

ICES WGRP Report 2007

ICES Oceanography Committee

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Report of the Working Group on Recruitment Process (WGRP)

September 2007



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1 Executive Summary

The WGRP was scheduled to meet in St. Johns, Newfoundland, Canada, following the International Larval Fish Conference. Plans were well advanced. However, health issues with one of co-chairs, and work reorganization for the other co-chair meant that the meeting had to be unexpectedly cancelled. Little new progress toward the terms of reference was possible. Prior to the scheduled meeting work had been completed on the first term of reference, resulting in a paper in Marine Ecology Progress Series, and sections of the Manual of Best Practices for Coupled Physical-Biological Models produced by WGPBI. Work on the second and third research themes is ongoing. As a result of the last minute cancellation of the planned WG meeting, we propose adopting the Terms of Reference for 2007 for 2008.

2 Background

In 2005 at a WG meeting in Barcelona, WGRP adopted new, challenging terms of reference (ToRs). The new ToRs were designed to make specific contributions to advice provided by ICES to its clients. We identified three broad themes of endeavour: 1) a review of the contribution of coupled physical-biological models to understanding of recruitment, 2) an analysis of the patterns and consequences of sources of selective mortality on characteristics of exploited stocks and 3) an assessment of the utility of multistage descriptions of recruitment in understanding the impacts of environmental changes on future patterns of recruitment. In slightly modified form these three research themes were adopted as ToRs for WGRP for 2006.

In 2006, WGRP worked by correspondence on the ToRs. The plan was to conduct detailed literature reviews and database development during 2006 so that the full WG could review and analyze the assembled information at a WGRP meeting in St. Johns Newfoundland in July 2007. We proposed to hold the WGRP meeting jointly with the 31st Annual Larval Fish conference. Plans for the meeting were well advanced. Regrettably last minute events conspired to force a cancellation of the meeting. Thomas Miller (USA), one of the co-chairs of the meeting experienced health issues that prevented him from travelling. Richard Nash (Norway), was unexpectedly prevented from travelling owing to constraints at work. Rather than hold a meeting without the two co-chairs it was felt advisable to cancel the meeting and reschedule. It is anticipated that WGRP will meet in 2008 either in Copenhagen at ICES Headquarters, or as a part of the 32nd Annual Larval Fish conference which is scheduled to be held in Kiel, Germany (4–7 August 2008)

2.1 Terms of reference

The terms of reference for the Working Group are provided in Annex 1.

3 Progress against ToRs

3.1 Review of the contribution of coupled physical–biological models to our understanding of recruitment

Several products have resulted, or are in the final stages of completion relative to this ToR.

The manuscript developed by Thomas Miller (USA, Co-Chair WGRP) on the development, application and prospects for individual-based, coupled physical biological models (ICPBMs) to understanding recruitment in fishes has been accepted by the journal Marine Ecology Progress Series. This review was first presented to the WGRP in 2005 for initial feedback. Based on comments received at that time, the review was expanded. The author was invited to give one of several keynote addresses at the workshop on Advances in Modelling Physical-

Biological Interactions in Fish Early Life History organized by the WG on Physical-Biological Interactions (WGPBI), held in Nantes, France in 2006. Subsequently, Miller submitted the work to be published with a group of papers arising from the conference. It is anticipated that these articles will appear late in 2007. The main conclusions of the review were provided in the 2006 WGRP report. One additional follow-up item from the Nantes Conference was the commitment to produce a manual of best practices. The manual is undergoing final editing by Elizabeth North (WGPBI), Alejandro Gallego (WKAMF and WGRP) and Pierre Petitgas (WKPBI) and it is anticipated that the manual will be released as an ICES report shortly.

3.2 Selective Processes in Early Life History

This research initiative was proposed as a five year project at the WGRP meeting in Barcelona in April 2005. Results of the initial literature review were to be presented at the cancelled St. Johns WG meeting. The initial review document has been produced collaboratively by Thomas Miller (USA and WGRP co-chair) with input from Chris Chambers (USA). The review has focused on several areas (detailed below). The material for the first two areas is largely complete. Work is continuing on the third area.

- 1) In this section of the literature review, we provide quantitative and qualitative summaries of the extent of changes in the characteristics of spawners and the phenology of spawning. The aim of this section is to understand the likely changes in the offspring ecology and recruitment potential that these changes may engender.

Selective processes affecting characteristics of the spawners: Several studies have reported strong correlations between the characteristics of adults and their offspring (Kamler, 2005). Most often the relationships are driven by maternal effects (Chambers and Leggett, 1996), although paternal effects have been reported (Bang *et al.*, 2006). Most often these effects are ascribed to characteristics at hatch (Heyer *et al.*, 2001). More recently, research has indicated that parental effects can impact other traits, such as foraging success and vulnerability to predation (Lister and Neff, 2006).

Several processes will induce changes in the characteristics of spawners that likely have significant impact on the traits of subsequent offspring. Most directly, commercial fish is strongly size selective and is known to alter the size and age distribution of spawners (Rjinsdorp, 1991). More recently, it has also become clear that other agents of change can alter not only the characteristics of spawners, but the phenology of spawning. For example, median day of spawning in striped bass in the Chesapeake Bay has advanced by 16 d in the two decades, likely a direct response to global climate change (A. Peer, Chesapeake Biological Laboratory, pers. comm.). Similar changes in spawning phenology have been reported in other systems (Gillet and Quetin, 2006)

- 2) The second section of the review builds on previous reviews of the pattern and scope of parental effects on offspring. These effects can be divided into genetic and non-genetic effects. Until Conover and Munch's (2002) landmark paper on evolutionary impacts of fishing, the potential for genetic effects had been largely ignored. Since that time, the recognition of their importance has grown (Andersen *et al.*, 2007). Recognition of the importance of non-genetic effects has been more common (Heyer *et al.*, 2001). Most often these non-genetic effects influence offspring size, and the consequences of changes in offspring size have been well studied (Anderson 1988, Miller *et al.*, 1988).
- 3) In the final section of the review, we seek to integrate the two former sections to draw conclusions regarding the impacts of year class strength and variability. Will changes in the pattern of selective mortality always result in weaker and more variable year classes? Existing, relative simple correlative models suggest that most directional selective agents lead to deleterious effects. But it is not clear that all changes in sources of selective mortality will necessarily be directional. There is reason to believe that some sources of mortality will act to

introduce more variability in the pattern of mortality. The impact of such changes is not at all clear and will depend on a complex web of interactions.

3.3 Multistage Models of Recruitment

This research initiative was also proposed at the WGRP meeting in Barcelona in April 2005, but as a three year project. The WGRP is undertaking a project to compile and analyse multistage recruitment models. The objectives of the project are to compare Paulik-style diagrams at three levels of resolutions: (1) different stocks of the same species, (2) different species in the same ecosystem and (3) different species within the same functional guild (i.e., ground fish vs. pelagics). The project is being lead by Richard Nash (Norway) and Tom Miller (USA). Currently, data are being compiled for several species and systems including Atlantic herring (*Clupea harengus*), Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), striped bass (*Morone saxatilis*) and Alaska/walleye pollack (*Theragra chalcogramma*). The Paulik diagrams will initially be presented in the form given by Nash and Dickey-Collas (2005) for North Sea herring. An up-dated version is given in ICES (2006).

4 Future Plans for WGRP

The WGRP will meet in either in Copenhagen, Denmark at ICES headquarters or in Kiel, Germany in conjunction with the 32nd larval fish conference. We proposed the same objectives for the meeting as had been developed for the cancelled St. John's meeting. Specifically, the first day of the meeting will be dedicated to the two research projects that we identified during our 2005 meeting: (1) selective processes in recruitment and (2) multistage models of recruitment. We anticipate that work on the former will lead to an ICES Cooperative Research Report, and peer-reviewed journal articles. In contrast it is expected that work on the later will result in peer-reviewed journal articles only.

4.1 Selective Processes in Early Life History

By July 2008, the WGRP will have completed its review of the literature relating to selective processes in early life history, and present its preliminary results at the Larval Fish Conference which precedes the WGRP meeting. Following the meeting, we will convene a small working team to begin work developing an ICES Cooperative Research report that will formally present the results of the project. We envisage the report focusing on the several key areas. The report will document the sources of selective mortality including selection on the parental spawning stock as well as on early life history stages. Selective processes need not be taken to refer just to mortality, they may relate to distribution of individual sizes, or spawning dates within the stock, or even to metapopulation structure within the species. The report will then discuss the long term evolutionary consequences of this selection on the population. Selective processes do not necessarily lead to changes in the population: evolutionary change only occurs when the selection is acting in a directional fashion. Alternatively, if the selective processes are acting in a stabilizing fashion, no change will be expected. To the extent possible, the report will document specific examples of selective processes during early life history and the consequences of these processes on the population. Finally, the report will explore the consequences of selective processes for the biological reference points employed in fisheries management.

4.2 Multistage Models of Recruitment

By July 2008, the WGRP will have completed the compilation of data on North Sea herring, North-east Arctic cod, striped bass and walleye pollock. The preliminary multistage recruitment models in the form of Paulik style diagrams will be presented to the WGRP at the annual meeting. During this meeting refinements to the modelling processes will be discussed,

agreement on proceeding with the other previously identified species and stocks sought and any other stocks and/or species with sufficient data identified.

5 Other Matters

Both co-chairs of the WG have served longer than desired by ICES policies. Richard Nash (initially UK, now Norway) has served since 2000 and Thomas Miller (USA) has served since 2003. It is the intention of the WGRP to replace both co-chairs in the next two-year period.

Since 2001, annual recruitments have been consistently below the levels predicted from the stock-recruitment relationship for these stocks. This pattern of poor recruitments already appears to be negatively affecting stock biomass. The Study Group on Recruitment Variability in North Sea Planktivorous fish (SGRECVAP) has assembled relevant fisheries, fishery-independent and environmental data, but SGRECVAP were not able to reach definitive conclusion. As a result, the herring working group (HAWG) has requested that WGRP work to further identify the causes and dynamics of the serial poor recruitment of North Sea Herring.

6 Future Meetings

2008	March 31–April 2, 2008 in at ICES Headquarters in Copenhagen, DK
2009	By correspondence

We have not planned WGRP beyond 2008, when we plan to meet at ICES Headquarters. By 2008, the WGRP anticipates that the bulk of the work on the two research project initiated in 2005 will have been completed. Thus, 2008 becomes a planning year to discuss, identify and initiate new research projects that reflect the interest of WGRP members, and the needs of ICES. Several ideas were suggested at the Barcelona meeting including “Recruitment correlations in large marine ecosystems” and ‘Recruitment in a changing global environment’ that were not taken up by WGRP. We will revisit these ideas and others in 2008 to determine the future direction of the WGRP.

7 Proposed Terms of Reference for 2008

2007/2/OCC00 The **Working Group on Recruitment Processes** [WGRP] (Co-Chairs: R. D. M. Nash, Norway, and T. Miller, USA) will meet at ICES Headquarters in Copenhagen, Denmark from 31 March to 2 April to:

- a) complete the synthesis and review of the evidence for sources, patterns and consequences of selective processes in fish early life history and its relevance to our understanding of forecasts of year class strength. (carried over from 2007)
- b) based on the results of the review of selective processes in early life history, prepare an ICES Cooperative Research Report that identifies the challenges presented to sustainable fisheries management (capture and aquaculture) of selective processes in early life history
- c) summarize and analyse data relevant to multi-stage models of recruitment to determine whether patterns exist either within species or within ecosystems that may lead to generalisations regarding the nature of population regulation (carried over from 2007)
- d) evaluate the findings of SGRECVAP (2006 and 2007 meetings) and undertake work on the causes and dynamics of the serial poor recruitment in North Sea herring, and provide a report of the WGRP deliberations to the HAWG in 2008.

WGRP will report by 1 August 2007 for the attention of the Oceanography Committee, ACFM and HAWG.

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	<p>ToR a and b) At present there is a general lack of information on the causes of mortality in young stages of fish. In particular predation mortality. It is only recently that new analytical tools are being developed (specifically genetics based) that will allow the levels and sources of predation to be identified. This information is fundamental to our understanding of the processes that affect recruitment levels.</p> <p>ToR c) The identification of where in the pre-recruit life history year class strength is determined is important for determining useful recruitment indices and forecast models for recruitment. There are a number of species that have been sampled regularly, both multiple sampling of a cohort over if young stages and over a number of years. A collation of these data will provide insight in to variability with a species across different environments and between species within an environment.</p> <p>ToR d) This is in reply to a recommendation from the Herring Assessment WG. This ToR will be dealt with by correspondence.</p>
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 individuals with quantitative skills in the area of biometry and population dynamics.
SECRETARIAT FACILITIES:	The Working Group will meet at ICES Headquarters in March 31- April 2, 2008, and will need meeting facilities for that meeting. Additional secretarial assistance will be required for an annual report.
FINANCIAL:	No financial implications
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 has close ties with the work of the Group. WGPBI also has close ties with WGRP – several people sit on both WGs. HAWG/ACFM.
LINKAGES TO OTHER ORGANISATIONS:	GOOS, GLOBEC and NAFO through its Working Group on Reproductive Potential.

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Annex 1: 2006 Terms of References

The **Working Group on Recruitment Process** [WGRP] (Co-Chairs: R. D. M. Nash (Norway) and T. J. Miller (USA)) will meet by correspondence in 2006:

- a) prepare a synthesis of multidisciplinary projects relevant to our understanding of recruitment processes and highlight unresolved issues which deserve further consideration (*carried over from 2005*)
- b) assess the role of spatial and temporal variability in the distribution and abundance of organisms together with the implications of these sources of variability on the design of sampling programmes and inferences drawn from them (*carried over from 2005*)
- c) conduct a synthesis and review of the evidence for sources, patterns and consequences of selective mortality in fish early life history and its relevance to our understanding of forecasts of year class strength
- d) summarize and analyse data relevant to multi-stage models of recruitment to determine whether patterns exist either within species or within ecosystems that may lead to generalisations regarding the nature of population regulation
- e) explore the potential of preparing a theme session article for Marine Ecology Progress Series on the Utility of Recruitment Research to Fisheries

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:	<p>Action plan 1</p> <p>ToR a) Action plan 1.3 Many countries have research programs on recruitment processes, many of which are also multidisciplinary. There is a need to determine which studies are currently underway and to determine which studies need to be undertaken to provide relevant information for the assessment and management of stocks in the ICES area.</p> <p>ToR b) Action plan 1.7, 1.11, 1.13.4 Survey data and sampling young stages of fish are fundamental to recruitment studies. Often these studies do not take in to account spatial heterogeneity in the distribution of the target organism and can thus present biased information on, e.g., recruitment for input to stock assessment or population models.</p> <p>ToR c) Action plan 1.2, 1.3, 1.6 At present there is a general lack of information on the causes of mortality in young stages of fish. In particular predation mortality. It is only recently that new analytical tools are being developed (specifically genetics based) that will allow the levels and sources of predation to be identified. This information is fundamental to our understanding of the processes that affect recruitment levels.</p> <p>ToR d) Action plan 1.2, 1.3 The identification of where in the pre-recruit life history year class strength is determined is important for determining useful recruitment indices and forecast models for recruitment. There are a number of species that have been sampled regularly, both multiple sampling of a cohort over if young stages and over a number of years. A collation of these data will provide insight in to variability with a species across different environments and between species within an environment.</p> <p>ToR e) Action plan 1.2, 1.3, 1.6 There is a need to critically review the studies and concepts within research on recruitment. These articles will provide insight, controversy and future direction for recruitment research.</p>
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 individuals with quantitative skills in the area of biometry and population dynamics.
Secretariat Facilities:	The Working Group will meet by correspondence in 2006 so will only need secretarial assistance for an annual report.

Financial:	No financial implications
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 has close ties with the work of the Group. WGPBI also has close ties with WGRP – several people sit on both WGs.
Linkages to other Organisations:	GOOS, GLOBEC and NAFO through its Working Group on Reproductive Potential.