



CIE Independent Peer Review Report

submitted by Beatriz A. Roel

**51st Stock Assessment Workshop/Stock
Assessment Review Committee (SAW/SARC):
Silver, Red, and Offshore hakes, and *Loligo*
squid.**

January 2011

Executive Summary

The SARC-51 Review Panel provided an independent peer review of key decisions and outputs from assessments for two stocks of silver hake (*Merluccius bilinearis*), two stocks of red hake (*Urophycis chuss*) offshore hake (*Merluccius albidus*), and longfin squid (*Loligo pealeii*). The review was held from 29 November to 3rd December 2010 in Woods Hole. Data and assessment reports were presented to the Panel, and issues considered against the Review Panel's Terms of Reference through open discussion. Additional analyses were requested at the review, and the results were considered. The Panel examined whether the Working Groups responses to their Terms of Reference (ToRs) were adequate, complete, and scientifically sound, and determined whether base-case analyses were preferred for determining stock status and developing management references.

The results from an analytical assessment run for silver hake were not considered adequate to serve as a basis for management advice. Concerns raised are documented in the Review Panel's report. Management advice was based on survey estimates for all hake stocks assessed and for *Loligo pealeii*. The uncertainties in the assessments are fully documented within the SARC-51 Review Panel report.

This reviewer supports the contents of the Review Panel report, where all ToRs were addressed followed by a summary of the Panel discussions. A *Summary of findings* where this reviewer felt further clarification or additional comments could be helpful is provided below under the corresponding heading. Main issues considered in relation to the Review Panel ToRs are the following:

1. Catch data
 - a. Species mis-specification for all hake stocks.
 - b. Concerns regarding historical nominal landings, particularly for the Distant Water fleets.
 - c. Precision in the estimation of discards not presented
2. Survey data
 - a. The type of trawl gear used on the historical NEFSC trawl surveys is likely to be sub-optimal for hake stocks.
 - b. The squid distribution in the water column extends well beyond the headline height of the survey net, particularly before the introduction of the Bigelow. This creates uncertainty in the fraction of squid that is available to the gear and thus in biomass estimation.
3. Evaluate the validity of the current stock definition
 - a. The available scientific information provided no strong biological evidence to support single or combined hake stocks.
 - b. The use of genetic stock differentiation was suggested.
4. Estimates of annual fishing mortality, recruitment and stock biomass for the time-series, and estimate uncertainty.
 - a. The use of ASAP for silver hake was appropriate however results were very sensitive to model configuration and the causes of the instability could not be determined. Therefore the ASAP assessment was not accepted as a basis for management advice.

- b. All assessments were then based on historical stock biomass trajectories and exploitation ratios estimated directly from surveys.
5. Biological reference points
 - a. Stock statuses were stated for definitions of “overfished” and “overfishing” when BRPs existed or/and “new” ones were proposed. In the case of Silver hake there were concerns regarding threshold definitions given apparent recent increase in total mortality.
 - b. In the case of Loligo the 2010 assessment considered that the current F reference point was not appropriate for this lightly exploited stock but a new F reference point was not proposed. A new biomass target and threshold were proposed based on average biomass and assumptions regarding mean depletion.
 - c. The stock status of offshore hake relative to BRPs could not be evaluated.
 6. State of the stocks.
 - a. Under proposed reference points neither the southern nor the northern silver hake stocks were overfished and overfishing was not occurring. The proposed BRPs are the best available at this time. Truncation of the age structure in recent years suggests increased total mortality while the analytical assessment based on the WG preferred run, although not accepted, suggested low biomass and high fishing mortality.
 - b. The red hake assessment indicated that neither the northern nor the southern stocks were overfished and overfishing was not occurring.
 - c. Loligo appears to be lightly exploited because annual catches were low relative to annual estimates of minimum consumption by a subset of fish predators and there was no evidence of fishing effects on annual survey biomass estimates during 1975-2009. The 2009 exploitation index was slightly below the median level.

Background

The Northeast Regional Stock Assessment Workshop or **SAW** is a formal scientific peer-review process for evaluating and presenting stock assessment results to managers. The SAW protocol is used to prepare and review assessments for fish stocks in the offshore US waters of the northwest Atlantic. Assessments are prepared by SAW working groups (federally led assessments) or ASMFC technical assessment committees (state led assessments) and reviewed by an independent panel of stock assessment experts called the Stock Assessment Review Committee or **SARC**.

The SARC is asked to determine the adequacy of the assessments in providing a scientific basis for management. If the panel accepts an assessment, the SAW report will include an assessment summary and a chapter providing details on the assessment development and results. In addition, each panelist provides a review and the panel provides an overall summary of the proceedings.

The SARC-51 review panel consisted of three Center for Independent Experts (CIE)-appointed reviewers, and an independent chair from the SSC of the New England Fishery Management Council.

This document represents the individual CIE Reviewer Report on the results of the Review Panel deliberations on the assessments of two stocks of silver hake (*Merluccius bilinearis*), two stocks of red hake (*Urophycis chuss*) offshore hake (*Merluccius albidus*), and longfin squid (*Loligo pealeii*), at the request of the Center for Independent Experts. This reviewer was provided with the Working Group reports for each species, and participated fully in the SARC Review Panel process.

Description of review activities

This review was undertaken by Dr Beatriz A. Roel at Cefas (Lowestoft, UK) and during the 51st Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC), which met to provide an external peer review of benchmark stock assessments for two stocks of silver hake (*Merluccius bilinearis*), two stocks of red hake (*Urophycis chuss*) offshore hake (*Merluccius albidus*), and longfin squid (*Loligo pealeii*).

The documentation (see bibliography) was reviewed prior to the meeting. I actively participated in the SAW/SARC panel meeting in Woods Hole and assisted with development of the SARC Review Panel meeting report. This separate report to CIE was completed on my return to Cefas.

The lead assessment scientists presented the individual data and assessment reports to the Panel, and issues were considered against the Review Panel's ToRs through open discussion. In turn, additional sensitivity runs were requested by the Review Panel, including by myself, and further consideration of these results was made in Woods Hole. The Review Panel examined whether the Data and Assessment Workshop's responses to their ToRs were adequate, complete, and scientifically sound, and determined whether the base-case analyses were appropriate for determining stock status and developing management references.

Summary of findings

The 51st Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC) met to provide an external peer review of benchmark stock assessments for two stocks of silver hake (*Merluccius bilinearis*), two stocks of red hake (*Urophycis chuss*) offshore hake (*Merluccius albidus*), and longfin squid (*Loligo pealeii*). This review determines whether the scientific assessments are adequate to serve as a basis for developing fishery management advice. Results of this review will form the scientific basis for fishery management in the northeast region. The Hake WG that held three meetings in preparation of the 2010 hake assessments prior to this Review and the Invertebrate WG, should be congratulated for their thorough, well-documented process leading to the assessment of the stocks. Moreover, I personally thank the stock assessment teams for their responsiveness and professionalism in providing additional analyses on the request of the Review Panel of which I was part.

My own review comments were fully incorporated in the SARC-51 Review Panel report. Below, however, my summary of findings is presented as stipulated in my own Statement of Work against each of the Review Panel Terms of Reference (Appendix 2). Within these, generic and assessment-specific observations and recommendations have been and are developed. Note that only where I have noted additional relevant issues to those presented in the Review Panel report are they highlighted here. All my other comments can be found in the Review Panel report.

Numbered recommendations (emboldened below) are correspondingly numbered within the Conclusions/recommendations section of this report, later.

A. Silver hake (2 Stocks: Northern and Southern)

For each stock or combined,

- 1. Estimate catch from all sources including landings, discards, and effort. Characterize the uncertainty in these sources of data, and estimate LPUE. Analyze and correct for any species mis-identification in these data.**

As part of the Review Panel, I share the concerns regarding accuracy of the historical nominal landings, particularly for the Distant Water Fleets. Prior to 1991, catches of silver hake and offshore hake were not reported separately. Since 1991, landings have been reported by species although the completeness of species reporting has been variable. The length-based and depth-based estimators used to partition the landings (and discards) based on NEFSC research survey data gave similar results (averaging 94 – 96% of nominal landings for the recent period with species reporting) and are adequate for this species given their predominance in the mixed-hake landings.

The use of two models to estimate the proportion of silver hake in landings where hake were not reported by species seemed appropriate and the lack of sensitivity of the results to the choice of model was reassuring.

The precision of discards estimates, which have represented up to 20-30% of catch biomass, is not presented. The numbers of observer trips in which silver hake have been sampled (Table A25 & A26 in the assessment working paper) is patchy and often low, and pooling of length compositions over some years has been carried out. A measure of the sampling rate by

fleet (numbers of trips observed compared with total numbers of fleet trips) over time would be informative as to the likely sampling variability.

Catch curves showing an increasingly steeper age profile were presented on request of the Panel suggesting high total mortality.

Recommendation 1. To provide a measure of discards sampling rate by fleet over time.

Recommendation 2. To run the assessments for the period where reliable landings data are available (probably from 1991) and compare the estimates, as well as the uncertainty on recruitment parameters and on MSY-related benchmarks.

Recommendation 3. To make more use of simple data exploration methods such as catch curves.

2. *Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Characterize the uncertainty and any bias in these sources of data.*

The survey data, consisting of age-structured indices from the NEFSC fall and spring surveys were presented disaggregated in north and south and combined. The north and south indices provided slightly conflicting stock trends. While the south indices suggested a slight decreasing trend over time the north indices indicated either an increasing trend with decline since 1998 or stability. The south indices appeared more variable relative to the north.

Despite the strong moderate year classes in the age composition, truncation in the age structure was apparent suggesting increased total mortality.

I shared the Panel view that the type of trawl gear used on the historical NEFSC trawl surveys is likely to be sub-optimal for a survey of hake stocks due to the very low headline height (1 – 2 m). Further, shifts in distribution of the stock could induce changes in overall catchability across years and ages.

Recommendation 4. An evaluation of the catchability of hake taken by the research trawl along the lines of the analysis of the components of catchability for *Loligo pealii* presented in the current review.

3. *Evaluate the validity of the current stock definition, and determine whether it should be changed. Take into account what is known about migration among stock areas.*

The WG presented the scientific information available on silver hake stock structure (morphometrics, larval distribution, growth, maturity). I agree with the WG conclusion that that there was no strong biological evidence to support a separate or combined stock assessment.

4. *Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from Silver hake TOR-5), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results.*

I agree with the Panel conclusion that the assessment models explored by the WG were appropriate to the data available, and appeared to have been applied correctly. However the

model proposed by the Hake WG, (ASAP, Legault and Restrepo 1998), was not yet suitable as a basis for developing management advice for reasons outlined in the Panel Review report. In short, model results were very sensitive to model configuration. Moreover, the preferred configuration, with consumption, exhibited strong residual patterns. The retrospective analysis showed a tendency of the model to underestimate F and to over-estimate SSB .

ASAP is a complex model which requires fixing the uncertainty associated with the sets of data fitted. The weighting is subjective and does not allow computation of variances of the likelihood components. Standardized residuals cannot be computed as a result.

Recommendation 5. There could be use in comparing the results from ASAP with a much simpler model such as Catch Survey Analysis (CSA; Mesnil, 2003), which models recruitment separately from fully recruited ages. As input data, it requires recruitment and fully recruited population indices as well as catch data aggregated in a similar manner.

Catch curves can be used successfully for data exploration. In particular, year-class curve models (YCC), fitted to the log abundance-at-age of a cohort can be used to look at changes in total mortality over time, and to examine the internal consistency in both catch and survey data. Further, slightly more complex models can be used to explore the combination of selectivity/availability-at-age, geographical differences in total mortality and/or relative recruitment strength, and temporal variation in total mortality (see Cotter *et al.*, 2007).

Recommendation 6. Compare the results from ASAP with another catch-at-age model, preferably a published, well-tested method.

5. *Evaluate the amount of silver hake consumed by other species as well as the amount due to cannibalism. Include estimates of uncertainty. Relate findings to the stock assessment model.*

My opinions and views are fully reflected in the evaluation of this ToR presented in the Review Panel report. Consumption studies provided estimates of cannibalism. Using area swept estimates of abundance for silver hake seemed the right approach to avoid potential circularity in the estimation.

6. *State the existing stock status definitions for “overfished” and “overfishing”. Then update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, and F_{MSY} ; and estimates of their uncertainty). If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the “new” (i.e., updated, redefined, or alternative) BRPs.*

In the absence of an agreed analytical model, the WG addressed this ToR by updating existing BRPs which were based on the fall survey weight per tow and biomass indices averaged over the period 1973-1982. I share the WG’s concerns regarding the impact on reference points of increasing total mortality in recent years.

Recommendation 7. Given indications that total mortality is increasing it would be advisable to consider a more recent period to derive biomass and the overfishing thresholds.

7. *Evaluate stock status (overfished and overfishing) with respect to the existing BRPs, as well as with respect to the “new” BRPs (from Silver hake TOR 6).*

The WG addressed this ToR both by evaluating stock status (for the northern and southern stocks) in relation to existing BRPs and to the “new” ones based on the fall survey arithmetic means and catch. The overall conclusion was that silver hake is not overfished and overfishing is not occurring in the northern or southern management areas. Although the stock status has been evaluated consistently with the current survey index assessment method, the analytical assessment (for run #6, recommended by HWG as the one providing the best interpretation of the data) was indicating low biomass and high fishing mortality. This could be interpreted as a reminder of the need to continue working towards a defensible analytical assessment.

Recommendation 8. To continue working towards an analytical assessment on which to base “new” BRPs.

8. *Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).*
- a. *Provide numerical short-term projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions about the most important uncertainties in the assessment (e.g., terminal year abundance, variability in recruitment).*
 - b. *Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.*
 - c. *Describe this stock’s vulnerability to becoming overfished, and how this could affect the choice of ABC.*

My opinions and views are fully reflected in the evaluation of this ToR presented in the Review Panel report.

9. *Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in recent SARC reviewed assessments and review panel reports. Identify new research recommendations.*

Although the HWG reported on previous recommendations, it is not clear to me whether they were properly evaluated and addressed.

The Panel proposed ageing the catches on the basis of samples taken from the catch instead of using age-length keys constructed from survey data. I support this recommendation, however this may result in an inconsistency over time of the catch at age matrix. A future analytical assessment model will have to take into account this potential inconsistency when fitting the catch at age data.

Development of a cpue index of abundance could be beneficial for this assessment. However, I take the point that cpue may not provide such index given that the behavior of the fleet may be related more to regulations and market opportunities than to stock abundance.

B. Red hake (2 Stocks: Northern and Southern)

For each stock or combined,

1. *Estimate catch from all sources including landings, discards, and effort. Characterize the uncertainty in these sources of data, and estimate LPUE. Analyze and correct for any species mis-identification in these data.*

My views for this ToR are reflected in the contents of the Review Panel report.

2. *Present the survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Characterize the uncertainty in these sources of data.*

I fully agree with the Panel's conclusion that this ToR was met, but that the uncertainty in survey results remains unknown. Further, the assumption of constant survey catchability implicit in the use of survey indices for management is unproven for red hake, because there is no analytical assessment to gauge it against and no age compositions to examine internal consistency.

Recommendation 9. To address validation of the ageing method for red hake and to collect and process the necessary samples to determine age composition from the surveys.

3. *Evaluate the validity of the current stock definition, and determine whether this should be changed. Take into account what is known about migration among stock areas.*

I shared the Panel views that based on the scientific information available on stock structure there was no strong biological evidence to support either a separate or combined red hake stock.

4. *Estimate measures of annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and characterize their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results.*

I share the Panel view that this ToR was fully addressed by WG. The AIM model was applied and two statistical catch at length models were attempted, However, diagnostics were not adequate to serve as a basis for management advice. Therefore, the assessment was based on the spring survey indices and exploitation indices from each area. This approach provides a scientifically credible basis for developing management advice.

No historical retrospective analysis can be carried out from a survey based assessment.

5. *State the existing stock status definitions for the terms “overfished” and “overfishing”. Then update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, and F_{MSY} , and estimates of their uncertainty). If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the “new” (i.e., updated, redefined, or alternative) BRPs.*

My views on this ToR were well reflected in the Review Panel report. The basis for the use of the spring survey data for reference point estimation seems scientifically valid.

6. *Evaluate stock status (overfished and overfishing) with respect to the existing BRPs, as well as with respect to the “new” BRPs (from Red hake TOR 5).*

My views on this ToR were well reflected in the Review Panel report.

7. *Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).*
 - a. *Provide numerical short-term projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions about the most important uncertainties in the assessment (e.g., terminal year abundance, variability in recruitment).*
 - b. *Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.*
 - c. *Describe this stock’s vulnerability to becoming overfished, and how this could affect the choice of ABC.*

My views on this ToR were well reflected in the Review Panel report.

8. *Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in recent SARC reviewed assessments and review panel reports. Identify new research recommendations.*

I share the Panel views on the WG proposed research recommendations. I also support further research recommendations proposed by the Panel.

C. Offshore hake

1. *Use models to estimate the commercial catch. Describe the uncertainty in these sources of data.*

My views on this ToR were reflected in the Panel report in that this Term of Reference was met in terms of reconstructing historical landings, discards and associated length/age compositions, as far as was possible with available data. However, landings and catches data are a major source of uncertainty for this stock assessment because landings of hakes (silver, offshore and red hake) were not reported by species until 1991 and even those that are reported may not be correctly identified

2. *Characterize the survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, age-length data, etc.). Describe the uncertainty in these sources of data.*

I concur with the views of the Panel on this ToR that the surveys are unlikely to provide reliable estimates of stock trends.

3. *Estimate measures of annual fishing mortality, recruitment and stock biomass for the time series, and characterize the uncertainty of those estimates.*

My views are reflected in the Review Panel report in that this Term of Reference was met. The WG attempted several assessment methods (AIM – An Index Method, and SEINE (Gedamke and Hoenig 2006)) but information was insufficient to carry out a stock assessment.

4. *State the existing stock status definitions for the terms “overfished” and “overfishing”. Then update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, and F_{MSY} ; and estimates of their uncertainty). If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the “new” (i.e., updated, redefined, or alternative) BRPs.*

I concur with the Panel that this ToR was met. Survey data may not be a good index of abundance (or of mean weight) and may be driven more by changes in distribution rather than changes in abundance. Therefore, no alternative reference points were recommended and the existing BRPs were rejected. Estimates of catches are highly uncertain and in the absence of a reliable index of stock size, it is not possible to construct biological reference points with such data and therefore it is not possible to evaluate the status of the stock.

5. *Evaluate stock status (overfishing and overfished) with respect to the existing BRPs, as well as with respect to the “new” BRPs (from Offshore hake TOR 4).*

I concur with the Panel that the stock status in relation to BRPs could not be evaluated.

6. *If a model can be developed, conduct single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).*

- a. Provide numerical short-term projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions about the most important uncertainties in the assessment (e.g., terminal year abundance, variability in recruitment).
- b. Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.
- c. Describe this stock's vulnerability to becoming overfished, and how this could affect the choice of ABC.

My views are reflected in the Panel Report.

7. Propose new research recommendations.

My views on research recommendations are reflected in the Panel Report. In addition, given uncertainty related to the mixed reporting of silver and offshore hake landings, I recommend that the feasibility of developing a combined “whiting” ABC and ACL scheme with suitable protection for offshore hake is investigated.

Recommendation 10. To investigate the utility for management of a combined “whiting” ABC and ACL scheme with suitable protection for offshore hake.

D. Longfin squid (*Loligo*)

1. *Characterize the commercial catch including landings, effort, LPUE and discards. Describe the uncertainty in these sources of data.*

My views on this ToR were accurately reflected in the Review Panel report.

2. *Characterize the survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, age-length data, etc.). Describe the uncertainty in these sources of data.*

The WG addressed this ToR and my views are reflected in the Review Panel report. The WG made a commendable effort to estimate survey catchability for the stock and its associated uncertainties although those may still be underestimated. I agree with the WG that q_{max} appears well estimated and the data used to compute this parameter was well presented and justified.

The short-lived nature of the stock may require in-season management based on seasonal abundance indices. Despite this consideration comparison between the spring and fall survey indices of abundance for a given year showed they were positively correlated. This could provide some support to the idea that successive cohorts may not be entirely independent from each other.

3. *Estimate annual fishing mortality, recruitment and stock biomass for the time series, and characterize the uncertainty of those estimates (consider *Loligo* TOR-4). Include a historical retrospective analysis to allow a comparison with previous assessment results.*

My views were reflected in the Review Panel report in that this ToR was addressed with the limitations associated with the short-lived characteristics of *Loligo pealeii*. Given limitations in the data and in the understanding of the stock dynamics, the historical stock trajectories of biomass, fishing mortality and recruitment were based on the survey estimates, and no modelling of the population dynamics was attempted.

Comparisons with previous assessment results were not considered because of differences in computation methodology and input data. However, given that the assessment is model free no retrospective bias was expected. No population model was attempted therefore no estimates of absolute biomass or fishing mortality are available. Given the protracted spawning season and subsequent overlap of fast growing cohorts the recruits index was not used as indicative of year-class strength.

Recommendation 11. Studies to better the understanding of *Loligo pealeii* life cycle and reproductive biology should be encouraged.

4. *Summarize what is known about consumptive removals of *Loligo* by predators and explore how this could influence estimates of natural mortality (M).*

My opinions and views are fully reflected in the evaluation of this ToR presented in the Review Panel report.

5. *State the existing stock status definitions for the terms “overfished” and “overfishing”. Then update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, and F_{MSY} ; and estimates of their uncertainty). Comment on the scientific adequacy of existing BRPs and for the “new” (i.e., updated, redefined, or alternative) BRPs.*

There are no existing biomass reference points for *L. pealeii*. The approach to estimate the current Fmsy proxy was considered not appropriate. A new biomass target (50% of carrying capacity, K) and threshold (25% of K) were proposed on the assumption that the stock is lightly exploited and that annual averages of the spring and fall biomass estimates for 1976-2008 would correspond to 90% of K. The proposed biomass reference points were considered scientifically defensible given the nature of the assessment based on direct estimates of biomass. At the very least, the sensitivity of assumptions regarding depletion could be tested if an assessment model was attempted.

The 2010 assessment considered that the current F reference point was not appropriate for this lightly exploited stock but a new F reference point was not proposed. Previous estimates of Fmsy proxy based on yield per recruit analysis appeared too high compared with historic estimates. I agree with the interpretation of the WG that the lack of contrast in the data and of evidence that fishing has impacted the average annual stock biomass during the period of exploitation considered result in unreliable estimates of an Fmsy proxy.

Recommendation 12. Fit a population dynamics model to the data to estimate stock depletion ($B_{current}/K$). Two-stage biomass models of the type developed by Roel and Butterworth (2000) could estimate depletion and may well be suited for the data available.

6. *Evaluate stock status with respect to the existing BRPs, as well as with respect to the “new” BRPs (from Loligo TOR 5).*

I share the Panel view that this ToR was addressed although stock status was evaluated only in respect to the “new” BRPs because biomass reference points did not exist and the existing Fmsy proxy was considered not appropriate for a lightly exploited stock such as *L. pealeii*.

With the Panel, I support the WG conclusion that during 2009, the *Loligo pealeii* stock was not overfished and overfishing was probably not occurring. The two-year average of catchability-adjusted spring and fall survey biomass levels during 2008-2009 was 54,618 mt, higher than a proposed threshold Bmsy proxy of 21,203 mt. Moreover, the use of a two-year average of catchability-adjusted survey biomass seems appropriate to smooth a rather noisy survey series.

7. *Develop approaches for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs), and comment on the ability to perform projections for this stock.*

My views on this ToR are reflected in the Review Panel report.

8. *Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in recent SARC reviewed assessments and review panel reports. Identify new research recommendations.*

A review of the research recommendations is presented in the Review Panel report, and my views are adequately reflected. Additional, numbered recommendations are specified in the preceding text.

Appendix 1: Bibliography

- Cotter, A. J. R., Mesnil, B., and Piet, G. J. 2007. Estimating stock parameters from trawl cpue-at-age series using year-class curves. *ICES Journal of Marine Science*, 64: 1–14.
- Legault, C. M., and Restrepo, V. R., 1998. A flexible forward age-structured assessment program. ICCAT Working Document SCRS/98/58. 15 pp.
- Mesnil, B. 2003. The catch-survey analysis (CSA) method of fish stock assessment: An evaluation using simulated data. *Fisheries Research*, 63: 193–212.
- Roel, B.A., Butterworth, D.S., 2000. Assessment of the South African chokka squid *Loligo vulgaris reynaudii*. Is disturbance of aggregations by the recent jig fishery having a negative impact on recruitment? *Fish. Res.* 48, 213–228.

Appendix 2

Statement of Work (T020-07, final 01 August 2010)

External Independent Peer Review by the Center for Independent Experts

51st Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC): Silver, Red, and Offshore hakes, and *Loligo* squid.

Statement of Work (SOW) for CIE Panelists (including a description of SARC Chairman's duties)

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description The purpose of this meeting will be to provide an external peer review of benchmark stock assessments for two stocks of silver hake (*Merluccius bilinearis*), two stocks of red hake (*Urophycis chuss*) offshore hake (*Merluccius albidus*), and longfin squid (*Loligo pealeii*). Hake aggregate in large numbers, swim fast, and prey on fish, crustaceans and squid. This review determines whether the scientific assessments are adequate to serve as a basis for developing fishery management advice. Results of this review will form the scientific basis for fishery management in the northeast region. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**. The SARC Summary Report format is attached as **Annex 4**.

The SARC50 review panel will be composed of three appointed reviewers from the Center of Independent Experts (CIE), and an independent chair from the SSC of the New England or Mid-Atlantic Fishery Management Council. The SARC panel will write the SARC Summary Report and each CIE reviewer will write an individual independent review report.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have working knowledge and recent experience in the assessment of pelagic stocks and with analyses of survey catchability, particularly for the inclusion of environmental covariates. For the hakes there are concerns about stock structure, and some issues of species

identification in commercial landings (e.g., offshore hake sometimes classified as silver hake). Reviewers should be familiar with methods of stock identification and indirect methods for imputing catch composition (e.g., finite mixture distribution methods). For both *Loligo* and offshore hake, experience with methods for assessing data poor stocks is desirable. Familiarity with the squid life history and the implications of temporally varying natural mortality and growth on population dynamics is also desirable.

In general, CIE reviewers for SARCs shall have working knowledge and recent experience in the application of modern fishery stock assessment models. Expertise should include statistical catch-at-age, state-space and index methods. Reviewers should also have experience in evaluating measures of model fit, identification, uncertainty, and forecasting. Reviewers should have experience in development of biological reference points that includes an appreciation for the varying quality and quantity of data available to support estimation of biological reference points.

Each CIE reviewer's duties shall not exceed a maximum of 16 days to complete all work tasks of the peer review described herein.

Not covered by the CIE, the SARC chair's duties should not exceed a maximum of 16 days (i.e., several days prior to the meeting for document review; the SARC meeting in Woods Hole; several days following the open meeting for SARC Summary Report preparation).

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in Woods Hole, Massachusetts during 29 November through 3 December, 2010.

Charge to SARC panel: The panel is to determine and write down whether each Term of Reference of the SAW (see **Annex 2**) was or was not completed successfully during the SARC meeting. To make this determination, panelists should consider whether the work provides a scientifically credible basis for developing fishery management advice. Criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable. Where possible, the chair shall identify or facilitate agreement among the reviewers for each Term of Reference of the SAW.

If the panel rejects any of the current Biological Reference Point (BRP) proxies for B_{MSY} and F_{MSY} , the panel should explain why those particular proxies are not suitable and the panel should recommend suitable alternatives. If such alternatives cannot be identified, then the panel should indicate that the existing BRPs are the best available at this time.

Statement of Tasks:

1. Prior to the meeting

(SARC chair and CIE reviewers)

Review the reports produced by the Working Groups and read background reports.

Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein:

Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email,

and FAX number) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide by FAX the requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: <http://deemedexports.noaa.gov/sponsor.html>).

Pre-review Background Documents: Approximately two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

2. During the Open meeting

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs can not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

(SARC chair)

Act as chairperson, where duties include control of the meeting, coordination of presentations and discussion, making sure all Terms of Reference of the SAW are reviewed, control of document flow, and facilitation of discussion. For the assessment, review both the Assessment Report and the draft Assessment Summary Report.

During the question and answer periods, provide appropriate feedback to the assessment scientists on the sufficiency of their analyses. It is permissible to discuss the stock assessment and to request additional information if it is needed to clarify or correct an existing analysis and if the information can be produced rather quickly.

(SARC CIE reviewers)

For each stock assessment, participate as a peer reviewer in panel discussions on assessment validity, results, recommendations, and conclusions. From a reviewer's point of view, determine whether each Term of Reference of the SAW was completed successfully. Terms of Reference that are completed successfully are likely to serve as a basis for providing scientific advice to management. If a reviewer considers any existing Biological Reference Point proxy to be inappropriate, the reviewer should try to recommend an alternative, should one exist.

During the question and answer periods, provide appropriate feedback to the assessment scientists on the sufficiency of their analyses. It is permissible to request additional information if it is needed to clarify or correct an existing analysis and if the information can be produced rather quickly.

3. After the Open meeting

(SARC CIE reviewers)

Each CIE reviewer shall prepare an Independent CIE Report (see **Annex 1**). This report should explain whether each Term of Reference of the SAW was or was not completed successfully during the SARC meeting, using the criteria specified above in the "Charge to SARC panel" statement.

If any existing Biological Reference Points (BRP) or their proxies are considered inappropriate, the Independent CIE Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRPs are the best available at this time.

During the meeting, additional questions that were not in the Terms of Reference but that are directly related to the assessments may be raised. Comments on these questions should be included in a separate section at the end of the Independent CIE Report produced by each reviewer.

The Independent CIE Report can also be used to provide greater detail than the SARC Summary Report on specific Terms of Reference or on additional questions raised during the meeting.

(SARC chair)

The SARC chair shall prepare a document summarizing the background of the work to be conducted as part of the SARC process and summarizing whether the process was adequate to complete the Terms of Reference of the SAW. If appropriate, the chair will include suggestions on how to improve the process. This document will constitute the introduction to the SARC Summary Report (see **Annex 4**).

(SARC chair and CIE reviewers)

The SARC Chair and CIE reviewers will prepare the SARC Summary Report. Each CIE reviewer and the chair will discuss whether they hold similar views on each Term of Reference and whether their opinions can be summarized into a single conclusion for all or only for some of the Terms of Reference of the SAW. For terms where a similar view can be reached, the SARC Summary Report will contain a summary of such opinions. In cases where multiple and/or differing views exist on a given Term of Reference, the SARC Summary Report will note that there is no agreement and will specify - in a summary manner – what the different opinions are and the reason(s) for the difference in opinions.

The chair's objective during this Summary Report development process will be to identify or facilitate the finding of an agreement rather than forcing the panel to reach an agreement. The chair will take the lead in editing and completing this report. The chair may express the chair's opinion on each Term of Reference of the SAW, either as part of the group opinion, or as a separate minority opinion.

The SARC Summary Report (please see **Annex 4** for information on contents) should address whether each Term of Reference of the SAW was completed successfully. For each Term of Reference, this report should state why that Term of Reference was or was not completed successfully. The Report should also include recommendations that might improve future assessments.

If any existing Biological Reference Point (BRP) proxies are considered inappropriate, the SARC Summary Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRP proxies are the best available at this time.

The contents of the draft SARC Summary Report will be approved by the CIE reviewers by the end of the SARC Summary Report development process. The SARC chair will complete all final editorial and formatting changes prior to approval of the contents of the draft SARC Summary Report by the CIE reviewers. The SARC chair will then submit the approved SARC Summary Report to the NEFSC contact (i.e., SAW Chairman).

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in **Annex 1**. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in **Annex 2**.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

- 1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.

- 2) Participate during the panel review meeting at the Woods Hole, Massachusetts during November 29 through December 3, 2010.
- 3) Conduct an independent peer review in accordance with the ToRs (**Annex 2**).
- 4) No later than December 17 2010, each CIE reviewer shall submit an independent peer review report addressed to the “Center for Independent Experts,” and sent to Mr. Manoj Shivilani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and to David Sampson, CIE Regional Coordinator, via email to david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

25 October 2010	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
15 November 2010	NMFS Project Contact will attempt to provide CIE Reviewers the pre-review documents by this date
29 Nov. – 3 Dec. 2010	Each reviewer participates and conducts an independent peer review during the panel review meeting in Woods Hole, MA
2-3 December 2010	SARC Chair and CIE reviewers work at drafting reports during meeting at Woods Hole, MA, USA
17 December 2010	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
20 December 2010	Draft of SARC Summary Report, reviewed by all CIE reviewers, due to the SARC Chair *
29 December 2010	SARC Chair sends Final SARC Summary Report, approved by CIE reviewers, to NEFSC contact (i.e., SAW Chairman)
3 January 2010	CIE submits CIE independent peer review reports to the COTR
10 January 2010	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

* The SARC Summary Report will not be submitted, reviewed, or approved by the CIE.

The SAW Chairman will assist the SARC chair prior to, during, and after the meeting in ensuring that documents are distributed in a timely fashion.

NEFSC staff and the SAW Chairman will make the final SARC Summary Report available to the public. Staff and the SAW Chairman will also be responsible for production and publication of the collective Working Group papers, which will serve as a SAW Assessment Report.

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent

substitutions. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:

- (1) each CIE report shall be completed with the format and content in accordance with **Annex 1**,
- (2) each CIE report shall address each ToR as specified in **Annex 2**,
- (3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

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Key Personnel:

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of whether they accept or reject the work that they reviewed, with an explanation of their decision (strengths, weaknesses of the analyses, etc.).
2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Findings of whether they accept or reject the work that they reviewed, and an explanation of their decisions (strengths, weaknesses of the analyses, etc.) for each ToR, and Conclusions and Recommendations in accordance with the ToRs. For each assessment reviewed, the report should address whether each Term of Reference of the SAW was completed successfully. For each Term of Reference, the Independent Review Report should state why that Term of Reference was or was not completed successfully. To make this determination, the SARC chair and CIE reviewers should consider whether the work provides a scientifically credible basis for developing fishery management advice.
 - a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including a concise summary of whether they accept or reject the work that they reviewed, and explain their decisions (strengths, weaknesses of the analyses, etc.), conclusions, and recommendations.
 - b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.
 - c. Reviewers should elaborate on any points raised in the SARC Summary Report that they feel might require further clarification.
 - d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.
 - e. The CIE independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not others read the SARC Summary Report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.
3. The reviewer report shall include the following appendices:
 - Appendix 1: Bibliography of materials provided for review
 - Appendix 2: A copy of the CIE Statement of Work
 - Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Assessment Terms of Reference for SAW/SARC51 (11/29 – 12/3, 2010)
(file vers.: 4/23/2010)

A. Silver hake (2 Stocks: Northern and Southern)

For each stock or combined,

1. Estimate catch from all sources including landings, discards, and effort. Characterize the uncertainty in these sources of data, and estimate LPUE. Analyze and correct for any species mis-identification in these data.
2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Characterize the uncertainty and any bias in these sources of data.
3. Evaluate the validity of the current stock definition, and determine whether it should be changed. Take into account what is known about migration among stock areas.
4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from Silver hake TOR-5), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results.
5. Evaluate the amount of silver hake consumed by other species as well as the amount due to cannibalism. Include estimates of uncertainty. Relate findings to the stock assessment model.
6. State the existing stock status definitions for “overfished” and “overfishing”. Then update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, and F_{MSY} ; and estimates of their uncertainty). If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the “new” (i.e., updated, redefined, or alternative) BRPs.
7. Evaluate stock status (overfished and overfishing) with respect to the existing BRPs, as well as with respect to the “new” BRPs (from Silver hake TOR 6).
8. Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).
 - d. Provide numerical short-term projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions about the most important uncertainties in the assessment (e.g., terminal year abundance, variability in recruitment).
 - e. Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.
 - f. Describe this stock’s vulnerability to becoming overfished, and how this could affect the choice of ABC.
9. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in recent SARC reviewed assessments and review panel reports. Identify new research recommendations.

B. Red hake (2 Stocks: Northern and Southern)

For each stock or combined,

1. Estimate catch from all sources including landings, discards, and effort. Characterize the uncertainty in these sources of data, and estimate LPUE. Analyze and correct for any species mis-identification in these data.
2. Present the survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Characterize the uncertainty in these sources of data.
3. Evaluate the validity of the current stock definition, and determine whether this should be changed. Take into account what is known about migration among stock areas.
4. Estimate measures of annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and characterize their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results.
5. State the existing stock status definitions for the terms “overfished” and “overfishing”. Then update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, and F_{MSY} ; and estimates of their uncertainty). If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the “new” (i.e., updated, redefined, or alternative) BRPs.
6. Evaluate stock status (overfished and overfishing) with respect to the existing BRPs, as well as with respect to the “new” BRPs (from Red hake TOR 5).
7. Develop and apply analytical approaches and data that can be used for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).
 - d. Provide numerical short-term projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F , and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions about the most important uncertainties in the assessment (e.g., terminal year abundance, variability in recruitment).
 - e. Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.
 - f. Describe this stock’s vulnerability to becoming overfished, and how this could affect the choice of ABC.
8. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in recent SARC reviewed assessments and review panel reports. Identify new research recommendations.

C. Offshore hake

1. Use models to estimate the commercial catch. Describe the uncertainty in these sources of data.
2. Characterize the survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, age-length data, etc.). Describe the uncertainty in these sources of data.
3. Estimate measures of annual fishing mortality, recruitment and stock biomass for the time series, and characterize the uncertainty of those estimates.
4. State the existing stock status definitions for the terms “overfished” and “overfishing”. Then update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, and F_{MSY} ; and estimates of their uncertainty). If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the “new” (i.e., updated, redefined, or alternative) BRPs.
5. Evaluate stock status (overfishing and overfished) with respect to the existing BRPs, as well as with respect to the “new” BRPs (from Offshore hake TOR 4).
6. If a model can be developed, conduct single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs).
 - d. Provide numerical short-term projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F , and probabilities of falling below threshold BRPs for biomass. In carrying out projections, consider a range of assumptions about the most important uncertainties in the assessment (e.g., terminal year abundance, variability in recruitment).
 - e. Comment on which projections seem most realistic, taking into consideration uncertainties in the assessment.
 - f. Describe this stock’s vulnerability to becoming overfished, and how this could affect the choice of ABC.
7. Propose new research recommendations.

D. Longfin squid (*Loligo*)

1. Characterize the commercial catch including landings, effort, LPUE and discards. Describe the uncertainty in these sources of data.
2. Characterize the survey data that are being used in the assessment (e.g., regional indices of abundance, recruitment, age-length data, etc.). Describe the uncertainty in these sources of data.
3. Estimate annual fishing mortality, recruitment and stock biomass for the time series, and characterize the uncertainty of those estimates (consider *Loligo* TOR-4). Include a historical retrospective analysis to allow a comparison with previous assessment results.
4. Summarize what is known about consumptive removals of *Loligo* by predators and explore how this could influence estimates of natural mortality (M).
5. State the existing stock status definitions for the terms “overfished” and “overfishing”. Then update or redefine biological reference points (BRPs; estimates or proxies for B_{MSY} , $B_{THRESHOLD}$, and F_{MSY} ; and estimates of their uncertainty). Comment on the scientific adequacy of existing BRPs and for the “new” (i.e., updated, redefined, or alternative) BRPs.
6. Evaluate stock status with respect to the existing BRPs, as well as with respect to the “new” BRPs (from *Loligo* TOR 5).
7. Develop approaches for computing candidate ABCs (Acceptable Biological Catch; see Appendix to the TORs), and comment on the ability to perform projections for this stock.
8. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in recent SARC reviewed assessments and review panel reports. Identify new research recommendations.