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International Council for the  
Exploration of the Sea

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Hydrography Committee

**REPORT OF THE WORKING GROUP ON SHELF SEAS OCEANOGRAPHY**

Bidston, United Kingdom, 4-6 April 1989

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Report of the Working Group on Shelf Seas Oceanography,  
Bidston, United Kingdom, 4-6 April 1989

The Working Group met at the Proudman Oceanographic Laboratory (POL), Bidston, on 4-6 April. Before the meeting began we were welcomed to POL by its Director, Dr B McCartney.

A list of those present at the meeting is attached as Annex A. The draft agenda (Annex B) was adopted with the inclusion of an item on SKAGEX, the proposed Skagerrak Experiment.

E Gmitrowicz acted as Rapporteur for the meeting.

I. National Reports

1. da Silva (Portugal) described the work of the Portugese National Institute of Fisheries Research and Hydrographic Institute on sardine recruitment. Interdisciplinary studies covering the whole Portugese coast began in the early 80's and include annual acoustic surveys for 0-group fish and monthly egg, larvae and plankton surveys. Physical oceanographic studies have been undertaken in the northern shelf area, the main fishing ground.

These studies have been coordinated with parallel studies conducted by the Spanish Institute of Oceanography and Portugese and Spanish scientists included in this work meet annually.

2. Dahlin (Sweden) There are plans to increase the frequency of pollution monitoring within Swedish waters and to combine the monitoring with modelling of the areas concerned. Results of past monitoring programmes will soon appear in AMBIO, a publication of the Swedish Royal Society.

A year ago an action plan to tackle marine pollution was drafted and underwritten with 1 million Swedish Kroner per annum for three years, after which further funding will be sought.

Other new programmes are:

- (a) mathematical modelling to simulate long-term flow patterns in the Skagerrak and Kattegat to determine the fate of pollutants;
  - (b) sediment mapping of the Skagerrak;
  - (c) studies using box models with high vertical resolution;
  - (d) international collaboration on toxic blooms, especially with the Nordic countries;
3. Otto (Netherlands) There has been a shift in the Netherlands from hydrographic to ecological studies with very limited pure physical oceanographic work, apart from modelling of the North Sea, being

undertaken. A group of scientists at the Netherlands Institute of Sea Research (NISR), formed to study ecological problems, has completed a study of the Wadden Sea and are now concentrating on the North Sea.

There are plans for a year long study of specific areas of the North Sea, carrying on from the British North Sea Programme.

4. Lefaiivre (Canada) spoke of the work of the Maurice-Lamontagne Institute on the Gulf of St Lawrence. There has been a year long study of wind driven upwelling on the north shore of the Gulf with particular emphasis on the use and calibration of satellite imagery as an indicator of upwelling. Smaller scale coastal studies have also been undertaken.
5. Lavin (Spain) described the physical oceanographic studies in relation to sardine spawning and recruitment off the north-west coast of Spain. The programme includes:
  - (a) a study of the frontal area between Cape Finisterre and the northern area of La Coruna to determine exchange across this region;
  - (b) the computation of upwelling and turbulence indices from coastal wind measurements;
  - (c) sea level measurements from Corrubedo to La Coruna and their relation to wind forcing;
  - (d) direct current measurements off Ria de Vigo during the upwelling season.
6. Olafsson (Iceland) The work of the Marine Research Institute in Reykjavik is concerned with variability in north Icelandic waters and the effect on recruitment. Years when warm North Atlantic Water (NAW) dominates are most productive while cold years, with a significant Polar Water influence are less productive, partly because the NAW is richer in nutrients. In cold years the peak of productivity is in early spring after which the nutrients are exhausted. In warm years the nutrients are replenished by the inflow of NAW and hence productivity continues for a longer period.
7. Howarth (UK) outlined the aims and methods of the British North Sea Programme. Surface salinity and temperature maps constructed from data collected during the monthly survey cruises were shown, which served to outline the reasons for choosing the survey cruise track, i.e. to survey the major estuaries and as much of the southern North Sea as possibly can be traversed in a two week period.
8. Turrell (UK) spoke about observations of the Fair Isle-Dooley current during the Autumn Circulation Experiment (ACE). The current was shown to be largely wind driven with a varying response depending on wind direction and degree of stratification.
9. Griffiths (UK) Over the last 6 years 50% of the staff at the Scottish Marine Biological Association have been made redundant. The Laboratory has recently become a Natural Environment Research Council

Institute and has been renamed the Dunstaffnage Laboratory. Work that continue at the Laboratory includes:

- (a) sea loch studies related to aquaculture;
  - (b) near surface current measurements in the North Sea;
  - (c) benthic fluxes in the North Sea.
10. Cmitrowicz (UK) briefly described a study of the Flamborough front region off the north-east coast of England being carried out as part of the British North Sea Programme. The Universities at Bangor and Lancaster are involved as well as POL, MAFF and the Dunstaffnage Laboratory. The varied instrumentation used includes OSCAR, ADCP, current meters, Lagrangian drifters and aircraft remote sensing.
  11. Rees (UK) presented plans for and some initial results from a 3 year study of fine sediment dynamics off the north-east coast of England. The focus is on the development of suitable instrumentation to determine the erodibility and dispersion of fine grained cohesive sediments and hence to determine the fate of particle bound pollutants.
  12. Saetre (Norway) The monitoring programme of the Institute of Marine Research, Bergen, has been expanded to include chemical (especially nutrients) and biological (especially plankton) sampling.

A working group set up by the Norwegian Government, in the wake of both the recent toxic algal bloom and a seal invasion from the north, has recommended the institution of a monitoring and forecasting system for Norwegian waters. This programme will begin in a small way in 1990.

Activities in the Barents Sea include climatic studies, physical modelling and bilateral cooperation with the USSR, particularly with regard to water exchange between the Barents and Polar Seas.

13. Becker (FRG) The Zirculation and Schadstoffumsatz in der Nordsee (ZISCH) programme ends in autumn 1989. Results to date indicate that during 1988-89 circulation and transport in the southern North Sea was abnormal.

A 3-year modelling study of eutrophication in the German Bight, specifically to study the occurrence and effect of blooms in deoxygenating bottom water under stratified conditions, has begun.

Other new programme include:

- (a) a study of the relations between nutrients and other pollutants;
  - (b) a study sponsored by the Ministry of Science and Technology to optimize sampling in the German Bight for trend analysis.
14. Osborn (USA) spoke about the Global Ecosystems Dynamics (GLOBEC) programme to study and understand ocean ecosystem dynamics and how they are influenced by physical processes so that predictability of population fluctuations in a changing global climate can be assessed.

This National Science Foundation (NSF) initiated programme is planned to run for 10-15 years and linkages with international bodies such as ICES and IOC as well as programmes in other countries are foreseen. NSF funding alone will not be sufficient and hence participation by NOAA and ONR is required, particularly in the area of instrument development.

15. Fennel (GDR) Work is continuing on the transition zone between the North Sea and the Baltic, with particular emphasis on exchanges, forcing mechanisms and interaction with bottom topography. Models, mainly analytical are also being used in these studies.

Analysis of data from PEX is almost complete, though some work is continuing in the biological response to physical variability.

## II. Cod Recruitment

Olafson outline a new Icelandic programme to study early cod and haddock recruitment off south-west Iceland. Previous studies have shown that cod and haddock spawn earlier in the fresher coastal region of the south west, where salinity stratification exists before the onset of thermal stratification further offshore. The eggs and larvae are transported clockwise around Iceland to the nursery grounds off north Iceland. Two sections will be studied, one in this south-west region where transport is dominated by the steady density drive flow and another off the north-west coast where flows are wind driven and more variable.

It was proposed that numerical modelling of this system would identify the dominant processes and highlight data gaps. It was also felt that this region was promising for an international, interdisciplinary recruitment study.

Parallels with the Norwegian coastal current were also discussed.

## III. Nutrient Trend Analysis

Dooley (ICES) The request for this item to be included came from the Advisory Committee on Marine Pollution (ACMP) and is primarily related to the problem of identifying nutrient trends, that may be due to man's activities, from the present data set. The validity of identifying temporal trends from nutrient data normalized relative to salinity was mentioned. The Dutch nutrient data, the only substantial data set submitted to ICES was then discussed. The data showed that although there is a discernible increase in nutrient levels with time, the rise is either not statistically significant or is based on little data.

Otto talked of his work with van Bennekom at the NISR in which they have shown an increase in nutrients in the open areas of the North Sea. Care was taken to differentiate between water influenced by the Rhine and water influenced by the Scheldt and to use only winter data unaffected by productivity.



Otto went onto register some reservations regarding salt normalization for non-passive tracers such as nutrients.

Dahlin Data collected as part of the Baltic monitoring programme shows nitrogen levels in the Baltic to be increasing and there to be an associated change in the make up of the algal population. The rise in nutrient levels is not mirroring trends in the inputs, suggesting that there is a buffering mechanism at work.

Gmitrowicz presented data from a paper by Dickson et al. (1988) that suggests that a single nitrate-salinity relationship has existed for the coastal waters of the whole of eastern England since 1960 despite significant increases in the nitrate loadings of the east coast rivers over this period and the variation in nitrate levels between individual rivers. It is possible that such interpretations are erroneous because the existing data is not of a high enough quality or is too gappy. An alternative explanation is that gross to net nutrient conversion mechanisms in estuaries may be responsible for this effect. To examine this latter possibility a 3-year combined field and laboratory programme to study nutrient transformation in the Wash, the Humber estuary and the Thames estuary is being proposed and if approved will involve cooperation between scientists at the Fisheries Laboratory Lowestoft, several universities and possibly the water authorities.

As to the monitoring of nutrient trends in the future 3 possible schemes were put forward by the working group:

- (a) long-term trends in a region;
- (b) long-term trends in water masses;
- (c) long-term trends in inputs (or outputs) to specific areas.

There followed presentations by Saetre and Dahlin describing the 1988 toxic bloom in the Skagerrak and Kattegat and conditions during the same period of 1989.

#### IV. A Well Instrumented Research Vessel

From the outset of the discussion it was felt by the group that a Theme Session was not the appropriate forum for tackling this topic. The possibility of instituting a study group was mooted but rejected in favour of the formation of a small group (Osborn, Dooley and Dahlin) to report to next year's meeting of the Working Group.

#### V. Shelf Sea Fronts

This session concentrated on the presentation of results from specific studies.

Krause presented some results from a frontal study in the German Bight, in which a large group of scientists was involved.

He concentrated on two types of front:

(a) Tidal Mixing Front (TMF)

TMF's are formed if buoyancy input by surface heating and differential advection dominate mixing by winds and tides. During spring in the German Bight such fronts exist during neap tides but are eroded by the more vigorous mixing during spring tides. In summer time the fronts are maintained throughout the neap-spring cycle. Although surface heating is dominant in forming the fronts, differential advection is subsequently set up leading to a reinforcement of the existing temperature stratification by salinity stratification.

(b) River Plume Front (RPF)

RPF's are relatively short-lived and have large tidal excursions. An aircraft fitted with an active laser sensor was therefore used in their study. The laser can be filtered to give frequencies at which turbidity (by Raman scattering), yellow substance and chlorophyll (both by fluorescence) can be measured. The yellow substance shows a good correlation with salinity and can be converted to salinity if surface calibration samples are taken during overflights. This tool allows water mass maps to be constructed from 2-3 hours of flight time.

Loeng described the structure of the Polar front and a seasonal tidal mixing front in the Barents Sea. The Polar front is well defined near Bear Island, is more diffused in the eastern Barents Sea and varies seasonally.

Mork showed salinity and temperature sections across the front between the North Atlantic current and the Norwegian coastal current which implies a vertical circulation. A similar situation is evident at the Gulf Stream front where observations had recently been made using expendable current profilers and a Batfish. Data from an oxygen sensor mounted on the Batfish again showed evidence of upwelling and downwelling at the front.

Mechanisms whereby wind and entrainment effects can sharpen frontal structure were also outlined.

There appears to be an increase in the amount of effort being put into the study of shelf sea fronts and the group felt that the time is right for a theme session or mini-symposium on interdisciplinary studies of shelf sea fronts.

VI. Sea Level Indices as a Proxy for Time Series of Oceanographic Circulation

The question of whether sea level indices can be used to approximate time series of circulation was put to the Working Group by IREP (now replaced by the Inter-Committee Recruitment Group), partly in relation to the Irminger current and cod recruitment. To help resolve the problem Dr D Prandle of the host institute, an expert of the subject, was invited to speak to the Working Group.

Considering the equations of motion for a fluid, he said that for low frequency flows with small spatial variability and essentially linear function, the sea surface elevation data may be used to detect circulation. He thus felt that the answer to the question is yes, though the condition under which satisfactory estimates can be made are limited.

This point was reinforced by some data present by Turrell for a section across the Fair Isle current between Wick and Lerwick. The first principal component of the flow, which accounted for 75% of the variance, gave a 0.7 correlation with the pressure difference between Wick and Lerwick. Prandle felt that this study is typical in that although there is some relation, it is not fully predictive.

#### VII. Aerospace Remote Sensing

The majority of the Working Group felt that if the Study Group on Aerospace Remote Sensing is to remain in being it can best serve any potential remote sensing users by providing information and fact sheets. There was some feeling, however, that it is not the work of an ICES group to provide information that can be researched by individual scientists.

A theme session on remote sensing should be limited to quantitative applications and not the techniques involved. There was discussion of a standing post session on such quantitative applications, which may encourage marine scientists to use remote sensing as a tool.

#### VIII. SKAGEX

Dahlin reported on the first planning meeting for a Joint Skagerrak Expedition (SKAGEX). The main objectives agreed at the meeting are:

- (a) to identify and quantify various water masses that enter and leave the Skagerrak area with the time aspect involved;
- (b) to link the circulation pattern to external forces and biological phenomena in the pelagic realm;
- (c) to investigate the pathway of pollutants through the Skagerrak;
- (d) to evaluate the results of the exercise in a model.

It is proposed that the exercise will be conducted in 1990-91 and will encompass a synoptic multiship exercise, divided into two fourteen-day sub-periods, followed by smaller investigations covering different seasons.

Members of the working group were in favour of a Skagerrak experiment but felt that to undertake such an exercise as early as 1990-91 did not leave enough time for effective planning based on previous studies in the area. Modelling should also be an aid in planning and not simply an eventual aim.

Criticisms were also made of the restricted period of the main synoptic exercise and the restricted group of countries involved. An

experiment involving the broader community of North Sea countries may be more effective.

IX. Other matters

Prof. Tom Osborn was proposed as the next Chairman of the Shelf Seas Oceanography Working Group on the retirement of Prof. Martin Mork.

Malaga was proposed as the venue for the next meeting of the working group for the period 27-28 March 1990.

In conclusion the Chairman thanked the participants, particularly Dr John Howarth for inviting us to Bidston and for his helpfulness and the hospitality of POL during the meeting.

The meeting closed at 1300 h on 6 April.

## EXECUTIVE SUMMARY SECTION

### I. Cod Recruitment

It was concluded that initiatives should be taken by the Icelandic representative to establish contacts between researchers who are concerned with cod recruitment studies in Canada, Greenland, Iceland and Norway. The aim should be to explore areas of common interests or problems and to seek means to share results and experiences. Clear evidence of the substantial role of physical variability in spawning success was presented to the WG. It is strongly recommended that modelling efforts be started to incorporate the physical variability with the biological process.

### II. Nutrient trends

The W.G. noted the historical trends in nutrient levels in the rivers, as for instance shown in paper CM 1988/C4, and the report by the ICES Hydrographer on the nutrient data in the ICES data base (both from JMG and earlier data). The group discussed the difficulties involved in a trend analysis on the basis of such historical data, as they are scattered in time and place, and especially outside the river plumes this may give problems. English studies (see CM 1988/C4) concluded that no systematic increase of levels in the open sea could be demonstrated along the British coast, and suggested the trapping of nutrients in estuarine or coastal waters. A Dutch study by Van Benekom (to be published soon), however, concludes that in the Southern Bight a significant increase can be shown.

Difficulties to be solved in a general evaluation are those of an appropriate selection of winter data in which productivity is not lowering the nutrient levels, and the application of "normalization" relative to salinity. It was concluded that these difficulties need further discussion before a general procedure can be recommended. A Dutch paper to be presented at the coming ICES Statutory Meeting dealing with these matters might be a basis for such a discussion.

### III. A well instrumented research vessel

Earlier suggestions of a theme session were rejected. Instead a small group (Osborn, Dooley and Dahlin) was appointed and asked to report to the next meeting of the S.S.O. WG. The group was asked to consider ways of increasing benefits from measurements from ships. Two specific aspects are:

1. Recovery and utility of surface temperature, salinity and nutrient data from research vessels underway between stations and ships of opportunity.
2. The comparability of instrumentation and data (e.g. CTD's and navigation) from the many research vessels active in the North Sea and the Baltic region.

The ad hoc group headed by T. Osborn should review the present systems in use, compare requirements for data and indicate appropriate additional systems.

#### IV. Shelf Sea Fronts

There appears to be an increase in the amount of effort being put into the study of shelf sea fronts and the WG felt that the time is right for a theme session or a mini-symposium on interdisciplinary studies on shelf sea fronts. Dr. G. Krause was asked to make preparations for a session at the 1990 - statutory meeting, and to present his suggestions at the next meeting of the WG. Dr. Krause accepted to act as a convener and to establish contacts with possible lecturers.

#### V. Sea level indices as a proxy for timeseries of circulation.

Dr. Prandtl discussed the close relationship between sea level and barotropic circulation. However, the relation is not always and direct - sometimes needing a detailed modelling and verification effort. Hence, statistical relations between tidal data and recruitment data may not reveal relationships with the circulation.

An example provided by B. Turrell showed that 70% of the current meter variance from 5 current meters was in the first principal component. There was 70% coherence with the slope from an appropriate pair of adjacent tide gauges. Dr. Prandtl indicated this level of agreement was typical. The coherence between sea level and current measurement is good but the incoherent fraction of the energy is substantial.

#### VI. Study Group on Aerospace Remote Sensing.

The working group acknowledges the work of the study group and recognize the report as stated: "Remote Sensing of the Ocean: Facts for the Newcomers". It lists the basic information facts on Remote Sensing; Satellite platforms, sensors available and selected bibliography. This is done quite nicely.

From the discussion, however, the following points were stressed: As any instrument to collect data, the integration of satellite data should be planned at the design stage of any experiment. Ship measurements should be allowed for near coast calibration. Mooring array should be designed with the integration in mind. The major advice is not to underestimate the efforts needed to be able to quantify the information obtained by remote sensing. Basically, they are the following:

1. Geometric corrections to produce an undistorted picture in order to compare a series of images, specially NOAA twice-a-day passes.
2. Radiometric corrections, specially needed to take care of the infra-red channel for sea-surface temperature evaluation.

3. To take full advantage of this new technique a discussion and whenever possible a formal collaboration with a scientist involved in remote sensing is advised.

#### VII. SKAGEX

Following a report from Dahlin the WG expressed support to the experiment, but criticised the short planning period and the organization of the experiment. Planning based on previous studies and involvement of a broader community of North Sea Countries would have been desired.

#### VIII. Chairman of S.S.O. WG.

After having served as chairman in 3 years professor Mork asks to be replaced. Professor Tom Osborn accepted to be candidate as chairman.

#### IX. Recommendation for next meeting of WG.

Dr. Castillejo, Malaga, has extended an invitation from his institute to be host of next meeting. The WG propose to meet 27-29 March 1990 in Fuengirola (Malaga, Spain) in order to deal with following items:

- a) to review progress of the Icelandic initiative on cod recruitment studies and to propose further actions,
- b) to review reports on studies of nutrient distributions presented at the 89 - statutory meeting of ICES and other documentation which can advance the work on nutrient trend analysis,
- c) to review report from the ad hoc group (headed by T. Osborn) on ship instrumentation and ways of increasing benefits from measurements from ships.
- d) to discuss a special session (theme session or minisymposium) on interdisciplinary studies of shelf sea fronts at the 1990 - statutory meeting of ICES.

Annex A

Participants of the Meeting

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Annex B

Meeting at Proudman Oceanographic Laboratory (POL), Bidston Observatory, Merseyside L43 7RA, England, 4-6 April 1989.

Tuesday 4 April, 1400-1800 h

Wednesday 5 April, 0900-1800 h

Thursday 6 April, 0900-1300 h

Draft Agenda

1. Opening of the meeting
  - 1.1 Local information
  - 1.2 Appointment of rapporteur
  - 1.3 Review of membership
  - 1.4 Adoption of Agenda
2. Reports on projects and activities in ICES countries (National Reports).

In accordance with resolutions 2.-21, adopted at last ICES meeting the Working Group is asked to:

3. Review progress on oceanographic studies in support of cod recruitment programmes.
4. Discuss the statistical methodology for nutrient trend analysis.
5. Initiate preparation of a 1990 Theme session on "a well-instrumented research vessel".
6. Review research on shelf sea fronts with special emphasis on lateral/vertical circulation patterns and their biological/chemical implications.
7. Evaluate if sea level indices represent a proxy for time series of oceanographic circulation in the ICES area.
8. Review the work of the Study Group on Aerospace Remote Sensing and propose further focussed activities for this Group.
9. Other matters:
  - 9.1 Matters referred to from other working groups.
  - 9.2 Forthcoming meetings.
  - 9.3 Any other business.
  - 9.4 Next Working Group meeting.

