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Report of the Planning Group on Aerial and Acoustic Surveys for Mackerel (PGAAM)

23–26 February 2004
Aberdeen, UK

International Council for the Exploration of the Sea

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1 INTRODUCTION

1.1 Terms of Reference

The Planning Group on Aerial and Acoustic Surveys for Mackerel [PGAAM] (Chair E. Shamray, Russia) met in Aberdeen, Scotland UK from 23–26 February 2004. The terms of reference and sections of the report in which the answers are provided, are as follows:

Item	ToR 2004	Section
a)	coordinate the timing and area allocation and methodologies for acoustic and aerial surveys for mackerel in the NEA;	4, 5, 6 & 7
b)	collate and evaluate the data collected by the aerial surveys, fishing- and research vessels in the Norwegian Sea during the summer and autumn of 2003;	5
c)	coordinate acoustic surveys within the North Sea-Shetland area to ensure full coverage and appropriate areas and timing;	6
d)	combine the October-November 2003 survey data of abundance and distribution of mackerel within the North Sea-Shetland area;	6
e)	identify participants to contribute to the aerial surveys for mackerel in the Norwegian Sea and coordinate collaboration between vessels;	5
f)	combine the summer 2003 aerial survey data with vessels data of distribution of mackerel in the Norwegian Sea;	5
g)	seek survey time for northward extension of acoustic surveys in ICES Subareas VIII and IX;	7
h)	consider the latest findings from the SIMFAMI project;	3
i)	identify surveys which are not targeted at mackerel, but which may have potential use for the estimation of mackerel distribution and abundance;	8, 9
j)	develop protocols and criteria to ensure standardisation of all sampling tools and survey gears.	4

1.2 Participants

A complete list of the participants can be found in Annex 1 of this report.

1.3 Background information

Mackerel are widely distributed in the North-East Atlantic. Examination of the time series of commercial mackerel catches taken from 1977–2003 reveal that mackerel is caught from the Iberian Peninsula in southern Europe up to around 73° N in the north. The distribution of catches is likely to vary from year to year due to environmental factors, stock size, and quota limitations for the participating nations. The distribution of commercial catches by quarter that is described in detail annually in the WGMHSA report should therefore be interpreted with caution: for example, some countries cannot fish in the different national EEZs or they have quota limitations. The commercial data are, therefore, indicative only of the wide area where mackerel are caught in the Northeast Atlantic, and the quarterly changes in the distribution of the fishery.

Various research surveys by different countries have verified that there is an even wider distribution of mackerel than that indicated by the commercial fisheries.

The assessment of the NEA mackerel stock complex is currently dependent on a single fishery independent estimate of biomass, derived from the ICES Triennial Mackerel and Horse Mackerel Egg Surveys. This is only available once every three years and makes the assessment increasingly insecure with elapsed time since the last survey. The results from the egg surveys also take a significant time to prepare (almost 1 year). While it is prohibitively expensive to carry out more frequent egg surveys, it may be possible to use other survey methods to provide data in the intermediate years.

At the same time, a number of different surveys have been carried out by a number of countries in recent years. All surveys have the potential to deliver information on the distribution and abundance of mackerel. However, the surveys cover only part of the known distribution area and consequently have not been able to deliver a valid stock estimate or complete distribution map. The aim of this Planning Group is to identify the deficiencies in area and timing of these surveys and to remedy these deficiencies.

The PGAAM met to coordinate vessels from appropriate countries which can collaborate with the Russian aerial surveys in the Norwegian Sea, to coordinate Scottish and Norwegian acoustic surveys in the Viking Bank area, to coordinate Spanish, Portuguese and French acoustic surveys, and to utilize the findings of the EU SIMFAMI project to provide tools to identify mackerel echo-traces.

The main objectives of PGAAM are to provide distributions of mackerel and biomass/number indices that may be used by WGMHSA in future assessments. Furthermore, it aims to collate information on the hydrographic and planktonic conditions of the Norwegian Sea and adjacent waters and to describe how feeding and migration of mackerel are influenced by this.

During the PGAAM meetings it was possible to group surveys (excluding triennial egg survey) as follows:

Geographical Area	Time	ICES area	EEZ	Present Status
Norwegian Sea	June-August	IIa, IIb, Vb, Va	Norwegian, Jan-Mayen, Faroese, Icelandic, International water	Coordinated
North Sea-Shetland area	October-November	IVa,	Norwegian, Great Britain,	Coordinated
Western area	March-May	VIIj, VIIb, VIIc, VIa	Irish, Great Britain	Non-targeting on mackerel but provide all kind of samples
Southern area	February-April	VIII, IXa	Portuguese, Spanish, French	Unknown from 2004
North Sea		IVb, IVc	EU	Expect in future
Irish and Celtic Seas		VIIa,d,e,f,g,h	EU	Expect in future

It will be noted that surveys on atlanto-scandian herring in the Norwegian Sea and on blue whiting west off the British Isles coordinated by the PGSPFN (PGNAPES from 2004) also provide mackerel distributions and biological samples.

Detailed results of the coordinated surveys in 2003 were evaluated at the 2004 PGAAM meeting and are presented in this report. The purpose of the report is to provide a short summary of the surveys and their findings: some results of PGAAM work are subject to further analyses and will be reported to the WGMHSA in September 2004.

2 MACKEREL TARGET STRENGTH

TS of mackerel were measured in Norway recently. The measurements were done at the frequencies 38 kHz and 120 kHz through the target-tracking method, and assuming that the TS of mackerel follows the "20log(L) + B" relation, which means that the dominating backscattering mechanism is proportional to an area. TS could not be measured at 200 kHz with the target-tracking method since the 200 kHz-system was not split-beam. Most fish possess swim-bladder, and for these the TS depends on the square of the length of the swim-bladder within the region the TS is used and measured. Mackerel do not possess a swim bladder. As a result, they are poor reflectors of sound and have low target strength (TS) at 38 kHz. The measurements of backscatter for caged mackerel showed:

$$TS = 20 \log10(\text{Length(in cm)}) - 86.0 \text{ at the acoustic frequency 38kHz.}$$

This TS relation is based on measurements on a freely swimming mackerel of weight 555 g and total length of 34 cm, which give TS = -55.4 ± 0.4 within 95% confidence interval. (See 2nd Annual Progress report of the SIMFAMI project, Contract number Q5RS-2001–02054 in press).

The backscattering mechanisms of mackerel are still not completely understood, although some TS modelling have been done in Norway in cooperation with Poland (presented at the FAST WG in Bergen in 2003 and at the 27th Scandinavian Symposium of Physical Acoustics). According to the intuitive model illustrated in Figure 2.1 below, and to provisional modelling studies, there are indications that for single-sized mackerel, a "jump frequency" exists somewhere between 100 and 200 kHz, where the TS may increase rapidly. The exact frequency will depend on the size of the mackerel, but was not revealed by the modelling studies. The frequency dependency of backscattering from mackerel has been measured at several occasions, but until 2003 none of these could confirm if 200 kHz is at the upper plateau in Figure 2.1. The intuitive model of backscatter from mackerel illustrated in Figure 2.1 below was developed prior to the measurements of backscatter from captured mackerel. During those measurements, however, the only acoustic frequency available above 200 kHz was at 710 kHz, but the calibration of the 710 kHz echo-sounder system was very difficult, the measurements were very noisy, and the measurements were therefore in total not trustworthy. The most recent measurements of the frequency dependency of backscatter from mackerel were done from RV "G. O. Sars" after the modelling work was known. The acoustic frequencies of the echo-sounder systems of RV "G. O. Sars" were requested to cover the frequency range 18–400 kHz and were therefore able to take into account the intuitive model and the provisional modelling results.

Measurements of the relative frequency response, r(f), of mackerel at sea and measurements of r(f) for captured mackerel confirms this (Table 2.1). The backscattering model and the measurements of r(f) in Table 2.1 indicates that a stable TS relation following the "20log(L) + B" relation can probably be calculated at 38 or (even better) at 70 kHz (flesh only(?)) or at 200 and possibly 364 kHz (flesh and bone(?)), while at 120 kHz should be avoided since it seem to be close to the "jump frequency". Backscatter at 18 kHz is too dependent on the size of the mackerel to be usable. Note that the measurements at 364 kHz that were done from RV "G. O. Sars" (3) in October 2003 have a large uncertainty. The calibration showed an asymmetric beam, and since the GPT (i.e., the electronic unit processing the signals) of the EK60 was later proved to operate properly, this is an indication that the wideband (30%) transducer resonant at 400 kHz was not performing optimally together with the 364 kHz GPT. The confirmation that the backscatter of mackerel at 200 kHz is at the upper plateau of the curve in Figure 2.1 is therefore not fully confirmed. There has not been measured TS of mackerel at 200 kHz, so TS at 200 kHz can at best preliminary be said to be approximately 6 dB higher than at 38kHz, i.e., TS=20log(L)-80 at 200kHz.

Modelling and measurements indicate that 200 kHz is a better frequency to integrate on than 38 kHz. However, until a TS relation has been measured at 200kHz directly, and until it has been re-confirmed that 200kHz is of the plateau of Figure 2.1 (e.g., during the Norwegian 2004 mackerel survey), it is still recommended to continue using the traditional TS at 38 kHz, integrating at a threshold of –82 dB. In 2002, PGAAM recommended that the common TS/L relationship, at the agreed integrating frequency (38 kHz) should be:

$$TS = 20 \log10(\text{Length}_{(\text{in cm})}) - 84.9 \text{ (Edwards } \textit{et al}\text{. 1984)}$$

Table 2.1. Measurements of r(f) for increasing average size of Atlantic mackerel.

GROUP	Weight [g]	Length [cm]	Fat [%]	r(18)	r(38)	r(70)	r(120)	r(200)	r(364)
Cage N[2]	255 ± 80	32 ± 2.5	15±7	1.5	1.0	0.8	1.3	4.1	
Surveys[1]	330 ±120	34 ± 5.0		1.4	1.0	1.1	1.1 – 2.0	4.1	3.6
Cage F[2]	385 ± 80	33 ± 2.0	30±5	1.5	1.0	0.8	1.6	4.3	
Cage SFF[2]	665 ± 75	38 ± 2.5	37±3	1.3	1.0	1.0	2.0	4.0	
Total				***1.3±0.4***	***1.0***	***1.0±0.1***	***1.0 – 2.0***	***4.2±1.0***	***3.6±1.4***

[1] Surveys of RV "G. O. Sars" (2) in 99–02, RV "G. O. Sars" (3) in 2003. EK500 99–02, EK60 02–03.
[2]Measured in Austevoll, Norway with Simrad EK500.

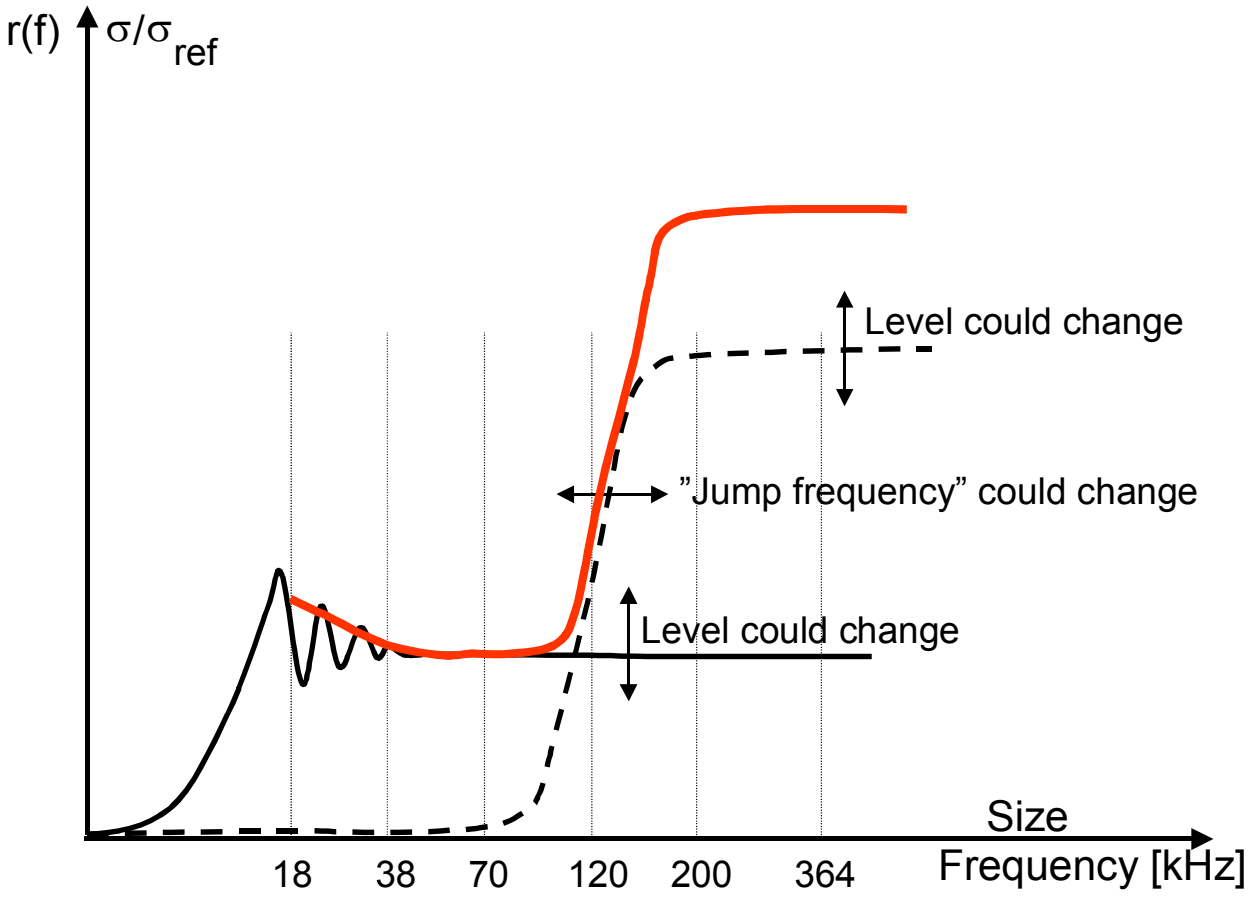

Figure 2.1. Intuitive model of backscatter from mackerel.

3 THE SIMFAMI PROJECT (TOR H)

3.1 SIMFAMI project progress

SIMFAMI (Species Identification Methods from Acoustic Multi-frequency Information) is a three-year project, which started in January 2002, and is funded by the European Commission. The project aims to apply modern multi-frequency acoustic techniques, in addition to the single-frequency methods available previously, to establish methods for acoustic identification of echo traces that are applicable to routine survey procedures. A website for the project has more details (http://simfami.marlab.ac.uk).

The SIMFAMI database is now up and running on an internet based server and forms a library of gound-truthed echograms. A total of 386 echograms have been submitted with 560 images and the associated species composition. The database has undergone various incarnations and is now in what most participants consider to be a very effective useable form. Methods for the collection of acoustic data have been updated with a view to providing useful programs for the community at large (e.g., in the case of noise reduction). The acoustic data are stored at host institutes and are accessible through an ftp site or on request. There have, however, been unforeseen problems with the transfer of data between partners due to the lack of a standard data exchange format for acoustic data (HAC format).

The identification of plankton has proceeded better than expected given the range of frequencies employed. The suite of algorithms developed in the project have produced some encouraging results, which indicate that a number of categories corresponding to many species can be isolated. In this regard the project has gone beyond what was expected: rather than just a filter out separate plankton, it is looking likely that the filter will also classify types of plankton. The algorithms have been incorporated into an extensive computer program which not only utilises a suite of models, but is of a framework that is easily adapted to include more models. The algorithms will be tested in the final year and there an extensive data set of ground-truthed plankton hauls has been built up.

Equally good progress has been made with the identification of fish without swim-bladders (see Sections 3.2 and 3.3 below). A number of algorithm development approaches have been pursued: one incorporating many frequencies as part of a frequency response based algorithm and one based on a triple frequency dB difference algorithm. Both have now been applied to mackerel. Two participants have conducted dedicated research cruises to target mackerel and there is, therefore, a large dataset which is available to verify these algorithms in year three.

It seems as though the frequency dependence of fish with swim-bladders is likely to be too invariant at most frequencies (38–200 kHz) to be able to develop an algorithm for the differentiation amongst these species. Efforts will therefore be concentrated on less common lower frequencies (12–18 kHz) which have shown to be possibly useful for size discrimination. Effort will also be put into analysis of extracted parameters at any one frequency to assist in the identification process.

At each step of algorithm development for a particular species, combinations of algorithms have been considered. In some cases, e.g., mackerel, the algorithms are part of a suite which aims to identify other targets also. In combination with noise and plankton filters, there are good prospects for providing algorithms which encompass many aspects of the identification process.

3.2 IMR mackerel identification algorithm

Korneliussen described the essence of the algorithm used by Norway in a Working Document of the 2003 PGAAM report. The algorithm is illustrated in Figure 3.2.1 below. The main acoustic feature used by the algorithm is the relative frequency response, r(f), defined as $r(f) \equiv s_v(f)/s_v(38\text{kHz})$, where s_v is the overall volume backscattering coefficient; f is the acoustic frequency; $s_v(38\text{kHz})$ is s_v at 38 kHz. The algorithm is supported by modelling illustrated in Figure 3.2.1, and by measurements of r(f) in Table 2.1 through several years, measurement situations and size classes of mackerel. The average r(f) from Table 2.1 are repeated below:

GROUP	r(18)	r(38)	r(70)	r(120)	r(200)	r(364)
Total	1.3±0.4	1.0	1.0±0.1	1.0 – 2.0	4.2±1.0	3.6±1.4

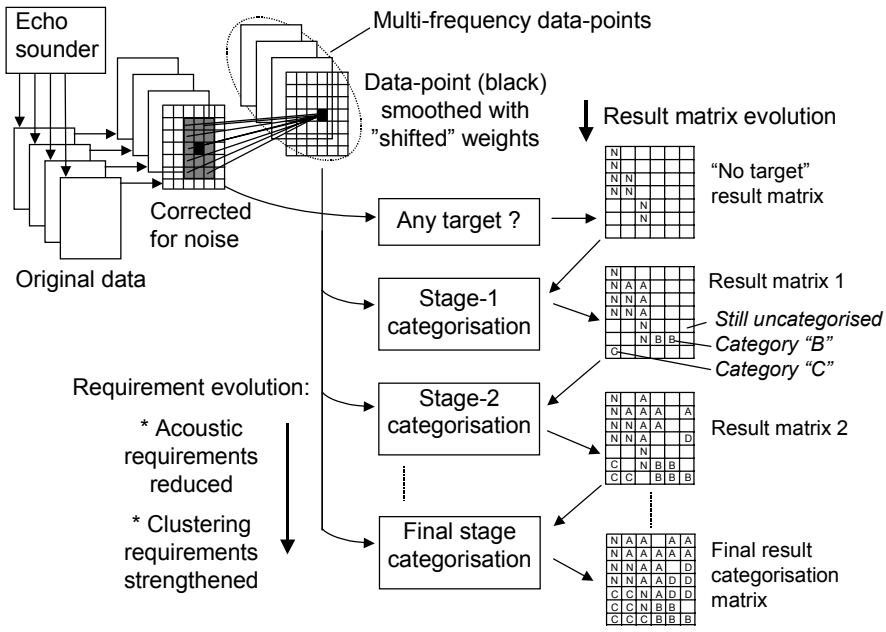

Figure 3.2.1. (From PGAAM report 2003). Data flow through the categorisation system. (See Figure 3.2.2. for detailed data flow through the categorisation system.)

The smoothed multi-frequency data-points are used to discriminate between the target classes. If the default weights are used on data with 0.3 m vertical resolution, the smoothed point is generated from the indicated 15 points with the filter weights reduced from 0.18 in the centre to 0.025 in the corners. In Stage-1 categorisation, strong model-based or

empirical requirements must be fulfilled by a multi-frequency data-point in order to put the corresponding volume segment into one of the specific acoustic target categories. The requirements on the data-point become weaker for each of the categorisation stages that follow but results from the previous categorisation stage are also used as new input.

The implementation of the algorithm applied prior to the 2003 PGAAM report used r{18kHz}: r{38kHz}: r{120kHz}: r{200kHz}= { 1.0: 1.0: 1.0: 1.0 } and 35% uncertainty of r(f) at each frequency as the starting relation of the Stage-1 categorization. (Or alternatively $\Delta r(f)_{f\neq 38kHz}$=50% if Δr(38kHz) is set to 0%). The summarized results of r(f) above show that frequency dependent Δr(f) should be used. Such new frequency dependent Δr(f) are now being implemented and tested at IMR in a 6-frequency identification algorithm.

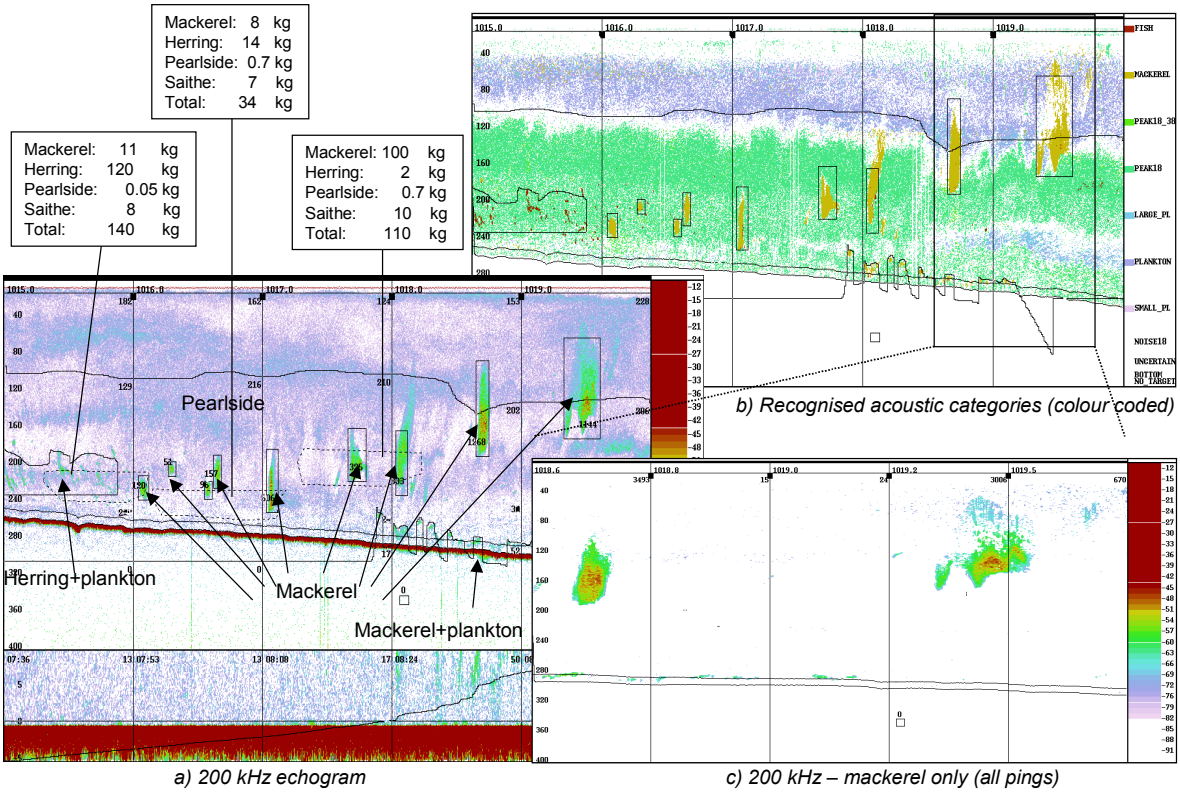

Figure 3.2.2. Acoustic categories identified by the IMR algorithms. Figure (a) shows the noise-corrected 200 kHz echogram and the result of the catches of the multiple open-close trawl system used to catch mackerel. Each bag of the trawl sample is illustrated by polygons. Figure (b) shows all acoustic categories identified by the algorithms used. Figure (c) shows a 200 kHz echogram for all available pings where only mackerel is retained and all other categories re removed.

3.3 FRS mackerel identification algorithm

FRS are in the process of refining their multifrequency algorithm for the identification of mackerel echo traces. Currently this consists of two strands. In the first strand a three-frequency plankton filter using data collected at 38, 120 and 200 kHz is applied. This is then enhanced to obtain an echogram of 'fish school candidates'; these candidates are then examined in strand two to determine whether or not they may be identified as mackerel. The second strand is the mackerel identification algorithm which uses a dB difference between 38 and 200 kHz data (38 minus 200 kHz) on a pixel by pixel basis. The colour coded dB difference echogram (blue for negative values; yellow for zero; red for positive) is then subject to a threshold (currently –6 dB) to extract only negative values. Some image processing is then applied to enhance and smooth the echo traces and to filter out small spurious marks. A positive mask of values greater than threshold is then enhanced and subtracted from the negative values. The final processed image is then used as a mask on the original 38 kHz data to isolate echo-traces as potential candidates for mackerel. The final selection is based on a user operator confirmation of potential mackerel candidates from this mask with the other echograms in synchronized view. A preliminary analysis of the algorithm indicates that it behaves in a similar manner to an experienced operator (see Section 6.1.2).

4 ACOUSTIC SURVEY PROCEDURES (TOR A, J)

Protocols and criteria to ensure standardization of all sampling tools and survey gears.

The acoustic surveys carried out under the auspices of this Planning Group are still under development and many of the tools and protocols are subject to improvements. The planning group feels that this is, therefore, not the appropriate time for the setting of standards. This is particularly the case for methods of echogram scrutiny and pre-processing of the acoustic data. Survey designs are planned following the paradigm of herring acoustic in the North Sea, but with modifications for the specific circumstances in particular areas and seasons. Until protocols, specifically for mackerel acoustic surveys are fully researched and validated, cruise leaders are advised to use the general rules set out in the "Manual for herring acoustic surveys in ICES divisions III, IV and VIa" (Annex I of the 2003 PGAAM report (Anon. 2003c)). Where the procedures for mackerel surveys deviate significantly the text includes areas in **bold and underline** giving advice in these cases.

The group advised all PGAAM participants to examine this document over the coming year with a view to updating its contents at the next meeting. This manual and modifications are intended for use in new or existing acoustic surveys specifically targeted on mackerel, and carried out under the auspices of this Planning Group. For other surveys, where mackerel is a secondary objective, the manual and modifications should be regarded as advisory only. The manual is attached as Annex I in the 2003 PGAAM report.

5 SURVEYS IN THE NORWEGIAN SEA (TOR A, B, E, F)

5.1 Surveys in 2003

5.1.1 Russian aerial survey

Russian aerial surveys in the Norwegian Sea in the summer 2003 were carried out according to plans discussed at the 2003 PGAAM meeting.

As in previous years aerial surveys carried out onboard the research aircraft Antonov-26 (An-26) "Arktika" using remote sensing equipment (Anon. 2002, 2003a; Zabavnikov *et al.* 1997). In summer 2003 airborne research surveys were carried out from 12 July – 2 August in the Norwegian Sea (Figure 5.1.1.1). During this time more than 10 flights were conducted.

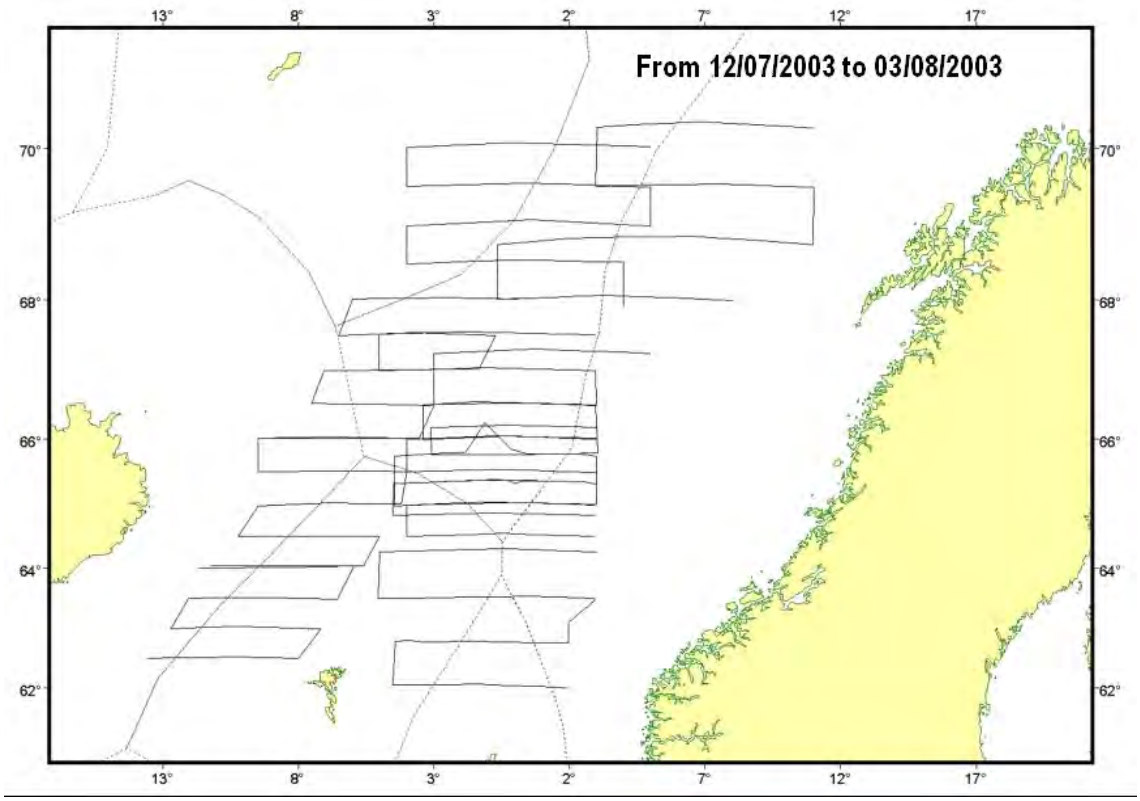

Figure 5.1.1.1. Flights tracks of Russian research aircraft “Arktika” in summer 2003.

In 2003 airborne research were continued with up grated hardware and software of Russian polarizable aviation LIDAR (PAL-1). This research allowed for the development of LIDAR methods to study mackerel. As a result, in 2003 the identification and interpretation of mackerel schools was made more efficient, and reliable, culminating in improved "Lidarograms", which include visualization and post-processing, and in the near real time (Figure 5.1.1.2). This technology requires further development and improvement.

During the airborne surveys of summer 2003, 96 pelagic fish schools, interpreted as mackerel, were detected using LIDAR A map of mackerel distribution, based on LIDAR data and visual observations is presented on Figure 5.1.1.3.

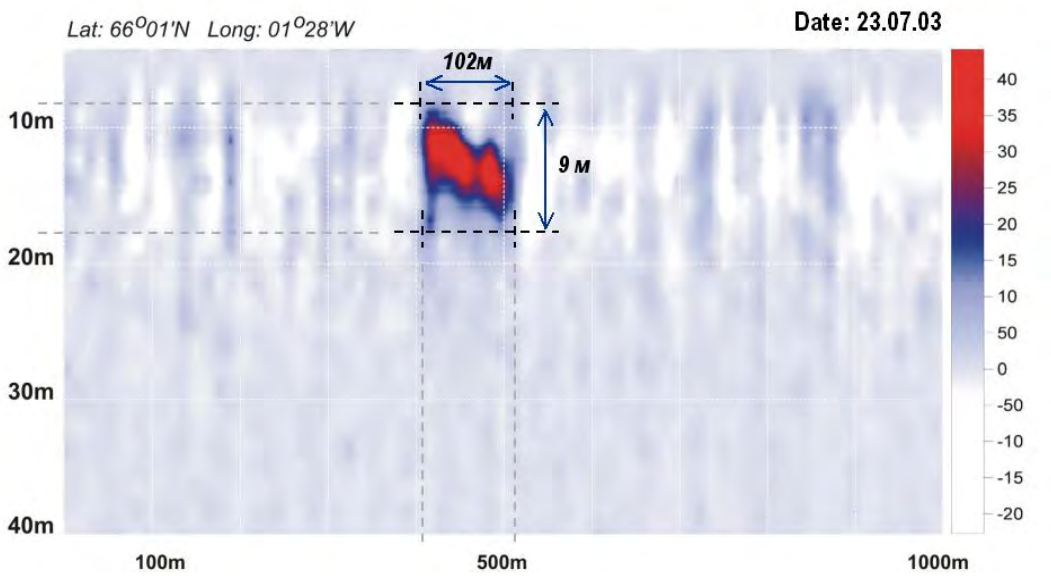

Figure 5.1.1.2. Example of "Lidarograms" made by Russian research aircraft "Arktika".

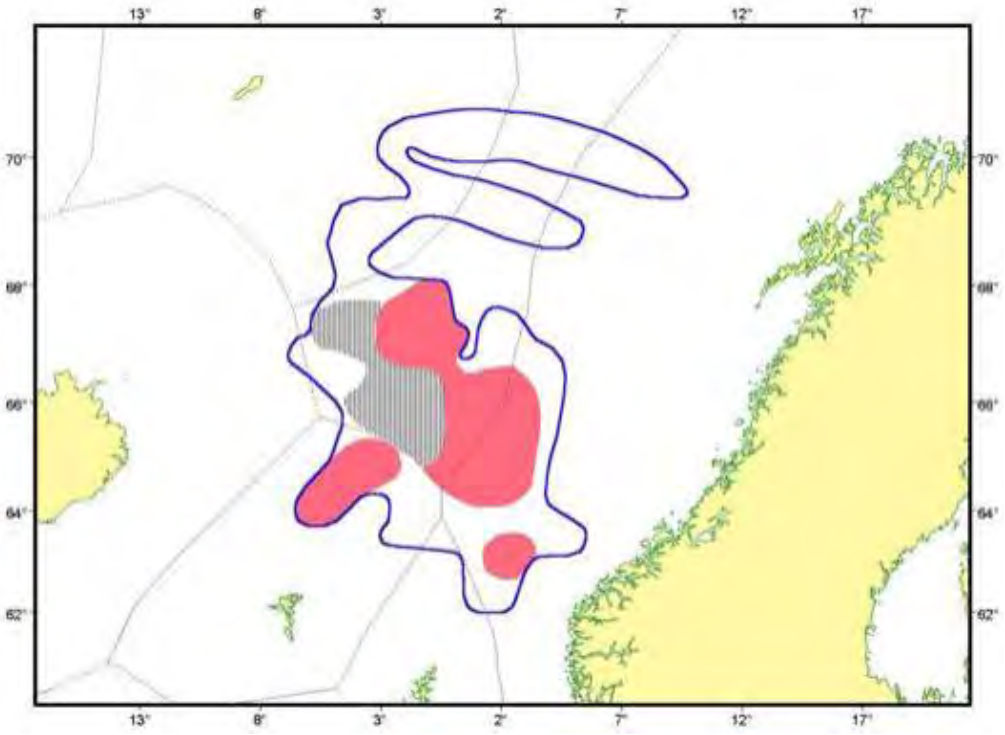

Figure 5.1.1.3. Distribution of mackerel carried out by Russian research aircraft "Arktika" (gray – blue whiting).

The results of airborne research have indicated that most feeding mackerel schools were detected in the southern part of the aerial survey area (Northern area of Faroese EEZ, South-West area of Norwegian EEZ); on the border between the Norwegian EEZ and International Water between 64°–67°N; and close to the Greenwich meridian between 66°-68°N. This results correlate well with data from the Norwegian and Russian trawl surveys in July 2003.Many pelagic fish schools were also detected in the South-West part of International waters, where vessel trawls discovered blue whiting schools.

A scientist from Icelandic Institute of Marine Research participated in the aerial surveys of the Eastern part of Icelandic EEZ to study feeding mackerel migration.

Joint research exercises were conducted between "Arktika", and the Russian RV "Smolensk" and Norwegian FV "Kings Bay". These exercises were carried out in the same positions or part thereof as 3 or more aircraft flights over the vessels tracks.

Joint research exercises were carried out by "Arktika" - RV "Smolensk" and "Arktika" - FV "Kings Bay" in July 16 and 23 respectively (Figure 5.1.1.4.). A good correlation between aircraft remote sensing data and vessels (in situ) data was obtained comparing of oceanographic data (SST, depth of picnocline, transparency and sub-surface plankton concentration) and mackerel schools.

As part of the research described above new data on the distribution of feeding mackerel and migration patterns, was obtained, including LIDAR data.

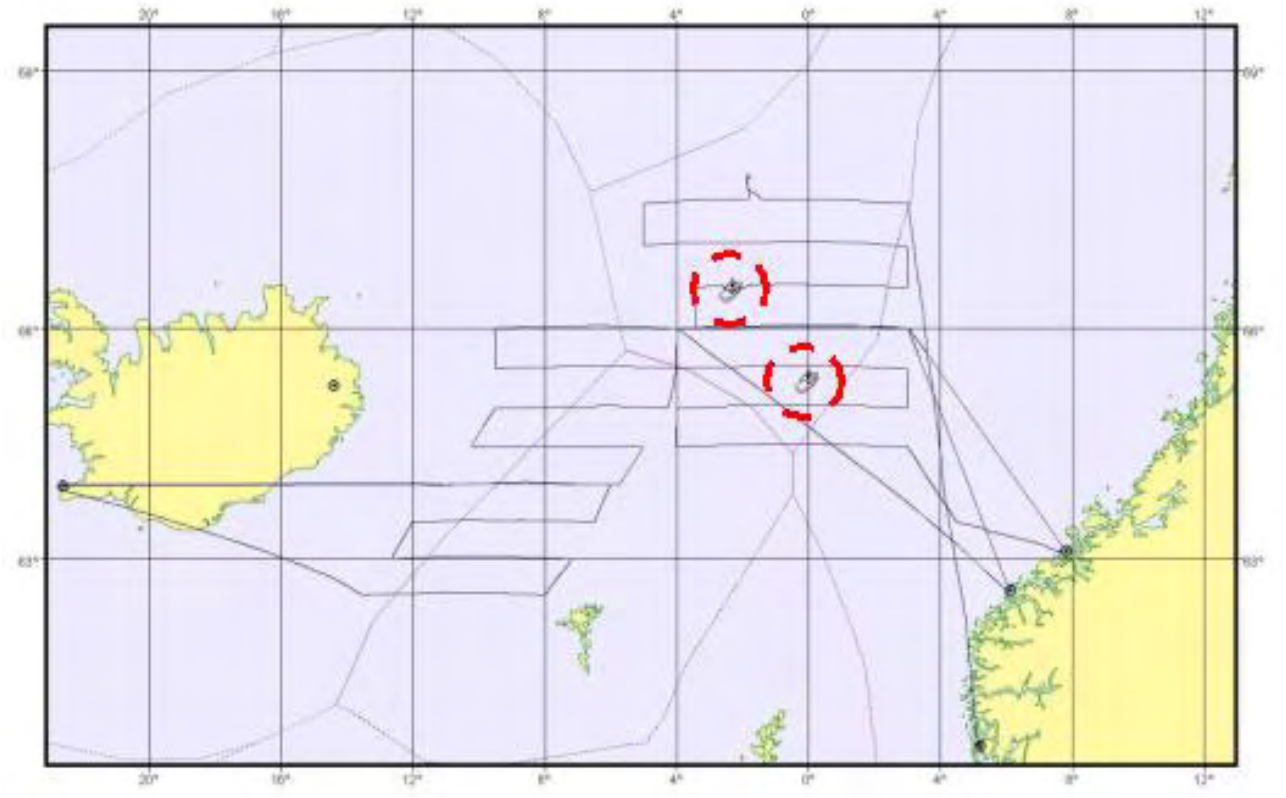

Figure 5.1.1.4. Intercalibrations between Russian aircraft and Russian RV "Smolensk" and Norwegian FV "Kings Bay" in July 2003.

5.1.2 Russian trawl-acoustic survey

The Russian trawl-acoustic survey in the open part of Norwegian Sea took place from 8 – 17 June 2003 with the RV "Smolensk". Approximately 38200 n.mi^2 were covered. Echo integration was carried out using a Simrad EK500 scientific echo-sounder with 38 kHz (split beam). Data collection and post-processing was done by means of FAMAS program, which is functionally similar to post- processing software BI500. Survey tracks, trawl and hydrographic stations are shown on Figure 5.1.2.1. Trawl stations carried out by RV "Smolensk" included 30-minutes tow duration with pelagic trawl with opening 50 x 50 meters.

In June, mackerel stock distribution was governed by hydrological conditions in the region (Figure 5.1.2.2). Small schools were found at depths 10 to 25 m in Eastern and South-Eastern part of the research area. Temperature of the water in above areas was higher than 9°C. In the Western part of the research area, where isothermal line of 9°C was very close to the surface, echograms from echo-sounder, showed no or very small number of mackerel schools. Measured Nautical Area Scattering Coefficients (S_A) for 5 mile intervals varied from 1 to 30 (m^2/nmi^2). Maximal mackerel schools were registered in position 65°45'N, 4°W. Low NASCs resulted from the fact that most of the fish avoided the vessel. Therefore, acoustic estimation of mackerel was not calculated.

The trawl method was used for estimating the biomass and distribution of mackerel schools. During the survey, the vessel made a total of 31 trawl hauls. Mean length of fish and mean weight of mackerel were 36.06 cm, 526 g accordingly. A preliminary result gave a biomass estimate of 720 000 tones.

During the survey, the RV "Smolensk" worked in conjunction with the research aircraft under the joint program (see above).

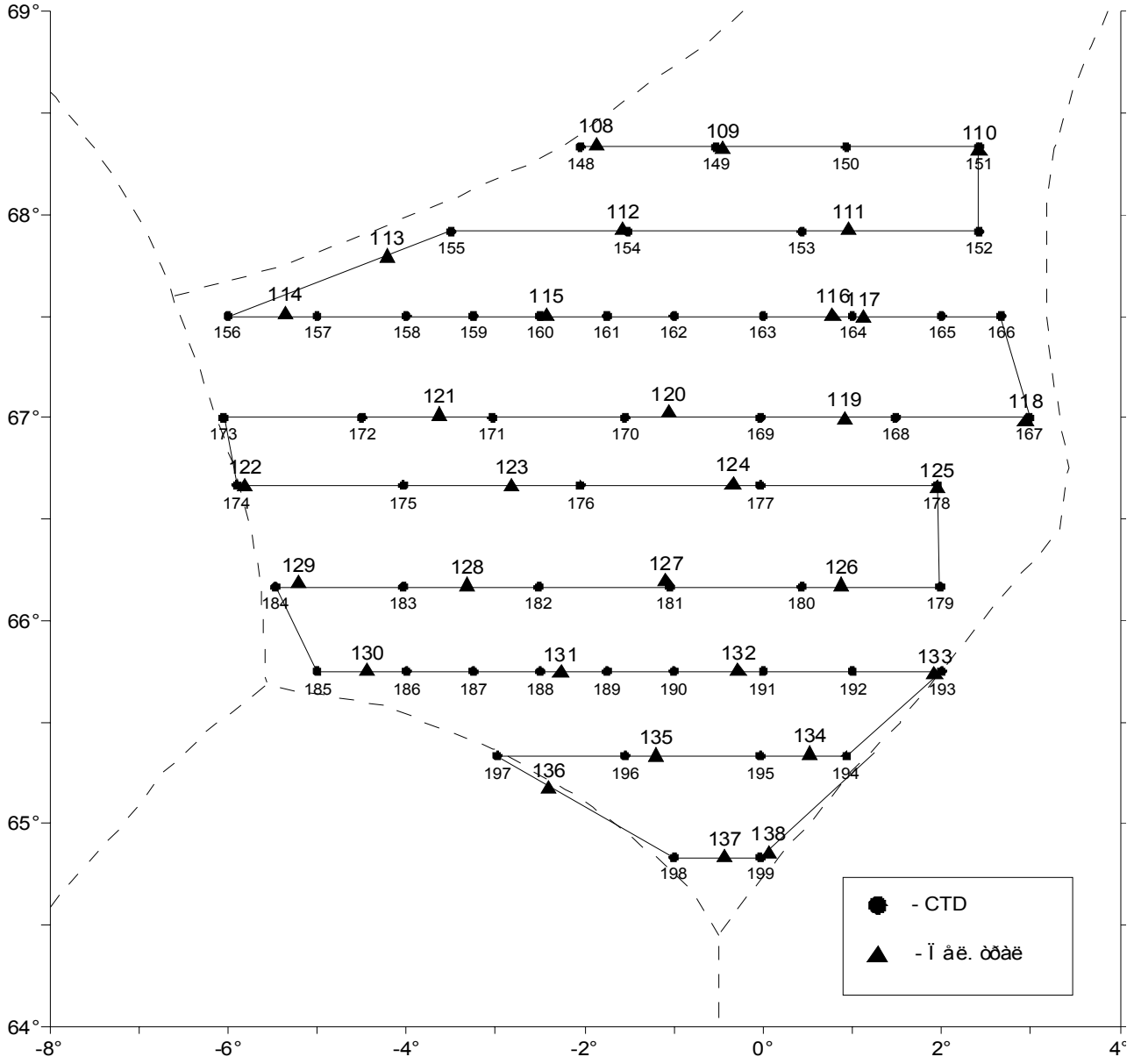

Figure 5.1.2.1. Survey tracks, trawl and hydrographic stations RV "Smolensk".

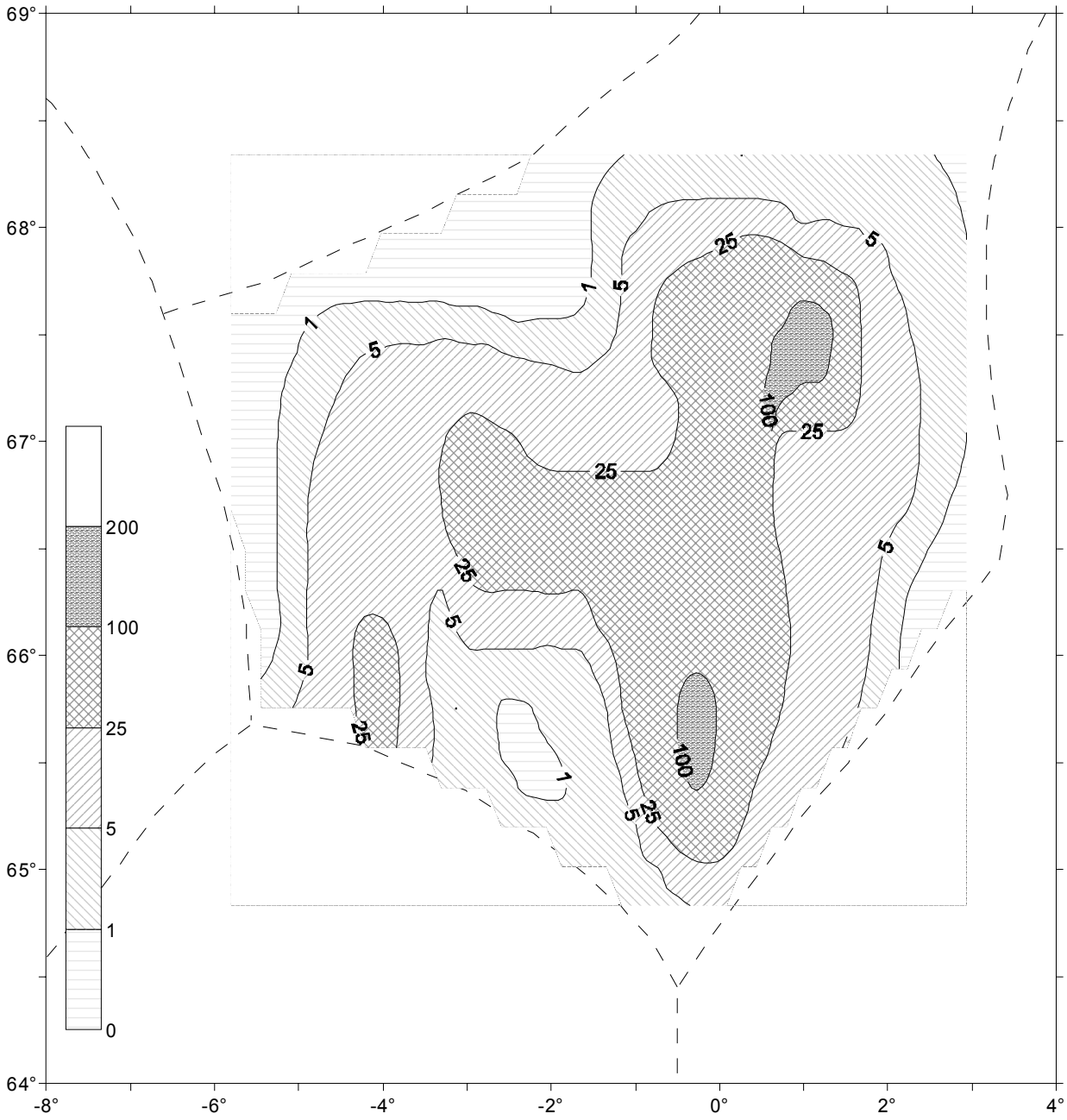

Figure 5.1.2.2. Distribution of mackerel as a result of a trawl survey by RV "Smolensk" (t/n.mi^2).

5.1.3 Norwegian trawl survey

During 15–30 July two Norwegian commercial purse seiners, "Endre Dyrøy" and "Kings Bay" carried out a trawl survey at prefixed stations. "Endre Dyrøy" started in the south and worked northwards while "Kings Bay" started in the north and worked southwards. Both vessels trawled the surface layer (the upper 40 m) at each station for 30 minutes. The distributions of catches are given in Figure 5.1.3.1. The largest catches were taken in the southern area, while the catch rates in the international zone were relatively low. The largest mackerel were caught in the Jan Mayen area.

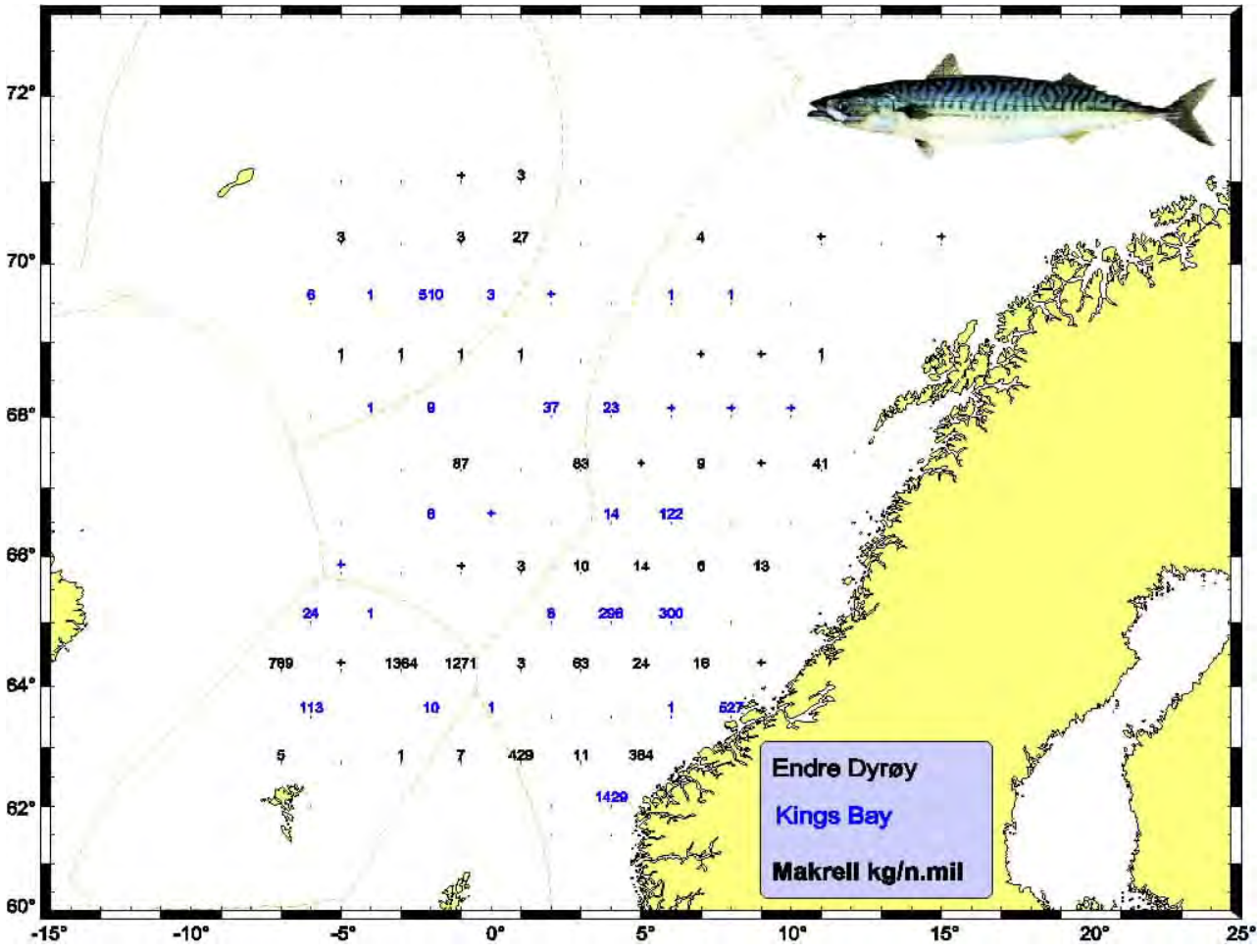

Figure 5.1.3.1. Distribution of mackerel catches given as kg/nautical mile, obtained by "Endre Dyrøy" and "Kings Bay".

5.2 Aerial survey in 2004

Russia plans to carry out surveys of feeding mackerel onboard the research aircraft An-26 "Arktika" and research vessels of in the Norwegian Sea as in previous years during July-August 2004 (Figure 5.2.1.a). Russia plans to cover the same area as in 2003 with about 120 flight hours during the period late June – early August. The main part of research flights will be carried out in International waters and nearby areas of different national EEZ. However airborne research period and area may be altered depending on development of oceanographic, meteorological and hydrobiological processes in the Norwegian Sea and closest area of the North Atlantic.

Norway will also perform aerial surveys in 2004 with a new LIDAR. This will be done in cooperation with the Russian survey and two Norwegian fishing vessels. The fishing vessels will work the gridlines as given in Figure 5.2.1 during 15–30 July. The aeroplane with the LIDAR will cover the same gridlines during 8–10 days when the two vessels are working in the area. The vessels will trawl in the surface layer as indicated in Figure 5.2.1.b

Detailed plans for the joint airborne remote sensing and vessels surveys between Russia and Norway will be exchanged by correspondence and agreed before July. The Russian and Norwegian contact persons for the joint research will be Vladimir Zabavnikov (ltei@pinro.ru copy inter@pinro.ru) and Eirik Tenningen (eirik.tenningen@imr.no) respectively. The Russian aerial surveys will, if possible, be assisted by a Faroese commercial vessel working in the EEZ the last week of July or first week of August. Aspects and possibilities of this cooperation will be agreed by correspondence in spring 2004. The Faroese contact person is Jan Arge Jacobsen (janarge@frs.fo).

The Russian aerial surveys in the end of July – beginning of August 2003 will probably also co-operate with Icelandic Marine Research Institute on pelagic fish stock distribution and abundance in the western area.

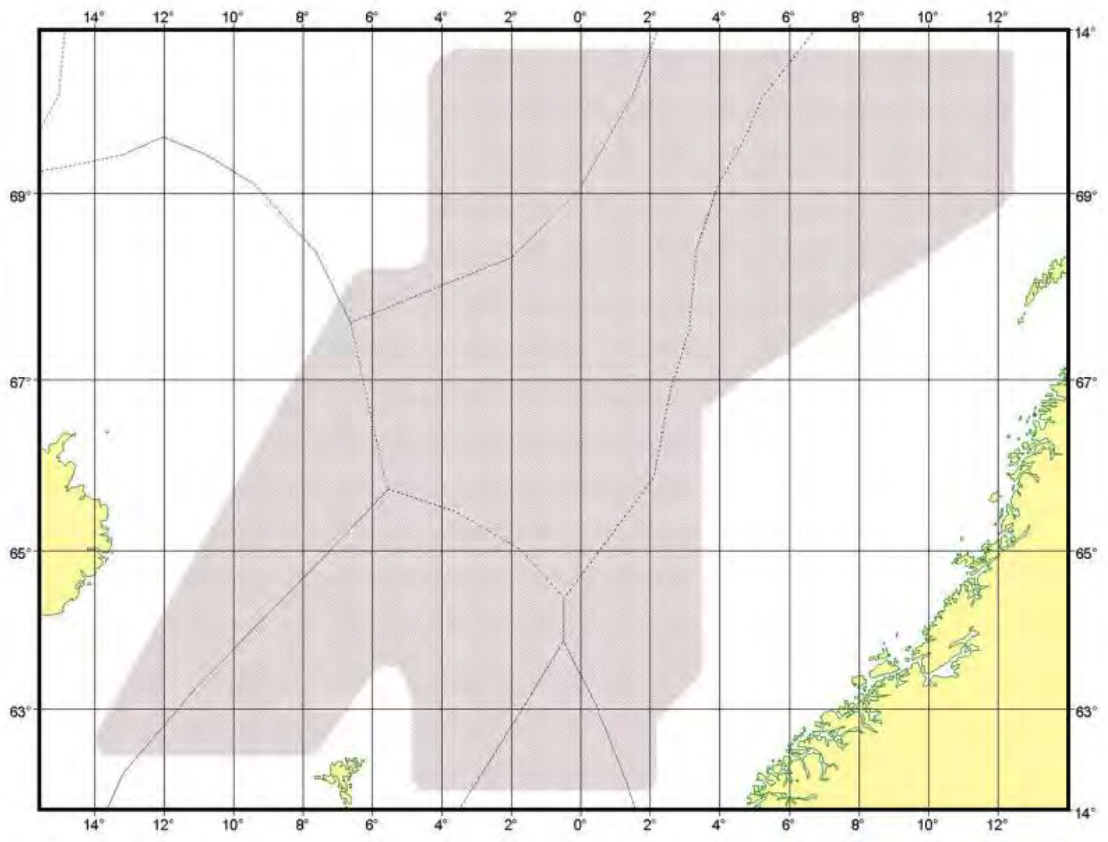

Figure 5.2.1.a**.** The planned survey area for the Russian aircraft and trawl survey 15–30 July 2004.

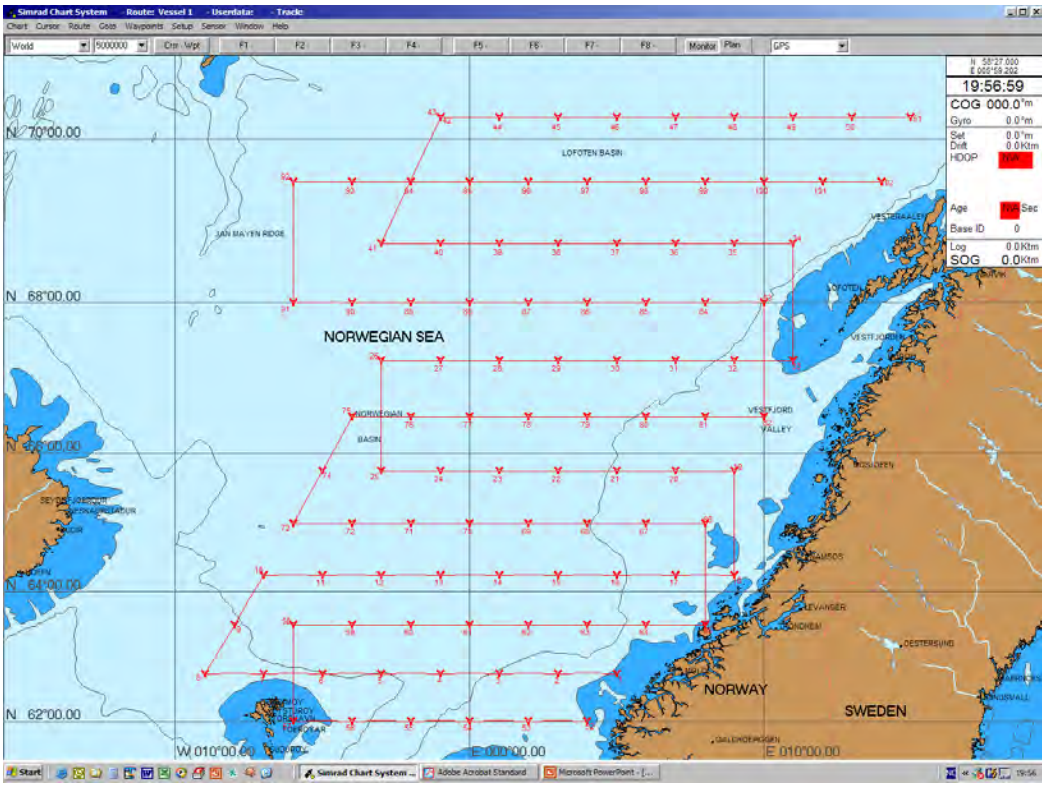

Figure 5.2.1.b. The planned survey grid for the Norwegian LIDAR and trawl survey 15–30 July 2004.

6 ACOUSTIC SURVEYS IN THE NORTH SEA - SHETLAND AREA (TOR A, C, D, E)

6.1 Acoustic surveys for mackerel in autumn 2003

6.1.1 Norwegian survey

The Norwegian acoustic survey in the North Sea took place from 16 October to 6 November with the new RV "G. O. Sars". The area covered and the cruise track is shown in Figure 6.1.1. In the first part of the survey, the cruise track was interlaced with that of Scottish RV "Scotia" (2°–4°E and 59°30'N – 61°30'N). This was followed by an intercalibration along one of the cruise lines. The remaining parts of the survey covered a somewhat larger area, from the western parts of the Norwegian trench to 2°W and from 59°30'N – 61°50'N, also covering the first part a second time.

The overall design of the survey was similar to that in previous years (1996, 1997, 1999, 2000, 2001, and 2002). Although the new vessel should be capable of trawling at 5 – 6 knots, we had to trawl at less than 4 knots due to poor quality of the trawls. Therefore the mackerel might not be representatively caught and the mean length obtained from the samples of the mackerel might be an underestimate.

The identification of mackerel was largely based on the frequency response and the target strength used was 20logL - 84.9. The first coverage resulted in a biomass estimate of 224 000 tonnes and the second in an estimate of 583 000 tonnes. The two coverages gave a combined estimate of 581 000 tonnes. The biomass estimates, the mean length, and mean weight are shown in Table 6.1.1. The registrations are outlined in Figure 6.1.1. Most of the mackerel was found from the western part of the Norwegian trench and 30 – 50 nautical miles further to the west. The mackerel was found at greater depths this year than in previous years.

Table 6.1.1. Mackerel mean length, mean weight, and estimated biomass.

Coverage No	Mean length [cm]	Mean weight [g]	Estimated biomass (10^3 tonnes)
1	33.0	296	224
2	33.0	296	583
Combined	33.0	296	581

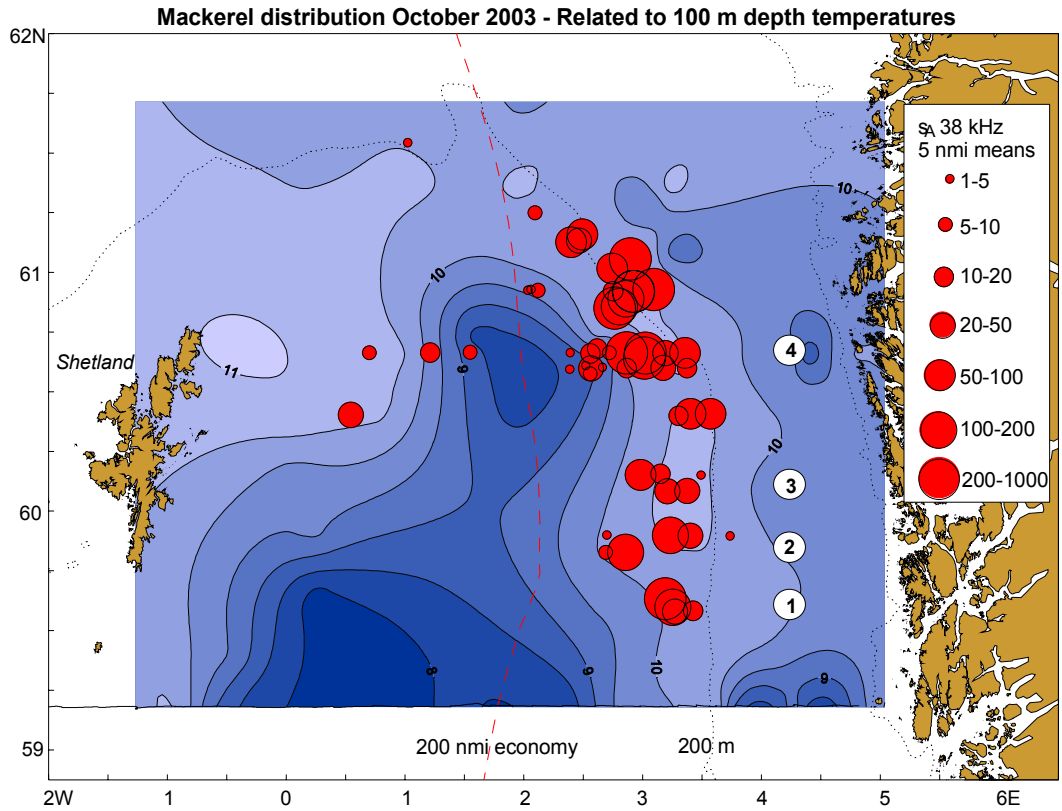

Figure 6.1.1. Grid lines and registrations of mackerel in the Norwegian survey with RV "G. O. Sars" related to the temperature distribution at 100m.

6.1.2 Scottish survey

The survey
The vessel left Aberdeen on 4 October and proceeded to Scapa Flow where calibration of the four transducers was carried out. Passage was then made through areas thought to contain mackerel (close to the 200 m contour) to confirm the location of high intensity strata for the survey. The first fishing trawl was carried out during this prospective passage route on 6 October. The survey commenced on 7 October at 02:15 at approximately 61°48'N 001°54'E. Transects progressed southward along lines of latitude, at spacings of 15 or 7.5 nautical miles (n.mi.) as planned; although transect design was altered slightly due to delays from gale force winds. The vessel docked into Lerwick harbour on 12 October for 24 hours to enable a change of personnel and to give staff their rest day in line with working time directives. The survey resumed at 06:05 on 13 October. On 17 October the vessel headed back into Lerwick to pick up a pump for the third engine to enable fishing with the larger (PT170) net. The opportunity was taken to carry out a second calibration of all four frequencies in Sandwick Bay. On 18 October, the vessel rendezvoused with the Norwegian RV *"G. O. Sars"* as planned and the two ships carried out an interlaced survey in the area close to the 200 m contour: transect spacing for each vessel was 15 n.mi. giving a combined spacing of 7.5 n.mi. At the end of this, the two vessels undertook an intercalibration exercise starting at 18:20 on 20 October. This lasted for approximately 3 hours (30 n.mi.) with each vessel taking the lead alternatively on two occasions. The intercalibration was completed at 21:40 and the vessels then broke off to continue their respective surveys. RV "Scotia" completed its survey shortly afterwards at 23:25 on 20 October. The vessel returned to Aberdeen on the morning of 22 October.

Results
The survey was completed and, despite encountering some poor weather, only a small amount of time was lost due to weather. The total mileage surveyed was approximately 2450 n.mi. A total of approximately 70 GB of acoustic data was archived and copied to DVD; this corresponds to 981 acoustic log intervals of 15 minutes duration. Calibrations were carried out of the four acoustic frequencies (18, 38, 120 and 200 kHz): calibration accuracy of the principal integration frequency (38 kHz) was within 0.05 dB (ICES recommends accuracy to be within 0.5 dB). Echo traces from mackerel were distinguished on the basis of the difference in acoustic return between the 38 and 200 kHz frequencies, using the latest version of the FRS mackerel identification algorithm, which was displayed in real time (assisting the direction of ground truth trawl hauls).

As expected, most of the mackerel were detected close to the border between EU and Norwegian waters, towards the east of the survey area around Viking Bank. Ground truth identification of the mackerel echo traces proved far more successful than in the previous (2002) survey: both the PT170 and PT160 (with the larger doors) were able to catch large quantities of mackerel. Of the 19 trawl hauls carried out, mackerel were caught in 15, giving a raised total of 16 569 kg. On two occasions, echo traces thought to be mackerel were fished on with rod and line for comparative purposes – these were logged as separate biological samples. 4732 mackerel were measured for length and 797 mackerel were sampled for weight, sex, maturity and otoliths. The length distribution and age length key are given in Figure 6.1.2.2 and Table 6.1.2.1 respectively. The age length key reflects the current perception of the stock's age structure, with a strong 1999 year class and a weak 2000 year class.

Other fish caught include herring (3816 lengths measured from a raised total of 17 246 kg), saithe (118 lengths), haddock (31 lengths), silversides and a variety of small gadoids. No cod were caught. Some hydrographic data were obtained from the deployment of a CTD unit: a total of 12 casts were taken. Overall, the survey proved very satisfactory. Considerable numbers of large mackerel schools were detected, and most of these were successfully ground truthed with pelagic trawls. The mackerel were contained within the survey area. The interlaced survey and intercalibration with the "G. O. Sars" was carried out successfully.

Survey estimates
Acoustic data were averaged in 15 minute equivalent distance sampling units (EDSUs) which, at a survey speed of 10 knots, represented 2.5 n.mi. per EDSU (Figure 6.1.2.3). The data were then analysed according to standard acoustic survey procedures using the Marine Laboratory Integrator Analysis Package (MILAP). This software uses a rectangular grid based averaging method incorporating all trawl data for lengths and age to produce an abundance estimate in number and biomass by age.

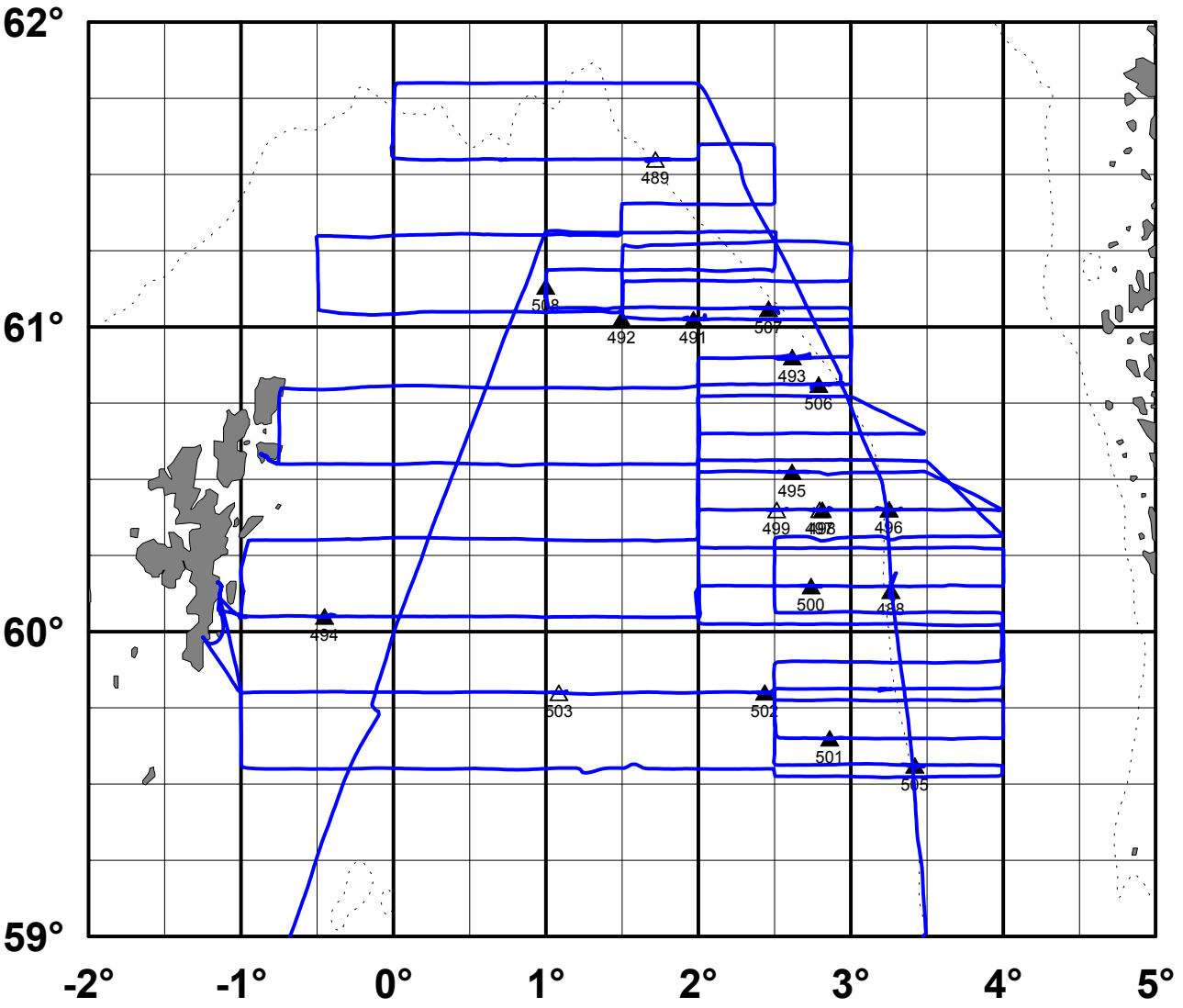

Figure 6.1.2.1. Cruise track of RV "Scotia's" October 2003 mackerel acoustic survey. Triangles indicate positions of trawls (catches of mackerel are filled triangles; catches with no mackerel are open triangles; labels are trawl number).

At the PGAAM meeting four options for analysing the survey were presented to the group based on the identification process. All options used some form of multifrequency identification process based on implementation of the FRS mackerel identification algorithm (see Section 3.2). The four options were as follows:

1) Original. In this case, the identification was based on last year's algorithm which was mostly down to user based confirmation of potential mackerel schools. Some editing of school boundaries was carried out.
2) Schools. In this case the 10 largest values obtained from the original analysis (above) were re-scrutinised. The manual editing of school boundaries was removed. All parts of any school that were shown to contain significant quantities of mackerel according to the algorithm were then taken as mackerel. Any schools that had a mixture of signals (indicating the presence of herring for example) would, therefore, be taken purely as mackerel if the most prevalent signal (in school area) was mackerel.
3) Manual. In this case the 10 largest values obtained from the original analysis (above) were re-scrutinised by members of the PGAAM group. School boundaries were redrawn and in the case of mixed schools – all of those areas thought to contain herring, for example, were taken out. The definition was based on examination of dB differences (all mainly positive areas removed).
4) Auto. In this case the 10 largest values obtained from the original analysis (above) were subject to the current FRS mackerel identification algorithm. This differs from last year (and therefore the 'original' analysis above) in two main respects: 1) a threshold of –6 dB is used to distinguish mackerel (< –6 dB difference at 38–200 kHz) – this is

based on the findings of the SIMFAMI project; and 2) that a positive mask of smoothed target areas greater than –6 dB is applied to remove areas which may contain herring for example.

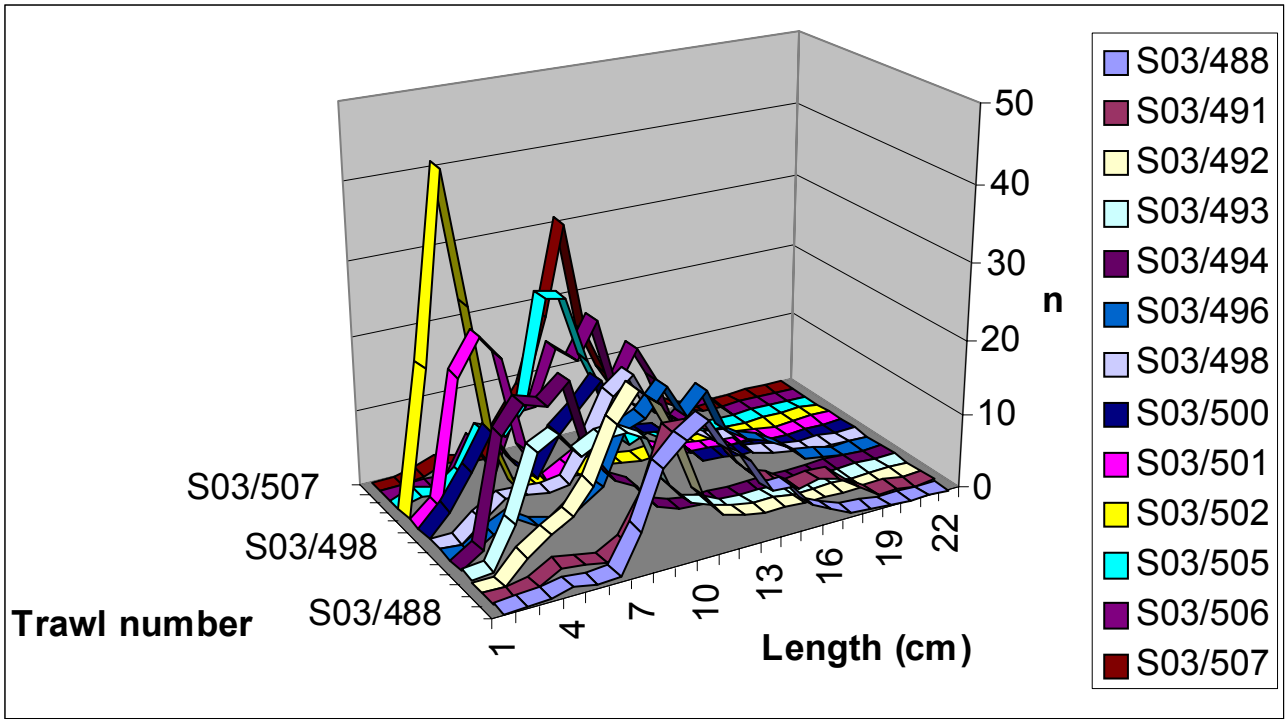

Figure 6.1.2.2. Length distributions of mackerel caught during the Scottish acoustic survey October 2003.

Table 6.1.2.1. Age length key for mackerel from trawl samples taken during the Scottish acoustic survey in October 2003.

Length (cm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grand Total
25	2																2
26	25																25
27	46																46
28	57	2															59
29	54	4															58
30	31	18															49
31	7	44	5	3	1												60
32		39	7	10	4												60
33	1	33	7	21	2	1											65
34		24	12	20	4	2	1	1									64
35		12	11	19	11	4	1	1									59
36		4	5	20	11	6	2	2									50
37			1	13	19	9	6			1							49
38			1	11	6	9	4	7	2								40
39				1	6	6	6	7	4	4	1	1					36
40			1	1	3	6	2	4	4	5	1	1	1	1			30
41						1	3	5	2	3	4	4		1	1		24
42								3	2	1	3	4		1			14
43										1		2			1		4
44										1						1	2
46														1			1
Grand Total	223	180	50	119	67	44	25	30	14	16	9	12	1	4	2	1	797

An assessment of biomass was carried out for all four options for the whole Scottish survey, albeit only considering the largest 10 EDSU values for options 2–4. The NASCs from these 10 EDSUs accounted for 70% of the total NASC for the survey.

The target strength to length relationship used was that recommended by the planning group: TS = 20log10L-84.9 dB per individual. The mackerel data from the trawl hauls were used to divide the area into three strata based on length distributions and geographic criteria. The three regions were: a large group in deeper water to the east of the region (mean length 35.5 cm); a smaller group in inshore and south-central waters (mean length 29.9 cm); and a medium sized group in northern inshore areas (mean length 32.6 cm).

The different EDSU NASCs derived from the four options are given in Figure 6.1.2.2. The survey estimates were as follows:

		Biomass (t)	Numbers (millions)
1	original	1,501,000	3,808
2	schools	1,803,000	4,606
3	manual	1,159,000	2,917
4	auto	1,084,000	2,745

The trends depicted here were expected. The 'schools' option (2) assumes that each school that is detected with a significant proportion of mackerel is composed entirely of mackerel. This option, therefore, assumes that there were no herring in the school and so when herring were present, the NASC was larger than for option (1). In all cases, the NASC for option (2) was approximately equal to or greater than option (1) and the biomass estimate was 20% larger. Clearly option (2) is not viable: it was conducted to illustrate the danger of allocating mixed schools to mackerel when they might contain herring and hence overestimate the biomass of mackerel. The somewhat surprising but altogether pleasing result is that options (3) and (4) were very similar. This indicates that the current version of the algorithm ('auto' option 4) performs in a similar way to an experienced operator (manual option 3). If anything, the 'auto' algorithm was more conservative than the manual option. It remains to be seen of course if full implementation of the algorithm for the whole survey would give similar results: this will be tested in due course. Both options (3) and (4) rendered smaller abundances than the original option (1). This was because option (1) was a preliminary estimate and the scrutiny was carried out prior to appreciation of the extent to which mackerel and herring occur within the same echo trace. The next step is to run a full implementation of the auto option (3) by applying the algorithm to the whole survey. This will be prepared in advance of the mackerel assessment working group.

For the purposes of this report the best estimate of mackerel in the area is option 4. The detailed results, including an age breakdown are given Table 6.1.2.2. The distribution of NASC values is given in Figure 6.1.2.4.

Table 6.1.2.2. Final results of the Scottish survey October 2003. Numbers are in millions of fish, length in cm, weight in g and biomass in thousands of tonnes.

Age	Number	Mean length	Mean weight	Biomass
1	713.22	28.26	239.84	171.06
2	886.71	32.38	377.66	334.88
3	233.69	33.76	434.32	101.50
4	467.05	34.31	459.48	214.58
5	186.29	35.32	507.22	94.49
6	96.47	36.59	569.86	54.97
7	45.55	37.66	626.23	28.53
8	46.38	37.92	645.49	29.94
9	20.62	39.41	726.62	14.99
10	18.10	39.68	745.23	13.49
11	10.38	40.72	809.69	8.41
12	12.31	40.97	827.37	10.19
13	1.53	40.00	761.18	1.17
14	4.08	41.32	854.92	3.49
15	1.71	41.39	855.13	1.46
16	0.77	44.00	1049.16	0.81
Total	**2,744.84**	**32.48**	**394.90**	**1,083.94**

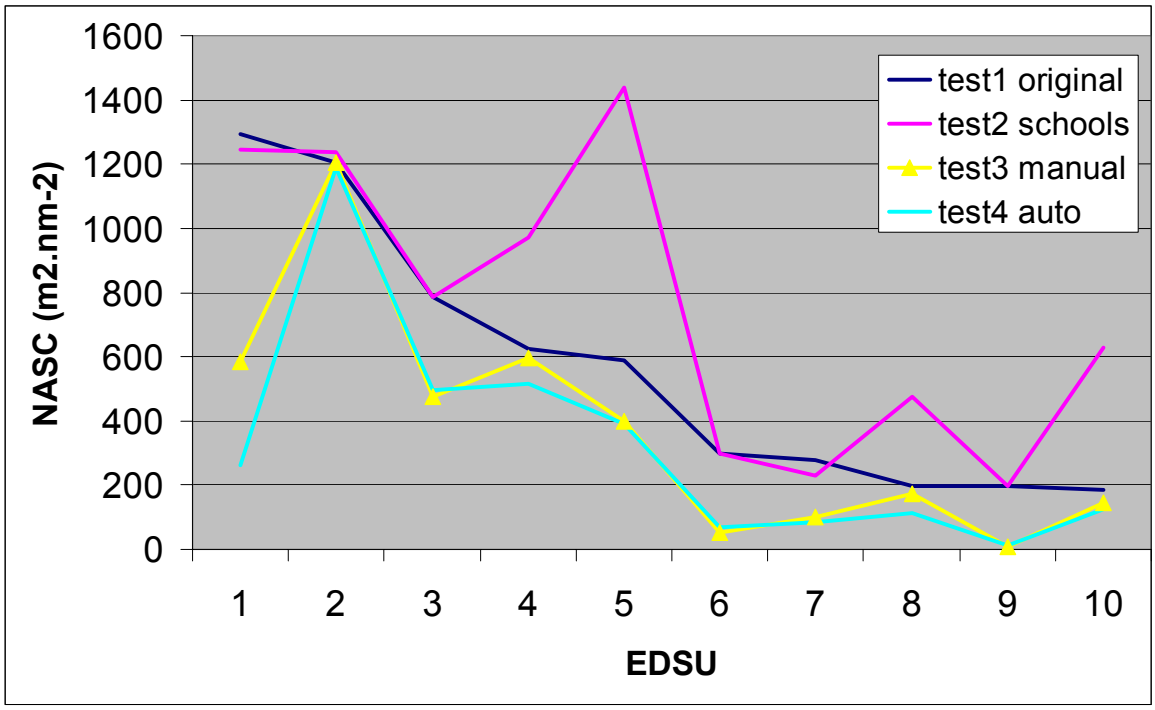

Figure 6.1.2.3. Plots of the Nautical Area Scattering Coefficients (NASCs) obtained using the four scrutiny options described in the text for the 10 Equivalent Distance Sampling Units (EDSUs) with the largest NASC values in the survey.

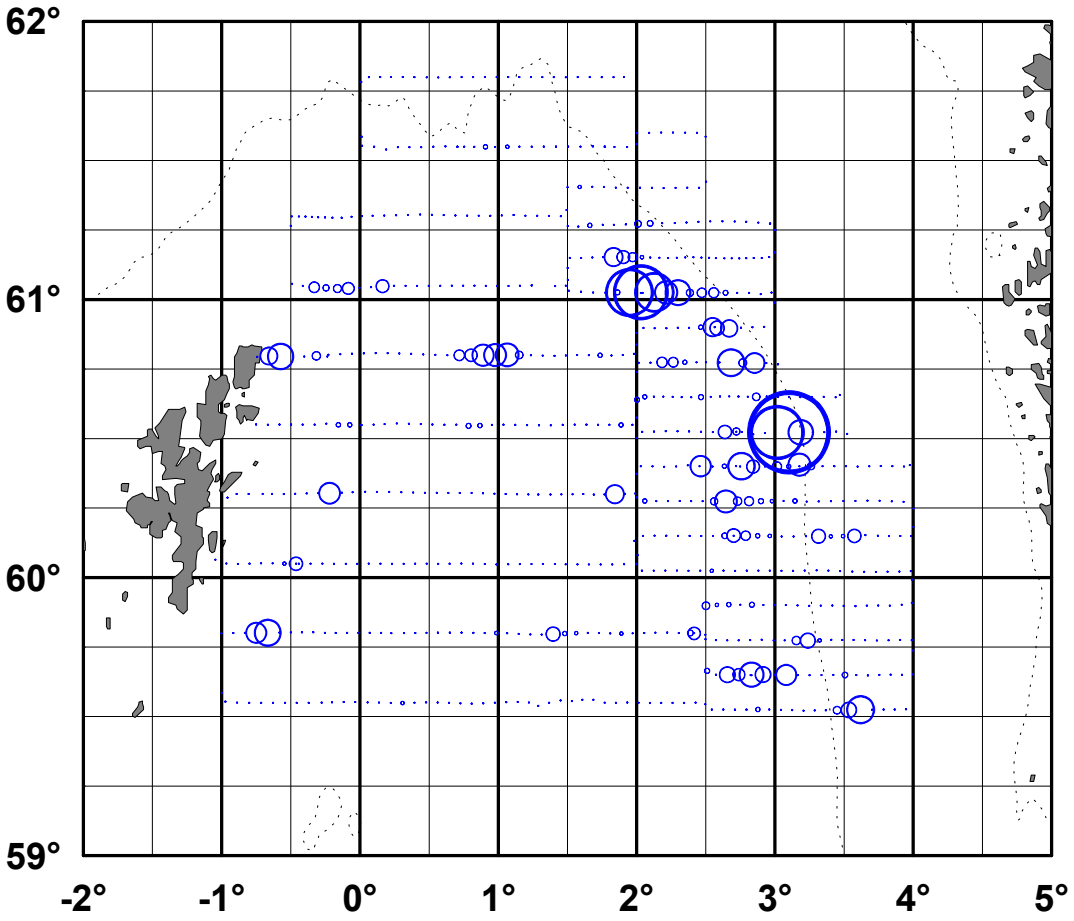

Figure 6.1.2.4. Map of the northern North Sea and a post plot of the distribution of mackerel. Circle size proportional to NASC attributed to mackerel in a 2.5 n.mi. EDSU, from the Scottish acoustic survey in October 2003; on a square root scale relative to a maximum value of 1189 $m^2.nmi^{-2}$.

6.1.3 Intercalibration

An intercalibration between RV "Scotia" and RV "G.O. Sars" was carried out on 20 October 2003. The results of this exercise are still to be fully analysed. Provisional analyses suggest, however, that the systems are working comparatively well (Figure 6.1.3.1). The mean NASC values attributed to mackerel from both ships were quite similar as seen from the figure: 2.4 $m^2.nmi^{-2}$ for the RV "Scotia" and 1.1 $m^2.nmi^{-2}$ for the RV "G. O. Sars" II. A more comprehensive analysis of the data will be prepared ahead of WGMHSA. This will be separated into an analysis of (1) system performance, which requires integrals of the whole water column (i.e., without any scrutiny); and (2), of the scrutiny process.

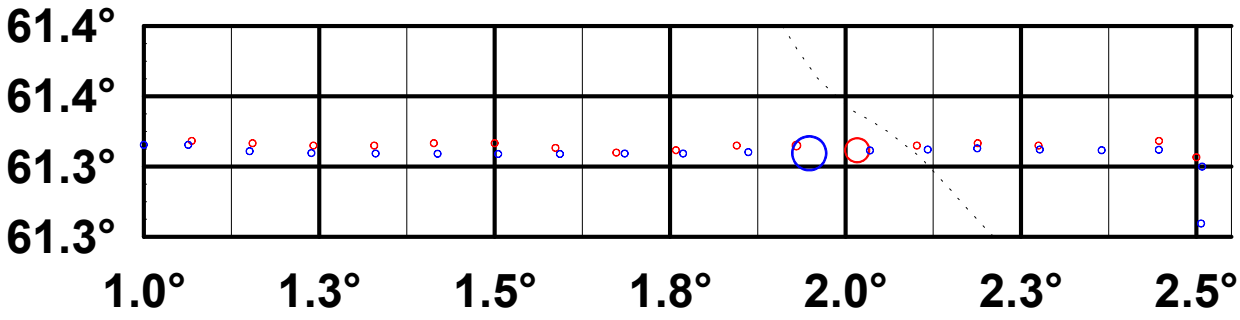

Figure 6.1.3.1. Post plot of the distribution of mackerel during the intercalibration between RV "G. O. Sars" and RV "Scotia". Circle size proportional to NASC attributed to mackerel: red circles = "G. O. Sars"; blue = "Scotia". Scaled on a square root scale relative to a maximum value of 40 $m^2.nmi.^{-2}$.

6.1.4 Combined estimate

The surveys in the northern North Sea, carried out by Norway and Scotland, were coordinated to allow for a combined estimate of mackerel abundance in the main area of abundance close to the 200 m contour in the central northern North Sea. This area, with expected high densities of mackerel was surveyed by both vessels using an interlaced parallel transect design. After this, an intercalibration was carried out to assess the performance of each vessels acoustic system and to evaluate any differences in scrutinising. After the intercalibration the Scottish vessel finished its activities, whilst the Norwegians carried out a second survey of the whole area (see Section 6.1.). Analysis of the data would, therefore, provide three abundance estimates: one complete area coverage from Scotland (Section 6.1.2 above); and restricted area survey covering the area occupied by the higher densities; and another complete area coverage carried out by the Norwegians. The combined estimate was calculated using a simple area based averaging method: the mean NASC was calculated from the survey NASCs and converted to fish density using the mean length in the surveyed area from the first Scottish survey (33.34 cm). This fish density was then raised to the area bound by the overlapping survey (5,322 $n.mi.^2$).

The abundance estimates for the combined survey were:

	Biomass (t)	Numbers (millions)
Scotland	491,638	1,318
Norway	635,263	1,701
Combined	553,148	1,482

The distribution of NASCs from the two surveys is given in Figure 6.1.4.1. The distribution indicates that mackerel were once again aligned along the western shallow edge of the 200 m contour. There is however, some cause for concern with regard to the variability of the estimates. Although the whole area was not surveyed in the combined survey, the estimates are half the size of the conservative "auto" estimate of the Scottish survey (see Section 6.1.2 above). The survey carried out by Norway immediately afterwards also indicates a low estimate (Section 6.1.1). Reasons for this remain subject to a closer analysis of the Scottish survey and will be examined ahead of the mackerel assessment working group.

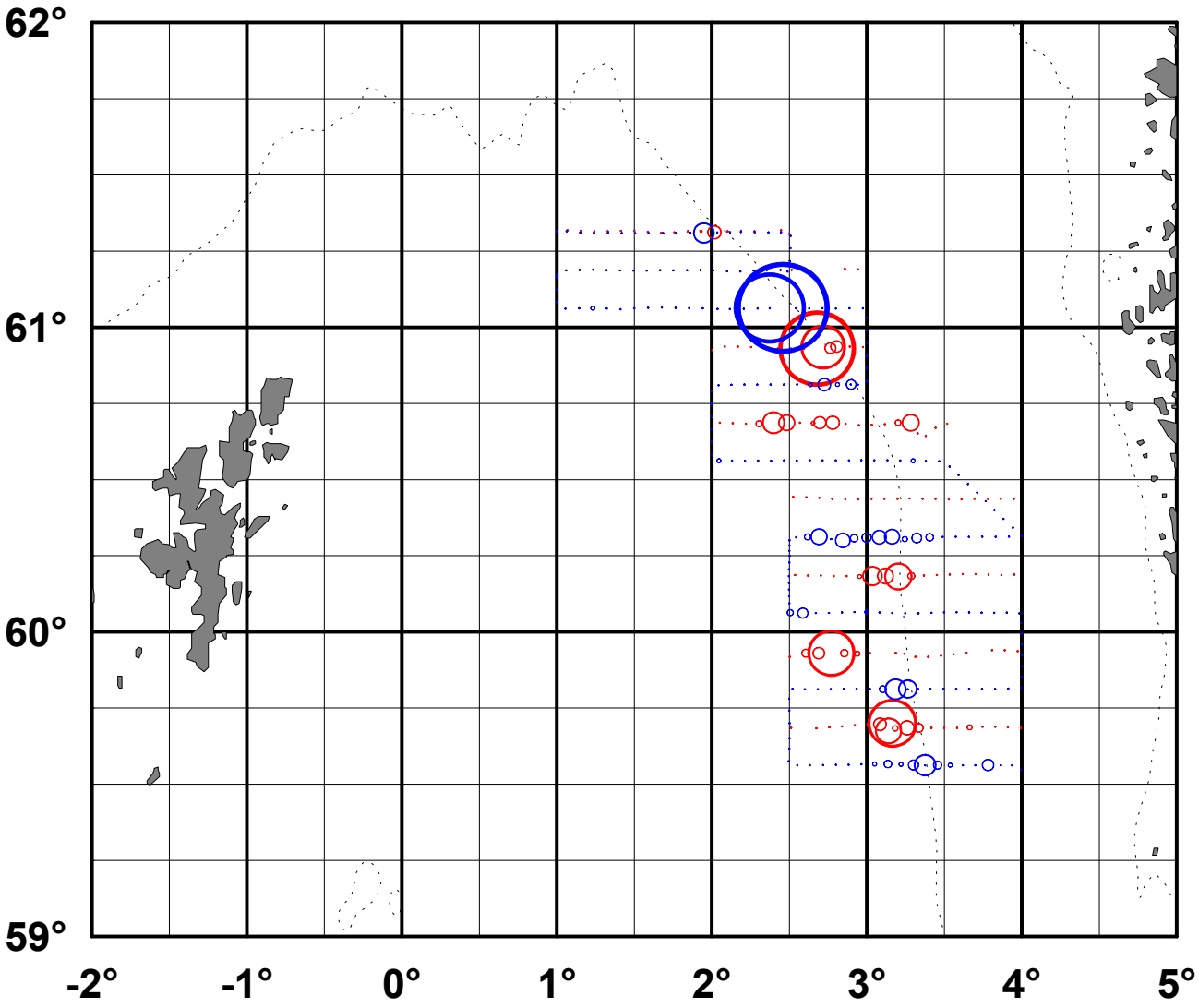

Figure 6.1.4.1. Map of the northern North Sea and a post plot of the distribution of mackerel. Circle size proportional to NASC attributed to mackerel, from the combined acoustic survey in October 2003: red circles = "G. O. Sars"; blue circles = "Scotia"; on a square root scale relative to a maximum value of 964 $m^2.nmi^{-2}$.

6.2 Acoustic surveys for mackerel in autumn 2004

In 2004, Norway (RV "G. O. Sars") and Scotland (RV "Scotia") will conduct a coordinated survey for mackerel in the North Sea.

From 23 October, RV "Scotia" and "G. O. Sars" will carry out an interlaced stratified survey containing the whole area. The survey will be designed in a similar manner to 2003 (see Figure 6.1.2.1). The inter transect distance, specific stratification and rendezvous location will be planned in the interim period and agreed by correspondence prior to 30 September 2004. The area of stratification will be based on the previous two years survey results, but will be finally decided once local knowledge of the location of the main concentrations of mackerel has been obtained from the fishery. The two vessels will inter-calibrate at an appropriate time.

Country/Vessel	Dates	Area	Cruise leader
Scotland "Scotia"	21.10–7.11	Viking Bank, northern and central part of IVa	Paul Fernandes fernandespg@marlab.ac.uk
Norway "G. O. Sars"	18.10–10.11	Northern and central part of IVa	Rolf J Korneliussen rolf@imr.no

7 SURVEYS IN THE SOUTHERN AREA (TOR A, G)

Southern area (ICES Divisions VIII and IX) is routinely covered in spring by Portugal and Spain and surveys have been coordinated since 1997 (Anon 1997). France also undertook surveys in spring covering the French plateau. Since 1998, survey design and strategies are the same for the whole area (Anon. 1998).

The Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX was active until 1999. In 2000 and 2001 the acoustic surveys in these areas were coordinated under the DG XIV Project PELASSES. The main objective of this project was concerned with the acoustic estimation of the sardine and anchovy populations and to map the distribution of the main pelagic fish species in southern NEA waters. Survey strategies were updated with the inclusion of new sample procedures.

The surveys cover large parts of the continental shelf in these waters. Even if the surveys are targeted at sardine and anchovy, they can also provide information and data on mackerel.

This project finished in 2002 and the surveys in the Southern areas have not been coordinated since 2003.

Unfortunately nobody from France, Portugal or Spain attended this meeting and no information about these surveys was given to PGAAM 2004.

PGAAM strongly recommends that France, Spain and Portugal, coordinates the acoustic surveys in the Southern area and provides information to PGAAM.

8 INFORMATION FROM OTHERS SURVEYS (TOR I)

The first PGAAM meeting presented a list of surveys in the North-East Atlantic not targeted at mackerel, but with potential to collect mackerel data to provide indices of mackerel abundance (Anon. 2002). Some surveys followed these recommendations and collected data and passed them to this planning group. Some of these results are presented below.

8.1 International atlanto-scandian herring survey in the Norwegian Sea

Since 1995, the Faroes, Iceland, Norway, Russia, and the EU (since 1997 except 2002 and 2003), have coordinated their survey effort on spring-spawning herring in the Norwegian Sea. The coordination of the surveys has enhanced the possibilities to assess abundances and distributions of the other pelagic fish species than herring. The surveys have also provided information about general biology and fish behaviour in relation to the physical and biological environment.

These international surveys are coordinated by PGSPFN (Anon. 2003b) and have provided oceanographic data as well as information about the distribution and abundance of pelagic fish species in late winter, spring and summer.

In 2004 the PGSPFN has been replaced by PGNAPES which will also coordinate the blue whiting surveys.

8.2 International blue whiting surveys west of the British Isles

Annual Russian-Norwegian surveys to estimate total and spawning biomasses of blue whiting have been carried out since 1983. The surveys are carried out during March-April in the deeper waters of the Faroese zone and in the shelf edge and bank areas west of The British Isles. These surveys might also be used for collecting biological data and provide estimates of mackerel abundance. To do this the present survey area has to be extended into shallower waters. In addition to Norway and Russia, also EU plans to join the survey in 2004 with one vessel from Ireland and one from the Netherlands. With this increase in effort it might be possible to include some mackerel investigations. PGAAM therefore recommends that these investigations should also be targeting mackerel.

8.3 The Norwegian post-smolt/mackerel survey in the Norwegian Sea

During the period 17 June-7 July 2004 a combined salmon–mackerel trawl survey was carried out with the R/V "Johan Hjort" in the parts of the Norwegian and international zone of the Norwegian Sea. This is the period when the mackerel migrate into the Norwegian Sea and the period when the trawl fishery for mackerel starts in the international zone. The area covered was approximately 62º – 69º N and 0º – 7º E. The pelagic trawl applied was the same as last year, the "Salmon Trawl" that is specially designed to catch fast swimming fish species in the surface layer (the upper 13–15 m). Mackerel were caught throughout the area. The mackerel appeared as in previous years in a mix with salmon (post-smolt) in most parts of the area (Figure 8.3).

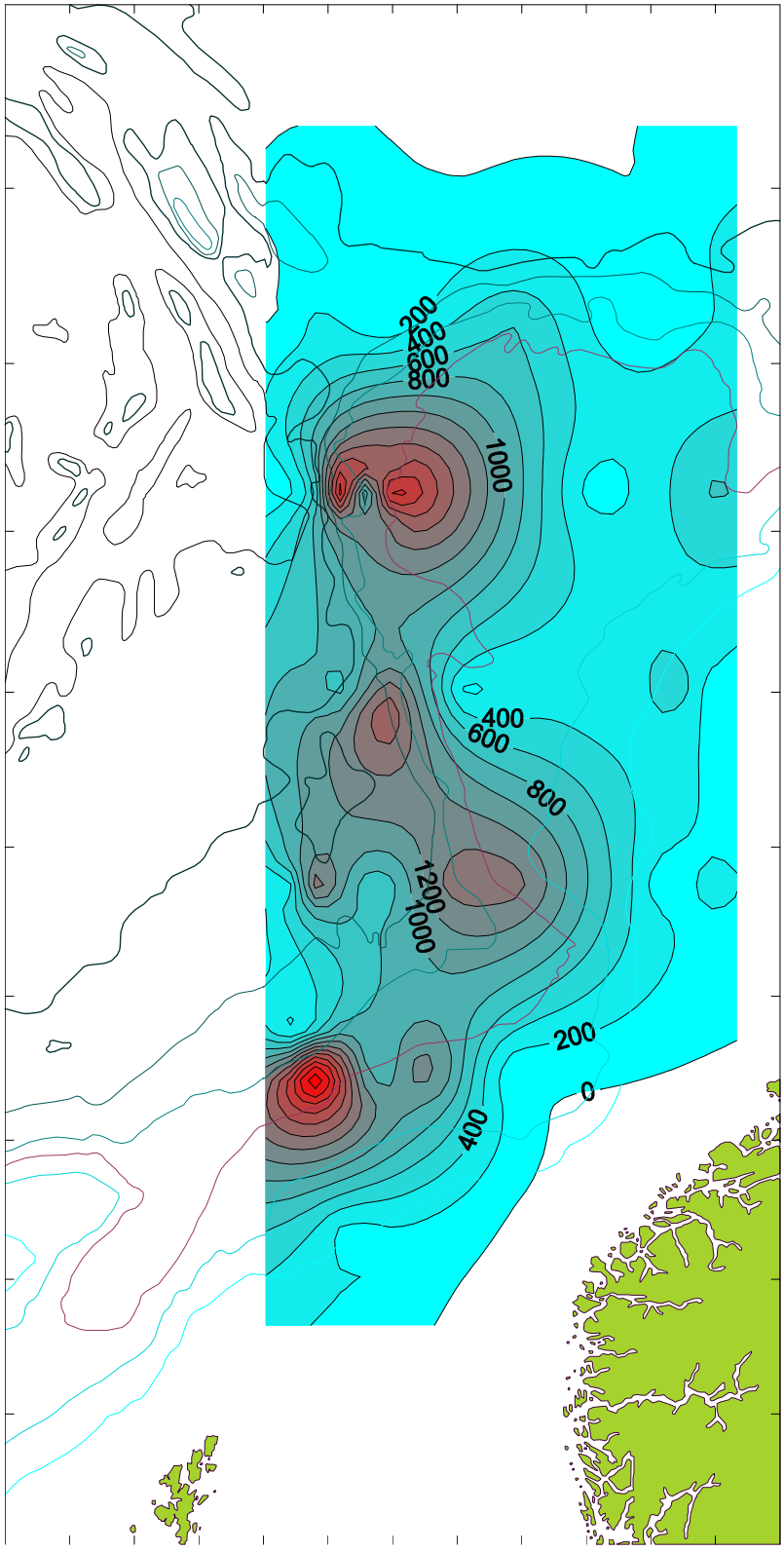

Figure 8.3. Catch rates of mackerel given as numbers per 30 min surface trawling by RV "Johan Hjort" during 17 June–7 July 2004.

9 INTEGRATED MACKEREL SURVEY IN 2004–2005 (TOR I)

The PGAAM 2003 (Anon. 2003c) suggested that 2004 could be the year of Integrated Mackerel Surveys. As mentioned earlier a lot of surveys are able to provide data on mackerel distribution and biological information. The 2004 ICES triennial mackerel egg survey that is coordinated by the WGMEGS will cover the area from the Gulf of Cadiz to the

Shetland Islands. In addition to this there are a large number of other coordinated surveys (herring, blue whiting, IBTS etc.), which can provide data on mackerel. The PGAAM suggests that mackerel data should be collected during these surveys. Data from these surveys are collated and published by different ICES Working Groups. Data concerning mackerel should be passed to PGAAM.

The proposal has been discussed with the Chairs of WGMHSA, WGMEGS, PGAAM, PGSPFN and PGHERS, and all support the idea.

Relevant surveys in 2004 are listed in Section 9 of the 2003 PGAAM report, and relevant WGMEGS, PGSPFN and PGHERS reports.

Most of these surveys are scheduled to take place later in 2004 and the results from above mentioned surveys will be passed to PGAAM by the relevant ICES working groups.

PGAAM will combine and present these data to WGMHSA in 2005.

10 RECOMMENDATIONS

The **Planning Group on Aerial and Acoustic Surveys for Mackerel** [PGAAM] (Chair to be announced) will meet in 2005, in conjunction with WGMEGS, at a venue to be decided, to:

a) co-ordinate the timing and area allocation and methodologies for acoustic and aerial surveys for mackerel in the north east Atlantic;

b) collate and evaluate the data collected by the aerial surveys, fishing, and research vessels in the Norwegian Sea during the summer and autumn of 2004;

c) co-ordinate acoustic surveys in the northern North Sea – Shetland area to ensure full coverage and appropriate areas and timing;

d) combine the 2004 survey data to determine the abundance and distribution of mackerel within the North Sea - Shetland area;

e) identify participants to contribute to the aerial surveys for mackerel in the Norwegian Sea and coordinate collaboration between vessels;

f) combine the summer 2004 aerial survey data with vessel data to determine the distribution of mackerel in the Norwegian Sea;

g) seek survey time for northward extension of acoustic surveys in ICES Subareas VIII and IX;

h) consider the latest findings from the SIMFAMI project;

i) identify surveys which are not targeted at mackerel, but which may have potential use for the estimation of mackerel distribution and abundance;

j) maintain protocols and criteria to ensure standardisation of all sampling tools and survey gears.

PGAAM will report by (to be decided 2004) for the attention of the Living Resources Committee, ACFM, and the Fisheries Technology Committee.

Supporting Information

Priority:	The PG is aimed at providing stock abundance estimates and distribution data for the mackerel stock assessment. The mackerel surveys are currently uncoordinated and cover only parts of the spatio-temporal distribution of the stock, and require co-ordination and collaboration.
Scientific Justification and Relation to Action Plan	This work is related to the following goals and specific subheads: a): 1.11 b): 1.2.2 c): 1.11 d): 1.2.2 e): 1.11 f): 1.2.2 g): 1.11 h): 1.13.4 i): 1.11 j): 1.11, 1.13 The assessment of NE Atlantic mackerel is currently dependent on a single fishery independent estimate of biomass, derived from the ICES Triennial Mackerel and Horse Mackerel Egg Surveys. This estimate is only available once every three years and makes the assessment increasingly insecure with elapsed time since the last survey. Therefore there is an urgent requirement for the development of other independent stock estimates, particularly in the intervening years, A collection of acoustic and aerial surveys has been carried out by a number of

	countries in recent years. However in all cases these cover only part of the known distribution area and consequently cannot deliver a valid stock estimate or complete distribution map. The aim of this planning group is to identify the deficiencies in area and timing of these surveys and to remedy these deficiencies. In the case of the aerial surveys this will initially involve optimising the coverage of the survey by involving vessels from different nations to provide the baseline biological data. In the longer term it is hoped that other countries could supplement the aerial component directly. For the acoustic surveys in the north, there is a need to identify the optimum spatio-temporal window for such surveys, and to coordinate the surveys from participating countries. For the southern surveys, the main requirements are to standardise survey practice for estimating mackerel biomass, and to extend the already substantial coverage of these surveys to the full distribution area. Currently there are Scottish and Norwegian surveys in the Viking Bank and Spanish, Portuguese and French surveys in Divisions VIII and IX. ToR h) A new EU project (SIMFAMI) on acoustic species identification using multi frequency methods has been approved and will start shortly. This project is intended to produce guidance on target strength to length relationships for this, and other, species and to develop multi-frequency methods for species ID and biomass estimation. The PG will be ideally placed to standardise and implement these findings. ToR j) The group will identify existing procedures to ensure that the sampling gear and any instrumentation used to monitor its performance are constructed, maintained and used in a consistent and standardized manner. Where necessary, procedures and protocols should be established for intercalibration to take into account platform and sampling tools-survey gear differences
Resource Requirements	None specific as this is ongoing if uncoordinated work
Participants	The planning group will require members from the acoustic and aerial surveys already underway and from those institutes which can provide additional survey effort.
Secretariat Facilities	None
Financial	None
Linkages to Advisory Committees	ACFM
Linkages to other Committees or groups	WGMHSA, WGMEGS, WGFAST, WGSPFN, RMC
Linkages to other organisations	EU projects SIMFAMI, PELASSES NEAFC
Cost Share	ICES 100%

The PGAAM recommends that during acoustic surveys for mackerel the Target Strength to length relationship TS=20 log L-84.9 dB should be used, integrating at an acoustic frequency of 38 kHz with a –82 dB threshold. Multi-frequency acoustic data should be collected wherever possible and should include at least 38 and 200 kHz.

The PGAAM advises all participants to examine "Manual for herring acoustic surveys in ICES divisions III, IV and VIa" (PGAAM report 2003, Annex I) with a view to updating this for use in new or existing acoustic surveys specifically targeted on mackerel.

The PGAAM recommends that wherever possible, data should be collected from surveys not targeted on mackerel, to assess their potential for the estimation of mackerel abundance, distribution and to provide biological samples of mackerel.

The PGAAM recommends that a review be conducted of databases and data format exchanges utilised during herring and blue whiting surveys with a view to use similar tools for mackerel surveys (PGSPFN report 2003, Appendix 2).

The PGAAM recommends that when feasible, members from this group should meet with those from PGNEPS to discuss common problems.

The PGAAM recommends that acoustic surveys for mackerel in the western approaches of the northeast Atlantic should be carried out in 2005.

The PGAAM strongly recommends that France, Spain and Portugal, coordinate acoustic surveys in the Southern area (ICES Sub-Areas VIII and IX) and provide information to PGAAM.

The PGAAM recommends Evgeny Shamray (Russia) to be Chair for the next 3 years.

11 WORKING DOCUMENTS

Gavrilov, E. N. Study on mackerel schools finding and assessment in the international waters of the Norwegian Sea during summer 2003. *Document available from*: Evgeny Gavrilov, Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), 6 Knipovich Street, 183763, Murmansk, Russia. E-mail: gavrilov@pinro.ru

Korneliussen, R. J. An algorithm used to separate acoustic categories by the use of the relative frequency response and clustering. *Document available from*: Rolf Korneliussen, Institute of Marine Research, P.O. Box 1870, Nordnes 5817, Bergen, Norway. E-mail*:* rolf@imr.no

Zabavnikov, V., Shamray, E., Lisovsy, A., Iversen, S. A. and Tenningen, E. Results of joint Russian and Norwegian complex investigations on feeding mackerel in the Norwegian Sea during July 2003. *Document available from*: Vladimir Zabavnikov, Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), 6 Knipovich Street, 183763, Murmansk, Russia. E-mail: ltei@pinro.ru

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Anon. 1997. Report of the Planning Group for Sardine Acoustic surveys in ICES Sub-Areas VIII and IX. Lisbon, 27–28 January 1997. ICES CM 1997/H:1.

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Anon. 2003a. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2002/ACFM:06.

Anon. 2003b. Report of the Planning Group on Surveys on Pelagic Fish in the Norwegian Sea. ICES CM 2003/D:10.

Anon. 2003c. Report of the Planning Group on Aerial and Acoustic Surveys for Mackerel. ICES CM 2003/G:06.

Edwards, J. I., F. Armstrong, *et al*. (1984). Herring, mackerel and sprat target strength experiments with behavioural observations. ICES CM 1984/B:34. 21 pp.

Zabavnikov V.B, Chernook V.I., Rodin A.V. 1997. Marine flying laboratory An-26 “Arktika”. *In*: Proceedings of the 3d International Airborne Remote Sensing Conference and Exhibition. – Copenhagen, Denmark. 1997, 3: 415–418.

ANNEX 1: LIST OF PARTICIPANTS

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23–26 February 2004

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