Northwest Atlantic Fisheries Organization

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Notes on NAFO Sampling Program

by

NAFO Secretariat

1. Introduction

The standardized ICNAF procedure for reporting sampling data was modified in 1978 with the requirement for considerably more detail than previously, and this program was adopted by the Scientific Council in 1979. After much discussion on the feasibility of maintaining such detailed data in the Secretariat computer files because scientists usually requested the data in some summarized form, the Scientific Council in 1984 agreed that the reporting of sampling data for 1983 and subsequent years should, with a few exceptions, conform generally to the pre-1979 format (*NAFO Sci. Coun. Rep.*, 1984, page 84). These exceptions are given in Section 12 below. Meanwhile, fisheries institutes were requested to resubmit their 1979-82 data in the summarized format (*NAFO Sci. Coun. Rep.*, 1983, pages 24-25). The notes in the following sections and the sampling forms have therefore been revised to reflect the present requirements.

2. Minimum Smapling Requirements

In the sampling program adopted by NAFO in 1979, following the termination of ICNAF, the minimum sampling requirement was specified as *one sample per 1,000 tons of fish caught for each division (or subdivision, where applicable), quarter of year, and gear type. As an approximate guideline, such a sample should consist of 200 fish from the entire length range for length composition and one fish per centimeter length group for age composition.*

Sampling data must be in sufficient quantity and detail to enable calculation of the length and age compositions of the commercial catches on a monthly basis. In cases where the data for a species are required by sex, it is necessary that twice the number of specimens be collected for length and ageing in order to produce usable age-length keys.

The reported length frequency data should reflect the length composition of catches in each month and division (or subdivision). Sampling should be more frequent when catches are high, and appropriate weighting factors should be applied to the individual samples to ensure that the monthly length frequencies represent the monthly catches.

3. Source of Sampling Data

Emphasis is placed on sampling the catches of commercial and/or exploratory fishing vessels using gears that are normally used for commercial fishing (in accordance with the NAFO trawl regulations, where applicable).

In the case of sampling data collected by observers under the Scientific Observer Program, the data should be reported by the country on whose vessels the data were collected or by the coastal state whose observers collected the data in collaboration with the country involved. In any case, the data (both length frequencies and age-length keys) must be attributed to the country on whose vessels the data were collected.

4. Smapling of Catches *versus* Landings

Commercial samples may be taken at sea from catches before any discarding has occurred, from catches at sea after discarding, from landed catches at the dock before any discarding has occurred, and from landed catches after discarding. The term "discarding", as used here, implies fish thrown overboard and not included in the nominal catch, as opposed to fish used for fishmeal and included in the nominal catch. Samples from commercial and/or exploratory fishing should be classified by type as follows:

Catch. The samples should be designated as catch samples, if it is fairly certain or definitely known that no discarding has occurred prior to sampling, whether the samples are taken from the catches at sea or taken from the landed catch at the dock or in the processing plant.

Landing. The samples should be designated as landing samples, whether they are taken at sea or in port, if it is known that discarding of small fish has occurred prior to sampling

In some countries the only opportunity for sampling is of landings of fish that have been sorted into market categories (i.e. large, medium, and small). Samples taken in this way must be properly weighted (by the catch or landing for each category) and combined into a representative sample of the catch (or landings) prior to submission.

5. Length Sampling Data

Length measurements should always be taken of fish which are randomly sampled from the actual catches (or landings) and which are in the natural condition (round fresh fish). If the fish are measured in any other conditions (e.g. gutted or dressed), necessitating the use of conversion factors, the appropriate conversion of the length measurements to those representative of "whole fresh" fish should be made before the length frequencies are reported.

Because the method of measuring differs among countries for the different species, it is important that information on measuring methods be reported. The revised forms provide for the recording of the various types of length measurements as follows:

Fork length - from the tip of the snout to the apex of the V forming the fork of the tail, for species with forked tails.

Total length - from the tip of the snout to the tip of the longest lobe of the tail when the lobe is extended posteriorly in line with the body. This is sometimes referred to as greatest total length. For fishes with non-forked tails, only total length is appropriate.

Mantle length - from antereodorsal protuberance of the mantle to the tip of the tail fin.

Other (to be specified) - for example, carapace length for shrimps, greatest diameter of upper value for scallops, etc.

In addition to indicating the type of length measurement (as noted above), it is very important that countries provide the method of recording the measurements as follows:

Nearest cm (rounded) - measurements are recorded to the nearest centimeter (i.e. fish in the length range 29.5-30.4 cm are actually recorded as 30 cm).

Cm below (truncated) - measurements are recorded to the centimeter below (i.e. fish in the length range 30.0-30.9 cm are recorded as 30 cm).

Other (to be specified) - for example, capelin are to be measured in half-cm units, and should be recorded to the nearest half-cm or half-cm below.

6. Age Sample Data

In order to assess the status of fish stocks by means of analytical models such as "Virtual Population" or "Cohort" analyses, realistic estimates of the age compositions of the catches are essential. The usual procedure is to collect substantial length composition data as being representative of the commercial catches of a species in a particular area over a given period of time. These data are supplemented by additional material for ageing, from which age-length keys are constructed. The representative length compositions are converted to age compositions by the application of the age-length keys to the length frequencies. These age composition estimates are then weighted by the catches to estimate the removals at age from the stock.

While the samples for length composition represent the basic sampling units, and these must be composed of fish randomly selected from the catches (or landings), samples taken to provide material for ageing may consist of fish which are randomly selected from the catches or which are selected by a stratified procedure:

Random sampling for age means that the sample is a random subsample of the length composition or it may be a separate small random sample of the catch taken specifically for ageing, with no attempt made to select fish by length groups.

Supplemented random sampling for age implies that the basic age sample was taken at random and some effort made to supplement the basic sample with fish in the upper and lower parts of the length frequency distribution in order to broaden the length spectrum of the age-length key.

Stratified sampling for age implies that a certain number of fish are selected from each length group represented in the catch length composition, and that the fish are selected at random within each length group.

Random age samples are the least effective of the three types, in that the number of specimens in each sample is usually only a fraction of the number of fish in the length sample, and consequently the entire range of the length groups represented by the catch length composition will rarely be covered. Thus ages cannot be properly assigned to those length groups in the length frequency where there are no ages in the corresponding length groups of the age-length key.

In contrast, stratified age samples are the most effective in that the length groups in the length frequency sample are usually also represented in the age-length key. This type of sample is also the most efficient in that the least number of fish are required to be taken for age determination.

7. Length Conversions

If the length measurements of fish taken for ageing are collected from specimens in the "round fresh" condition, the length groups in the length composition sample and those in the age-length key are directly comparable. If, on the other hand, the length composition sample consists of fish measured in the "round fresh" condition and the length measurements of the fish in the age sample are taken after the fish have been in frozen storage for a period of time, and, assuming that some skrinkage has occurred prior to measuring the frozen specimens, then the length intervals of the actual length composition data and of the age-length key are not directly comparable. The application of such an age-length key to the length composition data results in age compositions that are biased toward the higher age-groups. A very small skrinkage factor (say 3%) can result in serious bias in the calculated age compositions. It is therefore extremely important that the length measurements of fish from frozen age samples be adjusted by appropriate conversion factors to make them representative of "round fresh" fish, if the actual length samples are measured when the fish are "round fresh".

8. Weight Conversions

As in catch statistics, the weights reported in sampling data are required to be round fresh weights. If corrections are required for fish that are measured in the gutted or otherwise dressed condition, these should be made before the samples are reported on the sampling forms.

The proper application of length frequency data to obtain the length composition of the catch requires that the average weight of fish in the sample be given. This value is readily obtained if the sample weight is recorded at the time the sample is collected. If length sampling is carried out at sea where weighing may be difficult or impossible, the average weight of the reported length frequency should be calculated by applying an appropriate length-weight relationship.

Calculating the mean weight from length-weight regressions must be done with consideration for the possible bias in incorrect application. It is not correct to obtain the mean weight by applying the mean length of fish in the sample to a length-weight regression based on measurements of individual fish. The result will be an underestimate of the mean weight and a consequent overestimate of the number of fish in the catch. The non-linearity of the length-weight regression must be taken into account and this is done by applying a vector of weights-at-length to the length frequency.

9. Sampling by Sex

Differences in growth rate and maximum length between the male and female of many species (e.g. flatfishes, hakes, redfish, capelin) require that the sex of the sampled fish be determined. Failure to discriminate sex in these species results in unrealistic age distributions. There are two ways to proceed, the first of which is recommended when feasible.

a) Each sex should be treated as an indepdent sampling unit; that is, length frequency data and ageing data are collected for male and female as if they were separate species. However, the sex ratio must be reflected in the length frequency total for each sex, so that the "per mille" frequency of male and female combined total 1000. The mean length and the mean weight should always be given for each sex and not just for sexes combined.

b) In cases where sex is difficult to recognize while collecting length frequency data, the alternative is to determine the sex when the individual fish constituting the age samples are being examined. In this case, it is important that the selection of fish at each length interval be random with respect to sex, in order to ensure that the sex ratio of fish at each length interval in the sample reflects the true sex ratio of the corresponding length in the catch. The resulting age-length keys (male and female separate) should upon application to the length frequency (male and female combined) result in age frequencies of males and females that are representative of the age composition of the catches by sex.

10. Length Intervals and Sexing Criteria

The length groups to be used in the reporting of sampling data and the species to be reported by sex are listed below:

Cod (*Gadus morhua*)		- 3
Pollock (*Pollachius virens*)		- 3
Cusk (*Brosme brosme*)		- 3
White Hake (*Urophycis tenuis*)		- 3
Wolffish (*Anarhichas* sp.)		- 3
Striped wolffish (*Anarhichas lupus*)		- 3
Spotted wolffish (*Anarhichas minor*)		- 3
Roundnose grenadier (*Coryphaenoides rupestris*)	(by sex)	- 3
Haddock (*Melanogrammus aeglefinus*)		- 2
Red hake (*Urophycis chuss*)		- 2
American plaice (*Hippoglossoides platessoides*)	(by sex)	- 2
Witch (*Glyptocephalus cynoglossus*)	(by sex)	- 2
Yellowtail (SA 3-4) (*Limanda ferruginea*)	(by sex)	- 2
Greenland halibut (*Reinhardtius hippoglossoides*)	(by sex)	- 2
A. halibut (*Hippoglossus hippoglossus*)	(by sex)	- 2
Summer flounder (*Paralichthys dentatus*)		- 2
Greenland cod (*Gadus ogac*)		- 2
Redfish (*Sebastes* sp.)	(by sex)	- 1
Redfish (*Sebastes marinus*)	(by sex)	- 1
Redfish (*Sebastes mentella*)	(by sex)	- 1
Silver hake (*Merluccius bilinearis*)	(by sex)	- 1
Yellowtail (SA 5-6) (*Limanda ferruginea*)	(by sex)	- 1
Winter flounder (*Pseudopleuronectes americanus*)		- 1
Windowpane flounder (*Scophthalmus aquosus*)		- 1
Polar cod (*Boreogadus saida*)		- 1
Scup (*Stenotomus chrysops*)		- 1
Spotted hake (*Urophycis regia*)		- 1
Herring (*Clupea harengus*)		- 1
Mackerel (*Scomber scombrus*)		- 1
Butterfish (*Peprilus triacanthus*)		- 1
Menhaden (*Brevoortia tyrannus*)		- 1
Alewife (*Alosa pseudoharengus*)		- 1
Argentine (*Argentina* sp.)	(by sex)	- 1
Black sea bass (*Centropristis striata*)		- 1
Blueback herring (*Alosa aestivalis*)		- 1
Capelin (*Mallotus villosus*)	(by sex)	1/2 cm or 5 mm
Squid (*Illex* and *Loligo*)	(by sex)	
Sea scallops (*Placopecten magellanicus*)		
Northern prawn (*Pandalus borealis*)		

Note: Any other species not listed above should initially be reported in 1-cm groups

11. NAFO Sampling Forms (Rev 03/85)

The completeness of the NAFO data base, with regard to sampling data for the major commercial fisheries in the Northwest Atlantic, depends entirely on the extent to which member countries sample the catches of their fishing fleets and report these statistics to the Secretariat. To facilitate computer-processing of the data, the basic information required has been consolidated into two forms, designated as Sampling Form 1 and Sampling Form 2.

a) Sampling Form 1 - is designed for use in reporting sampling data for species when both length and age data are available. It is set up to accommodate monthly length frequencies per quarter of the year and quarterly age-length keys, requiring the use of a separate sheet for each quarter of the year and for each gear type and division. In the case of species where monthly age-length keys are required, the term "Quarter" should be interpreted as "Month" in two places on the form, and only one of the three columns under "Length composition" utilized, implying that a separate sheet will be used for each month of data.

For species which are required to be reported by sex, use separate sheets for males and females, but the sex ratio must be reflected in the length frequency total for each sex, so that the "per mille" frequency of males and females combined total 1,000. For example, if the length sample consisted of 200 fish, of which 90 were male and 110 were female, the frequencies recorded on the sampling sheets should total 450 for males and 550 for females after applying the appropriate conversion factor.

It is very important that the applicable length group be shown by circling one of the three indicators (1 cm, 2 cm or 3 cm), and under "1 cm" the starting length group must be given if this length-grouping is used. The box in the right part of the form (number of age samples making up the age-length-key) must be completed.

b) Sampling Form 2 - is designed for use in reporting length compositions of species when no age data are available. Twelve columns (one for each month) are provided for reporting the "per mille" length frequencies of species not required to be sexed. In the case of length samples which are sexed, a block of three columns should be used for each month - one for male, one for female, and one for total. Again the length frequencies of males and females should reflect the sex ratio so the combined frequency totals 1,000.

The details required below each length frequency on Sampling Forms 1 and 2 must be as complete as possible. Information on "Number of samples", "Number of fish measured" and "Mean weight (g)" must always be given for each length frequency. The last is particularly important because it is needed for use as a weighting factor to estimate the length composition of the catch in each month. This weight must be given as "round fresh weight". The "Mean length (mm)" may be recorded, if available, but this value is calculated during the computer processing. Information on "gear size" and "depth range" should be provided, when available, because these data are sometimes useful in evaluating how applicable the reported sampling data are to commercial fishing operations, particularly for redfish as an example.

12. Exceptions to the Pre-1979 Format

In adopting the pre-1979 format for reporting sampling data, the Scientific Council agreed to the following exceptions regarding the time periods and areas applicable to some stocks:

Species (area)	Length sample		Age sample	
	Time	Area	Time	Area
Cod and haddock (Div. 4X)	Month	Unit area[1]	Quarter	Unit area[1]
Cod (Div. 4Vn, Jan-Apr) Silver hake Capelin Herring (except Div. 4WX) Shrimp (SA 0+1)	Month	Division	Month	Division

Species (area)	Length sample		Age sample	
	Time	Area	Time	Area
Herring (Div. 4WX)	Month	Square[2]	Month	Square[2]
Squid	Week	Division	-	-
Scallops[3]	Month	Subarea	Year	Subarea

[1] Unit area as defined by Canadian Department of Fisheries and Oceans
[2] Squares refer to 10'×10' quadrangles
[3] Meat weight substitutes for length

Special forms have not been designed to cover these exceptions because only two entries on the sampling forms are affected. On Sampling Form 1 (length and age data), "Quarter" can be interpreted as "Month" for the age-length-key and only one of the length composition columns used; and "Division" can be interpreted as "Unit area" or "Square", in case there would be a separate sheet for data available from each unit area. Similar interpretations can be made in reporting length-frequency data on Sampling Form 2. In the case of squid, the columns on the latter form should be used to record weekly length frequencies, with each frequency being headed by the first date of the calendar week (i.e. Sunday).

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AGE/LENGTH TABLE FOR SPECIES REPORTED IN 1-CM, 2-CM OR 3-CM LENGTH GROUPS

Year:	Country:	Species:	
Quarter:	Division (or Subdivision):	Gear:	Sex (where applicable):
Exploratory or Commercial Fishing:		Catches or Landings:	Structure used for Ageing:
Check method of measuring fish (✓)	Fork length ☐ Mantle ☐ Total length ☐ Other _____	To nearest cm ☐ To cm below ☐	Reported by:

Check length group used			LENGTH COMPOSITION OF CATCH PER MILLE Months in Quarter			AGE-LENGTH KEY FOR QUARTER (Number sampled by age-group and length)																	
1cm	2cm	3cm																					
1	18-	18-																					
2	20-	21-																					
3	22-	24-																					
4	24-	27-																					
5	26-	30-																					
6	28-	33-																					
7	30-	36-																					
8	32-	39-																					
9	34-	42-																					
0	36-	45-																					
1	38-	48-																					
2	40-	51-																					
3	42-	54-																					
4	44-	57-																					
5	46-	60-																					
6	48-	63-																					
7	50-	66-																					
8	52-	69-																					
9	54-	72-																					
0	56-	75-																					
1	58-	78-																					
2	60-	81-																					
3	62-	84-																					
4	64-	87-																					
5	66-	90-																					
6	68-	93-																					
7	70-	96-																					
8	72-	99-																					
9	74-	102-																					
0	76-	105-																					
1	78-	108-																					
2	80-	111-																					
3	82-	114-																					
4	84-	117-																					
5	86-	120-																					
TOTALS																							

		Number of length samples	Number of age samples in quarter
		Number of fish measured in each month	
		Mean length of fish in each month (mm)	
		Mean weight of fish in each month (grams)	
		Range of depths in each month (meters)	
		Mesh or hook size (mm)	

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LENGTH FREQUENCIES OF SPECIES REPORTED WITHOUT AGEING DATA

Year:	Country:		Species:
[redacted]	Division (or Subdivision):	Gear:	Sex (where applicable):
Exploratory or Commercial Fishing:		Catches or Landings:	
Check method of measuring fish (✓)	Fork length ☐ Mantle ☐ Total length ☐ Other ____	To nearest cm ☐ To cm below ☐	Reported by:

Check length group used			LENGTH COMPOSITION (PER MILLE) BY MONTH (and sex, where applicable)											
1cm	2or 3cm	5mm												
1														
2														
3														
4														
5														
6														
7														
8														
9														
0														
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1														
2														
3														
4														
5														
Total														
No. of samples														
No. fish meas.														
Mean length (mm)														
Mean weight (g)														
Depth range (m)														
Mesh/hook (mm)														

NOTE: If reporting frequencies by sex, use groups of 3 columns above headed 'Male', 'Females', and 'Total'.

Sampling Form 2 (Rev. 03/85)