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Methods for sea lice surveillance on marine finfish farms

Méthodes de surveillance des poux de mer dans les exploitations de pisciculture marine

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 234, *Fisheries and aquaculture*.

Introduction

The term “sea lice” refers to several species of naturally occurring marine copepods that parasitize fish. They attach themselves to the skin, fins, and gills of wild and farmed fish, and feed on host mucus and skin. If an infestation is severe, it can negatively impact the health of affected fish.

The abundance of sea lice can be amplified on marine finfish farms and a concern is that farms can then act as a reservoir, releasing lice back into the broader marine environment. Farms could thus act as a source of infestation for wild fish, particularly salmonids. While it is possible to control lice levels on farms through integrated pest management approaches and the use of therapeutants, the same intervention cannot easily be applied to wild fish populations. For this reason, many jurisdictions place requirements on farmed salmon producers to carefully monitor lice levels on farms and to take appropriate actions to reduce on-farm lice populations where lice have been identified as a concern.

Where sea lice are identified as a concern to be managed, counts may be used in a number of ways. Over the past decade, it has become increasingly common for regulators to establish upper limits to abundance of lice on farms with the intent of minimizing potential impacts to wild fish populations. Farming companies can also monitor lice abundance to maintain appropriate fish welfare conditions. In addition, the development of reduced sensitivity to in-feed medication (following similar trends seen for bath treatments in the 1990s), is a concern to both regulators and producers. Clear and standardized sea lice counts are necessary for the early detection of any such trends. Both the aquaculture industry and pharmaceutical suppliers of ecto-parasiticides would then be in a position to make better and earlier determination of situations in which treatments were beginning to lose effectiveness, and thus, to initiate appropriate mitigation strategies.

Over the past two decades, a range of counting methods have been developed across countries, and sometimes within countries, such that it is often difficult to know how to interpret the sea lice levels reported from farm sites. The goals of this International Standard are to ensure that the sea lice counts carried out on marine finfish farms are accurate and fit for purpose and to establish a method for sea lice on-farm surveillance that can be carried out in any farming area, affording accurate, consistent estimates of lice. A standardized methodology will yield results that can better be compared across jurisdictions and geographic regions, supporting the development and implementation of effective lice management approaches and increasing public confidence that effective control measures are being implemented.

This International Standard has been developed in consideration of the

— intended use of the results of sampling,

— practical and economic constraints of sampling,

— species of lice of concern in an area,

— cage and site configurations,

— seasonal or environmental conditions, and

— potential impacts on fish health and welfare.

Methods for sea lice surveillance on marine finfish farms

1 Scope

This International Standard specifies both a method for sea lice counts on marine finfish farms and a method for sea lice surveillance that can be carried out in any farming area to provide consistent estimates of sea lice infestation.

It specifies the best practices associated with monitoring sea lice levels on marine finfish farms for various purposes including the assessment of abundance, prevalence, and treatment efficacy. This will include identifying minimum requirements for specific monitoring program elements (e.g. number of fish and cages to be sampled, frequency of sampling, the level of detail recorded, etc.). The standard will apply to all marine finfish farms which experience infestation with any of the range of "sea lice" (copepodid) parasites.

2 Normative references

There are no normative references in this International Standard.

3 Terms and definitions

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

3.1
sea lice
copepods of one of a number of lice species

Note 1 to entry: The most commonly occurring sea lice, depending on location, being the various salmon lice *Lepeophtheirus salmonis* Krøyer, *Caligus elongatus*, *Caligus clemensi*, *Caligus rogercresseyi*, etc. and the cod louse *Caligus curtus*.

3.2
sea lice stages
sea lice metamorphose to different life stages

Note 1 to entry: Sea lice stages includes the nauplii (free-swimming stage) through the copepodid stage (infectious stage) to various stages of chalimus growth (attached stages) where they are attached to a single point on the fish host. They then develop to pre-adult (for some lice species) and finally, adult stages, at which point they are able to move around on the fish host (motile stages).

3.3
finfish
fish of the class Osteichthyes

3.4
facility
collective structures used for the purposes of finfish aquaculture; including the enclosures (net pens), walkways, barges, floats plus associated lines and anchors

3.5
enclosures
containment structures, including net pens, cages, or similar structures used to contain finfish for the purposes of aquaculture

3.6
treatment
measure applied to remove sea lice

EXAMPLE Treatment such as in-feed drug products, topical pesticides, or other methods that remove lice, including mechanical removal.

3.7
abundance
mean number of lice across all of the fish that are examined at any particular sampling point

3.8
prevalence
proportion of fish on which at least one louse was observed from all of those examined during any particular sampling event

3.9
intensity
mean number of lice across only those fish on which lice have been observed during the examination at any particular sampling point

3.10
accuracy
quantitative measure of the degree of conformity with an accepted reference value

[SOURCE: ISO 6707-1:2004, definition 9.1.8]

3.11
precision
quantitative measure of the degree of agreement between individual measurements of the same property

[SOURCE: ISO 6707-1:2004, definition 9.1.9]

3.12
sea lice count
event involving a number of fish from a range of cages on a marine finfish farm on a specific date which enumerates the presence of different sea lice stages on these fish

3.13
sea lice surveillance
process by which sea lice levels are recorded and assessed over time; the protocol to organize and assess a series of sea lice counts

3.14
clustering
degree to which parasites tend to aggregate within units (in this case cages)

Note 1 to entry: Can be formally measured by the intraclass correlation coefficient (ICC) which describes how closely communities in the same unit tend to resemble each other.

4 Sampling design

4.1 Purpose, precision, and accuracy

The most important consideration in determining sampling design is the purpose for which the monitoring is being carried out. The key issue in deciding on a sampling strategy is specifying the level of precision or accuracy that is required as an outcome from the sampling process.

NOTE 1 The purpose of monitoring could be to fulfil regulatory requirements, in which case, it would be up to the relevant authority to decide on the design details, or it could be to monitor the effectiveness of the treatments for sea lice, in which case, the outcome could be of importance to both the authorities and producers of fish. The design and frequencies of the monitoring will therefore vary.

NOTE 2 When reporting mean sea lice levels for comparison against treatment triggers, or simply to visualize trends over time, it can be that ±20 % is adequate, while estimating efficacy of a treatment intervention can require a more tightly defined precision.

There are also a number of biological factors that will affect the accuracy of estimates. In particular, the level of clustering which exists in a given situation will impact on the importance of selecting a representative number of cages from within a farm.

NOTE 3 Clustering refers to the relationship of within-cage to between-cage variation and is known to be important in most ecological monitoring situations.

4.2 Specification of measure to be used (abundance, prevalence, and median intensity)

4.2.1 General

It is not only precision and accuracy that are associated with purpose; the actual metric that is used to express the level of sea lice load on fish may change in differing contexts and under varying conditions (see also Annex B). Abundance is the most commonly used metric when sampling sea lice. However, when sea lice levels are very low, as is assumed to be the case when trigger levels of, for example, 0,1 adult females per fish are in place, it is unlikely that abundance will be the best metric.

NOTE 1 General advice from the quantitative parasitology literature is that prevalence and median intensity may be better metrics to use than mean abundance in this circumstance.

NOTE 2 Regulatory thresholds are usually based on average sea lice figures, or in parasitological terminology, “abundance”; while estimates of intensity and prevalence are typically only used in epidemiological studies.

4.2.2 Abundance

Having taken note of the considerations above, a relevant level of accuracy should be selected. The cells contained in Table 1 indicate the estimated levels of accuracy that can be expected to be obtained under different configurations of cage coverage and total number of fish in the sample. The accuracy increases as the total number of fish sampled is increased (i.e. from left to right) and under normal conditions, where clustering is present, the same is true as a larger proportion of the cages is included (i.e. moving from top to bottom in the table). The diagonal lines in Table 1 indicate sampling strategies of equivalent accuracy.

NOTE The actual slope of the diagonal lines in Table 1 is dependent on the degree of clustering present in a given situation. The metric used to define this is the Intra-class Clustering Coefficient or ICC, which in the example shown, based on empirical data, has been set to a value of 0,35. As the ICC approaches a value of zero, i.e. no clustering, the lines of accuracy-equivalence would tend towards the vertical, indicating that accuracy is based only on total number of fish included in the sample.

Table 1 — Impact of number of fish and % of cages sampled on precision estimation

% of cages	Total number of fish sampled							
	20	30	40	50	100	150	200	300
10%								
25%								
50%								
100% (all)								

50 % precision

20% precision **10% precision** **5 % precision**

4.2.3 Prevalence and median intensity

In situations of low abundance (e.g. less than 0,2 individuals per fish), an alternative metric should be used to report sea lice infestation. This may be in addition to or in place of abundance. In such situations, the prevalence will also be low, in the region of 10 % to 15 % of fish having parasites. Similar general issues as those outlined in 4.1 will hold when determining accuracy. However, for prevalence, the maximum level of resolution in any estimate will be limited to $1/N$ (where N is the number of fish per cage, or per site, depending on the level at which prevalence is being estimated). Intensity measures consider only fish which have sea lice present on them, and thus, in such situations, taken with prevalence, can provide a more useful summary of infestation than abundance. In addition, by using a median value, they can also avoid the problems of bias introduced by a single 'outlier' in the circumstance where only a few fish are likely to be infected.

4.2.4 Minimum requirements for on-farm monitoring of sea lice levels and effect of treatment

Having taken note of the considerations in 4.1 and 4.2, the operator should be able to identify an appropriate approach for the on-farm monitoring of sea lice levels and to assess the effect of treatments. However, for the purpose of this International Standard, minimum requirements for such monitoring are set. The monitoring of sea lice levels is in Table 2 and the monitoring of the effect of treatment for sea lice is in Table 3. Table 2 and Table 3 both sets out the minimum requirements in terms of proportion cages and numbers of fish sampled for various scenarios.

Table 2 — Minimum sampling coverage, number of fish and percentage of cages when monitoring the sea lice levels

Number of cages present on finfish farm	% of cages sampled	Minimum number of fish to be sampled per cage
3 or less	100 %	10
4 to 12	50 %	10
More than 12	33 %	10

Table 3 — Minimum sampling coverage, number of fish and percentage of cages when monitoring the effect of treatment for sea lice

Number of cages present on finfish farm	% of treated cages sampled	Minimum number of fish to be sampled per cage before and after treatment
3 or less	100 %	20
4 to 12	100 %	20

Table 3 *(continued)*

Number of cages present on finfish farm	% of treated cages sampled	Minimum number of fish to be sampled per cage before and after treatment
More than 12	100 %	20

5 Information requirements for sampling events

5.1 General

Adequate sampling shall include several key elements. The contextual elements that shall be recorded are listed in Table 4, while the information specific to the sea lice present on the sampled fish is noted in Table 5.

5.2 Contextual elements at each sampling event

Each time fish are sampled to assess sea lice infestation, a number of contextual elements, which are important to the appropriate interpretation of the observation (see Annex A), shall be recorded as listed in Table 4.

Table 4 — Core contextual elements for sea lice sampling

Level of detail	Type of element		
	Event	Production	Environmental
Facility	Date of sampling Unique identifier for the facility or site	Total number of fish being held on the facility Total number of enclosures holding fish on the facility at the time of sampling Year class of fish stocked at the facility	Seawater temperature, normally at one or more standardized depths (e.g. surface or 3 m) with depth specified Salinity normally at one or more standardized depths (e.g. surface or 3 m) with depth specified
Enclosure	Unique identifier for the enclosure (pen, cage) Method used to catch fish from enclosure Date and product used in most recent use of sea lice treatment	Enclosure volume Estimated average weight of fish in the enclosure Estimated number of fish in the enclosure	
Fish		Observations of lice-related damage to the fish Poor performing fish	

5.3 Sea lice elements at each sampling event

Once the major lice species of concern has been identified (in many regions, this will be *Lepeophtheirus salmonis*), recorded observations of all sea lice on fish shall include annotation of the lice species as well as enumeration of specific life stages. The sea lice life stages of interest are the chalimus (also referred to as “attached”) stages and the motile stages (which include adult male and adult female, and for some species, pre-adult life stages).

