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Commission for
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GUIDELINES ON **aquaculture restocking and** **stock enhancement**



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GUIDELINES ON
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Preparation of this document

This document presents the guidelines on aquaculture restocking and stock enhancement that were prepared by the General Fisheries Commission for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations (FAO). Ensuring that restocking and stock enhancement are performed following a responsible and precautionary approach is a priority of the GFCM as addressed in its strategy for the sustainable development of Mediterranean and Black Sea aquaculture (Target 2: “Enhance interactions between aquaculture and the environment while ensuring animal health and welfare”). These guidelines provide guidance on how to reduce potential impacts on the environment, wild stocks and capture fisheries.

The guidelines were developed within the framework of the GFCM Scientific Advisory Committee on Aquaculture (CAQ) and are based on the results from three key meetings: an ad hoc meeting on Black Sea aquaculture species diversification that was held in Türkiye in February 2013, followed by two meetings of the Working Group on the Black Sea, in Bulgaria (April 2013) and Türkiye (February 2014). The CAQ then prepared draft principles for guidelines on restocking activities which were further developed following the regional workshop on aquaculture governance and regulatory issues held in Larnaca, Cyprus in October 2018.

At this meeting, issues related to restocking and stock enhancement activities were reiterated, along with the need for a monitoring programme to assess the impacts of restocking on wild stocks. Consequently, key items related to the conservation of marine biodiversity were identified (genetics, environment, technologies, monitoring and assessment) as a basis for draft principles for aquaculture stock enhancement guidelines. At its thirty-eighth session (Italy, May 2014), the Commission welcomed the principles for guidelines for restocking and subsequently adopted the guidelines at its forty-fourth session (online, November 2021) (FAO, 2022a).

This document builds on the work of the CAQ and integrates the results of a review of relevant documents, peer-reviewed articles and information received from aquaculture experts, researchers and practitioners from countries bordering the Mediterranean and the Black Sea. The data and information gathered were analysed to formulate and share best practices to address aquaculture stock enhancement in the Mediterranean and the Black Sea.

As part of their elaboration, these guidelines were shared amongst a wide array of stakeholders and experts in a participatory process to gather their inputs and priorities. The guidelines were then revised based on the results of these consultations to ensure that they aligned with their views. They were developed with the financial support of the European Union.

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The overall technical coordination was ensured by Houssam Hamza (Aquaculture Officer) and Fabio Massa (Senior Aquaculture Expert), with the support of GFCM staff and consultants, namely Linda Fourdain (Marine Aquaculture Expert), Georgios Paximadis (Specialist on Aquaculture Related Issues) and Davide Fezzardi (Senior Aquaculture Consultant). The publication was coordinated by Dominique Bourdenet (Knowledge Management Officer), with the valuable assistance of Alexandria Schutte (Knowledge Management Specialist), Ysé Bendjeddou (Publications Coordinator) and Matthew Kleiner (Junior Publication Specialist). The technical editing was performed by Malcolm Dickson and the graphic concept, design, infographics and layout were created by Yamrote Alemu.

Abbreviations and acronyms

CAQ	Scientific Advisory Committee on Aquaculture (GFCM)
CBD	Convention on Biological Diversity
CCRF	Code of Conduct for Responsible Fisheries (FAO)
FAO	Food and Agriculture Organization of the United Nations
GFCM	General Fisheries Commission for the Mediterranean
ICES	International Council for the Exploration of the Sea

Executive summary

Aquaculture practices in the Mediterranean and Black Sea extend beyond food production into activities carried out for restocking and stock enhancement purposes. Acknowledging the diverse role of aquaculture in the region, the General Fisheries Commission for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations (FAO) organized several activities to highlight the role of the aquaculture sector in marine fish restocking and stock enhancement, as well as the potential impacts of restocking on the environment, wild stocks and capture fisheries, stressing the need to follow responsible and precautionary approaches. In this context, the GFCM developed guidelines on aquaculture restocking and stock enhancement together with regional experts and adopted them in 2021.

The main purpose of these guidelines is to support Mediterranean and Black Sea countries in restocking and stock enhancement while preventing harm to biodiversity, natural habitats, ecosystems and related ecosystem services, based on good practices and the best available knowledge. Following an introduction on the background and scope of the guidelines, this document highlights that national aquaculture regulatory frameworks should include provisions regulating aquaculture restocking and stock enhancement, identifies the general principles for stock enhancement that should be followed and provides guidance on broodstock management, reproduction, the release of juveniles and potential management programmes.

1. Introduction

Covering more than just food production, Mediterranean and Black Sea aquaculture can also be employed for restocking and stock enhancement purposes through the release of hatchery-reared fish as a fisheries management tool (Molony *et al.*, 2005). The rationale is that, under specific conditions (for example, where natural productivity is high but recruitment is limited), stock enhancement could substantially increase the exploitation of natural aquatic productivity. Recent developments in aquaculture technology have opened up potential opportunities for new hatchery-based release programmes in support of management measures for the conservation of fish populations in the Mediterranean and the Black Sea.

The potential reasons for carrying out restocking and stock enhancement include: i) increasing production of commercial species; ii) aiding in the recovery of endangered species; iii) creating culture-based fisheries, i.e. fisheries based predominantly on the recapture of stocked fish; iv) enhancing or supplementing self-recruiting populations; and v) introducing restoration practices where the capacity to expand stocks naturally has been lost due to the destruction of spawning grounds or loss of ecosystem connectivity (Figure 1) (FAO, 2019).

In the Mediterranean, one example of restocking and stock enhancement is the conservation programme to restore vulnerable populations of dusky grouper (*Epinephelus marginatus*) in Italian marine protected areas after years of over-fishing that also assesses the success of restocking related to the survival rate of juveniles in the wild (La Mesa *et al.*, 2008).

Another Mediterranean example is the ongoing work on Atlantic bluefin tuna (*Thunnus thynnus*) that uses aquaculture techniques to produce millions of DNA-tagged larvae for release into the sea and ultimately provide evidence that stock assessment and recovery can be supported by aquaculture-based technologies in the Mediterranean (Bridges *et al.*, 2018). Türkiye has been implementing turbot (*Scophthalmus maximus*) enhancement programmes in the Black Sea since 1999 to address the overexploitation of turbot stocks, as well as environmental changes and anthropogenic pressures, with the aim of recovering spawning biomass and overcoming fish recruitment limitations (Ak *et al.*, 2016). Türkiye has also implemented stock enhancement of Black Sea trout (*Salmo trutta labrax*) and sturgeon (*Acipenseridae* family) in the Black Sea region (Ak *et al.*, 2016).

Administrators and policy makers should be fully aware of the potential ecological and socioeconomic threats posed by restocking and stock enhancement activities, including on biodiversity, natural habitats, ecosystems and related ecosystem services. They need to strictly follow procedures and principles linked to the precautionary approach to achieve conservation goals and overcome development challenges. Beyond national commitments, effective regional coordination is necessary to prevent any potential transboundary issues related to restocking and stock enhancement activities and to ensure that national, supranational and international obligations and responsibilities are met.

Among the existing international instruments, the Convention on Biological Diversity (CBD) represents a milestone in the international effort toward the conservation of biodiversity as its Parties are bound, as far as possible and as appropriate, “to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction” (Article 3; United Nations, 1992). In addition, the Food and Agriculture Organization of the United Nations Advisory Working Group on Aquatic Genetic Resources and Technologies has developed a comprehensive framework of minimum requirements to preserve and better manage existing aquatic diversity to enhance its contribution to food security, nutrition and livelihoods (FAO, 2016, 2018).

FIGURE 1. Potential reasons for conducting restocking and stock enhancement activities



2. Development process

A participatory and consultative process during the development of these guidelines ensured that they aligned with the views of key stakeholders, reflecting their priorities, inputs and expertise (Figure 2). This process began in 2014 at the Bari Regional Aquaculture Conference, at which different stakeholders stressed the importance of having tailored tools for the Mediterranean and the Black Sea for the sustainable development of the aquaculture sector.

The guidelines were proposed according to Mediterranean and Black Sea countries' priorities and regional strategy outputs towards the achievement of the United Nations Sustainable Development Goals and following the implementation of several case studies.

In addition, contributions from individual countries, experts and farmers, as well as the collection of best practices and success stories from farming aquatic foods in the region were taken into account.

The General Fisheries Commission for the Mediterranean guidelines have already been used by different stakeholders and countries and have been applied and tailored to the national and local levels. This framework of cooperation will be used to continue updating and improving the guidelines with new findings, as well as to improve knowledge sharing within the region and promote the blue transformation of aquaculture.

FIGURE 2. Features of the guidelines' development process



3. Scope

The guidelines follow a regional approach tailored to Mediterranean and Black Sea aquaculture and related stakeholders. They are based on common definitions and concepts constituting a shared template at the regional scale that should subsequently be adapted to national and local conditions.

The overall objective of the guidelines is to support Mediterranean and Black Sea countries in dealing with restocking and stock enhancement practices. This will be achieved through the provision of harmonized guiding principles and minimum common requirements to help prevent and minimize the risk of adverse impacts on biodiversity, natural habitats, ecosystems and related ecosystem services, as well as to promote the development and sharing of a knowledge base to address the challenges posed by restocking and stock enhancement practices.

The guidelines specifically aim to:

- **support countries in applying international protocols** and measures to avoid negative impacts from restocking and stock enhancement practices;
- **define common requirements** to avoid negative impacts from restocking and stock enhancement practices;
- **propose common definitions, concepts**, standards and reference documents to support appropriate measures based on prevention and precautionary principles;

- **support national and cross-border cooperation** between the various bodies responsible for aquaculture-related transboundary issues; and
- **foster the adoption of appropriate policy instruments** and decision-making processes to avoid negative impacts from restocking and stock enhancement practices.

The guidelines rely on the principles of good governance, accountability, prevention, the precautionary approach and social responsibility. They are based on best available knowledge and good practices in terms of restocking and stock enhancement.

The guidelines are advisory in nature and consistent with existing national, supra-national and international instruments. They should be considered as a tool at the disposal of Mediterranean and Black Sea countries to enhance existing processes.

The varying stages of maturity of aquaculture industries, resulting from regional specificities and different legal contexts in Mediterranean and Black Sea countries should be taken into account, along with the capacities of developing states to implement the guidelines.

To ensure their effective implementation and secure a level playing field in the region, these guidelines should be adjusted, if necessary, to specific conditions. Preparatory work on implementation needs should be carried out, as appropriate, possibly through the provision of technical assistance.

4. International context

The guidelines take into account relevant international instruments, declarations, initiatives and guidelines, in particular those relating to sustainable aquaculture development and responsible fisheries.



INTERNATIONAL CONTEXT



1992

The CBD, signed in 1992, which has three main goals: the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising from genetic resources (United Nations, 1992).



2007

The ecosystem approach to aquaculture formalized in 2007 at an FAO expert workshop as "a strategy for the integration of the activity within the wider ecosystem in such a way that it promotes sustainable development, equity, and resilience of interlinked social and ecological systems" (Soto, Aguilar-Manjarrez and Hishamunda, 2008).



1995

The 1995 Code of Conduct for Responsible Fisheries (CCRF) of FAO, particularly its Article 9 addressing "the responsible development of aquaculture including culture-based fisheries within transboundary aquatic ecosystems" and "the use of aquatic genetic resources for the purposes of aquaculture including culture-based fisheries" and advocating specifically under provision 9.3.5 "to promote research and, when feasible, the development of culture techniques for endangered species to protect, rehabilitate and enhance their stocks, taking into account the critical need to conserve genetic diversity of endangered species" (FAO, 1995).



2005

The International Council for the Exploration of the Sea (ICES) *Code of Practice on Introductions and Transfers of Marine Organisms 2005*, which recommends procedures and practices to reduce detrimental effects from intentional introductions and transfers of marine (including brackish water) organisms (ICES, 2005).



2002

The 2002 Johannesburg Declaration on Sustainable Development adopted at the World Summit on Sustainable Development, which reaffirmed international commitments for the protection of biodiversity (United Nations, 2002).





2011

The twenty-ninth session of the FAO Committee on Fisheries (Italy, 2011), which provided recommendations on the role of FAO in improving integration of fisheries and aquaculture development and management, biodiversity conservation and environmental protection (FAO, 2011).



2017

Resolution GFCM/41/2017/1 on a strategy for the sustainable development of Mediterranean and Black Sea aquaculture, which contains specific references to the need for strategic research on good practices in restocking (FAO, 2017a).



2019

The FAO publication, *The State of the World's Biodiversity for Food and Agriculture*, which addresses the sustainable use, development and conservation of biodiversity for food and agriculture worldwide, including the diversity of animals, plants and microorganisms at the genetic, species and ecosystem levels that sustain structures, functions and processes in and around production systems and provide food and non-food agricultural products (FAO, 2019).



2020

The 2020 Shanghai Declaration of the Global Conference on Aquaculture, which provides a roadmap to optimizing the role that aquaculture can play in achieving the 2030 Agenda for Sustainable Development (FAO, 2021).



2022

The draft FAO guidelines for sustainable aquaculture elaborated at the eleventh session of the Sub-Committee on Aquaculture in May 2022, which are global in scope and are intended to support the visibility, recognition and enhancement of the aquaculture sector's important role in contributing to global, regional and national efforts towards the eradication of hunger and poverty and socioeconomic development for the benefit of current and future generations (FAO, 2022b).

5. Guidelines

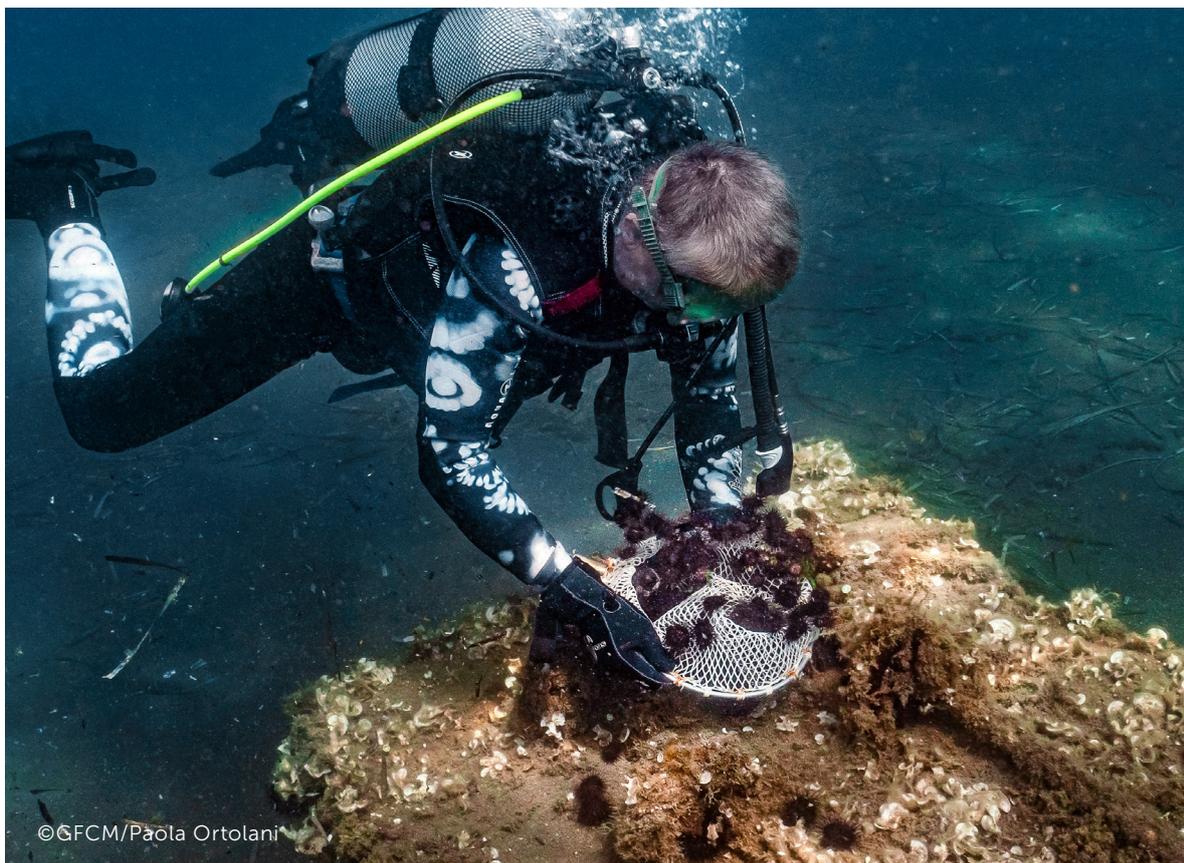
5.1 REGULATORY FRAMEWORK

The national regulatory framework dedicated to aquaculture should include provisions regulating aquaculture restocking and stock enhancement.

The provisions should be based on the precautionary principle that restocking and stock enhancement practices are potentially harmful to biodiversity, natural habitats, ecosystems and related ecosystem services and therefore guiding principles and minimum common requirements must be strictly followed to reduce any risk.

The regulatory framework should contain specific provisions on aquaculture restocking and stock enhancement activities, including:

- the designation of a national authority in charge and defining its competency;
- a list of national aquaculture research centres authorized to implement these activities;
- necessary administrative procedures and processes;
- the establishment of a national recording system; and
- the establishment of a monitoring programme.



5.2 GENERAL PRINCIPLES FOR STOCK ENHANCEMENT ACTIVITIES

5.2.1 Main principles

When carrying out restocking or releasing activities for marine stock enhancement from farmed fish species the following main principles should be considered:

- Programmes should be species-specific and restocking and stock enhancement programmes of non-native species should be prohibited.
- They should be based on the best aquaculture knowledge and stock assessment practices available.
- A good knowledge of species biology and ecology should be supported by research activities on these species, including a management and monitoring programme.
- Aquaculture technologies should be thoroughly understood and proven to be effective.
- Programmes should be based on scientific cooperation between different institutions from the concerned countries, particularly when dealing with shared stocks.
- The preparation of species-specific guidelines would be useful in the context of responsible aquaculture and fisheries.

5.2.2 Broodstock management and handling

- The basis of broodstock for breeding purposes should comprise specimens originating from local populations to ensure genetic consistency between hatchery-reared juveniles and wild stocks.
- A rotational broodstock selection strategy should be adopted to ensure full genetic variability within regional populations.
- Inclusion of juveniles released from hatcheries in subsequent broodstock captures should be avoided.
- A biosecurity plan and health management programme for broodstock and juveniles, including disease testing and health certification, should be available.

5.2.3 Reproduction, larval rearing and feeding strategies

- Natural or induced reproduction could be employed to obtain viable, fertilized eggs.
- Larval rearing and weaning should be carried out in such a way as to enhance the capacity of juveniles to exploit the available food in the environment following their release, thus increasing the likelihood of survival and decreasing mortality from malnutrition.

5.2.4 Release of juveniles

- The quality of stocked fingerlings should be equivalent to those found in the wild, and they should be guaranteed as pathogen-free, assessed by microbiological, parasitological and virological analyses, before release.
- The major factors affecting stocking effectiveness, including juvenile size and quality, habitat and natural spawning grounds, season and release techniques and protocols, should be appropriate and properly taken into consideration to ensure a higher survival rate.
- Restocking and stock enhancement activities should be very precise and the environmental carrying capacity should be known.
- The number of released fish should not exceed the carrying capacity of the receiving environment in relation to both feeding and habitat resources.
- Prior to release, the genetic variability of hatchery-produced juveniles should be assessed against the natural populations inhabiting the target area to preserve the genetic diversity for sustainable restocking and stock enhancement actions (for example, through DNA fingerprinting at microsatellite loci to assess the genetic variability of broodstock and F1 juveniles in comparison to natural populations).
- The morphological quality of hatchery juveniles should be assessed to evaluate the presence of skeletal anomalies (for example, through x-rays and in-toto staining). All juveniles with abnormalities or anomalies should be removed.

5.2.5 Monitoring programme

- These guidelines recommend the implementation of a data recording system to assess successful interactions with fisheries activities. The appendix provides an example.
- A monitoring programme to trace the released animals should be developed (for example, using molecular biological techniques or tagging) and implemented on a regular basis to assess the effectiveness of the activity.
- There should also be a monitoring programme for the other species in the area to make sure that the introduced species does not impact them negatively.
- A tagging programme is considered appropriate for restocking and stock enhancement activities if implemented in close cooperation with fishers, particularly for recapture and monitoring (estimation of dispersion pattern and fishing mortality), perhaps involving a questionnaire covering dates, locations, fishing gear and fish size and weight.



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Glossary

Aquaculture:

The farming of aquatic organisms that implies some sort of intervention in the rearing process to enhance production. Farming also implies individual or corporate ownership of the stock being cultivated (FAO, 2022c).

Aquaculture escape:

The sum of fish escape and escape through spawning (Arechavala-Lopez *et al.*, 2017).

Aquaculture governance:

The set of processes by which a jurisdiction manages its resources with respect to aquaculture, how its stakeholders participate in making and implementing decisions affecting the sector, how government personnel are accountable to the aquaculture community and other stakeholders, and how the respect of the rule of law is applied and enforced (FAO, 2017b).

Aquatic organisms:

Any species and subspecies living in water belonging to the animalia, plantae and protista kingdoms, including their reproductive products, gametes, fertilized eggs, seeds and propagules, embryos and juvenile stages of their individuals that might survive and subsequently reproduce (Council of the European Union, 2007).

Biodiversity:

The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part: this includes diversity within species, between species and of ecosystems (FAO, 2022c).

Biosecurity:

A strategic and integrated approach that encompasses the policy and regulatory frameworks for analysing and managing relevant risks of the sectors dealing with: human life and health (including food safety); animal life and health (including fish); plant life and health; and environment (FAO, 2009).

Culture-based fishery:

A fishery in which the use of aquaculture facilities is involved in the production of at least part of the life cycle of a conventionally fished resource; aquaculture is usually the initial hatchery phase that produces larvae or juveniles for release into natural or modified habitats (FAO, 2022c).

Ecosystem services:

The direct and indirect benefits people obtain from ecosystems including provisioning services, regulating services, cultural services and supporting services (Alcamo *et al.*, 2003).

Enhancements:

Limited technological interventions in the life cycle of common-pool aquatic resources that combine attributes of aquaculture (intervention in the life cycle of aquatic organisms) and capture fisheries (exploitation of common-pool resources) in a unique way (Lorenzen *et al.*, 2001).

Hazard:

A biological, chemical or physical agent in, or a condition of, an aquatic animal or aquatic animal product with the potential to cause an adverse effect on aquatic animal health or public health (WOAH, 2021).

Introduction:

The process by which a non-indigenous species is intentionally moved to an environment outside its natural range for use in aquaculture (Council of the European Union, 2007).

Non-indigenous species:

Any live specimen of a species and subspecies of aquatic organisms introduced outside its known natural range and the area of its natural dispersal potential (FAO, 2022c).

Restocking:

The release of cultured or wild caught aquatic species (usually juveniles) into the wild to restore the spawning biomass of severely overfished stocks to levels at which they can once again provide sustainable yields. This may also involve re-establishing a commercial species where it is locally extinct due to overfishing or releasing juveniles reared in conservation hatcheries to help restore endangered or threatened species (FAO, 2022c).

Restoration practices:

Restoring functionality and productive capacity to ecosystems, forests, landscapes, waterways, grasslands and rangelands in order to provide food, fuel, and fibre, improve livelihoods, store carbon, improve adaptive capacity, conserve biodiversity, prevent erosion and improve water provisioning and quality (FAO, 2019).

Stock enhancement:

Activities aimed at supplementing or sustaining the recruitment of one or more aquatic species and raising the total production or the production of selected elements of a fishery beyond a level that is sustainable through existing natural processes. In this sense, stock enhancement includes enhancement measures, which may take the form of: the introduction of new species; stocking natural and artificial water bodies, including with material originating from aquaculture installations; fertilization; environmental engineering, including habitat improvements and modification of water bodies; altering species composition, including through the elimination of undesirable species or constituting an artificial fauna of selected species; genetic modification and introduction of non-native species or genotypes (FAO, 2022c).

Sustainable development:

Management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment of continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, plants and animal genetic resources and is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable (FAO, 2022c).

Appendix

Data recording template to assess impacts of restocking and stock enhancement on wild stocks

AREA OF RELEASING/RESTOCKING

AREA

Geographical subarea (GSA)	
Coordinate(s)	

INSTITUTIONS

Main institution	
Cooperative institutions	

PURPOSES

Stock enhancement	<input type="checkbox"/>
Conservation	<input type="checkbox"/>
Other	<input type="checkbox"/>

ACTIVITIES (frequency)

Regular	<input type="checkbox"/>	Since (year)	
Occasional	<input type="checkbox"/>		
Cooperative countries			

ORIGIN OF BROODSTOCK/BREEDERS

GSA	<input type="checkbox"/>
From local population	<input type="checkbox"/>

SPECIES

Species name			
Autoctonus	<input type="checkbox"/>	Quantity	<input type="text"/>
Exotic	<input type="checkbox"/>	Size	<input type="text"/>

AQUACULTURE TECHNOLOGY

Hatchery	<input type="checkbox"/>	Density/stocking	<input type="text"/>
Other (specify)	<input type="text"/>	Feed: natural	<input type="text"/>
		Feed: artificial	<input type="text"/>
		Feed: mixed (a/n)	<input type="text"/>

FISHING ACTIVITIES

Shared fisheries resources	
Information	

PATHOLOGIES

<p>Pathogen free <input type="checkbox"/></p>	
<p>Veterinary information</p>	

PURPOSES

<p>Title</p>	
<p>Cooperative with</p>	
<p>Environmental conditions</p>	
<p>Survey on fishery resources</p>	
<p>Tagging programme</p>	
<p>Survey programme</p>	
<p>Survival estimation</p>	
<p>Recovery estimation</p>	
<p>Divulagation programme</p>	

GUIDELINES ON AQUACULTURE RESTOCKING AND STOCK ENHANCEMENT

This publication presents guidelines prepared and adopted by the GFCM with a view to supporting responsible restocking and stock enhancement practices in the Mediterranean and the Black Sea. Specifically, it emphasizes that a responsible and precautionary approach must be followed to minimize the potential impacts of restocking on the environment, wild stocks and capture fisheries. By recommending practical actions to stakeholders, these guidelines aim to support best practices in restocking and stock enhancement in order to prevent any harm to biodiversity, natural habitats, ecosystems and related ecosystem services and to provide decision-makers with a useful tool for policy development.

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