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International Council for the
Exploration of the Sea

C.M.1992/G:4
Demersal Fish Committee
Ref.: Pelagic and Baltic
Fish Committees

REPORT OF THE STUDY GROUP ON THE ANALYSIS OF FEEDING DATA

St. John's, 17-19 March 1992

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1. INTRODUCTION

1.1 Participants

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1.2 Terms of Reference

The terms of reference (C. Res. 1991/2:12) are:

a) agree on common database formats and appropriate software for the pre-processing of existing feeding data from ecosystems currently being studied by ICES member countries;

b) provide the formats and software to the Chairman of the Multispecies Assessment Working Group well in advance of the Working Group meeting so that the Working Group will be able to efficiently analyze the data and evaluate the statistical properties of estimates of total ration and species composition of diets.

1.3 Overview

The analysis of feeding habits data and factors influencing their variability is central not only to current multispecies models, but to identifying and testing feeding mechanisms for incorporation in future modeling efforts. At the 1990 meeting of the Multispecies Assessment Working Group (Anon. 1991), a number of major issues were identified that involved detailed statistical analyses of feeding data. Examination of stomach sampling data for 1981, 1985, 1986, and 1987 in the North Sea revealed, in some cases, large differences in quarterly mean stomach content weights at age. Given the assumption of constant quarterly consumption across years, these partial data suggest that the assumption may not have been completely justified. Confounding this analysis, however, is the fact that precision estimates (CV) of stomach content weight have not been provided for the various years of stomach sampling data [although some estimates of precision have been attempted (Pope and Hunton 1985)]. Mean stomach content weights at age are a function not only of the length-stratified sampling program for stomach content, but the application of age-length keys as well. More direct comparisons of feeding data (without the confounding effects of ALKs) would involve comparing empirical estimates of stomach content weight and species composition across length strata and years and the fitting of linear models of stomach content in relation to covariates of predator length, year, area, etc. Such analyses of interannual variation in feeding data, and their underlying precision (and thus the power to detect change in feeding levels or prey selection), have not been heretofore presented.

The Multispecies Working Group has also initiated a series of analyses to compare biological interactions among the various fishery ecosystems comprising the ICES area. The goal of these studies is to explore differing data sets with common methods, and to hopefully identify the generality of mechanisms determining predator-prey interactions. The replicate systems provide greater statistical power than analyses of single systems. As a first analysis, the growth rates of cod in Arctic/boreal systems were evaluated in relation to year, temperature, and prey and predator biomass levels (Anon. 1991). An important implication of these analyses was that direct estimates of ration would be important in explaining observed patterns in growth rate variability.

Due to the logistical problems of assembling the large diversity and number of feeding data sets, it was recommended that a Study Group be formed with the goal of developing a flexible data format that would (1) accommodate the differing sampling designs established to collect food habits data throughout the ICES area, while (2) allowing both time-series analyses within fishing systems and comparisons among systems. Additionally, an important goal of the Study Group was to further define the hypotheses to be tested using the various stomach sampling data, and to define the analyses to be conducted before and during the 1992 meeting of the Multispecies Assessment Working Group.

1.4 Acknowledgements

The Study Group thanks the staff and administration of the Department of Fisheries and Oceans, St. John's, Newfoundland, for their logistical and scientific support in hosting the Study Group meeting.

2. DESCRIPTION OF FEEDING DATA SETS

The Study Group reviewed the availability of feeding data for various species of fish in several areas of the North Atlantic (Table 2).

2.1 North Sea

There is an extensive set of feeding data collected from the North Sea from 1980 onwards, nearly all of which is available in the exchange tape format described in Daan (ed) (1989) and Anon. (1991). In most cases, the stomachs were collected, analyzed, and processed following an agreed protocol developed during the 1981 ICES Year of the Stomach [Daan (ed) 1989]. In consequence, although there have been some changes in procedures over the last decade, there is a considerable degree of compatibility both within and between years. Usually, the stomachs from a haul were treated as a bulked (pooled) sample and were subsequently further aggregated by combining samples within a statistical rectangle. However, the prey data are disaggregated at the level of species and size-class within species. The data from the many whiting stomachs collected in 1981 currently exist only in the form of primary (paper) records. These will eventually be computerized. In addition, a very large number of stomachs was collected during the ICES North Sea Stomach Sampling Project in 1991. It is intended that these will be analyzed, processed, and the results computerized in time for the 1993 meeting of the Multispecies Assessment Working Group.

2.2 Baltic Sea

An international cod stomach database has been established at the Danish Institute for Fisheries and Marine Research (DIFMAR) on the initiative of the Working Group on Multispecies Assessment of Baltic Fish.

The purpose of the database is to facilitate the compilation of cod stomachs for use in the MSVPA model for the Baltic (Anon. 1989b, 1990). However, the database contains more information than needed by the MSVPA model and can be of value in other connections, too.

The database contains stomach data sampled by Denmark, Finland, Germany, Poland, Sweden, and USSR from Subdivisions 22, 24-30, and 32 for the period 1977-1990. In total, about 50,000 stomachs have been analyzed and are reported to the database. Most of these stomachs (~40,000) have been reported from Subdivisions 25, 26, and 28 (Central Baltic). The data in the database are aggregated by country, year, quarter, subdivision, and cod length group.

The data have been reported to DIFMAR in main tables and two additional tables to each main table, which give the length distribution of herring and sprat found in the stomachs. These length data are given separately for two digestion stages, A and B, where digestion stage A means almost intact prey and B partly digested prey where, for instance, the head and tail are missing.

Digestion stage A items are reported in 1-cm units and digestion stage B in length groups <11 cm, 11-19 cm, and >19 cm.

Unfortunately, the data are not totally standardized, but today the standardization has improved.

Some preliminary analyses have been made (Sparholt et al. 1991) with the primary aims of showing the possibilities in the data, of giving a broad description of the food habit of cod in the Baltic, and of detecting problems in the data such as systematic differences between countries due to, for instance, differences in the working up procedure used when analyzing the stomach content.

2.3 Barents Sea

A description of the joint Russian-Norwegian stomach database for the Barents Sea was given in the last MSWG report (Anon. 1991). An updated overview of the contents of the database is given in Mehl and Yaragina (1991), where the results of the work based on this stomach database are also summarized.

The computerization of the qualitative Russian data for the period 1947-1983 will start in 1992.

2.4 Iceland

Cod stomachs were collected during bottom-trawl surveys in March 1977-1991 and October-November 1976-1983, 1985, and 1988-1991. Area of sampling was limited to the waters north and east of Iceland prior to 1985. In later years, sampling has covered the continental shelf waters as a whole. Sampling has been stratified by cod length. In general, stomach contents were analyzed by fishing station in bulk. Occasionally, however, additional stomachs have been sampled for individual analysis. Additional information on sampling and stomach content analysis is available in Palsson (1983). Results of analyses and modelling of data collected to 1988 were reported by Magnusson and Palsson (1989, 1991).

2.5 Northeast Newfoundland

Cod stomachs were collected during random depth-stratified bottom-trawl surveys conducted on the southern Labrador Shelf and the Northeast Newfoundland Shelf (NAFO Div. 2J3K) during November-December 1978 and 1980-1991. A maximum of 3 cod per 9-cm length group were sampled from the catch of every fishing haul. Cod stomachs were analyzed individually. Fish and several other prey taxa were identified to species. Items in each taxon were counted and weighed to the nearest 0.1 g. Length measurements were recorded for fish and decapod crustaceans when state of digestion permitted. An analysis of the data collected to 1986 was reported by Lilly (1991).

Cod stomachs were also collected during diel sampling at a single station on the northern Grand Bank in April 1981. In this case, stomachs were collected from 10 cod in each 10-cm length group from each station. Fish prey were assigned to one of 6 digestive states, and the number and total weight of individuals in each digestive state was recorded for each fish taxon.

2.6 Northeast USA

Stomach content data for fishes on the northeast USA shelf have been collected in various forms since 1963 (Langton and Bowman 1980). These sampling programs have employed a variety of sampling designs; there are six data formats in the data set: (1) percent stomach content, with individual stomach samples (1963-1966); (2) weight of stomach content items, individual stomach samples (1969-1972); (3) weight of stomach contents, bulked samples (1969-1972); (4) weight of stomach content items, individual stomachs (1973-1980); (5) volumetric analysis of individual stomach samples (at sea, 1981-present); and (6) weight of prey items collected in bulked samples (1981-1985). The most consistent of these data sets is (5), volumetric analysis of individual stomachs at sea. Most of the data were derived from spring (quarter 2) and autumn groundfish surveys (quarter 4). There were some special stomach sampling cruises in other quarters and years.

The various stomach sampling data sets contain information on about 30 predator species. The current sampling protocol identifies about 20 priority species for stomach sampling [cod, silver hake, goosefish (monkfish), spiny dogfish, other important predator stocks].

2.7 Southern Shelf VIIIc and IXa

2.7.1 Southern Shelf VIIIc and IXa (Spain)

The sampling of stomach contents during stratified-random bottom trawl surveys in division VIIIc of ICES began in 1980. The predators sampled were the most important commercial species caught with bottom trawl: hake, monkfish (2 species), megrim (2 species), blue whiting, and horse mackerel. The first stage finished in 1985 and served to provide qualitative information on the diet of the various species. The methodology employed is described in Gonzalez et al. (1985). Each stomach was analyzed in the laboratory. Stomach contents were identified to species and the number, weight, size, and degree of digestion of the prey were recorded.

In the second stage (1986-1987), the stomach contents of 33 species were analyzed to determine the trophic scheme of the demersal fish assemblage (Olaso and Pereda, 1986).

The third stage began in 1988 with a change to shipboard analysis of the stomach contents of the 20 most important species. Examination involved separation of food items into taxonomic categories. Fish, decapod crustaceans, and cephalopod molluscs were identified to species; but other groups were combined into higher order taxa. The volume of the stomach content was estimated by comparison to a series of moulds of standard sizes (Bowman, 1982; Olaso and Rodriguez-Marin, 1990).

2.7.2 Southern Shelf IXa (Portugal)

Five species are being subjected to stomach content analysis: hake, horse mackerel, mackerel, blue whiting, and John Dory. The collection of samples started in 1990 and has been done twice a year (summer and winter) during routine bottom trawl surveys. The sampling methods used are similar to those described in the Draft Manual for the Stomach Sampling Project for the North Sea. Stomachs are sorted into size-classes of 1 cm of fish standard length and stored individually. Stomach contents are identified to species level and the number, weight, size, and degree of digestion of the prey are recorded, whenever possible.

3. STATISTICAL ESTIMATORS AND USE OF STOMACH DATA IN VALIDATING FEEDING MODELS

3.1 Standard estimators vs. cluster sample statistics

The influence of sampling design on the CV of estimates of average stomach content (e.g., cluster sampling vs. simple random sampling) was briefly addressed at the last MSWG meeting. Since then, work has been done on this topic by Bogstad et al. (1991). They found that the between-tow variance was greater than the within-tow variance when looking at the amount of capelin in Barents Sea cod stomachs. A simulation study based on resampling suggests that little is gained in precision by sampling five instead of two stomachs from each 5-cm length group of fish.

Fogarty (1992) addressed the question of the precision of estimates of the stomach content weight partitioned by prey size and species.

Given the potential biases in mean and variance of stomach content weight due to the clustering effect of food habits data from trawl survey catches, the Study Group recommends that both standard and cluster-sample statistical methods be employed for the upcoming tasks of the MSWG. Although jackknife estimators are certainly available to compute variances for the cluster sampling, development of analytical formulae for these estimates is considered preferable, particularly as a basis of comparison with standard statistical methods.

3.2 Gastric Evacuation Rates and Consumption Models

On the gastric evacuation front, there have been some new publications; but the situation is not substantially changed from that outlined in the report of the workshop on stomach evacuation rates in fish (Anon. 1989a). Essentially, there are a variety of different gastric evacuation models describing the pattern of digestion and passage of food out of the stomach. There is no clear consensus as to which is universally applicable. Indeed, it appears that gastric evacuation is plastic; but there is no agreement on the extent to which this is influenced by factors such as prey type, prey size, and experimental design.

The ICES 1991 Year of the Stomach programme in the North Sea was designed to enable the feeding rate to be estimated from a variety of gastric evacuation models. These can be divided into two broad categories in which gastric evacuation is either (1) linear or (2) curvilinear. Information needed to apply the linear model includes the proportion of fish with empty stomachs and those containing skeletal remains. In the curvilinear models, evacuation rate varies in relation to the level of stomach fullness; therefore, information is required on the level of stomach fullness, preferably for individual fish.

One of the recommendations of the 1989 Workshop on Gastric Evacuation was to set up a database of the results of gastric evacuation experiments. This has been undertaken (Bromley 1990), but there is now a need to incorporate the results of more recent experiments into that database.

This should allow more rigorous analysis of a broad spectrum of results with the prospect of deriving improved and, hopefully, more generally accepted models of gastric evacuation.

Feeding in the trawl has also been identified as a potential problem which could bias estimates of the proportion of fish species consumed (Bromley and Last 1990). In the 1991 North Sea data, there is provision for recording the number of fish in the stomach which are in pristine condition; and it should, therefore, be possible to assess the level of the problem.

Of immediate concern to the 1992 Multispecies WG is the finding that the mean stomach content (per species, size group, and quarter) differs considerably, at least for whiting in the first quarter between 1981 and 1985, 1986, and 1987 (Anon. 1991). The international stomach database can be used to test whether the mean stomach content (per species, size group, and quarter) varies significantly between years. A basic assumption underlying the presently used version of the North Sea MSVPA is that it does not.

Since, for the time being, no general decision about a "best" consumption model can be made, it is important to analyze the deviations between consumption estimates based on different models. However, Jones' consumption model (C=R*S**B with C=consumption in g/h, R='constant' which depends on temperature and fish weight, $0 < B < 1$, Jones 1974) cannot be applied without bias to the bulked stomach content data from the North Sea sampling since, in this model, the stomach contents S has to be raised to a power B, and it can be shown that [avg(S)]**B > avg(S**B).

The amount and variability of this difference can be estimated from the subsets of individually sampled stomachs in the database and used in later analysis as a general correction factor (Magnusson and Palsson 1989; Anon. 1992). Comparisons between different data sets will show to what extent the variance and the distribution function of the stomach content change between years and areas.

In order to get a wider empirical basis of parameter estimates for Jones' model, which was mainly based on experiments with haddock, it should be tried to fit Jones' model to dos Santos' data on gastric evacuation of cod (dos Santos 1990). This has successfully been tried with a part of the data available in the international stomach evacuation database during the last meeting of the Baltic Multispecies WG (Anon. 1992). There is preliminary evidence that, by means of reparameterization, meal size is no longer needed in the model.

One of the priorities for using the new stomach content database (particularly the 1991 North Sea data) should be to fit the data into the different gastric evacuation models to estimate the feeding rate of fish populations.

4. DEVELOPMENT OF DATA FORMATS FOR COMPARATIVE STUDIES

4.1 Objectives

An integrated analysis of stomach content data collected for different systems requires that a standard data format is defined and that all data are standardized accordingly and made availale in this format. This is not a simple matter, because sampling procedures and the availability of useful auxiliary information may differ considerably between different countries. Within the North Sea Stomach Sampling Program, which has been carried out since 1981, considerable experience has been gained in exchanging data and over the years a format has been developed (Daan, ed. 1989; Anon. 1991), which appeared to present a good starting point for a revised format that could be applied Atlantic-wide.

The North Sea format is based on a flat ASCII file, where each record (fixed size) represents an individual prey category. Sample information is repeated in each record. It is flexible to the extent that (1) individual stomachs or bulked samples can be recorded, (2) individual cm-classes or predefined size categories can be recorded, and (3) prey categories can be distinguished at each possible taxonomic level and according to size category. Each individual stomach or sample is identified by a unique combination of year, quarter, stratum, and sample number. Coding of predator and prey is based on the flexible NODC system, which appears to be widely applied in stomach content research in the North Atlantic.

The ultimate goal of the Multispecies Assessment Working Group is to create a dis-aggregated set of data files in this format, which includes information on a variety of predator species in all systems and where all relevant original information is maintained. At the same time, an aggregated data set is required already for the June meeting to carry out specific analyses. In order to maintain continuity in the development of appropriate software code for statistical analyses of these data, an important prerequisite for developing a flexible exchange format is that it can be equally applied to present either dis-aggregated or aggregated data.

For the purposes of analyses to be conducted at the June MSWG meeting, partially aggregated data sets including the eight prey categories listed in footnote 'f' of Table 4.1 are required. Investigators are further encouraged to establish data sets fully dis-aggregated to lowest possible prey taxon, prey size, and digestion state.

4.2 Description of the format

The definition of the format is given in Table 4.1. The information to be included in most fields is self-evident. However, a few fields require further explanation:

- Sample (Fish) number must, in combination with year, quarter, stratum, and NODC predator code, be a unique number within each data set.

- CPUE represents a weighting factor that identifies the weight that a particular sample should get when evaluating parameter estimates for an entire population. This may be either a CPUE per stratum or a catch in an individual haul, depending on the particular sampling scheme. It should be noted these factors should only be applied for within quarter analyses and not for within year analyses!

- Time of day is given in local time units. This approach does not necessarily provide strictly comparable information on diel changes in stomach contents between systems.

- The official NODC code does not yet contain all possible prey organisms observed in different areas of the North Atlantic. Therefore, in some cases, the definition of ad hoc NODC codes has been necessary. Differences between systems are restricted to the non-fish compartment.

- To allow for maximum flexibility in the definition of size-classes, both the lower and upper limit of the size-class is required for both predator and prey. Strictly, for individual cm classes, the upper limit is given by the cm class + 1. For the partially aggregated data set, prey may be aggregated into four size categories: <10 cm, 10-15 cm, >15 cm, and unknown.

In respect of the partially aggregated data set required for the June meeting, eight prey categories are distinguished, four size categories of fish and four digestion stages. These requirements define the level of dis-aggregation in the file. An example of the logic is provided in Table 4.2.

5. DESCRIPTION OF THE ANALYSES TO BE UNDERTAKEN AT THE JUNE 1992 MSWG MEETING

The Study Group decided that the analyses to be conducted during the next MSWG meeting should focus on four predator species: cod, whiting, European hake, and silver hake. Cod is ideal for within-ecosystem and among-ecosystem comparisons, because it has been sampled for a series of years in ecosystems across the northern arc of the Atlantic and is the predator of major interest in Arctic/boreal systems. Whiting was chosen because of its importance in the North Sea and the opportunity it provides for a between-species (cod, whiting) comparison within a system. The hakes were chosen because of their importance in the more southern areas.

5.1 Applicability to existing multispecies models

The Multispecies Virtual Population Analysis (MSVPA) model of the North Sea currently assumes constancy of ration by age group within quarter, over the years included in the retrospective analysis. The conversion of stomach content sampled by length into stomach content by age is complicated. A more direct method of testing the assumption of constancy of stomach content is to either conduct analyses of variance for exact length in terms of predator, or to fit regression models to the stomach weight data and primary covariants (e.g., fish length, quarter, etc.) and test differences in regression parameters.

Likewise, for the MULTSPEC model (Bogstad and Tjelmeland 1990, 1991), assumptions on length-dependent suitability of capelin for cod and maximum consumption by cod could be evaluated. The analysis may also throw light on what kind of functional feeding relationship applies to cod feeding on capelin. Different functional feeding relationships are used in the MULTSPEC model for the Barents Sea and the cod-capelin model for Icelandic waters (Magnusson and Palsson 1991).

The approach will be to use general linear models (regression, analysis of variance, analysis of covariance, etc.) to test hypotheses that are inherent to existing multispecies models such as MSVPA as well as hypotheses that would form the basis of developing multispecies models; for example, cod-capelin interaction models for Arctic/boreal ecosystems. Two classes of hypotheses were posed: those that are applicable within ecosystems, and those that are applicable among ecosystems. Following are some hypotheses which might be tested during the MSWG meeting. The list is not comprehensive and it may not be possible to test all these hypotheses during the MSWG meeting.

5.2 Testable hypotheses within ecosystems

(a) Are there significant year effects on mean stomach weight, proportion of empty stomachs, etc.?
- MSVPA uses a constant mean stomach content weight.

(b) Is there a significant temperature effect on mean stomach content weight, proportion of empty stomachs, etc.?
- Ideally, temperature would be the individual or mean bottom temperatures associated with the trawl(s) or survey strata.
- Where temperature is not available in the trawl database, attempts should be made to access hydrographic data by quarter by stratum.

(c) Are there significant differences in digestion stage and stomach fullness with respect to time of day?

(d) Are there significant year or quarter effects in the percentage of fish or other aggregated prey categories (capelin, crustacea, mollusk, polychaete, echinoderm, other food, unidentified fish) in the diet?
- This hypothesis could be tested for individual predator size categories.

(e) Are there significant sub-area or depth effects in mean stomach weight, proportion empty, etc.?
- This may alias migration effects.

(f) Are there significant differences in mean stomach weight as a result of the predominant prey category in the stomach?
- This may be examined by an interaction term in the model.

(g) Is there a significant effect of prey abundance on mean stomach weight, proportion of empty stomachs or mean weight of the specific prey in the stomach?
- This will require providing time series of prey abundances for the different ecosystems.

5.3 Testable hypotheses among ecosystems

(a) Are there ecosystem effects on mean stomach content weight, proportion of empty stomachs, etc.?

(b) Are there significant ecosystem effects on the relationship between temperature and mean stomach content weight, proportion of empty stomachs, etc.?

(c) Are there significant ecosystem effects on consumption rates?
- This question requires that turnover rate (with temperature dependency) is applied to the stomach data in order to get consumption estimates for the different ecosystems.

5.4 Special studies of cod-capelin interactions

In the terms of reference to the last MSWG meeting, it was stated that one should conduct statistical analyses on the underlying relationships of cod growth in relation to prey abundance and environmental variability, and explore existing predation data for Arctic/boreal ecosystems. This was only partly achieved, because of time constraints and the fact that the feeding data were not available in a common data format. The common database format agreed upon by this Study Group will greatly assist the analyses mentioned above. Of greatest interest at this time would be statistical analyses of cod-capelin interactions, both within and among ecosystems. Cod-capelin interactions are also mentioned in this year's terms of reference for both the Arctic Fisheries Working Group and the Atlanto-Scandian Herring and Capelin Working Group. Questions of interest include the following:

(a) Are there year effects in total stomach content weight, weight of capelin, and percent capelin in the diet, by predator size (and age, if possible)?

(b) What is the relationship between the quantity of capelin in cod stomachs, by size group, and the quantity of capelin in the ecosystem?

(c) After removal of other environmental effects, such as temperature, is annual variability in cod length (and weight) at age related to variability in total stomach content weight or weight of capelin in stomachs? Is there evidence of prey switching at times of low capelin abundance?

6. LOGISTICS

The Study Group recommended that persons intending to reformat data into the suggested format attempt to do so at their earliest convenience, so that problems and ambiguities can be identified and resolved as soon as possible and the data files can be made available on the ICES computer for preliminary analyses prior to the start of the MSWG meeting. Every effort should be made to have the data files accessible by mid-May.

G. Lilly and P. Shelton agreed to coordinate the preparation of data into the appropriate format for analysis at the June meeting. They made be contacted as follows:

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Preparation of data involves two steps:

(1) Reformatting of data

During the meeting, it was suggested that the coordinators provide a few lines of sample code for incorporation into the report. The coordinators feel it would be more useful if participants attempt the reformating of their data, using Tables 4.1 and 4.2 as a guide, and send a few lines of code to the coordinators to be checked for consistency with the agreed format. The sample lines should include information from more than one sample/specimen and more than one prey type. Explanatory notes should be provided for any non-obvious manipulations.

(2) Transferring of data files to the ICES computer

The coordinators will, by the end of April, provide detailed instructions on the naming conventions for directories and files, and the procedures for transfering files to the ICES computer. It is anticipated that participants can send data electronically to the ICES computer or send the data on disc to St. John's for electronic forwarding to ICES.

The Study Group encourages the development of software prior to the June meeting. This will be coordinated by Lilly and Shelton. Software will be required to: (1) aggregate data to suitable levels for analysis, (2) provide graphic output which illustrates properties of the data, (3) provide summary statistics of important variables, and (4) carry out the analyses suggested in Section 5. A library of software applicable across databases will be developed.

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Table 2. Descriptions of feeding data sets available for analysing statistical properties of food data.

Area	Species	Quarters/ years	Bulked vs. Individual	Status of computerization	Haul information	Goal of set	Special notes
North Sea	Cod	1980/1,2,3,4	B	+	–*	Pop. est.	Southern N.S.
		1981/1,2,3,4	B	+	–	"	Total N.S.
		1982/1,2,3,4	B	+	–	"	Southern N.S.
		1984/2	I	+	–	Diel stomach	Single square
		1985/1,3	B	+	–	Pop. est.	Total N.S.
		1986/1,3	B	+	–	"	"
		1987/1,3	B	+	–	"	"
	Whiting	1985/1,3	B	+	–	"	"
		1986/1,3	B	+	–	"	"
		1987/1,3	B	+	–	"	"
	Haddock	1981/1,2,3,4	B	+	–	"	"
	Mackerel	1980–1983	B	+	–	"	"
	Saithe	1981/1,2,3,4	B	+	–	"	"
		1985/1,3	B	+	–	"	"
		1986/1,3	B	+	–	"	"
		1987/1,3	B	+	–	"	"
Baltic Sea (central) Denmark Poland (USSR) Sweden	Cod	1977–1990/ 1,2,3,4	B,I	+	–	"	Cod in length groups, some diel experiments, 50 thousand

*No./hr. per square available.

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Table 2. (Cont'd.)

Area	Species	Quarters/ years	Bulked vs. Individual	Status of computerization	Haul information	Goal of set	Special notes
Barents Sea	Cod	1947-1983 (Russian)	I	-	-		Qualitative 1 million
		1984-1991/ 1,2,3,4	I	+	(+)	Pop. est.	40-50 thousand, best in 1,3
	Haddock	1984-1990/ 1,2,3,4	I	+	(+)	"	10 thousand
	Capelin	Some	I	+	(+)	"	
	Herring	"	I	+	(+)	"	
	Redfish	"	I	+	(+)	"	
	Blue whiting	"	I	+	(+)	"	
	Polar cod	"	I	+	(+)	"	
	Plaice	"	I	+	(+)	"	
Iceland	Cod	1979-1991/ 1,4	B,(I)	+	+	Pop. est.	29 thousand from Groundfish survey 7 thousand from commercial
Northeast Newfoundland	Cod	1978-1991/ 4	I	+	+	Pop. est.	27 thousand
		1981/2	I	+	+	Diel stomach	400
Northeast USA	20 priority species	1963-1992/ 2,4	B,I	+	+	Pop. est., Diel stomach	Data formats variable, 1981-present most uniform data set
		1981-1992/ 2,4	I	+	+	Pop. est.	Volumetric sampling at sea

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Table 2. (Cont'd.)

Area	Species	Quarters/ years	Bulked vs. Individual	Status of computerization	Haul information	Goal of set	Special notes
Southern Shelf VIIIc & IXa (Spain)	Hake Megrim Monkfish Blue whiting Horse mackerel Others	1980-1985/ 2,4	I	+	+	Diet	8 thousand
		1986-1987/ 2,4	I	+	+	Trophic scheme	7 thousand
		1988-1991	I	+	+	Food habits	12 thousand (volumetric)
Southern Shelf IXa (Portugal)	Hake Horse mackerel Mackerel Blue whiting John Dory	1990-1991/ 2,4	I	+	+	Food habits for Pop. est.	

Table 4.1. Data format for feeding information to be analyzed at June 1992 MSWG meeting (partially aggregated data).

Position	Name	Type[a]	Range of values	Comment
1-2	Ecosystem name	2N	1-8	Footnote[b] for coding scheme
3-4	Year	2N	01-99	Year - 1900
5	Quarter	1N	1-4	
6-9	Square/stratum	4AN		ICES rectangle or survey stratum #
10-19	Predator code	10N		NODC 10-digit, see footnote[c]
20-24	Sample number	5N	1-99999	Unique fish I.D.
25-27	Country	3A		ICES alpha codes No data: XXX
28-31	Ship	4A		ICES alpha, if available No data: XXXX
32-34	Sampling method	3A		Footnote[d] for coding scheme No data: XXX
35-40	Station/haul	6AN		Use national system No data: XXXXXX
41-42	Month	2N	01-12	Not known: 99
43-44	Day	2N	01-31	Not known: 99
45-48	Time of day	4N	0-2399, 9999	Local time, hh/mm, start of tow Not known: 9999
49	Quadrant	1N	1-4, 9	See footnote[e] Not known: 9
50-53	Latitude	4N	0-9000, 9999	dd/mm Not known: 9999
54-58	Longitude	5N	0-18000, 99999	ddd/mm Not known: 99999
59-61	Depth (meters)	3N	1-999	Mean depth of tow Not known: 999
62-64	Temperature (bottom)	3N	-9.9 to 99.8	XX.X one implied decimal Not known: 999

Table 4.1. (Cont'd.)

Position	Name	Type	Range of values	Comments
65-68	Predator (mean) length	4N	1-9999	mm XXXX
69-73	Predator (mean) weight	5N	1-99999	grams XXXXX Not known: 99999
74-75	Predator (mean) age	2N	0-99	Not known: 99
76-79	Predator lower length bound	4N	1-9999	mm XXXX
80-83	Predator upper length bound	4N	1-9999	mm XXXX
84-90	CPUE	7N	1-9999999	Weighting coefficient for sample Not known: 1
91-93	Number with food	3N	0-999	0, 1 for individual samples
94-96	Number regurgitated	3N	0-999	0, 1 for individual samples
97-99	Number with skeletal remains	3N	0-999	0, 1 for individual samples
100-102	Number empty	3N	0-999	0, 1 for individual samples
103-112	Prey species code	10N		NODC 10-digit, see footnote[f]
113-116	Prey lower length bound	4N	1-9999	mm XXXX[g] Not known: 9999
117-120	Prey upper length bound	4N	1-9999	mm XXXX[g] Not known: 9999
121-128	Prey weight	8N	1-99999999	Total weight mg XXXXXXXX
129-134	Prey number	6N	1-999999	Total number Not known: 999999
135	Digestion stage	1N	0-2, 9	See footnote[h]

[a]All numeric fields (N) right justified, zero filled; all alpha (A) and mixed alpha/numeric fields (AN) left justified, space filled.

[b]North Sea=1, Baltic Sea=2, Barents Sea=3, Iceland=4, Northeastern Newfoundland=5, Northeastern USA=6, Southern Shelf=7, Faroes=8.

[c]NODC codes for predators:

Cod	_Gadus morhua_	8791030402
Whiting	_Merlangius merlangus_	8791031801
European hake	_Merluccius merluccius_	8791040105
Silver hake	_Merluccius bilinearis_	8791040101

[d]DEM=Demersally caught by trawling or seining gears
PEL=pelagically caught by trawling or seining gears
DHL=demersal hook and line
PHL=pelagic hook and line
DGN=demersal gill net
PGN=pelagic gill net

[e]Quadrants for position identification are: 1=NE, 2=NW, 3=SW, 4=SE
(The axes of the quadrants are the equator and the Greenwich meridian.)

[f]NODC prey codes which may appear in the partially aggregated set:

Capelin _Mallotus villosus_	8755030201
Fish (unidentified)	8799999999
Fish (other)	8700000000
Crustacean	6100000000
Mollusc	5085000000
Polychaete	5001000000
Echinoderm	8100000000
Other food	9999999999

[g]Prey size categories:

<10 cm	lower bound: 0000	upper bound: 0100
10-15 cm	lower bound: 0100	upper bound: 0150
>15 cm	lower bound: 0150	upper bound: 9999
unknown	lower bound: 9999	upper bound: 9999

[h]Digestion stages are: 0=Pristine, 1=Affected by digestion, 2=Skeletal remains, 9=Unknown

Table 4.2. Example of the records in a partially aggregated data set.

Fish number	Prey	Size-class	Digestive state
1	Capelin	10-15	0
1	Capelin	10-15	1
1	Capelin	10-15	2
1	Capelin	Unknown	2
1	Unid. fish	10-15	2
1	Unid. fish	Unknown	2
1	Fish	< 10	0
1	Fish	< 10	1
1	Fish	< 10	2
1	Fish	10-15	0
1	Fish	10-15	1
1	Fish	Unknown	2
1	Crustacea	Unknown	0
1	Crustacea	Unknown	1
1	Crustacea	Unknown	2
1	Polychaete	Unknown	0
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