Centre for Independent Experts

Independent Experts Report of the Center of Independent Experts (CIE) review of the Eastern Bering Sea pollock stock assessment and management conducted for the Alaska Fisheries Science Center (AFSC), 28 June - 2 July 2010.

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Executive Summary

This document is the individual CIE Reviewer report of the review of the Eastern Bering Sea pollock stock assessment and management for the Alaska Fisheries Science Center (AFSC). It represents the views of the independent reviewer, Dr Chris Darby.

The review was conducted as an open meeting at the Alaska Fisheries Center, Seattle, Washington, from 28 June - 2 July 2010. All of the meeting's Terms of Reference were addressed. Documents were made available prior to the meeting; areas that required clarification, or, where it was considered that additional analysis was needed, were raised during the meeting by the review team and additional results, presentations and documents provided subsequently.

The ability, attitude, and coordinated approach presented by the AFSC are all considered to be of a very high scientific standard with best scientific practice being followed in the data collection, collation and assessment process. Some areas of "weakness" were identified where there is a requirement for more information and analysis, either by the presenters themselves, by the stock assessor as a result of model results or by the review team. It is clear that the researchers are aware of many of the issues and are addressing them in their research programs. Details were also provided in presentations as to where research programs are heading in the future, indicating a strong drive to improve the quality and utility of the data collection, analysis and ultimately the management advice.

The fishery dependent data collection, collation procedures were reviewed and considered to be high quality with observer and sampling protocols, annual and research reports in place to maintain standards and record findings and to provide continual improvements. A specific recommendation for more detailed analysis of ageing processes was made as this is considered a weakness in the whole process.

The survey information gathered for the assessment of stocks and also the determination of the background processes that determine population and ecosystem dynamics, is in many cases unique and, coupled with the high quality research programs associated with it, provides a high quality resource for the analysis required to produce current and future advice for fisheries and ecosystem management.

The pollock assessment model is considered highly developed and appropriate to the provision of the fishery and population metrics required for the management of the stock under the tiered protocol used for setting catches. Research is ongoing to refine the estimation of parameters and their uncertainty in order to improve its utility. Recommendations are made as to where clarification of model and its output, especially the average fishing mortality metric, would help in the provision of management advice and future evaluations.

It is of concern that the current management strategy has resulted in a decline to near to B20%, the level at which the fishery would be closed, despite recent assessments indicating that the reference exploitation rate has been well below the management target for the stock. Consequently, the main area considered to be missing from the process is a full simulation evaluation of the coupled assessment model and management process in order to test the robustness of the procedures and rules in place.

Background

The Center of Independent Experts (CIE) review of the Eastern Bering Sea pollock stock assessment and management for the Alaska Fisheries Science Center (AFSC) was conducted at the Alaska Fisheries Center, Seattle, Washington, from 28 June - 2 July 2010.

The review, chaired by Anne Hollowed for the AFSC, was conducted as an open meeting with presentations to the review team and interested participants, followed by questions and discussions. It was attended by a conservation group, representatives from industry processors, scientists involved in the assessment and management process, and fisheries managers; all provided input to the discussions. The review meeting had good background support from the AFSC staff during the meeting with a web site prepared prior to the meeting for documentation and wifi arrangements allowing dissemination of information, as required, during the meeting.

This document is the individual CIE Reviewer report of the meeting; it represents the views of the independent reviewer, Dr Chris Darby.

Documents on the data collection process, observer coverage and protocols, survey protocols and analysis, the assessment model and management protocol were provided to the review team via the web site well before the review (Appendix 1). Where scientific analysis had led to the formulation of, or changes to sampling procedures, for instance sampling for length and age, these were also provided. In addition previous reviews of the assessment and management were made available to the review team.

Documents were reviewed prior to the meeting and areas that required clarification, or, where it was considered that additional analysis was needed, were raised at the meeting by the reviewers. Additional results, presentations and documents provided during the meeting were reviewed during the evenings.

During the meeting the review panel was provided with presentations on the species and stock biology, the collection of catch data, the observer program, trawl and acoustic surveys, fitting of the stock assessment model and management process. Presentations were well prepared and well balanced in each area. Sufficient time was allowed for each topic and to clarify issues that arose. Comments from the industry observers, especially on the observer process and quality of catch information, were sought and these made a valuable contribution to the review process. Additional work, when requested by the reviewers, was completed in time for further discussions at the meeting or research papers providing more detailed analysis supplied as needed.

The ability, attitude, and coordinated approach presented by the AFSC are all considered to be of a very high scientific standard, with best scientific practices being followed in the data collection, collation and assessment process. Studies and analysis are based on good scientific and statistical science and often supported by peer reviewed research papers reporting and disseminating their results and developments. Some areas of “weakness” were identified where there is a requirement for more information and analysis, either by the presenters themselves, by the stock assessor as a result of model results or by the review team. It is clear that the researchers are aware of many of the issues and are addressing them in their research programs.

Details were also provided in presentations as to where research programs are going to be taken in the future indicating a strong drive to improve the quality and utility of the data collection and analysis.

It was very noticeable that there is an ongoing investment in time and research to extend the information gathering process to the ecosystem level through projects such as BSIERP. This will lead to a greater understanding of the linkages to the dynamics of the lower trophic levels, predator and prey species and thereby driving forces determining the pollock dynamics. This program is an area of research that is far ahead of those in the majority of the rest of the world and will be followed with interest.

TOR (a) Quality of input data and methods used to process them for inclusion in the assessment (specifically fishery and survey data).

Data for the assessment are collected from fishery dependent (landings and discards) and from fishery independent (survey) sources.

Fishery dependent data

Catch and discard sampling

Information on the catch history and the composition of catches and discards is presented within the assessment document. Historic catch levels were more uncertain due to the international nature of the fishery at that time and lower observer coverage. Recent data have greater certainty following the introduction of the US EEZ and increased rates of observer coverage. Discarding was as high as 9% in 1992 but has declined to around 1%; estimates are included within the assessment catch data. There is strong regional variation with higher rates of discards around the Aleutian Islands albeit a very low tonnage compared to the total catch.

A presentation to the review team described the Observer Program including the selection of boats and hauls to sample. Pollock catch data for the Eastern Bering Sea is collated by area from observer estimates of retained and discarded catch. For boats greater than 125ft, the sampling protocol specifies the selection of hauls to be sampled, the approach to sampling each haul and the number of length and age samples to take from each sample. Currently, only 30% of boats between 60 and 124ft are sampled, with the vessel selecting which trips are monitored; boats less than 60 ft are not sampled. Catches from unobserved trips are obtained from landings reports.

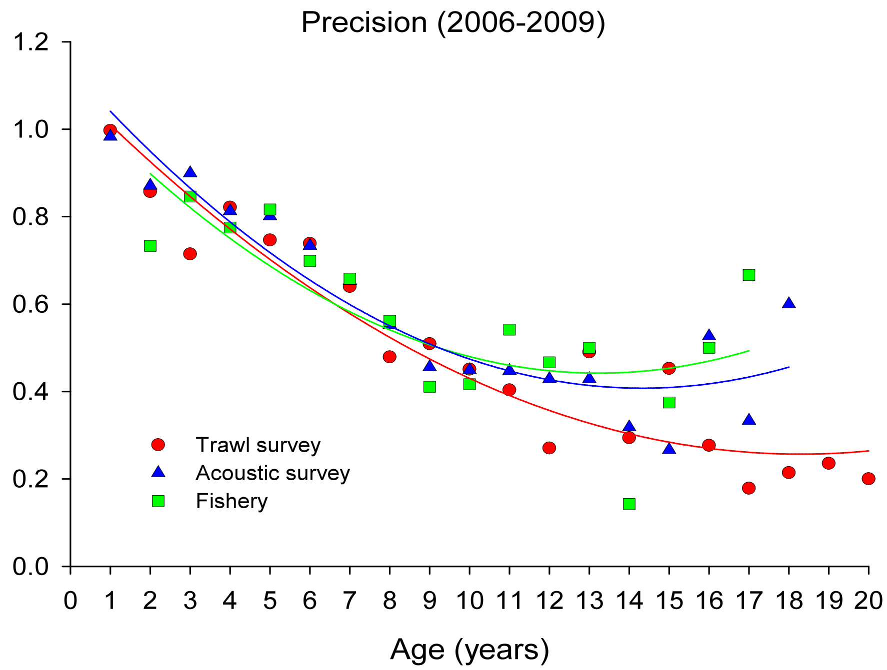
The observer sampling scheme is designed to prevent autocorrelation in samples of length and age data when sampled from hauls within the same area or on the same trip and is appropriate for its task. The applied protocols have been evaluated using bootstrap sampling, reviewed internally and externally and modifications been introduced when required. The methods applied to sample catches are considered appropriate and the analysis and reviews of the sampling schemes allows testing of alternatives, especially if restricted by costs in the future.

Observer coverage also provides information on the bycatch of other fish species and marine mammal and bird by catch. The utility and quality of the information provided by the program is reflected in the use that the industry is making of the real time records of catches and bycatch to determine its own strategies within the Sea State project. Sea State uses the observer data to provide feedback for closing areas of high bycatch and controlling the problem at source, in real time. Collaboration at this level reflects confidence of industry in the data, which they are part funding, and invokes useful discussion as to how to resolve complex issues in which they are highly experienced participants. The reduced sampling levels for the smaller vessels could be a potential weakness as behavior and or fishing location may change with an observer on board, however, under the new Chinook salmon bycatch regulations (TOR(e)) observer coverage is to be extended to all vessels from 2011 which will result in detailed information on the behavior of the smaller vessels.

Age and length

As outlined in the previous section, the sampling for length and age is controlled by protocols established to prevent autocorrelation in samples from influencing the results; the procedures for collection of otoliths and length samples are considered appropriate.

A presentation to the review team on the ageing of pollock outlined the techniques used to read the ages of fish. Several techniques are available to determine otolith age, a combination of surface reading, breaking or slicing followed by burning or baking in an oven to char the edges. Otolith readers are allowed to choose the approach that they use, as suits them. The figure below taken from the AFSC presentation shows the level of agreement between readers, recorded within the quality control process.



The figure highlights two issues that give major cause for concern:

1) Overall the level of agreement between readers is very low after age 5. Within the European ageing program a stock which has less that 70% agreement is classified as having poor quality ageing information. The majority of pollock ages have less than that level of agreement and this seems very low for a stock that experiences very strong annual temperature fluctuations.
2) There appears to be a marked difference in the level of agreement at the oldest ages between the source of the otoliths. Trawl survey otoliths have the lowest level at 20%, markedly lower than the fishery and acoustic values which average around 50%.

In the current assessment although ageing error has previously been modeled within the fit function for the catch data, the lack of agreement in the ageing process is currently not included. Given that the management of this stock under Tier 1 of the management plan requires that there is a reliable pdf of F_{MSY}, I would recommend in the short term:

1) Reinstatement of the transition matrix allowing ageing error in the model fit. This should be preceded by an investigation as to whether the apparent difference in the level of agreement between data sources is real. If it is established that it is, then a transition matrix would be needed for each data source.
2) A full statistical analysis as to the extent to which different methods for reading otoliths have resulted in the differing levels of agreement. The readers are allowed to choose their own method for reading an otolith, this choice may add noise and or bias to the reading process both of which need to be quantified.

3) Initiation of study into the potential for improved levels of agreement from alternative methods of ageing pollock.

The reading of the pollock ages was the weakest area of the CIE review of the stock assessment data raising procedures. It is of key importance to the analysis and especially the production of the pdf of F_{MSY} required for the management plan. If a more accurate method of reading ages cannot be found then it is essential that statistically reliable estimates of the transition matrix (which should be reintroduced to the assessment model) are developed for each year. This could require more otoliths to be read each year.

Substantial amounts of money and time are spent in collecting catch and survey data and designing the optimum sampling schemes for length, age and spatial coverage etc. Therefore, allocating a small part of that towards developing an age reading technique that is standardized between readers and which improves the very low level of agreement could provide a good return.

Fishery independent data

The bottom trawl survey

A presentation to the review team described the Eastern Bering Sea Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources (BTS), covering its history, design, standardization, catch characteristics, the measurement and effect of environment and future developments.

The bottom trawl survey is designed to provide data on 20 species for which there is a good time series of sampling from the area. The gear design changed in 1982 with no inter-calibration. Additional stations were added for crab samples in 1987 and the survey design has been constant since 1988. Sampling for pollock otoliths changed in 2006 to allow for expected catch rates by area. The survey design is standardised in terms of the trawl gear used, the time and method of deployment, the vessels used to conduct the survey and the sampling procedures. Each year a survey report is produced detailing catch results, environmental conditions. Sample reports were made available to the review team.

Indices are calculated at age per unit swept area based on survey strata. Studies have established that the spatial distribution of catch rates is related to the distribution of bottom water temperature in the year of the survey. Other studies have also highlighted diurnal movement of pollock into the water column at night, similarly a spatial distribution related to light intensity and depth has been observed. Restrictions to fishing in daylight hours allow for potential diurnal changes in catchability, ongoing research is being conducted to determine linkages that can be used to improve the precision of estimates of pollock abundance.

A known “weakness” of the bottom trawl survey is that there is a dip in catchability from age 1 to ages 2 & 3 with a reappearance at age 4; which is considered to be movement of fish of the “missing” ages into the water column above the 2 metre headline height. They are observed in the water column by the acoustic survey in alternate years. A consequence of this behavioural change is that large year classes are first observed at age 1 but then have greater uncertainty associated with them at ages 2 and 3 (in years in which the acoustic survey is not conducted) until they are observed again at age 4, an age at which in the most recent year they have made an important contribution to the catches and spawning biomass.

The Acoustic-Trawl Survey

The design and performance of the Eastern Bering Sea Acoustic-Trawl Survey were discussed following presentations on the general acoustic survey program for the Bering Sea and the specifics of the 2009 survey. The survey is conducted biennially, although recently there have been a series of consecutive years, and at the same time of year as the BTS. The survey area is less than that of the bottom trawl survey, in deeper water to the southwestern edge of the BTS range, covering the majority of the pollock distribution. In six survey years it has been extended to cover the northwest where it has entered into Russian waters providing information on the portion of stock in that area (<1% in 2009).

Catch rates are dominated by juvenile fish which are located predominantly in the water column during the daylight hours when survey data are collected; adults are located closer to the sea bed. Biomass is estimated from the surface to 3m from the bottom for the assessment index. The survey catch rates show an inverse relationship to the BTS having higher proportionately catches at ages 2 & 3 which are generally very low in the trawl survey.

As with the BTS swept area estimates, recent total Eastern Bering Sea pollock biomass has been declining and currently values are estimated to be at the lowest in the time series. Due to the recent continuation of the survey in all years since 2006, the acoustic survey has been able to track the progress of the relatively stronger 2006 year class at ages 2 and 3 in the stock, providing greater certainty as to its recent contribution to the stock.

An active research program is being conducted by the acoustic research team to reduce uncertainty and bias in the indices of abundance. This includes: comparison of estimated biomass levels between older and newer, noise reduced, vessels; extending the biomass integration to the seabed using species and size composition data from the BTS; and acoustic estimation of plankton biomass, especially Euphasids.

An area of research presented to the review team that will clearly help the assessment of pollock in the gap years, when the research vessel is not available, is the derivation of acoustic backscatter estimates of pollock biomass obtained from the commercial vessels chartered to conduct the bottom trawl survey. Comparison of pelagic biomass estimates obtained from the commercial vessels with recent acoustic survey results has shown good correlation - tracking the recent decline in pollock biomass.

The survey design is standardised in terms of the gear used, the timing and depth of data used in the integration, the vessels used to conduct the survey and the trawl sampling procedures. Each year a survey report is produced detailing catch results, environmental conditions; example reports were made available to the review team.

Comments on fisheries independent data program

The research being conducted for both survey programs is directly relevant to the assessment of the pollock stock and I am sure is providing invaluable input for other species and stocks. The teams are aware of the need to provide standardized indices for stock assessment as well as the requirement for improvement of the utility of the data that they collect. Their studies and analysis are based on good scientific and statistical science which is often supported by research papers reporting and disseminating their results and developments. The presentations indicated a good understanding of the team's role the current assessment and management process and how future developments could be used to support ecosystem research and management. The research studies being conducted were relevant and focussed, the team's enthusiasm for their research and drive to provide improved information for this stock and its ecosystem was clear and very refreshing.

TOR (b) The level and adequacy of knowledge on pollock stock structure, biology, and life history.

Stock structure and life history

Presentations and discussions covered the genetic structure of the pollock stock in the Bering Sea and potential stock structure and migration patterns inferred from seasonal commercial and survey catch rates. There is a good understanding within the assessment and monitoring teams with regard to the general the biology and life history of the stock, and also of the current limits to their knowledge especially at the level required for detailed spatial management.

Three stocks of pollock stock are identified for management: the Eastern Bering Sea; the Aleutian Islands Region; and the Central Bering Sea Bogoslof Island pollock. The Bogoslof stock is considered to form a distinct spawning aggregation that has connection with the deep water region of the Aleutian Basin. Genetic studies show little to no definitive isolation, although there are weak differences at a large scale, indicating that there must be some exchange between the currently defied stock units.

The conclusions were presented from a recent Pollock Movement Workshop which identified methods for further differentiation of stock structure and migration patterns inferred from seasonal patterns in commercial and survey catch rates and the design of future tagging programs. To date there is no information that would lead to recommendations for changes to the stock units currently used for management. However, there is a clear drive within the AFSC research program to gain a greater understanding of the seasonal movement stock units through research studies of survey information, the behavior of fishers and spatial changes in catch rates. This program will lead to improved understanding of the system within which pollock is fished and improved spatial management advice in the future.

Natural mortality

The assumed values of natural mortality are higher for young fish (ages 1 and 2) decreasing to a constant 0.3 for ages 3 and above. In 2009, AFSC hosted a workshop on natural mortality estimation; age and length based natural mortality estimates were derived for pollock, which were similar to the youngest and oldest ages used in the assessment but larger for middle-age groups. The reference assessment model values were selected because studies have found that specifying a conservative (lower) natural mortality rate is typically more precautionary when natural mortality rates are uncertain. This is approach is discussed further in the modeling section (TOR(c)) and the final section (TOR(f)).

Maturity

The assessment maturity at age estimates have been reviewed recently based on samples collected during 2002 and 2003. Values equivalent to those that had previously been used in the assessment were recorded.

TOR (c) Evaluation, findings, and recommendations of the analytical approach (application of a statistical ADMB integrated catch-age model) used to assess stock status and estimation/presentation of uncertainty including MSE approaches.

General

Presentations and discussions covered the data to which the assessment model if fitted including error structures and assigned variance levels, the model forecast assumptions and algorithm and the model output.

The drive and enthusiasm of the assessment team is commendable, the science is high quality and well ahead of the majority of fisheries management areas that I have been involved with. Research is ongoing and there is a regular output of peer-reviewed publications linked to the assessment. The stock assessors are aware of the data gathering and collation studies that are being undertaken to provide and improve the information on the stock, and its environment, and consequently the potential linkages to future model developments and the provision of more detailed management advice.

The assessment data

The data to which the assessment model is fitted are discussed under TOR(a and b) these included total catch and survey numbers at age and the proportions of numbers at age in each year. External estimates of weight, maturity and natural mortality at age are also fitted; average values of each are used in the forecasts for management. A study presented and discussed at the review indicated that the optimum performance for predicting future weight at age was based on a 10 year average.

The assessment model

General

The assessment model is described in the assessment report and background documents provided. The model has a long, ongoing history of development which has improved the estimates of management metrics and their variance as required for the Tier 1 management process. Some of the background, and several of the points raised by the reviewers, is reported within previous reports and assessment papers, which reflects the volume of research that has been conducted in the model development process. The assessor was able to provide details when requested and sensitivity runs requested by the review team were produced as required during the review process. It was noticeable that the assessment and review process places a heavy load on a key assessor for this stock – he should avoid buses.

Model framework

The framework in which the model has been developed is suited to the current model structure and future developments; the code has recently been reviewed externally and the review provided as part of the background documentation. Discussions with the assessment team covered the fit of the model to the data, the structure of the model and the output from the most recent assessment in comparison with previous assessment results and advice.

It was noted that in recent assessments, estimates and their uncertainty have been provided from the likelihood fits to the data, whereas reference levels for the management HCR were determined using full MCMC simulations. A suggestion was made to carry out a full MCMC for the final model fit each year in order to ensure consistency.

Ageing errors

The approach to modeling of the catch at age and survey data are considered appropriate in that the proportions at age and the total catch numbers are considered separately. However, as discussed under TOR(a) the lack of agreement in the age reading of otoliths needs to be considered within the model structure. An error matrix has been used in previous assessment models and should be considered again.

A sensitivity run introducing an error matrix common to the catch at age data and surveys and constant across all years was trialed at the review; based on a previous year's assessment model. The results, presented to the review team during the meeting, established that there is no major sensitivity in the estimates of the harmonic and arithmetic mean fishing mortalities to the additional error. Further investigations should examine the sensitivity of the pdf required for the Tier 1 HCR to the errors.

Given the difference in the ageing errors from each data source noted previously, there may be a requirement for separate age matrices for the catch data and individual surveys and for additional samples each year to construct the matrices; in addition variation in the error in time e.g. related to year class strength may be an important factor and should be investigated in the raw data if possible.

Selection at age

Modeling of the selection at age for the fishery has evolved with time. Currently the model fits a selection at each age in each year, with values constrained from year to year by a random walk. This is a model structure that has been used in other assessment areas and the justification for its use for this assessment is well documented and was described within the review. However, the model is highly parameterized and some of the noise in the data capture process may lead to artificial estimates of change in selectivity and consequently target reference level, which is also evaluated annually. A request was therefore made for the model to be fitted with lower levels of random walk variability, effectively decreasing the model degrees of freedom. The results of the sensitivity runs were presented to the review team in the additional runs document, and they indicated relatively little sensitivity in the fishing mortality estimates of the final year to the constrained selection; an indication that fitting all of the current parameters in the model is not resulting in changes to the point estimates. Further evaluations would be useful to establish the sensitivity variance of estimates, particularly the pdf of F_{MSY}, as used in the management plan, to the constraint.

Acoustic survey uncertainty

The assessment report appears to note that the acoustic survey is assigned a constant 20% c.v. (presumably for all years), but does not state a) why this has occurred; b) whether this is an area for development or research (given that annual errors are estimated within the survey analysis); and c) how sensitive the model estimates and the management reference levels are to this assumption.

The stock and recruitment model

The stock and recruitment model fitted in the assessment is not specified directly in the assessment text. References are made, within the assessment model details section, to re-parameterization of the Beverton–Holt model to allow for the use of a steepness parameter. The Ricker model parameterization is also discussed, but the final choice of model could not be found.

It is assumed that the Ricker formulation is used, based on Figure 1.37, as recruitment declines at high stock abundances and the Beverton-Holt model should not take this form. Substantial amounts of cannibalism are referred to within Ecosystem Considerations section of the report and it is assumed that this led to the choice of model. A clearer section on model selection would be helpful.

Stock and recruitment model fitting is also discussed below and under TOR(f)

Diagnostic output

The main difficulty in reviewing the assessment report is that some of the information required for evaluation of the model fit and determination of the levels of mortality was missing:

1) standardized catch residuals for the commercial and survey fits;
2) a table of fishing mortalities at age;
3) weights at age for the youngest ages.

This seems to be the result of familiarity with the assessment and a requirement to produce a report describing the history of the fishery and assessment for the SAFE process and managers, rather than a lack of process. A standard assessment report which provides specific details on the fit of the model for each component with standardized residuals, profiles of the likelihood and routine outputs is recommended even if it does not feed into the downstream management report; it would ease the pressures on the assessor as well as making the review process more routine. It would also allow the consequences of changes to the model structure to be evaluated in comparisons with historic assessment reports.

Conservative model fits for stock and recruitment and natural mortality

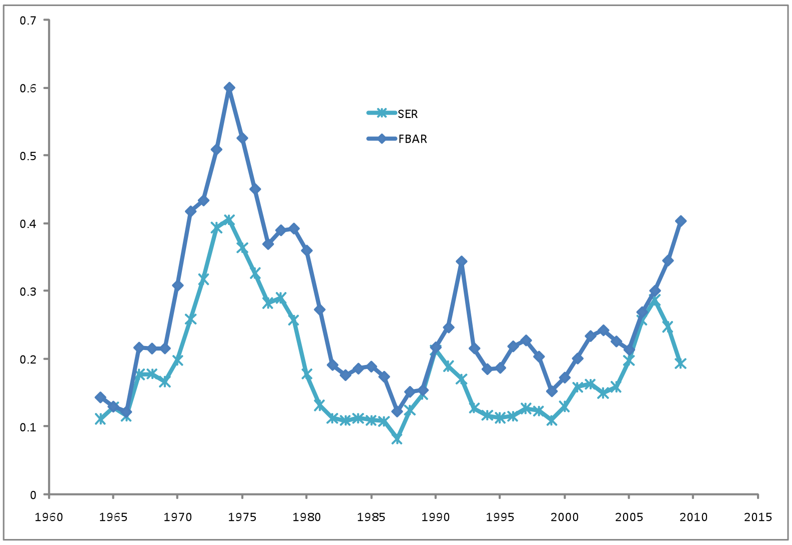
Selection of a conservative model constraint - the prior on steepness in the stock and recruit curve - and a conservative value for an externally estimated natural mortality parameter for the mid range ages, are both highlighted within the discussion of the assessment model structure. Conservative approaches to parameter estimation have been questioned in some areas (ICES, IWC), where it is generally considered that parameter estimates should be based on the best model fit to the available data and the management harvest strategies applied to the stock should then be designed to be precautionary (conservative) by allowing for uncertainty and/or potential bias. The current procedure for the assessment and management seems to be applying two levels of precaution - within the assessment and also within the management. This is discussed further under TOR(f) further work.

Reference levels of fishing mortality

The assessment results are consistent with the fisheries independent survey trends of total biomass in indicating that the biomass is at or near to the lowest level in the time series. Recent recruitment has been low but indications are that the improved 2006 year class will provide some rebuilding.

A major concern of the review team was the use of the spawning exploitation rate (SER) as the single metric reflecting the rate at which fishing is occurring. SER is a calculation of the amount of spawning that is forgone during the fishing year (approximately a weighted index of the exploitation rate). As pointed out by Thompson (1996), it can be heavily influenced by strong or weak year classes passing through the age structure, which is the case recently.

The figure below illustrates the time series of the SER as estimated for the pollock stock and also the average fishing mortality across all ages (FBAR). The two time series track each other well until an aberrant year class follows a period of stable recruitment. In both the early nineties and recently a series of low recruitments have been followed by a strong year class. The effect of the strong year class is to weight the fishing mortality towards low selection, at the youngest ages. In the most recent years the SER has therefore given the impression that overall fishing mortality has been decreasing, whereas in actuality it has been increasing at all ages during the last 4 years.



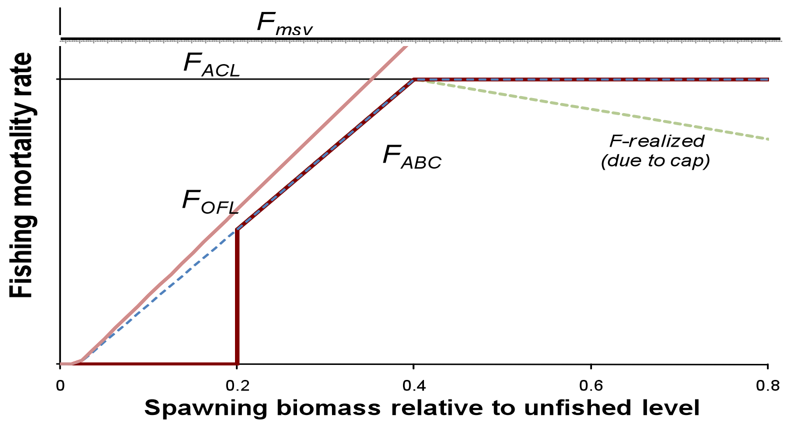
The change in exploitation rate to achieve the management target is based on the fishing mortality relative to F_{MSY} and therefore does not suffer from the year class effect. However, the impression of a declining exploitation rate as presented to managers and stakeholders, compared to an increase at all ages in recent years is problematic and has caused some of the problems referred to in the OCEANA submission to the review.

TOR (d) The appropriateness of the harvest strategy used by the North Pacific Fishery Management Council (including uncertainty adjustments).

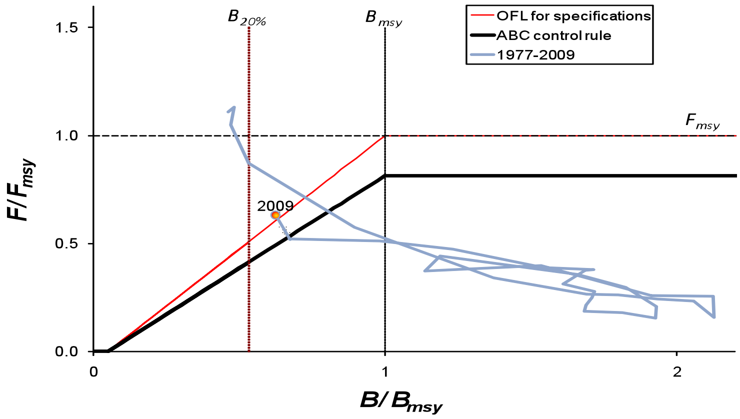
Presentations and discussions covered the overall management system within which the pollock harvest strategy is defined and enacted; the assessment and management review process for all stocks; the structure of the pollock harvest control rule in terms of targets and overfishing definitions; the linkage between the model output and the control rule structure and the historic and potential dynamics of the stock under the rule.

The current HCR structure

Generically the concept of a harvest strategy (HCR) based on a Tier system classification of the quality of the information available for a stock, is appropriate and is becoming more frequent in control rules designed for fisheries. The harvest strategy for pollock (copied in the figure below) is constructed from sound theoretical reference levels for fisheries systems assumed to be in equilibrium. Overfishing (F_{OFL}) and target (F_{ABC}) fishing levels have been defined based on a framework which considers the uncertainty of the estimates of stock metrics and the reference levels. A reduction in fishing mortality below B_{MSY}, 40% of the estimate of the un-fished level of spawning biomass is used to reduce exploitation at low stock sizes; the fishery is closed at B20%, 20% of the un-fished biomass under ecosystem considerations that allow prey for sea lions.



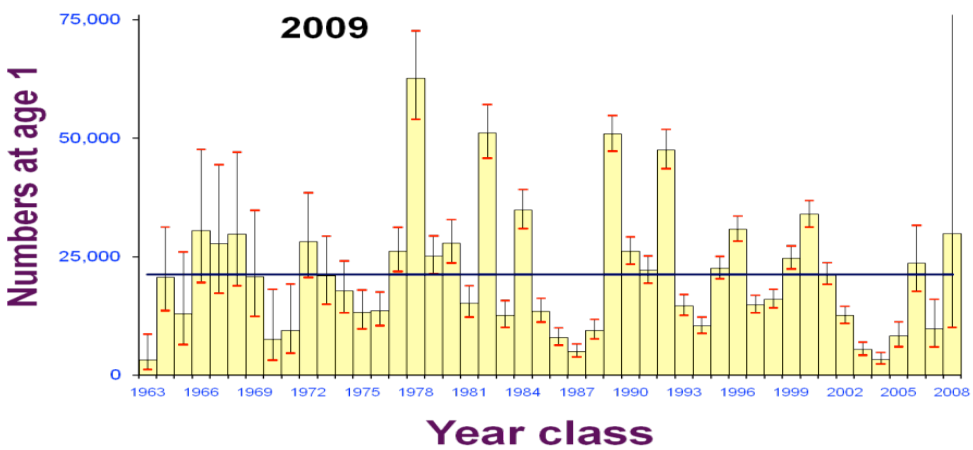
A concern arises when the above rule is compared to the actual trajectory of relative exploitation rate and resulting biomass that has actually occurred during the assessed time series for the pollock stock as reported within the assessment document.



Apart from the initial and recent years of the time series, fishing mortality has been well below the target level as a result of the cap on total catch across all species; the resulting spawning biomass remained well above B_{MSY}. However, even though the mortality rate has remained well below the target level, following a series of four years with low recruitment to the stock, there has been a substantial decline in the SSB to just above the level at which the fishery is required to be closed. If fishing mortality had been higher in recent years, at or close to the target values, it might have been expected that the biomass decline would have been more substantial and the fishery closed. This suggests that although a HCR based on the theoretical equilibrium population structure might be expected to perform well, in reality the current structure could lead to closure of the fishery with greater frequency than would be expected.

The time series of recruitment that has led to the substantial decline in SSB at the current exploitation rates is copied from the assessment results below. Five years of poor recruitment with one average year have been recorded since 2002. A similar pattern of recruitment was recorded from 1981, therefore such sequences have occurred before and are likely to again. The response of the stock to such a sequence of recruitment at lower levels of exploitation than defined by the HCR, suggests that the HCR is not robust to autocorrelation resulting from sequences of low recruitment and that, had recent fishing mortality levels been closer to the specified target values, the consequences for the fishery would have been far more severe.

Consequently it is suggested that an evaluation of the HCR is conducted in which autocorrelation is built into the generated recruitment series in order to evaluate the performance of the current HCR with recruitment series that approximate the observed series rather than based on random re-sampling from a fitted equilibrium curve.



Environmental change

The HCR has been defined to be relative, rather than using absolute values. Changes to the environment would be expected reflected in altered growth and maturity rates and will therefore be factored into the derivation of F_{MSY} and B_{MSY} each year, an example being if productivity declines with increasing temperature. A presentation examined the consequences for the fishery and future management decisions that may result from environmental change. The work examined the structure of the harvest control rule in terms of each of its constituent components and their influence on the outcomes for the fishery in terms of yield, probability of closure and for the stock in terms of long term SSB. Studies such as this are essential to inform management and industry of the likely consequences of the chosen harvest strategies.

B20%

Discussions with the assessment and management teams raised the issue of B20%, given that it is such a severe transition point in the HCR and that the stock is estimated to be close to that value. B20% is the biomass of pollock that is deemed necessary to support the ecosystem predators, specifically Steller's sea lions. However, the value of B20% is independent of the population abundance of sea lions, and therefore could be the same level pollock abundance for a high or a low abundance of sea lions. This lack of dependence is surprising given the critical nature of the threshold to the pollock fishery (and potentially sea lions). If the current B20% threshold is immovable, it is suggested that a differing transition towards this level within the HCR is sought such that the fishery does not suffer the consequences of a sudden closure if it can be avoided. The assessment and management teams are aware of the problem and work such as that conducted in the previous section is addressing the issue.

OCEANA open letter

The issue of B20% was also raised in a submission to the review by OCEANA with is discussed in Annex 1.

TOR (e) Whether harvest strategy is adequate within an ecosystem approach to management (e.g., bycatch, importance of pollock as forage).

Ecosystem indicators and models

A presentation and subsequent discussions reviewed the ecosystems chapter within the SAFE report to management and the role of the pollock stock and its fisheries within the Bering Sea ecosystem.

Apex predator biomass has been stable for a number of years, although the summation hides a decline in cod and an increase in arrow tooth flounder. The biomass of all forage fish recorded within the Bering Sea ecosystem is low compared to historic levels. A significant part of the decline is that of pollock which dominates the system. The reasons for the decrease are unclear but most likely a result of lower recruitment and or productivity in the current environment. All stocks within the management program are estimated to be sustainably fished and have biomasses above target levels.

Presentations to the review showed the time series of indicators of individual species status and summary metrics currently under development. The development of ecosystem advice and an ecosystem management strategy is at a very early stage. Observations of developments in the productivity of species that affect the pollock stock dynamics (e.g. zooplankton) or which are affected by it (e.g. arrowtooth flounder) are considered within the process leading to the final advice from the SSC. Such considerations are appropriate and a significant advance on fisheries advice from other areas. The consequences of the final advice in terms of quantitative projections are beyond the current development of ecosystem models but the development of integrated ecosystem models, such as FEAST, which was discussed at the meeting, will help to indicate trends and sensitivities.

Salmon bycatch

Presentations reviewed the current salmon bycatch regulations and the recent discussions and developments, including the introduction of bycatch quotas per vessel, restricted areas and the introduction of additional observers on smaller vessels. Representatives from the industry discussed the use by the industry of real time observer reports within the Sea State program.

The salmon bycatch data collection and analysis were presented to the review. Linkages have been made to temperature, fleet behavior, salmon abundance, season and spatial location of the fishery. Recommendations have been made and an agreed management plan based on individual vessel quotas imposed. Observer coverage is to be extended to smaller vessels and the industry has become involved in the process through an analysis of the observer data used to help them track uptake within the Sea State real time observer data program. A program of real time closures has been developed with a bycatch ceiling for each vessel. For chum salmon in the B season closed areas may be more effective and these are being developed.

No linkage of the numbers of salmon bycatch to potential partial fishing mortalities in the combined or individual salmon stocks was presented so that an evaluation of the current salmon mortality rate resulting from the pollock fishery could not be made. Consequently, the effects of, for instance, halving of the numbers caught in the next few years cannot be quantified; it could result from the new measures or from poor salmon recruitment years. An assessment of the scale of the problem in relation to the costs involved in gathering the data and the costs in loss of pollock yield would have been instructive.

The pollock harvest strategy within an ecosystem approach to management

The current pollock harvest strategy, which is designed to reduce exploitation as the biomass declines below B_{MSY}, will reduce fishing effort and thereby bycatch mortality rates as the pollock biomass declines. Therefore it can be concluded that the impact on other species will be reduced but, within an ecosystem context, the eventual consequences cannot be determined without information on the links to the other populations affected. The work conducted by the teams working on ecosystem dynamics, multispecies effects and the salmon bycatch will highlight the links and the directions and magnitude of the changes. The work could lead to the development of new or modifications to the current harvest policies that will relate to the pollock fishery and its impact, but it is too early to conclude as to how the harvest rate will change based on the final outcome of the studies. Retaining at least B20% of the stock within the environment will help to maintain the ecosystem and based on the observations that: forage feeder production dynamics seem to be linked (probably through environmental controls) and that the pollock contribute a large part of the forage feeder biomass, and maintaining a significant part of the biomass will contribute to ecosystem health in its broadest sense. In general managing individual stocks to B_{MSY} or above is considered a suitable first approximation towards good ecosystem management.

TOR (f) Recommendations for further assessment improvements for management in both the long and short term

A number of recommendations have been made within each TOR and they are drawn together and elaborated here.

Ageing

Overall the level of agreement between readers is very low after age 5. Within the European ageing program a stock which has less that 70% agreement is classified as poor quality ageing information. The majority of pollock ages have less than that level of agreement and this seems very low for a stock that experiences a very strong annual temperature fluctuation. There appears to be a marked difference between the source of the otolith and the level of agreement at the oldest ages. Trawl survey otoliths have the lowest level at 20%, markedly lower than the fishery and acoustic values, which average around 50%.

The reading of the pollock ages was the weakest area within of the CIE review for the stock assessment it is of key importance to the analysis and especially the production of the pdf of F_{MSY} required for the management plan. If a more accurate method of reading ages cannot be found then it is essential that statistically reliable estimates of the transition matrix (which should be reintroduced to the assessment model) are developed for each year. This could require substantially more otoliths to be read. Substantial amounts of money and time are spent in collecting catch and survey data and designing the optimum sampling schemes for length, age and spatial coverage etc. Therefore, allocating a small part of that towards developing an age reading technique that is standardized between readers and which improves the very low level of agreement could provide a good return.

Stock Assessment

Staffing and assessment reports

It was very obvious throughout the review that there was a heavy reliance on a key stock assessor for the production and presentations of the assessment and it output. This reliance on one person could present problems and result in an excessive workload at key times especially when the stock declines towards B20% and the pressures for evaluations and reviews increase.

One way in which the workload could be reduced is to separate the information within the assessment report into two documents; currently the report has a split personality. It tries to present the technical aspects of the new data sets available each year from the surveys and observer program, the diagnostics from the model fit to the data and projections and also provide a non-technical summary of the output for managers and the SAFE report. It cannot provide the full set of details required for a full review of the model and summarize the background to the assessment and consequences for management without being too large to produce each year. An approach that has been used elsewhere is the production of an annual technical report that can be used by reviewers and a summary report for managers that can be updated with new information each year if it is available and relevant. A lot of what is required for the technical report can be automated output which would have produced the tables that were not available in the current review document (fishing mortality at age, standardized residuals for the catch and survey components) reducing time and stress on the assessors.

The exploitation metric presented for management

A major concern of the review team was the use of the spawning exploitation rate (SER) as the single metric reflecting the rate at which fishing is occurring. SER is a calculation of the amount of spawning that is forgone during the fishing year (approximately a weighted index of the exploitation rate). As pointed out by Thompson (1996), it can be heavily influenced by strong or weak year classes passing through the age structure. This is the case recently where the SER which has been weighted towards the youngest ages in the selection range due to the 2006 year class, which is dominating the stock structure.

The impression of a declining exploitation rate given by the SER, as presented in the assessment report, compared to an increase in exploitation rate at all ages in fishing mortality rate is problematic and has caused some of the difficulties referred to in the OCEANA submission to the review.

Conservative model fits for stock and recruitment and natural mortality and Bayesian estimation of probability densities

Selection of a conservative model constraint - the prior on steepness in the stock and recruit curve - and a conservative value for an externally estimated natural mortality parameter for the mid range ages, is highlighted within the discussion of the assessment model structure.

Conservative approaches to parameter estimation have been questioned in some areas (ICES, IWC), where it is generally considered that parameter estimates should be based on the best model fit to the available data and the management harvest strategies applied to the stock should then be designed to be precautionary by allowing for uncertainty and potential bias. The current procedure for the assessment and management seems to be applying two levels of precaution, within the assessment and also within the management.

The management of this stock under Tier 1 of the management plan requires that there is a reliable pdf of F_{MSY}. The current pdf could be considered to be a constrained estimate due to the prior restriction on the steepness of the stock and recruit curve. I would have preferred to have seen an evaluation of the effects of this on the model estimates in order to determine the effects of the constraint, especially on the structure of the pdf and the consequences for management. This may be available in previous studies but should be produced as and when the model structure is revised, for instance the recent change to annually varying selectivity.

In addition to the constraints applied, the full Bayesian assessment has not been fitted for the estimation of parameters and the pdf of the management metrics since the model structure has been revised. Although, the model is considered to estimate the pdf appropriately, the B20 etc were based on the full Bayesian assessment and therefore it is perhaps appropriate that full MCMC should be applied for the final assessment each year, especially when the stock is close to the reference levels.

Management plan evaluation

A recommendation for a full management plan evaluation is based on a series of observations from the review process.

The first observation concerns the decrease in stock biomass when the exploitation rate has been low throughout the recent time period in comparison to the target levels required by the management plan. Apart from the initial years of the time series, fishing mortality has been well below the target level as a result of the cap on total catch across all species; the resulting spawning biomass remained well above B_{MSY}. Even though the mortality rate has remained well below the target level, following a series of five years with low recruitment to the stock, there has been a substantial decline in the SSB to just above the level at which the fishery is required to be closed. If fishing mortality had been higher in recent years, at or close to the target values, it might have been expected that the biomass decline would have been more substantial and the fishery closed. This suggests that, although a HCR based on the theoretical equilibrium population structure might be expected to perform well, in reality the current structure could lead to closure of the fishery with greater frequency than would be expected.

The second observation is that research from the groups studying the pollock have raised a number of questions that could be tested within a simulation study to evaluate the sensitivity of the model estimates and the outcome of the harvest control rule to their effects. In a similar format to that presented for TOR(d) to the review on modifications to the HCR in the context of environmental effects, the evaluation could follow a similar structure to that conducted by the IWC using a simulated population from which samples are taken. Some suggestions for the study would be:

1) The sensitivity of the stock and fishery outcomes to autocorrelation in recruitment rather than based on random re-sampling from a fitted equilibrium curve.
2) The assumptions concerning natural mortality.
3) The steepness assumption in the stock and recruit curve.
4) The use of MCMC sampling each year in the estimation of the pdf for msy.
5) The lack of agreement in ageing pollock.
6) The assumption of independence in the acoustic and bottom trawl survey series.

Such a study would keep at least one PhD, post doc quiet for a while. Whilst the study would not a definitive answer to all issues, especially as modeling the cap on total catch in the Bering sea would be problematic as well as the salmon bycatch restrictions, it would highlight key areas of model and HCR sensitivity that could be addressed by modifications to the rule; in my opinion especially (1). By linking the outcome to the current studies into the economics of the fishery it will help to inform managers as to the costs and benefits of changes.

Annex 1: An open letter to the review from OCEANA

A submission to the review by OCEANA was considered at the meeting. John Warrenchuk of OCEANA presented the issues and time was set aside in order that the questions could be addressed by the assessment and management teams and the responses discussed.

The main concern form OCEANA was that the management process was failing to ensure enough pollock remain in the Bering Sea to spawn, rebuild the pollock stock, provide prey for endangered Steller sea lions and Northern fur seals, and provide for an ecologically sustainable pollock fishery.

The points raised were related to the estimation and presentation of uncertainty in the stock biomass, the recent revisions in the assessment estimates due to uncertainty in the magnitude of the 2006 year class and what they considered to be high levels of current exploitation rate. Each of the issues was discussed in the review and explanations provided.

Part of the problem has been the decreasing estimate of the 2006 year class which is not expected to contribute as much biomass as was previously forecast; the forecasts for future biomass have therefore not been achieved in subsequent years. In addition the average fishing mortality metric used as a standard for the assessment, spawning exploitation rate, has declined in recent years whereas actual fishing mortality has increased; as discussed in TOR(c) this is related to the current stock structure and needs to be highlighted in presentations.

Appendix 1: Bibliography of materials provided for review

Key documents

Stock assessment and Fishery Evaluation (SAFE) report, 2009 Eastern Bering Sea pollock

Other links

All 2009 Alaska groundfish assessments
2009 BSAI Groundfish Plan Team Summary
2010 - 2011 NPFMC TAC/ABC Recommendations

Past reviews

1995 REFM External review of EBS pollock
1996 Oceana review of EBS pollock (Ludwig)
2000 CIE Review of EBS pollock (Stokes)
2009 Greenpeace review of EBS pollock model (by Steve Martell, UBC)
Compilation of SSC and Plan Team comments on the assessments (extract from meeting reports)

Management, observer program, etc

North Pacific observer program's 2010 Observer Sampling Manual
Cahalan, J, J Mondragon, and J Gasper. 2010. Catch sampling and estimation in the Federal groundfish fisheries off Alaska, 42 p. Online
Barbeaux, S. J., S. Gaichas, J. N. Ianelli, and M. W. Dorn. 2005. Evaluation of biological sampling protocols for at-sea groundfish observers in Alaska. Alaska Fisheries Research Bulletin 11(2):82-101. (Online)
Ianelli, J.N. 2005. Assessment and Fisheries Management of Eastern Bering Sea Walleye Pollock: is Sustainability Luck Bulletin of Marine Science, Volume 76, Number 2, April 2005 , pp. 321-336(16)
NPFMC Fisheries management plan. http://www.fakr.noaa.gov/npfmc/fmp/bsai/BSAI.pdf
Report of the 2002 Harvest strategy review and AFSC comments on 2002 Harvest Strategy Review
Technical Guidance on Precautionary Approach and NS 1
Salmon EIS: http://www.fakr.noaa.gov/sustainablefisheries/bycatch/default.htm)

Survey documents

Lauth, R. R. 2010. Results of the 2009 eastern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate resources, 228 p. Online
Kotwicki, S., T.W. Buckley, T. Honkalehto, and G. Walters. 2005. Variation in the distribution of walleye pollock (*Theragra chalcogramma*) with temperature and implications for seasonal migration. Fish. Bull 103:574–587.
Honkalehto, T., N. Williamson, D. Jones, A. McCarthy, and D. McKelvey. 2009. Results of the Echo Integration-Trawl Survey of Walleye Pollock (*Theragra chalcogramma*) on the U.S. and Russian Bering Sea Shelf in June and July 2008. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-194. http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-194.pdf .
Ressler, P. T. Honkalehto, R. Towler, amd C. Wilson. 2008. Using acoustic data from vessels of opportunity to estiimate walleye pollock abundance in the Eastern Bering Sea. ICES CIEM SEAFACTS International Symposium on the Ecosystem Approach. Bergen, Norway, June 2008.
von Szalay PG, Somerton DA, Kotwicki S. 2007. Correlating trawl and acoustic data in the Eastern Bering Sea: A first step toward improving biomass estimates of walleye pollock (*Theragra chalcogramma*) and Pacific cod (*Gadus macrocephalus*)? Fisheries Research 86(1) 77-83.
Walline, P. D. 2007. Geostatistical simulations of eastern Bering Sea walleye pollock spatial distributions, to estimate sampling precision. ICES J. Mar. Sci. 64:559-569.
Williamson, N., and J. Traynor. 1996. Application of a one-dimensional geostatistical procedure to fisheries acoustic surveys of Alaskan pollock. ICES J. Mar. Sci. 53:423-428.

Ecosystem

Ecosystem considerations: http://www.afsc.noaa.gov/REFM/docs/2009/ecosystem.pdf
Bering Sea Integrated Ecosystem Research Plan http://bsierp.nprb.org/
Jurado-Molina J., P. A. Livingston and J. N. Ianelli. 2005. Incorporating predation interactions to a statistical catch-at-age model for a predator-prey system in the eastern Bering Sea. Canadian Journal of Fisheries and Aquatic Sciences. 62(8): 1865-1873.

Other documents

NMFS workshop report on natural mortality (website: http://tinyurl.com/27grn7z)
Stahl and Kruse 2008a. Classification of Ovarian Stages of Walleye Pollock
Stahl and Kruse 2008b. Spatial and Temporal Variability in Size at Maturity of Walleye Pollock in the Eastern Bering Sea
Ianelli, J.N. and D.A. Fournier. 1998. Alternative age-structured analyses of the NRC simulated stock assessment data. In Restrepo, V.R. [ed.]. Analyses of simulated data sets in support of the NRC study on stock assessment methods. NOAA Tech. Memo. NMFS-F/SPO-30. 96 p.
Grant, W. S., Spies, I., and Canino, M. F. 2010. Shifting-balance stock structure in North Pacific walleye pollock (Gadus chalcogrammus). – ICES Journal of Marine Science, 67: 000–000.
Kimura, D.K., J.J. Lyons, S.E. MacLellan, and B.J. Goetz. 1992. Effects of year-class strength on age determination. Aust. J. Mar. Freshwater Res. 43:1221-8.
Wespestad, V. G., L. W. Fritz, W. J. Ingraham, and B. A. Megrey. 2000. On relationships between cannibalism, climate variability, physical transport, and recruitment success of Bering Sea walleye pollock (Theragra chalcogramma). ICES Journal of Marine Science 57:272-278.

Presentations

	Lead presenter
Introduction to the CIE Review of EBS pollock June 28-July 1 2010	Jame Ianelli
Genetic population structure of walleye pollock in the Bering Sea	Michael Canino
Ageing EBS Walleye Pollock stocks	Betty Goetz
Eastern Bering Sea Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources	Ken Weinberg
Eastern Bering Sea Acoustic-Trawl Survey Overview	Chris Wilson
The 2009 Acoustic-Trawl surveys of pollock	Taina Honkalehto
Using acoustic data collected by commercial fishing vessels to develop an annual index of abundance for walleye pollock in the eastern Bering Sea	Taina Honkalehto
Analyzing fish spatial and temporal distribution patterns using un-calibrated acoustic data from multiple vessels	Steve Barbeaux
Ecosystem modeling and ecosystem assessments in Alaska	Kerim Aydin
AFSC Observer Program	Martin Dorn
Age composition information and fishery data	James Ianelli
Summary of Eastern Bering Sea Pollock Management	Jane DiCosimo
Salmon Bycatch regulations and investigations in EBS pollock fishery	Diana Stram
Economic research	Lisa Pfeiffer
Assessment	James Ianelli
Harvest strategy comparison	James Ianelli
SAFE Guidelines	
December 2009 Letter from Oceana to NPFMC	John Warrenchuk

Appendix 2: The CIE Statement of Work

Attachment A: Statement of Work for Dr. Chris Darby (CEFAS)

External Independent Peer Review by the Center for Independent Experts

Eastern Bering Sea Pollock Stock Assessment and Management Methods

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.com.

Project Description: The Alaska Fisheries Science Center (AFSC) requests a Center of Independent Experts (CIE) review of stock assessments for the Eastern Bering Sea pollock stock assessment and management. The pollock fishery is large and the species involved is a key component of the ecosystem. The population dynamics characteristics and central role in North Pacific groundfish fisheries justify the need for periodic review of the scientific approaches for assessment and recommendations for management. Recent research projects studied movements, stock structure and reproductive ecology of pollock. The Bering Sea Integrated Ecosystem Research Program (BSIERP) funded a management strategy evaluation component that has the potential for guiding changes if needed in current management practices. A CIE review will provide timely feedback to these studies, and will be useful for the management of the Eastern Bering Ecosystem and fisheries. The ToRs of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

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 application of stock assessment, including population dynamics, separable age-structured models, harvest strategies, survey methodology, and the AD Model Builder programming language. They should also have experience conducting stock assessments for fisheries management. Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting tentatively scheduled at the Alaska Fisheries Science Center in Seattle, Washington during 28 June through 2 July 2010.

Statement of Tasks: Each CIE reviewers shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: 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) 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: If the panel review meeting is conducted 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 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: 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. The list of documents and background papers are provided at the end of this document

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.

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.

Other Tasks – Contribution to Summary Report: Each CIE reviewer may assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. Each CIE reviewer is not required to reach a consensus, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

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 in Seattle, Washington during 28 June through 2 July 2010, as specified herein.
3) LOCATION and DATES as specified herein, and conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than 16 July 2010, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to David Die ddie@rsmas.miami.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.

17 May 2010	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
7 June 2010	NMFS Project Contact sends the CIE Reviewers the pre-review documents
28 June – 2 July 2010	Each reviewer participates and conducts an independent peer review during the panel review meeting
16 July 2010	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
30 July 2010	CIE submits CIE independent peer review reports to the COTR
6 August 2010	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

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 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.

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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 the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, 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 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 weaknesses and strengths of the science reviewed, regardless of whether or not they read the 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: Terms of Reference for the Peer Review

Eastern Bering Sea Pollock Stock Assessment and Management Methods

CIE reviewers shall address the following Terms of Reference during the peer review and in the CIE reports.

a. Evaluation, findings, and recommendations on quality of input data and methods used to process them for inclusion in the assessment (specifically fishery and survey data).
b. Evaluation, findings, and recommendations on the level and adequacy of knowledge on pollock stock structure, biology, and life history.
c. Evaluation, findings, and recommendations of the analytical approach (application of a statistical ADMB integrated catch-age model) used to assess stock status and estimation/presentation of uncertainty including MSE approaches.
d. Evaluation, findings, and recommendations on the appropriateness of the harvest strategy used by the North Pacific Fishery Management Council (including uncertainty adjustments).
e. Evaluation, findings, and recommendations of whether harvest strategy is adequate within an ecosystem approach to management (e.g., bycatch, importance of pollock as forage).
f. Recommendations for further assessment improvements for management in both the long and short term.

Annex 3: Agenda—Eastern Bering Sea Pollock Stock Assessment and Management Methods

Alaska Fisheries Science Center
7600 Sand Point Way NE, Seattle, WA 98115Seattle, Washington
Week of June 14th 2010

Security and check-in:	Julie Pearce Julie.Pearce@noaa.gov	(206) 526 6547
Additional documents:	James Ianelli, Jim.Ianelli@noaa.gov	(206) 526 6510

Format will be from 9AM to 5PM each day with time for lunch and morning and afternoon breaks .

Monday, June 14th

1. **Informal meeting**
    a. Review of supplied documents

Tuesday, June 15th

Morning

2. **Preliminaries**
    a. Introductions
    b. Adopt agenda
    c. Overview of EBS pollock biology, fishery, and history of assessment

Afternoon

3. **Fishery independent data**
    a. Biological—stock structure, maturity, age and growth
    b. Groundfish survey data—abundance indices, age compositions
    c. Acoustic survey data—abundance indices, age compositions
    d. Research areas—alternative survey indices, opportunistic studies
    e. Food habits studies, multispecies modeling, BSIERP studies

Wednesday, June 16th

Morning

4. **Fishery data**
    a. Observer program overview Sampling protocols
    b. Catch accounting system
    c. Age composition estimation
5. **Assessment model**
    a. Catchabilities
    b. Likelihood formulations, data weighting
    c. Selectivity

Afternoon

    d. Spatial dynamics
    e. Natural mortality

Thursday, June 17th

6. **Management**
    a. Inseason practices
    b. Bycatch regulations and studies
    c.
7. **Model alternatives/sensitivities**
    a. Alternative model runs, further discussion as needed

List of documents

Primary document

2009 SAFE report chapter: http://www.afsc.noaa.gov/REFM/docs/2009/EBSpollock.pdf

Supplemental documents

Ecosystem considerations: http://www.afsc.noaa.gov/REFM/docs/2009/ecosystem.pdf

Previous CIE review of EBS pollock (Stokes)

CIE review of Aleutian Islands pollock and Aleutian Islands atka mackerel.

Compilation of SSC and Plan Team comments on the assessments (extract from meeting reports)

Greenpeace review of assessment model (by Steve Martell, UBC)

Report from the EBS bottom trawl survey: recent methods and results.

Kastelle, C. R., and Kimura, D. K. 2006. Age validation of walleye pollock (*Theragra chalcogramma*) from the Gulf of Alaska using the disequilibrium of Pb-210 and Ra-226. e ICES Journal of Marine Science, 63: 1520e1529.

Kotwicki, S., T.W. Buckley, T. Honkalehto, and G. Walters. 2005. Variation in the distribution of walleye pollock (*Theragra chalcogramma*) with temperature and implications for seasonal migration. Fish. Bull 103:574-587.

Stahl, J., and G. Kruse. 2008a. Spatial and temporal variability in size at maturity of walleye pollock in the eastern Bering Sea. Transactions of the American Fisheries Society 137:1543-1557.

Stahl, J., and G. Kruse. 2008b. Classification of Ovarian Stages of Walleye Pollock (*Theragra chalcogramma*). In Resiliency of Gadid Stocks to Fishing and Climate Change. Alaska Sea Grant College Program · AK-SG-08-01.

Honkalehto, T., N. Williamson, D. Jones, A. McCarthy, and D. McKelvey. 2009. Results of the Echo Integration-Trawl Survey of Walleye Pollock (*Theragra chalcogramma*) on the U.S. and Russian Bering Sea Shelf in June and July 2007. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-194. http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-194.pdf .

Background documents

Marine stewardship certification document.

Bycatch documents (Salmon EIS)

Bering Sea Integrated Ecosystem Research Plan

NMFS workshop report on natural mortality

Report from the 2009 workshop on spatial analyses and EBS pollock

NPFMC Fisheries management plan.

Bailey, K.M., T.J. Quinn, P. Bentzen, and W.S. Grant. 1999. Population structure and dynamics of walleye pollock, Theragra chalcogramma. Advances in Mar. Biol. 37:179-255.

Barbeaux, S. J., S. Gaichas, J. N. Ianelli, and M. W. Dorn. 2005. Evaluation of biological sampling protocols for at-sea groundfish observers in Alaska. Alaska Fisheries Research Bulletin 11(2):82-101.

Ianelli, J.N. and D.A. Fournier. 1998. Alternative age-structured analyses of the NRC simulated stock assessment data. In Restrepo, V.R. [ed.]. Analyses of simulated data sets in support of the NRC study on stock assessment methods. NOAA Tech. Memo. NMFS-F/SPO-30. 96 p.

Jurado-Molina J., P. A. Livingston and J. N. Ianelli. 2005. Incorporating predation interactions to a statistical catch-at-age model for a predator-prey system in the eastern Bering Sea. Canadian Journal of Fisheries and Aquatic Sciences. 62(8): 1865-1873.

Kimura, D.K., J.J. Lyons, S.E. MacLellan, and B.J. Goetz. 1992. Effects of year-class strength on age determination. Aust. J. Mar. Freshwater Res. 43:1221-8.

Moss, J.H., E.V. Farley, Jr., A.M. Feldmann, and J.N. Ianelli. (2009). Spatial distribution, energetic status, and food habits of eastern Bering Sea age-0 walleye pollock. Transactions of the American Fisheries Society.

Ressler, P. T. Honkalehto, R. Towler, amd C. Wilson. 2008. Using acoustic data from vessels of opportunity to estiimate walleye pollock abundance in the Eastern Bering Sea. ICES CIEM SEAFACTS International Symposium on the Ecosystem Approach. Bergen, Nor way, June 2008.

Swartzman, G.L., A.G. Winter, K.O. Coyle, R.D. Brodeur, T. Buckley, L. Ciannelli, G.L. Hunt, Jr., J. Ianelli, and S.A. Macklin (2005). Relationship of age-0 pollock abundance and distribution around the Pribilof Islands with other shelf regions of the Eastern Bering Sea. Fisheries Research, Vol. 74, pp. 273-287.

von Szalay PG, Somerton DA, Kotwicki S. 2007. Correlating trawl and acoustic data in the Eastern Bering Sea: A first step toward improving biomass estimates of walleye pollock (Theragra chalcogramma) and Pacific cod (Gadus macrocephalus)? Fisheries Research 86(1) 77-83.

Walline, P. D. 2007. Geostatistical simulations of eastern Bering Sea walleye pollock spatial distributions, to estimate sampling precision. ICES J. Mar. Sci. 64:559-569.

Wespestad, V. G., L. W. Fritz, W. J. Ingraham, and B. A. Megrey. 2000. On relationships between cannibalism, climate variability, physical transport, and recruitment success of Bering Sea walleye pollock (Theragra chalcogramma). ICES Journal of Marine Science 57:272-278.

Williamson, N., and J. Traynor. 1996. Application of a one-dimensional geostatistical procedure to fisheries acoustic surveys of Alaskan pollock. ICES J. Mar. Sci. 53:423-428.

Appendix 3 Participant list to the review of the Eastern Bering Sea pollock stock assessment and management for the Alaska Fisheries Science Center (AFSC)

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