

**Report of the  
Working Group on Recruitment Processes**

**By Correspondence**

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## 1 TERMS OF REFERENCE

The **Working Group on Recruitment Processes** [WGRP] (Co-Chairs: R.D.M. Nash, UK and T. Miller, USA) will work by correspondence in 2003 to:

- a) consider a review of the changes and progress in approaches that have taken place since the publication of *Cooperative Research Report* No 155 (1992) on “Models for Recruitment Processes”;
- b) prepare for a session at the next meeting of the Working Group to consider the spatial and temporal variation in mortality of fish eggs and larvae;
- c) review multidisciplinary projects dealing with recruitment research;
- d) plan a joint session with WGZE on deriving and reconstructing fine scale spatial patterns in zooplankton distribution and their relevance and use for larval fish growth modelling;

WGRP will report by 1<sup>st</sup> August 2003 for the attention of the Oceanography Committee

## 2 REPORT

The Group did not meet during 2003 and communication among members was very limited. A number of the WG members participated in a number of other Working Groups and Study Groups. Also a number of other Working and Study Group activities and reports are of interest and relevance to the WGRP and are mentioned below.

Some members participated in the Study Group on Growth, Maturity and Condition in Stock Projections (SGGROMAT) in ICES Headquarters in December 2002 (ICES 2003a). This study group is primarily concerned with developing process-based growth, maturity, condition and fecundity models and the implementation of process-based models in a new projection methodology. The problems to be addressed are that current ICES projection methodologies do not take account of biological processes. In addition, recruitment is generally modelled as a function of spawning-stock biomass (male and female), which may be a poor proxy for reproductive potential. Existing knowledge about processes influencing growth and reproduction for individual stocks is not incorporated into the projections. It is currently unclear what form models for growth should take (e.g., age- or length-based). Therefore, during the first meeting the SG reviewed the available data on weights, maturity, condition, fecundity and age-length and age-weight keys for a variety of stocks. The SG identified condition as an influencing factor on e.g. recruitment and recommended that condition data should be routinely collected during standard fishery surveys.

The Study Group on Multispecies Assessments in the Baltic (SGMAB; ICES 2003b) explored the use of modified conventional stock-recruitment relationships for prediction purposes. In this case, environmental factors were incorporated and the outputs explored. The SG also looked at longer term forecasts of cod that incorporated environmentally driven survival rates for recruitment, based on the results and experiences gained from the STORE program.

Some members participated in a meeting of the Study Group on Biological –Physical Interactions (SGBPI) in Chapel Hill, NC, USA in March 2003 (ICES 2003c). Research programs that have integrated biological oceanographic and physical oceanographic sampling (e.g., GLOBEC, and STEREO) have yielded considerable insights into factors that regulate fisheries recruitment. Moreover, recent improvements in global ocean observing systems will likely mean that biological and physical data will be more tightly integrated and more widely available in the future. These trends present opportunities together with theoretical and practical challenges for recruitment studies. As the ToR for the SGBPI deal with areas of direct interest to the WG, the co-chairs recommend that the WG continues to be represented on the SGBPI.

The Working Group on Cod and Climate Change (WGCC; ICES 2003d) detailed the chapters for a new book on cod that will cover topics ranging from stock structure and history, recruitment to the response of cod to climate change. The intention is to have a Climate Change and Fisheries Symposium in May 2004 with the book at the publishers in the summer of 2004. During the 2002 WGCCC meeting, several overlapping areas of interest were identified between the two WGs including processes affecting recruitment, the role of the environment, and how to incorporate environment into the assessment process. The WGRP considered initiating a Workshop comparing multispecies and environmental predictions in the Baltic and the Arcto-Norwegian cod stock, which to date has not been progressed. The WGRP agreed to invite participation of CCC members if and when such a workshop is to be held. The WGCCC reconfirmed their interest in working with the WGRP on common problems and instructed the co-chairs to promote open lines of communication with the WGRP. The WGCCC also laid out a series of Workshops they intend to hold over the next

few years: Impact of Zooplankton on Cod Abundance and Production (in 2005), Decline (and Recovery) of Cod Stocks Throughout the North Atlantic (in 2006) and Influence of Climate on Tropho-Dynamics of Cod Ecosystems (in 2006).

The Planning Group on North Sea Cod and Plaice Egg Surveys in the North Sea (PGEGGS; ICES 2003e) gives overviews of knowledge on cod and plaice spawning and early life history for the North Sea. In the winter and spring of 2004 there will be multiple surveys of cod and plaice covering the entire North Sea and eastern English Channel. Extending on from previous work undertaken in tandem with surveys in the Irish Sea efforts will be made to develop genetic markers for the identification of cod-type eggs to species. These surveys will provide much needed information on the spatial distribution of early life history stages of at least cod and plaice. Similar studies were undertaken over the whole Irish Sea in 1995 and 2000 (Armstrong 1997, 2002) and in the eastern Irish Sea 2001 to 2003 (C. Fox, CEFAS, Lowestoft and R.D.M. Nash, PEML, Isle of Man *pers. comm.*).

The WG Co-Chairs have corresponded with colleagues from WGZE to discuss and coordinate a future meeting. It has been proposed that the two WG jointly sponsor a theme session for the 2004 meeting on **Larval fish growth, feeding and recruitment in relation to patterns and activity in plankton communities**. By proposing the session, the WG's recognize that Plankton production as food supply for larval fish or through to adult pelagic fish is not yet well understood, while there are increasing demands to address fish stock issues in an ecological context. Within this theme title there are many issues of concern to fisheries and marine environmental managers and to attempts at synthesis and modelling in marine oceanography.

Examples include:

- Hydrobiological questions of temporal and spatial scales of population and metapopulation structures and the action and interaction between larval predators and their plankton prey.
- Plankton invertebrate predator fields and how, as competitors and predators, these may interact with fish population dynamics.
- Behaviours in plankton communities such as feeding in relation to say turbulence, diel migrations, patchiness etc.
- Climate change scenarios and match/mismatch between the adaptive physiological ranges of fish larvae and key zooplankton prey, examining growth and production at local to basin scales.
- Questions of how we might estimate and index plankton species diversity or productivity in ways meaningful to problems of fish larval/O-group growth, recruitment and fish stock management.
- Biochemical approaches in studies of food chains, individual growth and survival, diet selection and the relative trophic efficiencies of predators and prey.
- Address the increasing interest in the post larvae and 0-group stages, which feed in the plankton. Then, for demersal species, consider diet switch in settlement phases to the consumption of the settled elements of epibenthic species production.
- New technologies (acoustics/video) for investigating the relationships between fish larvae and zooplankton, both prey species and competitors or predators such as chaetognaths or jellyfish.

WGRP and WGZE both view this proposed session as a necessary precursor to a focused joint meeting of the two WGs that will seek to identify research questions.

## 2.1 Recommendations

The Working Group on Recruitment Processes (Co-Chairs: Dr R.D.M. Nash, UK and Dr. T. Miller USA) will meet on 5–7 April 2004 in Copenhagen to:

- a) Review multidisciplinary projects dealing with recruitment research, with attention to providing a synthesis of the projects and highlight unresolved issues which deserve further consideration;
- b) Review the consequences of improvements and expansions of global ocean observing systems on studies of recruitment;
- c) Review the implications of the SGBPI report and their proposed reorganization as a WG on recruitment studies;
- d) Critically review methods for incorporating spatial and temporal variability in the distribution and abundance of larval fishes together with the implications of these sources of variability on the design of sampling programs and inferences drawn from them;
- e) Review the development of new approaches or techniques used in the study of factors and processes that influence the development and survival of fish eggs and larvae in relation to recruitment of the formation of year-class strength.

### 3 REFERENCES

- Armstrong, M.J. 1997. Estimation of fish biomass in the Irish Sea by means of the annual egg production method. The Queen's University of Belfast, European Community Specific Program for Research, Technological Development and Demonstration in the Field of Agriculture and Fisheries: 1991–1994, AIR3-CT94-2263.
- Armstrong, M.J. 2002. Development and validation of egg-production based biomass estimates, using cod and plaice stocks in the Irish Sea. Department of Agriculture and Environmental Science, Contract Final Report, Commission of the European Communities, Directorate general for Fisheries, Contract 98/090, 256 pp.
- ICES 2001. Report of the Study group on the Incorporation of Process Information into Stock-Recruitment Models. ICES CM 2001/C:02, 50p.
- ICES 2003a. Report of the Study Group on Growth, Maturity and Condition in Stock Projections. ICES CM 2003/D:01, 95pp.
- ICES 2003b. Report of the Study Group on Multispecies Assessment of the Baltic. ICES CM 2003/H:03, 82pp.
- ICES 2003c. Report of the Study group on Modelling of Physical/Biological Interactions ICES CM 2003/C:04, 49pp.
- ICES 2003d. Report of the ICES/GLOBEC Working Group on Cod and Climate Change. ICES CM 2003/C:11, 19pp.
- ICES 2003e. Report of the Planning Group on North Sea Cod and Plaice Egg Surveys in the North Sea ICES CM 2003/G:06, 45pp.

## ANNEX 1: TERMS OF REFERENCE/RECOMMENDATIONS FOR 2003

2C17 The **Working Group on Recruitment Processes** [WGRP] (Co-Chairs: R.D.M. Nash, UK and T. Miller, USA) will work by correspondence in 2003 to:

- e) consider a review of the changes and progress in approaches that have taken place since the publication of *Cooperative Research Report* No 155 (1992) on “Models for Recruitment Processes”;
- f) prepare for a session at the next meeting of the Working Group to consider the spatial and temporal variation in mortality of fish eggs and larvae;
- g) review multidisciplinary projects dealing with recruitment research;
- h) plan a joint session with WGZE on deriving and reconstructing fine scale spatial patterns in zooplankton distribution and their relevance and use for larval fish growth modelling;

WGRP will report by 31 May 2003 for the attention of the Oceanography Committee

### Supporting Information

Priority:	Because the relationship between spawning stock and recruitment is fundamental to the scientific approach to fisheries management, the work of this group should be considered of high priority to ICES.
Scientific Justification and relation to Action Plan:	<ul style="list-style-type: none"> <li>a) the objective is to provide a synthesis of new approaches and technologies for the study of recruitment and to identify outstanding challenges and fruitful directions for research in the coming decade.</li> <li>b) The session will review previous studies and consider recent information on sources and variation of mortality. It should instigate new approaches for linking mortality to models of growth and transport. P. Pepin and M. Dickey-Collas will take the lead in the preparation and conduct of this session.</li> <li>c) This synthesis of relevant projects will help to highlight those unresolved issues that deserve further consideration.</li> <li>d) The current state-of-the art approaches to studying fish recruitment processes involve coupled physical biological models (IBMs). These require relationships to generate larval growth. At present two main approaches have been adopted. In one approach, temperature is the only external variable driving the function. The second approach attempts to implement more complex bio-energetic growth models. The latter requires understanding of larval foraging and prey distribution in space and time. As this is a common area of interest to WGZE and WGRP a joint session examining the state of the art would be highly beneficial</li> </ul>
Resource Requirements:	The WG requires active participation from the members assigned by the Delegates. A complement of 15-20 active members is required to accomplish the work identified in the resolution.
Participants:	In addition to regular members, the WG feels there would be benefit from greater participation by quantitative individuals. We note that Nicolas Bez (Centre de geostatistiques des Mines de Paris, France), and C.M. O'Brien (Lowestoft, UK) would be welcome additions in this area where the Working Group is lacking expertise.
Secretariat Facilities:	None
Financial:	N/a
Linkages To Advisory Committees:	The activities of the WG are developing to provide more accurate medium-term forecasts of stock projections
Linkages To other Committees or Groups:	The activities of the WG are designed to provide input of knowledge to various Assessment WGs. There is no potential overlap in activities because the latter do not have the resources to consider the nature of this new knowledge outside the scope of their current activities. WGZE and SGGROMAT also have close ties with the work of the Group
Linkages to other Organisations	NAFO via its Working Group on Reproductive Potential.

## ANNEX 2: TERMS OF REFERENCE/RECOMMENDATIONS FOR 2004

The Working Group on Recruitment Processes (Co-Chairs: Dr R.D.M. Nash, UK and Dr. T. Miller USA) will meet on 5–7 April 2004 in Copenhagen to:

- a) Review multidisciplinary projects dealing with recruitment research, with attention to providing a synthesis of the projects and highlight unresolved issues which deserve further consideration;
- b) Review the consequences of improvements and expansions of global ocean observing systems on studies of recruitment;
- c) Review the implications of the SGBPI report and their proposed reorganization as a WG on recruitment studies;
- d) Critically review methods for incorporating spatial and temporal variability in the distribution and abundance of larval fishes together with the implications of these sources of variability on the design of sampling programs and inferences drawn from them;
- e) Review the development of new approaches or techniques used in the study of factors and processes that influence the development and survival of fish eggs and larvae in relation to recruitment of the formation of year-class strength.

WGRP will report by 31 May 2004 for the attention of the Oceanography Committee

### Supporting Information

Priority:	Because the relationship between spawning stock and recruitment is fundamental to the scientific approach to fisheries management, the work of this group should be considered of high priority to ICES.
Scientific Justification and relation to Action Plan:	<ol style="list-style-type: none"> <li>a) the objective is to provide a synthesis of new approaches and technologies for the study of recruitment and to identify outstanding challenges and fruitful directions for research in the coming decade.</li> <li>b) Recent improvements and expansions in the global ocean observation systems are providing more detailed information that is useful for recruitment research. The larger data sets and perspectives will allow a greater perception of how recruitment process work both between and within populations. The identification and understanding of large scale forcing functions will provide a more integrated and uniform approach to recruitment processes research.</li> <li>c) The SGBPI has a large modelling element which is of direct relevance to the WGRP. This WG needs to foster close ties with SGBPI so that the modelling aspects of recruitment processes can be further enhanced and mutually beneficial lines of exploration can be pursued.</li> <li>d) At present there are a number of research programs which are examining the abundance and distribution of early life history stages of fishes. In general these studies are designed to input data for stock assessment. Quantifying the precision and possible sources of bias in these estimates will enhance the utility of these studies to forecasting. Moreover, this progress will also provide an increased understanding of the mechanisms regulating recruitment variability.</li> <li>e) Development and survival of the early life history stages is only well know for a relatively small number of fish species. An understanding of both of these are essential for and understanding of recruitment and ultimately year-class strength</li> </ol>
Resource Requirements:	The WG requires active participation from the members assigned by the Delegates. A complement of 15-20 active members is required to accomplish the work identified in the resolution.
Participants:	In addition to regular members, the WG feels there would be benefit from greater participation by quantitative individuals. We note that Nicolas Bez (Centre de geostatistiques des Mines de Paris, France), and C.M. O'Brien (Lowestoft, UK) would be welcome additions in this area where the Working Group is lacking expertise.
Secretariat Facilities:	Meeting room for 3 days plus standard copier and electronic facilities
Financial:	N/a

Linkages To Advisory Committees:	The activities of the WG are developing to provide more accurate medium-term forecasts of stock projections
Linkages To other Committees or Groups:	The activities of the WG are designed to provide input of knowledge to various Assessment WGs. There is no potential overlap in activities because the latter do not have the resources to consider the nature of this new knowledge outside the scope of their current activities. WGZE and SGGROMAT also have close ties with the work of the Group
Linkages to other Organisations	NAFO via its Working Group on Reproductive Potential.