

Collection of biological material from cod during commercial fishing trips

Biological samples of cod are collected on the deck of the vessel during commercial fishing trips. Samples are taken separately for cod caught by trawl and cod caught by gill-nets during commercial fishing. Samples are collected at least once a month, depending on fishing conditions.

During commercial fishing trips, biological analysis and mass measurements are performed on cod. Information is collected from each fishing report, from each fishing subdivision where the vessel fished during the trip. Information is collected for each catch "fraction" in the respective fishing report (for landed cod, discarded cod, or fish below the minimum commercial size). **Information is collected based on the specific situation in each trip and each fishing report.**

Biological analysis involves collecting data to create an age-length key for each fishing subdivision from the data collected during the trip (at least 30 otoliths from 30 fish in each 5 cm length group). In standard biological analysis, the following information is compiled for each fish:

- Maximum length, cm
- Total weight, g
- Sex
- Gonadal maturity stage (according to the 7-point scale)
- Otoliths for age determination
- Notes

Otoliths are collected in logbooks. Each logbook specifies:

- Date of fishing
- Trip number
- Fishing gear
- Fishing act number
- Vessel
- Fishing subarea
- Catch fraction
- Individual fish numbers in each logbook (from - to)

Each page of the logbooks lists the specific fish's order number, as well as the fish's length in centimeters, weight, gender, and maturity stage. Later, the information from the logbooks is transcribed onto biological analysis forms.

Mass measurements

Mass measurements are taken for randomly selected, unsorted fish from each catch fraction. The maximum length in centimetres is recorded for the measured fish. Mass measurements are carried out according to the size of the catch. If the catch is small (< 200 kg), it is preferable to measure all of it. In the case of a larger catch, a sample portion is taken. The measured sample portion is indicated in kilograms. If possible, the measured sample weight is weighed or calculated later using biological analysis data.

Quality control of trip data

Quality control of trip data involves entering each trip's data into a separate Excel database file. The data file contains restrictions (minimum and maximum allowable values) for the following biological parameters:

- Fish total length, cm
- Total weight, g
- Age

The data file also predefines values that can be assigned to the following biological parameters:

- Gender
- Gonadal maturity stage

Once the data for a specific trip is input, an analysis of fish length and weight data is performed. A linear regression model is created to determine the trend line and forecast confidence intervals. Entries outside the confidence intervals are marked as erroneous and reviewed and corrected if necessary. Biological data is rechecked when age determination is carried out. The age determiner compares records for each individual fish with information in the logbooks and biological analysis forms. Any identified errors are corrected in the Excel database file and on the biological analysis forms.

In 2014, the assessment of the precision level of biological material collected in commercial fishing was carried out.

1.7.1. Definition of Precision Levels

The European Union Commission Regulation EC 1639/2001 with amendments EC 1581/2004, as well as the European Commission Decision EU 93/2010, require an annual assessment of the precision level of catch and discard data, as well as the calculation of the precision level of biological parameters at three-year intervals. These documents specify three precision levels:

- Level 1 - The assessable parameters can be estimated with a precision of $\pm 40\%$ using a 95% confidence interval or achieving approximately 20% of the coefficient of variation.
- Level 2 - The assessable parameters can be estimated with a precision of $\pm 25\%$ using a 95% confidence interval or achieving approximately 12.5% of the coefficient of variation.
- Level 3 - The assessable parameters can be estimated with a precision of $\pm 5\%$ using a 95% confidence interval or achieving approximately 2.5% of the coefficient of variation.

The precision of catch length and age distribution, as well as biological parameter precision, for assessable fish stocks must be calculated by quarters and fishing gears. Afterward, the overall precision is calculated as the weighted average. The attainable precision level depends on the species under study.

1.7.2. Calculation of Precision Levels

For the calculation of precision levels, two methods are employed: the bootstrap method and the analytical method.

1.7.2.1. Bootstrap Method for Precision Level Calculation

The bootstrap method is primarily used for calculating 95% confidence intervals and assessing precision levels. The bootstrap method assumes that the observed parameter, such as the distribution of fish lengths in a sample, represents the distribution of values for the entire population from which the sample was obtained. From the obtained sample dataset, 2000 random pseudo-samples are generated. For each of these pseudo-samples, the mean value for the specific parameter is determined. The 2.5th and 97.5th percentiles from these 2000 pseudo-samples are then used as the 95% confidence interval for the population parameter's mean value.

1.7.2.2. Analytical Method for Precision Level Calculation

For certain parameters, such as the mean weight of fish in each age class, the 95% confidence interval and, consequently, the precision level were calculated analytically using the formula:

$$\hat{\mu} \pm t(n-1)_{\alpha} \cdot s / \sqrt{n},$$

Where:

μ is the estimated parameter mean value,

n is the number of observations (fish) in the specific class,

t_{α} is the two-tailed t-distribution value at the confidence level α ,

σ is the standard error of the mean

This formula is used for certain parameters, such as the mean weight of fish in each age class, where $t(n-1)_{\alpha}$ represents the two-tailed t-distribution value corresponding to the confidence level α and $n-1$ degrees of freedom, while \sqrt{n} represents the standard error of the mean.