasive alien species within the European Union. It establishes, based on a risk assessment, a list of invasive alien species of concern. Each Member State may draw up a list of species of concern on its territory, using the same method.

In the Mediterranean:

- The **Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean** was adopted on February 16, 1976 in Barcelona.
- The **SPA/BD Protocol** to the Barcelona Convention was adopted in 1995 and came into force in 1999. The SPA/BD Protocol provides the regional framework for the conservation and sustainable use of biological diversity in the Mediterranean. It calls on the Parties to protect areas of particular natural or cultural value, through the creation of Specially Protected Areas (SPAs) or Specially Protected Areas of Mediterranean Importance (SPAMIs), and to protect threatened or endangered plant and animal species listed in its annexes. The SPA/BD Protocol provides the regional framework for the

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II. Actions already carried out in the Mediterranean to fight the blue crabs' invasion

II.1 Action plans for controlling the blue crab

II.1.1 Spain | Action plan for controlling the blue crab

The American blue crab *Callinectes sapidus* is listed as a commercial species and is not included in the national catalog of invasive alien species in Spain, in accordance with Decree 630/2013. The Spanish Department of Fisheries has developed a **professional fishing plan for the exploitation of blue crabs to reduce their abundance**. Catalonia pioneered the regulation of American blue crab landings in fish markets in September 2016. **Commercial catches increased from 15.8 tons in 2017 to over 450 tons in 2019**, a figure that has remained stable since and generates approximately 1.5 million euros annually.

The main objective was to **reduce abundance and control the blue crab population, although a sustainability plan for blue crab fisheries at the Mediterranean scale is currently being developed**. What is considered a conservation (rather than fishing) organism is counterproductive for controlling and rebuilding declining indigenous species populations, as well as for the indigenous fishery products affected by the proliferation of crabs. From a conservation standpoint, in the current situation, a ban on commercial fishing of blue crabs would represent a serious and unnecessary social conflict, especially because the main group affected by this hypothetical ban would be coastal fishermen, the very group most impacted by the invasion.

However, **commercial fishing should not be equated with an "invasion control" activity**. On the one hand, the possibility of controlling the crab population through fishing has not been demonstrated, and on the other hand, generating an economic activity around the species would make it difficult to implement effective control actions, should they be developed. **Blue crab fishing is only allowed for professional fishing and not for recreational fishing** in Catalonia. These objectives imply that fishing activities should not be guided solely by the maximization of economic profit but should focus efforts on areas and periods that have the greatest impact on blue crab populations. Such targeted fishing would require smooth collaboration between research centres, administrations, and fishermen, as well as the availability of economic resources. In this regard, a blue crab co-management committee was established in Catalonia with the participation of all relevant sectors, which could serve as a model for other regions.

In the **Balearic Islands**, **American blue crabs are captured by both professional and recreational fishermen, but recreational fishermen primarily carry out the capture**. **Common methods include the use**

of crab pots, nets, and baited traps. These methods are effective and widely used to manage the crab population and prevent its spread. The captured blue crabs are mainly sold in local and international markets, where they are considered a delicacy.

In **mainland Spain**, there is a **dedicated commercial line for blue crabs**, available in markets throughout the country. However, in the Balearic Islands, the blue crabs seen in markets actually come from mainland Spain rather than local waters. **While commercial capture is permitted in the Balearics, it is not economically viable, and recreational fishermen are not allowed to sell their catches**.

In **Mallorca**, the Consell Insular de Mallorca has shown that granting **recreational fishing permits can be an effective strategy to reduce local populations**. Balancing these approaches is key to effective management.

II.1.2 France | Territorial Plan for the Control of the American Blue Crab

A **Territorial Plan for the Control of the American Blue Crab** (*Callinectes sapidus*) was implemented in 2024 for the Corsica region (France). This strategic management document for the American blue crab is a **regional adaptation of the national strategy for controlling invasive alien species** (IAS).

The overall goal is to **provide a framework guided by the five pillars of the national strategy** (NS), aiming to **strengthen and structure collective action**. Specific actions are also implemented, based on robust scientific foundations and a shared territorial control strategy for greater effectiveness, while aligning financially with project funding requirements. **Ten objectives** from the NS related to IAS have been broken down into **25 operations**, each including precise actions to be deployed at the regional level. Extensive scientific work has informed these actions and will continue to refine them. For example, the type of actions and their prioritization in lagoon areas (where physico-chemical monitoring exists), as well as the definition of periods and individuals to target for more effective site-specific action, are being clearly identified. The overall objective of this Territorial Action Plan is to provide a working framework guided by the five pillars of the national strategy, namely:

- **Action 1: Prevention, Early Detection, and Monitoring** – Prevention of the introduction and spread of new invasive alien species.
- **Action 2: Management and Restoration** – Species management interventions and ecosystem restoration.
- **Action 3: Knowledge** – Improvement and sharing of knowledge.
- **Action 4: Communication** – Communication, awareness-raising, mobilization, and training.
- **Action 5: Governance** – Governance.

II.1.3 Italy | Italian Containment plan 2025-2026: measures to protect biodiversity

The **Italian Blue Crab containment plan** funded with a total of 10 million euros as outlined in the Legislative Decree on Agriculture for the 2025-2026 period, aims to safeguard biodiversity in affected habitats, control and combat the spread of invasive species, prevent further economic losses, and support the recovery of farming and fishing activities:

- Decree "omnibus" n. 104 - 10 August 2023: economic support to crab fisheries - 2.9 M Euros.
- Ministerial Decree n. 628456 - 13 November 2023: economic support to compensate loss in investment for clam seeds and expenses incurred for farm protection - 10 M Euros.
- Decree Agricultura n. 63/2024: further economic support - 27 M Euros.
- National solidarity fund – Law 102/2004 - 3.7 M Euros.

Key measures include controlling and disposing of the blue crab, protecting aquaculture infrastructure, promoting alternative uses for biomass, and providing financial support to businesses in the sector.

The plan foresees the broadening of management measures to other regions in Italy (e.g., 2025-2026). For effective implementation there is the need for multilevel cooperation among institutions, stakeholders, and research institutes. Adaptation to new conditions (e.g., commercial fishing development) could be needed. Effective monitoring will allow adaptation – integration of ongoing monitoring under another legislation/framework (e.g., DCF, MSFD, WFD, EcAp) is critical.

The measures aim at combating invasive alien species focus on safeguarding local biodiversity, conserving natural ecosystems, and protecting economic activities and human health, with different objectives:

1. Targeted fishing, when conducted with the appropriate methods, is recognized as an effective measure to protect biodiversity.
2. Establishment of a Working Group (WG) has been proposed to oversee the implementation of measures that ensure the sustainability of lagoons, such as morphological modifications to facilitate seawater exchange between marine and lagoon environments.
3. Target females (ovigerous) to reduce populations
4. Selective fishing carried out mainly with passive gears (pots, nets), refund to fishers per kg (about 1 Euro/Kg).
5. Commercial fraction (blue crab) can be sold.
6. Incidental catch of other commercial species caught cannot be sold.
7. Incidental catch of C. sapidus from other fishing can be refunded.
8. Economic support for the disposal of crabs (about 0.5 Euro/Kg).

Further supports are implemented to enable the implementation of the fishing activities:

- Activate fish markets, cooperatives, local administrations to enable the landing of crabs, their quantification, and disposal.
- Support scientific testing of innovative fishing gear.
- Support the adoption of gears, where needed and justified.
- Ensure addressing the feasibility of economic uses of crabs beyond human consumption.

II.1.4 Tunisia | Strategy for Blue Crab Valorisation

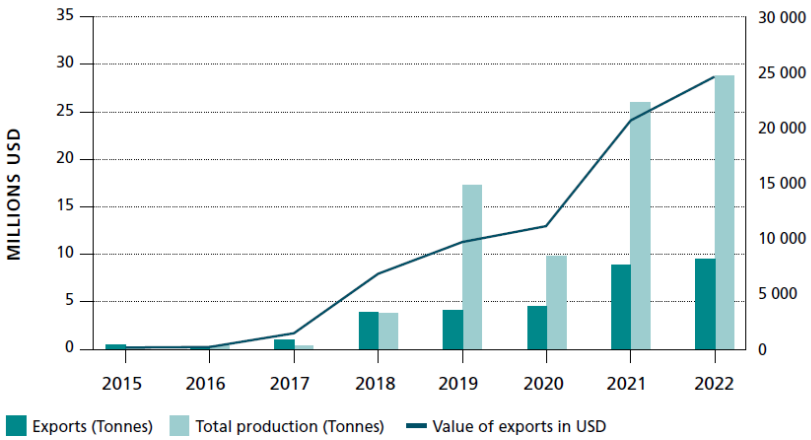
Following the invasion of *Portunus segnis* in Tunisia in 2014, the Tunisian government implemented significant measures to limit the spread of the blue swimming crab and support local fisheries. In 2017, a national plan to encourage fishing, promotion, and commercialization of blue crabs was officially enacted including different actions (Ben Souissi *et al.*, 2024):

1. **Establishment of collection zones for blue crabs retained in the fishing nets to avoid their release to the sea and ensure income for fishermen.**
2. **The government purchases all blue crab catches without limits at a rate of 0.8 USD per kg,** with 0.4 USD funded by the government and 0.4 USD by industrial stakeholders.
3. **Stimulating demand through the national marketing** of blue crabs and exploring international markets.
4. **Encouragement of both national and international investments** to establish processing factories.
5. **Strengthening scientific research for the rational management** of this new edible resource, including stock assessments and the development of appropriate fishing technologies.

Tunisia was one of the first countries to implement industrial commercialization of the blue crab to limit its invasion.

In collaboration with various institutions (laboratories, associations, fishermen's groups, etc.), the Tunisian government has implemented several **awareness-raising actions to encourage citizens to consume and exploit blue crab**.

FIGURE 4
Total *P segnis* production in Tunisia and exports from 2015 to 2022



*(Production during 2015 and 2016 is underestimated due to catches returned to the sea)
In 2017, production of some landing sites is missed in official statistics, which explains why exports excced catches

Figure 1. Evolution of blue crab production and value in Tunisia from 2015 to 2022. Figure extracted from (Ben Souissi *et al.*, 2024).

Currently, there are **49 seafood processing factories, 17 of which specifically focus on processing blue crabs** (Ben Souissi *et al.*, 2024). The largest investment in a blue crab processing factory in Ghannouch comes from the Middle East, amounting to 70 million dollars (Ben Souissi *et al.*, 2024). This investment has created 1,600 jobs, 1,400 of which are for women. The factory has a production capacity of 110 tons per day, primarily for export, and features a large cold storage room with a capacity of up to 6,000 tons (Ben Souissi *et al.*, 2024).

In 2022, approximately **25,000 tons of blue crabs were caught in Tunisia**, with around 6,000 tons exported worldwide. The blue crab fishing industry in Tunisia generated nearly 30 million USD in revenue in 2022 (Figure 1).

II.1.5 Turkey | Valorisation of blue crabs

In Turkey, **the American blue crab (*Callinectes sapidus*) has become an important economic resource**, particularly in regions such as the Göksu delta, Dalyan and the Akyatan lagoon. Initially a threat to local fisheries due to its tendency to damage nets, the species is now exploited commercially.

Events such as the “Mavi Yengeç Koşusu” (blue crab race) raise public **awareness and promote its presence**. Crabs fetch high prices, **between 8 and 10 euros per kg**, and **are exported to Eastern Asia**, where their meat is a highly prized delicacy (source here) and the shells, used in cosmetics, are much sought-after

(source here). However, despite the economic benefits, the blue crab's non-indigenous status and its potential impact on the environment remain largely ignored.

In Turkey, **around 300 to 500 tons of blue crabs are exported every year**, making a significant contribution to the local economy. Efforts are underway to create an **industrial zone for the processing and export of these crabs**. **The species is actively promoted** for its sustainability, but these campaigns unintentionally contribute to the spread of the species, **potentially introducing it to new areas**. In Dalyan, efforts to preserve female crabs are aimed at sustaining the population, but they also encourage the uncontrolled growth of the species. Furthermore, as Turkey is not an official member of the EU, it is not obliged to adopt EU regulations concerning invasive species. As a result, there is **no national alien species management policy** and, despite ongoing international projects, there is still no comprehensive action plan to address the potential risks of the blue crab to local biodiversity. The lack of awareness and regulatory measures raises serious concerns about the ecological consequences of promoting this species without proper management.

II.2 Raising awareness about the consumption of the blue crab

II.2.1 Italy | UseIt: Using Operational Synergies for the Integrated Management of Invasive Alien Species in Italy

The USEit project aims to **establish an integrated and collaborative approach to enhance IAS management in both marine and terrestrial environments**. This objective will be achieved through technical and technological innovations, coupled with studies **to optimize information management** and **explore the economic potential of IAS**.

II.2.2 Italy | WWF: Transforming small-scale fisheries

WWF is engaged in several countries on working on NIS, including Italy, Tunisia, and Greece. The issue is addressed also through the work on small-scale fisheries which is coordinated in a regional initiative (Transforming small-scale fisheries | WWF). The WWF work in Italy highlights collaborations with fishers, chefs, and restaurants to raise awareness about the invasive Blue Crab's culinary potential. For this work WWF partnered with famous restaurants and chefs, including Harry's Piccolo (Michelin 2-star restaurant) and Mimi e Cocotte in Triest, to create innovative dishes using the crab (from dinner menus to street food), showcasing it as a valuable resource. Training sessions for Harry's Bistro staff reinforced the sustainability message behind the dishes, emphasizing a shift in perspective on invasive species. Mimi e Cocotte also participated in the "Ciacola di Mare" talk, sharing sustainable food practices and offering Blue Crab panino samples to engage the public. Additionally, Michelin-starred chef Antonia Klugmann hosted a live cooking show, preparing Blue Crab dishes and advocating for local, underutilized ingredients. In Northern Italy, the WWF Transforming Small-Scale Fisheries project hosted a hands-on cooking competition with a specialized business development company that also supports the development in the field of transnational cooperation ENAIP VENETO, allowing participants to explore Blue Crab's versatility. Local fishers acted as judges in the event, which fostered collaboration and innovative solutions.

WWF also facilitated cross-border knowledge exchange between Italian and Tunisian fishers by introducing traditional Tunisian crab traps, promoting sustainable practices and better management of Blue Crab populations across the Mediterranean.

Figure. Examples of WWF´s work in Italy: Event with famous Chefs on the WWF Ambassador boat “Blue Panda” in Trieste, training with the kitchen staff of famous restaurants, cooking competitions including different stakeholders (fishers, NGO, researchers, fisheries management organization representatives), and the winner dish creations. (from left to right and top to bottom). Photos’ credits: Clementine Laurent

II.2.3 Greece | Pick the Aliens

"Pick the Alien" project **aims to address the dual challenges of invasive species proliferation and overfishing in the Mediterranean**, particularly in Greece. It seeks to **mitigate ecological impacts by promoting the consumption of edible alien species** such as lionfish, spinefoots (*Siganus spp.*), and blue crabs (*Callinectes sapidus*). The project emphasizes collaboration among fishers, chefs, seafood processors, and consumers to create a sustainable supply chain and raise awareness about responsible seafood consumption. Key outcomes include:

1. **Sustainable Fisheries Practices**: Experimental traps for lionfish have been tested, although their efficiency varies due to technical and environmental factors.
2. **Market Integration**: Alien species have been introduced to menus in restaurants and hotels, with efforts to develop processed products like salted spinefoot fish.
3. **Public Engagement**: Gastronomic festivals and cooking competitions have highlighted the culinary potential of invasive species, with strong public participation and media coverage.
4. **Community Benefits**: Training initiatives for women in seafood processing and educational campaigns aim to enhance local economies and involve stakeholders in sustainable practices.

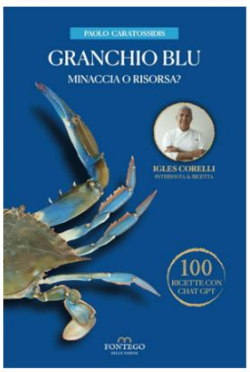
The project's successes in engaging diverse stakeholders and promoting invasive species as a culinary resource underline its potential to balance ecological and socioeconomic goals in managing marine ecosystems. More information: https://isea.com.gr/pick-the-alien-eng/?lang=en).

II.2.4 Italy | BlueEat project

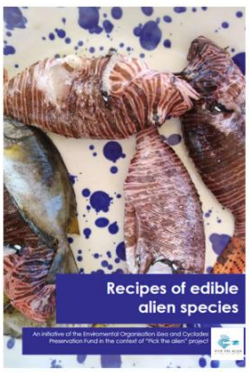
Blueat **explores new possibilities for the management and utilization of alien species**, which are becoming increasingly prevalent in the Mediterranean due to changes in the marine environment. The goal of the Blueat project is to **integrate these NIS species into the Italian gastronomic traditions the as quickly as possible, transforming an environmental challenge into an economic opportunity for the Italian agri-food sector**. The project aims to generate positive outcomes for the sea, the ecosystem, indigenous fauna, fishing, and coastal tourism, while minimizing the impact on both the environment and the socio-economic system, which could otherwise suffer if this "invasion" is left unmanaged. The objectives are to: (**i**) **promotes and transition small-scale and traditional fishing** into sustainable practices. Collaborate with fishermen and their local cooperatives to sustainably capture alien species; experiment with new fishing tools and methods; involve universities and research organizations in the process, (**ii**) E**ncourage the consumption and culinary use of alien species** with the goal of incorporating them into traditional Italian cuisine. Promote these species in markets, restaurants, and the Horeca sector; publicize them through social media, television, and other mass media outlets, as well as through innovative apps; organize fairs, events, congresses, research and study labs, and show-cooking demonstrations, (**iii**) **Shift fish market demand from traditional species to alien species**. Assist in creating an innovative micro-supply chain for alien species that can be replicated in coastal regions across the country; raise awareness of the environmental and socio-economic sustainability objectives; highlight the nutritional and gastronomic benefits of these species. More information: https://www.blueat.eu/

II.2.5 Books of recipes on blue crabs in the Mediterranean Sea

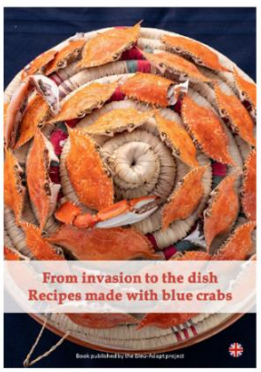
Cookbooks have been published to raise awareness among citizens about consuming blue crabs and to provide guidance on how to prepare them. For instance, in 2023, a book titled *"Granchio blu: Minaccia o risorsa"* was published in Italy, featuring 100 recipes using blue crabs. The *Pick the Aliens* project also produced a recipe book focused on cooking invasive edible species in the Mediterranean.



Book of receipes entitled "Granchio Blu. Minaccia o Risorsa?: 100 Ricette con ChatGPT (Italian Edition)". Paolo Caratossidis, Fontego Delle Farine Editions, 2023.



Book of receipes entitled « Recipes of edible alien species". Pick the Alien project,



Book of receipes entitled "From invasion to the dish: receipes made with blue crabs", Bleu-Adapt Project.

Book of receipes entitled "The American blue crab: an invader to be savored", Environmental Agency of Corsica.

The Italy-Tunisia *Bleu-Adapt* project published a book titled *"From Invasion to the Dish: Recipes Made with Blue Crabs"*, containing 30 blue crab recipes created by the fisherwomen of the Kerkennah Islands. This book is available in Italian, French, and English, and is distributed free of charge.

In Corsica (France), a cookbook was also published by the Environmental Agency of Corsica during a public awareness event held in September 2024.

II.3 International cooperation programs

II.3.1 Italy-Tunisia | Bleu-Adapt project

The goal of the BLEU-ADAPT (Interreg Italy-Tunisia) project was to **provide a rapid response to the biological invasion of blue crabs and to support adaptive management of the issue in Italy and Tunisia**. This objective led to a series of **specific actions**, closely aligned with local realities. The bilateral collaboration facilitated an in-depth risk analysis, driven by ecological and socio-economic information collected through participatory approaches with the fishing community. **Geographic data combined with environmental data** were also used to model the potential geographical expansion of the species. The information gathered during the project was used to **implement adaptive management practices**. The communication strategy targeted key stakeholders in species management and potential end-users, encouraging the natural responsiveness of civil society through specific training. Finally, **considering the commercial potential of the blue crab**, a series of pilot actions were directed towards **promoting and developing the value chain of this species in the Italian and Tunisian markets**, involving all socio-economic actors and even the general public, thus creating new market opportunities with the ultimate goal of stimulating a socio-economic dynamic around the invasive species fishing activities. This adaptation strategy provided a **concrete and immediately effective solution to tackle the blue crab** issue in Tunisia and served as an effective model for its expansion into other fishing regions in Italy and Tunisia. More information: https://bleu-adapt.eu/apropos/#presentation.

II.3.2 Italy-Slovenia | BLUECRAB project

The BLUECRAB project (Interreg Italy-Slovenia) objectives are to bring long-term benefits to both fishing operators and local communities, who are currently the most affected by the blue crab invasion, particularly from an economic and environmental perspective. The BLUECRAB project also involves **creating a cross-border partnership that includes business support organizations**, **public authorities, NGOs, specialized universities, and research centers, as well as numerous associated partners such as regions, development agencies, and other institutions**. This partnership is essential to tackling the environmental crisis, requiring an integrated approach and a combination of scientific, technical-operational, and local expertise. To safeguard the biodiversity of Upper Adriatic areas threatened by the blue crab invasion through sustainable **monitoring, surveillance, and management systems**, with the active involvement of institutions, local communities, and fishing operators. BLUECRAB project will establish a permanent observatory for scientific and economic studies aimed at mitigating the harmful effects of the blue crab. It will also develop a cross-border strategy and two action plans, tested through two pilot activities: systematic monitoring of the blue crab's spread using apps and IT tools, and selective fishing practices based on sex and reproduction. Additionally, guidelines will be developed to encourage the consumption of this species as a means of controlling its population locally. More information: https://www.ita-slo.eu/en/bluecrab.

II.3.3 Spain-Portugal | CRABMEDPOL project

The CRABMEDPOL project, led by the Spanish Institute of Oceanography (IEO-CSIC), focuses on using the **Atlantic blue crab as a model species to evaluate the effects of chemical pollution and microplastics on marine organisms**. It also explores the species' potential role as a sentinel for pollution in Mediterranean ecosystems. The project involves analyzing and validating various chemical and biological indicators at different levels of biological organization in the blue crab, ranging from proteomics to behavioral biomarkers. These analyses aim to provide insights into the bioaccumulation of environmental contaminants, including micro- and nano-plastics, and their impacts on the health of the species. Spanning three years, the project is divided into three phases. The first phase involves the development and validation of experimental procedures. The second phase consists of two controlled laboratory experiments, known as microcosm studies. The final phase includes an environmental analysis using the Mar Menor coastal lagoon as a case study to assess real-world impacts.

II.3.4 International | General Fisheries Commission for the Mediterranean – GFCM – Research programme on blue crabs

General Fisheries Commission for the Mediterranean
Commission générale des pêches pour la Méditerranée

The GFCM issued Recommendation GFCM/42/2018/7 on the implementation of a regional research programme on blue crab in the Mediterranean Sea, in order to properly evaluate their population status and maintain sustainable fisheries. The main objective of this research programme is to **set up a coordinated science-based framework for the sustainable management of blue crab fisheries**, taking into account both economic and environmental objectives. The research programme has **six specific objectives**, each corresponding to as many work packages (WP):

1. Collect as much information as possible on the **biological and ecological characteristics** of the two species of blue crabs in order to **support responsible fisheries management**.
2. Collect **fisheries independent data** to provide valuable additional information on catch composition and on the overall affected faunistic community.
3. Collect **fisheries-dependent data** on Mediterranean blue crab to provide a foundation for an effective management structure and process.
4. **Establish an ad hoc framework for blue crab stock assessment**, considering both the habitats of the crabs and the particular characteristics of the fisheries.
5. Understand both the **technical/technological and socio-economic aspects** of blue crab fisheries.
6. Develop adaptive **management measures at local, national and regional levels** to keep blue crab populations at low levels.

More information: https://www.fao.org/gfcm/researchprogramme-bluecrabs/en/).

III. Recommendations for the management of blue crab species in the Mediterranean

Concerns about the invasion of blue crabs, Portunidae *Callinectes sapidus* and *Portunus segnis*, have been growing for several years. Even at the beginning of their invasion, intensive fishing and canning were identified as the only defences against their spread. However, in addition to these control measures, it is necessary to carry out a number of important actions for the effective implementation of control measures for these species in the Mediterranean.

As in Spain, France and Italy, action plans to combat the invasion of blue crabs have been put in place to limit their impact on economic activities and biodiversity.

An **international workshop was organized in Rome (Italy) on January 24, 2025** at the Ministry of Agriculture, Food Sovereignty and Forestry (MASAF), bringing together **43 participants and experts of invasive species from 16 Mediterranean countries** to present the current situation of the invasion of the two blue crabs *Callinectes sapidus* and *Portunus segnis* in the Mediterranean, and to present local initiatives in each country to mitigate and combat blue crabs. **A round-table discussion** was organized to **propose recommendations for the implementation of an action plan against blue crabs in the Mediterranean.**

It became clear that **eradication** (i.e. the removal of all individuals from an invaded area) **is impossible** in the case of blue crabs, which currently have viable, reproducing populations that are integrated into ecosystems. However, the challenge now is to **find ways of mitigating blue crabs** to **protect biodiversity** by reducing blue crab abundance, and to **reduce the socio-economic impacts** on artisanal fishing and aquaculture.

The recommendations proposed in this report to combat the blue crab invasion have the overall aim of **helping Mediterranean countries to adapt these measures to their country's socio-economic and ecological context**.

The aim is to propose **five national and international strategies**, and to strengthen and structure collective actions as well as specific actions based on solid scientific foundations and a common Mediterranean control strategy for greater effectiveness.

The proposed plan of recommendations comprises **five actions** and **one action of governance**:

1. Monitoring blue crabs and quantifying ecological impacts (national/regional scales)
2. Spatial control and fisheries (national/regional scales)
3. Awareness on consumption and socio-ecological implications (national/regional scales)
4. Early detection and rapid response (national/international scales)
5. International cooperation programs (international scales)

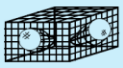
Action plan to fight the blue crab invasion in the Mediterranean Sea

National & Regional scales

1 Monitoring blue crabs and quantifying ecological impacts

- **Population dynamics** → Monitor **population structure**, sexual maturity, reproduction to **determine sensitive periods for the species.** A **stock assessment analysis is essential .**
- **Biological studies** → **Reproduction and growth** rates, **habitat** use (acoustic telemetry) and migrations.
- **Ecological impacts** → **Food web analysis** (isotopes, stomach contents), **species functional response** to quantify impacts on local biodiversity

2 Spatial control and fisheries



- **Control periods** → Based on population monitoring, set up **intensive fishing operations during sensitive periods** for the species (e.g. breeding season, migration periods of females at sea) to extract as many individuals as possible.
- **Fishing gears** → Develop **efficient catching methods**: test types of **fishing gears adapted** to blue crabs and local substrate conditions
- **Blue crab chain** → On a national scale, develop a **blue crab marketing chain**. The national chain will enable **short-line sales of specimens without international exports**, to limit economic competition between countries.

3 Awareness on consumption and socio-ecological issues

- **Education** → Public education and awareness is essential to the development of a blue crab chain. **Public events on blue crab consumption** (show cooking, TV programs, recipe books, etc.) **are essential.**
- **Engagement** → Raising public awareness of **the impact of blue crabs on socio-economic activities and biodiversity** is essential. Explain that **commercialization is a method of population control** to help preserve ecosystems.
- **Stakeholders** → **Include stakeholders and conduct Local Ecological Knowledge (LEK) studies** to determine **management expectations** and **perceptions of blue crab impacts**.

4 Early detection and rapid response

- **Education** → Raise public awareness and **provide information on best practices to be used when encountering a blue crab** (e.g. don't release it into the water, destroy the specimen, report its presence), **based on European and international regulations on invasive species.**
- **Citizen science** → Develop **harmonized citizen science programs to report the presence of blue crabs** for **early detection** and **monitoring of species persistence**.
- **Monitoring** → Scientists and managers need to s**et up monitoring systems in areas not invaded by blue crabs and/or at the start of the local invasion**, to **detect their presence and implement containment and removal measures**. This is **particularly the case for *Portunus segnis*, which is still in its expansion phase.**

International scale

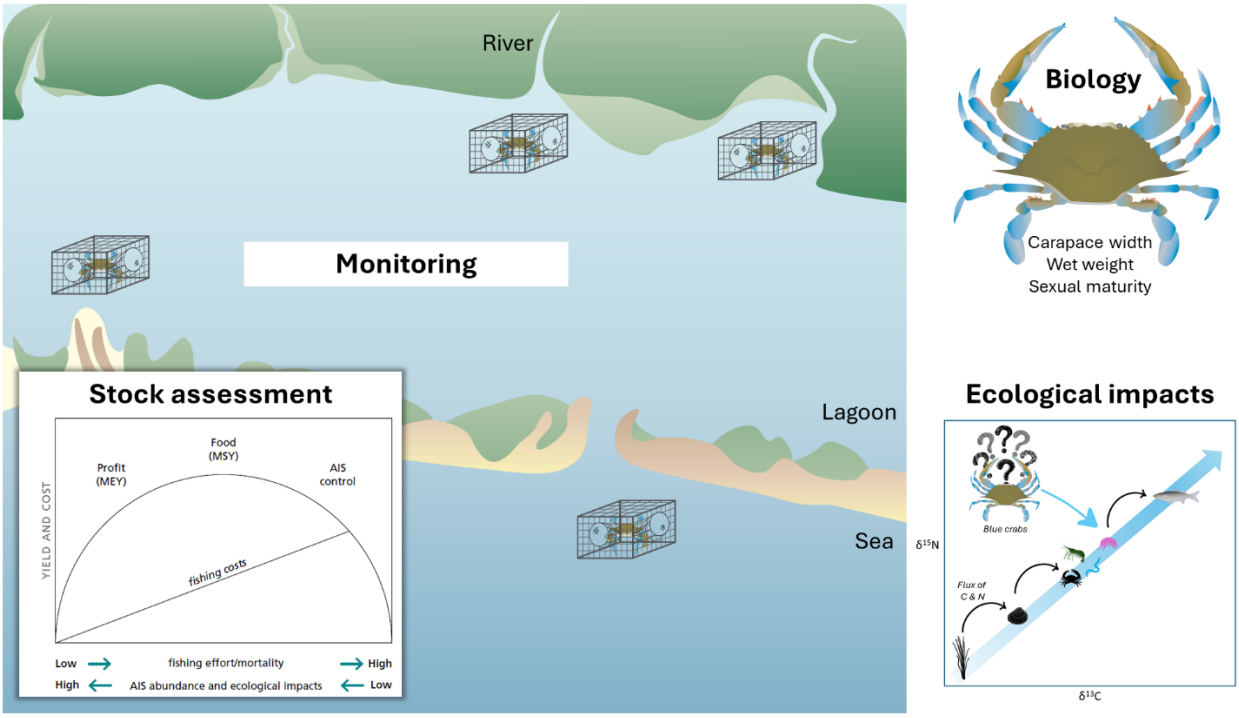
5 International cooperation programs

- **Transboundary projects** → Increase **cross-border projects between the north and south of the Mediterranean** to **combine expertise** between researchers/institutions **for a better understanding of international issues.**
- **Best practices** → **International meetings and workshops** will provide an **opportunity to exchange best practices** in terms of blue crab response and **management in Mediterranean country**.
- **Harmonized actions** → An **international Mediterranean blue crab action committee** should be set up **to harmonize all the proposed recommendations**.

Gouvernance

- **Program evaluation using indicators defined for each operation**, and will make it possible to monitor the progress of each action according to the initial schedule.
- **Inclusion of all stakeholders in the governance process:** ministries, scientists, managers, fishermen/fish farmers, government departments, **to ensure a global vision of the issue.**
- Set up **meetings twice a year** (one interim, one annual) **to review progress and production of deliverables.**

❶ Monitoring blue crabs and quantifying ecological impacts



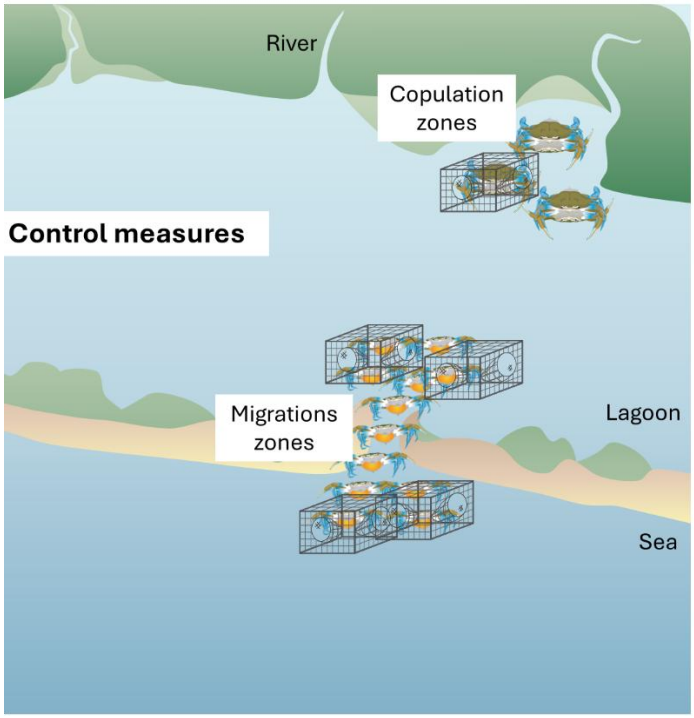
To analyze populations structures and ecological impacts of blue crabs, it is essential to **identify pilot sites** that are representative of invaded sites on a national/regional scale. **These pilot sites will serve as laboratories for carrying out the action 1 tasks**.

The first action involves **monitoring the population dynamics** of blue crabs, including their **structure, sexual maturity, and reproduction**, to identify **sensitive periods** for the species. This involves measuring carapace length, wet weight, sexual maturity, egg mass and egg colour. Indicators such as the proportion of each size class will help determine **population structure and growth rates**. **Long-term, high-frequency population monitoring** (minimum 1 to 2 times a month) should be implemented to obtain robust data on blue crab populations. It is also recommended to carry out **spatial monitoring** in the same area (i.e. several fisheries in different areas of invaded sites on a local scale) to determine the spatial distribution of blue crabs and their habitat use, in order to gain a better understanding of which areas should be prioritized for population control. The monitoring needs to include the **measurements of environmental parameters** as temperature, salinity, oxygen, etc. to identify the effect of environment on population structure.

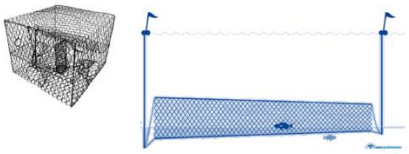
Stock assessment is also crucial to implement effective actions. Biological studies focus on **reproduction** (sexual maturity, males/females' ratio, reproduction periods, eggs)**, growth, and migrations** (using techniques such as acoustic analysis for the last). **Assessment stock models need to be developed**, based **on classic fishing models**, to **determine the quantities of blue crabs that need to be fished** to have a significant control effect on populations and avoid population sustainability.

Finally, **ecological impacts need to be assessed** through food web analyses (e.g., isotopes, stomach content) to evaluate the effects of blue crabs on local biodiversity and ecosystem functions. The analysis of ecological impacts will need to consider **analyses of ecosystem services**, including fisheries and aquacultures, **to determine how the blue crab invasion mitigates ecosystem services** at the pilot sites. Also, if available, a **comparison could be made with baselines on native species/biodiversity before** blue crab invasion, to compare the effects of blue crabs on biodiversity.

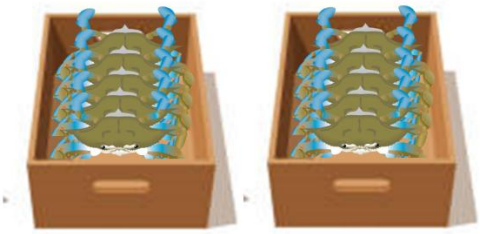
❷ Spatial control and fisheries



Fishing gears adapted to pilot site



Blue crab chain market

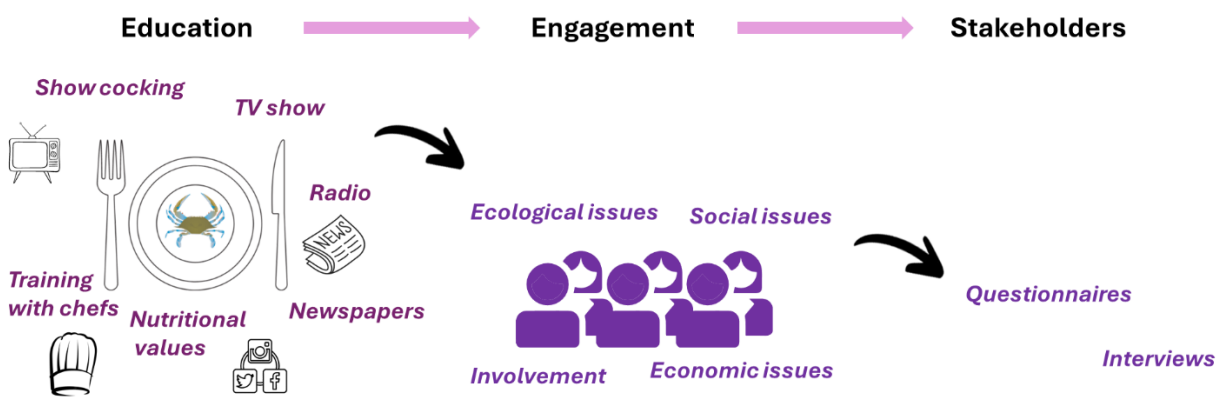


To control blue crab populations, it is proposed to **establish control periods** based on population monitoring, particularly **during sensitive periods for the species** such as reproduction. **Females are often the limiting element in blue crab populations**. Then it is important to **determine where, when and how** to catch as many females as possible during key periods. It has been recognized that it is **during the copulation and migration periods of ovigerous females that action should be taken**. For each pilot site, the aim will be to **locate the migration routes** of the females before they go out to sea, by setting up **barriers between the lagoons and the sea, for example**.

The control action must be carried out with efficient fishing equipment to capture as many individuals as possible. Then, developing adapted fishing tools is also necessary, with **tests on specific gear** designed to capture blue crabs while minimizing impacts on local substrates. Many types of fishing equipment are used in the Mediterranean, but not all work in the same way in all areas. Therefore, as part of action 1 of the monitoring program, it is **recommended to test the different types of fishing gears to determine which are the most effective, depending on the substrate** in the pilot site.

On a national scale, **creating a blue crab marketing chain** will allow for the quick sale of specimens **without relying on international exports**, reducing competition between countries and supporting local fishers. The creation of a blue crab chain is of great interest, particularly to enhance the value of catches made during control operations. This will make it possible to compensate for economic losses linked to the impact of blue crabs on small-scale fishing and aquaculture, and to use marketing as a control measure. The creation of a blue crab chain needs to be discussed, framed and set up in collaboration between **government departments, fishermen/fish farmers, restaurateurs and seafood marketing** companies, to ensure the distribution and eventual transformation of blue crabs for consumption.

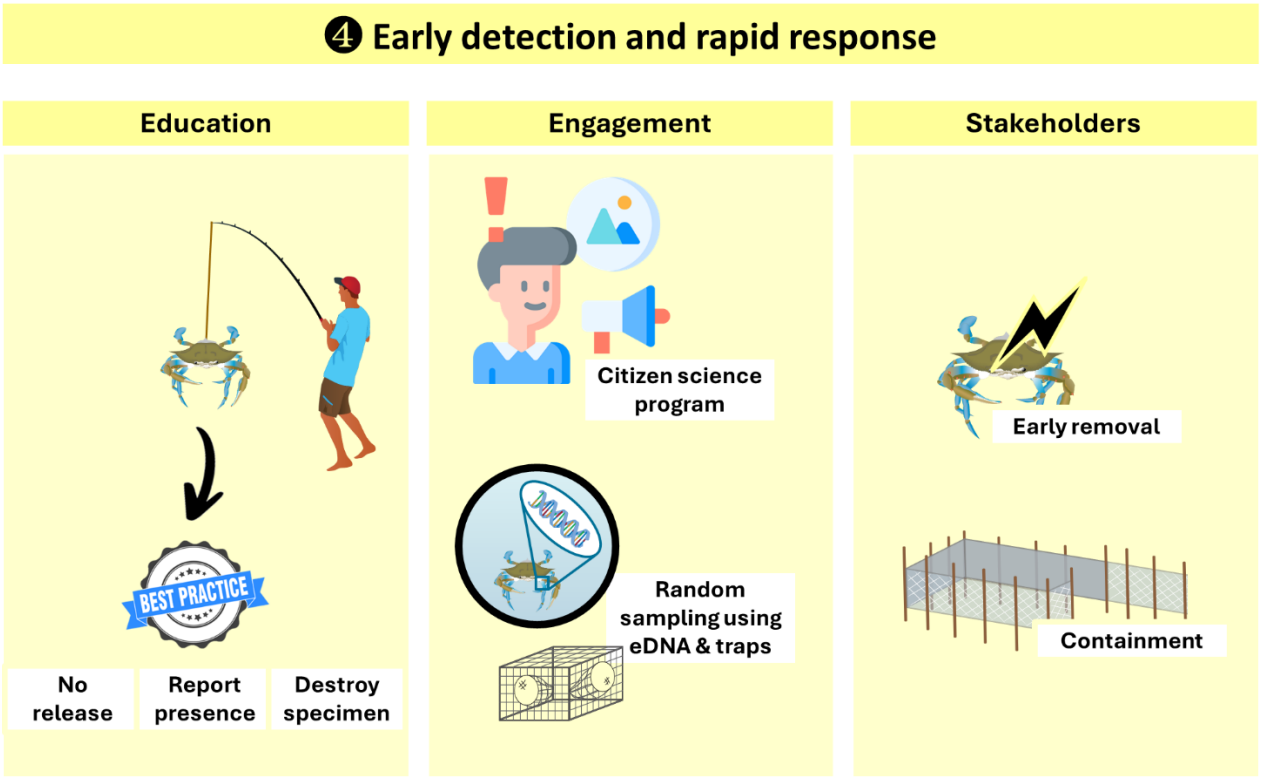
❸ Awareness on consumption and socio-ecological implications



Engaging stakeholders is an inevitable part of creating a blue crab chain. **Public awareness** is critical to **promoting the consumption of blue crabs and develop a blue crab market chain**. Events such as **cooking workshops, television programs, and cocking trainings recipe contests,** can help integrate this species into dietary habits. Explain the nutritional value of blue crabs could help consumers to buy and eat blue crabs. Raising public awareness of the possible uses of blue crab will encourage citizens to use blue crab either as a **new food resource** or for **industrial purposes**. Indeed, the chitin in blue crab shells can also be used for food, cosmetic and medical purposes, and this opportunity also represents another application in the use of blue crabs as an industrial resource.

Additionally, it is **important to highlight the socio-economic and ecological implications of their proliferation, explaining that commercialization can serve as a control measure**. Events for the general public, in collaboration with government departments, managers, fishermen and scientists, should be set up, combining **conferences and communications tools on the impacts of blue crabs**, games and animations on the socio-economic and ecological challenges of blue crab management. Documentaries, television programs, radio broadcasts and press articles will be used to communicate these aspects.

Stakeholders' engagement is also essential. Stakeholders, including fishers and local managers, consumers, should be involved through **Local Ecological Knowledge** (LEK) studies to enhance perceptions and improve the effectiveness of management measures. **Questionnaires and interviews** should be carried out on a regular basis throughout the implementation of the action plan to **monitor the evolution of stakeholders' perceptions of the effectiveness of the actions** taken and the **evolution of the impacts** caused by blue crabs. This is an important **indicator for determining the success of these actions**. Stakeholders should be involved in the **removal control operations** with scientists and managers where stakeholders could contribute to the species control actions.

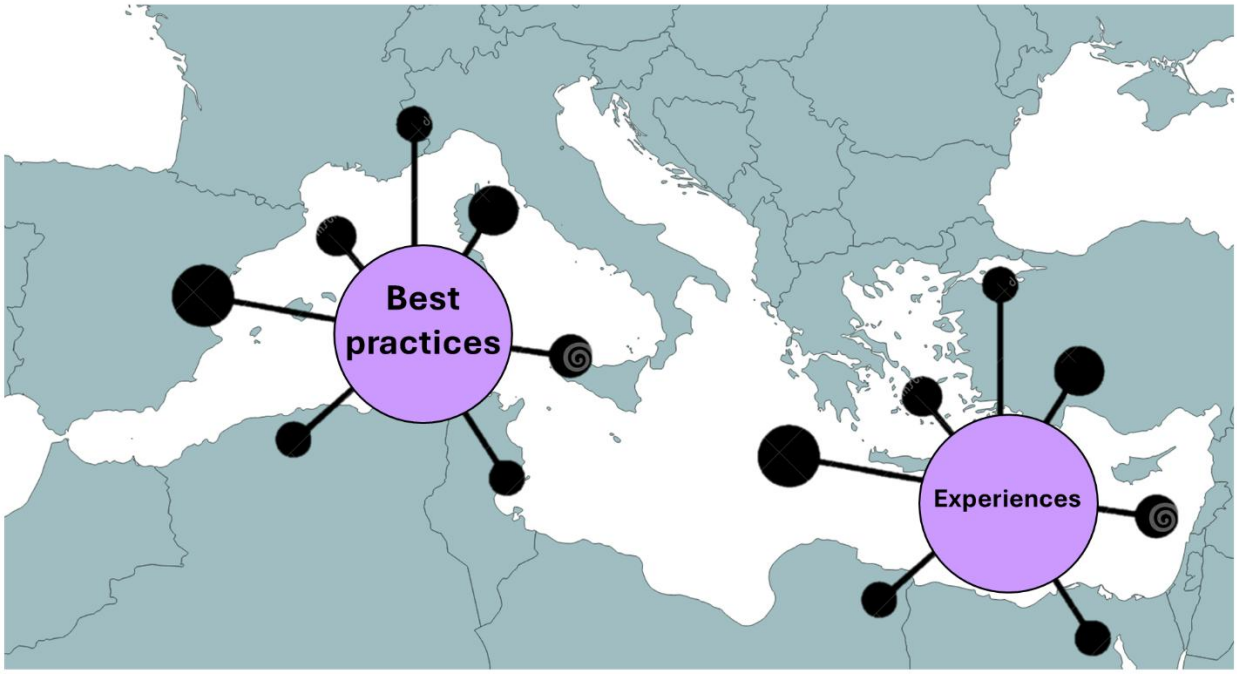


Increased awareness and dissemination of **best practices for handling encounters with blue crabs** (e.g., not releasing them, reporting their presence, etc.) are essential. To avoid accidental or unfortunate introductions, **public awareness campaigns should be set up to pass on good practices when encountering a blue crab**. Whether in the form of brochures, workshops, via social networks or organizing **control actions events**, these awareness campaigns will help prevent the release of specimens accidentally caught by recreational fishing, for example.

Harmonized **citizen science programs** are needed to **effectively monitor the expansion of blue crabs** to contribute to the **Early detections and rapid response (EDRR) programs** to limit the expansion of the both species. These citizen science programs should consist of easy-to-use platforms for reporting the presence of a blue crab, allowing users to enter information about the capture site (GPS coordinates, date, etc.) and photos. At the same time, **monitoring systems need to be implemented**, in particular **using eDNA** to detect the potential presence of blue crabs. These programs will enable scientists and managers to take action to implement containment or intensive fishing measures to limit the establishment of a new population.

Surveillance systems should be established in areas not yet invaded to enable early detection and apply containment measures, especially for *Portunus segnis*, which continues to expand.

❺ International cooperation programs



International cooperation is crucial for effectively managing blue crab invasions. **Cross-border projects between the northern and southern Mediterranean regions should be developed** to combine expertise and address global challenges. **International meetings and workshops** provide opportunities to exchange best practices for managing and utilizing blue crabs. By responding to **large-scale calls for projects** (e.g. European, regional, etc.), this will enable Mediterranean countries to collaborate, exchange practices and implement harmonized protocols to help compare data.

Lastly, the **creation of a Mediterranean Blue Crab Action Committee** is recommended to harmonize efforts and implement coordinated actions at the regional level. The establishment of this committee/consortium could be facilitated through the GFCM Blue Crabs program.

Gouvernance

1. Composition

- **Action plan governance is an important body for the proper implementation of the actions proposed** in the action plan. Governance must bring together all stakeholders, in particular ministries, scientists, fishermen and aquaculturists, managers and, where appropriate, those involved in catering and value chains.
- The governance group must **meet at least twice a year**, i.e. every 6 months, to monitor the progress of the actions undertaken. Progress indicators must be defined by the governance group in order to define successes or failures in the implementation of actions.
- **The governance group must include all stakeholders in the process:** ministries, scientists, managers, fishermen/fish farmers, government departments, **to ensure a global vision of the issue.** The governance group ensures fluid communication between stakeholders.

2. Strategy development

- Develop short-, medium- and long-term objectives.
- Define priorities according to the seriousness of the threat, the areas affected and the resources available.
- Ensure consistency of actions with national and international regulations.

3. Resource management

- Ensure efficient allocation of financial, human and material resources for control actions.
- Identify additional sources of funding (subsidies, public-private partnerships, etc.).

4. **Monitoring and follow-up**
   - Set up systems to monitor and evaluate actions taken, in order to measure their effectiveness.
   - Encourage scientific research to better understand invasive species and their impacts.
   - Adapt the strategy according to the results obtained and new information.

5. **Reporting results**
   - Produce regular reports to inform partners, decision-makers and the public on progress made.
   - Highlight good practices and lessons learned to inspire other similar initiatives.

Action plans on a regional and/or national scale purposed in this document should also be implemented as part of the research and actions carried out and in collaboration with the Research programme on blue crabs run by the General Fisheries Commission for the Mediterranean (GFCM).

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