

ICES/GLOBEC WGCCC Report 2005

ICES Oceanography Committee
ICES CM 2005/C:11

Report of the ICES/GLOBEC Working Group on Cod and Climate Change (WGCCC)

By Correspondence



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Conseil International pour l'Exploration de la Mer

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Executive Summary

In January 2004 the ICES/GLOBEC Working Group on Cod and Climate Change (WGCCC) launched a Revised Strategic and New Action Plan, which outlined the main activities within the group for its final phase 2005–2009:

- 1) **Fisheries Management:** To incorporate environmental information into fisheries management.
- 2) **Zooplankton-Cod Linkages:** To understand the relative importance of zooplankton in determining the variability in cod abundance and production.
- 3) **Comparative Analyses:** To understand the relative importance of climate variability in causing fluctuations in North Atlantic cod stocks by means of comparative studies.
- 4) **Climate Change:** To evaluate the impact of climate change scenarios on cod distribution and production throughout the North Atlantic.
- 5) **Tropho-dynamics of Cod Ecosystems:** To understand the role of cod in the ecosystem and the importance to cod of climate-induced variability in their prey and predators.
- 6) **Synthesis:** To provide a synthesis of the research information obtained on cod stocks.

To achieve the above objectives a number of different activities are being undertaken, included those listed below (the numbers in parentheses related to the Terms of Reference for WGCCC (ICES CM 2004/C:13)).

- A Workshop on *Impact of Zooplankton on Cod Abundance and Production* Co-Convened by Øvind Fiksen (Norway), Christian Möllmann (Denmark) and Jeff Runge (USA) met at ICES Headquarters, Copenhagen, Denmark from 7 to 9 June 2005. The 18 scientists participating provided 16 working papers that documented considerable progress with regards to zooplankton population dynamics, community structure and the consequences for cod [b)].
- A multi-authored peer reviewed book, *Cod in a changing climate – effects of physical variability on a key predator in North Atlantic marine ecosystems*, is to be published within Springer's IGBP series. Draft versions of the chapters have been returned to the editors Keith Brander, ICES, Denmark and Ken Drinkwater, IMR, Norway. Publication is expected in mid 2006 [a) i)].
- A Theme Session at the ICES Annual Science Conference in Aberdeen, Scotland 20–24 September 2005 will have the same focus as the book and will be co-convened by the editors. In addition to presentations of all book chapters other talks on these topics will be given (abstracts have been received) [f)].
- An ICES Cooperative Research Report on *Spawning and life history information for North Atlantic cod stocks* is soon to be published. The main purpose of the report, edited by Keith Brander, is to provide information for comparative studies of cod biology and population dynamics. It is available at <http://www.ices.dk/globec/> [a) ii)].
- A workshop will be arranged in 2006, covering two interlinked topics, The Decline and Recovery of Cod Stocks throughout the North Atlantic and The Influence of Climate on Tropho-Dynamics of Cod Ecosystems [c)].
- Publication of the proceedings of the Symposium on the influence of Climate Change on North Atlantic fish stocks [a) iii)].

The next WGCCC meeting is scheduled in conjunction with the workshop (time yet to be decided).

Kai Wieland, Greenland, will be joining Geir Ottersen, Norway as Co-Chair of WGCCC in September 2005 following final approval at the ICES ASC.

1 Introduction and Terms of Reference

The ICES/GLOBEC Working Group on Cod and Climate Change [WGCCC] (Chair: G. Ottersen, Norway) worked by correspondence during 2005. The Terms of Reference (ICES CM 2004/C:13) for WGCCC in 2005 are:

- a) review and evaluate the progress on the Synthesis Activities including:
 - i) publication of the book on cod,
 - ii) publication of the CRR on the life history aspects of cod stocks throughout the North Atlantic,
 - iii) publication of the proceedings of the Symposium on the Influence of Climate Change on North Atlantic fish stocks;
- b) plan and prepare the Workshop on the Impact of Zooplankton on Cod Abundance and Production;
- c) plan the back-to-back Workshops on the Decline and Recovery of Cod Stocks Throughout the North Atlantic and on the Influence of Climate on Trophodynamics of Cod Ecosystems;
- d) initiate plans for a Workshop on Cod and Future Climate Change and discuss other Workshops;
- e) review and evaluate the results from the Workshop on the transport of cod larvae;
- f) plan the Theme Sessions on Cod in a Changing Climate (ASC 2005) and Physics Relevant to Marine Ecosystems (ASC 2006).

2 Review of past activities

2.1 Update on ICES/GLOBEC office

Progress with the ICES/GLOBEC office is reviewed and reported on annually by the Steering Group (SGNARO) and is also reported to the ICES Bureau in January and June each year. Information presented here deals with areas of interest to WGCCC and is intended to supplement rather than repeat information in the other progress reports.

Work during the current year can be divided among four major headings:

- 1) Application of results from the CCC programme within the ICES assessment process:
 - a) In spite of a substantial number of relevant publications showing how recruitment and growth of cod have been affected by changes in the planktonic ecosystem, in temperature and in climate indicators such as the NAO, these results continue to have a negligible impact on the assessment process. Since the effects of climate change are now included in forward planning for most major industries and sectors (water supply, tourism, health, building, agriculture etc.) this is disappointing and continuing efforts are needed to rectify the situation.
 - b) The Regional Ecosystem Study Group for the North Sea (REGNS) held a workshop at ICES HQ from 9–11 May 2005. REGNS was set up in response to the Bergen Ministerial Declaration and is tasked with preparing an Integrated Ecosystem Assessment for the North Sea. The Bergen Declaration invited ICES and GLOBEC to advise on the development of an ecosystem science programme for the North Sea and the coordinator assisted, by assembling data on plankton, fisheries and oceanographic variables and liaising with Canadian colleagues who carried out a preliminary analysis. (see the REGNS report: ICES CM 2005/D:08)

- 2) Meetings, talks, papers and reports. The work being carried out within the CCC programme is relevant to a number of developing areas in the study and assessment of marine ecosystems. The Coordinator was invited to give talks and contribute to a number of studies including:
 - a) Climate related work – lead author on fisheries for fourth IPCC report; contributing author for Arctic Climate Impact Assessment; development of plankton indicators of climate change; invitation to GODAE Symposium in November 2004 to give plenary talk and convene a break-out group (with Dr Brad de Young, Canada) on potential pilot projects for operational oceanography in fisheries; talk on “Is climate change moving the goalposts for fisheries management?” at a conference on Biodiversity in Paris, January 2005; talk on “Climate change and fish distribution in the North Sea” at a North Sea Commission Conference in March 2005; talk on “Effect of climate change on fish distribution and dynamics in the North Atlantic” at ES-SAS Symposium Victoria May 2005; talk on “Marine biodiversity is affected by climate change and fishing” at the Green Week organised by DG Environment June 2005.
 - b) Ecosystem approach, development of monitoring and ecosystem indicators, structure of marine ecosystems – talk on “Long term plankton monitoring for marine management” at a North Sea Commission Conference in March 2005.

Most of the presentations made over the past year are available from the ICES/GLOBEC website. A poster about the ICES/GLOBEC programme is also available.

- 3) Scientific Steering Committees, Programme Reviews etc. for PNEC (France), Marine Productivity (UK), German GLOBEC, Norwegian Research Council.
- 4) Funding renewal and proposal writing.

A proposal for an EU Marie Curie Research Training Network (on fisheries induced adaptive change) will go ahead and will provide a post-doctoral fellow to work at ICES from May 2006. Additional funding from DEFRA (UK) covers costs preparation, travel and attendance.

2.2 Strategic plan

Based on discussions at the Workshop and Annual Meeting in 2003, WGCCC decided to compile a revised Strategic and new Action Plan for 2005–2009. It was further decided that the WG would be disband in 2009, which coincides with the official end of the GLOBEC programme. The revised CCC plan was circulated in January 2004 and consisted of some of the former topics and objectives, a modified version of others, and one new objective. It was presented to and accepted by the International GLOBEC Scientific Steering Committee in April 2004 and the Oceanography Committee at the ICES ASC in September 2004. The themes and their objectives are as follows (the full Strategic and new Action Plan can be found in last years WGCCC report, ICES CM 2004/C:13).

- 1) **Fisheries Management:** To incorporate environmental information into fisheries management
- 2) **Zooplankton–Cod Linkages:** To understand the relative importance of zooplankton in determining the variability in cod abundance and production.
- 3) **Comparative Analyses:** To understand the relative importance of climate variability in causing fluctuations in North Atlantic cod stocks by means of comparative studies.
- 4) **Climate Change:** To evaluate the impact of climate change scenarios on cod distribution and production throughout the North Atlantic.
- 5) **Tropho-dynamics of Cod Ecosystems:** To understand the role of cod in the ecosystem and the importance to cod of climate-induced variability in their prey and predators.

- 6) **Synthesis:** To provide a synthesis of the research information obtained on cod stocks.

2.3 Synthesis activities

2.3.1 Publication of the book on cod and climate – TOR a (i)

At the 2000 WGCCC Meeting (ICES CM 2000/C:11) it was decided that a major component of the WGCCC synthesis activities would be the publication of a book on cod. At the 2002 Meeting (ICES CM 2002/C:15) an outline including specific chapters was adopted and lead co-authors were suggested with K. Brander and K. Drinkwater agreeing to be the co-editors. In 2003, a Synthesis Workshop was held (ICES CM 2003/C:10) to discuss in detail what each of the chapters would cover, to coordinate the chapters, and to agree upon formats, audience, publication, and a timetable.

The chapters and co-authors are:

Chapter 1: Introduction: K. Brander (ICES/GLOBEC) and K. Drinkwater (Norway)

Chapter 2: Stock Structure and History: G. Marteinsdottir (Iceland), D. Ruzzante (Canada) and

Chapter 3: Cod and Climate Change Program: B. Rothschild (USA), S. Sundby (Norway) and R. Dickson (UK)

Chapter 4: Physical Oceanographic Setting: K. Drinkwater (Norway) and H. Loeng (Norway)

Chapter 5: Biological Oceanographic Setting: M. Heath (UK) and G. Lough (USA)

Chapter 6: Growth and Condition: L. Buckley (USA), J.-D. Dutil (Canada) and T. Marshall (UK)

Chapter 7: Recruitment: F. Köster (Denmark) and M. Fogarty (USA)

Chapter 8: Larval Transport: P. Pepin (Canada) and H.-H. Hinrichsen (Germany)

Chapter 9: Distribution and Migration: G. Ottersen (Norway) and D. Swain (Canada)

Chapter 10: The Role of Cod in the Ecosystem: J. Link (USA), G. Lilly (Canada), B. Bogstad (Norway) and H. Sparholt (ICES)

Chapter 11: Implications for Fisheries Management: K. Brander (ICES/GLOBEC) and S. Murawski (USA)

Chapter 12: Response of Cod to Climate Change: K. Drinkwater (Norway) with input from others

Chapter 13: Summary: K. Brander (ICES/GLOBEC) and K. Drinkwater (Norway)

In February 2004 the editors signed an agreement with Springer to publish the book on cod in the IGBP series.

In May 2004 K. Brander distributed detailed guidelines to all authors to ensure they keep to the intended content and a consistent style. The original date of delivery of the manuscript to the publishers by the end of 2004 was found to be unrealistic and has now been set to the end of 2005. The editors have received good draft versions of nearly all chapters. However reviews, editorial suggestions and rewriting will take time, so publication is not expected before the autumn of 2006.

2.3.2 CRR on the life history aspects of cod stocks throughout the North Atlantic – TOR a (ii)

This synthesis of information on spawning and life history of North Atlantic cod stocks is an update of ICES *Cooperative Research Report 205 (CRR 205)*, published in 1994, but it has been completely re-written. The editor, K. Brander, has compiled an enormous body of new information which has become available over the intervening decade. Contributions have been made by 35 different authors covering the 20 main cod stocks all around the north Atlantic. In addition to chapters on each stock, summary tables present key life history information on all stocks, facilitating comparison. Single chapters or the full report may be downloaded from <http://www.ices.dk/globec/> (CRR on Life History). As part of the work on the CRR a searchable reference data base of all the around 2000 articles referred to in the report has been compiled. This database will be made available at <http://www.ices.dk/globec/>

2.3.3 Proceedings of the Symposium on the Influence of Climate Change on North Atlantic fish stocks – TOR a (iii)

The WGCCC sponsored ICES Symposium on the Influence of Climate Change on North Atlantic Fish Stocks was held 11–14 May in Bergen, Norway. Following the opening talk by Jim Hurrell (USA) 62 talks and 35 posters, organized into five major sessions, were given. These sessions were on Zooplankton, Distribution Shifts, Production (which included sub-sessions on Ecosystems and Trophic Interactions, on Growth, Condition, Reproduction and Mortality and on Recruitment and Abundance), Climate Change Impacts, and Management under a Changing Climate. For each Session, invited papers given, by Mike Heath (UK) on zooplankton, George Rose (Canada) on distribution, Gudrun Marteinsdottir (Iceland) on production, Laura Richards (Canada) on climate change, Colin Bannister (UK) on management issues. The quality of the invited and submitted papers was very high, with much evidence of steady progress in the field of climate effects on fisheries. Many of the papers and posters can be viewed at <http://www.imr.no/2004symposium/web/index.html> and 35–40 of them will be published in a special issue of the ICES Journal of Marine Science. The co-editors of the issue are H. Loeng (Norway), R. Cook (UK), B. Megrey (USA), and K. Drinkwater (Norway). The submitted manuscripts have been reviewed and those accepted are now under revision.

2.4 CRR on Transport Workshop – TOR e

The WGCCC Cod Transport Workshop (ICES CM 2002/C:13) was held 14–17 April 2003, in Hillerød, Denmark under Co-Chairs J. Quinlan (USA) and B. Ådlandsvik (Norway). At the 2002 WGCCC Meeting (ICES CM2002/C:15), it was recommended that the workshop report be published as an *ICES Cooperative Research Report* to allow broader dissemination of the results. This is to be undertaken by K. Brander and K. Drinkwater but due to the other WGCCC activities, little progress was made on this recommendation during the past year. The WG reconfirmed the commitment to this recommendation at the 2004 WGCCC Meeting (ICES CM 2004/C:13) but that it is to continue to have lower priority than the synthesis activities, i.e., the cod book, and updated CRR on cod and the publication of the 2004 Symposium proceedings.

3 Future WGCCC activities

3.1 Workshop on the Impact of Zooplankton on Cod Abundance and Production – TOR b

The Workshop (WKIZC), co-convened by Øvind Fiksen (Norway), Christian Möllmann (Denmark) and Jeff Runge (USA) will meet at ICES Headquarters, Copenhagen, Denmark from 7 to 9 June 2005. The Terms of Reference were:

- a) to determine the zooplankton species in the diets of cod, their temporal and spatial changes;
- b) to determine the variability in zooplankton populations and their relationships to cod;
- c) to examine the vital rates (growth, reproduction, mortality, recruitment) of zooplankton which are relevant to cod life histories ("stock assessment" of zooplankton);
- d) to determine how the timing of zooplankton production and spatial dynamics (including patchiness) of *nauplii* relates to the spawning, distribution and survival of early stages of cod;
- e) to establish the links between zooplankton and later stages of cod.

18 scientists attended the workshop and provided 16 working papers, which were posted on the ICES/GLOBEC website prior to the meeting. The final programme for the meeting and most of the presentations can be viewed on the website, which will also include a reference database (once technical problems with website software are overcome).

There has been considerable progress with observation and modelling of zooplankton population dynamics, feeding behaviour of cod larvae on zooplankton, growth and mortality and large scale investigations of changes in zooplankton community structure and their consequences for cod population dynamics.

3.2 Workshops on the Decline and Recovery of Cod Stocks throughout the North Atlantic and on the Influence of Climate on Tropho-Dynamics of Cod Ecosystems – TOR c

The 2003 WGCCC meeting suggested two workshops for 2006, (i) the Decline and Recovery of Cod Stocks throughout the North Atlantic (WKDRC) and (ii) the Influence of Climate on Tropho-Dynamics of Cod Ecosystems (WKICT). The focus of these two workshops was outlined in the WGCCC 2003 report (ICES CM 2003/C:11) and the new Action Plan.

WKDRC: During the presentations on the update of the cod stocks around the North Atlantic, the WG was struck by the similarity in the abundance trends of many of the stocks, from high values in the 1960s that in some cases persisted through into the 1970s and 1980s, followed by a decline to relatively low levels. In addition, there were often declines in size-at-age and age of maturity. The cause of these declines and the potential for recovery are among the most important issues for cod fisheries today. The Workshop will compare the changes that have occurred in all of the cod stocks around the Atlantic and address the relative importance of fishing and climate induced ecosystem changes.

WKICT: Widely observed changes in abundance, size-at-age and maturity of cod in many stocks throughout the North Atlantic in recent years will be addressed from a tropho-dynamic and bioenergetic perspective. Both observations and theory will be considered, including mass balance and scaling from individual based modelling. The role of forage species will be reviewed, particularly that of capelin in the Barents Sea and Icelandic waters and sprat in the Baltic. This thus addresses questions about cod dynamics from a more ecosystem-based perspective. Questions to be answered include: To what extent are observed changes in cod stocks due to climate-induced variability in their principal prey species? What is the role of climate change on predators of cod (e.g., pelagic fish on larvae, harp seals on adults)?

At the 2004 meeting the WG noted that these two workshops had been regarded as complementary and linked when first proposed. Since it would be difficult for the WG to hold two separate workshops in 2006, it was decided to run them as two halves of a single meeting (WKDICE), with different co-conveners. Later discussion revealed that there was more interest in the Decline and Recovery of Cod Stocks throughout the North Atlantic so this will be

the main focus of the joint workshop, but with topics related to trophodynamics also to be covered. B. Rothschild (USA), George Lilly (Canada), Svein Sundby (Norway) and Kai Wieland (Greenland) will co-convene the workshop. The workshop will tentatively be arranged in spring 2006 at St John's Canada, alternatively Nuuk, Greenland.

3.3 Workshops scheduled for 2007 and beyond – TOR d

3.3.1 Workshop on the Future of Cod in a Changing Climate (2007)

The WGCCC Strategic and new Action Plan outlines the background for the workshop as follows. The response in abundance, distribution, and production of cod to climate scenarios for the future will be examined. Results from statistical and dynamic downscaling of output from General Circulation Models (GCMs) will be applied. Established climate-cod relations will be utilised. However, while temperature-cod and NAO-cod links have been studied for many stocks, further analyses through retrospective analyses are necessary for other climate variables. We must also take into consideration that simple linear extrapolation of established relations may be inappropriate due to non-linearities in either climate itself, in the climate-ecology impacts or in the links between cod and other trophic levels. The workshop will build upon the 1997 ICES/GLOBEC Workshop on Prediction and Decadal-Scale Ocean Climate Fluctuations of the North Atlantic (ICES CM 1998/C:14), which for the first time brought atmospheric climatologists into the WGCCC community to discuss climate variability and prediction and responses in North Atlantic ecosystems. It will also use information obtained from the CCC program linking the physical environment to distribution, growth, maturity, recruitment, etc. The effects of the expected changes to the cod stocks on human communities will also be addressed. K. Drinkwater, Norway has volunteered to co-convene the workshop, other co-conveners are being sought.

3.3.2 Workshops scheduled for 2008 and 2009

The WGCCC Strategic and new Action Plan outlines plans for two further workshops. i) Workshop on Implications of Results from CCC for Fisheries Management (2008) and ii) Synthesis II Workshop. No further active measures towards the planning of these meetings have yet been taken.

3.4 ASC Theme Sessions

3.4.1 Theme Session on Cod in a Changing Climate (ASC 2005) – TOR f

The Theme Session Cod in a Changing Climate (AA) at the ICES 2005 ASC, Co-Conveners K. Brander (ICES/GLOBEC) and K. Drinkwater (Norway) has mainly focused on presenting the book on cod. Presentations on all 12 book chapters have been confirmed, as well as an additional 8 papers. The book and the Theme Session are intended to make information on status and trends in cod stocks available to a wider public and to make them aware of the contribution of ICES to international marine science. The biological and life history processes underlying climate-driven changes in fish stocks include recruitment (i.e., the number of young fish produced), growth, maturation, natural mortality, and migration. Thanks to the commercial importance of North Atlantic cod, a long history of research, and a dedicated programme within ICES on Cod and Climate Change over the past decade, much has been learned about these processes and about their interaction with each other and with the food chain, predators, and other components of the marine ecosystem. Cod is probably the most comprehensively studied marine fish species, occupying a key role in several North Atlantic ecosystems. An understanding of its dynamics is of direct and indirect relevance to other species and to gaining insight into the response of the marine ecosystem to climate change and variability. The Cod and Climate Change programme is a regional component of the Global Ocean Ecosystem Dynamics (GLOBEC) programme of IGBP. Speakers will review many

aspects of our knowledge of cod, but will also report new results and analyses. They will use a comparative approach to draw conclusions from differences and similarities between the many stocks, which occupy a range of different physical and biological situations.

3.4.2 Theme Session on Physical Processes Influencing Marine Ecosystems (ASC 2006) – TOR f

During the past several years the PICES (WGCCCC-Climate Change and Carrying Capacity) and ICES (WGCCC) regional GLOBEC programmes having been communicating on climate-related topics of common interest. In 2002, Co-Chairs of the two WGs attended and made presentations at the other's annual WG meeting. Discussion has centered on fostering cooperation and joint activities between the two WGs. The WGCCC proposed that similar theme sessions be held at the PICES and ICES 2006 ASC with hopefully members from both WGs in attendance at each. The topic of the theme session will be Physical Processes Influencing Marine Ecosystems.

3.5 Identification of new WGCCC Co-Chair

K. Drinkwater stepped down as Co-Chair of the WGCCC following the 2004 ICES ASC. G. Ottersen will remain as Co-Chair but requested that a new Co-Chair be found. Kai Wieland, Greenland, has volunteered to join G. Ottersen as Co-Chair and is supported by WGCCC. K. Wieland will formally become Co-Chair following final approval at the 2005 ICES ASC.

4 Recommendations and draft resolutions for future meetings

Recommendation I

The **ICES/GLOBEC Working Group on Cod and Climate Change** [WGCCC] (Co-Chairs: G. Ottersen, Norway and K. Wieland*, Greenland) will meet in spring 2006 in St John's, Canada (to be confirmed – the alternative is Nuuk, Greenland) to.

- a) review and evaluate the progress on the Synthesis Activities including:
 - i) publication of the book on cod,
 - ii) publication of the proceedings of the Symposium on the Influence of Climate Change on North Atlantic fish stocks;
- b) review and evaluate the Workshop on the Impact of Zooplankton on Cod Abundance and Production
- c) decide if the 2002 Workshop on The Transport of Cod Larvae should be published as a CRR;
- d) review and evaluate the Theme Session on Cod in a Changing Climate (ASC 2005)
- e) make final preparations for the Workshop on the Decline and Recovery of Cod Stocks Throughout the North Atlantic including tropho-dynamic effects;
- f) review plans for a Theme Session on Physics Relevant to Marine Ecosystems (ASC 2006)
- g) continue planning for a Workshop on Cod and Future Climate Change and discuss other Workshops;

WGCCC will report by 31 May 2005 for the attention of the Oceanography Committee.

Supporting Information

Priority:	This Group is of fundamental importance to the future of the ICES Advisory Process.
Scientific Justification:	<p>The work will be carried out to review past activities and plan future Workshops and Theme Sessions.</p> <ol style="list-style-type: none"> a. <ol style="list-style-type: none"> i. One of the major components of the synthesis planned by the WGCCC is the publication of a book on cod. The process has been somewhat delayed, but recent progress has been good and the book is now scheduled for publication in 2006. An update will be provided. ii. The ICES Symposium was held in May 2004 and the papers will be published in the <i>ICES Journal of Marine Science</i> after the ongoing reviewing and rewriting process. An update will be provided. b. Early stages of copepod zooplankton, particular <i>Calanus</i> species are important prey for larval and early juvenile stages of cod. Survival and growth through these early stages have been shown to be critical for establishing a strong cod year class. A better understanding of zooplankton-cod linkages should therefore be an important step towards better early estimates of year-class strength and thus recruitment to the cod stocks. The report from the workshop will be evaluated. c. The Transport Workshop was held in 2002 and it has been recommended that it be published as a CRR. Progress in carrying this work forward will be assessed and a final decision made. d. A Theme Session on Cod in a Changing Climate, with main focus on the book, will be held at ASC in 2005. The session will be evaluated. e. The final preparations for the workshop on the Decline and Recovery of Cod Stocks throughout the North Atlantic including tropho-dynamic effects will be carried out. f. Discuss a Theme Session at the 2006 ASC on Physics Relevant to Marine Ecosystems in cooperation with PICES g. As part of the CCC strategic plan, a Workshop on the Response of Cod to Climate Change is scheduled for 2007. Planning for this Workshop will continue.
Resource Requirements:	Assistance of the ICES/GLOBEC Coordinator in maintaining and exchanging information via the web site, Newsletters, databases and workshop bulletin boards.
Participants:	The WG meeting is expected to attract 15–20 participants.
Secretariat Facilities:	None
Financial:	None.
Linkages To Advisory Committees:	Relevant to the work of the ACFM and ACE.
Linkages To other Committees or Groups:	Living Resources, SGNARO, WGZE, WGRP, WGBPI.

Linkages to other Organisations:	GLOBEC is a co-sponsor of the WGCCC.
Secretariat Marginal Cost Share:	100%

Recommendation II

A Workshop on the Decline and Recovery of Cod Stocks throughout the North Atlantic including tropho-dynamic effects (Brian Rothschild, USA; George Lilly, Canada; Svein Sundby, Norway and Kai Wieland, Greenland) will be held in spring 2006, in St John's, Canada (to be confirmed) to:

- a) provide an overview and comparison of the declines which have taken place in cod stocks
- b) evaluate the relative roles of fishing and climate in causing declines in abundance
- c) evaluate the causes of observed changes in rates of survival, growth and maturity, including a tropho-dynamic perspective
- d) evaluate the consequences for stock resilience of decreases in mean weight and length and age/size diversity
- e) document and comment on historic evidence of previous cod stock recoveries and the environmental and fisheries circumstances in which these occurred
- f) comment on past projections of cod stock recovery, evaluate whether they were correct and draw conclusions concerning how future projections can be improved
- g) evaluate the role of cod forage species (e.g., capelin) for variability in abundance and size-at-age of cod
- h) evaluate the role of cod predators (e.g., seals) for variability in abundance and size-at-age of cod
- i) evaluate the role of climate mediated through cod predators and prey
- j) evaluate the relationship between the decline and recovery of cod stocks and changes in the marine ecosystems

Supporting Information

Priority:	This Workshop is a component of the Cod and Climate Change strategic plan.
Scientific Justification	<p>During the presentations on the state of the cod stocks around the North Atlantic at the 2003 meeting, the WG was struck by the similarity in the abundance trends of many of the stocks, from high values in the 1960s that in some cases persisted through into the 1970s and 1980s, followed by a decline to relatively low levels. In addition, there were often declines in size-at age and age of maturity. Building upon the work of Dutil and Brander (2003) that showed the effects of temperature on cod production and the updated information on cod stocks throughout the North Atlantic resulting from the ongoing synthesis the Workshop will compare the changes that have occurred in all of the cod stocks around the Atlantic to assess the relative importance climate-induced ecosystem changes and fishing as causes of the observed declines.</p> <p>There have been periods when cod stocks have shown rapid increases, sometimes in spite of increasing fishing mortality. It would be valuable to document these and to examine the environmental and fisheries circumstances in which they occurred.</p> <p>Past declines in cod stocks have eventually resulted in drastic fisheries management actions intended to rebuild the stocks, but in most cases stock recovery have not taken place as predicted.</p> <p>The reasons why such projections have been inaccurate will be evaluated, in order to draw conclusions which may help to make better projections in future.</p> <p>Widely observed changes in abundance, size-at-age and maturity of cod in many stocks throughout the North Atlantic in recent years will be addressed from a tropho-dynamic perspective. The role of forage species will be reviewed, particularly that of capelin in the Barents Sea and Icelandic waters and sprat in the Baltic. This thus addresses the question of cod from a more ecosystem-based perspective. Questions to be answered include: To what extent are observed changes in cod stocks due to climate-induced variability in their principal prey species? What is the role of climate change on predators of cod (e.g., pelagic fish on larvae, harp seals on adults)?</p>
Resource Requirements:	Assistance of the ICES/GLOBEC Coordinator in maintaining and exchanging information and data to potential participants.
Participants:	This Workshop is expected to attract 15–25 participants, most of who would contribute papers. The majority will be drawn from the ICES scientific community, although a number of scientists from outside ICES are also expected to contribute.
Secretariat Facilities:	None
Financial:	None
Linkages To Advisory Committees:	Relevant to the work of the ACFM and ACE.
Linkages To other Committees or Groups:	Living Resources, SGNARO, AFWG, WGBFAS, WGHARP
Linkages to other Organisations:	GLOBEC is a co-sponsor of the WGCCC.

Secretariat Marginal Cost Share:	-
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Annex 1: Action Plan Progress Review

Year	Committee Acronym	Committee name	Expert Group	Reference to other committees	Expert Group report (ICES Code)	Resolution No.			
2004/2005	OCC	Oceanography			2005/CX9	2C09			
Action	Action Required	ToR's	ToR		Satisfactory Progress	No Progress	Unsatisfactory Progress	Output (link to relevant report)	Comments (e.g., delays, problems, other types of progress, needs, etc.)
Plan									
No.	Text	Text	Ref. (a, b, c)	S	0	U	Report code and section	Text	
		Review and evaluate the progress on the Synthesis Activities including:	a)						
1.2.1, 1.3, 1.6, 1.7, 5.3, 5.13.2, 8.4, 10.2	Please see Action Plan items below.	Publication of the book on cod	a(i)	X			WGCC 2.3.1	Slightly delayed	
1.2.1, 5.3, 5.13.2, 6.1	Please see Action Plan items below.	Publication of the CRR on the life history aspects of cod stocks throughout the North Atlantic.	a(ii)	X			WGCC 2.3.2	Report is published	
1.2.1, 1.3, 1.5, 1.6, 1.7, 5.2, 5.13.2, 10.2	Please see Action Plan items below.	Publication of the proceedings of the Symposium on the Influence of Climate Change on North Atlantic fish stocks;	a(iii)	X			WGCCC 2.3.3		
1.2.1, 1.3, 1.5, 1.7, 4.11.2, 5.3, 5.10, 5.13.2,	Please see Action Plan items below.	Plan and prepare the Workshop on the Impact of Zooplankton on Cod Abundance and Production;	b)	X			WGCCC 3.1	Workshop was held June 7-9 2005	
1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 4.2, 4.10, 4.11, 5.2, 5.3, 6.1	Please see Action Plan items below.	c) Plan the back-to-back Workshops on the Decline and Recovery of Cod Stocks Throughout the North Atlantic and on the Influence of Climate on Tropho-Dynamics of Cod Ecosystems; d) initiate plans for a Workshop on Cod and Future Climate Change and discuss other Workshops;	c) and d)	X			WGCCC 3.2	Will be one joint workshop	
1.3, 1.5	Please see Action Plan items below.	Review and evaluate the results from the Workshop on the transport of cod larvae	e)	X			WGCCC 2.4	An initial report was published shortly after the workshop. Will be followed up, time allowing.	
5.14, 5.15	Please see Action Plan items below.	Plan the Theme Sessions on Cod in a Changing Climate (ASC 2005) and Physics Relevant to Marine Ecosystems (ASC 2006).	f)	X					

Action Plan items	
1.1	Provide feedback to Science Committees about research needs and priorities that are identified in the advisory process. [MCAP/Advisory Committees] 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. [MHC/OCC/LRC/RMC/BCC/DFC]*
1.2	Particular planned activities include the following: Understand and quantify the biology and life history, stock structure, dynamics, and trophic relationships of commercially and ecologically important species. [LRC/OCC/BCC/MHC/DFC]
1.2.1	Increase knowledge of the effects of physical forcing, including climate variability, and biological interactions, on recruitment processes of important commercial species. [MHC/OCC/RMC/LRC/MARC/BCC/DFC]*
1.3	Develop and apply biophysical modelling, and improve capacity in such modelling to cover biological-physical interactions in the sea. [LRC/OCC/BCC/MHC/DFC]*
1.5	Assess and predict impacts of climate variability and climate change, on scales from populations to marine ecosystems, including impacts on commercially important fish stocks. [OCC/LRC/BCC/DFC]
1.6	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. [OCC/LRC/MHC/BCC/DFC]
1.7	Provide scientific advice and information on the status and outlook for the fish stocks, marine ecosystems, and the marine environment requested by the Commissions, other regulatory agencies, and Member Countries of ICES, and any other advice, which ICES may consider relevant. [MCAP/Advisory Committees]
4.2	Promote, through workshops, study groups, and training courses, the development and better application of methods for resource enumeration, status evaluations, and forecasts. [RMC/FC/DFC]
4.10	Develop the scientific basis for an ecosystem approach to management, including assessments and the provision of scientific advice. Specifically, the following activities are needed:
4.11	Incorporate scientific information on ecosystem components and processes into the advice that is provided to clients. [MHC/RMC/BCC/Advisory Committees]*
4.11.2	Encourage wider involvement by stakeholders, academics, and the public in ICES-sponsored Symposia and the ICES ASC, including evaluating the possibility of sessions for non-technical audiences. [CONC]
5.2	Establish and maintain links with organisations and scientists in other disciplines (such as economics and social sciences), fisheries management agencies and other interested parties (such as stakeholders in the fishing industry) with a view to widening the sources of knowledge incorporated in fisheries models. [RMC/DFC]
5.3	Further develop joint activities with PICES in support of the ICES/PICES Memorandum of Understanding, including co-sponsorship of symposia, joint working groups, and collaboration on projects in marine ecology and environmental processes, and on advancing our capacity to understand marine ecosystems, climate variability, and marine ecosystem impacts. [OCC/MHC/LRC/DFC]
5.10	Continue to act as the North Atlantic regional implementation body for GLOBEC (The Cod and Climate Change Programme).
5.13.2	Establish more consistent mechanisms such as joint working groups, co-sponsored symposia, and cross-attendance at meetings, for regular exchange of information and progress with other marine scientific organisations with which ICES does not have a formal Memorandum of Understanding, such as ICLARM, CCAMLR, the NAFO Scientific Council, the Arctic Council, the European Science Foundation Marine Board, and the World Fisheries Council. [CONC/all Science Committees]
5.14	Establish relationships with international marine science organisations that have a substantial academic membership, e.g., the American Society for Limnology and Oceanography (ASLO), the European Geophysical Society, and similar organisations. [CONC/all Science Committees]
5.15	Integrate and expand databases to support ICES programmes within a well-defined data management policy. [CONC/MCAP/all Science Committees]*
6.1	Promote ICES publications that reach out to diverse scientific communities and engender their participation, using a variety of media. [PUB/all Science Committees/Secretariat]
8.4	Make available to a wide public information on status and trends in fishery resources, fishery activities, and quality of the environment. [ACFM/ACME/ACE]
10.2	