GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN

COMMISSION GÉNÉRALE DES PÊCHES POUR LA MÉDITERRANÉE

Key elements for guidelines on a harmonized environmental monitoring programme (EMP) for marine finfish cage farming in the Mediterranean and Black Sea

BACKGROUND

1. This document contains the key elements for guidelines on a harmonized environmental monitoring programme (EMP) for marine finfish cage farming in the Mediterranean and Black Sea within the activities of the Working Group on Site Selection and Carrying Capacity (WGSC). During the sixth and seventh sessions (Tirana, Albania, December 2008 and Rome, Italy, March 2010) of the Committee on Aquaculture (CAQ), it was agreed that there was a need to harmonize and to implement the procedures for site selection and management of Mediterranean aquaculture, and the importance to have an environmental monitoring programme (EMP) in place for the areas surrounding aquaculture activities was stressed.

2. At its thirty-sixth session (Morocco, May 2012), the Commission, acting upon the advice made on aquaculture management, gave mandate to the Secretariat and to the CAQ to proceed with the preparation of specific guidelines on EMP. Subsequently, at its eighth session, the CAQ endorsed the preparation of guidelines on aquaculture environmental monitoring for the Mediterranean and Black Sea. Finally, at the thirty-seventh session of the Commission, the need to prepare guidelines on harmonized environmental monitoring programme for Mediterranean and Black Sea aquaculture was reiterated.

3. The importance of a harmonized EMP for Mediterranean and Black Sea marine aquaculture activities has been evocated during the last years in many experts meetings and fora. This document embeds principles and builds on fundamentals which have been produced over time by CAQ and its subsidiary bodies. More specifically, it draws inspiration from the different documents and outcomes produced within the SHoCMed project activities, the results of ad hoc meetings (Morocco, February 2013 and Turkey, December 2013) and the collaboration with GFCM partners and CAQ network of experts and research institutes.

4. The key elements for guidelines comprise the scope and objective of an EMP, the essential information to be collected and the sampling design, EMP responsibility, as well as a glossary of the most common terms related to an EMP (see EMP Glossary) and the main bibliographic references (Annex A).

KEY ELEMENTS FOR GUIDELINES ON A HARMONIZED ENVIRONMENTAL MONITORING PROGRAMME FOR MARINE FINFISH CAGE FARMING IN THE MEDITERRANEAN AND BLACK SEA

INTRODUCTION

5. In the Mediterranean and Black Sea, aquaculture plays and will continue to play a major role in enhancing global fish production. The strategic role of the aquaculture sector in responding to the growing demand for seafood and in delivering social and economic benefits to coastal communities is widely recognized.

Marine cage finfish farming

6. Mediterranean and Black Sea marine aquaculture production has shown a staggering positive trend during the last twenty years, mainly due to the increased production of the European seabass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*), which increased from a mere 11 300 tonnes in 1991 to about 273 374 tonnes in 2011. This was possible, among other things, thanks to the improvement of floating cage technology in fish farming. Starting from the early 1990s, culture of fish in floating cages has increased, with many farms progressively and steadily moving toward deploying installations in the open sea. Consequently, in 2011, marine finfish aquaculture in floating cages represented about the 85 percent of total production of European seabass and gilthead seabream.

7. However, the expansion of aquaculture is faced with a number of environmental and socioeconomic issues that may compromise its sustainability and further development. Foremost, there is competition for space with other sectors and activities when allocating an area at sea for aquaculture activities. In this respect, the lack of a regulatory legal framework as well as of criteria for the planning and implementation of an environmental monitoring programme (EMP) for aquaculture activities at sea are additional elements contributing to limiting the development of sustainable aquaculture.

8. The General Fisheries Commission for the Mediterranean (GFCM) is taking stock of the rapid expansion of marine aquaculture, which calls for an integrated coastal zone management (ICZM) approach in which aquaculture should be integrated with other coastal uses; this is also in accordance with the provisions under Article 9 of the FAO Code of Conduct for Responsible Fisheries (CCRF) and consistent with the principles of the ecosystem approach to aquaculture (EAA) development that requires, among other things, the establishment of appropriate policy framework strategies and development plans for sustainable aquaculture.

9. The GFCM acknowledges that opportunities for the aquaculture to grow further go along with the need to strike a balance between minimizing effects on the environment and pursuing a growing production in the region's coastal zones. This calls for better harmonized regulatory and monitoring frameworks, especially in relation to environmental impact assessment (EIA) and site selection procedures, which would favour the development of zoning of aquaculture within an ecosystem perspective. Aquaculture activities, as well as all other human activities, if not managed in a sustainable manner could negatively affect marine ecosystem functions and services at the local, national and regional levels, particularly in the case of shared ecosystems.

Allocated zones for aquaculture (AZA) and allowable zone of effect (AZE)

10. Coastal marine aquaculture requires high quality water and strict environmental characteristics which may be available in limited areas where complex interactions with other coastal users may cause conflicts and competition for space. The sustainable integration of aquaculture in the environment and with other coastal zone activities would be achieved through the adoption and implementation of allocated zones for aquaculture (AZA), spatial planning, improved and harmonized

site selection criteria, and holding capacity standards adapted to the GFCM area within an EAA perspective.

11. The implementation of a regional strategy for the establishment of AZA is considered by the GFCM as an immediate priority for the responsible development and management of aquaculture activities in the Mediterranean and Black Sea. Consequently, in 2012, the Commission adopted a specific resolution (GFCM/36/2012/1) on Guidelines on allocated zones for aquaculture (AZA).

12. The Commission considered that the establishment of AZA may facilitate the integration of aquaculture activities into coastal zone areas that are exploited by other users and contribute to the enhancement of coordination between the different public agencies involved in aquaculture licensing and monitoring processes. In particular, the Committee on Aquaculture (CAQ) has stressed the relevance of environmental quality and recommended that an aquaculture environmental monitoring programme (EMP) should be implemented in areas surrounding finfish farms, known as "allowable zone of effect (AZE)". The Commission, at its thirty-sixth session (Marrakech, Morocco, May 2012), acting on advice on aquaculture management, gave a mandate to the Secretariat and to the CAQ to proceed with the preparation of specific guidelines on environmental monitoring of aquaculture.

13. The resolution adopted by the GFCM emphasises that the quality of the marine environment is essential and considers monitoring of finfish marine aquaculture to be fundamental for evaluating the effects and impacts of aquaculture on the environment and on aquaculture itself. For every AZA (or polygon within AZA), an AZE be defined in the close proximity of each farm. Such zone shall be accompanied by an EMP to ensure that the environmental quality standards (EQS) are within optimal levels, and consequently the agreed environmental quality objectives (EQO) are respected (Fig. 1). The EMP shall be flexible and adaptable, taking into account the scale (time and space) approach, and environmental monitoring shall be mandatory.

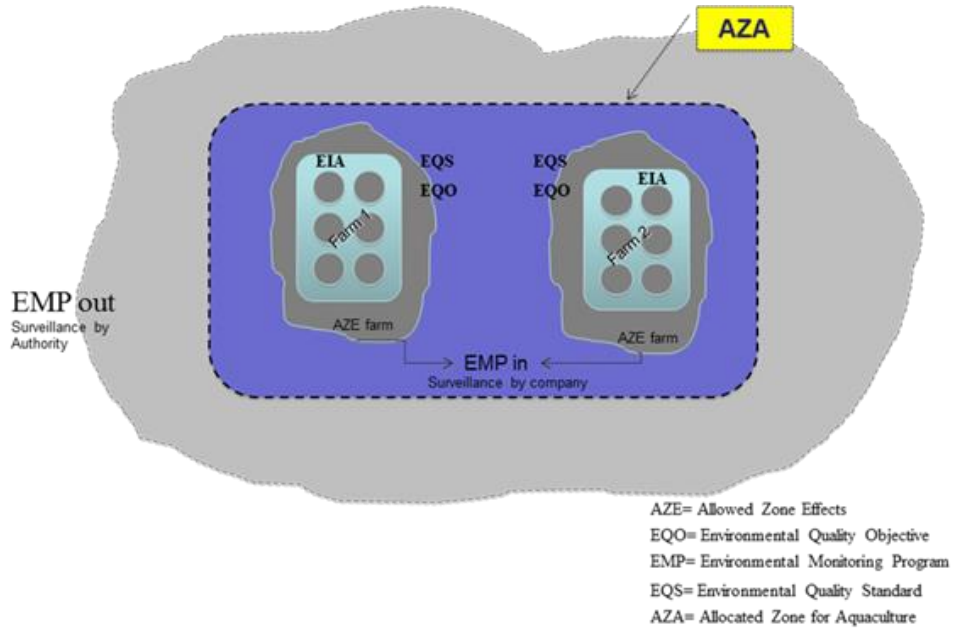

Figure 1: Different zones within an AZA (Source: Macias *et al.*, in preparation).

DEFINITION, SCOPE AND PRINCIPLES, CRITERIA, AND OBJECTIVES OF THE ENVIRONMENTAL MONITORING PROGRAMME (EMP)

EMP definition

14. The EMP for marine cage finfish farming is defined as a functional tool at the disposal of the authorities and the aquaculture industry (e.g. farmers) for aquaculture management practices to ensure the sustainability of the sector itself. The EMP is also intended as a record-keeping system for documenting series of information and values of environmental parameters relevant to aquaculture activities, which will be used to perform periodic environmental assessment and monitoring.

15. The EMP record-keeping system should be based on the best scientific knowledge available in relation to marine aquaculture environmental monitoring and which would be adaptable to Mediterranean Sea and Black Sea aquaculture conditions.

16. The EMP is also intended as a functional procedure to be adapted to the local sustainable reference system for aquaculture and should be adjusted at local or at country level without prejudice to more detailed and appropriate existing regulations. The functionality of the EMP should be periodically monitored and adapted and/or revised as necessary in function of the quality of the identified environmental objectives.

EMP scope and principles

17. The purposes of the EMP at regional level are to enable the different counterparts to meet safe environmental objectives, to ensure long-term sustainability of living marine resources, sustainable development of aquaculture and protection of sensitive habitats. At the national level, the main purpose is to adopt a harmonized regulated activity so as to ensure adequate measures for the conservation of the water quality status surrounding finfish farms at sea.

18. The EMP shall be implemented to avoid any potential harmful effects on the marine environment at the local and regional levels, and to respect the shared ecological services provided by ecosystems.

19. More specifically, the information provided by the EMP will serve to:

- minimize the global impact of aquaculture;
- respect the ecological services provided by ecosystems;
- minimize local impacts on the environment and biodiversity;
- ensure compliance with regulations and achievement of environmental objectives and contribute to the protection of biodiversity;
- ensure the long-term sustainability of fin-fish culture;
- help define actions to be taken to improve farm management practices; and
- evaluate the achievement of quality objectives of the measures adopted to protect the environment and of bringing the obtained results to the attention of the civil society and the public.

EMP functionality

20. The EMP is aimed at identifying how aquaculture activities could affect the surrounding environment, by being based on measurement of specific environmental parameters. The EMP also provides feedback on any potential adverse environmental impacts through assessment of the recorded monitoring results, and comparison with defined values for environmental attributes and objectives.

21. The monitoring requirements should comprise a minimum scheme that can be applied in any type of marine environment, as well as additional requirements that can be adapted according to the

different scales of farm activities and depending on the sensitivity of the receiving environment.

EMP reporting system and contents

22. If not properly managed, marine aquaculture can result in a variety of adverse environmental impacts that are mainly determined by the release of organic matter and nutrients, for example, those originating from faecal waste and uneaten fish feed. Further potential sources of impacts include the use of chemicals, farmed fish escape events, and diseases outbreaks.

23. Following the establishment of an AZA for marine aquaculture activities, a specific EMP should be established by the authorities in charge of granting the maritime concession, and of monitoring the environment and ensuring nature protection, in order to protect the environment and aquaculture itself, and to avoid any potential irreversible impact by the finfish farm on the marine ecosystem. The EMP shall describe the process and activities that are required to define the quality of the environment.

24. The EMP shall be flexible and adaptable, and take into account the scale (time and space) approach, as well as the type of facility, farming system and production levels.

25. The EMP requires data on the "zero state" for all indicators and on defined limits of tolerance.

26. The EMP requires the collection of a series of information on the particular area, and of data considered as most appropriate to describe the environmental conditions of the water and sediment. These should be registered in a logbook that will be referred to as the record-keeping system, which is intended to record physical, chemical and biological information collected within the monitored areas, including the area located in the immediate vicinity of a finfish farm and termed "allowable zone of effect (AZE).

27. The logbook should include the frequency of sampling, the physical and chemical variables and other attributes to be monitored, as well as the number and locations of the sampling stations relative to the locations of the fish cages.

28. The record-keeping system should comprise two logbook types: logbook 1 (Lb1) and logbook 2 (Lb2). The first refers to the AZA and the farm/farms within the AZA, while the second refers to the monitoring activities undertaken within the zone surrounding the farm/farms, and which may possibly experience an adverse environmental impact.

29. Logbook 1 should contain at least the following information:

- Maps with locations of the fish farm, fish cages and monitoring stations;
- Water depth (min, max, mean);
- Mean sea current speed;
- Sediment grain size;
- Information on the benthic community;
- Information on sensitive habitats, if any;
- Information on the finfish farm/farms: (cages farming system and characteristics; cultured species and cycles; production capacity; estimated feed conversion ratio (FCR); potential maximum cultured biomass per year; potential maximum feed quantity used per year).

30. Logbook 2 should contain information that will be recorded during the monitoring activities. These should be collected according to a typology classification that is based on the production category and the mean sea current speed.

31. The sampling frequency should be annual and made during the period when there is maximum biomass in the cages.

32. The number of sampling stations[1] should be as follows:

- 2 control stations
- 1 under the cages
- 1 up-current located 50 m from the cages
- 1 down-current located 25 m from the cages
- 1 down-current located 50 m from the cages

33. The variables to be recorded in Logbook 2 should at least include the following physical, chemical and biological attributes:

Water monitoring*	Sediment monitoring
Temperature (°C)	Macrobenthic community
Salinity (psu)	Visual inspection
Turbidity (Secchi depth)	Redox potential (Eh, mV)
Dissolved oxygen (% saturation; mg/l)	Sulphide (µM)
Chlorophyll a (mg/l)	Organic matter (LOI, %)
pH (unit)	pH (unit)
Ammonium (N-NO_4, µM)	Total Organic Carbon (TOC, %)
Nitrite (N-NO_2, µM)	Total Nitrogen (µM)
Nitrate (N-NO_3, µM)	Total Phosphorous (µM)
Phosphate (P-PO_4, µM)	Gas bubbles (Outgassing)
TSM - Total Suspended Matter (mg/l)	Litter present on the seabed in the vicinity of the farm
POM - Particulate Organic Matter (mg/l)	

*At each station, samples will be collected at three different layers (surface, intermediate, and deep)

34. In Logbook 2 there should also be some dedicated space to allow the recording of:

- Escapee incidents (species; size; number)
- Disease incidents (type of disease; species at risk; number of outbreaks; medical treatment used)
- Disasters and weather-related events (e.g. presence of jelly fish; mortalities caused by exogenous pollution; storm events, etc.)

EMP design of sampling stations

35. The EMP should be accompanied by a sampling plan and design. The design should indicate the exact locations of the stations where the data/samples will be collected in relation to the layout of the finfish farm facilities.

36. The EMP sampling design should be based on transects located within the AZE (*EMP-in*), while control stations should be located outside the AZE (*EMP-out*) see Figure 1. Sampling designs are usually of two main types: i) use of transects that follow the direction of the main sea current (Figure 2) and ii) random stratified sampling (Figure 3).

37. Sampling stations should be located such that consideration is given to the putatively impacted zone around the farm, while the sampling protocol should be site-specific. In the case of uncertainty, sampling stations should be located at a distance of 50 m from the farm operations. Reference data

[1] The sampling station layout design shall be reported separately.

should include data collected before deployment of the finfish cages. The use of BACI (Before-After-Control-Impact) or M-BACI (multiple controls) designs are considered as the most appropriate.

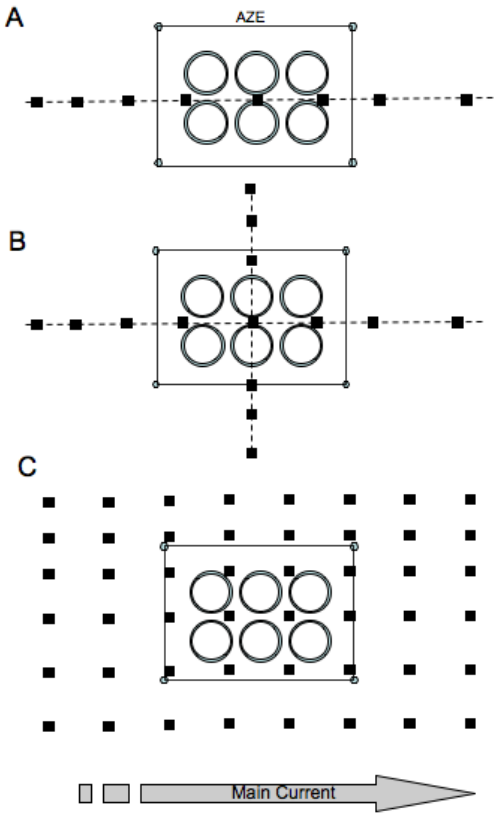

Figure 2: Examples of monitoring programmes based on transects laid across the AZE. A) Simple design using a single transect following the direction of the main current. B) Two transects that intersect at the centre of AZE. C) Several transects laid perpendicular to AZE, with the aim of applying spatial statistics such as the Kriging technique. At each sampling site, one or several samples can be collected. Source: Sanchez-Jerez and Karakassis, 2012.

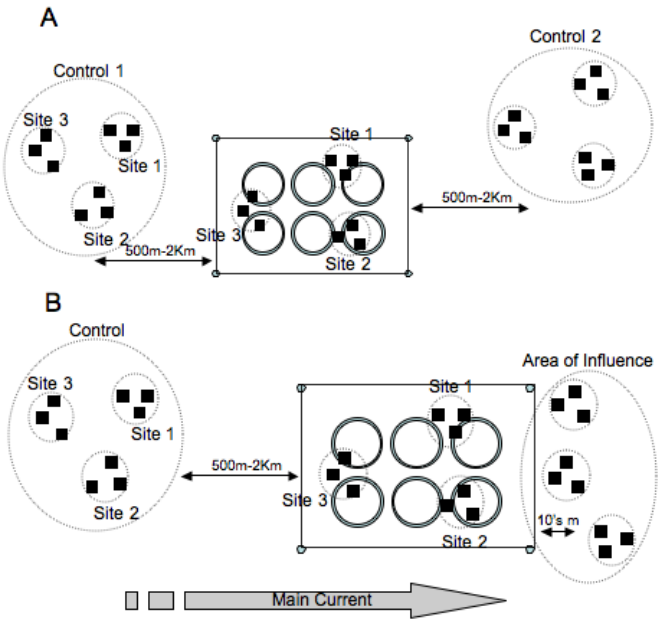

Figure 3: Random stratified sampling considering (A) an Impact zone (AZE) with two control zones that are sufficiently distant from the aquaculture facilities, and (B) three zones: Impact zone (AZE), area of influence and one or several controls. Inside each zone, several sites are randomly selected, with three samples collected, for example, using a Van Veen grab. Source: Sanchez-Jerez and Karakassis, 2012.

EMP responsibility

38. The responsibility for the EMP and data recording should be:

- Within the AZE: Aquaculture farms should record the data for the EMP. Alternatively, data collection will be under the responsibility of the competent authorities;
- Outside the AZE: data recording should be the responsibility of the authorities in charge of granting maritime concessions and/or of environmental/nature protection.

39. Data recorded within and outside the AZE should be analyzed by the authorities in charge of granting maritime concessions and/or environmental/nature protection.

40. The data and results from the EMP should be recorded and stored in a way that is easy to understand and which would be easily accessible for the sake of transparency, in order to strengthen the image of aquaculture products with the society at large.

Annex A

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