ICES IBPPAND REPORT 2013

ICES ADVISORY COMMITTEE

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Report of the Inter-Benchmark Protocol on *Pandalus* in Skagerrak and Norwegian Deep (IBPPand)

12–19 September 2013

Dartmouth, NS, Canada

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CIEM Conseil International pour l'Exploration de la Mer

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Executive Summary

The Inter-Benchmark for northern shrimp (*Pandalus borealis*) in the Norwegian Deep and Skagerrak (SKND, ICES Areas IIIA and IVA) met by WebEx and correspondence in 2011/2012 and within the NIPAG meeting in September 2013. The Benchmark had two main objectives; to establish the genetic basis for the unit stock and to select an appropriate assessment method for providing information on the past and present state of the stock, reference points and projections.

The genetic study (Søvik *et al*., in prep.) analysed samples of approximately 100 shrimp each from two locations in the Norwegian Deep, the Fladen Ground, three locations in Skagerrak, and seven fjords. The conclusion from the study was that that there was some weak genetic structure primarily associated with the fjords but that shrimp in Skagerrak and the Norwegian Deep can be considered as belonging to one single stock for assessment purposes.

In the initial stages of the Benchmark, three assessment methods were evaluated: (1) Length-based model, (2) Biomass dynamic model, and (3) An Index method (AIM). After reviewing results at a Benchmark WebEx in October 2012, it was decided that AIM was not suitable as an assessment method for SKND *Pandalus*. It was concluded that the length-based, and the production models, provided possible frameworks for the assessment, but additional work was needed.

Following further intercessional work, the Benchmark carried out further review of the assessment models at the NIPAG meeting in Dartmouth Canada in September 2013 and through WebEx with experts in Copenhagen that could not attend NIPAG, allowing a conclusion to be reached on the assessment method. While both the length-based and the biomass dynamic models gave generally similar results (except for the recent period) and were considered capable of forming the basis for the stock assessment, the Benchmark preferred the length-based model because it made more use of the available data from the surveys and the catches and because it was relatively easy to update and run. However it was decided that the biomass dynamic model should be run alongside the length-based model, at least initially, to provide reassurance that the assessments from the two models continued to remain consistent.

1 Introduction

As decided by ACOM (2010/2/ACOM58), an Inter Benchmark Protocol for *Pandalus* (IBPPand) in Skagerrak and Norwegian Deep (SKND) was established to be chaired by Carsten Hvingel (Norway), with invited external experts Ingibjörg Jónsdóttir (Iceland), and David C. Hardie (Canada), to meet by correspondence and WebEx.

The Terms of Reference were:

a) Review the proposed updates in data analysis and assessment methodology as described in the stock issue list.

b) Prioritize the issues and provide guidance to stock experts on methods with which to solve issues.

c) Describe the choice of preferred method for data analysis and assessment in a concise report. Include recommendations on progress to be made in cases where work is not yet finalized.

d) Describe the resulting data analysis procedure and assessment methodology in the stock annex.

e) Evaluate the management measures in force.

f) Review and agree on the resulting stock annex.

The intent was that IBPPand would report by 31st April 2012 for the attention of ACOM.

2 Benchmark process

The first Benchmark WebEx was held in early October 2012 with only one of the reviewers (Hardie, Canada) available. No outstanding issues with the input data were identified. It was noted that the genetic study was ongoing and that results would be available in the near future. Further review of the analyses was carried out in the October 2012 NIPAG meeting in Tromsø. Three candidate assessment methods were proposed: (1) An Index Method, (2) Length-based model, and (3) Biomass dynamic model. A WebEx held during the September 2013 NIPAG meeting in Halifax carried out further review and made final conclusions on the assessment method to be applied for SKND *Pandalus*. An invited independent expert reviewer (Dr Mohn, Canada) provided comments at this WebEx.

2.1 An Index Method

An Index Method (AIM) allows the user to fit a relationship between time-series of relative stock abundance indices and catch data. Underlying the methodology is a linear model of population growth, which characterizes the population response to varying levels of fishing mortality. If the underlying model is valid, AIM can be used to estimate the level of relative fishing mortality at which the population is likely to be stable. The index methodology can also be used to construct reference points based on relative abundance indices and catches and to perform deterministic or stochastic projections to achieve a target stock size. AIM is part of the NMFS toolbox of methods (http://nft.nefsc.noaa.gov/). In the application to SKND *Pandalus*, no significant correlation was found between relative F and the replacement ratio (Figure 1). Further, the Benchmark felt that combining the input survey series lacked a firm logical basis. The Benchmark concluded that AIM can be useful as a diagnostic tool for SKND *Pandalus*, but is not recommended as the primary assessment tool.

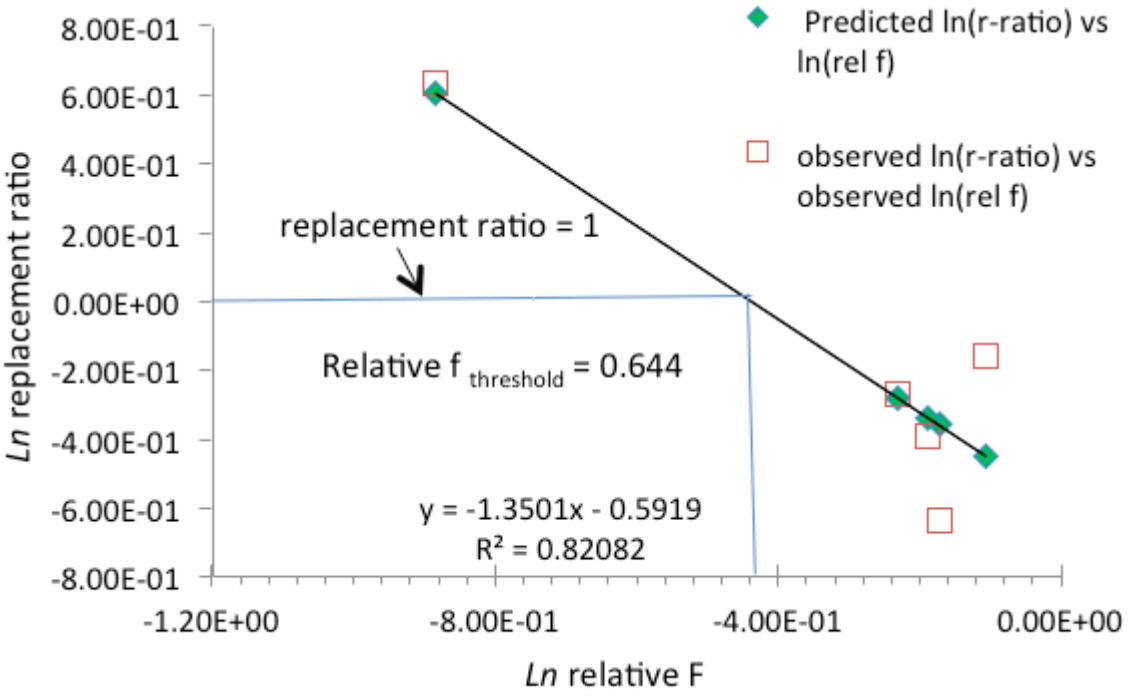

Figure 1. Relationship between relative F and the replacement ratio for SKND *Pandalus*.

2.2 Length–based stochastic assessment model

The length-based stochastic assessment model applied to SKND *Pandalus* (ICES Areas IIIA and IVA East) is described by Nielsen *et al*. (2012; 2013). The model is age-based, but it also estimates the relation between age and length assuming a von Bertalanffy growth curve, allowing the model to be fit to survey and catch length composition observations. The model was reviewed by WebEx in October 2012. Further work on updating the length distribution time-series from the Norwegian shrimp survey was carried out at the 2012 NIPAG meeting but not in time to redo the model and re-evaluate the results. Revisions to the model and updated results were reviewed at a WebEx held during the September 2013 NIPAG meeting in Halifax. Input data were from the 2012 NIPAG meeting, but with updated survey information that became available subsequent to the meeting. The model was changed to have equal standard deviations for survey and catch which seemed more reasonable as this parameter describes the standard deviation of the length distribution in the population. Review comments during the Benchmark noted that the model did not fit the survey data as well as it did the catch data. It was also noted that the model was somewhat sensitive to estimate of shrimp growth and the value of M that is provided. It was also pointed out that the model did not directly provide estimates of MSY reference points because the production function or stock–recruit function is not modelled, consequently proxies would have to be developed. In this regard, the observation that, due to the high M-value, F_{MAX} nearly has an asymptotic value poses an additional issue. On the positive side it was noted that the model uses all the data that are available (i.e. length frequencies of the catch and survey data) and that it tracks individual cohorts. The estimates of SSB and average F on ages 2–3 are illustrated in Figure 2. It should be noted that the high F in the last year (2012) is estimated based on survey data only because the catch data are not yet available. After discussion by NIPAG and review comments from the independent external reviewer, the model was accepted as the basis for assessment of SKND shrimp.

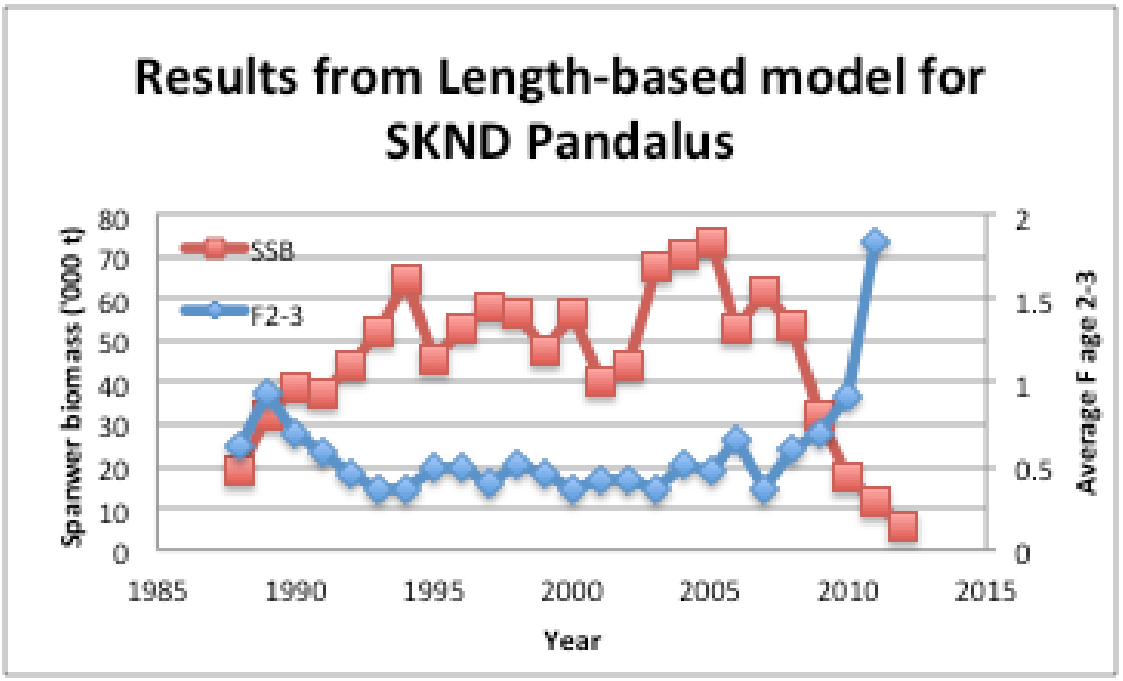

Figure 2. Estimates of SSB and average F on ages 2–3 for SKND herring based on the updated model run from September 2013.

2.3 Bayesian surplus production model

The Bayesian surplus production model applied to the SKND *Pandalus* stock is described in Hvingel (2012; 2013). The model is similar to one currently used to assess the Barents Sea and West Greenland *Pandalus* stocks. Although predation is an important source of mortality for shrimp (Hvingel, 2005 and references therein), it was not included as an explicit variable because the available composite predator abundance indices varied little over time and was found not to hold any information regarding shrimp stock dynamics. The application of the model to SKND *Pandalus* was reviewed in October 2012 by WebEx and at the NIPAG meeting in 2012, and updated results were reviewed again at the 2013 NIPAG meeting, including by WebEx. Comments on the model were received during the Benchmark, including from the invited expert independent reviewer present at NIPAG in September 2013 (Dr Bob Mohn). Although the model fits the input biomass indices quite well, the uncertainty in parameter estimates is relatively large. Advantages of the surplus production model over the length-based model is that it provides direct estimates of all MSY reference points required under the ICES approach: F_{MSY}, $B_{lim}=0.3xB_{MSY}$ and $B_{trigger}=0.5*B_{MSY}$ (as defined for the Barents Sea shrimp stock).

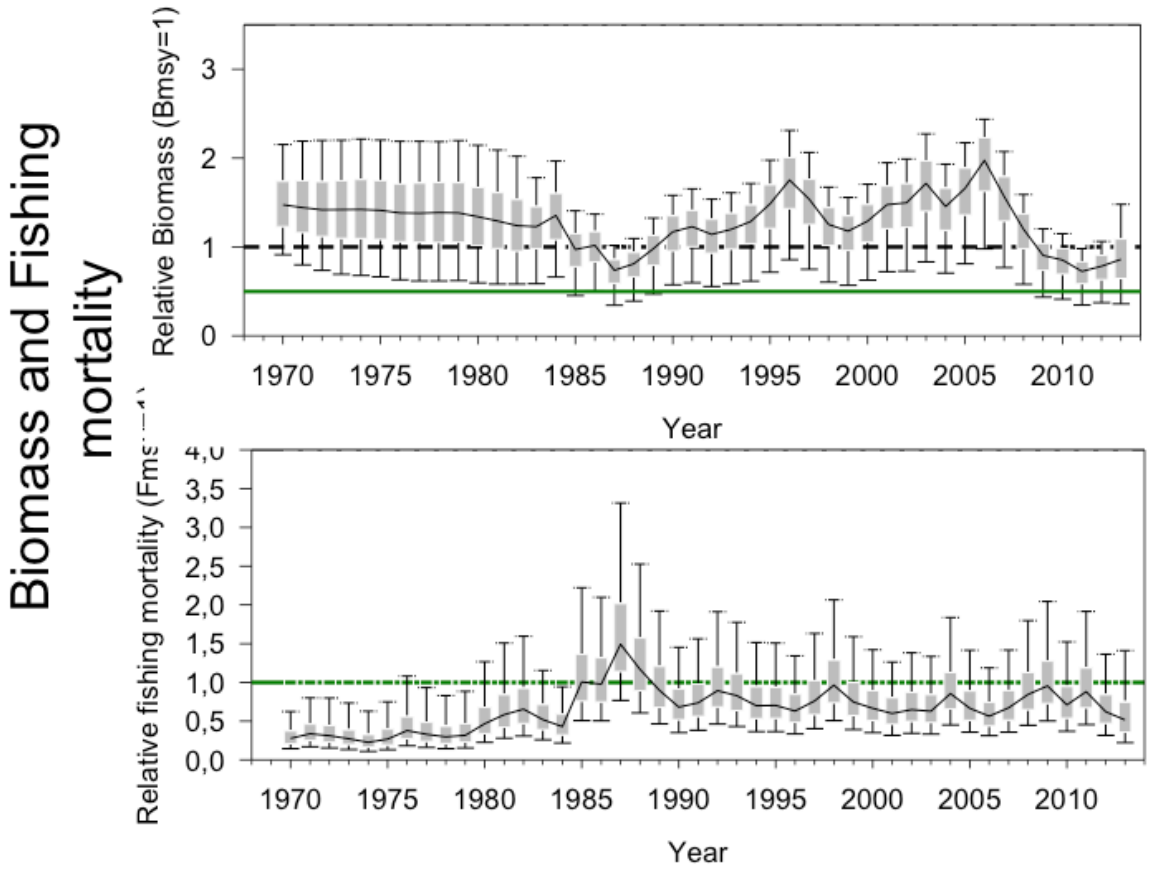

Figure 3. Estimates of biomass and fishing mortality for the SKND *Pandalus* stock from the application of the Bayesian surplus production model. Values are relative the MSY values.

3 External Reviewers comments

3.1 Comments by Invited Independent External Reviewer Dr David Hardie at the October 2012 WebEx

A general comment: I understand that there is always much work to do in a short period, but I found the WebEx to be very rushed. I knew very few of the participants, although many seemed to know each other very well. Although sometimes a bit of a tedious process, a round-table can be useful for new participants to have some idea who they are working with. In part, this is a great limitation of the WebEx working environment. Beyond this, most of the presentations (if there in-fact were any presentations) tended to be quite superficial and very rushed. A certain minimum standard should be required to allow this work to go forward efficiently (or, if no minimum standard is to be set, then the participants should be warned that there will be little/no presentation of the work at the meeting itself). As mentioned by others, the quality of some of the audio and some aspects of the technology used, made this an even more difficult and frustrating process.

Data – I was expecting a more thorough presentation of the data. There seem to be some quite important problems and sources of variability within dataseries (e.g. like boiling at sea). I was surprised how quickly these problems were dismissed as "solved". A presentation showing the actual dataseries with an explicit description of what has been done to try to compensate for some of the issues with the data would have been worthwhile. It seemed to be assumed that all were quite familiar with the data. This might have been true for those who were working with the data on the various models, but it was not true of everyone.

Population genetic structure – work is not finished yet, so no conclusions can be given either way (this is a progress report). Preliminary results suggest that the loci examined may have sufficient resolution to detect population differentiation, but not yet. Some questions for future meetings: Are the loci species-specific, or from (some) other species? If the latter; any problems with null alleles? As the authors point out, there is still quite a bit of work to do here to be able to say anything with sufficient rigor so as to inform splitting/lumping of stocks.

AIM – key result that fishing is not greatly impacting biomass except when exploitation is very high. What does this suggest about the feasibility of fitting models that are predicated on the fundamental concept that fishing changes size/age structure, growth and abundance so that models can interpret changes in catch dynamics and structure to infer population size and F. If fishing is NOT having these effects on the fishery, then is it unrealistic to expect models to fit the data very well?

- useful because it does not over-interpret the data;
- limitation that it can't deal with ecosystem changes is fair, but does this differ from the other models provided? I know that some other versions of the BDM can include temperature and cod, but the one proposed here does not, so this not really a comparative limitation, although it is an absolute one. One way to overcome this is to include the AIM approach along with ecosystem indicators, to be discussed in a more subjective way, as is done with a Traffic Light type of approach.

Models

Proviso: I am not a modeller. I made this clear when I was asked to participate as an external expert (my point was, that I am not an expert insofar as modelling fisheries data in concerned). I agreed to participate on the basis that there might be questions about shrimp biology or other more qualitative approaches to the assessment. I got the sense, and perhaps I am wrong here, that the assessment is proceeding towards modelling approaches. Personally, I have no objection to this based on what I saw, but I want to point out to the rest of the group that I should not be relied upon to provide rigorous review of the modelling approaches. This is relevant not only to my comments below, but perhaps also to the question of my continued involvement into 2013. Given the direction that the assessment approach seems to be going, it may be doing the group a disservice not to find a reviewer who is better versed in these modelling approaches.

Length–based model and biomass dynamic models

- It is always useful to outline assumptions, both general and specific, of a model. This would be useful to see with some discussion of the sensitivity of the model to these assumptions.
- the problem that fishing mortality seems to have little influence on the stock seems to deserve further treatment. If models that interpret changes in catch dynamics and structure to infer population size and fishing mortality are to be believed, the ways in which fishing change size/age structure, growth and abundance need to be rigorously explored. The fit of the commercial observations to modelled size structure suggest that the growth/size-structure relationship with fishing may hold up, I did not see how strong inferences about population size and fishing mortality could be made from what was presented. Again, this is likely, at least in part, due to my limited expertise in this field, so perhaps Peter and Ingrid can provide more useful insight here.
- the fit of observations to fishery and survey data provide a useful picture of the potential utility of the model, but are there other approaches that could be presented (e.g. retrospective analysis?).

Overall view

- All the work presented shows some promise, but at the moment it does not appear that any one piece could operate as a stand-alone assessment approach.
- A trend-based analysis of point-estimates from various dataseries, perhaps combined with the AIM approach, was not discussed but would seem to be to be a viable approach. However, I defer to the opinions of others who are better suited to give one with regards to how valuable the results of the length-based and biomass dynamic models might be.
- On the other hand, the fit of the models to data suggest that they may be useful tools to be assessed more fully. As has been suggested by others in the group, moving ahead to compare both models to the AIM results is likely the best approach. Diagnostic outputs to compare model fits/retrospective analysis may be useful. Expert (not me) advice is needed as this work moves forward.

3.2 Comments by Invited Independent Expert Reviewer Dr Robert Mohn at the September 2013 WebEx

Dr Mohn noted that the length-based model fits to numbers at length in the survey whereas other similar models commonly fit to the abundance and proportions at length separately. In his experience the proportions at length tend to dominate the fitting process. It is unclear whether or not this approach would improve the model fit, but may improve diagnostics.

With regard to the process error in the surplus production model, Dr Mohn pointed out the need to examine the estimated time-series of the process error in more detail. In addition he noted that there could be an advantage in carrying out a retrospective error analysis of the stock given the presence of large and possibly autocorrelated process error. Correlated errors in the process error should reflect systematic changes in the principal elements of productivity, growth, natural mortality, etc.

Dr Mohn expressed the view based on the presentations that neither model could be rejected as being flawed and advised that both models be applied side by side for the near future but supported choosing one model for the basis for the assessment and advice. An alternative, he suggested, might be to take the more pessimistic of the two on an annual basis as the basis for the assessment and advice, but it was recognized that such an approach could be open to criticism. Although model averaging was not supported by the Benchmark, the possibility existed to integrate the risk over both models. This would require the development of a common metric from the two models to determine risk against. Potential candidates are biomass or biomass relative to B_{MSY} or carrying capacity.

4 Conclusions

The major problem in the assessment of the SKND *Pandalus* stock, as pointed out by the WG members in the 1990s, is that high natural mortality influences stock fluctuations more than the fishery. Also the relatively few age groups in the population create problems with assessment-based predictions, particularly when survey-based recruitment data are uncertain. Consequently only short-term projections from either the length-based or the Bayesian surplus production model should be considered in making decisions. Although the length-based model is accepted as the basis for the assessment, it is recommended that both models be run in each assessment for the next few years to confirm that the results from the length-based model remain consistent with those from the Bayesian surplus production model.

5 References

Hvingel, C. 2005. Deriving Quantitative Biological Advice for the Shrimp Fishery in Skagerrak and Norwegian Deep (ICES Divisions IVa east and IIIa). NAFO SCR Doc. 05/84.

Hvingel, C. 2012. North Sea *Pandalus* benchmark stock assessment - a Bayesian surplus production model. NAFO SCR Doc. 12/66.

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Nielsen, A, Munch-Petersen, S., Eigaard, O., Guldborg, S., and Ulmestrand, M. 2012. A stochastic length-based assessment model for the *Pandalus* stock in Skagerrak and the Norwegian Deep. NAFO SCR Doc. 12/61.

Nielsen, A, Munch-Petersen, S., Eigaard, O., Guldborg, S., and Ulmestrand, M. 2013. A stochastic length-based assessment model for the *Pandalus* stock in Skagerrak and the Norwegian Deep. NAFO SCR Doc. 13/074.

6 Benchmark information

Stock	*Pandalus* in the Norwegian deep and Skagerrak	
Stock coordinator	Name: Mats Ulmestrand	E-mail:mats.ulmestrand@slu.se
Stock assessor	Name:	E-mail:
Data contact	Name:	E-mail:

Issue	Problem/Aim	Work needed/ possible direction of solution	Data needed to be able to do this: are these available/where should these come from?	External expertise needed at benchmark type of expertise/proposed names
Tuning series	The Norwegian survey time-series indices from 1984–2003 should be recalculated in order to provide confidence intervals and length–frequency distributions	Work completed		
	the Swedish effort data should be standardized	Work complerted		
Discards				
Biological Parameters	Population structure: should the Skagerrak and the Norwegian Deep shrimp be treated as one stock.	Genetics work completed and in prep for publication. Results confirm that SKND *Pandalus* should be treated as one stock for assessment purposes	Gentic samples from the geographic range of the stock and from different periods.	Reviewed by NIPAG September 2013

ISSUE	PROBLEM/AIM	WORK NEEDED/ POSSIBLE DIRECTION OF SOLUTION	DATA NEEDED TO BE ABLE TO DO THIS: ARE THESE AVAILABLE/WHERE SHOULD THESE COME FROM?	EXTERNAL EXPERTISE NEEDED AT BENCHMARK TYPE OF EXPERTISE/PROPOSED NAMES
Assessment method	Implementation of a quantitative assessment model to replace the current method of qualitative evaluation of trends in cacth and biomass series and information on population dempgraphics	Three potential modelling approaches explored in initial stages of benchmark: Lengthbased model Biomass dynamic model Index method Models 1 and 2 considered suitable and subject to further review. Model 1 selected as the basis for the assessment with Model 2 also to be run to provide additional information	Survey indices , commercial catch data, length frequencies.	Dr Robert Mohn acted as invited independent expert to review the methods and results for Models 1 and 2. Models and results also reviewed by NIPAG September 2013
Biological Reference Points	MSY reference points should be established	MSY proxy reference points will be determined from Model 1	Output from Model 1	

Annex 1: Participants list

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Annex 2: Terms of Reference

As decided by ACOM in September 2011.

2010/2/ACOM58 **Inter Benchmark Protocol for Pandalus in Skagerrak and Norwegian Deep (IBPPand)** that will serve as in Inter Benchmark Protocol, chaired by Carsten Hvingel*, Norway, with invited external experts Bob Mohn**, will meet by correspondence to:

a) Review the proposed updates in data analysis and assessment methodology as described in the stock issue list.

b) Prioritize the issues and provide guidance to stock experts on methods with which to solve issues.

c) Describe the choice of preferred method for data analysis and assessment in a concise report. Include recommendations on progress to be made in cases where work is not yet finalized.

d) Describe the resulting data analysis procedure and assessment methodology in the stock annex.

e) Evaluate the management measures in force.

f) Review and agree on the resulting stock annex.

IBPPand will report by 31st April 2012 for the attention of ACOM.

* Per 2011

** Per July 2013

Annex 3: Stock Annex