INTERNATIONAL STANDARD

ISO 12878

First edition
2012-07-01

Environmental monitoring of the impacts from marine finfish farms on soft bottom

Surveillance environnementale des impacts sur le fond mou des exploitations de pisciculture marine

Reference number
ISO 12878:2012(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword ... iv

Introduction ... v

1 Scope ... 1

2 Normative references ... 1

3 Terms and definitions ... 1

4 Principles for monitoring ... 3
4.1 Aim and principles ... 3
4.2 Impact zones ... 4
4.3 Survey types ... 5

5 Methodology ... 5
5.1 Sampling strategy ... 5
5.2 Frequency of operational monitoring of local impact zone ... 7
5.3 Frequency of operational transect monitoring ... 7
5.4 Evaluation of results ... 10
5.5 Maps and charts ... 11
5.6 Additional data collection — Biological production at finfish farm ... 11
5.7 Report ... 11

6 Quality assurance and quality control ... 11
6.1 Aim and principles ... 11
6.2 Equipment calibration and operating safety ... 12
6.3 Checklists, sample log and anomaly reporting ... 12
6.4 Taxa identification ... 12

Annex A (informative) **Examples on environmental monitoring on the seabed impact from marine finfish farms** ... 13

Annex B (informative) **Example — Base map** ... 21

Annex C (informative) **Example of monitoring report format and some sample content** ... 22

Bibliography ... 30

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12878 was prepared by Technical Committee ISO/TC 234, *Fisheries and aquaculture*.

Introduction

Particulate effluents from finfish farms can affect environmental conditions on the surrounding seafloor as well as the health of the farmed fish. These effluents consist of excess feed and faecal pellets from the fish, and are released as particles in a variety of sizes, depending on the fish species, feed type, temperature and other conditions in the aquaculture operation. Depending on the hydrodynamic and bathymetric conditions in the area, the particles settle on the seabed at various distances from the finfish cages. This leads to changes in the chemistry and the biology of the sediments, and if the effluent load is high it can even result in sediments depleted of biota.

The aquaculture industry is dependent on favourable environmental conditions to ensure good fish health and optimal growth. Excessive accumulation of organic material in the form of waste feed pellets and fish faeces can change the habitat characteristics of bottom substrates, leading to eutrophication and associated negative changes in biodiversity. Repeated and systematic monitoring can give an overview of changes in bottom conditions, and remedial action can be implemented should the developments be in a negative direction.

All livestock farming has some impact on the environment. It is intended that the environmental impact on the seabed not exceed acceptable and agreed-upon limits established for the local impact zone or farm licence area. Threshold values for environmental impact are expected to be set to prevent unacceptable impact on the seabed in the surrounding area and on its biota. Threshold values are also expected to ensure favourable living conditions for farmed fish such that finfish farm sites can be in use over a longer time period. Pollution control authorities define threshold values for environmental quality. For personnel and organizations using this International Standard, it can be helpful to have a reference to the legal and policy framework of their country or state. It is strongly intended to streamline the environmental monitoring process in a way that involves all institutions responsible for the marine environment.

The main emphasis of this International Standard is on methods for measuring impacts on the bottom conditions at and around finfish farm sites. In certain cases, there can be a need for a broader environmental monitoring programme to highlight a given set of problems or to consider the condition of the receiving environment, as a whole. In this International Standard, examples of monitoring surveys of finfish farms in some countries are presented in Annex A.

Finfish farm sites, which are sited over seabed consisting of bedrock, larger rocks/stones or other hard substrate, can be surveyed following the guidelines given in ISO 19493. This International Standard only gives guidelines for monitoring of effluents from finfish farms sited on soft bottom.

Environmental monitoring of the impacts from marine finfish farms on soft bottom

1 Scope

This International Standard establishes an approach for sampling and empirical measurement of soft-bottom impacts from marine finfish net pen farms, and gives examples of detailed procedures for how environmental impacts from finfish net pen farm sites can be monitored in the field, including guidelines for quality assurance of sampling protocols and safety. The emphasis of the environmental impact in this International Standard is on eutrophication effects on the seabed.

This International Standard identifies ecological objectives, the indicators used, and the methodology and design, and encompasses guidelines for quality assurance of sampling protocols and operational safety.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 16665, *Water quality — Guidelines for quantitative sampling and sample processing of marine soft-bottom macrofauna*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
anchoring area
area delimited by the anchoring points of the cage area

3.2
anchor line
line, cable or chain from the anchor points to the cage area

3.3
anchor points
attachment point of the anchor line

3.4
area of influence
area of seabed where environment is influenced or expected to be influenced, based on the available information or as identified through the use of predictive models

3.5
baseline monitoring
sampling of an area of influence, which previously was not used for finfish production

3.6
benthic
associated with the seafloor

[ISO 16665:2005, definition 2.2]

3.7
benthic macrofauna
bottom-dwelling animals retained on a mesh screen of 0,5 mm or 1 mm aperture size

[ISO 16665:2005, definition 2.3]

3.8
biological production
biomass remaining in the cages(s) at the end of the year, minus the starting biomass at the beginning of the year, plus harvested biomass, mortalities and waste

NOTE The term “waste” includes escapees and sorted-out fish, which are not harvested.

3.9
cage
floating framework with attached net bag, which encloses the fish, and which forms a part of the fish farm

3.10
cage area
area of seabed directly below the cage

3.11
environmental monitoring
systematic observation, measurement and calculation of the condition of the environment, emission of pollutants or populations and species, which are necessary for the assessment of the condition of the environment, the development of environment policies and the planning of environmental protection measures, as well as the control of the effectiveness thereof

3.12
fish farm site
geographically defined location for aquaculture

3.13
hard substrate
hard bottom
substrate consisting of bedrock, larger rocks/stones or fixed marine constructions such as wharfs, quays and pipelines

3.14
indicator species
benthic species that defines a trait or characteristic of the environment or that serves as a measure of the environmental conditions existing in a given location

3.15
monitoring level
scope of survey required to determine whether or not the environmental impact is retained within specified threshold values

3.16
monitoring programme
set of routine measurements of parameters which describe environmental effects from finfish farms

3.17
operational monitoring
sampling conducted during operation of a finfish aquaculture facility

3.18
pilot survey
survey used for simple rapid assessment and basic information on a site

3.19
production cycle
period from the time fish are initially stocked into the sea until the cohort is completely removed through harvesting or transfer

3.20
receiving environment
water body that receives input of natural or anthropogenic origin

3.21
reference station
sampling station chosen to represent background or natural environmental conditions in a given area on seabed, i.e. free from direct anthropogenic influences

NOTE Adapted from ISO 16665:2005.

3.22
sampling station
precise location where recording is carried out and any samples are collected

NOTE Adapted from ISO 16665:2005.

3.23
sediment condition
classification of the observed condition in the sediment

3.24
soft bottom
areas of seafloor consisting of loose deposited particles, including clay, mud, sand and gravel, shells and maerl, where it is possible to sample with a grab or a corer

NOTE A minimum of three sampling attempts are intended to be carried out. If any one is successful, it is intended that the substrate be treated as soft. It also includes mixed substrata with gravels, small stones and pebbles scattered on a bed of finer material, but excludes cobble.

3.25
soft-bottom fauna
animals living on or completely/partially buried in soft sediments

3.26
tenure
total area on seabed that is licensed or otherwise permitted by governmental authority to be utilized for finfish farming

3.27
threshold value
value of a parameter that divides between defined levels of impact in a monitoring programme

3.28
transect monitoring
documentation of qualitative and quantitative changes over a distance

4 Principles for monitoring

4.1 Aim and principles

The ecological objective of the monitoring is systematic observation, measurement and calculation of the condition of the environment, emission of pollutants or populations and species, which are necessary for the assessment of the condition of the environment, and the planning of environmental protection measures, as well as the control of the effectiveness thereof.

The effort of environmental monitoring should be proportional to the scale of impact and should focus on long term sustainable use of the seabed in farming areas.

Principles for monitoring of environmental impact on the seabed may be summarized as follows:

— before a site is utilized for aquaculture production, baseline monitoring should be carried out, if possible;

— if baseline monitoring is not possible, a reference station may be utilized for comparison;

— threshold values for environmental impact should be set such that finfish farm sites may be in use over a longer time period.. These values should aim to ensure favourable living conditions for farmed fish as well as to prevent unacceptable impact on the surrounding seabed area. The responsible government may have established threshold values for unacceptable impact and impact categories;

— monitoring of the seabed should be regular; the more impact a finfish farm has on the seabed, the more often the monitoring survey should be performed (see Table 3);

— different monitoring surveys may be used in different areas: where little impact is tolerated by pollution authorities or by society, the survey should be able to detect subtle changes; where more impact is tolerated, a simpler survey may be enough to provide a satisfactory result;

— the monitoring survey used should be suited to the task and the following considered: the aim of the monitoring; how detailed the survey should be to provide a comprehensive result; the level of accuracy needed for the measured variables; practicality, efficiency, time consumption and costs involved in relation to the outcome; transparency;

— surveys comprising multiple parameters are less sensitive to anomalies in individual parameters and may provide a more robust result;

— the variables that make up a monitoring survey may be organized in modules and be replaced or modified, as appropriate, according to new knowledge, techniques or legislations.

4.2 Impact zones

Finfish farm effluent consists of large particles (e.g. waste feed pellets and intact faecal pellets), smaller suspended particles (e.g. feed dust and broken faecal pellets) and dissolved material (nutrients, organic compounds, etc.). These types of effluents have different potential dispersal kinetics and affect the water column and seafloor at varying distances from the finfish farm. Normally, a greater impact is accepted under a finfish farm than further out into the receiving environment. Around a finfish farm, various impact zones are formed, which are affected to different degrees (see Table 1). For medium- to high-current sites, it is possible that the maximum impact does not occur under the farm, but rather adjacent and down current to the farm.

Table 1 — Overview of impact zones

	Type of impact zone		
	Local impact zone	**Intermediate impact zone**	**Regional impact zone**
Definition	Area of seabed under and near a finfish farm where most of the larger particles are deposited, e.g. less than 30 m from cages.	Area of seabed between the local impact zone and the regional impact zone, where sedimentation of smaller particles occurs. At deep, high-current sites, also larger particles can accumulate here.	Area of seabed beyond intermediate zone
Source of impact	Finfish farm	The finfish farm is the main source of impact, but other factors can also contribute.	The finfish farm is one of several potential sources of impact.
Potential impact	Changes in the physical, chemical and biological conditions on the seafloor	Usually less impacts relative to the local impact zone.	Changes in benthic fauna and community structure

The type of survey used depends on the level of impact and on the kind of impact zone which is monitored.

4.3 Survey types

Surveys may be divided into three main categories (see Table 2) according to the objectives.

Table 2 — Overview of main categories of survey type

Survey type	Objectives
Baseline monitoring	Characterizes conditions in a given area of seabed before operation of a finfish aquaculture facility. Also maps or identifies the impact of other sources. Faunal composition and/or biogeochemical and hydrodynamic parameters are compared with specified assessment criteria or simply with other representative areas of seabed (reference areas).
Operational monitoring of local impact zone	The samples are taken close to the aquaculture facility in the local impact zone for frequent surveillance of impact from finfish farm.
Operational transect monitoring	The samples are taken in a transect from the local, to the intermediate and to the regional impact zone for surveillance of the impact o the finfish farm, impact of other potential sources and for documentation of natural environmental and biological changes.

In addition, a pilot survey may be conducted. A pilot survey gives a general overview of bottom and faunal conditions and is used either for simple rapid assessment or to give basic information for designing more detailed sampling programmes.

For further information on the different survey types, see ISO 16665.

5 Methodology

5.1 Sampling strategy

5.1.1 Sampling programme and planning

The design of the sampling programme depends on the detailed aims of the survey and the required power of the data. The programme should be developed with regard to local bathymetric and hydrodynamic conditions in the survey seabed area, information on local contamination sources and knowledge from previous surveys, if any. The number of sampling stations, their positions and numbers of replicate samples to be taken at each sampling station, as described in the following subclauses, should be established according to the main prevalent currents within the area and prior to the initiation of the survey.

Baseline monitoring of the seafloor is conducted before operation of a finfish aquaculture facility is started. Based on information about water currents, bathymetry and layout for the planned finfish farm, the amount and pattern of the deposition of effluents from the farm on the seafloor may be predicted. A frequently used term for this deposition is “footprint of deposition” around the cages. There are several ways to estimate the footprint of deposition. A simplified method for prediction is to include the potential site area of seabed, plus the expected deposition downstream of the finfish farm. Recommended computerized tools for prediction of deposition footprints around finfish operations are also available. Based on the predicted footprint of deposition and information about water currents, bathymetry and layout for the planned finfish farm, the geographical coordinates for the sampling stations for baseline and operational monitoring can be set out as described in 5.1.2.

For finfish farms that are already established, positioning makes reference to the positions of cages and containments and, if possible, to geographic position survey locations. It can be set out directly as described in 5.1.2.

For groups of adjacent compact cages or cage arrays, the samples should be taken along the outer edge of, and, if possible, in between the individual cages. The sampling area of seabed should, as far as possible, be representative of the entire area under the finfish farm (local impact zone).

For dispersed cages, the samples should be taken along the outer edge of the cages, and if possible,, in between the individual dispersed cages. At least one sample should be taken at each cage, depending on the total number of cages at the finfish farm site, as well as a holistic assessment of how the most representative picture may be achieved.

5.1.2 Positioning of sampling stations

Before the positioning of sampling stations, information about water currents, bathymetry, layout and deposition footprint for the finfish farm should be available.

5.1.2.1 Sampling stations for operational monitoring of local impact zone

A minimum of four samples should be taken from each finfish farming site. Additional samples should be considered depending on the size of the operation. Sampling should be carried out from the edge of the cages or containments, or in their immediate vicinity. The sampling points should be positioned according to the bathymetry, dominant current direction and the dimensions and layout of the finfish farm, such that they represent as greatly as possible, the entire local impact zone.

All the observations made should be noted in the field log and included in the subsequent evaluation of results. All sampling positions should be shown on a map, preferably geo-referenced.

5.1.2.2 Sampling stations for operational transect monitoring

Samples from at least three sampling stations, at least one in each impact zone, should be taken. These three stations shall be considered fixed long-term monitoring stations, provided the cages do not shift in location due to intentional or unintentional changes.

The number of replicates taken on each sampling station should be chosen on the basis of statistical necessity. At least two replicates are recommended at each sampling station:

— at least one set of samples should be taken in the local impact zone downstream as close to the cage area as practicable (sampling station 1) at the perimeter of containment structures;

— at least one set should be taken downstream in the intermediate impact zone (sampling station 2), typically 30 m away from cage area or as defined by the regulator;

— at least one set should be taken downstream in the regional impact zone (sampling station 3), typically, 100 m from cage area or as defined by the regulator;

— if a depression exists in the area of influence where accumulation of waste from the finfish farm is probable, sampling station 3 is positioned in this depression. In this case, sampling station 2 should be taken downstream in the intermediate impact zone, half-way between the cage area and the depression.

If the cages are located over a steep slope without sediment accumulation, sampling station 1 and sampling station 2 should be positioned at the foot of the slope. If it is not possible to obtain samples from near the finfish farm (sampling station 1) or further out into the intermediate impact zone (sampling station 2), all three sampling stations should be positioned in the nearest deep area of seabed.

5.1.2.3 Sampling stations for baseline monitoring

The same number of stations for baseline monitoring are positioned, if possible, at the same geographical coordinates or relative positions as stations for operational monitoring of the local impact zone plus stations for operational transect monitoring. Furthermore, one or more reference stations should be chosen between 500 m and 2 000 m beyond the local impact zone. Reference stations are used to determine whether observed changes adjacent to the farm are a result of farm activities or due to changes in the broader receiving environment. They can also be used to indicate changes in the receiving environment associated with carrying capacity. The reference stations should, as far as possible, be representative of conditions unaffected by effluent sources and allow assessment of natural temporal and spatial variations in the soft-bottom faunal communities.

Reference stations should be located in conditions as similar as possible to those at the regular sampling stations, i.e. with similar depth and sediment type as indicated by analyses of sediment grain size distribution. Multiple reference stations are particularly important in heterogeneous areas of seabed. Reference stations should be considered as fixed long-term monitoring stations.

A baseline survey consists of a minimum of eight sampling stations: a minimum of four sampling stations, which during operation of the finfish farm are used as sampling stations for operational monitoring of local impact