

**REPORT OF THE  
ICES/GLOBEC WORKING GROUP ON  
COD AND CLIMATE CHANGE**

**By Correspondence**

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Conseil International pour l'Exploration de la Mer

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## 1 INTRODUCTION AND TERMS OF REFERENCE

The **ICES/GLOBEC Working Group on Cod and Climate Change** (Chair: Dr K. Drinkwater, Canada) worked by correspondence during 2000/2001. The terms of reference for the working group were to:

- a) review and evaluate the outcome of the workshop on the Dynamics of Cod Growth and determine follow-up activities;
- b) prepare for the workshop on the Transport of Cod Larvae;
- c) plan and initiate the synthesis of work to date on Cod and Climate Change by:
  - i) requesting funds for the preparation of a book on cod and climate change and if successful, holding a meeting of a small steering group to develop an outline for the book as well as plan the necessary activities and determine the people required to write and publish the book;
  - ii) assembling references and additional data on cod stocks throughout the North Atlantic with the purpose of making the information available through publication and on a CD;
  - iii) examining possible ways by which environmental information can be incorporated into the assessment process;
- d) initiate plans for a symposium on Climate Variability and Fisheries;
- e) consult with Oceanography Committee Working Groups on possible joint activities and data requirements.

The Workshop will report to the Oceanography Committee at the 2001 Annual Science Conference.

## 2 REVIEW OF 2000/2001 ACTIVITIES

### 2.1 ICES/GLOBEC North Atlantic Regional Office

The Council of ICES decided in 2000 to continue to support the ICES/GLOBEC office by covering the indirect costs, provided that there are sufficient external funds to cover the direct costs (salary, travel etc.). The current (August 2001) funding situation is that external costs are fully covered until March 2002 and partly covered until the end of 2002. A strategy for securing funding at least to the end of 2004 has been put forward by the Steering Group for the ICES/GLOBEC North Atlantic programme and Regional Office (SGNARO, re-established by the Bureau at its meeting in January 2001) and proposals covering this period are being prepared or have already been submitted. Although it will be some time before formal confirmation of continued funding can be expected from all the countries and agencies involved, the prospects appear to be good. The report of SGNARO (ICES CM 2001/C:13) will be presented to the Oceanography Committee and the Bureau.

A considerable proportion of the Coordinator's time over the past year has been taken up with funding issues and in assisting SGNARO, but progress has also been made on scientific work and support. The report of the Workshop on Gadoid Stocks in the North Sea during the 1960s and 1970s (Fourth ICES/GLBEC Backward Facing Workshop) was published as Cooperative Research Report No 244. Two issues of the ICES/GLOBEC Newsletter were produced and generated a substantial level of interest and correspondence. For the first time too much material was sent in to publish it all and the next issue has been offered several articles, including a paper which is shortly to appear in Nature and which is relevant to developing further pan-Atlantic cooperation in relation to copepod dynamics.

A brief chronological overview of work carried out by the Coordinator since the last meeting of WGCCC in May 2000 is as follows:

Year 2000	
June	Co-convenor and speaker at a Theme Session and workshop at the ASLO meeting in Copenhagen
July	International GLOBEC Focus 3 Modelling workshop in Chapel Hill, North Carolina
August	Chair and rapporteur for sessions at EurOCEAN 2000
October	Talk at PICES meeting Hakodate, Japan on "Ecosystem Comparison"
November	Publication of EU ACACIA Project. (Assessment of Potential Effects and Adaptations for Climate Change in Europe, contribution to IPCC Third Assessment).

December	Final meeting of EU project on Sustainable Fisheries (SAP) in Bergen and paper at Symposium.
<b>Year 2001</b>	
January	Drafting group meeting for Arctic Climate Impact Assessment; evaluation meeting for German GLOBEC programme
February	Paper on "Climate and Fisheries" at Hanse Conference, Bremen
March	Paper at IIASA, Laxenburg, Austria on "Management of Adaptive Responses to Fishing"
April	EU seminar on New Instruments for FP6; SAHFOS Council meeting
June	NORWATE meeting, Halifax; UK Marine Productivity Steering Committee; ICES Planning Group on Comparing the Structure of Marine Ecosystems
July	Public lecture on "Climate and Fisheries", Concarneau, France
August	Opening address and paper at CPR Symposium; two papers at ICES Decadal Symposium
September	Paper on cod growth at ASC Theme Session V

The Coordinator took part in the steering and review process for national GLOBEC programmes in the UK (Marine Productivity) and in Germany. The former is moving into its second, fieldwork phase and the latter is undergoing technical scrutiny, prior to a final decision on funding.

A workshop in Halifax NS in June 2001 brought together scientists from many North Atlantic countries to discuss the development of international cooperation for studies of the North West Atlantic Ecosystem (NORWATE). A number of proposals were put forward for coordination and synthesis, some of which would require assistance from the ICES/GLOBEC office.

The background to the Arctic Climate Impact Assessment was provided in Section 6.2 of last year's report (ICES CM 2000/C:11). The Coordinator is a member of the drafting group for the chapter on Marine Systems and took part in a planning meeting for this work in January 2001.

Papers which have been published or submitted are given in Appendix A.

## **2.2 1999 Backward Facing IV Workshop**

The report of the Workshop on Gadoid Stocks in the North Sea during the 1960s and 1970s: The Fourth ICES/GLOBEC Backward-Facing Workshop that was held in Aberdeen, Scotland in March 1999 was published as an ICES Cooperative Research Report (No. 244) in April, 2001 under the editorship of Mike Heath (UK) and Keith Brander (ICES/GLOBEC Secretary).

## **2.3 2000 Workshop on the Dynamics of Cod Growth**

The Workshop on the Dynamics of Cod Growth was held on May 8–10 at Dartmouth, Nova Scotia, immediately prior to the 2000 meeting of the WGCCC under the direction of co-convenors Neils Anderson (Denmark) Geir Ottersen (Norway) and Doug Swain (Canada). An initial summary was presented in last year's report. A total of 28 scientists attended from 8 countries. An additional 17 scientists contributed to the workshop through the Web bulletin board prior to the meeting. The terms of reference for the Workshop were to:

- a) develop models of growth in order to improve the quality of stock forecasting;
- b) describe major sources of uncertainty in the prediction of growth rates and advise on further studies to reduce this uncertainty;
- c) assess the contribution of growth rate variability to the observed variability in stock biomass and stock forecasts;
- d) recommend standard methods for comparing growth rates; and
- e) develop specific case studies, which will be relevant to the advice of ICES.

The Workshop report was published as an ICES document (ICES CM 2000/C:12) and was given high praise at the review by the Oceanography Committee at the 2000 ICES ASC meeting. In light of this and in keeping with the recommendation of the WGCCC at their 2000 meeting, a decision was made to publish it as an ICES Cooperative Research Report. The co-convenors, with the approval of the WGCCC, have decided to wait until after the theme

session on gadoid growth during the 2001 ICES Annual Science Conference (see below) before publishing the report in order to incorporate any additional information and analyses presented there.

#### **2.4 2000 Theme Session on Climate-Plankton-Fisheries Interactions**

Many of the Global Ocean Ecosystem Dynamics (GLOBEC) studies in the 1990s focused upon the dynamics of zooplankton, with special emphasis upon their connection to the physical environment. Justification was often built upon their links to the commercial fisheries. The principal purposes of the theme session on Climate-Plankton-Fisheries Interactions co-sponsored by the WGCCC and the WGOH were twofold: one to present the results of studies on the role of the physical environment including ocean climate on the plankton and secondly to show the relationship between zooplankton and fish. A total of 19 papers and 6 posters were presented. Roger Harris (UK) kindly summed up the session and commented on the progress being made.

The presentations and posters covered studies of the physical controls governing phytoplankton and zooplankton production as well as relationships between climate, zooplankton and fish through a variety of methods. Geographically, most of the studies centered on the northern North Atlantic, but work on the northern Pacific off eastern South America, off Africa and the Antarctic were also included. New understanding of the distribution and the role of the physical environment on *Calanus finmarchicus*, in particular, were forthcoming. The studies divided into four main categories: field studies, retrospective analyses, modelling and new technological methods. A report of the theme session appears in the 2000 ICES Annual Report.

Some major conclusions from the theme session include the following. Based upon observations and modelling, the distribution of phytoplankton and zooplankton, such as *Calanus finmarchicus* in the northern North Atlantic were shown to be strongly influenced by the physical environment, including hydrographic properties, circulation and/or mixing. Ecological modelling has made important advances, adding increasing complexity, such as incorporating the numerous stages of zooplankton and fish larvae. While such models can reproduce many of the observations, there are still discrepancies between model and data. Better understanding of the behaviour and distribution of the various life history stages and their incorporation into the models will be important if the rapid advance being made through modelling is to continue. In the North Sea, major ecosystem changes are principally driven by fluctuations in the Atlantic Water inflow, except along the southeastern coastal areas, where the ecosystem variability is controlled by nutrient input. Large-scale atmospheric processes as indexed by the North Atlantic Oscillation (NAO) appear to drive part of these fluctuations and were also implicated in studies in the Baltic and on Georges Bank. The role of zooplankton on fish recruitment appears spatially dependent. A positive relation was observed between zooplankton and fish on Georges Bank and a negative relationship off eastern Canada, while the total amount of zooplankton on Georges Bank and the Middle Atlantic Bight was remarkably stable between 1977 to 1999, in spite of large changes in both demersal and pelagic fish stocks. The reason for the differences may be related to species considerations as well as collection procedures, including frequency and timing. With regard to linkages between zooplankton variation and fish recruitment, a major outstanding issue is the extent to which early life stages of fish are food limited. Problems with the zooplankton time series were noted, that is they are often of short duration and not always overlapping in space or time with the fish species of interest. In addition, the large extent of the patchiness of the zooplankton itself introduces a level of variation that can make it difficult to observe the underlying relationships between the zooplankton and higher trophic levels. While correlation analyses must be viewed cautiously, especially given the difficulties with the zooplankton time series, such results may help us to focus on the important operative processes.

#### **2.5 2001 International GLOBEC Meetings, Lima, Peru**

Ken Drinkwater (Canada) and Geir Ottersen (Norway) attended the International GLOBEC Scientific Steering Meeting held in Lima, Peru, in May 2001. They reported on the activities of the WGCCC, including the Workshop on the Dynamics of Cod Growth and future activities such as the Workshop on the Transport of Cod Larvae and on the proposed book as part of the CCC synthesis activities. In regards to the latter, International GLOBEC at their 2000 meeting indicated that they might be willing to provide financial support. At this year's meeting they confirmed a contribution of \$5000 US towards a meeting of potential contributors to the book to be organized by the WGCCC during this year (see below for more details on the synthesis book).

Next year International GLOBEC is sponsoring an OPEN Science Meeting to be held in Qingdao, China, on 15–18 October 2002. They are encouraging participation of the regional GLOBEC programs, of which the WGCCC is one of four such groups. A call for proposals for session topics was received in August 2001. The WGCCC plans to participate in this meeting, with decisions on the nature of the participation and subject focus to be made in the near future.

The FOCUS 1 Working Group of International GLOBEC dealing with Retrospective Analysis is planning a Workshop on comparative ecosystems to be held tentatively in 2003. The purpose of such a workshop is to examine ecosystem

variability around the world to determine possible common causes and differences. Are there large-scale teleconnections around the globe that suggest climate variability as an important driving force of such changes? This workshop will offer an opportunity to compare changes in the cod stocks around the North Atlantic with what is happening to other species throughout the world's oceans. The Chair of the WGCCC is on the organizing committee for the workshop.

## **2.6 2001 CPR Symposium and ICES Decadal Symposium**

The WGCCC did not schedule any workshops during 2001, instead encouraging its members to participate in the Symposia held in Edinburgh, Scotland. These were the Symposium celebrating the 70<sup>th</sup> Anniversary of the Continuous Plankton Recorder (CPR) held on 7 August and the Symposium on Hydrobiological Variability in the ICES Area, 1990–1999 held during 8–10 August 2001. Keith Brander gave three talks including a keynote address to the CPR Symposium addressing, amongst other things, how the CPR can provide information for fisheries. Several WGCCC members made oral presentations or presented posters at the Decadal Symposium on subjects related to either climate variability or on the response of cod stocks to climate variability with emphasis upon changes in the 1990s. A total of 6 oral presentations and 6 posters covered various aspects of cod variability from the Baltic to Newfoundland.

## **3 FUTURE WGCCC ACTIVITIES**

### **3.1 Follow-On Activities to the Cod Growth Workshop**

#### **3.1.1 Theme Session on Cod Growth**

At the ICES/GLOBEC Workshop on the Dynamics of Growth in Cod in May 2000, a recommendation was made to propose a theme session on gadoid growth for the ICES ASC. This recommendation was accepted by ICES at the 2000 ASC and a theme session entitled Growth and Condition in Gadoid Stocks and Implications for Sustainable Management will take place during the 2001 ASC meeting in Oslo, Norway. Co-chairs Larry Buckley (USA), Jean-Denis Dutil (Canada) and Tara Marshall (Norway) have organized this theme session and a total of 29 papers are scheduled for presentation.

There has been an increasing body of evidence demonstrating linkages among growth, physiological condition, reproductive effort, and production in Gadoid stocks. This work suggests that not all Gadoid stocks or all individuals within a stock exhibit similar growth responses under similar environmental conditions. Within a stock, fishes of different size have different requirements, with larval and juvenile fish growing better at higher temperatures than adult fish. Predictions on the production of a stock and the consequences for sustainable management require a better understanding of the genetic, ontogenic, and phenotypic aspects of individual growth, as well as better growth models. Growth encompasses a host of physiological mechanisms ranging from ingestion to assimilation and synthesis of new tissue. Enhanced growth is generally accompanied with an improvement in physiological condition. Indices of the physiological condition have long been used as proxies to estimate growth rate in larval fish. Recent applications of physiological indicators in juvenile and adult fish offer new avenues of research to investigate growth dynamics, reproductive effort, and production in wild fish. The aim of the Theme Session is to explore these new tools and to examine stock- and size-specific growth responses to various factors, including climate variability, stock density, and size selective fishing. The Session will consider both multivariate analyses at the stock level and field and laboratory studies on growth and condition.

#### **3.1.2 GADOLIFE**

As a direct result of the ICES/GLOBEC Workshop on the Dynamics of Cod Growth and following one of the Workshop recommendations, a team of international scientists wrote a major proposal. Entitled "Growth Dynamics and Regulation of Energy Allocation in Gadoids of Different Life Strategies and in Different Environments (GADOLIFE)" parts of the project were submitted for funding during 2001 to the Canadian Strategic Science Fund and other parts to the EU funding agency. The project involved a combination of lab, field, bioenergetic modelling and retrospective analysis studies of growth in gadoids, including cod. The aim is to improve understanding of growth variations through increased knowledge of food acquisition and energy allocation in gadoids and development of mechanistic bioenergetic models. Included were environmental effects. Comparison of cod stocks in Canada (southern Gulf of St. Lawrence and western Scotian Shelf) with those in the North Sea and the Baltic would be carried out as well as between cod and other species such as haddock, whiting and hake in European waters. The lead researcher on the EU proposal was Neils Anderson (Denmark) who was one of the co-chairs of the Workshop on the Dynamics of Cod Growth and on the Canadian proposal was Jean-Denis Dutil (Canada) who attended the workshop and is one of the co-chairs of the Theme Session on gadoid growth. Many of the participating PIs on the proposals also attended the Workshop. The Canadian proposal obtained funding, but the EU proposal will be resubmitted in October 2001.

### **3.1.3 Growth Studies using Otolith Back-Calculations**

One of the follow-up activities proposed at last years meeting (See Section 3.3 of CM 2000/C:11) was on the use of otolith back-calculation as a means of determining growth history. Recent technical advances in otolith microchemistry and in data storage tags provide the means for determining ambient temperature for individual fish.

Articles describing the scientific background appeared in both the ICES/GLOBEC Newsletter (# 6 and 7) and the ICES Newsletter (#37) and generated a number of enquiries and responses.

The Coordinator of the European Fish Ageing Network expressed interest in further cooperative work.

Several proposals for funding of future studies using these techniques are currently being prepared and it may be useful to hold informal discussions during the ASC in 2001 about coordinating these and exchanging ideas. The Theme Session on Gadoid Growth provides a highly relevant context for such discussions.

### **3.2 Workshop on the Transport of Cod Larvae**

In last year's report, the WGCCC proposed a workshop on the transport of cod larvae to be held in the spring of 2002. This proposal was part of the Working Group's 5-year plan established in May 1998 and outlined in the 1998 report of the WGCCC (ICES CM 1998/C:10). At that time the focus was to be on the larval drift between Iceland and West Greenland but at the 2000 meeting it was decided to expand the focus to include other areas where larval drift is important (ICES CM 2000/C:11). During the past year, two co-chairs were selected, a site and date chosen and discussions held to firm up the main topics and activities of the workshop. In addition, discussions with other Working and Study Groups have been held to solicit their support and participation for the Workshop. These include the Working Group of Recruitment Processes, the Study Groups on the Incorporation of Process Information into Stock-Recruitment Models and the Study Group on Modelling of Physical/Biological Interactions. These Groups plan to hold their annual meetings at a time adjacent to the Transport Workshop in order that their members can attend and contribute to the Workshop. The following preliminary notice was sent to members and prospective participants in June 2001. A number of scientists have expressed interest in contributing or attending and a second notice will be sent out.

The drift of cod larvae has significant implications in several regions of the North Atlantic. For example, Icelandic cod can drift as larvae towards West Greenland. Under certain environmental conditions off West Greenland, these cod thrive and subsequently return to Iceland to spawn. This can cause large uncertainties in the assessment of the Icelandic stocks. Transport of cod larvae has also been hypothesized to affect recruitment patterns in several other areas of the North Atlantic including in the Gulf of Maine, Davis Strait and the Faroes. The ICES Working Group on Cod and Climate Change (WGCCC) therefore decided to hold a workshop that will explore transport processes and their role in the life histories of the affected cod stocks. In particular, we hope to be able to use circulation models to explore the physical processes that lead to the variability in transport of larvae. Comparisons will be made between different regions and stocks. In addition, attempts will be made to determine if larval transport indices derived from model results can be used to improve assessment models.

The workshop will address interannual variability in transport within a stock as well as transport across stock boundaries. Rapid advances in circulation models at a variety of scales have improved the prospect of developing scenarios for changes in circulation under different conditions of climate change. There are also improving prospects for operational now-casting and forecasting of circulation.

The ICES WG on Cod and Climate Changes therefore will hold a workshop on the Transport of Cod Larvae in Copenhagen during April 16–18, 2002. The workshop is intended for physical oceanographers, modellers (both physical and biophysical), fisheries scientists and assessment biologists. John Quinlan (USA) and Michael St. John (Germany) have agreed to co-chair the meeting.

The draft terms of reference are:

- a) couple circulation models with early life history models to determine the physical and biological processes responsible for the transport or retention of cod larvae;
- b) develop, if possible, interannual transport indices based on physical variables that reflect the magnitude of the larvae drift or retention;
- c) attempt to incorporate these indices into the cod assessment process;

- d) collate and synthesize existing direct and indirect observational information about egg and larval transport for all stocks and years. [Direct information is egg and larvae surveys while indirect information includes unusual distribution and migration in later life, elemental analysis of otoliths, genetic identification, and meristic characters.]

A website will be set up for exchange of information, ideas and data prior to the meeting.

### **3.3 Synthesis**

Given that WGCCC has been active for almost 10 years it was decided at its 2000 meeting that a formal synthesis of the results from its activities should be undertaken. It was agreed that this should take the form of a book to summarize our knowledge of cod and how the WGCCC has contributed. It would primarily be a review but new work would be included where required or needed. Also at that meeting Mike Heath (UK) agreed to lead this effort with the help of Ken Frank (Canada). Unfortunately, since that meeting other commitments required that Dr Heath withdraw his offer. Ken Drinkwater (Canada) and Keith Brander (ICES/GLOBEC Secretary) have taken over the initial planning stages. They met with Mike Heath in June 2001 in Dartmouth and agreed on the general philosophy and a tentative outline for the book. Geir Ottersen and Ken Frank also commented on the strategy and initial outline.

Much of the past work that has been published on cod has been based upon research on individual stocks. This book should highlight comparisons between stocks and especially look at stocks across the full range of environmental conditions over the North Atlantic. In keeping with GLOBEC aims, the book will also highlight climate affects cod through its life history but not exclusively. It is important to determine the relative importance of climate compared to biotic influences such as density dependence, predator-prey interactions, etc. The book will consist of an introduction along with chapters on the stock structure, the physical environment, the planktonic environment, growth and reproduction, recruitment, larval transport, distribution and migration, feeding, predation, etc. In addition, there will be chapters on the Cod and Climate Change Program and its role, implications for fisheries management, impacts of climate change on cod, and a summary chapter. It is proposed to select lead authors for each chapter with support from a small group of contributing authors (minimum of 1). There should be one person from each side of the Atlantic in each group. The proposal also suggested that lead and contributing authors be selected during the autumn of 2001 and a small group of these should meet if possible to discuss the contents of the chapters (International GLOBEC has provided funding of \$5000 US for such a meeting). Further discussion of the book will be carried out at the 2002 WGCCC meeting in the spring. A Synthesis Workshop in the spring of 2003 is planned to allow the authors to present the main focus and points of their chapters, obtain feedback, allow comments on linkages between chapters and identify possible missing information. First drafts of the chapters would be ready by the autumn of 2003, final drafts by the spring of 2004 and the results presented at the Symposium on the Influence of Climate Change on North Atlantic Fisheries in the summer of 2004.

### **3.4 Symposium on the Influence of Climate Change on North Atlantic Fisheries**

At the 2000 WGCCC meeting it was decided to recommend to ICES that a Symposium on the Influence of Climate Change on North Atlantic Fisheries be held in 2004 in Bergen, Norway. This recommendation was subsequently accepted after submission at the 2000 ASC meeting. It will be co-chaired by Harald Loeng (Norway), Ken Drinkwater (Canada) and Robin Cook (UK). Topics to be covered will include climate variability, plankton and fisheries, recruitment, growth, distribution and migration and the influence of climate variability on short and medium-term fish stock prediction. The synthesis of the Cod and Climate Change program will be presented (see Section 3.3). Besides oral presentations and posters, a panel discussion and summary is planned.

## **4 RECOMMENDATIONS AND TERMS OF REFERENCE FOR FUTURE MEETINGS**

### **Recommendation I:**

**The ICES/GLOBEC Working Group on Cod and Climate Change** (Chair: Dr K. Drinkwater, Canada) will meet in Copenhagen, Denmark on April 19–20, 2002 to:

- a) continue with the review and evaluation of work carried out to date on Cod and Climate Change including results and possible follow-up work from the Workshop on Transport of Cod Larvae
- b) plan and prepare workshops over the next two years in order to:
  - i) coordinate the synthesis work and the preparation of material for the book
  - ii) continue the evaluation of studies on Long-Term Climate Change and Prediction;

- c) foster further cooperation and interaction with the Working Group on Recruitment Processes, the Study Groups on the Incorporation of Process Information into Stock-Recruitment Models and the Study Group on Modelling of Physical/Biological Interactions;
- d) determine the Working Group's contribution to the GLOBEC Open Science Meeting in China in October 2002.

The Working Group will report to the Oceanography Committee at the 2002 ICES Annual Science Conference.

### **Supporting Information**

**Priority:** This Group is of fundamental importance to the future of the ICES Advisory Process.

### **Scientific Justification:**

During the 1998 annual meeting of the CCCWG formulated its five year plan for the Oceanography Committee and for the Implementation Plan of the International GLOBEC programme (The ICES/GLOBEC cod and climate change programme is the North Atlantic regional component of the International GLOBEC programme). The plan was extended during the 2000 annual meeting to include additional activities through to 2004–2005. The first three years have been successfully completed and plans for year four are progressing on schedule. Further preparations and planning are required during the coming year to continue the program through to completion. The meeting will be held in conjunction with the workshop on Transport of Cod Larvae.

- a. The Workshop on Transport of Cod Larvae will immediately precede the WGCCC meeting. An evaluation of the success of the workshop in meeting its stated terms of reference will be carried out in order to determine what follow-up activities should be initiated and how best to carry them out.
- b. (i) To facilitate the synthesis activities and publication of the book a workshop of lead and contributing authors is required to ensure linkages between the selected chapters and to identify potential gaps. This will be essential to ensure proper synthesis of WGCCC program.  
  
(ii) During the 2000 meeting, the WGCCC felt there was a need for climate predictions for assessment purposes and also information on the response of cod to climate change scenarios. It was decided to propose a workshop on these two topics to be held in 2005. This decision will be reviewed and discussed.
- c. Members of the WGRP and the Study Groups have shown an interest in attending the Workshop on Transport of Cod Larvae. To facilitate their participation, all three as well as the WGCCC are planning their annual meetings immediately following the Workshop. This will provide an opportunity to discuss matters of mutual interest and to possibly hold a short joint session.
- d. The International GLOBEC Open Science Meeting scheduled for October 2002, in Qingdao, China has requested participation from the regional and national programs. This provides an opportunity to showcase some of the work of the ICES WGCCC.

### **Relation to Strategic Plan:**

The ICES/GLOBEC programme contributes to Goals 1,4,5 and 8 of the Strategic Plan.

### **Resource Requirements:**

Assistance from the ICES/GLOBEC Coordinator in maintaining the exchange of information via the web site, Newsletters, databases and workshop bulletin boards.

Participants: Participation at WGCCC is usually more than 25. Part of the reason for holding two Study Groups, the Recruitment Processes WG and the Workshop on Transport Processes at the same time and location is to encourage cross-participation.

**Secretariat Facilities:**

Dependent on availability of meeting rooms at ICES HQ

**Financial:** None

**Linkages to Advisory Committees:**

WGCC has close relevance to the work of the Advisory Committees

**Linkages to Other Committees or Groups**

Living Resources, to whom the Group reports. Also links to SGNARO, RPWG, SGPRISM, SGMPI

**Linkages to Other Organisations:**

GLOBEC is a co-sponsor of the group.

**Recommendation II:**

A Workshop on the **Transport of Cod Larvae** will be held on April 16–18, 2002 in Copenhagen, Denmark under the co-chairmanship of J. Quinlan (USA) and M. St. John (Germany) to:

- a. couple circulation models with early life history models to determine the physical and biological processes responsible for the transport or retention of cod larvae;
- b. develop, if possible, interannual transport indices based on physical variables that reflect the magnitude of the larvae drift or retention;
- c. attempt to incorporate these indices into the cod assessment process; and
- d. collate and synthesize existing direct and indirect observational information about egg and larval transport for all stocks and years. [Direct information is egg and larvae surveys while indirect information includes unusual distribution and migration in later life, elemental analysis of otoliths, genetic identification, and meristic characters.]
- e. evaluate the effects of variations in transport during early life on subsequent recruitment

**Supporting Information**

**Priority:** This Group will carry out a fundamental component of the Cod and Climate Change strategic plan.

**Scientific Justification:**

The drift of cod larvae has significant implications in several regions of the North Atlantic. For example, Icelandic cod can drift as larvae towards West Greenland. Under certain environmental conditions off West Greenland, these cod thrive and subsequently return to Iceland to spawn. This can cause large uncertainties in the assessment of the Icelandic stocks. Transport of cod larvae has also been hypothesized to affect recruitment patterns in several other areas of the North Atlantic including in the Gulf of Maine, Davis Strait and the Faroes. The ICES Working Group on Cod and Climate Change (WGCCC) therefore decided to hold a workshop that will explore transport processes and their role in the life histories of the affected cod stocks. In particular, we hope to be able to use circulation models to explore the physical processes that lead to the variability in transport of larvae. Comparisons will be made between different regions and stocks. In addition, attempts will be made to determine if larval transport indices derived from model results can be used to improve assessment models.

The workshop will deal with interannual variability in transport within a stock as well as transport across stock boundaries. Rapid advances in circulation models at a variety of scales have improved the prospect of developing scenarios for changes in circulation under different conditions of climate change. There are also improving prospects for operational now-casting and forecasting of circulation.

**Relation to Strategic Plan:**

The workshop will contribute to Goals 1,4,5 and 8 of the Strategic Plan.

**Resource Requirements:**

Assistance from the ICES/GLOBEC Coordinator in maintaining the exchange of information via the web site, Newsletters, databases and workshop bulletin boards.

Participants: Participation at workshops of the WGCCC is usually more than 25. Part of the reason for holding two Study Groups, the Recruitment Processes WG and the Workshop on Transport Processes at the same time and location is to encourage cross-participation. The workshop is expected to attract a number of scientists from outside the regular ICES scientific community.

**Secretariat Facilities:**

Dependent on availability of meeting rooms at ICES HQ

**Financial:** None

**Linkages to Advisory Committees:**

Relevant to the work of the ACFM and ACE

**Linkages to Other Committees or Groups**

Living Resources, to whom the Group reports. Also links to SGNARO, RPWG, SGPRISM, SGMPI

**Linkages to Other Organisations:**

GLOBEC is a co-sponsor of the group.

## APPENDIX A – PAPERS PUBLISHED OR SUBMITTED IN 2000/2001

Brander, K. M. 2000. Effects of environmental variability on growth and recruitment in cod (*Gadus morhua*) using a comparative approach. *Oceanologica Acta*. 23(4):485–496.

De Clers S. and Brander, K.M. 2000. Fisheries: in Parry, M.L. (Ed.) *Assessment of Potential Effects and Adaptations for Climate Change in Europe*. Jackson Environmental Institut, University of East Anglia, Norwich, UK 320pp.

Brander K.M. (submitted for SAP Symposium volume) What kinds of fish stock predictions do we need and what kinds of information will help us to make better predictions?

Brander, K. M., Dickson R.R. and Shepherd J.G. 2001 Modelling the timing of plankton production and its effect on recruitment of cod (*Gadus morhua*). *ICES Journal of Marine Science* 58.