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INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

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Report of the Working Group on Shelf Seas Oceanography
Bergen Norway
12-14 May 1987

The Working Group met at the Institute of Marine Research, Nordnes, Bergen, Norway on 12-14 May. The meeting opened at 1400 h 12 May with a welcoming address from Mr O J Østvedt, the President of ICES and Deputy Director of the Institute in which he stressed the continuing importance of fisheries hydrography and environmental matters in the Working Group's Programme. Mr Østvedt was thanked by the incoming Chairman, Professor Martin Mork.

The following members were present: J Backhaus, G Becker, E Buch, Y Camus, H Dahlin, R Dickson, B Hansen, J Howarth, S-A Malmberg, M Mork (Chairman), I Perry, (representing P Smith), and R Saetre. C Griffiths and E Svensson participated as observers and L Middtun, G Furnes and J Blindheim attended part-time; apologies were received from B Jamart, G krause, A Martin, O Vagn Olsen, L Otto, J da Silva, P Smith and the ICES Hydrographer. The working group discussed possible changes in its membership due to retirement and additions prompted by changes in the Working Group's tasks.

The draft agenda at Annex A was adopted with the addition of an item on "IREP and Coastal Current Problems".

R R Dickson acted as Rapporteur for the meeting. At the Chairman's request he briefly explained the rationale behind the change in the Working Group's name and terms of reference, essentially in order that it should better reflect the emphasis of current activity and funding by laying increased stress on water quality modelling and biological problems including larval drift.

I. Progress and plans

The working group then reviewed past results and future plans for shelf seas oceanography in member countries from which the following main points emerged.

1. Dickson (UK). The first ultra-long current meter records from the Irish Sea were showing surprisingly steady residual current directions in certain areas, the most stable associated with non-linear tidal forcing.

- e. Howarth (UK) described (a) plans for a shelf-edge experiment in March-May 1988 by J Huthnance where a range of localised shelf-edge processes would be studied intensively in a localised area (b) results of an investigation of top-to-bottom current profiles via acoustic doppler, HF radar and a variety of current meters. This study at a number of sites off the Irish and N Wales coasts was showing some evidence of a log-layer near the surface but not much of an Ekman spiral. There also seemed to be an almost instantaneous momentum transfer between wind and surface current.

3. Buch (DK) described the recent fisheries hydrography of the Banks off West Greenland based on environmental changes at 14 standard hydrographic sections. A positive relationship between cod year class strength and temperature meant that the refrigerating winter air mass observed in the early 1980's has been reflected both in increased ice cover and in a subsequent drop to near-zero cod catch in the most recent years. The weight at age of cod was also much lower in recent years and a southward shift in the centre of the W Greenland cod fishery between the late 70's and mid 80's suggests some form of emmigration may be underway. The revelation from Perry and Saetre that similar types of response to cold temperatures had been observed in cod off Labrador and in the Barents Sea prompted the suggestion that the relationships between cod and temperature might form a viable future theme session for Hydrography Committee. The relationship is complex however, as Saetre showed high temperatures are necessary for good year classes in the Barents Sea but are not sufficient cause on their own. As with Malmberg's experience at Iceland favourable temperatures and feeding conditions must go together.

4. Dahlin (SW) described three current activities (a) a 5-year research program investigating eutrophication in the Stockholm archipelago where the potential cause is a change in the efficiency of a sewage treatment plant, in the SE Kattegat where inputs by rivers appear to centre on the nitrogen cycle, not phosphorus, and the open sea at the Kattegat; (b) investigations of the polluting effects of forest industry in coastal waters especially the fate of chlorinated hydrocarbons and dioxin; (c) the compilation of a

variety of assessment reports. All these studies had modelling of one type or another in support, and some of the problems associated with modelling were discussed, (e.g. N Sea boundary conditions for Skagerrak/Kattegat models; the trustworthiness of past monitoring data in the presence of high natural variability and a variable degree of observer precision). Some greater detail was presented on the results of the Oresund model which predicts that some changes in the route and volume of the salt inflow to the Baltic would take place if the proposed Sweden-Denmark tunnel/bridge project is proceeded with.

5. Perry (Can) briefly mentioned the Canadian Atlantic Storms Project (CASP) and its US counterpart (GALE) before describing, in greater detail, the Southwest Nova Scotia Fisheries Ecology Program. This study aims to follow the environmental influences on the haddock from egg and larval stages onwards. The physical part of the study was largely carried out in 1983-85 and included studies on the interannual variability of currents and watermasses, and on the processes controlling dispersion of larvae from the clockwise circulation around Browns Bank. Organisationally it was reported that the fisheries and physical disciplines were being merged in part to address the questions of what physical oceanography was needed by fisheries and what experiments should be set up to meet these needs. Present questions centre round (a) what factors determine why the northern cod cross from the relatively warm waters of the Davis Straight across the cold Labrador current to the coast; (b) what are the physical triggers to inshore movement of the silver hake from the shelf break; (c) what factors control recruitment variability and (d) the monitoring of ocean climate.

6. Griffiths (UK) described various recent investigations and initiatives being carried out by SMBA; (a) continued investigation of current profiles using the S4 at two sites off the English east coast with data passing to a neighbouring buoy for transmission ashore via ARGOS. (b) A third option for determining very near-surface flows which contrasts with the current-following system by P Coller or the spar-buoy approach by Howarth, in floating a current meter to obtain currents with reference to the wave trough. The eventual aim is long time-series of near surface measurements for the oil industry, with long records necessary to define extrema. (c) Joint SMBA/DAFS work in the Firth of Clyde (past), Firth of Lorne (present) and Autumn Circulation Experiment (ACE: near-future). (d) Some Cs

commissioned work with MAFF. (e) 2-D Clyde circulation modelling using Pingree's model and organisationally. (f) The transfer of phytoplankton investigations under the physical oceanography division (D Ellett).

7. Hansen (Faroes) briefly described (a) a joint study with SMBA which has used ARGOS buoys to identify a clockwise circulation around Faroe Bank and hence explain the long retention-times for larvae on top of the Bank. Further ARGOS drifter releases will be made this year. (b) a growing eutrophication problem in certain sill-fjords where summer stagnation normally caused O₂ depletion to 50% saturation, but where mariculture has recently exaggerated this tendency to 5% O₂ saturation in summer 1986. There is danger of anoxic conditions developing this year as a result.
8. Becker (FRG) briefly described the project on circulation and pollutant transfer in the North Sea which has finished its second main survey (February-March 87) and whose preliminary results will be reported in Santander. His main report concerned the project on fronts in the German Bight where an intensive grid of CTD, nutrients and oxygen measurements plus dye diffusion have been used to study the time and space scales of the front and its perturbations. Rhodamine injected at the front showed no tendency to mix across it in the short term (5-10 d timescale) but streaked along it with some spreading towards the coast. On eutrophication, Becker disputed the view that the decrease in O₂ saturation to 25% in 1981-83 was due to a change in stratification since stratification conditions had not changed remarkably in 1900-85. He regards the cause simply as the increased nutrients supplied by Elbe and Weser, though with some short-term combined effect from increased stratification and nutrients at times of high river discharge.
9. Camus (Fr) reported progress in working-up the EPSHOM Cruise on the phytoplankton and physical distributions associated with a front off Brest that arises due to the baroclinic tide.
10. Malmberg (Iceland) described the increasingly interdisciplinary work on fisheries hydrography around Iceland. Total cod stock and spawning stock size have decreased fairly regularly between 1955 to 1985 with the main problem attributable to recruitment. Migration from Greenland can change the stock by 20% and growth (through food conditions) by 25%. With the

environmental changes well described by the established network of time-series stations and sections, new experiments are concentrating on (a) (with Denmark) growth conditions along the capelin feeding zone north of Iceland, (b) an ecological program in Isfjord, (c) the relationship between stock size and salinity off N Iceland, since Iceland seems to be one area where freshwater outflow can be linked to recruitment.

11. Saetre (Norway) introduced a new 5 year program of egg and larval studies along the Norwegian coast where the main aims are (a) describing egg and larval distributions and (b) investigating recruitment mechanisms for selected species in relation to their environment. The Norwegian coast is characterised by successive spawnings of different species northward and the uneven bathymetry promotes clockwise circulations (some temporary, some permanent) around all the major offshore banks (eg Halten and Trena) on Halten Bank a Taylor column circulation extends to the surface in winter but is decoupled from it in summer. Modelling in support of this study is via G Furnes and the IBM centre. Since the direct identification of recruitment mechanisms will be difficult, the plan is to sample the post larvae - the ones that did survive - and back-calculate via daily otolith rings etc to identify their origins. Argos buoys are used extensively to follow larval drift with emphasis on the pycnocline where herring larvae numbers (for example) reach a maximum.
12. Mork (Norway) described continuing work on the oceanography of the coastal current and the outbursts of brackish water from the Skagerrak using current meters, doppler profiler, SEASOAR and the facilities of the new Nansen Centre of Remote Sensing. Other work briefly mentioned concerned aspects of fish farming, several fjord projects and the evaluation of environmental impacts due to hydropower plants.
13. Svensson (Norway) described physical and biological modelling of processes in eddies of the coastal current using field measurements and remote sensing for initialisation. A Halten Bank modelling study will follow.
14. Midttun (Norway) brought the "progress and plans" session to a close by describing work into the identification of biological/environmental links in the Barents Sea from the immediate post-spawning stage to O-group. The study identifies links between year class strength and conditions during larval drift; and within the Barents Sea an attempt is being made to

simulate observed currents in collaboration with PINRO laboratory Murmansk.

II. Shelf Seas Water Quality Modelling

The afternoon session on 13 May began with a discussion on water quality modelling introduced by Prof J Backhaus.

1. Backhaus (FRG). The Backhaus model is driven using 6 hourly real wind forcing 1969-82, is initialised and run with summer and winter T,S fields and mean stratification, and has been applied to a range of tasks.
 - dispersion of Cs around the West European shelf over 12 years. Good fit to much of the survey data but problems in coping with the mid 70's change in Cs distributions which can only be explained by increased transport through the North Channel. However attempts to impose increased through-flow in the model merely result in increased flow around the shelf west of Ireland. Backhaus concludes that the model lacks sufficient resolution in the Irish Sea to simulate the slight (but important) north-south slopes through the North Channel and to deal with this change realistically; thus either the near-field must be refined considerably or we must let the model run for the North Sea only and initialise it using observed data at the approaches to the North Sea. [Prandle had found similar difficulties in simulating the mid-70's situation of the Irish Sea in this model.]
 - Applied to larval drift in the North Sea the model has the capability of tracking both "passive" and "active" particles in time and space. Active particles can migrate vertically. The problem addressed was what causes Buchan herring larvae to be distributed either to west Jutland or south along the Scottish coast, as observed. The model study showed that those particles which remain in the top 30 m go to Jutland, while those which remain near the seabed go south, i.e. the depth of the larvae was critical to their distribution so that information on larval vertical distribution is vital.
 - The model has been used to estimate the likely error involved in "freezing in" the mean density field. Using salinity as a passive tracer the model has been used to estimate monthly salinity anomaly distributions from a knowledge of freshwater input at the coast (no evaporation or precipitation). Estimating flow anomalies induced by

salinity anomaly distributions is the next step towards synoptic modelling of the North Sea.

Some of the environmental variables which might promote eutrophication have been investigated via models of Kattegat, Kiel Bight and German Bight. So far these simulations have failed to match the observed O₂ depletion. Backhaus suspects it may not be an excessive spring bloom but an excessive summer bloom that is responsible. A fine-resolution eddy-resolving model of Kiel Bight is encouraging in immediately producing eddies of correct scale, and such near-field modelling is likely to be expanded.

2. Dahlin (SW) described two models relating to Baltic problems.
 - the Gt Belts model designed to investigate the feasibility of the Denmark-Sweden bridge/tunnel proposal. The model predicted a 17% decrease in the salt inflow through the Oresund which proved decisive since it is vital not to encourage further Baltic stagnation by impeding the penetration of salt through the transition area.
 - The present prolonged stagnation in the Baltic Deep Basin's which has restricted cod spawning and has recently confined the cod to the surface layer has also been the subject of a modelling study. The simulated time-variation of O₂ and other parameters in the Gotland Deep is closely similar to the variation observed and reported by Fonselius and others.

3. Dickson (UK) described the plans for water quality modelling as they relate to the contaminant inputs along the NE coast of England. The main point was that the parameters and processes for inclusion, and hence the entire thrust of the field measurement programme, depended on the geochemical behaviour of the problem contaminants in question. Geochemical behaviour is frequently known for chemical elements but may not be known for compounds, and certain organic contaminants may change their geochemical behaviour as they degrade in the sea. Thus the determination of the contaminant geochemistry in question via laboratory or field experiments is often the first step in an effective water quality modelling programme.

4. JONSMOD. Responding to a Hydrography Committee recommendation that closer ties should be re-established between the WG on Shelf Seas Oceanography and JONSMOD, Prof Backhaus reported contacting the JONSMOD Chairman P. Dyke, who advised that formal links with ICES were no longer possible but

welcomed specific problems from the WG or Hydrography Committee. Meeting every 2 years, the next meeting of JONSMOD will take place during 1988 in Hamburg.

5. The papers submitted for the water quality modelling session in Santander were then reviewed. To meet the twin aims of (a) making the assumptions, good points and bad points of available models better known and (b) providing modellers with the data they require, it was agreed that the eleven papers submitted constituted a viable and valuable beginning; it was recognised however that since the subject was a broad one, similar sessions would be required and should be encouraged at the Statutory Meetings over the next few years, probably in association with a poster session as this year.

III. Joint Field Studies

1. It was agreed that the SCAPINS exercise, as originally concerned was now no longer viable and will not be considered further. However substantial parts of the original program had been activated in the form of the two exercises described below.
2. J Howarth described plans for NERC North Sea Program, 1988-92. Costing £9m the ultimate aim of a water quality model for the North Sea was being advanced via three main objectives:
 - a physical transport model with an evolving T and S field
 - studies of non-conservative processes
 - the definition of a particular seasonal cycle in the North Sea

The North Sea had been chosen for the experiment since it exhibited a wide range of tidal strengths, a variation from stratified through frontal to mixed conditions, a major frontal system crossing the south-central North Sea, a reasonable change in water depths and sediment type etc.

Over a 15-month period a ship will be permanently operating in the North Sea on a monthly cycle of 12 d survey work and 14 d of process studies. The survey would include CTD, irradiance, fluorescence, nutrients, trace metals, air/sea contaminant exchanges (CO₂, DMS) supported by 6 moored current meter stations in mixed, frontal and stratified regimes, drifting

buoys and associated measurements (meteorological observations, tide gauges etc).

A wide range of process studies included the dynamics and circulation of fronts, eddy statistics via tracers and floats, bed-induced resuspension, air-sea exchange using purposeful tracers plus work on plankton, sediments, benthos and estuaries.

Recent instrument developments contributing to the programme included a so-called "biological buoy" (Tett), acoustic doppler, Decca/argos drifters, HF radar and an undulating pump.

During discussion it was agreed that coordination of this major effort with other field programs (particularly the Norwegian program in the northern North Sea, the FRG program in the German Bight and the Danish work west of Jutland) was essential for a number of environmental problems of the North Sea and such coordination formed an appropriate and necessary task for this working group. Howarth in particular, mentioned that funding would be available for the participation of non-UK scientists in the NERC program.

3. The Autumn Circulation Experiment (ACE), 1987 was then introduced for discussion. This aims to study the current system which connects the west coast of Scotland through the Fair Isle Gap via the Dooley current to the Norwegian Coastal current, though the intention is to study different pieces of this current separately in both summer and winter, via an international effort from UK (UCNW, SMBA, DAFS, BIDSTON), Norway (IMR) and Denmark (DFH).

Subsequent discussion centred on the possibility of FRG (Becker) providing some additional survey coverage in the northern North Sea in 20 August-6 September, whether there was a data management role for the Service Hydrographique in the experiment, and on possible ways of filling remaining gaps in current meter coverage in key segments of this current system. (eg. the Dooley current where it crosses the northern North Sea, and the need for additional coverage of the flow through the Norwegian Trench.)

IV Data Quality Matters

1. The quality of nutrient data collected during IYFS surveys was discussed in the light of the Hydrographers findings reported at the previous meeting of

the Group. It was agreed that an extensive international data set, produced at the correct time of year to observe trends was potentially being compromised by the practice of storing samples for later analysis ashore, and both to resolve and possibly to reverse this problem it was recommended that efforts should be made to send chemists on all ships to conduct on-board analysis during the IYFS of February 1989 (during the North Sea Study).

2. Becker reported that some samples of Batch 104 of Standard Seawater from IOS Wormley are faulty (0.05 higher). Dr Culkin, IOS, knows of the problem and the cause is under investigation.
3. Dickson gave a brief update of Kirkwood's continuing study of evaporative losses in salinity samples under long storage conditions. The final part of this study has been to check evaporation by weighing samples accurately after long time intervals and this confirms his previously reported results re the type of sample bottle best and worst suited to storage.
4. With the PEX group meeting separately to discuss questions of data quality in detail, the working group discussed this point only briefly! As Dahlin pointed out, although most ships in PEX analysed immediately, some preserved their samples for later analysis and this would give rise to a variable error depending on season, due to production processes.
5. Finally under this heading, the working group reviewed papers submitted for the special session to be convened by the Hydrographer in Santander on "shelf seas use of CTD's". While the titles suggest that most papers will deal with the more specialised vehicles and methods for deploying CTD's rather than basic standard usage, it was agreed that the 6 papers submitted should constitute a valuable follow-up to the equivalent session at the statutory meeting in London, 1985.

V Miscellaneous/administrative

1. The Working Group were reminded of the need to begin planning their contributions to the theme session on "Eulerian current meter data

processing and problems" which J Howarth is convening at the Statutory meeting in Bergen in 1988.

2. At the Statutory Meeting in Santander members of the Working Group will begin to explore within Hydrography Committee various means of visualising complex data including the preparation of films/videos to display model output.
3. The same procedure for electing new working group Chairmen as that adopted by the Working Group on Oceanic Hydrography was adopted by this working group also: ie. Chairman Hydrography Committee will write to each member of Hydrography Committee requesting that the member submits one nomination per country after consultation with the member of the working group in question. The nomination with most votes is selected.
4. A brief review was given of future meetings and conferences of relevance, including the Intergovernmental North Sea Conference, the GESAMP coastal discharges working group, the Conference on the Ecology of the North Sea in Texel 15-21 May 1988 and the ICES Symposium on the Early Life History of Fish in Bergen, October 1988.
5. At the kind invitation of Dr Svend-Aage Malmberg, it was decided that the next meeting of the working group should take place in Reykjavik Iceland on 26-28 April 1988.

In conclusion the Chairman thanked the participants for their contribution to the success of the meeting, and particularly to Dr Saetre and others from the host Institute both for the efficient local arrangements, and for their hospitality both during and outside the meeting. It appeared to be generally agreed that the change in the working group's business had resulted in a general reinvigoration of the Group's activities.

The meeting closed at 1200 h 14 May.

Recommendations

The Working Group on Shelf Seas Oceanography recommends:

1. That attempts be made to check possible errors in hydro-chemistry due to sample-storage by arranging duplicate on-board analysis on at least one ship during the International Young Fish Surveys.
2. That the Hydrography Committee and Marine Environmental Quality Committee should jointly convene a water quality modelling special theme session during the 1988 Statutory Meeting and subsequently if necessary, as a follow-up to the 1987 Santander session.
3. That the Working Group should meet in Reykjavik, Iceland, the Hydrographer being present, on 26-28 April 1988 to discuss the following:
 - A critical review of perceived environmental influences on cod (larval, juvenile and adult) and their distribution in different coastal areas.
 - a review of relevant progress in the current EUROMAR working groups.
 - submissions for the special topic session on "current meter data processing and problems". (J Howarth convenor).
 - nutrient trends analyses for the shelf:- methods and results.
 - PEX.

ANNEX A

International Council for the Exploration of the Sea Working Group on Shelf Seas Oceanography

Meeting at Institute of Marine Research (Havforskningsinstituttet), top floor, Nordnespynten, Bergen, Norway 12-14 May 1987 starting at 1400 on Tuesday 12 May.

Draft Agenda

1. Opening of the meeting
 - 1.1 Local information
 - 1.2 Appointment of a rapporteur
 - 1.3 Review of membership
 - 1.4 Adoption of agenda
2. Discussion of new Terms of Reference
3. Reports on projects and activities in ICES countries
4. Shelf Seas Water Quality Modelling
 - 4.1 Validation and development of hydrodynamic models
 - 4.2 Parameters and processes for inclusion in water quality models
 - 4.3 JONSMID activities
 - 4.4 Contributions to WQM session in Santander
5. Field Studies
 - 5.1 SCAPINS
 - 5.2 Coordination of planned National programmes in the North Sea
 - 5.3 ACE (Autumn Circulation Experiment)
6. Data Quality
 - 6.1 IYFS hydro-chemistry data
 - 6.2 Issues arising from PEX
 - 6.3 Contributions to the CTD session in Santander
7. Other Matters
 - 7.1 Matters referred to from other working groups
 - 7.2 AOB
 - 7.3 "Irish Sea" Status report
8. Any other business
 - 8.1 Next WG meeting

