INTERNATIONAL COUNCIL FOR
THE EXPLORATION OF THE SEA

REPORT OF THE PLANNING GROUP ON THE STOMACH SAMPLING PROJECT FOR 1991.

Lowestoft, 6-7 April 1989

Contents

1. Terms of reference.

At the Council Meeting in 1988 in Bergen, the recommendation was adopted (C. Res. 1988/2:12) that:

A Planning Group on the Stomach Sampling Project for 1991 will be established under the chairmanship of Dr. N. Daan and will meet in Lowestoft from 6-7 April 1989 at national expense to:
(a) define the requirements, priorities and logistics of a large-scale stomach sampling programme to be undertaken in 1991.
(b) and to submit a detailed proposal to the Statutory Meeting in 1989.

2. Participation.

T.W. Boon	(UK, England)
P.J. Bromley	(UK, England)
R. de Clerck	(Belgium)
N. Daan	(Chairman, Netherlands)
H.J.L. Heessen	(Netherlands)
J.R.G. Hislop	(UK, Scotland)
J.M. Last	(UK, England)
G.R. Lilly	(Canada)
S. Mehl	(Norway)
J.G. Pope	(UK, England)
J. Reinert	(Faroes)
A.P. Robb	(UK, Scotland)
H. Sparholt	(Denmark)
T.K. Stokes	(UK, England)

3. Objectives.

The ICES Stomach Sampling Project in 1981 has allowed a great leap forward in the assessment of the effect of species interactions on the population dynamics of exploited fish species in the North Sea. The food composition data for the five predator species investigated - cod, haddock whiting, saithe and mackerel were applied in MSVPA and the results indicated that long term catch predictions cannot accurately be made when species interactions are not taken into account. However, any multi-species assessment is at present bound to rely very heavily on a single year of stomach content data. Since changes have taken place in various fish stocks, in particular the herring stock, predictions of catch levels in the 1990s must be considered as considerable extrapolations from the situation in the early 1980s. Therefore, a repetition of the exercise in 1981 is needed to tune the estimated predation mortalities generated by the various predators to the new situation.

In addition, a major drawback of the 1981 data base is that little or no information has been collected on the predation on and by 0-group fish, whereas the available evidence suggests that the interactions during this phase are extremely important. Therefore, a repetition of the large scale stomach sampling programme in 1991 should be extended to include sampling of 0-group fish.

One general uncertainty in applying multi-species models is that feeding rates of fish in the sea are not well known. In principle, feeding rates should equal stomach evacuation rates. Since the latter may vary among different prey types and sizes, stomach content composition data may not reflect the actual food composition. The new programme should address this problem more carefully than the former one,

which requires different procedures in the sampling strategy and/or in the analysis. Such adaptations, however, should not interfere with the requirement that the data to be collected in 1991 can be analysed in a manner that is entirely consistent with the methods used in 1981.

In conclusion, the objectives of the Stomach Sampling Project in 1991 can be summarised as:
- to obtain a reliable new data set on food composition of the five main predator species in the North Sea for use in MSVPA;
- to quantify predation on and by 0-group commercial fish species;
- to improve estimates of consumption by the various predators;
- to maintain compatibility of the results with those from the 1981 project.

4. Priority species.

Cod, whiting, haddock, saithe and **mackerel** were, as in the 1981 stomach sampling project, considered to be the most important species to sample during the 1991 Stomach Sampling Project.

An important addition to the sampling procedure from 1981 should be the sampling of stomachs from **0-groups** of the five species. Special arrangements for sampling 0-group properly will be made and are described below in this report.

According to Daan et al. (in press) and Sparholt (1987), other fish than the five MSVPA predators could be important predators on the MSVPA prey species. Especially scad, rays, and grey gurnards seem to be worth considering, because their biomass in the North Sea is large. According to Sparholt (1987) the biomass of **scad** in the central and southern North Sea exceeds 1 million tonnes during some parts of the year due to a large-scale immigration from areas west of the British Isles the estimated biomass of rays (200000 to 300000 tonnes) and grey gurnard (50000 to 150000 tonnes) is also large. These species might therefore be of special importance for the estimation of the residual natural mortality. The Planning Group thought it important to get information on the diet of these three species for 1991, because this information would then be directly comparable to the data on the diet of the five MSVPA predators. It is therefore recommended that stomachs from **scad**, **rays** (all species), and **grey gurnards** should also be sampled in 1991.

Herring and sandeel are known to prey upon eggs and larvae of other fish. Although predation on eggs and larvae is somewhat outside the scope of the MSVPA model, the Working Group felt that the complete temporal and spatial coverage of the North Sea planned for 1991 provides a good opportunity to sample stomachs of these species.

It is therefore recommended that stomachs from **herring** and **sandeel** should be sampled during specific times of the year, particularly in spring.

The biomass of **dab** in the North Sea is very large (according to Sparholt (1987) about 1.5 million tonnes). The importance of dab as a fish consumer was discussed, but the available data on the diet (e.g. De Clerck, 1988) indicate that its predation on fish can be neglected.
The biomass of **long rough dab** in the North Sea is also considerable (about 200,000 tonnes, Sparholt, 1987). Although long rough dabs do eat some fish, the available information indicates that the percentage of fish in their diet is small, especially for the main size groups found in the North Sea.
Lemon sole and **plaice** are also common in the North Sea but neither consumes significant amounts of fish.

5. Logistics.

5.1. Coordination.

On the basis of the experience gained in 1981, it seemed appropriate to uncouple the responsibility for the overall project and the commitment to analyse the actual samples of a particular species. It was decided that J.R.G. Hislop should replace N. Daan as the project coordinator.

The following people volunteered to take up the responsibility as species coordinators:

H.J.L. Heessen	(Netherlands)	-	**cod**
A.P. Robb	(UK, Scotland)	-	**whiting**
D. Skagen	(Norway)	-	**mackerel**
H. Gislason	(Denmark)	-	**saithe**
P.J. Bromley	(UK, England)	-	**0-group gadoids**
H. Sparholt	(Denmark)	-	**rays**
N. Daan	(Netherlands)	-	**other species**

It should be noted that the available manpower will limit the analysis of other species but, because these are of secondary importance, some delay in the analysis can be accepted. For haddock a coordinator must still be found.

5.2. Aspects of sampling.

5.2.1. Surveys.

Consideration was given to the needs and likely availability of ship time. It was decided that adequate sampling of all but 0-group stomachs could be achieved by the coordinated use of at least three ships in each quarter of 1991. These ships should use a GOV trawl except where a cruise forms part of an on-going survey series using a different gear.

Quarter one poses no difficulties as the International Young Fish Survey (carried out in February) involves eight vessels and covers the entire North Sea. It was suggested, however, that for 1991 one of these eight ships be re-deployed either to another quarter and/or to 0-group sampling.
The coverage during the third quarter by existing, planned surveys is good. Many countries already operate summer groundfish surveys to provide annual abundance estimates. These cruises have provided, and can continue to provide, stomach samples of 1-group and older fish plus incidental samples of demersal 0-group fish. The second and fourth quarters are not well covered by on-going survey programmes. Many countries have, however, already requested (and are likely to have) additional cruises scheduled for these quarters in 1991.
In particular, England and Wales are likely to have cruises in March (but may be April or May) and November, the Netherlands will have a November cruise and Denmark, Scotland and The Netherlands are investigating the possibilities of (four or five) additional cruises in these quarters. The timing of these committed cruises is flexible. It is therefore expected that at least three ships will be able to operate in each of quarters two and four. These additional cruises do not, of course, form part of any current survey series and cannot, therefore, provide relative abundance indices. They will, however give good temporal coverage of the North Sea and may provide insight into intra-annual fish movements.

The Planning Group noted that, with the exception of the International Young Fish Surveys, there is a complete lack of co-ordination in the planning of the ongoing bottom trawl surveys at other times of the year. This hampers a proper

redeployment of research vessel effort in relation to the Stomach Sampling Programme envisaged for 1991 and also limits the utility of the results obtained during individual surveys for general stock assessment purposes.

Therefore, it was felt that ICES should reconsider the terms of reference of the IYFS Working Group with a view of replacing this group by a general North Sea Bottom Trawl Surveys Working Group.

There are other annual surveys conducted in the North Sea which might provide additional useful data. One such survey is the International Beam Trawl survey carried out in August/September in the central and southern North Sea. This survey could be a valuable source of whiting and grey gurnard stomachs for the third quarter.

The one area of sampling that the group envisaged might be difficult was that of pelagic 0-group gadoids. It was considered best that some (geographically) wide-ranging sampling cruises should take place as well as a more intensive, sequential sampling regime in one or more areas. The group also considered the possibilities of using pelagic and demersal trawls on the same cruise; it was decided that this would be difficult. The group's opinion was that dedicated 0-group sampling cruises using the IYPGT should be used. A total of three ships would be needed for this purpose. Whether or not these ships will be available is not yet clear but the flexibility in timing of committed cruises may well permit successful 0-group sampling to be performed.

5.2.2. Sampling strategies.
To pool or not to pool
Whether stomachs should be stored and analysed separately, or could be analysed as a pooled sample (as in 1981) was discussed at length during the Stomach Evacuation Workshop (Lowestoft, 3-5 April 1989). It was recognised that single stomachs were for some purposes potentially more useful than pooled samples. Indeed, processing individual stomachs might be an essential requirement for the application of some methods for estimating the composition of the diet and calculating consumption.

However, the matter is still unresolved and tests will soon be made to compare the virtues of the two methods. It must be appreciated that it takes much longer to collect and analyse individual stomachs and, if this approach is thought necessary, it will almost certainly mean that fewer stomachs can be collected. It was agreed that if such a sacrifice has to be made, the correct procedure would be to take fewer stomachs per haul rather than to sample fewer hauls.

Size classes and sampling intensity.
It is intended to maintain sampling levels for cod, whiting, saithe and mackerel at, or above, those achieved in 1981. Haddock sampling has been reduced because according to the 1981 data the impact of this species on other exploited fish species is relatively small and therefore less precision is required. For mackerel and saithe it will be necessary to collect additional samples from the commercial catches because these two species are not satisfactorily sampled by research vessel bottom trawl surveys, especially in the northern North Sea. It will be up to the species coordinators to arrange this.

The numbers of stomachs to be samples per species per haul are shown in Table 1. It should be noted that new size classes have been introduced since 1981. These refer in particular to the smaller fish (<15 cm). These finer subdivisions allow a better treatment of 0-group fish and make it possible to apply more precise ALKs than was possible in 1981.

Regurgitation.
It is sometimes impossible to decide whether a stomach is empty or has lost part of its contents. This problem is particularly acute in the case of whiting. Although this is an extremely important matter - it is necessary to know what proportion of the population is feeding both to calculate the mean weight of the stomach contents and to calculate consumption using the constant-evacuation model (Bromley, 1988) - there appears to be no infallible way of distinguishing between empty and regurgitated stomachs. The matter has to be left to the judgement and experience of those who collect the samples at sea.

Recently ingested items.
Completely undigested fish are sometimes found in the mouths, gullets and stomachs of trawl caught fish. Some of these have obviously been mechanically forced into the "predator" or have wriggled into an open mouth on deck. Such fish are not true prey and can be discounted. When the prey is in the stomach of the predator, it is not known if it was eaten a) before the predator encountered the trawl, b) while the predator was swimming in the mouth of the trawl or c) in the codend. There is no a priori reason to reject prey eaten in the mouth of the net - fish may take advantage of fish herded by the trawl and evade capture - but there is still disagreement as to whether such prey should be included. However, a policy to exclude all freshly eaten prey would certainly downwardly bias the mean weight of the stomach contents. It was decided that "immaculate" prey should be included in the data base, coded in such a way that analyses could be performed with or without them, according to taste.

5.3. Stomach analysis.
The analysis of a species will be the responsibility of the respective coordinator. However, he may make arangements with other laboratories to assist in the analyses.
Data will be recorded as in the 1981 stomach project but with the following additions: (1)the numbers of stomachs which contain only skeletal remains will be recorded separately (2) digestion stage codes will be introduced (Stage 1: unblemished; Stage 2: measurable; Stage 3: not measurable Stage 4: skeletal material). The stomach contents recording sheet will be modified accordingly and a provisional example is shown in fig. 1.

The level to which prey must be identified depends on the type of prey. The minimum requirement for MSVPA is that fish and all exploited non-fish prey are identified to species level and other prey classified by broader categories (e.g. Crustacea, Mollusca). However, individual coordinators are at liberty to make a more detailed analysis. The Group is of the opinion that fish stomachs contain a great deal of material that should be of interest to North Sea ecologists, who should be encouraged to participate in the analysis.

5.4. Computer analysis.
In the past, data exchange has been hampered as a consequence of different sets of programs being developed at different institutes. This situation has been subsequently improved by defining a common format for exchanging stomach content data, but even now some of the data sets collected in 1981 are not available in exchange tape format.

In recent, years, the situation has considerably improved by implementing Pascal software that has been developed on a VAX-system in IJmuiden, in Scotland and Denmark. Use of the same software would obviously ensure enhanced compatibility in the analysis of the data and since this set of programs is the only one which can both read data from exchange tapes and write data to exchange tapes, it was decided that the ultimate analysis should be centered around this software.

Some adaptations will be required to incorporate the changes discussed in the former paragraphs, but IJmuiden will make available and support this software among the potential users. The exchange tape format will have to undergo some slight revisions as well.

6. Recommendations.

The Planning Group recommends that:

1. A stomach sampling programme comparable to that in 1981 be conducted in 1991 and that Dr. J.R.G. Hislop acts as the project coordinator;

2. Countries are strongly urged to make available a) extra ship time in order to achieve a quarterly coverage of the total North Sea and b) manpower to allow the analysis of the samples within a reasonable time span.

3. The ICES gives consideration to the formation of an International Bottom Trawl Surveys working group to co-ordinate effort and standardize gears and methods of bottom trawl surveys within the North Sea, Skagerak and Kattegat.

4. The IYFS Working Group is requested to consider the redeployment of some effort from the 1991 survey to the second and/or fourth quarter of that year to provide improved sampling coverage to the Stomach Sampling Project.

5. The species coordinators meet in Aberdeen at the end of 1990 or early in 1991, at national expense, to prepare a revised version of the Manual for the North Sea Stomach Sampling Project.

7. References

Daan, N. P.J. Bromley, J.R.G. Hislop & N.A. Nielsen, 1989, (in press). Ecology of North Sea fish. Neth.J. Sea Res. 23:

Sparholt, H., 1987. An estimate of the total biomass of fish in the North Sea, with special emphasis on fish eating species not included in the MSVPA model. ICES CM 1987/G:52 (mimeo).

Clerck, R. de & E. Torreele, 1988. Feeding habits of common dab (*Limanda limanda* L.) in the southern North Sea ICES CM 1988/G:26 (mimeo).

Bromley, P.J., 1988. Gastric digestion and evacuation in whiting, *Merlangius merlangius* (L). J. Fish Biol. 33: 331-338.

Fig 1. Provisional recording sheet stomach content data. A continuation sheet may be used.

ICES STOMACH SAMPLING PROJECT □ of □

PREDATOR: ———————— YEAR: . . . .
PREDATOR CODE: . . . . QUARTER: .

A. Sample information

COUNTRY: . . . .   DATE (Day-Month): . . - . .
SHIP: . . . .   TIME (GMT): . . . .
HAUL: . . . .   DEPTH (m):
SQUARE: . . . .   TEMPERATURE (0.1°C): . . . .

B. Predator information

PREDATOR SIZE CODE: . . . . .   N-food: . . . .
                                 N-regurgitated: . . . .
                                 N-skeletal remains: . . . .
                                 N-empty: . . . .

                                 N-sample: . . . .

C. Stomach contents.

N	CM*	n	Taxonomic unit	PREYCODE	SIZE CODE (mm)	WEIGHT (g)	NUMBER	DS	Additional information
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N : Fish number
n : Item number
DS : Stage of digestion [1: unblemished; 2: measurable; 3: not measurable; 4: skeletal material]
*: Actual cm group (optimal)

Table 1.   Numbers of stomachs to be sampled per haul per size class.

Size class	Cod	Whiting	Saithe	Mackerel	Haddock	Scad	Gurnard	Rays (total length)
6-7	5	5	5	5	5	5		
7-8	5	5	5	5	5	5		
8-10	5	5	5	5	5	5		
10-12	5	5	5	5	5	5		
12-15	5	5	5	5	5	5		
15-20	10	10	25	25	5	10	10	10
20-25	10	10	25	25	5	10	10	10
25-30	10	10	25	25	5	10	10	10
30-35	10	10	25	25	5	10	10	10
35-40	10	10	25	25	5	10	10	10
40-50	10	10	25		5	10	10	10
50-60	10	10	25		5			10
60-70	25	10	25		5			10
80-100	25		25					10
100-120	25		25					10
120-150	25		25					10

Pelagic 0-group gadoids
Herring   } 50-60 individuals per haul.
Sandeels