Guidelines for coastal fish monitoring

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BACKGROUND

Fish are studied to an increasing extent in environmental science. Standardized techniques for long-term monitoring and predictions of the size and productive capacity of fish populations, as well as continuous control of their health in a wide context thus are required. This report describes a basic programme and guidelines designed to study coastal fish in the Baltic and Kattegat. The system also constitutes a basis for an integration of physiological health studies and measurements of contaminant levels with basic ecological data.

Monitoring strategy

The monitoring strategy is designed to indicate impact of, in particular, exposure to eutrophicating and toxic substances. The effects of eutrophication are most efficiently monitoried at the community level and climate change impact will also likely be detected by monitoring community structure. There are well developed models predicting the reactions of the Baltic coastal freshwater fish community (Hartmann 1977, Neuman and Sandström 1996). However, for marine fish there is still a considerable lack of understanding.

When monitoring toxic impact, an integrated approach has been suggested by many reviewers (Owens 1991, Sprague 1991). Sentinel species should be selected according to well specified criteria, and monitoring should be performed on many levels indicating the health of the population. A tiered strategy is often recommended for the analysis of observed deviations, including biochemical endpoints to support interpretations of possible toxic influence (Neuman and Sandström 1996).

Two sentinel fish species have been approved for Baltic coastal monitoring: perch and viviparous blenny. Both species are stationary, large enough also for biochemical and chemical sampling, generally abundant in their prefered respective habitats, and with a biology allowing far-reaching analyses of reproductive impacts. Perch may be monitored in most sheltered habitats in the Baltic, while the viviparous blenny more represents the open coasts and the Kattegat.

Programme design

Community reactions are monitored by analysing changes in the abundances of populations, cyprinids generally acting as sensitive indicators of coastal eutrophication. Sentinel monitoring as well is based on population density but a number of additional characteristics should be studied, e.g. age structure, growth and reproduction.

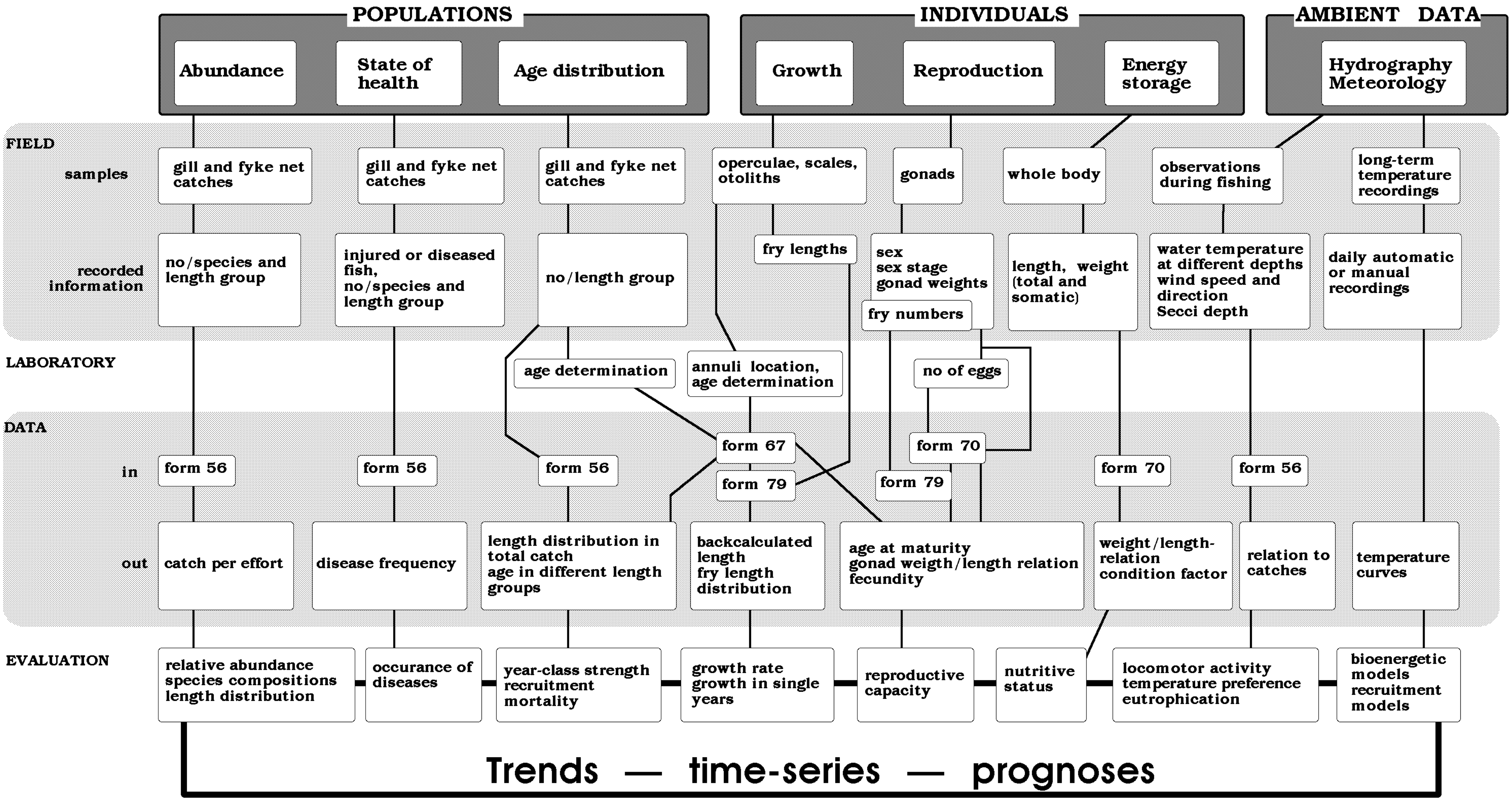
The system is designed for truly coastal species. These are mainly demersal. Warmwater adapted limnic species dominate in most Baltic coastal areas. In the Kattegat, the viviparous blenny is one of the few typical nonmigratory coastal species available for monitoring of the whole lifecycle. Pelagic coldwater species like the herring often occur also in coastal areas, but they are migratory members of another community more representing the open sea.

Both population monitoring and sampling of fish for analytical purposes are done by means of fishing using established methods – gill nets and fyke nets. A detailed description of the principles behind the system is given by Neuman (1985). The design of the test fishing, as in all other monitoring of inter-year variations in biological processes, places strict demands on statistical planning. The methods described here have been developed through many years of pilot studies and statistical tests. By means of stratification as regards choice of species and size groups, depth intervals, stations and saeson, it has been possible to create statistically satisfactory programmes at reasonable expense. Consequently, this programme has a design that definitely separates it from inventory studies. However, such geographical mappings of, e.g., species distribution should be included in the predesign studies that should be made prior to each individual monitoring programme.

The flow of information through the system is illustrated on p. 5. Other measurements on the individual level, being outside the scope of the basic programme described here – contaminant analyses, biomarkers, physiology, pathology etc. – can easily be included. A large number of such methods have been described by Neuman (1985) and up-dated guidelines are currently prepared (Larsson *et al.* in prep.). The basic programme can be (and in some countries already is) applied both in reference areas, i.e., areas without local anthropogenic influence, and in hot spot monitoring.

These guidelines are prepared in two sections: ”Community structure” and ”Sentinel species”. In the latter detailed monitoring advice is presented for the two coastal species approved for HELCOM monitoring, perch and viviparous blenny.

Fish monitoring and prognosis



COMMUNITY STRUCTURE

General

Most methods of measuring changes in fish abundance provide catches of several species and thus also information on changes to the species composition. An important objective in fisheries management and nature conservation is to retain a natural abundance and species composition of the fish.

In abundance studies, certain restrictions and priorities must be made depending on the demands of the statistical tests and according to cost-efficiency analyses. Absolute density can not be measured using common techniques but instead studies are made of the changes in the relative measure catch per effort and the species composition. Bottom gill nets are recommended in Baltic coastal fish monitoring.

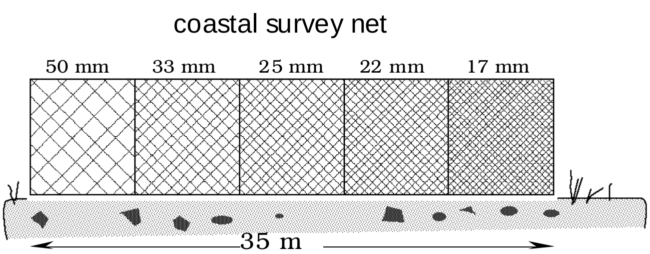
Abiotic ambient factors influence behaviour and metabolism in fish. Thus, for example, locomotory activity normally increases with increasing temperature, and thus also the catches in the test fishings with passive nets. Locomotory activity may also be influenced by changes in the wind, current, salinity and visibility. When interpreting catches, the importance of these factors should be considered, and thus they are registered during the test fishings.

Since fish are poikilothermal organisms, the metabolism is strongly governed by temperature, affecting growth and survival. Growth capacity has a strong positive temperature dependency up to an optimum temperature depending on species and size. Survival during the first year of life is both directly and indirectly, via food uptake and growth, linked to temperature. Consequently, when analysing year-class strength it is essential to include temperature.

Choice of net

The choice of nets is governed by the species composition in the community to be studied and the desire to obtain reasonably accurate estimates of size- and age-distributions. Net sets have been extensively used by fishery biologists to study fish communities. The basic unit in the recommended system is a link of four nets with different mesh sizes set in a locality – "station"– with uniform (hydrographical) conditions. In the northern Baltic, however, depths and substrates often vary considerably also in the small scale, making it difficult to find uniform areas large enough for a representive use of four nets. A multi-mesh-size coastal survey net was developed to allow representative samples to be collected in such variable conditions. Coastal survey nets are consequently recommended in the Gulf of Bothnia and along the Finnish coast of the Gulf of Finland. Net sets should be used in all other parts of the Baltic.

Description of the nets



The coastal survey net (code 9) consists of 3 m (10 feet) deep bottom gill nets – the height in the water is about 2.5 m – with a length of 35 m (see sketch to the right). The lower net-rope (main line) is 10% longer than the upper net-rope (=38.5 m). The nets are made up of five parts, each 7 m long. These have different mesh sizes and are placed in the following order: 17 mm, 22 mm, 25 mm, 33 mm, 50 mm (mesh bar). The nets are made of green monofilament nylon of 0.20 mm diameter in the two largest mesh sizes and 0.17 mm in the others. The upper net-rope for coastal survey nets is patented net-rope no. 2 ½, the lower net-rope is plastic net-rope no. 2 (weight = 3.2 kg/100 m).

The set of nets (code 53) consists of bottom set gill nets which are 1.8 m (6 feet) deep and made of spun green nylon. A net consists of a 60 m long stretched net bundle which is attached to a 27 m net-rope (pat. net-rope 1½, 35 cm between floats, buoyancy 6 g/m) and a 33 m lower net-rope (pat. net-rope 1½ weight 2.2 kg/100 m). A set of nets is composed of four nets with mesh sizes 17, 21, 25 and 30 mm.

Yarn thickness is no. 210/3 for mesh size 60 mm, no. 212/2 for 50–33 mm and no. 110/2 for the other sizes, according to the Tex-system (e.g., 110/2 means 2 filaments each weighing 110 g per 10 000 m).

Localities

The smallest geographical unit is a *station* at which either a net set or two coastal survey nets are placed. A group of neighbouring stations with similar conditions (depth, exposure, etc.) and exposed to the same influence of environmental disturbances, forms a *section*. Within a section the bottom depth at the nets must not differ more than 2 metres between stations. An *area* is a denominated geographical area within which there may be one or more sections.

The recommended number of stations and the number of visits per station may vary depending upon the morphometric characters of the area and the abundance of fish. To select monitoring stations a predesign study has to be made. A large number of stations (>20) are visited once to provide a mapping of spatial variability. Cirka 10 stations are selected for a continued three year evaluation period. Based on these experiences, the number of stations may be further reduced after performing statistical tests of homogeneity. Monitoring of abundance trends, using net sets or survey nets, is generally possible by sampling a minimum of six stations per area.

Fishing performance

<u>Fishing techniques</u>

Nets must be set lightly stretched from an anchored buoy, which is placed out at the start of the fishing period and removed at the end. The direction of the net (the set) should be constant when fishing in shallow water. A main rule is that the nets are set parallel to the shore.

Before the fishing is started each station must be carefully documented as regards the type of bottom and position (longitude, latitude). Landmarks and buoy sites can be photographed.

Occasional broken mesh are tolerated. Checks must be made on every occasion when the nets are emptied.

Exposure
The nets are set between 14 and 16 hrs. They are collected on the following day between 7 and 10 hrs. The times given are standard times (= solar time). Within each area the times for setting and lifting should vary as little as possible between fishing efforts.

Fishing period
Fishing is done during the period July 25 – August 15, if possible within a 14-day period. Areas to be compared should be fished with as short time difference as possible.

Frequency
At least six fishing efforts are done at each station. All stations within a section are fished on the same day. If all sections cannot be fished on the same day, the fishing is continued in the remaining sections before returning to the first section.

Data registration
Form 56 (see p. 31) is used. Instructions to fill in the form are given on the reverse (see p. 32).

The form is divided into three parts, so-called card types, namely hydrographical and meteorological data, catch data and disease data. The heading of the form (columns 1–15) is the same for all three parts. Code lists and abbreviations are given on pp. 40–42.

Catch data may be transferred to a data base by recording programmes. The Institute of Coastal Research has developed a computerised program (FIRRE, developed in MS Access 2.0) for recording, handling and analysing test fishing data. Data quality is assured by validations of, e.g, lengths recorded, hydrographical observations and areal codes. Results such as mean catch per unit effort in different areas can be produced as standardised graphic presentations or as tables.

Ambient data
The ambient data are recorded section by section on Form 56, see p. 31. The exception is the bottom temperature of the deepest point at each station, see below.

An account of how the different measurements are made is given below. The accuracy of the instrument should be checked regularly.

Water depth is not normally registered.

Water temperature is measured with a thermistor or a thermometer fitted into a water-collector. The surface temperature at one point per section is entered onto the ambient data part of the form, whereas the bottom temperature of the deepest point at each station is recorded on the catch data part. All temperatures are registered in tens of degrees Celsius without using the decimal point.

Wind direction is estimated and is given according to the compass (0–360°) as the direction from which the wind is coming.

Wind velocity is estimated in m/sec.

Water current direction is estimated. It refers to the direction in which the current is flowing and is given according to the compass direction. For example, 360° current comes from the south.

Salinity is measured using a salinometer (usually not measured in the Baltic).

Industrial operations are only recorded when appropriate.

Fog is not usually recorded

The visibility is measured in sheltered conditions under a shaded surface using a round white Secchi disc, 25 cm in diameter. The disc is first lowered so far that it cannot be seen and is then lifted up. The visibility depth, given in decimetres, is the depth at which the disc first becomes visible. The line must be held vertically in the water.

Air pressure is measured in mm Hg but is not normally measured.

Catch data

The catch is reported by station and is separated into species (for species code list see p. 40) in 2.5 cm length groups. Weights need not be registered.

Disease data

External visible signs of disease are always examined in the catches. Species and length group of diseased fish are registered separately on the form. The disease codes are listed on the reverse of the form. Six different codes are used. If code 6, other symptoms, is chosen then an explanation must be given on the reverse of the form. Notes are made of species, length group, number and the kind of symptoms present.

Other considerations

The fishing effort must always be one. The disturbance code is given according to p. 42.

Data processing

Since stratified sampling is used when planning the fishing efforts, the variation in the material is minimized, which enables measurements of changes in the fish populations to be made on the basis of relatively small catches.

In the statistical processing of the material it is assumed that the catch per station and day is an observation of an hypothetical population, which during the relevant fishing period would be generated by, e.g., six fishing efforts at a very large number of stations. The material can be treated by trend analysis and analysis of variance by ranks using non-parametric methods. The trend for an individual station can be calculated using, e.g., Kendall's tau. A common trend for a group of stations (section) can be calculated using Mann-Kendall's test and chi-2, which, in favourable situations, provides evidence of population increases or decreases already after a few years. The Kruskal-Wallis test is recommended for comparisons between individual years. In this test the mean value for a station is used as an observation of the above-mentioned hypothetical population. Parametric methods can also be used. Logarithmic transformation, or square root transformation, of data often stabilizes the variance yielding distributions satisfying the assumptions of anova.

SENTINEL SPECIES

General

HELCOM suggests two coastal species of fish as sentinels in the monitoring of contaminants and their effects, the marine viviparous blenny (*Zoarces viviparus*) and the limnic perch (*Perca fluviatilis*). These two species were selected on certain criteria: stationary behavior, well-known biology, common and easy to catch, mode of reproduction allowing analytical studies and a size large enough for chemical and biochemical analyses on individuals.

HELCOM has recognized the need for monitoring of effects also beyond the immediate influence area. Impact from a polluted river primarily will be detected in the estaurine communities by hot spot monitoring. When the water passes out to the open coast, a very different ecosystem will be exposed. Such coastal or near-coastal areas are distinguished from the hot spots classified by HELCOM as ”areas of concern”. The viviparous blenny should be a priority species selected for monitoring coastal areas of concern as well as hot spots on open coasts. Most Baltic hot spots are, however, situated in areas where the low salinity favours a fish community dominated by limnic species. In such areas of limnic character, perch is the priority species.

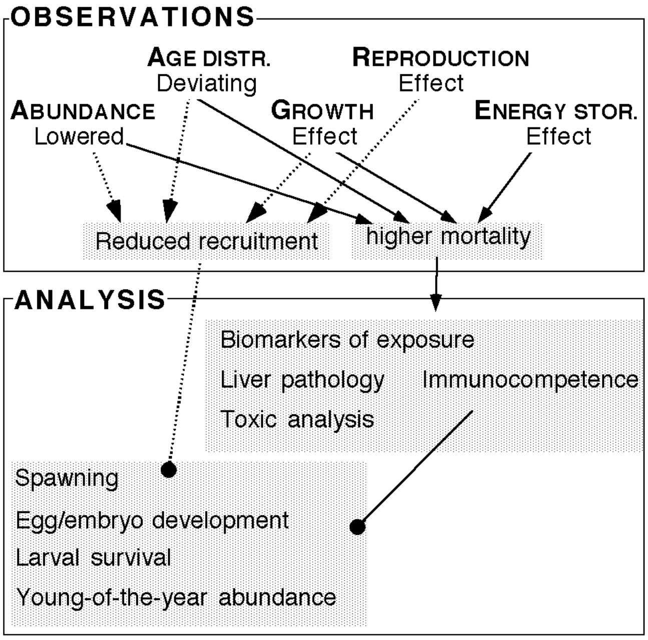
There is a definite need of close harmonization between contaminants and biological effects monitoring programmes. The same species and sampling sites should be used, and the analyses should as far as possible be made on the same individual specimens. As the criteria for selecting species do not differ between contaminants monitoring and other aspects of monitoring, the viviparous blenny and perch are priority species in integrated programmes.

Sentinel species monitoring should be based on a concept of integrating studies at the population and organism levels. The central population characteristics studied are abundance and age compositions. Lowered abundance and deviating age distribution indicate a recruitment damage or increased mortality (figure p. 14). The health of the population is further estimated by samplings of fish for studies of individual growth rate, age and size at maturation, gonad growth and energy storage. These are priority variables describing the life-history of the fish, but they are also important endpoints of different toxic disturbances at lower levels. Responses strongly indicate a risk of reduced recruitment or higher adult mortality. Although not included in these guidelines, biochemical indicators can provide improved analytical opportunities. Among possible biomarkers, enzyme inductions (e.g. EROD, ethoxyresorufin-O-deethylase) indicating toxic exposure, liver histopathology and white blood-cell counts may be mentioned.

Analytical procedures take over, when there is a signal received from the monitoring programme. First of all, the probability that a deviation is the result of toxic exposure, and not an expression of a normal reaction to environmental variations, e.g. temperature or food availability, should be evaluated by analyzing damage to vital functions like the liver and the immunocompetence system. In most cases there is at least some knowledge about the priority contaminants in the area, and the concentrations of these substanses should be analyzed, preferably accompanied by some biomarker indicating exposure.

Viviparous blenny monitoring is designed to provide accurate estimates of reproduction. After a long period of pregnancy (4–6 month), the fry are delivered at a size of 35–55 mm. The reproductive capacity of single females and the development and survival of the early fry stages, which are particularly sensitive to contaminants, thus can be studied with high precision. In perch, the variables monitored to indicate reproduction failure, e.g. relative gonad size, are only rough measures of reduced reproductive capacity. The reproduction biology of perch, however, makes analytical studies of most events regulating recruitment possible. Techniques are developed to study embryogenesis and larval survival on naturally deposited roe experimentally and in the field, and studies can be made on abundance and growth of young-of-the-year in autumn, after their first growth season, when year-class size is mainly determined.

These guidelines are provided separately for each of the sentinel species, perch and viviparous blenny, and give detailed descriptions on field samplings and laboratory analyses. Additional information on the sampling procedures, e.g. the selection of stations and recording of ambient data, is presented in ”Community structure”.



A conceptual model explaining the strategy of monitoring and analysing possible toxic influence on a perch population.

Sentinel species – perch

ABUNDANCE

See "Community structure".

AGE AND SEX DISTRIBUTION

General

By means of annual rings in different types of bony tissue it is possible to study the age distribution and growth. How to analyze annual rings is explained in the section on "Growth" below. The age composition of the fish stock can be used for calculating recruitment from the changes in the survival of the young-of-the-year (0+) in different years, the so-called year-class size, and the mortality in catchable ages. Knowledge of the absolute number of surviving fry in an area is not obtained but the method is useful in illustrating changes in the relative size of year-classes. Normally only a sample of the catch is age-determined but as the lengths of all fish are measured in the test fishings it is possible to estimate the age distribution of the entire catch on the basis of the relationship between age and length. The same material is used in the analyses of both age and growth, and the collection and sampling is described below.

One sex, usually females, is generally selected for age determinations. The number of males is, however, also recorded when collecting materials. This provides a base for calculations of sex rates in different length classes. Sex rate is a variable suspected to be sensitive to impact from a range of substances exhibiting hormonal effects.

Collection

Sampling is done in connection with the test fishing for abundance data. A pre-determined number of individuals is collected from different length groups. Only females are selected for samplings. The number of males is, however, also recorded in each length group (form 80).

The recommended sample size depends upon the selected precision in the estimations made to produce a length-at-age key. Assuming that the numbers of an age class within a length interval is a binomially distributed variable, the confidence interval may be approximately calculated. As an example, the 95% confidence interval of p (=the share) at maximal variance (p=0.5) and sample sizes n= 10, 50, 100, 300, or 1000 will be ±0.31, ±0.14, ±0.10, ±0.06, and ±0.03 respectively. Thus at a sample size of 50 observations, the interval will be ±0.14 at p=0.5. If 25 two-year olds were observed in length class 14 (12.5–15 cm), the lower limit of the 95% confidence interval is $0.36 \cdot 50=18$ and the upper limit $0.64 \cdot 50= 32$. Approximately normal distribution was assumed in this example. If the sample size is small and/or the share is small, other methods should be used. Roughly, a normal distribution may be accepted if $n \cdot p(1\text{-}p)$ is larger than 5. The recommended sampling routines for perch are given in the table below.

Length range	12.6–15.0	15.1–17.5	17.6–20.0	20.1–22.5	22.6–25.0	25.1–27.5	27.6 –30.0	>30 (cm)
Length group	14	16	19	21	24	26	29	≥31
Number of females	[1)]	50	50	50	50	[1)]	[1)]	[1)]

[1)] All are collected, but maximally 25 from each.

The collection must be started already at the first test fishing to secure as much material as possible from less common length groups. Once collection of a length group has been started it must not be interrupted within a net (survey net) or station (net set) catch but must be completed regardless of the numbers stated in the table above. In this way consideration is also paid to the size variation which may occur within length groups.

Sampling
The samples are stored in scale sample bags. Notes are made on these of, at the top, the serial number in the sampling series and below it the area code, section code (when applicable), fish species, total length (mm), sex and date of catch (year–week–day).

The operculum is collected from perch. It is removed by hand only, or from larger fish by using a knife, whereby the centre of the operculum, the pointed part of the bone, must be included (see figure under ”Growth” on page 14). The operculum is put in boiling water for about a minute after which it is easy to remove skin and meat residues in cold water under a running tap, as well as the bone that is attached to the rear edge (suboperculum). If possible the left-hand gill cover should be chosen.

Analysis of annual rings
The method is described under ”Growth”, see p. 17.

Data registration
Described under ”Growth”, see p. 17.

Data processing
<u>Year- class sizes</u>
Calculation of the relative year-class sizes requires sample collections from several years. The number of fish of a certain age in a sample from a certain catch-year can then be weighed both against the total number of fish in the sample and against the percentage of that age in the total material from all years.

A modified version of Svärdson’s (1961) method to calculate relative year-class strength (Neuman 1974) is recommended. It should be noted, that this technique does not allow detections of long-term trends in recruitment. Below is presented an example, based on perch age samples collected in the Kvädöfjärden reference area 1991–1995. The analysis is made on the age distribution in the total catch, calculated by using a length-at-age key.

The upper row for each catch-year gives the number of individuals of different ages in the sample. The next row gives the percentage age distribution in the sample. Subsequently, the number of fish of different ages is summed for all years, after which the percentage age distribution of the entire material is calculated. If the samplings cover many years this distribution gives a measure of what is normal for the species in the area studied.

Calculation of relative year-class strength

year of catch	total catch	age in years 4	5	6	7
1991	453	317	77	33	26
	%	70.0	17.0	7.3	5.7
	%	139	68	41	84
1992	357	252	95	10	0
	%	70.7	26.6	2.7	0.0
	%	140*	106	15	0
1993	382	52	257	63	10
	%	13.7	67.3	16.4	2.6
	%	27	269*	93	38
1994	704	293	73	262	76
	%	41.6	10.4	37.2	10.8
	%	82	42	210*	158
1995	320	204	51	25	40
	%	63.8	16.0	7.7	12.5
	%	126	64	44	184
Age distribution (%) calculated for the total material					
	%	50.5	25.0	17.7	6.8

* year-class 1988

Using the table, we can for example study the 1988 cohort, i.e. fishes four year old in 1992. These contribute to 70.7% of the total number of 4–7 year old fishes in the 1992 sample. Calculated over the whole 1991–1995 period 50.5% of the fishes were four year old. Consequently, the 1988 year class was 140% of the average in in the 1992 catches (70.7·100/50.5=140). The calculation is made correspondingly for the five, six and seven year olds in 1993, 1994 and 1995. These years the 1988 year class was 269, 210 and 184 %, respectively, of the average. The mean value for this cohort over the total period thus is 201%. The relative year class strengths 1986–1989 (can not be calculated for fish born 1990 and later) are presented in the table below:

Year of birth	1986	1987	1988	1989
%	41	124	201	37

<u>Mortality</u>

The total mortality from age t to $(t+1)$ is defined as $A_{t,t+1} = (N_t – N_{t+1})/N_t$, ($N$ = the number of fish). The instantaneous mortality (Z) is obtained by differentiating with respect to t, which gives: $Z = –(lnN_{t+1} – lnN_t)$ and thus $A=1–e^{–z}$. t is usually set to one year.

One standard method allowing calculations also on data from single years is to use catch curves – for an individual year the logarithmic catch per effort (y-axis) is plotted for the age-classes (x-axis) included. The slope (=–Z, see above) of the straight line estimates annual mortality. This method assumes, that there is a constant recruitment.

As is seen in the table above, however, recruitment success in perch may differ very much between years. A more accurate technique calculating mortality should be to analyse age distributions in samples collected over a number of subsequent years. By following the decrease in catch per effort of different cohorts from year to year, the average annual mortality (A) can be calculated.

Using the year class strength data in the table above, mean annual mortality calculated according to the formula $\bar{A}=(\sum_{t=1991}^{1993} 1-\frac{N_{t+1}}{N_t})/3$, was 0.28 for the 1987 cohort and 0.27 for the 1988 cohort. However estimates of mortality can vary strongly between years, and large data sets are necessary to reach reliable mean values. The example also demonstrates the influence of temperature variations on swimming activity and hence catch per effort data, ultimately reducing the accuracy of mortality estimates. High catches in 1991 and especially 1994 more reflect high temperatures than changes in abundance. This effect of temperature can be partly eliminated, as the relation between temperature and catches in gill nets is known. A model for adjustments is under development at the Institute of Coastal Research in order to reduce the uncertainties of mortality estimates. Cohort analyses may also be made on percentage age distributions. This method is, however, sensitive also to variations in recruitment and differences in survival between cohorts, variance components which can not easily be estimated. Seen over a longer period of time both methods, however, can be used to calculate average mortality in the population.

Sex rate

In normal conditions the sex rate should be 1 / 1 in young fish of the species generally studied. In perch, females strongly dominate in larger size classes, and above 30 cm only very few males are observed. The analysis of sex rate can be made by fitting a straight line to the observed percentages of females in different length groups. If the slope of the line decreases as an effect of increased shares of females in smaller size classes, an effect on sex rate is indicated. The significance of differences can be studied by regression analysis.

GROWTH

General

Growth studies are essential when estimating production. Growth rate is an important variable in life-history studies, and can also be utilised as an indication of the physiological status of individuals. As such, it has the advantage of integrating at a high level but the disadvantage of being exposed to large variations between years and individuals. Length growth in each year of life can be calculated in some species, (see analysis of annual rings below). If desired, the length growth can be converted via weight–length relationships to weight increment. Growth of young-of-the-year (0+) can be measured directly from their length or weight.

Collection and sampling

Collection and sampling have been described above under the heading ”Age distribution” (p. 13 and 14).

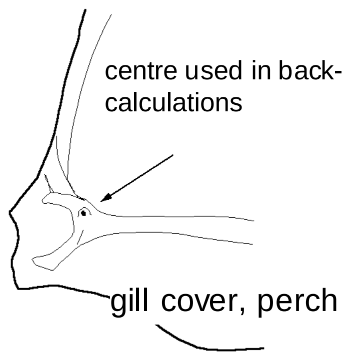
Analysis of annual rings
Perch stop growing during the winter. When the translocation of calcium in bone tissue also ceases in connection with the termination of growth, irregularities occur in the bone structure, so-called annual rings or annuli. These rings are visible in the gill cover as transparent bands.

In perch the spacing between the annual rings is in a given relationship to the length increment of the fish in corresponding years, which allows us to determine their size by means of back-calculations.

The relationship between the size of the gill cover and the body length changes slightly with the length of the fish and thus cannot be described linearly but instead by a gently sloping curve. The relationship is described by an exponential function: $L = k x R^b$, where L is the length of the fish, R the gill cover radius, k the intercept of the line, and b the slope of the line for the regression log-fish length on log-gill cover.

Back-calculated body lengths can be obtained from the relationship $L = L_S x (r/R)^b$, where L = the back-calculated body length, L_S = the final body length, r = the intermediary gill cover radius. In perch, the k and b values are 19.45 cm and 0.861, respectively (Agnedal 1968).

The distance between the annual rings is determined by means of a stereo-microscope, a projector or by means of computerised pictorial analysis techniques. Combinations of the latter and the former also occur. The centre and the outer edge are marked on the enlarged picture together with the annual rings along a radius (R) in the part of the growth sample shown in the figures below. If growth has taken place during the year of collection, a + sign is noted in the report form.



Data registration
All registration of growth data is done on form 67 (see pp. 33–34). In cases where registration is done manually there are instructions on how to use the form on the reverse.

Data processing
The average increase in length during each year of life is calculated according to the formulas described above in the section on analysis of annual rings. Growth rate varies with age and often also with sex. By standardizing with regard to these factors, all data can be used to create mean values for different calendar years and areas. Differences in growth between calendar years, year-classes and areas are compared using analysis of variance.

STORAGE OF ENERGY
General
The fish use the ingested food for somatic growth and also to create energy reserves required for growth of genital organs and to be able to survive periods of starvation during the winter. The energy status of the fish thus

provides information on its possibilities to survive and reproduce, and also may be regarded as an indicator of its general health status. For the fish to start gonad growth it is necessary that it has recovered from the previous year's spawning. Interpretation of gonad data according to the section on "Reproduction" will be made with higher precision if information is available on the energy status of the fish. The measure usually used to indicate energy status is the condition factor, which is calculated from the relation between weight and length.

Collection and data registration
See section on "Reproduction", p. 18 and 19.

Dataprocessing
The condition factor, C, is calculated from the formula:

$$C = \frac{100 \times \text{weight in grams}}{(\text{length in cm})^3}$$

The mean value is calculated from the entire material divided by sex and length group. Comparisons between years and areas are made with analysis of variance. Trend analysis is used to study changes with time.

REPRODUCTION

General
Fecundity, i.e., the number of eggs per female, is an important variable affecting population dynamics. Both toxic substances and food availability may influence the reproduction capacity of the fish. Generally, the gonado-somatic index (GSI = gonad weight in relation to body weight) is used as a measure of the reproductive capacity, but this measure is also influenced by variation in fish condition. A more correct measure is obtained by relating the weight of the sexual organs to the length of the fish. If the analysed samples contain fish of different lengths, than differences between, e.g., areas of investigation, can be studied by means of regression analyses. Since the gonads grow during the entire period until spawning it is, of course, important that compared samples are collected simultaneously. As regards females, measurements of fecundity will give more reliable measures of reproduction but these are very laborious and should not be attempted unless there are indications on disturbances in relative gonad size studies.

Maturation rate is studied by assessing the developmental stage of the sexual organs according to some standardized routine – here it is recommended to use four classes. Maturation studies in perch can not be made before the end of August, as the gonads are resting during summer.

Information on the nutritional status of the fish is also required for analyses of variations in reproduction capacity. The condition factor, i.e., the relation between weight and length, provides such information. The material collected for gonad analysis must, thus, also be studied in respect to condition, see Storage of energy, p. 17–18.

Collection
The collection starts during the early autumn following the start of gonad growth, in perch during September. The studies are normally concentrated to one sex, females. A given number of individuals is collected from different length groups, using either coastal survey nets or sets of nets. A minimum of 25 fishes per length class from and including length class 14 (12.5–15 cm) up to and including class 24 (22.5–25 cm) and all individuals from larger length classes should be collected.

If males are included, also length class 11(10–12.5) should be sampled.

Analysis
The analysis must be done on fresh material immediately after catching. If this is impossible for some reason and the catch is frozen, it must be remembered that freezing affects both length and weight.

At sampling, the total length (mm) and the total weight (0.1 g) of the fish is measured. The fish is opened, after which the sex is recorded. The gonads are weighed (0.1 g) and the sexual developmental stage is determined. Intestines and stomach are removed (but not the liver), after which the somatic weight is measured (0.1 g)

When determining the sexual stage, a classification is used where class 1 consists of juvenile fish and those with no visible gonad growth. Class 2 consists of fish with observable gonad growth, class 3 those with loose roe or milt (running ripe fish), and class 4 spent fish. Classes 3 and 4 do not occur during the prescribed sampling period. Individuals with clearly deviating, defect gonads are placed in class 9.

Data registration
Form 70 is used. Instructions how to use the form are given on pp. 35–36.

Dataprocessing
The proportion of fishes with normally growing gonads (class 2) is determined for each sex in each length class. For fishes with developed sex organs a calculation is made for each sex of the relationship between gonad weight and total length. Differences between individual years and areas can be studied with regression analysis. Changes over longer periods are studied using trend analysis.

Size at sexual maturation is established by probit analysis. The share of mature fish in each length class is estimated. The data are converted to probits or plotted on probit paper. A straight line is adjusted to the relation probit-log length and is used to estimate the length at which 50% of the fish have reached sexual maturity. The confidence interval for the length at sexual maturation can be estimated. Significant differences between samples in length at 50% maturation are tested by analysis of covariance (ancova).

Sentinel species – viviparous blenny

ABUNDANCE

See section ”Community structure” for general guidance on abundance monitoring. Fyke nets are recommended for viviparous blenny monitoring.

Description of fyke nets

The fyke nets are 55 cm high with a semi-circular opening and a leader or wing that is 5 m long. They are made of 17 mm mesh in the arm and 10 mm in the crib of yarn quality no. 210/12 in twisted nylon.

Localities

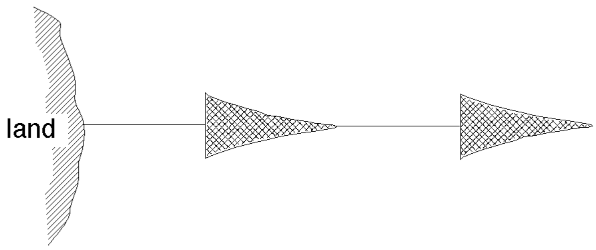
The smallest geographical unit is a station at which two fyke nets joined leader to crib are placed. A group of neighbouring stations with similar conditions (depth, exposure, etc.) and exposed to the same influence of environmental disturbances, forms a section. Within a section the bottom depth at the nets must not differ more than 2 metres between stations. An area (p. 31) is a named geographical area within which there may be one or more sections.

The recommended number of stations and the number of visits per station may vary depending upon the morphometric characters of the area and the abundance of fish. To select monitoring stations a predesign study has to be made. A large number of stations are visited once to provide a mapping of spatial variability. Ca 20 stations are selected for a continued three year evaluation period according to the routines described above. Based on these experiences, the number of stations may be further reduced after performing statistical tests of homogeneity.

Fishing performance

<u>Fishing techniques</u>

Fyke nets are set tightly stretched at right angles to the shore. The fyke nets are placed in pairs with leader to crib as illustrated in the figure to the right. Stones with buoys are attached with short lines to the inner leader and the outer crib.



Before the fishing is started each station must be carefully documented as regards the type of bottom and position (longitude, latitude). Landmarks and buoy sites can be photographed.

Occasional broken mesh are not tolerated in fyke nets. Checks must be made on every occasion when the nets are emptied. Before the fyke nets are used they must be checked on land to ensure that when they are stretched all parts are extended.

<u>Exposure</u>

Fyke nets are emptied daily between 7 and 10. They are replaced immediately after being emptied. The times given are standard times (= solar time).

Fishing period
Fishing is done during the period October 15 – November 15, if possible within a 14-day period. Areas to be compared should be fished with as short time difference as possible.

Frequency
At least six fishing efforts are done at each station. All stations within a section are fished on the same day. If all sections cannot be fished on the same day, the fishing is continued in the remaining sections before returning to the first section.

Data registration
Form 56 (see p. 31) is used. Instructions to fill in the form are given on the reverse (see p. 32).

The form is divided into three parts, so-called card types, namely hydrographical and meteorological data, catch data and disease data. The heading of the form (columns 1–15) is the same for all three parts. Code lists and abbreviations are given on pp. 40–42.

Catch data may be transferred to a data base by recording programmes. Data quality should be assured by validations of, e.g, lengths recorded, hydrographical observations and areal codes. Results such as mean catch per unit effort in different areas can be produced as standardised graphic presentations or as tables.

Ambient data
The ambient data are recorded section by section on Form 56, see p. 31. The exception is the bottom temperature of the deepest point at each station, see below.

An account of how the different measurements are made is given below. The accuracy of the instrument should be checked regularly.

Water depth is not normally registered.

Water temperature is measured with a thermistor or a thermometer fitted into a water-collector. The surface temperature at one point per section is entered onto the ambient data part of the form, whereas the bottom temperature of the deepest point at each station is recorded on the catch data part. All temperatures are registered in tens of degrees Celsius without using the decimal point.

Wind direction is estimated and is given according to the compass (0–360°) as the direction from which the wind is coming.

Wind velocity is estimated in m/sec.

Water current direction is estimated. It refers to the direction in which the current is flowing and is given according to the compass direction. For example, 360° current comes from the south.

Salinity is measured using a salinometer (usually not measured in the Baltic).

Industrial operations are only recorded when appropriate.

Fog is not usually recorded

The visibility is measured in sheltered conditions under a shaded surface using a round white Secchi disc, 25 cm in diameter. The disc is first lowered so far that it cannot be seen and is then lifted up. The visibility depth, given in decimetres, is the depth at which the disc first becomes visible. The line must be held vertically in the water.

Air pressure is measured in mm Hg but is not normally measured.

Catch data
The catch is reported by station in 2.5 cm length groups. Weights need not be registered.

Disease data
External visible signs of disease are always examined in the catches. The disease codes are listed on the reverse of the form. Six different codes are used. If code 6, other symptoms, is chosen then an explanation must be given on the reverse of the form. Notes are made of species, length group, number and the kind of symptoms present, preferably with reference to Thulin *et al.* (1989).

Other considerations
The fishing effort must always be one. The disturbance code is given according to p. 42.

Data processing
Since stratified sampling is used when planning the fishing efforts, the variation in the material is minimized, which enables measurements of changes in the fish populations to be made on the basis of relatively small catches.

In the statistical processing of the material it is assumed that the catch per station and day is an observation of an hypothetical population which, during the relevant fishing period would be generated by, e.g., six fishing efforts at a very large number of stations. The material can be treated by trend analysis and analysis of variance by ranks using non-parametric methods. The trend for an individual station can be calculated using, e.g., Kendall's tau. A common trend for a group of stations (section) can be calculated using Mann-Kendall's test and chi-2 which, in favourable situations, provides evidence of population increases or decreases already after a few years. The Kruskal-Wallis test is recommended for comparisons between individual years. In this test the mean value for a station is used as an observation of the above-mentioned hypothetical population. Parametric methods can also be used. Logarithmic transformation, or square root transformation, of data often stabilizes the variance yielding distributions satisfying the assumptions of anova.

AGE AND SEX DISTRIBUTION

General

By means of annual rings in different types of bony tissue it is possible to study the age distribution and growth. How to analyze annual rings is explained in the section on "Growth" below. The age composition of the fish stock can be used for calculating recruitment from the changes in the survival of the young-of-the-year (0+) in different years, the so-called year-class size, and the mortality in catchable ages. Knowledge of the absolute number of surviving fry in an area is not obtained but the method is useful in illustrating changes in the relative size of year-classes. Normally only a sample of the catch is age-determined but as the lengths of all fish are measured in the test fishings it is possible to estimate the age distribution of the entire catch on the basis of the relationship between age and length. The same material is used in the analyses of both age and growth, and the collection and sampling is described below.

One sex, usually females, is generally selected for age determinations. The number of males is, however, also recorded when collecting materials. This provides a base for calculations of sex rates in different length classes. Sex rate is a variable suspected to be sensitive to impact from a range of substances exhibiting hormonal effects.

Collection

Sampling is done in connection with the test fishing. A pre-determined number of females is collected from different length groups. The recommended sample size depends upon the selected precision in the estimations made to produce a length-at-age key. Assuming that the numbers of an age class within a length interval is a binomially distributed variable, the confidence interval may be approximately calculated. As an example, the 95% confidence interval of p (=the share) at maximal variance (p=0.5) and sample sizes n= 10, 50, 100, 300, or 1000 will be ±0.31, ±0.14, ±0.10, ±0.06, and ±0.03 respectively. Thus at a sample size of 50 observations, the interval will be ±0.14 at p=0.5. If 25 two-year olds were observed in length class 14 (12.5–15 cm), the lower limit of the 95% confidence interval is $0.36 \cdot 50=18$ and the upper limit $0.64 \times 50= 32$. Approximately normal distribution was assumed in this example. If the sample size is small and/or the share is small, other methods should be used. Roughly, a normal distribution may be accepted if $n \cdot p(1-p)$ is larger than 5. The recommended sampling routines for viviparous blenny are given in the table below.

Length range	12.6–15.0	15.1–17.5	17.6–20.0	20.1–22.5	22.6–25.0	25.1–27.5	27.6 –30.0	>30 (cm)
Length group	14	16	19	21	24	26	29	≥31
No of females	1)	1)	50	50	50	50	1)	1)

1) All are collected, but maximally 25 from each.

The collection must be started already at the first test fishing to secure as much material as possible from less common length groups. Once collection of a length group has been started it must not be interrupted within a fyke net catch but must be completed regardless of the numbers stated in the table above. In this way consideration is also paid to the size variation which may occur within length groups.

Sampling

The samples are stored in scale sample bags. Notes are made on these of, at the top, the serial number in the sampling series and below it the area code, section code (when applicable), fish species, total length (mm), sex and date of catch (year–week–day).

Otoliths

Otoliths are removed from viviparous blenny. Both otoliths must be collected and rinsed clean in water. The samples must be carefully handled as otoliths are fragile.

Analysis of annual rings

The method is described under ”Growth”, see p. 26.

Data registration

Described under ”Growth”, see p. 26.

Data processing

Year- class sizes

Calculation of the relative year-class sizes requires sample collections from several years. The number of fish of a certain age in a sample from a certain catch-year can then be weighed both against the total number of fish in the sample and against the percentage of that age in the total material from all years.

A modified version of Svärdson's (1961) method to calculate relative year-class strength (Neuman 1974) is recommended. It should be noted, that this technique does not allow detections of long-term trends in recruitment. Below is presented an example, based on perch age samples collected in

Calculation of relative year-class strength

year of catch	total catch	age in years			
		4	5	6	7
1991	453	317	77	33	26
	%	70.0	17.0	7.3	5.7
	%	139	68	41	84
1992	357	252	95	10	0
	%	70.7	26.6	2.7	0.0
	%	140*	106	15	0
1993	382	52	257	63	10
	%	13.7	67.3	16.4	2.6
	%	27	269*	93	38
1994	704	293	73	262	76
	%	41.6	10.4	37.2	10.8
	%	82	42	210*	158
1995	320	204	51	25	40
	%	63.8	16.0	7.7	12.5
	%	126	64	44	184
Age distribution (%) calculated for the total material					
	%	50.5	25.0	17.7	6.8

* year-class 1988

the Kvädöfjärden reference area 1991–1995. The analysis is made on the age distribution in the total catch, calculated by using a length-at-age key.

The upper row for each catch-year gives the number of individuals of different ages in the sample. The next row gives the percentage age distribution in the sample. Subsequently, the number of fish of different ages is summed for all years, after which the percentage age distribution of the entire material is calculated. If the samplings cover many years this distribution gives a measure of what is normal for the species in the area studied.

Using the table, we can for example study the 1988 cohort, i.e. fishes four year old in 1992. These contribute to 70.7% of the total number of 4–7 year old fishes in the 1992 sample. Calculated over the whole 1991–1995 period 50.5% of the fishes were four year old. Consequently, the 1988 year class was 140% of the average in in the 1992 catches (70.7 x 100/50.5=140). The calculation is made correspondingly for the five, six and seven year olds in 1993, 1994 and 1995. These years the 1988 year class was 269, 210 and 184 %, respectively, of the average. The mean value for this cohort over the total period thus is 201%. The relative year class strengths 1986–1989 (can not be calculated for fish born 1990 and later) are presented in the table below:

Year of birth	1986	1987	1988	1989
%	41	124	201	37

Mortality

The total mortality from age t to $(t+1)$ is defined as $A_{t,t+1} = (N_t - N_{t+1})/N_t$, ($N$ = the number of fish). The instantaneous mortality (Z) is obtained by differentiating with respect to t, which gives: $Z = -(lnN_{t+1} - lnN_t)$ and thus $A=1-e^{-z}$. t is usually set to one year.

One standard method allowing calculations also on data from single years is to use catch curves – for an individual year the logarithmic catch per effort (y-axis) is plotted for the age-classes (x-axis) included. The slope (=$-Z$, see above) of the straight line estimates annual mortality. This method assumes, that there is a constant recruitment.

As is seen in the table above, however, recruitment success may differ very much between years. A more accurate technique calculating mortality should be to analyse age distributions in samples collected over a number of subsequent years. By following the decrease in catch per effort of different cohorts from year to year, the average annual mortality (A) can be calculated.

Using the year class strength data in the table above, mean annual mortality calculated according to the formula $\bar{A} = \left(\sum_{t=1991}^{1993} 1 - \frac{N_{t+1}}{N_t}\right)/3$, was 0.28 for the 1987 cohort and 0.27 for the 1988 cohort. However estimates of mortality can vary strongly between years, and large data set are necessary to reach reliable mean values. The example also demonstrates the influence of temperature variations on swimming activity of warmwater fish and hence catch per effort data, ultimately reducing the accuracy of mortality estimates. High catches in 1991 and especially 1994 more reflect high temperatures than changes in abundance. Cohort analyses may also be made on percentage

age distributions. This method is, however, sensitive also to variations in recruitment and differences in survival between cohorts, variance components which can not easily be estimated. Seen over a longer period of time both methods, however, can be used to calculate average mortality in the population and it should be recognized that problems related to variable recruitment and temperature effects on catches may be smaller in other species than perch.

As viviparous blenny is sampled in late autumn, after the autumn circulation, a temperature impact on activity should be small compared to summer samplings, when the temperature can differ very much between years.

Sex rate

In normal conditions the sex rate should be 1 / 1 in young fish of the species generally studied. However, the possibility to analyse changes in sex rate by fyke net sampling of viviparous blenny is not yet evaluated, as well as the possibility to estimate sex rate already at the larval stage before parturition. If this is technically possible, the analysis of impact on sex differentiation could be very strong in this species.

GROWTH

General

Growth studies are essential when estimating production. Growth rate is an important variable in life-history studies, and can also be utilised as an indication of the physiological status of individuals. As such, it has the advantage of integrating at a high level but the disadvantage of being exposed to large variations between years and individuals.

Collection and sampling

Collection and sampling have been described above under the heading ”Age distribution” (p. 23 and 24).

Analysis of annual rings

The blenny stops growing during the winter. When the translocation of calcium in bone tissue also ceases in connection with the termination of growth, irregularities occur in the bone structure, so-called annual rings or annuli. These rings are visible in the otoliths as transparent bands.

Organs which do not permit back-calculations, such as otoliths, which are recommended for the viviparous blenny, can only be used for a determination of the relationship between age and size when caught. The mean growth of the year-classes can, however, be studied if sufficient material of different age at capture is available. Determination of age by means of otoliths today often makes use of videotechniques combined with computerised pictorial analysis.

Data registration

All registration of growth data is done on form 67 (see pp. 33–34). In cases where registration is done manually there are instructions on how to use the form on the reverse. For species where no back-calculation is done, the age together with information from the scale sample bag are noted in a table for later processing.

Data processing

The average increase in length during each year of life is calculated according to the formulas described above in the section on analysis of annual rings. Growth rate varies with age and often also with sex. By standardizing with regard to these factors, all data can be used to create mean values for different calendar years and areas. Differences in growth between calendar years, year-classes and areas are compared using analysis of variance.

STORAGE OF ENERGY

General

The fish use the ingested food for somatic growth and also to create energy reserves required for growth of genital organs and to be able to survive periods of starvation during the winter. The energy status of the fish thus provides information on its possibilities to survive and reproduce, and also may be regarded as an indicator of its general health status. For the fish to start gonad growth it is necessary that it has recovered from the previous year's spawning. Interpretation of gonad data according to the section on "Reproduction" will be made with higher precision if information is available on the energy status of the fish. The measure usually used to indicate energy status is the condition factor, which is calculated from the relation between weight and length.

Collection, sampling and data registration

See section on "Reproduction", p. 27 and 28.

Dataprocessing

The condition factor, C, is calculated from the formula:

$$C = \frac{100 \times \text{weight in grams}}{(\text{length in cm})^3}$$

The mean value is calculated from the entire material divided by sex and length group. Comparisons between years and areas are made with analysis of variance. Trend analysis is used to study changes with time.

REPRODUCTION

General

After a long period of pregnancy (4–6 months), the viviparous blenny gives birth to its young, sized 35–55 mm, in numbers ranging from a few tens to a few hundreds. The reproductive capacity of the single female and the mortality among the early fry stages, which are normally particularly sensitive to environmental disturbances, thus can be studied with high precision. By analysing the length distribution of the fry, it is possible to record growth inhibition, which indicates an increased risk of juvenile mortality. It is also possible to link properties associated with the female, e.g., high body burden of toxic substances or deteriorated health status, to poor survival and growth of the fry and increased malformation frequencies.

Collection

Pregnant females are collected in small fine-meshed fyke nets in connection with the standardized test fishing for abundance monitoring. However, the catches also can be done in other ways provided that strict uniformity is observed between years and areas compared.

The collection is done during 15 October–15 November. The collection period should be kept as short and as similar between areas as possible. Sufficiently many blennies are collected in order to allow at least 50 pregnant females to be studied. In order to be able to register the proportion of pregnant fish all fish in a sample (the catch in at least one fyke net) must be kept for analysis. The fish are stored alive.

Sampling
The fish are killed, after which the belly is cut open for establishment of sex. In females the total length (mm) and the total weight (g) are registered. The ovary is quickly cut open. Living and dead fry are counted and classified in length groups of 2.5 mm. The occurance of malformed fry is recorded. Fry which had died at an early development stage can also be registered since they are preserved in the ovarian fluid. The somatic weight (g) of the female is measured after the sexual organs, stomach and intestines have been removed. The total weight (0.1 g) of the brood is measured. When 50 pregnant females have been found the sampling is continued until the entire sample has been examined, after which the sampling is terminated.

Data registration
Form 79 (see pp. 37–38) is used. Instructions how to use the form are given on the reverse.

Dataprocessing
The proportion of pregnant females provides information on size and age at sexual maturity and on disturbances during the earliest phases of the reproduction processes. The reproductive capacity of the females is estimated as the total number of fry per female and the total weight of the brood in relation to the total length of the female. The relationship is described with regression analysis.

Even in natural areas it often occurs that fry die soon after hatching (at a length less than 15 mm). On the other hand, it is rare that larger fry die. When calculating fry mortality, i.e., the proportion of dead among the total number of fry in a sample, the early and late deaths are divided into, and treated as, separate groups. Influence is also measured as the frequency of females with large (>15 mm) dead fry. The frequency of malformed fry is also an indication of effect.

The length distribution of the dead fry provides information on when death has occurred during the period of gestation, whereas the length distribution of living fry may reveal growth inhibitions. Several 2.5 mm length groups might be represented in one brood, but in more than 95% of the females the maximum of the length distribution lies within one of the three longest groups. Other females are classified as ”abnormal” and their occurence is used as an indicator of disturbance. When comparing the size of ”developed” fry between ”normal” females, the length group with the highest number of fry should be used. Simultaneous spawning and similar natural conditions for fry growth must be assumed when comparing between areas and years. The risk that these prerequisites are not fullfilled can be avoided if the length distributions and not the absolute values are compared. The analysis is then based on the assumption that fry belonging to the three largest length groups in a female are ”normal” whereas shorter fry are ”retarded”. The percentage of ”retarded” fry and their length distribution can be compared between females.

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TEST FISHING

form no 56

form	area	section	station	gear
1	3	5	7	9
5 6				

year	week	d
11	13	15

Fisherman ____________ **Area :** ____________

AMBIENT DATA

c	water level	TEMPERATURE SETTING surface	TEMPERATURE SETTING bottom	TEMPERATURE LIFTING surface	TEMPERATURE LIFTING bottom	WIND SETTING dir.	WIND SETTING str.	WIND LIFTING dir.	WIND LIFTING str.	CURRENT SETTING dir.	CURRENT LIFTING dir.	SALINITY SETTING surface	SALINITY SETTING bottom	SALINITY LIFTING surface	SALINITY LIFTING bottom	OPERATION s	OPERATION l	fog	Secchi-depth	AIRPRESSURE setting	AIRPRESSURE lifting	eff.	disturbance	disease	
16	17	20	23	26	29	32	35	37	40	42	45	48	51	54	57	60	61	62	63	66	69	72	74	75	76
1																									

CATCH DATA

c	(gear) seg. no	disturbance	TEMP s	TEMP l	species	total weigth	length group	number	length group	number	length group	number	length group	number	length group	number	length group	number	length group	number	length group	number	length group	number
16	17	19	20	23	26	30	35	37	40	42	45	47	50	52	55	57	60	62	65	67	70	72	75	77
2																								
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DISEASE DATA

c	species	length group	number	disease code	species	length group	number	disease code	species	length group	number	disease code	species	length group	number	disease code	species	length group	number	disease code	species	length group	number	disease code
16	17	21	23	25	27	31	33	35	37	41	43	45	47	51	53	55	57	61	63	65	67	71	73	75
3																								
3																								
3																								

INSTRUCTIONS TO FORM 56

This form is used for registration of test fishing data when nets or traps are used. Differences in the registration according to fishing gear is explained below.

All references are made to "Guidelines for coastal fish monitoring", shortened "GM" below. Column number refers to the first column in each data field.

Col no Explanation

3 Area, Code, two letters
5 Section, Numeric code for the section in question.
7 Station, Numeric code for the station in question.
9 Type of gear, Numeric code. Coastal survey net: 9, net set: 53, fyke net: 54.
11 Year. Two last digits from the year of catch.
13 Week number. Week no 1 is the first week of the year that holds four or more days
15 Day number. Monday=1 etc.

Ambient data (card type 1)

Several data fields have both an s and a l-part where s is used when the nets are set and l when nets and traps are lifted.

17 Water-level is given i relation to the normal water–level — is recorded with minus sign if the level is below normal.
20 Water temperature (s, l) Surface temperture at 0.5 m depth in one point per section (the same as for the visibility). Bottom temperature 0.5 m above bottom at the deepest part of the station can be given here if only one station is to be recorded, else bottom temperatures should be recorded under catch data (column 20—26). All temperatures are registered in Celsius degrees with one decimal (the decimalpoint is preprinted on the form).
32 Wind direction (s) 0=no wind, 360 wind comes from north.
35 Wind velocity (s) in m/sec
37 Wind direction and velocity (l)
42 Water current direction (s, l) 0=no current, 360 current comes from south
48 Salinity (Marine waters, s, l) is measured as per mille with one decimal (the decimal point is preprinted)
60 Industrial operation (s, l) 0=no discharge, 1=unheated discharge (at power plants), 2=discharge at normal operation.
62 Fog (s) 0=none or natural fog, 1=fog caused by cooling water.
63 Visibility (s) in m with one decimal (preprinted decimalpoint). Shall be measured at water depths exceeding the maximal visibilty. If no such place is to be found within reasonable distance 999 is recorded.
72 Effort in whole nights. (minimum=1)
74 Disturbance according to code list in GM p. 42. If column 17-20 is recorded under catch data below, the disturbance code should be recorded i column 19.

75 Disease registration considers external visible symptoms of disease, 1=control - no affected fish found and 2=affected indiviuals found. Affected fishes will be registrered at the bottom of the form, see adjoining part under disease data.

Catch data (card type 2)

If different gear-numbers, stations or segments are registered here, disturbance codes and temperatures must also be entered here. The surface temperature shall always be registered under the ambient data above.

17 Gear number, Segment or Station, numeric code according to the area in question.
19 Disturbance code according to code list in GM p. 42. (also see column 74 under the ambient data above)
20 Temperature at bottom (s, l) is measured in degrees (Celsius) with one decimal (preprinted decimal point) For traps only when they are lifted (l).
26 Species according to codelist in GM p. 40. Start to the left in the data field, e. g. |I|D| | | TOMT is noted in this data field when the gear is empty.
30 Total weight in kg with two decimals (preprinted decimalpoint) for all fish on this line.

35 Length group with 2.5 cm width.

lgr	9	11	14	16	19 etc
	7.6–10.0	10.1–12.5	12.6–15.0	15.1–17.5	17.6–20.0 cm

The code refers to the number closest to the middle of the interval. If the length group exceeds 99 it is divided into two data fields (90+) e.g. a pike in lengthgroup 104 is written

	LENGTH GROUP	NUMBER	LENGTH GROUP	NUMBER
G Ä D D	9 0	1	1 4	

Note! The last numberfield is left empty. If there is more than nine length groups, use an additional line. For these ocassions you write a duplication sign (∿) in the column 17—29.

37 Number of fish in the foregoing length group.

Disease data (card type 3)

The disease code i column 25 is recorded according to the codes in the frame below. For each new length group the code of the species has to be repeated. Codes of species and length groups can be recorded in an arbitrary order.

Explanation

Disease codes

1 Wounds. Open wound. Don't record scares or healed wounds.
2 Skeletal defect. Evident spinal shortening/spinal curvature.
3 Tumour. Protuberances from skin or fins. Example: papilloma on flat-fish, cauliflower disease on eel, lymphosarcoma on pike.
4 Fin rot/erosion. Shortened, often pussy fins, sometimes with black-pigmented edges. **Don't** record fins injured by nets.
5 Lymphocystis. One or more nodules on skin or/and fins.
6 Other symptoms. Could be used to describe less common diseases. Use your own words or refer to figure no in Thulin et al. 1989 "Fisksjukdomar i kustvatten (Fish diseases in coastal waters)", example below. This should be done in the remark field. Code 6 could be used for other remarks as well.

Exemple of description of symptoms by disease code 6.

SPECIE	LGR	NUMBER	
ABBO	14	1	LEFT GILL COVER SHORTENED
TORS	34	1	SYMPTOMS IN ACCORDANCE TO FIGURE 22—23 (LATERAL LINE NECROSIS)

Instructions from back of form 56

AGE AND GROWTH

form no 67

form	area	species	gear
1	3	5	9
67			

stn.no.	year of catch	year of birth	sex	sample no.	number of lines	growth, year of catch	final length	Recorded value 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
11	14	16	18	19	22	23	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78

INSTRUCTIONS TO FORM 67

This form is used for registration of age and growth data. All references are made to ”Guidelines for coastal fish monitoring”, shortened ”GM” below. Column number refers to the first column in each data field.

Col no	Explanation
3	Area. Code, two letters.
5	Species according to code list in GM p. 40. Start to the left in the data field, e. g. | I | D | | |
9	Type of gear. Numeric code. Coastal survey net: 9, Net set: 53, fyke net: 54.
11	Section. Numeric code for the area in question.
12	Station. Numeric code for the station in question.
14	Year of catch. Two last digits.
16	Year of birth. Two last digits.
18	Sex. 0=female (♀), 1=male (♂) och indeterminate sex=9.
19	Number. Each fish is given a serial number according to the sample bag. The number is unique within area and year. This also applies to other samples, e. g. individual status.
22	Number of lines. If more than one line is needed a 9 is recorded here. The column 11—19 will have to be repeated. This might be done with the duplication sign (∿)
23	Growth the year of catch. If there has been growth the year of catch a + sign is recorded here.
24	Final length in mm according to the sample bag. With final length is meant the tail-fin stretched maximally in the length direction of the fish.
27—78	Intermediate body lengths. In each length data field is recorded the distance from the center of the scale (operculum etc) to the annuli. The degree of magnification is without importance. Knowing the relation between the scale (operculum, wing bone) length and the body length the distances are transformed to real body lengths.
27	First annual ring.

Eighteen lengths can be written on one line.

Instructions from back of form 67.

form no 70
Individual status

form	area	section	stn	gear	year
1	3	5	7	9	11
7 0					

Area: ____________________

Collector ______________

Year ______________

No: ______________

				LENGTH in mm			WEIGHT in grams																
w	d	species	number	total	code	other	total	somatic	gonad	sex	status	wholebody	food	growth	gonad	liver	muscle	eye	intestine	gills	parasites	age	remarks
13	15	16	20	24	28	29	33	40	46	51	52	53	54	55	56	57	58	59	60	61	62	63	65

INSTRUCTIONS TO FORM 70

This form is used for registration of individual status. All references are made to ”Guidelines for coastal fish monitoring”, shortened ”GM” below. Column number refers to the first column in each data field.

Col no	Explanation
3	Area, Code, two letters
5	Section, Numeric code for the section in question.
7	Station, Numeric code for the station in question.
9	Type of gear, Numeric code. Coastal survey net: 9, net set: 53, fyke net: 54.
11	Year. Two last digits from the catching-year
13	Week number. Week no 1 is the first week of the year that holds four or more days
15	Number of day. Monday=1 etc.
16	Species according to code list in GM p. 40. Start to the left in the data field, e.g. | I | D | | |
20	Number. Each fish is given a serial number, unique within area and year. This also applies to other samples, e. g. growth.
24	Total length in mm — tail-fin stretched maximally in the length direction of the fish.
28	Length code. Referring to column 29—32, other length. Is recorded according to separate instruction.
29	Other length. Is specified within each project. In this case column 28 always must be recorded.
33	Total weight in grams with two decimals. (10 grams is noted as 1000. Do not put any decimal point).
40	Somatic weight in grams with two decimal (somatic weight= total weight with gonads, intestines and stomach removed.
46	Gonad weight in grams with two decimals.
51	Sex. 0=female (♀), 1=male (♂) and indeterminate sex=9.
52	Sex status. 1=the gonads not developed, 2=growing gonads, but not mature for spawning, 3=mature for spawning, running ripe, 4=spawned and 9=abnormal or deseased.
53—61	Samples taken. If a sample has been taken it is recorded in the specified column. Method of preservation 1=frozen/dried, 2=formalin and 3=alcohol. Other methods of preservation are specified within each project.
53	The whole fish is preserved.
54	Stomach sample
55	Growth sample
56	Gonad
57	Liver
58	Muscle
59	Eye
60	Intestine
61	Gills
62	Material secured for examination of parasites, 1 is recorded in the column
63	The age of the fish
65	Remarks — in reserve. Instructions are given within each project.

Instructions from back of form 70.

Kustlaboratoriet

970102	form	area	section	stn	gear
	1	3	5	7	9
	79				

sampling date		
year	month	day
11	13	15

Viviparous blenny

form no 79

Fry

	number	disease code	length mm	weight in grams: total	somatic	liver	gonad	growth	other	sex	sex stage	fry status	lgr	no	lgr	no	lgr	no	lgr	no	lgr	no	lgr	no	lgr	no	lgr	no	lgr	no
16	17	20	21	24	28	32	35	38	39	40	41	42	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77
1																														
1																														
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1																														
1																														

	number	remarks
16	17	20
2		
2		
2		

INSTRUCTION TO FORM 79

This form is used for registration of numbers and length distributions of living respectively dead fry of viviparous blenny. Males as well as non-pregnant females can also be registered. References below are made to the document ”Guidelines for coastal fish monitoring” (GM). Column numbers refer to the first column in each data field.

Code Explanation

3 Area. Code, two letters.

5 Section. Numeric code for section in question.

7 Station. Numeric code for section in question.

9 Type of gear. Numeric code. Fyke net: 54

11 Year. Two last digits of the year of catch.

13 Month. January= 01 etc.

15 Day. Monday= 1 etc.

Sample data (card type 1)

Females without fry should also be registered.

17 Number. Every fish is given a serial number, unique within area and year. This also applies to other samples, e.g. growth..

20 Disease code 1. Open wounds2. Skeletal defects3. Tumour4. Fin rot/erosion6. Other symptoms7. Predationdamage 8. Mechanical damage. Symptoms are described at the bottom part of the form, connected to the serial number of the fish.

21 Total length, mm — tailfin stretched maximally in the length direction of the fish.

24 Total weight, Grams with one decimal.

28 Somatic weight, Grams with one decimal. Note: liver weight included.

32 Liver weight, Grams with one decimal.

35 Gonad weight, Grams with one decimal. In pregnant females, all eggs and embryos are removed from the gonad, blotted on paper or a fine-meshed net, and weighed.

38 Growth. If age samples (otoliths) are collected, a 1 is noted in this column.

maj 97

39 Other. Samples collected 1. Whole body, 2. Muscle, 3. Blood, 4. Gonad, 5. Liver, 6. Intestines, 7. Eye, 8. Bile, 9. Other – or that more than one sample was taken. Additional information can be given at the bottom part of the form.

40 Sex
0= Female,
1= Male,
9= Not possible to determine.

41 Sex stage
1. Juvenile or not developed, both sexes.
2. Fertilised eggs before hatching.
3. After hatching, developing fry.
4. After parturition.
5. Developing mature male.

Fry

Fry are recorded in 2.5 mm length groups. All fry are registered in the groups, living or dead. Malformed living or dead fry are also registered. A description of the observed malformation is noted at the bottom part of the form, with reference to the serial number of the female.

42 Fry status
1. Living,
2. Dead,
3. Unfertilised not hatched eggs,
4. Malformed.

43 Length group code

1	4	6	9	etc
0–2.5	2.6–5.0	5.1–7.5	7.6–10.0	mm

A measure board should be used.

45 Number, Number of fry in each length group. If the numbers of a certain length group exceeds 99 the length group is repeated and the remaing number registered.

Remarks

17 Number Serial number of the fish

20 Free text

Instructions from back of form 79.

Form 80

Sex rate

Species ______________________

Area ______________________

Section ______________________

Year ______________________

Lgr	Sex	Day	Day	Day	Day	Day	Day	Number	%
14	♀								
	♂								
16	♀								
	♂								
19	♀								
	♂								
21	♀								
	♂								
24	♀								
	♂								
26	♀								
	♂								
29	♀								
	♂								
31	♀								
	♂								
34	♀								
	♂								
36	♀								
	♂								
39	♀								
	♂								
41	♀								
	♂								
44	♀								
	♂								
46	♀								
	♂								

Code list of species

Rules for coding: The codes are based on the species nams in Swedish. If that is not a compound word the code is made of the first four letters. For compounded names the code is made of the first two letters in each part. If there will be a duplicate (marked *) the last letter in the code is replaced with the one following immediately after until there is a unique code.

LATIN	ENGLISH	SWEDISH	CODE
Abramis ballerus	blue bream	faren	FARE
Abramis brama	bream	braxen	BRAX
Acipenser sturio	sturgeon	stör	STÖR
Acipenser ruthenus	sterlet	sterlett	STER
Agonus cataphractus	armed bullhead	skäggsimpa	SKSM *
Alburnus alburnus	bleak	löja, benlöja	LÖJA
Alosa fallax	twaite shad	staksill	STSI
Ammodytes lancea	lesser sandeel	tobis	TOBI
Anarchias lupus	Atlantic catfish	havskatt	HAKA
Anguilla anguilla	silver eel	blankål	BLÅL
Anguilla anguilla	yellow eel	gulål	GUÅL
Arnoglossus laterna	scaldfish	tungevar	TUVA
Aspius aspius	asp	asp	ASP
Barbus barbus	barbel	flodbarb	FLBA
Belone belone	garfish	horngädda	HOGÄ
Blicca bjoerkna	silver bream	björkna	BJÖR
Brama raii	Ray's bream	havsbraxen	HABR
Callionymus lyra	common dragonet	randig sjökock	SJKO
Cancer pagurus	edible crab	krabba (krabbtaska)	KRAB
Carassius carassius	crucian carp	ruda	RUDA
Carcinus maenas	shore crab	tångkrabba	TÅKR
Centrolabrus exoletus	rock cook	grässnultra	GRSN
Chirolophis ascanii	Atlantic warbonnet	tångsnärta	TÅST
Chondrostoma nasus	nase	noskarp	NOKA
Ciliata mustela	five-beard rockling	femtömmad skärlånga	FESK
Clupea harengus harengus	herring	sill	SILL
Clupea harengus membras	Baltic herring	strömming	STRÖ
Coregonus albula	vendace	siklöja	SILÖ
Coregonus lavaretus	whitefish	sik	SIK
Cottus gobio	bullhead	stensimpa	SSIM
Crenimugil labrosus	thick-lipped mullet	tjockläppad multe	TJMU
Ctenolabrus rupestris	goldsinny	stensnultra	STSN
Cyclopterus lumpus	lumpsucker	sjurygg	SJRY
Cyprinus carpio	carp	karp	KARP
Dicentrarchus labrax	sea perch (sea bass)	havsabborre	HAAB
Engraulis engrausicholus	anchovy	ansjovis	ANSJ
Entelurus aequireus	greater pipefish	havsnål	HANÅ
Esox lucius	pike	gädda	GÄDD
Eutrigla gurnardus	grey gurnard	knot	KNOT
Gadus morhua	cod	torsk	TORS
Gaidropsaurus vulgaris	three-beard rockling	tretömmad skärlånga	SKLÅ
Gasterosteus aculeatus	three-spined stickleback	storspigg	STSP
Glyptocephalus cynoglossus	sole witch	rödtunga	RÖTU
Gobius niger	black goby	svart smörbult	SVSM
Gymnocephalus cernua	ruffe	gers	GERS

LATIN	ENGLISH	SWEDISH	CODE
Hippoglossoides platessoides	American plaice	lerskädda	LESK
Hippoglossus hippoglossus	halibut	hälleflundra	HÄFL
Homarus vulgaris	European lobster	hummer	HUMM
Hyas araneus		maskeringskrabba	MAKA
Hyperoplus lanceolatus	greater sandeel	tobiskung	TOKU
Labrus berggylta	ballan wrasse	berggylta	BEGY
Lampetra fluviatilis	lamprey	flodnejonöga	FLNE
Leander adspersus	common prawn	tångräka	TÅRÄ
Leucaspius delineatus	beliga	groplöja	GRLÖ
Leuciscus cephalus	chub	färna	FÄRN
Leuciscus idus	ide	id	ID
Leuciscus leuciscus	dace	stäm	STÄM
Limanda limanda	dab	sandskädda	SASK
Liparis liparis	common sea-snail	vanlig ringbuk	RIBU
Liparis montagui	Montagu's sea-snail	Montagus ringbuk	MORI
Lophius piscatorius	anglerfish	marulk	MAUL
Lota lota	burbot	lake	LAKE
Lumpenus lampretaeformis	snake blenny	spetsstjärtat långebarn	SPLÅ
Melanogrammus aeglefinus	haddock	kolja	KOLJ
Merlangius merlangus	whiting	vitling	VITL
Merluccius merluccius	hake	kummel	KUMM
Microstomum kitt	lemon sole	bergtunga	BETU
Molva molva	ling, drizzie	långa	LÅNG
Myoxocephalus quadricornis	fourhorned sculpin	hornsimpa	HOSI
Myoxocephalus scorpius	bullrout, sea scorpion	rötsimpa	RÖSI
Nephrops norvegicus	Norway lobster	havskräfta	HAKR
Onchorhynchus mykiss	rainbow trout, steelhead trout	regnbåge	REBÅ
Onos cimbrius	four-beard rockling	fyrtömmad skärlånga	FYSK
Osmerus eperlanus	smelt	nors	NORS
Pelecus cultratus	kaife	skärkniv	SKKN
Perca fluviatilis	perch	abborre	ABBO
Petromyzon marinus	sea lamprey	havsnejonöga	HANE
Pholis gunnellus	butterfish	tejstefisk	TEFI
Phoxinus phoxinus	minnow	elritsa	ELRI
Phrynorhombus norvegicus	Norwegian topknot	småvar	SMVA
Platichthys flesus	flounder	skrubbskädda	SKSK
Pleuronectes platessa	plaice	rödspotta	RÖSP
Pollachius pollachius	pollack	lyrtorsk	LYTO
Pollachius virens	saithe	gråsej	GRSE
Pomatoschistus minutus	sand goby, little goby	sandstubb	SAST
Pomatoschistus pictus	painted goby	bergstubb	BEST
Portunus puber	fiddler crab	simkrabba	SIKR
Psetta maxima	turbot	piggvar	PIVA
Pungitius pungitius	nine-spined stickleback	småspigg	SMSP
Raniceps raninus	lesser forkbeard	paddtorsk	PATO
Rutilus rutilus	roach	mört	MÖRT
Salmo salar	salmon	lax	LAX
Salmo trutta	trout	öring	ÖRIN
Salvelinus alpinus	arctic charr	röding	RÖDI
Salvelinus fontinalis	brook trout	bäckröding	BÄRÖ
Salvelinus namaycush	lake trout	kanadaröding	KARÖ
Scardinius erythrophthalmus	rudd	sarv	SARV
Scomber scombrus	mackerel	makrill	MAKR
Scophthalmus rhombus	brill	slätvar	SLVA
Scyliurhinus caniculus	lesser spotted dogfish	småfläckig rödhaj	RÖHA

LATIN	ENGLISH	SWEDISH	CODE
Solea solea	sole	äkta tunga	ÄKTU
Spinachia spinachia	fifteen-spined stickleback	tångspigg	TÅSP
Sprattus sprattus	sprat	skarpsill	SKSI
Squalus acanthias	picked dogfish, spurdog	pigghaj	PIHA
Stizostedion lucioperca	pike perch (zander)	gös	GÖS
Sygnathus typhle	broadnosed pipefish	tångsnälla	TÅSN
Symphodus melops	corkwing wrasse	skärsnultra	SKSN
Taurulus bubalis	longspined bullhead	oxsimpa	OXSI
Thymallus thymallus	grayling	harr	HARR
Tinca tinca	tench	sutare	SUTA
Trachinus draco	greater weever	fjärsing	FJÄR
Trachurus trachurus	horse mackerel	taggmakrill	TAMA
Trisopterus minutus	poor cod	glyskolja	GLKO
Vimba vimba	vimba bream	vimma	VIMM
Zeugopterus punctatus	topknot	bergvar	BEVA
Zoarces viviparus	eel-pout, viviparous blenny	tånglake	TÅLA
	empty tool		TOMT
	severely disturbed fishing (without recorded catches)		KVAD

Disturbance code

Code
0 No disturbance
1 Gale
2 Seal damage
3 Strong algal growth on the gears. Noted for trap nets and fykes when they are cleaned.
4 Clogging by drifting algae.
5 Damaged gear due to a big catch or the gear is full. No more fish can be caught.
6 Clogging by jellyfish.
7 Drifting ice.
8 Ice cover over the gear.
9 Other reason. (Damage by boat traffic, other human inference etc.)

Referring to the codes 1, 3, 4 and 7 the disturbance should have been severe enough to really affect the catch.

Disturbance code shall always be recorded when seals have affected the catch (code 2) and when there is ice cover over the gear (code 8).

Regardless of the type of disturbance the catch should always be recorded. If, however, the disturbance is so severe that no catch could be registered the ”species code” KVAD is recorded.

Guidelines for coastal fish monitoring

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NATIONAL BOARD OF FISHERIES
Institute of Coastal Research