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9–13 MAY 2005

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International Council for the Exploration of the Sea

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Contents

Executive summary

Nineteen ICES working groups had been identified as appropriate candidates to support the REGNS process, and supply advice and data in the compilation and analysis of information required to carry out the pilot Integrated Ecosystem Assessment of the North Sea. This request was included in the ToR for the 2005 cycle of WG meetings, and resulted in 15 responses, with 12 providing substantive input in a suitable format (metadata and/or data compilations; see Table 1).

To assist the progress towards integrated assessment, REGNS 2005 compiled a summary (Table 2) of the information that had been provided to them by this process. This summary table was placed on the REGNS website www.ices.dk/globec/regns, where it is being updated as new information becomes available.

An assessment framework was agreed to deal with differences in the spatial and temporal scales of the data collected. This broadly can be described in two parts, namely; **i)**. an overview assessment of the North Sea whole based upon limited number of parameters observed with long time series and covering the entire North Sea, and **ii)** targeted thematic assessments to integrate spatially and temporally discontinuous data sets within sub-regions of the North Sea. The assessment framework is described diagrammatically in Figure 1.

Since this is a step wise process it was considered essential that a sub-group of REGNS, working as an Intersessional Correspondence Group (ICG), be established to undertake the first steps leading to the ecosystem overview analysis already initiated by REGNS (see following section). A meeting of members of this subgroup was convened on Day 3 to define a work plan to undertake this task and to prepare an assessment paper to be presented at the ICES Annual Science Conference in Aberdeen this year (see abstract Annex 5). Ideally, the data should cover the period from 1950 to present and at a spatial resolution of ICES statistical square (30 by 30 nautical miles) covering regions IV a, b and c and regions IIIa (Skaggerak) and VIId (Eastern English Channel).

The operational procedures to collate the data highlighted in Table 4 (below) for routine periodic assessment (possibly annually) also need to be revised in order to make the procedure more efficient. The data should be readily accessed via the ICES DOME database and it is therefore recommended by REGNS that the Data Centre prioritise the storage, interrogation and retrieval of these data so that minimal effort is required to compile the data for future assessment purposes.

Table 4: List of parameters identified by the ICG for inclusion in the database for the initial (2005) overview assessment (Action 2 in Figure 1).

PLANKTON. (CHL, SP. AB. BIO.)	NITRATE	OXYGEN	WINDS
Demersal Fish (Sp. ab. bio)	Phosphate	Suspended Solids	Freshwater Inputs
Pelagic Fish (Sp. ab. bio)	Silica	Temperature (surface and bottom)	Waves
NAO	Nitrite	Salinity	Flux (water movements)

An initial proof of concept analysis of North Sea data was undertaken and presented at the workshop. From this it was concluded that a full assessment would be of value in better describing spatial and temporal patters in the ecological status of the North Sea and that the REGNS process should proceed to its conclusion in September 2006.

REGNS needs a dialogue with the experts in ICES, within such groups as the IBTSWG. The Study Group believes it is timely that ICES supports an internal dialogue to consider what shape an ideal, coordinated ecosystem monitoring programme for a regional ecosystem might take. As the most wide ranging and frequent North Sea survey programme, the International Bottom Trawl Survey is the most obvious link into a more extensive monitoring scheme. The most appropriate first step, then, might be to convene a joint meeting between REGNS and IBTSWG. This forum could then consider how best to explore future monitoring logistics.

We therefore propose that such a meeting be considered in the form of a one-day workshop to be held in conjunction with the 2006 meeting of the IBTSWG, and attach as Annex 4 draft Terms of Reference for such a meeting.

1 Opening of the Workshop

A Workshop to progress an Integrated Assessment of the North Sea (9–11 May, 2004) and the meeting of the REGNS Study Group (12–13 May 2004) was held at ICES Copenhagen, Denmark.

Andy Kenny (Chair) welcomed the participants (Annex 1) to the Workshop and introduced the agenda for the three day Workshop (Annex 2). There was also a meeting of REGNS following the Workshop (over 2 days) to essentially bring together the findings from the workshop. Andy Kenny emphasised the overriding objective of the Workshop which is to seek agreement on the methodological approach (or framework) for undertaking an Integrated Ecosystem Assessment of the North Sea (IEA) and to agree that such an assessment could realistically be undertaken by ICES. Reference was also made to last years report where definitions of an Integrated Assessment were described (ICES, 2004). The following objectives for the Workshop were introduced:

- Identify and Prioritise key data sets and any gaps
- Define groups of data (spatial and temporal scales)
- Agree on assessment methods and outputs
- Define and agree plan of action for each assessment group
- Agree and define overall reporting structure and format

The discussions in response to these objectives largely addressed the workshop ToR (See Section 2).The first day of the workshop was given to hearing presentations from the various representatives of the working groups who were given common ToR in 2003 and 2004. This was useful in allowing everyone to see the diversity of data and the differences in spatial and temporal scales the various groups deal with. At the end of the first day two presentations were made which introduced some important issues to consider, namely; i) methods for presenting output (see Section 2.2) and ii) how to deal with large spatial and temporal differences in the data sets (see Section 2.1).

2 Workshop to produce a preliminary "proof of concept" integrated ecosystem assessment for the North Sea

The following ToRs were assigned to REGNS to address at the workshop:

i) Compile and synthesise material from the twenty identified "source" Working Groups, which have been requested to provide data, information and indicators;

ii) Produce summary presentations of the material as an overview (e.g., using methods for re-scaling and reducing dimensionality; "traffic lights", etc.,);

iii) Identify gaps in the material provided and the subjects covered;

iv) Review patterns and interactions among the indicators. Preliminary description of system behaviour (e.g., evidence for "regime shift" in the late 1980s) and strength of attribution of causes of observed changes;

ToR i and iii were taken together (see Section 2.1) as they were closely related to each other as were ToR ii and iv (see Section 2.2).

2.1 Compile information from 'Source' Working Groups and identify gaps in the material provided. (ToR i and iii)

Nineteen ICES working groups had been identified as appropriate candidates to support the REGNS process, and supply advice and data in the compilation and analysis of information required to carry out the pilot Integrated Ecosystem Assessment of the North Sea. This request was included in the ToR for the 2005 cycle of working group meetings, and resulted in 15 responses, with 12 providing substantive input in a suitable format (metadata and/or data compilations; Table 1). In addition, OSPAR was identified as a source of information on aspects human activities in the North Sea, and on aspects of chemical contamination and inputs of contaminants to the sea.

Table 1: Summary of responses from ICES 'Source' working groups.

WORKING GROUP	CONTACT	REPORT PROVIDED	REGNS EXAMPLE DATA PROVIDED
WGEF	Maurice Clarke	In progress	-
WGITMO	Stephen Gollash	Y	Y
WGMME	Mark Tasker/ Jim Read	Y	Y
WGECO	Stuart Rogers	Y	Y
WGPE	Francisco Rey	N (*Annual Status Reports*)	N
PGNSP	Martin Holt/ John Siddorn/Hein Rune Skjoldal	Y	Y
WGSE	Stefan Garthe/ Jim Reid	Y	Y
WGZE	Steve Hay	N (*Annual Status Reports*)	N
WGHABD	Jennifer Martin	Y	Y
WGSAEM	Rob Fryer	Y	N
WGMS	Foppe Smedes/ Ian Davies	Y	Y
MCWG	Jacek Tronczy	N (*Held by ICES*)	N
WGFE	Jim Ellis/ Stuart Rogers	Y	Y
WGBEC	John Thain/ Jacob Strand	Y	Y
BEWG	Heye Rumohr/ Silvana Birchenough	Y	N
WGMNM	David Connor	Y	Y
WGPDMO	Thomas Lang/ Werner Wosinok	Y	Y
WGEXT	Sian Boyd/ Poul Eric Neilsen	Y	Y
WGOH	Alicia Lavin/ Sarah Hughes	Y	Y
OSPAR Working Groups	Richard Emmerson/ Ian Davies	Reports available	Y

It was clear from the information received that different groups had approached the task in different ways. In some cases, large tables of data had been provided. In other cases, references had been given to published (or soon to be published) reports, and some other groups had provided metadata indicating the scope of information to which they had access. To assist the progress towards integrated assessment, REGNS 2005 compiled a summary (Table 2) of the information that had been provided to them by this process.

This summary table was placed on the REGNS website www.ices.dk/globec/regns, where it is being updated as new information becomes available. For example, inflows to the North Sea estimated by the NORWECOM model were added on 24 May. The table includes links which

either provide access to the data or give further information on what is available and where it may be accessed.

Table 2: Data available for REGNS from ICES, OSPAR and SAHFOS.

DATA SOURCE	DATA ITEMS	DATES	TIME UNIT	SPACE UNIT	CURRENT REPORTING ARRANGEMENTS	NOTES
ICES	Oceanography	1973–2004	Month	ICES rectangle	Annual report on ocean climate available through ICES website	Also earlier years. Includes nutrients, Chl, oxygen
ICES	Fish assessment output	1960 – 2004	Year	North Sea	Annual assessments published by ICES	
ICES (Fishstat)	Fish landings	1970 – 2004	Year	IV a, b, c	Annual data collated and assessed by various ICES WGs.	
ICES DATRAS	Trawl survey (IBTS)	1965–2005	Quarter	ICES rectangle	Annual data collated and assessed by various ICES WGs.	
PGNSP	Water mass fluxes (depth integrated)	Jan 1955–March 2005	Monthly	13 selected sections or parts of sections throughout NS	IMR NORWECOM model data matrix (13 sections x 600 months (1955–2004) available at REGNS website	Monthly means of temporally highly resolved model output calculated separately for flow in (south or east), out (north or west) and net
MCWG	Contaminant concentrations in fish and shellfish	1978 – 2003 but very variable between locations	Mostly annual	North Sea	Not formally reported or assessed by MCWG	Data available on ICES database, subject to ICES data policy.
OSPAR	MON2004 CEMP assessment of temporal changes in contaminant concentrations in sediment	1978 – 2003 but very variable between locations	Mostly annual	North Sea	Report to be published on OSPAR website in mid-2005	To be published by OSPAR and repeated annually, at a reduced intensity.
OSPAR	MON2004 CEMP assessment of temporal changes in contaminant concentrations in biota	1978 – 2003 but very variable between locations	Mostly annual	North Sea	Report to be published on OSPAR website in mid-2005	To be published by OSPAR and repeated annually, at a reduced intensity.
OSPAR	Temporal trend analysis of riverine and direct discharges (RID) of contaminants	1992 – 2003	Annual, but based on more detailed information	OSPAR Regions	Report to be published on OSPAR website in mid-2005	Report and data available from OSPAR website. Full detailed data only available from Contracting Parties.
OSPAR	Temporal trend analysis of atmospheric inputs (CAMP) of contaminants	1990 – 2003	Annual	OSPAR Regions	Report to be published on OSPAR website in mid-2005	Report and data available from OSPAR website.

DATA SOURCE	DATA ITEMS	DATES	TIME UNIT	SPACE UNIT	CURRENT REPORTING ARRANGEMENTS	NOTES
OSPAR	MON2004 preliminary assessment of TBT effects (imposex/intersex) in gastropods	Mainly 2000 – 2003. Some older.	Mostly annual	North Sea	Report to be published on OSPAR website in mid-2005	MON2005 plans to update their preliminary assessment, using OSPAR assessment criteria
SAHFOS (CPR)	Plankton, Chl	1948 – 2003	Month	IV a, b, c	Routine ecological status reports in SAHFOS annual report, and available through their website.	Full taxonomy and ICES rectangles from WinCPR
WGBEC	Biological effects of contaminants in fish	1993 – 2004	year	point obs. UK, N, F	Not formally reported or assessed by WGBEC. Potential for coordinated assessment to be considered by OSPAR MON2005.	PAH-specific effects Metal-specific effects General effects
WGBEC	Biological effects of contaminants in marine snails	1997 – 2004	year	point obs. UK, N, S, DK	Not formally reported or assessed by WGBEC. Potential for coordinated assessment to be considered by OSPAR MON2005.	Imposex/intersex mainly in Nucella, but also in Buccinum, Hinia, Neptunea and Littorina.
WGECO	No data to contribute	N/A	N/A	N/A	N/A	WGECO contribute to the scientific process, particularly on the scope of the work (WGECO 2005 report)
WGEF	Currently working on data for 5 elasmobranch species	?	?	?	No report yet available.	
WGHABD	www.ifremer.fr/envlit/documentation/dossiers/ciem/aindex.htm				Two Tables provided	
WGITMO	Introduced spp	Long time series	Annual	point obs.	Report available	Report and data
WGMME	Marine mammals	2000–2004		10*10km	Report available	Report and data
WGMS (ICES data)	Metals in sediment	1985–2003	Variable 1–10 years	North Sea (mainly Coast and Estuaries)	Not formally reported or assessed by WGMS.	Data normalized on Al or from sieved fractions.
WGMS (ICES data)	Organic contaminants in sediment	1985–2003	Variable 1–10 years	North Sea (mainly Coast and Estuaries)	Not formally reported or assessed by WGMS.	Data normalized on CORG, limited data available for sieved fractions.
WGMS (ICES data)	TBT in sediment	1998–2003	Variable 1–3 years	Few on North Sea (mainly Coast and Estuaries)	Not formally reported or assessed by WGMS.	Data normalized on CORG, limited data available for sieved fractions.
WGPE	No response	No response	No response	No response	Annual status report available on ICES website.	REGNS will obtain plankton data from CPR records

DATA SOURCE	DATA ITEMS	DATES	TIME UNIT	SPACE UNIT	CURRENT REPORTING ARRANGEMENTS	NOTES
WGSE	Breeding bird numbers	1970 – 2004	Annual in some cases. Others 15 year cycle.	ICES Regions	WGSE 2003 listed numbers by ICES region. Annual national reports.	See also WGSE 2004 report.
WGEXT	Dredging of marine aggregates	1998– 2004	Year	km2 UK, N, S, DK, B, D, NL	Data collated annually in WGEXT report on behalf of OSPAR.	Licensed areas, actually dredged areas, quantity dredged, sediment type dredged.

There was a productive discussion during the Workshop on the types of information which would be needed to fulfil the REGNS objectives, and the temporal and spatial scales which should be considered. As a result, a tabulation of metadata was compiled, reflecting the datasets required to carry out a comprehensive IEA, and indicating the existence and availability of these data over a range of space and time-scales (see Annex 3). The metadata were ordered into three categories: abiotic, biotic and human activities. Some categories of data, such as salinity, are available in a variety of space and time scales and this has been reflected in the table. Individual data types were assigned one of two priorities. Priority 1 data were considered to be of relevance to a more immediate overall integrated assessment of the status of the whole of the North Sea, whilst priority 2 data were regarded as being more suitable for either more localised or more theme-specific IEAs. This is discussed further below.

The compilation and synthesis of information and data revealed a considerable amount of spatial and temporal variation. In general, it was observed that certain types of data, notably related to fisheries, physical oceanography, plankton and nutrients, were measured typically throughout the North Sea, with many programmes covering several decades of observation (Annex 3). Other sources of data, notably: biological effects (ecotoxicology), sediment chemistry (contaminants), species introductions, hazardous algal blooms in coastal waters and benthos surveys (to name a few) tend to be more localized (for example concentrated in coastal waters) or cover a more limited period of time, i.e., years rather than decades. This division is not by chance, it simply reflects that a number of monitoring and R&D programmes have been established in response to specific human activities, or more localised phenomena, which often are managed by specific licensing and regulation regimes. Other programmes measure processes and state changes driven by natural forces on a wide scale. The exceptions to this are the fish stock assessment programmes which are subject to regulation and management, but which also have wide spatial coverage. Clearly, an assessment framework is required which reflects this fundamental division in the types of data available.

Figure 1 (below) describes the Integrated Ecosystem Assessment framework concluded by the REGNS workshop following extensive discussions and drawing heavily on the work of WGECO at their meeting in 2005. It begins with the sources of data being compiled and synthesized into a metadata table (Annex 3). This is then used to identify those data sets which provide comprehensive spatial and temporal coverage at the North Sea scale, and from which a data matrix can be constructed to underpin an integrated ecosystem assessment or "ecosystem overview". Both detailed spatial and temporal analysis of this overview matrix, aimed at regional classification, will set the backdrop and inform more localized spatial, temporal and issue-specific "thematic" integrated assessments. These thematic assessments will utilise additional data identified from the metadata table (Annex 3) not previously used in the overview assessment.

Since this is a step wise process it was considered essential that a sub-group of REGNS, working as an Intersessional Correspondence Group (ICG), be established to undertake the first

steps leading to the ecosystem overview analysis already initiated by REGNS (see following section). A meeting of members of this subgroup was convened on Day 3 to define a work plan to undertake this task and to prepare an assessment paper to be presented at the ICES Annual Science Conference in Aberdeen this year (see abstract Annex 5). The ICG discussed the data format requirements (Table 3) and list of parameters to be used (Table 4), which are reflected in the comprehensive metadata table (Annex 3).

Ideally, the data should cover the period from 1950 to present and at a spatial resolution of ICES statistical square (30 by 30 nautical miles) covering regions IV a, b and c and regions IIIa (Skaggerak) and VIId (Eastern English Channel). The data providers should either provide raw data on a site (station) specific basis (supported by positional data e.g., latitude and longitude) or as averaged data for each ICES statistical square. In the case of the former the data will be averaged by statistical square for the purposes of analysis. It was agreed that a database would be constructed and maintained initially by FRS Aberdeen, and specific actions were identified to populate it (Table 5), with data sets to be forwarded to Doug Beare at FRS before the end of June 2005.

Table 3: Format requested by ICG.

LATITUDE	LONGITUDE	YEAR	MONTH	ICES STAT. SQUARE	PARAMETER MEASURED

The ICG noted that some important data sets did not readily conform to the requirements for complete time series with full spatial coverage over the North Sea as described in the above text. Examples of these included data on contaminant concentrations in biota and sediments, and numbers of (breeding) seabirds. In the case of contaminant concentrations, the data emphasize the coastal zone. Breeding seabird numbers are obtained from coastal breeding colonies, but to some degree reflect conditions in the wider coastal zone and could be considered to be relevant to the wider North Sea. Similarly, some of the environmental parameters which may be considered to drive the system operate at the margins of the North Sea. Examples include the fluxes of fresh and salt water into and out of the North Sea, and the inputs of contaminants to coastal waters.

Table 4: List of parameters identified by the ICG for inclusion in the database for the initial (2005) overview assessment (Action 2 in Figure 1).

PLANKTON. (CHL, SP. AB. BIO.)	NITRATE	OXYGEN	WINDS
Demersal Fish (Sp. ab. bio)	Phosphate	Suspended Solids	Freshwater Inputs
Pelagic Fish (Sp. ab. bio)	Silica	Temperature (surface and bottom)	Waves
NAO	Nitrite	Salinity	Flux (water movements)

Table 5: List of actions to supply data to FRS Aberdeen.

DATASET	ACTION
Nutrients, Silica, Oxygen, Suspended solids	Doug Beare
Salinity and Temperature	Sarah Hughes
Fluxes	Hein Rune Skjoldal and Geir Ottersen
Plankton	Andy Kenny, Sophie Pitois and John Siddorn
Winds	John Siddorn
Freshwater (river) inputs	John Siddorn and Ian Davies
Demersal Fish (species, densities, age, length etc)	Doug Beare
Pelagic Fish (species, densities, age, length etc.,)	Doug Beare
Seabirds	Jim Reid
Marine mammals	Jim Reid
Contaminants	Ian Davies
Fish Diseases	Werner Wosinok

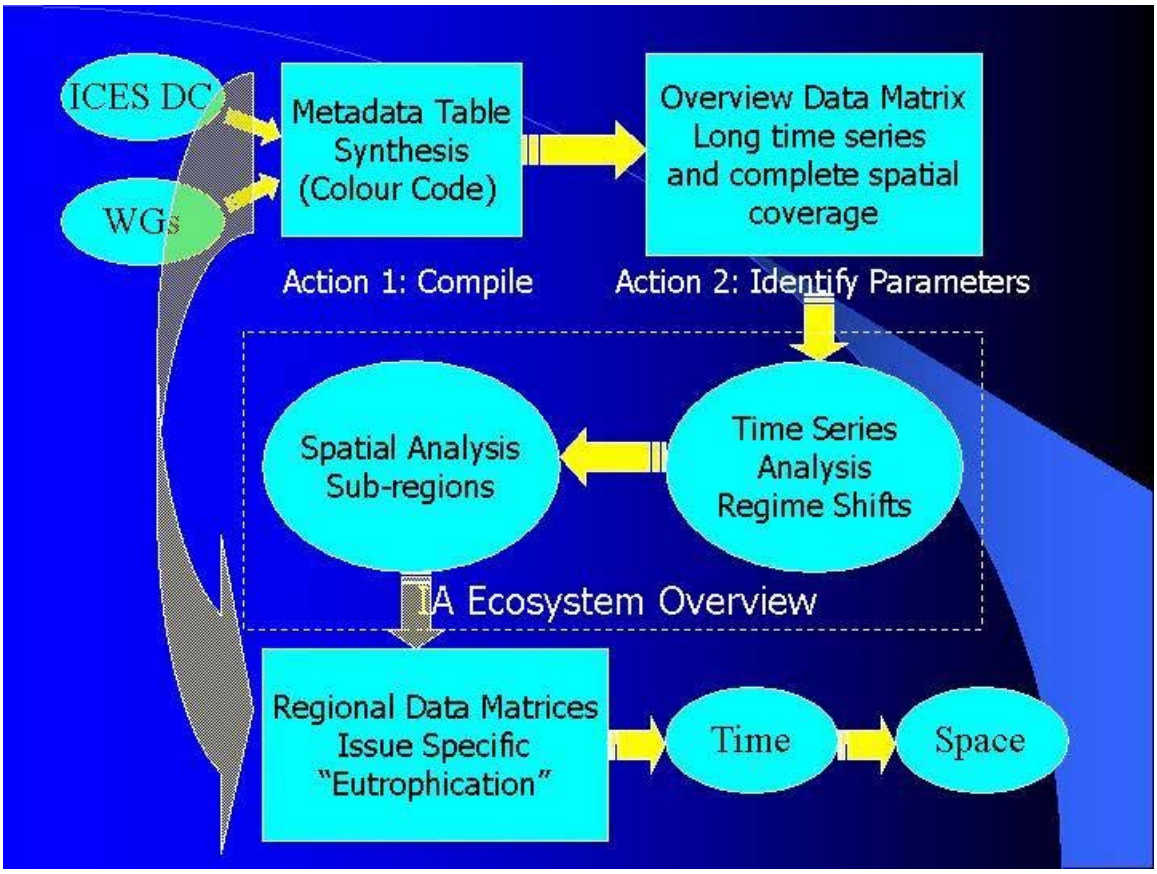

Figure 1: Integrated Assessment Framework showing the stages in the data collation and assessment process, namely; i) sources of data from working groups and the ICES Data Centre are identified, ii) a compilation of metadata created to inform the spatial and temporal characteristics of the data sources, iii) a database consisting of long time series and wide spatial coverage is created for the North Sea. iv) a numerical assessment of the data to investigate spatial and temporal trends is undertaken. Spatial analysis will identify sub-regions within the North Sea which are consistent over time. v) Identified sub-regions will assist the production of thematic assessments which tend to be site specific.

The operational procedures to collate the data highlighted in Table 4 for routine periodic assessment (possibly annually) also need to be revised in order to make the procedure more efficient. The data should be readily accessed via the ICES DOME database and it is therefore recommended by REGNS that the Data Centre prioritise the storage, interrogation and retrieval of these data so that minimal effort is required to compile the data for future assessment purposes.

Overall North Sea IEA timetable

The ICG will complete the overview assessment to be presented at the ICES ASC in Aberdeen in September 2005. Discussions with the Chair of the IBTSWG will also be initiated to agree on the scope of any possible joint meeting between REGNS and IBTSWG at the ASC. Thematic Assessments will largely be the subject of the workshop in 2006 – 'doing workshop' (time and place to be confirmed). Work on the thematic assessments will be progressed intersessionally leading to their completion and presentation as a series of papers at the 2006 ASC in an IEA theme session. The overall timetable of key events is shown in Figure 2 below:

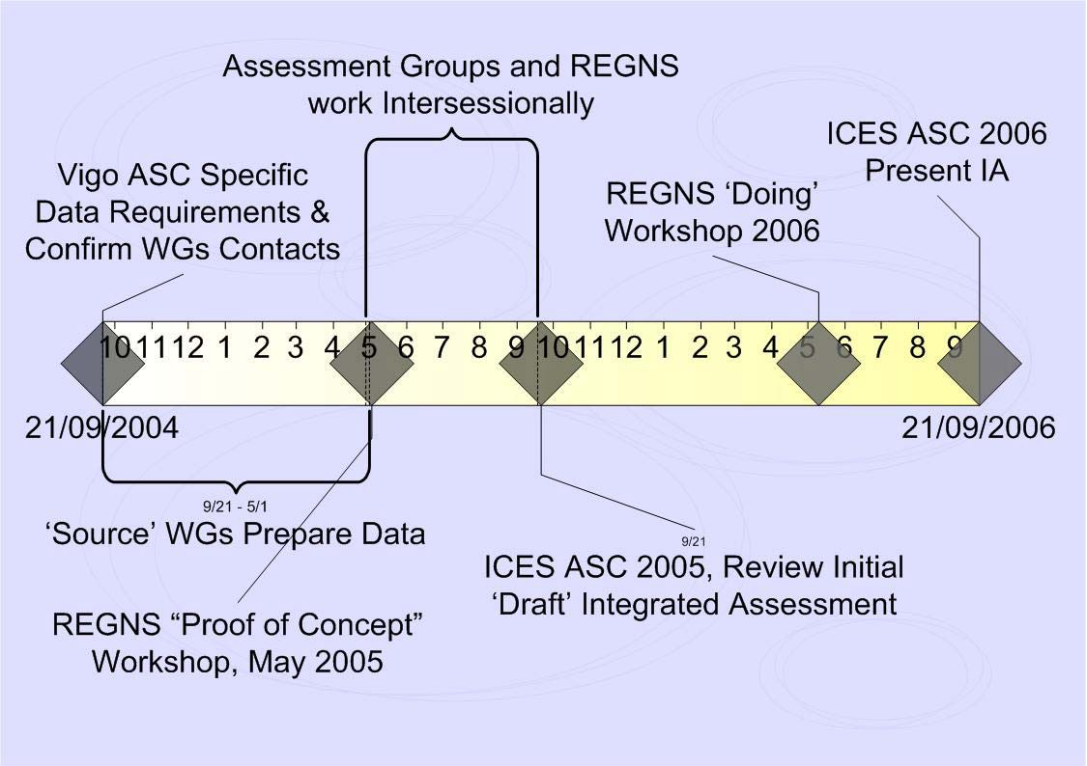

Figure 2: Overall timetable showing timing of key milestones.

2.2 Produce summary presentations and review any preliminary trends and patterns in the data

2.2.1 Introduction

Ecosystem status reports and integrated ecosystem assessments have been produced for the Eastern Scotian Shelf (DFO, 2003; Choi *et al.*, 2005). An essential, but difficult, part of such exercises is to extract some understanding of the functioning, changes and "health" of the ecosystem without becoming swamped by information from the large number of variables (indicators) which are used to measure many aspects of the physical, chemical and biological state of the system.

One of the methodologies, used by Canadian colleagues, involves rescaling and reducing dimensionality. The changes over time can then be presented on a common scale, which is useful for giving an overview and as a preliminary step in identifying coherent patterns of change. With their assistance, an analysis of North Sea data was carried out as part of the preliminary "proof of concept" approach adopted by the REGNS workshop.

The analysis presented here serves to introduce the methodology, show how the results can be presented and provide a rationale for assembling data sets. Even such a preliminary analysis identifies some of the major changes in the physical and biological state of the North Sea that have occurred over the past three decades. In particular, it brings out a fairly abrupt change that took place in 1987–1988 and has been described as a "regime shift" (Reid *et al.*, 2001; Beaugrand, 2004). This is discussed in relation to recent publications dealing with major ecosystem changes in the North Sea and eastern North Atlantic.

Rescaling and reducing dimensionality can provide an effective way of presenting and simplifying multiple data sets and as such contribute to an integrated ecosystem assessment. The strengths and limitations are discussed, together with a proposal for further development of the approach.

2.2.2 Approach

Choi *et al* (op. cit.) comment on the importance of data selection and give criteria for selection of data. For this preliminary analysis of North Sea data the principal criterion has been data availability at appropriate spatial scales and duration. Values were averaged over three areas corresponding to ICES regions IVa, b and c. The data, which include biotic, abiotic and human variables, are listed in Table 6. They come from three sources: the Continuous Plankton Recorder survey (SAHFOS), the ICES oceanography database and the ICES fisheries databases.

The variables (indicators) were compared with each other by presenting them in the order of the first eigenvector obtained from a multivariate ordination, so that the indicator sequence reflected the degree of similarity in their temporal dynamics. The way that suites of the variables changed over time could therefore be visualised. Annual variables were coloured from red through orange to green as the standardised anomalies changed from –3 to +3 (in units of standard deviation – see key on Figure 2). Missing data were shown in white (Choi *et al*., op.cit.).

2.2.3 Results

The results of the analysis are presented as the sorted standardised anomalies of the indicators used (Figure 3). A fairly abrupt transition occurred in 1987–1988. Phytoplankton (CPR index) and temperatures increased while SSB and landings of a number of fish species decreased. A time-series of the composite variables (PCA1), that summarises some of the changes observed in the North Sea , which accounts for ~25% of the total variation in the data, contrasts the cool, low phytoplankton period prior to 1987 with the warm, high phytoplankton period since 1988 (Figure 4). Points for 2004–2005 should be ignored as the data set was incomplete.

Table 6: North Sea variables used in the analysis sorted on the first axis of variation.

CODE USED IN FIGURE 2	VARIABLE	STD. ANOMALY (FIRST AXIS)	STD. ANOMALY (SECOND AXIS)
Green - N	Greenness (Chl) N. North Sea	0.8	-0.22
Green - C	Greenness (Chl) Central North Sea	0.79	-0.2
SST - N	Surface temperature N. North Sea	0.72	0.22
F - Mack	Mackerel Fishing mortality	0.71	0.31
F - EPlaic	Plaice Fishing mortality	0.69	-0.09
Land -HM	Horse mackerel landings	0.68	-0.42
SST - S	Surface temperature S. North Sea	0.64	0.11
Land - BW	Blue whiting landings	0.62	-0.19
SST - C	Surface temperature Central North Sea	0.57	0.22
BoT - N	Bottom temperature N. North Sea	0.54	0.22
Land-Monk	Monkfish landings	0.5	-0.39
TotB - CSole	Sole total biomass	0.48	-0.58
Land-Angler	Angler landings	0.45	0.11
Land-CEC	Cockle landings	0.45	-0.67
Land-Redf	Redfish landings	0.43	-0.62
F - EHake	Hake Fishing mortality	0.42	-0.47
Land - Mac	Mackerel landings	0.37	0.4
TCop - C	Total copepods Central North Sea	0.37	-0.38
Land - Her	Herring landings	0.37	-0.46
Land - ESprat	Sprat landings	0.35	0.68
Land - CSole	Sole landings	0.33	-0.48
BoT - C	Bottom temperature Central North Sea	0.27	0.18
F - COD	Cod Fishing mortality	0.26	-0.16
Land-Brill	Brill landings	0.24	0.54
SSB - CSole	Sole SSB	0.22	-0.41
Land-Argen	Argentine landings	0.19	-0.56
R - CSole	Sole Recruitment	0.17	-0.22
F - CSole	Sole Fishing mortality	0.16	-0.01
Chl - C	Chl a Central North Sea	0.15	-0.54
TCop - S	Total copepods S. North Sea	0.14	-0.33
Cal - N	Calanus N. North Sea	0.1	-0.13
Chl - S	Chl a Southern North Sea	0.08	0.14
BoT - S	Bottom temperature S. North Sea	0.03	-0.22
Green - S	Greenness (Chl) S. North Sea	-0.07	0.04
TCop - N	Total copepods N North Sea	-0.07	0.04
R - Mack	Mackerel recruitment	-0.07	0
Land - Mack	Mackerel landings	-0.11	0.11
Chl - N	Chl a N. North Sea	-0.13	-0.07
Land-Halibut	Halibut landings	-0.16	0.2
SSB - Hadd	Haddock SSB	-0.17	0.61
Cal - S	Calanus S. North Sea	-0.18	0.38
Land-CD	Common dab landings	-0.2	0.62
Cal - C	Calanus Central North Sea	-0.2	0.07
R - Saith	Saithe recruitment	-0.24	0.17
R - EPlaic	Plaice recruitment	-0.26	-0.29
TotB - Hadd	Haddock total biomass	-0.29	0.24
Land - EPlaic	Plaice landings	-0.35	-0.74
R - Hadd	Haddock recruitment	-0.41	0.01
F - Saith	Saithe Fishing mortality	-0.41	-0.74
R - EHake	Hake recruitment	-0.42	-0.13

CODE USED IN FIGURE 2	VARIABLE	STD. ANOMALY (FIRST AXIS)	STD. ANOMALY (SECOND AXIS)
TotB - Saith	Saithe total biomass	-0.44	0.61
TotB - EPlaic	Plaice total biomass	-0.5	-0.62
Land-BMus	Blue mussel landings	-0.53	0.21
Land - EHake	Hake landings	-0.53	-0.74
F - Hadd	Haddock Fishing mortality	-0.54	-0.6
SSB - Saith	Saithe SSB	-0.56	0.75
SSB - EPlaic	Plaice SSB	-0.56	-0.64
Land-BLing	Blue ling landings	-0.57	-0.31
R - COD	Cod recruitment	-0.66	-0.14
SSB - Mack	Mackerel SSB	-0.72	0.03
Land-AWolf	Wolffish landings	-0.74	-0.5
TotB - Mack	Mackerel total biomass	-0.75	0.12
Land - Hadd	Haddock landings	-0.82	0.13
TotB - COD	Cod total biomass	-0.82	-0.12
Land - COD	Cod catch	-0.83	-0.12
TotB - EHake	Hake total biomass	-0.85	0.02
Land - Saith	Saithe landings	-0.86	0.06
Land - Whitin	Whiting landings	-0.9	-0.14
Land - Cod	Cod landing	-0.9	-0.17
SSB - EHake	Hake SSB	-0.91	-0.07
Land-Salm	Salmon landings	-0.92	0.12
SSB - COD	Cod SSB	-0.92	-0.01

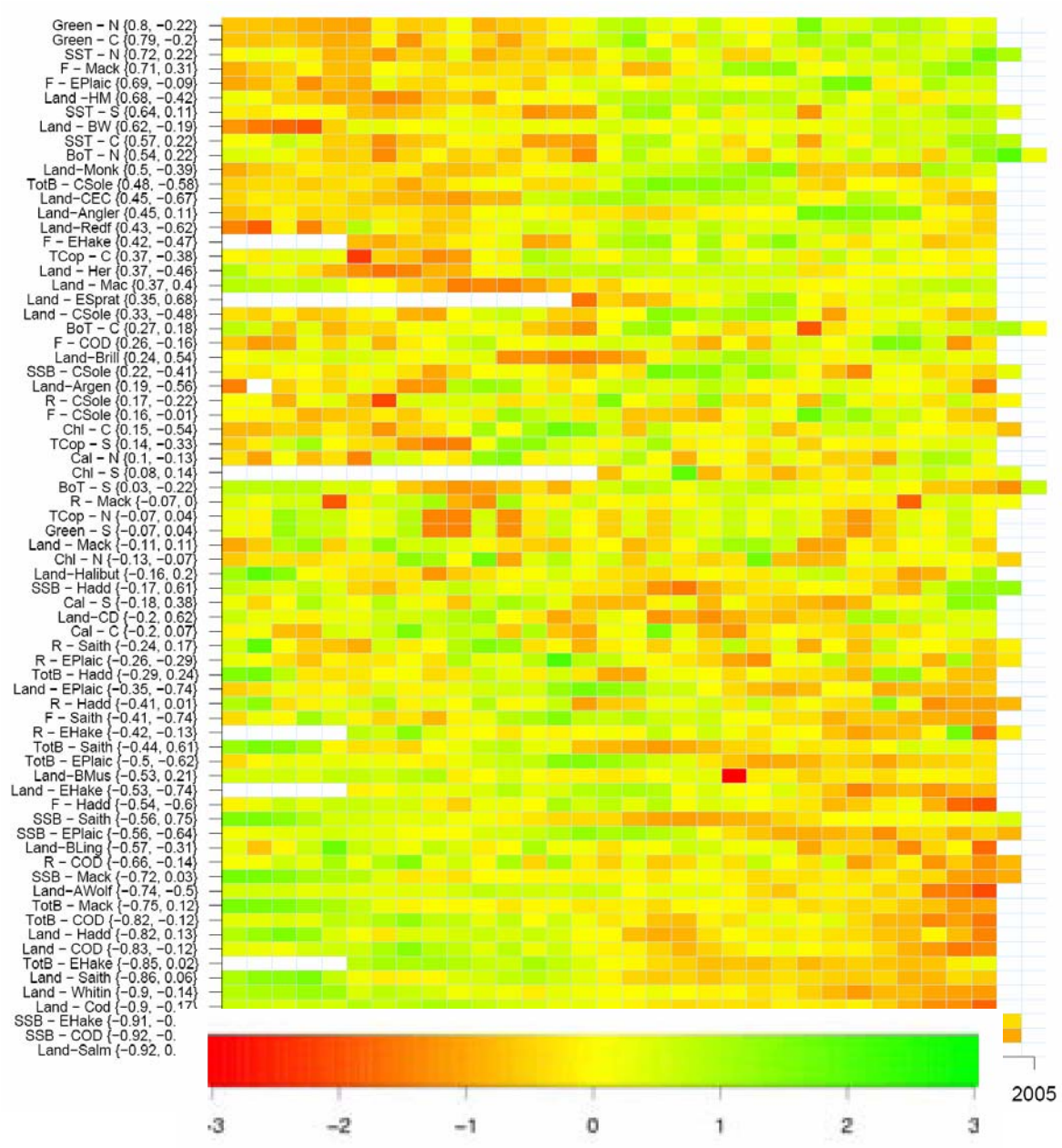

Figure 3: Sorted standardised anomalies (standard deviation units) of the indicators of the North Sea. The sort sequence is based upon the first axis of variation. Factor loadings of the first two axes of variation are in parentheses {} and are also shown in Table 6.

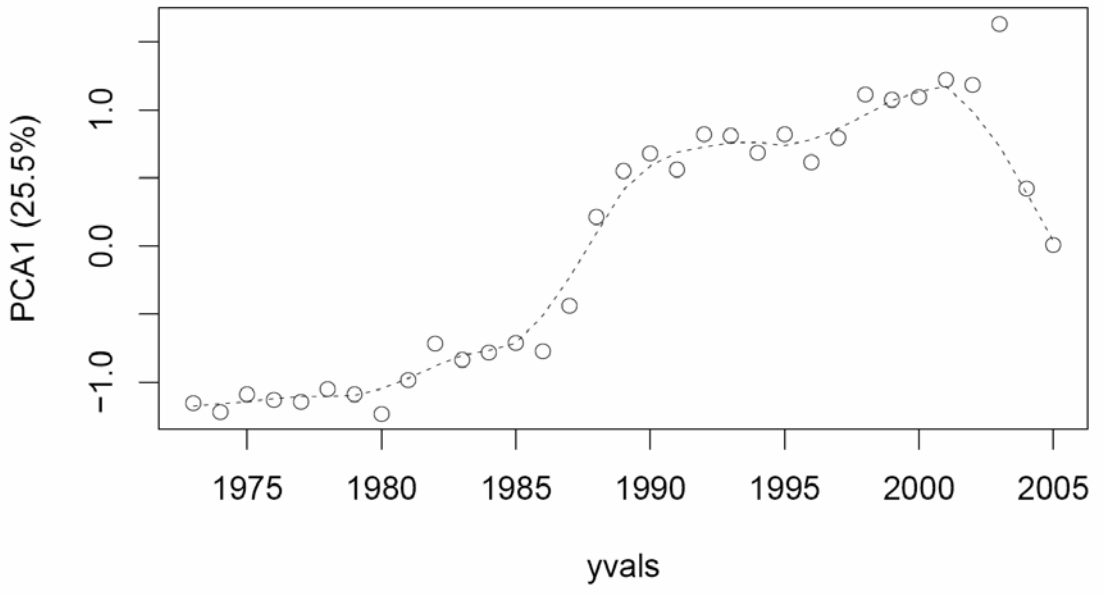

Figure 4: Time-series of the composite variables (PCA1) that summarises some of the changes observed in the North Sea.

2.2.4 Discussion

The results from this preliminary analysis are very similar to published analyses of substantially the same data set (Reid *et al*., 2003; Beaugrand, 2004) which examined the evidence for the "regime shift" in 1987–1988 and moved on to explore causes, mechanisms and consequences. Large scale hydro-meteorological forcing was identified as a major contributor to the observed changes and acted in a number of ways. The Working Document presented to REGNS by Skjoldal *et al*. reinforces the published analyses in showing that inflows into the northeastern North Sea increased sharply in 1988 (Figure 5), with consequences for temperature, plankton and fish.

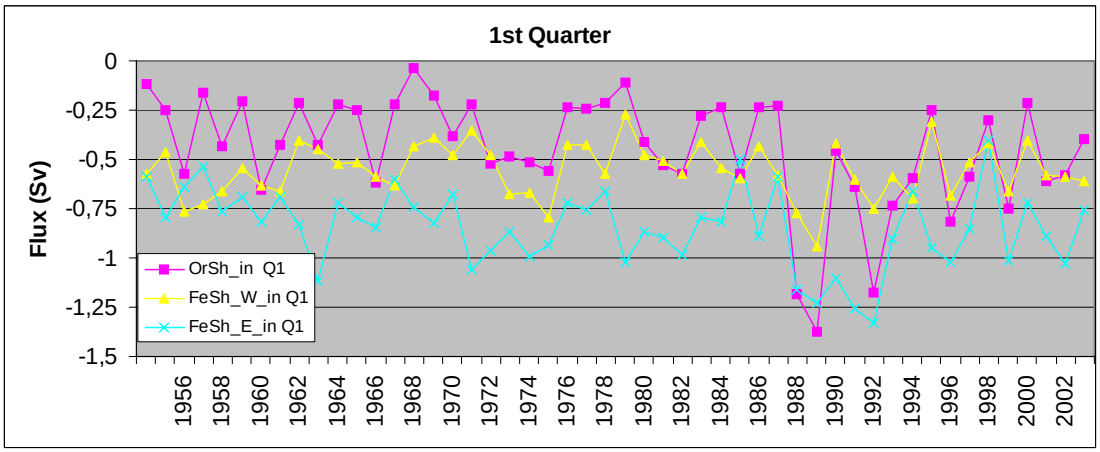

Figure 5: Time series of southwards (in) fluxes across the northern boundaries to the North Sea shown as averages for the 1st (January-March) over the period 1955–2004. The northern boundaries are made up of the section between Orkney and Shetland (OrSh) and the western and eastern parts of the Feie-Shetland section (FeSh). From Skjodal *et al* REGNS Working Document.

More detailed published analyses of changes in the North Sea plankton show that the population of the previously dominant copepod species, *Calanus finmarchicus* declined and was re-

placed by southern species. (Beare *et al*, 2004). The seasonal timing of plankton production also altered in response to climate changes. This has consequences for plankton predator species, including fish, whose life cycles are timed in order to make use of seasonal production of particular prey species (Edwards and Richardson, 2004). The survival of young cod in the North Sea appears to depend on the abundance, seasonal timing and size composition of their prey. Changes in all of these since 1958 resulted in increased survival and good recruitment of cod throughout the 1960s and 1970s and then a progressive decline over the past thirty years (Beaugrand *et al*, 2003).

We now consider the methodology and presentation used in the analysis presented here. The integration and visual display of data sets in a 'traffic light' approach have been used effectively as part of the Eastern Scotian Shelf Integrated Management (ESSIM) process (Choi *et al*, 2005) and similar methods have been used by Link *et al* (2005) for the US NE shelf area. Although the method has broad application in regional ecosystem assessments, the availability of consolidated and time-series data, normalised to an appropriate mean value, is a fundamental requirement. In the eastern Scotian Shelf example, a wide range of biotic and abiotic variables were available for the description and interpretation of underlying causes. Thirty nine first-order indicators of the ecology of the ESS were chosen based upon data availability, reliability and relevance. Most data were annual and extended back to at least 1960. Biotic variables included the abundance, distribution and composition of finfish, invertebrates, phytoplankton, zooplankton and marine mammals while abiotic variables included oceanic and atmospheric indicators of ocean climate. Human variables included fishery landings and revenue, area of bottom trawled and the population size of Nova Scotia.

The interpretation of visual patterns in the traffic light display highlights important signals in the ESS ecosystem. As with the preliminary analysis for the North Sea shown above, the presentation provides an overview of changes in key ecosystem components and can therefore form an important part of an integrated ecosystem assessment at the regional scale. However there are a number of limitations with the approach and other forms of analysis, targeted assessments and data interpretations should also be employed (ICES, 2005).

One of the limitations relates to the need to represent multidimensional relationships between data in only two dimensions. Relationships between individual ecosystem attributes (displayed as rows) can only be inferred by their adjacency within the display. Therefore every attribute, except the very top and bottom rows, has two equally close linkages, two linkages one step removed, and so on. This will distort the reality that some attributes have many linkages that are strong and direct, while other attributes may have few linkages that are weaker and indirect. This aspect will be considered further during intersessional work.

Careful selection of the biotic, abiotic and human variables for use in the integrated assessment is essential, and need not be dependent only on those that are available, well understood and routinely collected. Ideally the selection of attributes should reflect fundamental understanding of the ecosystem and have clear links to management process. Using only easily available datasets in such an integrated assessment may lead to an unbalanced presentation. Some ecological components (e.g., fish abundance) have multiple measurements and can therefore occupy many rows in the matrix whereas others (e.g., benthos, phytoplankton) that are difficult to measure are represented by only one or a few rows. This in effect introduces a weighting and will distort the interpretation of the different types of ecosystem components, because an entity represented by many rows would look much more important than one represented by few.

The transitions in colour-coding, are consistent within a variable, but are not calibrated across different types of variables. Thus a change over time in colour-coding (e.g., green to red) does not necessarily have the same ecological significance for one attribute as it does for another.

Rescaling and reducing dimensionality, combined with traffic light presentation are useful in communication and high-level interpretation. They help to identify major system changes whose causes and dynamics can then be explored using other methods. The approach is particularly useful as an early tool in the process of building an ecosystem assessment, but should not be regarded as an end-product in itself.

As with any presentation of a large body of information about a complex system, a traffic light display, with many long time-series datasets, can be interpreted by different users in different ways. There is a danger that it may be used to support their preconceptions and entrench opposing positions rather than helping to resolve differences.

3 REGNS meeting 12–13 May 2005

3.1 Measuring impacts of past management actions at the system level; issues of predictability and impact of future management actions

The issues of measuring and predicting impacts of past and future management actions are closely related to our ability to assess the impacts of various human activities on the ecosystem. This ability is currently limited for several reasons. The ecosystem components are interlinked in food webs. Therefore, direct effects on species and populations are commonly associated with indirect effects mediated through food web interactions. Different pressures may also have an impact on the same ecosystem components, directly or indirectly. Assessments of indirect effects and impacts from multiple pressures are notoriously difficult to undertake and present a fundamental challenge when conducting an integrated assessment.

ICES has been involved in environmental assessments over the last two decades. From the definition and statement of purpose contained in advice from ICES ACMP in 1988 (ICES, 1988), it is clear that this was broadly the same process and product that we now are considering under the name of integrated assessment. ICES co-sponsored the North Sea Task Force (NSTF), which produced the 1993 Quality Status Report (QSR) for the North Sea, and ICES also provided input and advice to the work of OSPAR in the 2000 QSR, including peer review of the major part of that report. Based on those experiences, ACME in 2000 provided advice on major obstacles and limitations and on how to improve the process and product of an environmental assessment (ICES, 2000). Difficulties identified by ACME included data handling and data availability, including lack of data, for example, on inputs of trace organic contaminants and biological data from outside the fisheries sector.

WGECO considered the REGNS integrated assessment of the North Sea ecosystem as one of their ToRs and in that context summarised experiences from Canada in conducting similar assessments (ICES, 2005). The Canadian approach includes two types of document:

1) a descriptive Ecosystem Overview Document that presents information on current status and recent trends for as many ecosystem components and human activities as possible; and

2) an Ecosystem Assessment Document that integrates the descriptive information presented in the Ecosystem Overview Document. The integration would be step-wise including consideration of physical and chemical drivers for biological change, interactions among biological components, and considerations of pressures and impacts from human activities.

WGECO suggested an approach for integrated assessment based on two tabulations. One table provides an overview of the interaction between specific mechanisms of pressure and individual ecosystem components. The second table provides an overview of the relationship be-

tween the human activities in or affecting the North Sea and these mechanisms. The approach links change in the state of ecosystem components with the pressures that may have contributed to that change. The approach will also allow direct links to be made between the data-sets supplied and potential indicators that have been derived for them in several international fora.

REGNS considered that the approach suggested by WGECO provided a helpful summary of most of the major considerations required in the assessment of compiled data-sets. These factors are included implicitly in the metadata table compiled at the Workshop (Annex 2). We are aware, however, of the basic difficulties inherent in the assessment of indirect and multiple effects from various human activities, and that there are no 'quick fixes' that resolve these difficulties. We anticipate that it will be necessary to have a dual approach in which the assessment of integrated data-sets is supplemented with more in-depth and diagnostic analyses of causal chains in thematic assessments, and at scales appropriate to the dynamics of the ecosystem (e.g., flux of nutrients and contaminants, and migration of organisms). However, we recognise that an advantage of the Canadian approach is that it is neither geographically nor thematically restricted. Rather, it is broad scale and assumes no *a priori* assumptions about mechanisms. It seeks to derive causal mechanisms from the broad assessment and to learn about the wider (geographical, temporal, biological) impact of the pressures leading to the observed changes, and thereby offer new insights. Other agencies currently conduct specific thematic assessments, but we consider that adopting an Integrated Assessment approach that includes thematic elements will allow more region-specific issues to be placed in an appropriate North Sea context, and will allow the interpretation of the patterns of change over bigger areas.

4 Advise on future monitoring and modelling required for improved integrated ecosystem assessment

4.1 Modelling

Modelled data have many benefits in contributing to an Integrated Ecosystem Assessment. Firstly, spatial and temporal resolutions can be relatively high and the data are consistently available in time and space. Also, by definition, modelled output is co-located in time and space so its integration is relatively straightforward. Even where different models, or combinations of *in situ* and modelled data, are used the temporal and spatial characteristics are such that data comparisons and combinations become relatively straightforward. Furthermore, models provide the unique capability to go back in time and simulate earlier scenarios, a possibility not readily available to monitoring scientists.

Clearly, however, modelled data are of varying quality depending upon the maturity of the systems and the quality (and quantity) of measured data available for assessing model output.

Products available

The NORSEPP group data products are listed in the group's 2005 report, a distillation of which has been made available to the REGNS workshop in Copenhagen, May 2005. Note that this distilled version may not be the definitive list.

Potential future contributions

There is the potential for a broad array of biogeochemical, as well as hydrodynamic, variables being made available to REGNS from the NORSEPP group from coupled hydrodynamic-ecosystem models presently being run at contributing organisations. A conceptual diagram of an ecosystem model is shown in Figure 6.

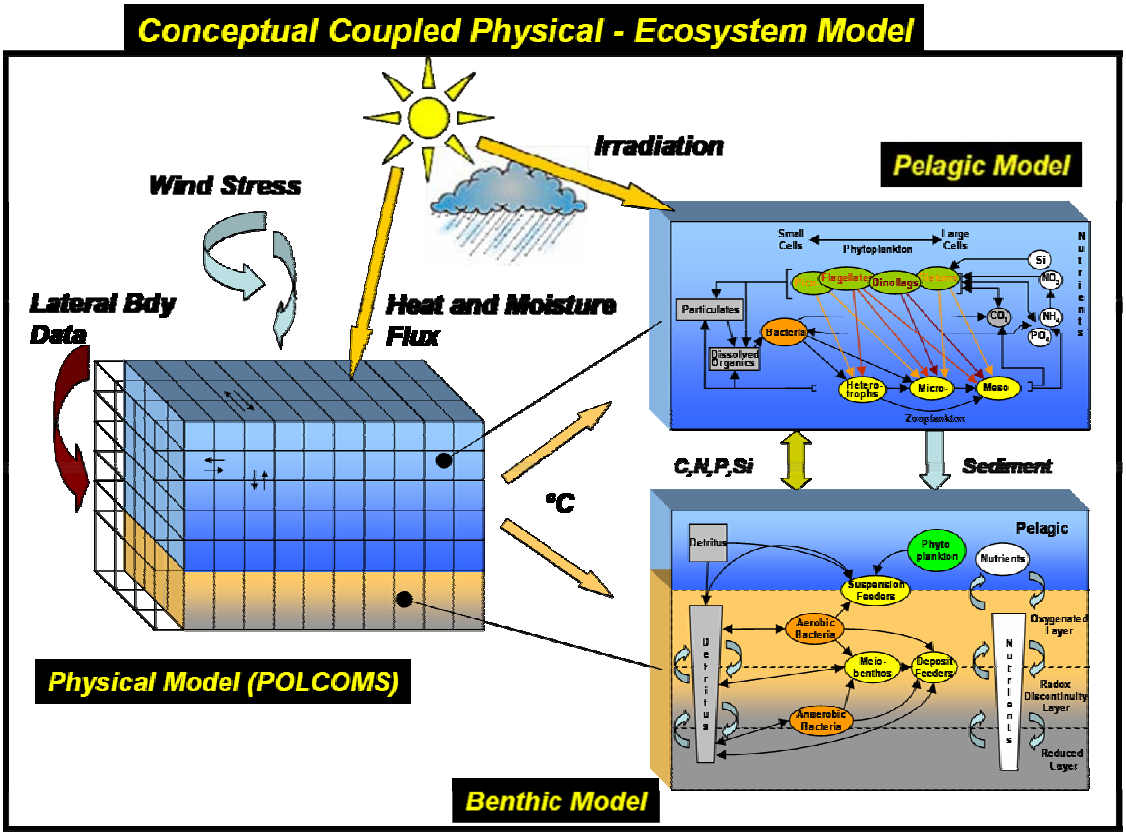

Figure 6: A conceptual ecosystem model based on the POLCOMS-ERSEM system.

In principle, any of the components that make up this system may usefully contribute to an assessment. These include physics (temperature, salinity, mixing, stratification, flux and velocities, etc), biogeochemistry (nutrients, detritus – organic and inorganic – oxygen, etc) and biology (chlorophyll, plankton biomass, bacterial biomass, production rates, euphotic depth, etc), all of which are direct outputs from the model. Indirect model products may also be used; plots of eutrophication traffic lights following OSPAR conventions, or HAB likelihood using fuzzy logic tests on model output, are examples of model data being processed in such a way as to give a spatial and temporal map of system state.

The potential for use of model data can be divided into three types:

1) *in situ* data are essentially unavailable, and models broaden the available parameter sets (e.g., time series of flows through key regions, bottom stresses and potentially many more);

2) *in situ* and model data types partially overlap, and models act as descriptors for system behaviour to improve understanding of the measured data (e.g., modelled chlorophyll distributions as a proxy for plankton distribution, adding value to sparse *in situ* measured biological datasets);

3) data types overlap – models can be used as interpolators (e.g., nutrients, chlorophyll, temperature, salinity).

Clearly, care must be taken with the use of modelled data in ensuring that they are both valid and accurate. Validation against *in situ* measurements of these parameters is essential before they are used. This becomes more of an issue for the biochemical data, which result from more recent technology and are more difficult to verify than the hydrodynamic data. Plankton, chlorophyll and other similar biological state variables become more difficult still to verify, as

they are both difficult to assess against *in situ* data as well as being conceptually different from the *in situ* measures themselves. For example, most lower trophic ecosystem models use "functional group" approaches where, for instance, a group may be nominally prescribed the name, and typical behaviour, of diatoms. However, in reality dinoflagellates comprise many disparate species with, often, very different behaviour.

4.1.1 Developing models to suit the needs of *Regional* Integrated *Ecosystem* Assessments

Present advances in both technical expertise and computing power are giving the modelling community greater flexibility to model regional systems. It is clear that any integrated assessment of the North Sea would benefit from the classification of the region into biogeographical or biophysical regions, each having their own distinctive characteristics which are spatially consistent over time. The impact of contaminants in near-shore regions or the site-specific impacts of aggregate removal are obvious examples. The present modelling systems are not suitable for this type of assessment but high resolution models, with emphasis on the processes important in those regions, would be possible in the future. Many regional and estuarine scale models are already being implemented for research purposes at typical horizontal resolutions of 1 nm, and in some cases up to 200 m resolution, around the North Sea region.

Implementation of these systems is by no means straightforward, especially if region-specific processes are to be included, and would require substantive funding where these projects do not overlap with existing/planned work.

4.1.2 Summary

Modelling can and should provide a significant contribution to any Integrated Assessment of the North Sea. However, coupled ecosystem model output is broad in range and therefore a challenge is to highlight those subsets of the data that can best contribute. Data gaps will occur and the approach taken by REGNS to rationalise the thematic assessments according to subregions will identify what and where the gaps occur in the *in situ* measurements, satellite and other data. This would then provide a useful starting point to drawing up a list of future products that can be provided.

4.2 Monitoring

Currently ICES member states undertake annual coordinated fish stock assessment surveys. The majority of these ICES-coordinated surveys are funded by national contribution, with additional funding through the EU Data Regulation. For the North Sea the EU funding is approximately 40 million Euro per year. Fish stock assessment surveys are generally carried out using Government owned research vessels, and staffed by Government employees. International coordination of survey aspects such as sampling protocols, quality assurance, survey timing and area, data processing and analysis, and data archiving is through ICES Working Groups, for example the IBTSWG. Additional measurements of other aspects of the ecosystem apart from biological and abundance data for commercial fish species are increasingly being added to the agreed survey protocols. For example, the IBTS quarterly surveys include CTD and surface and bottom nutrient sampling. Other monitoring is carried out by different member states, and different surveys are often pursued in patchy, opportunistic or unsystematic ways. Examples here include benthic sampling conducted during some national groundfish surveys, and seabird and sea mammal observations carried out on *ad hoc* or opportunistic ways by different member states. Current resources directed at such this additional monitoring are unknown, but are certainly much less than those spent on commercial fish surveys. It has been estimated that for the North Sea, the resources placed into monitoring different aspects of the ecosystem other than commercial fish species are approximately 2% (SGGOOS, 2004).

That is the current position. However, we know that the policy need for integrated ecosystem monitoring is growing. REGNS is beginning to discover the patchiness of available ecological data for the North Sea. Yet ICES is being requested to provide integrated ecosystem assessments. This is required by a raft of policy drivers, such as the reformed Common Fisheries Policy, the forthcoming EU Marine Strategy, the Bergen Declaration, OSPAR, etc. We would here make the distinction between surveillance and monitoring. There is a need for regular ecological assessment but the timescale over which that might happen is crucial. The aim is for integrated assessment and this means addressing key interactions in the ecosystem; that is we need to look at processes as well as patterns. The timescale over which important changes occur and can be detected drives the regularity of assessment. While surveillance (relatively long periods between repeated surveys) might detect change *per se*, monitoring (relatively short periods between repeated surveys) is more useful for detecting trends. Potentially important changes can occur over relatively short periods of time, and we would argue that monitoring be done on as fine a temporal scale as is feasible given current resource levels. Furthermore, we would argue that an integrated monitoring programme should include trigger points, which, if reached, should result in action being taken to address inimical change.

In order to serve the requirement for integrated ecosystem assessments, ICES member states must begin to consider new ways of sampling and monitoring the ecosystem. We suspect that no new, large, additional resource will become available to the marine science community in order to gather the data required. Such funding can ultimately come only from national funds, and throughout the ICES region there is great pressure on how such funds are distributed among public services. We do not anticipate a large redirection of funding towards the marine ecosystem. However, we do perceive a possible imbalance in the way current resources are deployed between assessing commercial fish species on the one hand, and assessing the ecosystem on the other. We propose that the only practical, pragmatic and honest approach for ICES to take is to suggest methods of realigning current survey and monitoring activities, but in such a way as not to jeopardise the present supply of data to the stock assessment process. This will require a great deal of discussion, debate and ingenuity. The current fish stock assessment process needs to be served by Member States. However, we are aware that this is under review, with possible moves from annual assessment to multi-annual assessments. The EU Data Regulation is beginning to consider funding additional measurements in order to supply the environmental indicators for fisheries management demanded by the reformed CFP. At the same time, groups such as REGNS are not fully aware of the requirements and science that underpins fish assessment survey design. We need a dialogue with the experts in ICES, within such groups as the IBTSWG. We believe it is timely that ICES supports an internal dialogue to consider what shape an ideal, coordinated ecosystem monitoring programme for a regional ecosystem might take. As the most wide ranging and frequent North Sea survey programme, the International Bottom Trawl Survey is the most obvious link into a more extensive monitoring scheme. The most appropriate first step, then, might be to convene a joint meeting between REGNS and WGIBTS. This forum could then consider how best to explore future monitoring logistics.

We therefore propose that such a meeting might be considered in the form of a one-day workshop to be held in conjunction with the 2006 meeting of the IBTSWG, and attach as Annex 4 draft Terms of Reference for such a meeting. This proposal must be first discussed with the Chair of WGIBTS, and we suggest that such a meeting might take place at the Aberdeen ASC.

5 Advise on designing the scientific and institutional requirements in order to facilitate the continuation of integrated ecosystem assessments within ICES

Integrated assessment involves analysis of integrated data sets. Timely reporting and handling of data streams are therefore critical to an effective assessment process. Data and information need to be available for compilation, analyses and evaluation by topical WGs as well as by REGNS.

Integrated assessment is a key component of an ecosystem approach to management and we foresee a growing demand for cost-effective production of such assessments. We therefore recommend a continuation of REGNS as a WG from 2007 following the completion of the REGNS process. The Working Group should be set up with the objective of conducting a regular Integrated Assessment of the North Sea ('WGIANS'). We foresee the group would consist of a relatively small core of permanent members with additional representation from source Working Groups where required. The group would carry out an annual IA covering the major components of the North Sea ecosystem; i.e., major physical forcing, primary productivity, zooplankton dynamics, nutrient dynamics, fisheries statistics. This would be assisted by the improved frequency and availability of model output (e.g., NORWECOM), fisheries and environmental data (e.g., ICES, WinCPR) which are envisaged. Additional thematic IEAs would be conducted at less frequent intervals designed to address particular themes or issues, such as: eutrophication, HABs, ecotoxicology. The timetable for the latter would be influenced by external drivers such as the OSPAR assessment process.

PGNSP/NORSEPP is planning to produce quarterly updates on meteorological and oceanographic conditions (including some biological information and output from models). This will facilitate the production of annual assessments by REGNS.

Thematic assessments (pollution, eutrophication, impacts of fisheries, etc.,) can be done at less frequent intervals and possibly at a rotating time schedule. This should be harmonised with the assessment requirements of organisations such as OSPAR and EEA to support their work and thus increase the relevance of ICES to society in line with the ICES vision.

It was also considered that the work of REGNS and its outputs may be relevant to a number of other WGs and that we should ensure these groups are made aware of REGNS so we can build upon each others work prior to our next meetings.

Table 7: Relevant WGs to REGNS.

	NAME	2006 MEETING	CHAIR
IBTSWG	International Bottom Trawl Survey Working Group	March	Markku Viitasalo
WKEUT	Workshop on Times Series Data relevant to Eutrophication Ecological Quality Objectives	Nov	T. Smayda, USA and G. Ærteberg, Denmark
SGMSNS	Study Group on Multispecies Assessment in the North Sea	May	M. Vinther, Denmark and E.D. Bell, UK
SGMID	Study Group on Management of Integrated Data	April	P. Wiebe, USA and C. Zimmermann, Gemany
WGICZM	Working Group on Integrated Coastal Zone Management	April	J. Støttrup, Denmark
WKSAD	Workshop on Survey Design and Data Analysis	May	P. G. Fernandes, UK and M. Pennington, Norway

	NAME	2006 MEETING	CHAIR
PGEGGS	Planning Group on North Sea Cod and Plaice Egg Surveys in the North Sea	May	Clive Fox, UK
PGNAPES	Planning Group on Northeast Atlantic Pelagic Ecosystem Surveys	May	J. A. Jakobsen, Faroe Islands

6 Election of a new Chair and resolutions for 2006 REGNS meeting

This was the third meeting of REGNS officially as a Study Group and its work should be completed within 3 years. However, the timetable for undertaking a comprehensive assessment of the North Sea extends beyond 2005 and is not due to be completed until the end of 2006. It is therefore recommended that REGNS be extended for one further year so the group's work can be completed. Assuming this resolution will be endorsed a vote was taken to elect a new Chair. Those present voted for the present Chair, Andy Kenny to continue as Chair for the additional year.

REGNS also considered the objectives and tasks to be undertaken during the 2006 session and this was finalised during the last day of the meeting and is presented in Annex 6 for consideration and endorsement by ICES.

7 Closure of the meeting

The meeting was officially closed at 2pm on 13 May. Andy Kenny thanked all those who attended and contributed to the discussions and looked forward to meeting everyone in Scotland at the ASC in Aberdeen later this year, and making preparations for the final REGNS "Regional Integrated Ecosystem Assessment" Workshop in xx, xx? 2006.

8 References

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Annex 1: List of participants for Regional Ecosystem Study Group for the North Sea (REGNS) meeting

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***These people attended the both the Workshop and the Study Group meeting.**

The Head of the ICES Science Programme, Adi Kellermann, the ICES/GLOBEC Coordinator, Keith Brander as well as Lena Larsen and Janus Larsen (ICES Data Centre Programme) also took part in the Workshop and Study Group meeting.

Annex 2: Agenda for the North Sea integrated assessment Workshop and Regional Ecosystem Group for the North Sea (REGNS)ICES Headquarters, Copenhagen 9–11 May 2005

Day 1 (9 May)

Meeting Opens 10 AM

- Introductions and REGNS process (Andy Kenny)
- Workshop Objectives (Andy Kenny)
- Overview of WG inputs (presentations from contributors)
  - Lena Inger Larsen (ICES): "ICES Data Centre – what it holds" (20 minutes)
  - Jacob Strand (DMU): "biological effects data" (10 minutes)
  - Werner Wosniok (Uni. Bremen): "fish diseases data" (10 minutes)
  - John Siddorn (Met.Office): "modelling outputs, Met.Office, MUMM and BSH" (10 minutes)
  - Geir Ottersen (IMR): "water mass fluxes from NORWECOM applied to North Sea fish recruitment" (10 minutes)
  - Sarah Hughes (FRS): "North Sea salinity and temperature data" (10 minutes)
  - Ian Davies (FRS): "OSPAR CEMP assessment data" (10 minutes)
  - Andy Kenny (CEFAS): "other sources of data" (10 minutes)
  - Keith Brander (ICES): "Integrated Ecosystem Assessment of the North Sea"
  - Stuart Rogers (CEFAS): "Issues raised by WGECO for REGNS to consider"
- Synthesis of the issues and agree plan of work for Days 2 and 3 (Andy Kenny)

Day 2 (10 May)

Start 9 AM

- One approach to an Integrated Assessment (to address the issues)
- Consensus on approach – feedback from participants
- Group the data and individuals – defining the assessment groups
- Breakout assessment groups to prioritise data sets, collate summary information and outputs and to define methods for assessment
- Feedback from assessment groups
- Plenary session – how to integrate across assessment groups and how to summarise the outputs.

Day 3 (11 May)

Start 9 AM (11 May)

- Time line for ICES Integrated Assessment
- Breakout assessment groups – define plan of actions
- Agree plan of actions and individual responsibilities

END at about 3 PM.

Annex 3: Metadata requirements for integrated assessment of the North Sea

REGNS, Integrated Assessment (IA) of the North Sea: Metadata of required datasets - Compiled 12/5/05

A - abiotic, B - biotic, H - human influence **Priority 1 - 2005 IA; Priority 2 - 2006 IA**

	Data list		Priority	Spatial extent						Spatial resolution	Temporal extent						Temporal resolution	ICES WG	Comments
											Decades								
		identifier		IVa	IVb	IVc	IIIa	coast	VIId	defined	50–60	60–70	70–80	80–90	90–00	00–10	defined		
A	bathymetry		2	x	x	x	x		x								variable		e.g., UKHO
A	modelled bottom oxygen	NORWECOM	2	x	x	x	x		x	20x20 grid, output on section	x	x	x	x	x	x	monthly	PGNSP	potential output
A	modelled bottom temp,	POLCOMS-ERSEM	2		x	x													
A	modelled tidal currents		1	x	x	x	x	x	x	model grid									e.g., POLCOMS
A	modelled tidal surge	Met Office	2	x	x	x		x	x	model grid		x	x	x	x	x	daily - monthly		UK Met Office - POL model
A	modelled transport pathways and rates	NAOSIM	2	x	x	x	x		x	model grid									Karcher et al, validation with radiotracers
A	modelled wave spectra	Met Office	1	x	x	x	x		x	model grid		x	x	x	x	x	daily - monthly		UK Met Office model
A	NAO index		1							basin-wide							monthly		available on-line
A	nitrate	national surveys	1		x	x								x	x		annual		winter nitrate distribution
A	nitrate	point observations	2			x				site specific									automated buoys, high temporal resolution
A	phosphate	national surveys	1			x													
A	rainfall and runoff		2																RID data?
A	salinity	CTD profiles	1	x	x	x				site specific			x	x	x	x	variable		RV cruises

REGNS, Integrated Assessment (IA) of the North Sea: Metadata of required datasets - Compiled 12/5/05

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	Data list		Priority	Spatial extent						Spatial resolution	Temporal extent						Temporal resolution	ICES WG	Comments
											Decades								
		identifier		IVa	IVb	IVc	IIIa	coast	VIId	defined	50–60	60–70	70–80	80–90	90–00	00–10	defined		
A	salinity	towed bodies	2	x	x	x				site specific			x	x	x	x	variable		Tintow, Scanfish at Dogger and Oyster Grounds
A	salinity	ferry routes	2			x				route specific			x	x	x	x	weekly - monthly		ferry routes
A	salinity	moored buoys	2			x				point source						x	hourly		automated buoys with high temporal resolution; e.g., CEFAS Smartbuoy (http://www.cefas.co.uk/monitoring/page-b4.asp); other systems e.g., Wavenet
A	sea level observations		2					x		fixed points									
A	seasonal and interannual water fluxes	NORWECOM	1	x	x	x	x		x	20x20 grid, output on section	x	x	x	x	x	x	monthly	PGNSP	potential validation against 1987 Autumn Circulation Experiment; Skogen, M.D., Svendsen, E. and Ostrowski, M. (1997) Quantifying volume transports during SKAGEX with the Norwegian ecological model system. Cont. Shelf Res. 17(15): 1817–1837
A	silicate	national surveys	1																
A	SST	CTD profiles	1	x	x	x				site specific			x	x	x	x	variable		RV cruises
A	SST	towed bodies	2	x	x	x				site specific			x	x	x	x	variable		Tintow, Scanfish at Dogger and Oyster Grounds
A	SST	UK inshore temp network	2					x		site specific	x	x	x	x	x	x	variable - weekly		1876 - present at 15 sites in UK
A	SST	BSH synoptic	1	x	x	x	x										monthly		BSH

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	Data list		Priority	Spatial extent						Spatial resolution	Temporal extent						Temporal resolution	ICES WG	Comments
											Decades								
		identifier		IVa	IVb	IVc	IIIa	coast	VIId	defined	50–60	60–70	70–80	80–90	90–00	00–10	defined		
A	SST	moored buoys	2			x				point source						x	hourly		automated buoys with high temporal resolution; e.g., CEFAS Smartbuoy (http://www.cefas.co.uk/monitoring/page-b4.asp); other systems
A	SST	ferry routes	1			x				route specific			x	x	x	x	weekly - monthly		ferry routes
A	stratification - timing and strengthof summer stratification		1	x	x														modelled plus observations
A	suspended particulate material	national surveys	2																
A	tidal heights		2					x											
A	wave spectra	point observa-tions	2	x	x	x				site specific									Wavenet moored instruments; http://www.cefas.co.uk/wavenet/default.htm
B	benthos	1986 NS BS	2											x			one-off	WGBE	North Sea Benthos Survey
B	benthos	2000 NS BS	2													x	one-off	WGBE	North Sea Benthos Survey
B	benthos - epibenthos: abundance, biomass and diversity		2												x		variable		abundance, biomass and diversity
B	benthos - infauna: abundance, biomass and diversity		2												x		variable		abundance, biomass and diversity
B	cetacean sightings	JCD	2		x	x	x	x	x	stats square				x	x	x	patchy	WGMME	all species of cetaceans, not seals
B	chlorophyl	national surveys	1																

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	Data list	identifier	Priority	Spatial extent						Spatial resolution	Temporal extent							Temporal resolution	ICES WG	Comments
											Decades									
				IVa	IVb	IVc	IIIa	coast	VIId	defined	50–60	60–70	70–80	80–90	90–00	00–10	defined			
B	chlorophyll index	CPR	1	x	x	x	x			32x32 nm pixels	x	x	x	x	x	x	Monthly/yearly/seasonnal	WGZE	Sahfos WinCPR Web Site WinCPR data available from 1948 to 97, being updated soon
B	fish diseases	lymphocystis	2		x					37F7 +				x	x	x	bi-annual	WGPDMO, WGBEC	20–24 cm female Dab, 17 stations with good temporal coverage, at differing resolution
B	fish diseases	epidermal hyperplasia/ papiloma	2		x					37F7 +				x	x	x	bi-annual	WGPDMO WGBEC	20–24 cm female Dab,
B	fish diseases	acute/ healing skin ulcerations	2		x					37F7 +				x	x	x	bi-annual	WGPDMO, WGBEC	20–24 cm female Dab,
B	fish diseases	X-cell gill disease	2		x					37F7 +				x	x	x	bi-annual	WGPDMO, WGBEC	20–24 cm female Dab,
B	fisheries - abundance, biomass, diversity	ground fish survey	1	x	x	x				ICES rectangle			x	x	x	x	annual (Aug-Sept)		gear and ship changes
B	fisheries - acoustic density	demersal	2	x	x	x				0.5 nm					x	x	Aug-Sept		
B	fisheries - acoustic density	sandeels, Dogger	2		x					1 nm					x	x	spring-summer		
B	fisheries - dredge density		2																
B	fisheries - feeding	stomach	2		x					1 BTS survey				x	x				year of stomach, ICES
B	fisheries - feeding	stomach, Dog-	2		x					5 nm						x	spring-summer		

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	Data list		Priority	Spatial extent						Spatial resolution	Temporal extent						Temporal resolution	ICES WG	Comments
											Decades								
		identifier		IVa	IVb	IVc	IIIa	coast	VIId	defined	50–60	60–70	70–80	80–90	90–00	00–10	defined		
		ger																	
B	fisheries - length/weight at age		1	x	x	x				ICES rectangle			x	x	x	x	Jan		
B	fisheries - size spectra		1	x	x	x				ICES rectangle			x	x	x	x	Q1, Q3		
B	fisheries - tagging	conventional	2		x	x					x	x	x	x	x		variable		variety of species
B	fisheries - tagging	DSTS	2		x	x									x	x	variable		plaice, cod, ray
B	harmful algal blooms	CPR	1	x	x	x	x	x	x	ICES grid				x	x	x	Monthly/yearly/seasonal		CPR,
B	modelled primary production and anomaly	NORWECOM	2	x	x	x	x		x	20x20 grid, output on section	x	x	x	x	x	x	monthly	PGNSP	potential output
B	phytoplankton abundance	CPR	1	x	x	x	x			32x32 nm pixels	x	x	x	x	x	x	Monthly/yearly/seasonal	WGZE, WGECO	Sahfos WinCPR Web Site WinCPR data available from 1948 to 97, being updated soon; potential ecosystem interactions, (Richardson paper - plankton not fish due to lack of fish data in appropriate format)
B	salmon - arrival	70 rivers	2					x		70 rivers	x	x	x	x	x	x	annual		arrival time
B	seabird adult survival	National and bespoke studies	2	x	x	x		x		site specific				x	x	x	annual	WGSE	Best data for IVa on kittiwake, puffin for IVb for kittiwake, shag, auks, terns IVc
B	seabird breeding nos	national surveys	2	x	x	x	x	x	x	site specific			x	x	x	x	15y cycle	WGSE	all species
B	seabird breeding productivity	National and bespoke studies	2	x	x	x		x		site specific				x	x	x	annual	WGSE	Most data for kittiwake, fulmar, terns, shag
B	seabird breeding season diet	bespoke studies	2	x	x	x	x	x	x	site specific			x	x	x	x	annual	WGSE	Limited number of species

REGNS, Integrated Assessment (IA) of the North Sea: Metadata of required datasets - Compiled 12/5/05

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	Data list		Priority	Spatial extent						Spatial resolution	Temporal extent						Temporal resolution	ICES WG	Comments
											Decades								
		identifier		IVa	IVb	IVc	IIIa	coast	VIId	defined	50–60	60–70	70–80	80–90	90–00	00–10	defined		
B	seabird clutch size	National and bespoke studies	2	x	x	x	x	x	x	site specific			x	x	x	x	annual	WGSE	Several species, in some cases many decades
B	seabird distribution at sea	ESAS	2	x	x	x	x	x	x	stats square				x	x	x	patchy*	WGSE	all species ; can be aggregated by season/decade
B	seabird egg laying date	bespoke studies	2	x	x	x		x	x	site specific			x	x	x	x	annual	WGSE	national and bespoke studies, several species
B	zooplankton abundance	CPR	1	x	x	x	x			32x32 nm pixels	x	x	x	x	x	x	Monthly/yearly/seasonnal	WGZE, WGECO	Sahfos WinCPR Web Site WinCPR data available from 1948 to 97, being updated soon; Reid et al (eds) (2003) Special Issue: Achievements of the Continuous Plankton Recorder and a vision for its future. Prog. Oceanog., 58 (2–4), 116–358.
H	aggregate extraction		2		x	x	x		x	areal km2					x	x	annual	WGEXT	collated on behalf of OSPAR by ICES; area dredged, amounts dredged, sediment type dredged
H	atmospheric inputs of Cd	CAMP national surveys	2	x	x	x	x	x	x	Published by OSPAR region					x	x	Published as annual		OSPAR (INPUT)
H	atmospheric inputs of Hg	CAMP national surveys	2	x	x	x	x	x	x	Published by OSPAR region					x	x	Published as annual		OSPAR (INPUT)
H	atmospheric inputs of N	CAMP national surveys	2	x	x	x	x	x	x	Published by OSPAR region					x	x	Published as annual		OSPAR (INPUT), input from WGSAEM on data quality etc
H	atmospheric inputs of P	CAMP national	2	x	x	x	x	x	x	Published by OSPAR region					x	x	Published as annual		OSPAR (INPUT), input from WGSAEM

REGNS, Integrated Assessment (IA) of the North Sea: Metadata of required datasets - Compiled 12/5/05

A - abiotic, B - biotic, H - human influence **Priority 1 - 2005 IA; Priority 2 - 2006 IA**

	Data list		Priority	Spatial extent						Spatial resolution	Temporal extent						Temporal resolution	ICES WG	Comments
											Decades								
		identifier		IVa	IVb	IVc	IIIa	coast	VIId	defined	50–60	60–70	70–80	80–90	90–00	00–10	defined		
		surveys																	on data quality etc
H	atmospheric inputs of Pb	CAMP national surveys	2	x	x	x	x	x	x	Published by OSPAR region					x	x	Published as annual		OSPAR (INPUT)
H	contaminants in biota - radionuclides	national surveys	2	x	x	x	x	x	x	variable		x	x	x	x	x	weekly - annual	none	potential for describing ecosystem processes and model validation; OSPAR, HELCOM; biological uptake of artificial radionuclides; potential radiological impact
H	contaminants in fish and shellfish - CBs	national surveys	2	x	x	x	x	x	x	site specific				x	x	x	Annual	MCWG	OSPAR (INPUT)
H	contaminants in fish and shellfish - Metals (Hg, Cd, Pb, Ni, Cu, Zn, etc	national surveys	2	x	x	x	x	x	x	site specific				x	x	x	Annual	OSPAR (MON)	MCWG is relevant ICES WG
H	contaminants in fish and shellfish - pesticides (lindane, DDT)	national surveys	2	x	x	x	x	x	x	site specific				x	x	x	Annual	OSPAR (MON)	MCWG is relevant ICES WG
H	Contaminants in fish and shellfish. Temporal trend assessments, comparisons with BRCs/BACs and EACs		2																
H	contaminants in seawater - radionuclides	national surveys	2	x	x	x	x	x	x	variable		x	x	x	x	x	variable	none	potential for describing ecosystem processes and model validation; OSPAR, HELCOM;
H	contaminants in sedi-	national surveys	2	x	x	x		x	x	site specific				x	x	x	Annual	OSPAR	WGMS is relevant ICES WG

REGNS, Integrated Assessment (IA) of the North Sea: Metadata of required datasets - Compiled 12/5/05

A - abiotic, B - biotic, H - human influence **Priority 1 - 2005 IA; Priority 2 - 2006 IA**

	Data list	identifier	Priority	Spatial extent						Spatial resolution	Temporal extent						Temporal resolution	ICES WG	Comments
											Decades								
				IVa	IVb	IVc	IIIa	coast	VIId	defined	50–60	60–70	70–80	80–90	90–00	00–10	defined		
	ments - pesticides (lindane, DDT)																	(MON)	
H	contaminants in sediments - CBs	national surveys	2	x	x	x		x	x	site specific				x	x	x	Annual	WGMS	OSPAR MON; Temporal trend assessments, comparisons with BACs and EACs,
H	contaminants in sediments - Metals (Hg, Cd, Pb, Ni, Cu, Zn, etc	national surveys	2	x	x	x		x	x	site specific				x	x	x	Annual	OSPAR (MON)	WGMS is relevant ICES WG
H	contaminants in sediments - PAHs	national surveys	2	x	x	x		x	x	site specific				x	x	x	Annual	OSPAR (MON)	WGMS is relevant ICES WG
H	contaminants in sediments - PAHs	national surveys	2	x	x	x	x	x	x	site specific				x	x	x	Annual	OSPAR (MON)	MCWG is relevant ICES WG
H	dredge spoil disposal		2	x	x	x		x											OSPAR annual report, EIHA
H	ecotoxicology - PAH-specific effects in fish	national surveys	2	x	x	x		x		site specific					x	x	annual	wgbec	EROD/CYP1a, PAH-metabolites, DNA adducts in dab and cod - needs expert interpretation
H	eutrophication status	POLCOMS-ERSEM	2		x	x													
H	eutrophication status	OSPAR	1	x	x	x	x	x	x						x	x	every 5 years		OSPAR assessment process
H	fisheries - catch per unit effort		1	x	x	x			x										
H	fisheries - discards		1	x	x	x			x										
H	fisheries - distribution of fishing effort		1	x	x	x			x	1km - ICES rectangle					x	x	weekly - annual		Overflight and satellite data

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	Data list		Priority	Spatial extent						Spatial resolution	Temporal extent						Temporal resolution	ICES WG	Comments
											Decades								
		identifier		IVa	IVb	IVc	IIIa	coast	VIId	defined	50–60	60–70	70–80	80–90	90–00	00–10	defined		
H	fisheries - economics		2																
H	fisheries - impacts of trawling		2		x	x									x	x	variable		
H	fisheries - landings		1	x	x	x			x										
H	fisheries - production modelling		2																
H	fisheries - age structure		1	x	x	x			x										
H	fisheries - fish mortality		1	x	x	x			x										
H	marine mammal bycatch		2																OSPAR EcoQO?, EU?,, ACE review 2004
H	marine mammals organic contam		2															????	
H	oiled guillemots	beach bird survey	2	x		x		x		region specific			x	x	x	x	annual (Feb)	WGSE	variable in space and time
H	RID inputs of Cd	national surveys	2	x	x	x	x	x	x	Published by OSPAR region					x	x	Published as annual		OSPAR (INPUT), input from WGSAEM on data quality etc
H	RID inputs of Hg	national surveys	2	x	x	x	x	x	x	Published by OSPAR region					x	x	Published as annual		OSPAR (INPUT), input from WGSAEM on data quality etc
H	RID inputs of N	national surveys	1	x	x	x	x	x	x	Published by OSPAR region					x	x	Published as annual		OSPAR (INPUT), input from WGSAEM on data quality etc
H	RID inputs of P	national surveys	1	x	x	x	x	x	x	Published by OSPAR region					x	x	Published as annual		OSPAR (INPUT), input from WGSAEM on data quality etc
H	RID inputs of Pb	national surveys	2	x	x	x	x	x	x	Published by OSPAR region					x	x	Published as annual		OSPAR (INPUT), input from WGSAEM on data quality etc

REGNS, Integrated Assessment (IA) of the North Sea: Metadata of required datasets - Compiled 12/5/05

A - abiotic, B - biotic, H - human influence **Priority 1 - 2005 IA; Priority 2 - 2006 IA**

	Data list		Priority	Spatial extent						Spatial resolution	Temporal extent						Temporal resolution	ICES WG	Comments
											Decades								
		identifier		IVa	IVb	IVc	IIIa	coast	VIId	defined	50–60	60–70	70–80	80–90	90–00	00–10	defined		
H	TBT-specific effects in marine snails	national surveys	2				x	x		site specific					x	x	annual	WGBEC	Nucella, Buccinum, Neptunea, Littorina, Hinia

Annex 4: Proposed Draft ToR for a joint 1 day Workshop between REGNS and IBTSWG – for discussion with the Chair of IBTSWG

A joint REGNS-IBTSWG workshop will convene to discuss integrated ecosystem monitoring (Chair: xx) at [wherever] from [whenever] to:

a) review the requirement for integrated ecosystem monitoring by current policy drivers (e.g., the reformed Common Fisheries Policy, the EU Marine Strategy, the ICES requirement for Integrated Ecosystem Assessment);

b) identify important components of the North Sea ecosystem, which if subject to systematic monitoring, would contribute to regular ecological assessment of the North Sea;

c) highlight known key interactions and relationships between these components that would enable integrated ecological assessment of the North Sea;

d) define a basic integrated monitoring protocol for obtaining ecosystem information from the IBTS surveys on an annual / multi-annual basis;

e) determine a process for reporting the results of regular integrated IBTS ecological assessment;

f) assess the additional cost of the proposed integrated ecosystem IBTS monitoring survey.

Supporting information

PRIORITY:	HIGH.
Scientific Justification and relation to Action Plan:	REGNS has been requested to devise an Integrated Ecological Assessment of the North Sea. As this implies continued monitoring of the ecosystem, then pragmatic, logistic, scientific protocols must be identified. The joint REGNS-IBTSWG Workshop will apply scientific advice and expertise to the tasks identified in the Terms of Reference. It will convene in [month] 2006 and also work closely with REGNS and the new proposed Working Group on Integrated Assessment. The success of the Workshop will depend on excellent preparation for, and productive co-operation at, the meeting. It will also depend on the participation of key personnel from both REGNS and IBTSWG. Good communication with other Working Groups, and other appropriate scientists and organisations involved in ecosystem monitoring will take place. A timely report of the Workshop will be produced, and work will be tailored closely not only to the Terms of Reference but also to other drivers of the work perceived to be relevant, such as the ICES Action Plan, the reformed Common Fisheries Policy, the forthcoming EU Marine Strategy, the Bergen Declaration, and OSPAR. **The objectives of the Study Group relate directly to the following actions in the ICES Action Plan 2003–2007:** 1.7 Play an active role in the design, implementation, and execution of global and regional research and monitoring programmes, in collaborations between the ICES and other international oceanographic research or monitoring programmes such as GOOS and GLOBEC. 1.8 Implement a North Sea-oriented monitoring programme that incorporates oceanographic and fisheries data. 1.10 Develop better tools and training opportunities for monitoring and observation of physical, chemical and biological properties of marine ecosystems. 1.11 Continue to improve the coordination, conduct, and analysis of oceanographic and biological surveys to assure their accuracy and precision.
Resource Requirements:	Staff time from ICES may be needed in order to adequately prepare for the Workshop and to provide the necessary support in compiling the report. Otherwise, the Workshop requires few other resources.
Participants:	The Workshop will include participants from REGNS and IBTSWG and some additional

	experts who have the necessary experience in ecological monitoring.
Secretariat Facilities:	None
Financial:	None
Linkages to Advisory Committees:	ACE
Linkages to other Committees or Groups:	All Science Committees
Linkages to other Organisations:	OSPAR
Cost share	?????

Annex 5: An integrated ecosystem assessment of the North Sea – a pilot project

Author: REGNS

Abstract

A Regional Ecosystem Study Group for the North Sea (REGNS) was established in 2003 with the principal aim of producing a comprehensive Integrated Ecosystem Assessment of the North Sea by 2006.

An integrated assessment may mean one of two things; namely: i) a process of actions which support 'adaptive management and the ecosystem approach' (ICES 2003b), but it also relates to ii) the combined numerical assessment of data and information from various sources (including monitoring and R&D programmes).

This paper sets out the initial results of an integration of oceanographic, fisheries, planktonic and nutrients data covering the North Sea over a period of decades (to the present day). It highlights a number of significant trends which contribute to our understanding of the dynamic relationships between different components of the marine ecosystem at different spatial and temporal scales.

The present North Sea regional integrated assessment sets the backdrop by which more targeted spatial, temporal or thematic integrated assessments can be undertaken. An integrated assessment framework which enables the integration of data sets of different spatial and temporal scales is described and the outputs presented in a way which facilitates the adaptive management of human pressures (impacts) on the marine ecosystem.

Annex 6: Recommendations

The **Regional Ecosystem Study Group for the North Sea** (REGNS) (Chair: A. Kenny, UK) will meet at place??, dates ?? 2006 to:

a) Hold a workshop to evaluate and plan the finalisation of the 2006 integrated ecosystem assessment for the North Sea.

- i) review the outcome of the work of an intersessional correspondence group (sub-group of REGNS) with compilation and analyses of a comprehensive integrated data set for different aspects and components of the North Sea ecosystem;
- ii) review the outcome of intersessional work on relating state variables of the ecosystem with human pressures according to themes (eutrophication, pollution, conservation, fisheries, climate, and management);
- iii) prepare plans for finalisation of the integrated ecosystem assessment which must take account of the relationship between the thematic human pressures assessments (in ii above) and the overview integrated assessment (in i above);
- iv) prepare plans for presenting the outcome of the integrated ecosystem assessment at the 2006 ICES Annual Science Conference.

b) Advise on follow-up work to translate the experiences of REGNS in producing an integrated ecosystem assessment into a regular process in ICES of producing or contributing to the production of updated integrated assessments for the North Sea ecosystem.

c) Based on the experience with the production of the 2006 North Sea integrated assessment, consider requirements that need to be taken into account in a design of a holistic monitoring of the North Sea ecosystem.

d) in joint session with IBTSWG hold a one day workshop to:

1) Review the requirement for integrated ecosystem monitoring by current policy drivers (e.g., the reformed Common Fisheries Policy, the EU Marine Strategy, the ICES requirement for Integrated Ecosystem Assessment)

2) Identify important components of the North Sea ecosystem, which if subject to systematic monitoring, would contribute to regular ecological assessment of the North Sea.

3) Highlight known key interactions and relationships between these components that would enable integrated ecological assessment of the North Sea.

4) Define a basic integrated monitoring protocol for obtaining ecosystem information from the IBTS surveys on an annual / multi-annual basis.

5) Determine a process for reporting the results of regular integrated IBTS ecological assessment.

6) Assess the additional cost of the proposed integrated ecosystem IBTS monitoring survey

Supporting information

Priority:	High.
Scientific Justification and relation to Action	The Workshop will review the material that is generated for the purpose of the REGNS process and investigate how this material can be interpreted in the context of the framework developed by REGNS in 2005. The 2006 Workshop is expected to be a significant step towards delivery of

<table>
<tr><td>Plan:</td><td>the thematic Integrated Assessments, with the Integrated Assessments being the subject of a Theme Session at the 2006 ASC. The data analysis will need to be undertaken (in part) intersessionally during 2005/6 with the outputs being presented and reviewed at the 2006 Workshop (April). The plan is to have prepared complete (although draft) thematic integrated assessments for review at the 2006 ASC. This timetable was set out in the 2004 REGNS report Section 4.1.

The success (and timeliness) of the Workshop products will depend on excellent preparation and sustained support through to completion. It is unlikely that this can be provided entirely at the national level, and input from the Secretariat may be required. The task will include good communication with a wide range of “source” Working Groups; compiling their material in a standard form for joint analysis; facilitating early availability of data information and indicators for analysis by Workshop members, and other interested scientists; early compilation and dissemination of working documents and draft to workshop participants; overseeing additional work to ensure timely production of the report (editing, preparation of figures and tables, etc.). Individual members of REGNS will take responsibility for facilitating (but not necessarily leading or drafting) the work on each of the six themes identified in the table below:

<table>
<tr><th>.THEME</th><th>WGS</th><th>FACILITATOR</th></tr>
<tr><td>Eutrophication</td><td>WGPE, WGHABD, WGZE, WGPBI, BEWG, WGFE</td><td>Hein-Rune Skjoldal</td></tr>
<tr><td>Conservation of Habitats and Species</td><td>WGMME, WGSE, WGEXT, WGITMO</td><td>Mark Tasker</td></tr>
<tr><td>Chemical Pollution</td><td>WGPDMO, WGMS, MCWG, WGBEC</td><td>Andy Kenny</td></tr>
<tr><td>Fisheries</td><td>WGECO, WGFE, WGEF</td><td>Clive Fox</td></tr>
<tr><td>Climate and Natural Variations</td><td>WGOH</td><td>Bill Turrell</td></tr>
</table>
</td></tr>
<tr><td>Resource Requirements:</td><td>Staff time from ICES may be needed in order to adequately prepare for the Workshop and to provide the necessary support in compiling the report. Otherwise, the Workshop requires few other resources.</td></tr>
<tr><td>Participants:</td><td>The Workshop will include participants from REGNS and IBTSWG and some additional experts who have the necessary experience in ecological monitoring.</td></tr>
<tr><td>Secretariat Facilities:</td><td>None</td></tr>
<tr><td>Financial:</td><td>None</td></tr>
<tr><td>Linkages to Advisory Committees:</td><td>ACE and ACFM</td></tr>
<tr><td>Linkages to other Committees or Groups:</td><td>All Science Committees</td></tr>
<tr><td>Linkages to other Organi-</td><td>OSPAR</td></tr>
</table>

sations:	
Cost share	?????

Annex 7: Action Plan Audit

Year	Committee Acronym	Committee name	Expert Group	Reference to other committees	Expert Group report (ICES Code)	Resolution No.		
2004/2005	RMC	Resource Management Committee	REGNS		D:08	2D06		
Action Plan	Action Required	ToR's	ToR	Satisfactory Progress	No Progress	Unsatisfactory Progress	Output (link to relevant	Comments (e.g., delays, problems, other types of progress, needs, etc.
No.	Text	Text	Ref. (a, b, c)	S	0	U	Report code and section	Text
1.2	Increase knowledge with respect to the functioning of marine ecosystems. This will be achieved through continued basic research on the biological, chemical, and physical processes of marine ecosystems and specific activities directed at improved understanding of observed and potential variability in the marine environment due to physical forcing and biological interactions.	Hold a Workshop to produce a preliminary "proof of concept" integrated ecosystem assessment for the North Sea to: **i.** Compile and synthesise material from the twenty identified "source" Working Groups, which have been requested to provide data, information and indicators; **ii.** Produce summary presentations of the material as an overview (e.g., using methods for re-scaling and reducing dimensionality; "traffic lights", etc.); **iii.** Identify gaps in the material provided and the subjects covered; **iv.** Review patterns and interactions among the indicators. Preliminary description of system behaviour (e.g., evidence for "regime shift" in the late 1980s) and strength of attribution of causes of observed changes;	a)	S			Section 2	Initial overview analysis of North Sea data has been undertaken as a proof of concept which has highligted significant trends and changes in the the North Sea Ecosystem
1.3	Increase knowledge of the effects of physical forcing, including climate variability, and biological interactions, on recruitment processes of important commercial species.	Hold a Workshop to produce a preliminary "proof of concept" integrated ecosystem assessment for the North Sea to: **i.** Compile and synthesise material from the twenty identified "source" Working Groups, which have been requested to provide data, information and indicators; **ii.** Produce summary presentations of the material as an overview (e.g., using methods for re-scaling and reducing dimensionality; "traffic lights", etc.); **iii.** Identify gaps in the material provided and the subjects covered; **iv.** Review patterns and interactions among the indicators. Preliminary description of system behaviour (e.g., evidence for "regime shift" in the late 1980s) and strength of attribution of causes of observed changes;	a)	S			Section 2	Examination of flux data for North Sea sub-regions helps explain the cause of ecological change
1.6	Assess and predict impacts of climate variability and climate change, on scales from populations to marine ecosystems, including impacts on commercially important fish stocks.	Hold a Workshop to produce a preliminary "proof of concept" integrated ecosystem assessment for the North Sea to: **i.** Compile and synthesise material from the twenty identified "source" Working Groups, which have been requested to provide data, information and indicators; **ii.** Produce summary presentations of the material as an overview (e.g., using methods for re-scaling and reducing dimensionality; "traffic lights", etc.); **iii.** Identify gaps in the material provided and the subjects covered; **iv.** Review patterns and interactions among the indicators. Preliminary description of system behaviour (e.g., evidence for "regime shift" in the late 1980s) and strength of attribution of causes of observed changes;	a)	S			Section 2	Inclusion of fish stock data (demersal and pelagic commercial species) has been included in the assessment.
2.2	Develop a process for conducting holistic assessments of the impact of human activities, and identify a suite of indicators or variables that will facilitate the monitoring of ecosystem status and evaluating whether ecosystem quality objectives (EcoQOs) are being met.	Comment on how to measure impacts of past management actions at the system level and consider and comment on issues of predictability and impact of future management actions;	c) and d)	S			Section 3	The initial analysis establishes proof of concept. Additional human pressure data sets have been identified and this will enable the relationships between ecosystem indicators and human pressure parameters to be fully evaluated
3.3	Develop a framework for an integrated evaluation of the impacts of human activities in the coastal zone, (e.g., mariculture, dredging/extraction, building structures), as an aid to coastal zone management.	Comment on how to measure impacts of past management actions at the system level and consider and comment on issues of predictability and impact of future management actions;	c) and d)	S			Section 3	As above
4.11.1	Continue and expand the development of tools, possibly ecosystem models, that facilitate the assessment of monitoring and scientific knowledge of ecosystem functions in a holistic manner.	Advise on future monitoring and modelling required for improved integrated ecosystem assessment	d)	S			Section 4	Links with PGNSPP are helping to establish a modelling framework which extends current oceanographic capability to help understand the significance of human pressure impacts on a more localised scale.
4.11.2	Incorporate scientific information on ecosystem components and processes into the advice that is provided to clients.	Advise on designing the scientific and institutional requirements in order to facilitate the continuation of integrated ecosystem assessments within ICES	e)	S			Section 5	Methods for presenting integrated assessment results to support ecosystem advice are being evaluated and developed. Additional WGs have been identified, particularly relating to the pelagic stock assessments, and will be made aware of the REGNS assessment.
4.11.4	Consider more fully the impacts of human activities on the marine ecosystem, through provision of more integrated ecosystem advice.	Advise on designing the scientific and institutional requirements in order to facilitate the continuation of integrated ecosystem assessments within ICES	e)	S			Section 5	Links with the WGICZM will be established to ensure they are aware of the REGNS outputs and asked to comment and input to the process from a planning and managing human pressures perspective.