A Review of Non-Target stocks and Methods in the Gulf of Alaska

Prepared for the Center For Independent Experts and the Alaska Fishery Science Center

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Executive Summary

During the review of non-target species groups for the Alaska region in Seattle WA, USA, a number of data sources and analytical methods were presented to a review panel. Additionally, the application of these methods and sources of data to sculpins, skates, octopus, grenadier, sharks, and squids were also examined in light of a tiered approach with Tier 5 being a survey biomass times natural mortality approach, and Tier 6 stocks consisting of only catch information. This was a large amount of material to review. Despite that fact, good progress was made and a number of recommendations and conclusions were drawn, and outlined in this report. Chief among these was the fact that the current Tier 5 assessments lacked a firm biomass measure due to flaws in the survey analysis approach.

Background

Over May 28th-31st The Alaska Fishery Science Center (AFSC) held a review of Non-target species groups for the Alaska region in Seattle WA, USA. The purpose of the meeting was to review a number of methods and analytical approaches to some of the non-targeted stocks of the region, principally the data poor stocks of Tier 5 & 6. Methods included examination of the landings reporting, at sea observer program, four bottom trawl surveys, a long line survey. Analysis included a consumption model for Octopus, biomass times natural mortality methods for Tier 5 stocks, average or maximum landings methods for Tier 6 stocks, and a full SS3 model for Alaska skate. The goal of the review was to examine the appropriateness of setting OFL (Overfishing Limits) for some of the most data poor stocks in the region; Tier 5 & 6.

The Tier system in the region bins assessments is based on the level of information such that:

Tiers 1-2 based on MSY directly
- Tier 1: use when uncertainty can be estimated
- Tier 2: use when uncertainty can't be estimated

Tiers 3-4 based on spawning per recruit
- Tier 3: use when recruitment can be estimated
- Tier 4: use when recruitment can't be estimated

Tier 5 based on natural mortality rate times an estimate of survey biomass
Tier 6 based on average catch

From these assessments an estimate of OFL (or the Over Fishing Limit or MSY) is derived and is used by a Science and Statistical Committee (or SSC), who then estimates (as best they can) the scientific uncertainty; and reduce the OFL (or overfishing limit) by some number to reflect that uncertainty, producing an ABC (or Allowable Biological Catch). Managers may then further reduce this number to reflect management uncertainty, resulting in an Allowable Catch Limit (ACL).

Here the focus was on Tier 5 & 6 stocks.

Description of the Individual Reviewer's Role

In keeping with the Terms of Reference (or TORs), the reviewer's role is to examine the methods used to assess these stocks including data inputs, application of methods, and assumptions. After doing so the reviewer should critique the application of these methods and analysis to each of the stocks under consideration. Where applicable, the reviewer should make comments, ask appropriate questions, and where deficiencies are found, highlight those, make recommendations and provide conclusions.

Summary of Findings

General comments:
Prior to exploring the Terms of Reference, it is often useful to step back and examine a review for bigger issues. In this case a number of species, stocks and methods were under review simultaneously. While a fully detailed summary of events is probably not warranted, major themes during this review became apparent.

Here a number of data poor stocks were being assessed; some with only an estimate of biomass from a survey or surveys, some with only catch information as a non-target species. Still others employed more novel approaches.

In the US system, peer reviewed estimates of MSY or OFL are used by a Science and Statistical Committee (or SSC), who then estimates (as best they can) the scientific uncertainty; and reduce the OFL (or overfishing limit) by some number to reflect that uncertainty, producing an ABC or Allowable Biological Catch. Managers may then further reduce this number to reflect management uncertainty, resulting in an ACL (allowable Catch Limit).

Throughout the assessment review, there was some concern by the Panel, as a whole, of analysts "looking for the right number" for which ACLs could be set. It became apparent during the review that often the SSC were setting the buffer between OFL and ABC using a standard number rather than basing the buffer on actual uncertainty. As such there was political pressure, in some cases, to use methods which arrived at a particular answer. Continuously the panel was informed that certain estimates were used because they yielded a "precautionary" estimate.

Analysts should only be concerned with the appropriate and best estimations of population parameters, even in data poor situations. SSCs should only be concerned with estimating scientific uncertainty. This uncertainty in other areas of the country utilizes information not only from the assessment itself, but incorporates life history characteristics, role on the ecosystem, and other measures of vulnerability to derive the ABC. Using a set number for scientific uncertainty and forcing the analysts to make outcome-based decisions, in most cases is not appropriate. It is the SSC's role, not the analyst, to balance uncertainty with social economic needs.

<u>Recommendation 1</u>: That the SSC explore other approaches (such as P*) to set the buffer between the OFL and ABC rather than a fixed value as is currently done.

Throughout the review meeting, it was surprising that representatives from the Alaska Department of Fish and Game were not present and that few, if any, of their data collected was used. Particularly for

some of the stocks in question, survey information from the State of Alaska could have shed light on some of the issues raised during the review. It may be that the data would have been excluded given the scope, but the inshore portions of the GOA could be very important for some of these stocks, if only to give information on where these stocks are NOT.

Recommendation 2: That survey, observer (if any), and catch (if any) information available from the State of Alaska be reviewed for their utility for some of the more shallow stocks under this review.

Overall the analysts performed well and were thorough in their work during this review. Their hard work especially given budgetary and resource constraints is admirable. However, a number of the documents were not available on time, which leads to a more hurried review. Also the amount of information was quite high. This review was looking not only at the assessments for the individual stocks themselves, but the methods that are used by the NPFMC and NPSC to estimate catch, and abundance. This is a very tall order without concise documentation available well in advance of the actual meeting. For example, there was no concise reference documentation on how the bottom trawl surveys were conducted, and while there was such documentation of the observer program, there was no presentation by staff that could highlight the relevant information pertinent for review of these stocks.

Recommendation 3: Concise documents be made available to the reviewers at least 2 weeks prior to the review, and that presentations of all relevant information and data sources be made at the review meeting.

Terms of Reference (TOR)

1. *Evaluation of data used in the assessments, specifically trawl and longline survey, abundance estimates, survey indices and recommendations for processing data for use in assessments, and whether available age data should be used in the assessments.*

Catch and Observer estimates

Catch information comes in many forms for the Alaska-area groundfish. These include catcher vessel and processor vessel reporting, estimates by at-sea and shore-side observers, detailed logbooks, etc. Catch information is important as it is utilized in Tier 6 assessments where only a reliable history of catch is available. The difficulty with many of the stocks in this assessment round comes from identification to the proper species. Additionally, it was unclear how, if any, cross-checking between reporting methods was done. Also unclear was how vessels under 40' reported. Overall while catch of the target species and important incidental species was probably adequate, catch of some of the other less desirable incidental catch is probably not.

Recommendation 4: A cross check between fishery dependent reporting systems (at-sea observer, dockside observer, and harvester reports) be conducted to measure variability among them.

Observer information is also critical. Given the problems with species identification and potential for unreported discards with industry reports, at-sea observer coverage is vital for many of the assessments during this review. Without a doubt this part of the US has some of the best at-sea observer coverage rates in the country, and industry is usually very supportive of this program.

However, a number of problems were encountered. While coverage of up to 100% for some vessels was surprising and impressive, many operations only had one observer. Placement of this observer below decks would hamper observation of discards occurring elsewhere on the vessel. Further many vessels have only recently been participating in the 30% coverage regime as set up by the AFSC. Prior to this, much of the coverage was instead selected by the industry, potentially biasing the results. Only time will tell if the selection process as outlined in this review will yield un-biased estimates of retained/targeted catch, incidental catch, and discards. A full analysis with portside sampling might yield valuable results and may expose bias.

For vessels under 60' there seemed to be no observer coverage whatsoever, which is problematic. While this might be only a small part of the overall targeted species catch, for some of these incidental species inshore catch and discards maybe important. Until overage is extended to this part of the fleet, that importance cannot be measured.

Time did not allow for a full programmatic review of the methods employed by at-sea observers; but what was revealed was rather troubling. Estimates of catch were in some cases based on subsamples. While subsampling is appropriate under a variety of situations, the volume subsampled and the timing during the unloading from the cod end, is extremely important. Often species will stratify in the cod end of the net. Additionally, large bodied species may not fit neatly into the rather small baskets used in some subsampling protocols. Much of this seems to be left to the judgment of the at-sea observers, while in other cases procedures seem to be set with almost no flexibility.

As such the following recommendation is suggested:

<u>Recommendation 5</u>: A full programmatic review of the at-sea observing program and the analytical approach for estimating discards be conducted in the near future, and before these stocks are again peer reviewed.

Despite these difficulties with the at-sea observing process, the uses of the estimates in scaling up seem appropriate. The methods employed are in line with methods used in other parts of the US, in particular the New England area.

One question, though, that was forgotten during the review related to how some of the observer coverage was scaled. Within the presentation on this subject one slide seemed to indicate that the kept-to-discard ratio from hauls were averaged together for a stratum, then used to scale up to the unobserved hauls.

Fishery independent surveys

<u>Bottom trawl</u>

There are four bottom trawl surveys in use in the area The EBS shelf, EBS slope, The Aleutian Islands, and the GOA. After reviewing the information each survey seemed to have an appropriate design, with good stratification gear use, and other factors. As such the surveys seem to do the best job possible in capturing the trends of the populations under review.

However, there are a number of concerns with how these surveys are used to estimate population sizes particularly in use for the Tier 5 assessments. Each survey is considered to be additive, and because no

data exist to suggest otherwise, q is set to 1. In essence the efficiency is set to 1, which allows one survey to simply be added to the others, which in turn allows for a region wide assessment of the stocks in question. Unfortunately, this is a baseless assumption out of convenience. Some stocks in this area may have efficiency far less than 1, while other stocks, such as dogfish, may have efficiency coefficients greater than 1 due to herding by the dust plume. One possible way to examine this is to overlap strata from adjacent surveys to get at the relative differences in efficiency. Additionally, another way would be to conduct depletion experiments in the same general area to look at efficiencies.

Further there were many questions about expansion to areas that were untrawlable. Large sections of the survey area consisted of "structure, or hard bottom". These areas are not very conducive to trawling and end up damaging the net. However, these areas of hard or complex bottom usually hold more and different types of fish than adjacent trawlable areas. Expansion of catches from trawlable to untrawlable areas suggests that both areas are the same in both species diversity and density.

As such:

Recommendation 6: Full programmatic review of the bottom trawl surveys be conducted individually. Such a review should also include the analysis of data, in particularly the use of q=1 and extrapolation to "un-fishable" areas.

Conclusion 1: Until Recommendation 6 is addressed the bottom trawl surveys as combined are not generally useful as an absolute estimate of stock biomass; and further should not be used for management purposes until these issues are successfully resolved.

Long line

The long line survey in the Gulf of Alaska is primarily used as an index for sable fish but encounters both spiny dogfish and grenadier as incidental catches. Unlike the trawl surveys the long line survey samples every year, samples areas that are untrawlable, and at deeper depths, making it more ideal in some ways than the bottom trawl surveys.

However, one difficulty with the long line survey is that it cannot be used to estimate absolute biomass. Further it suffers from whale depredation and hook competition. Also the survey design is as fixed stations, presumably where high catches of sablefish (its principle target) are high. So while it may be good as a relative abundance index for sablefish, given that populations migrate within their range makes it difficult to use for some of the non-target stocks assessed here. Moving to a more stratified random design would help to alleviate some of these issues. Such can be accomplished within the current survey framework relatively easily; by adding in random stations and in other areas replacing some fixed stations with random stations.

Recommendation 7: That a study be conducted to examine the feasibility of incorporating a fix/random design in the long line survey to account for changes in both target and non-target stock movements from year to year.

Overall, the long line survey can be a useful index of relative abundance and may provide a bridge between bottom trawl surveys particularly in areas that are not trawlable.

2. *Evaluation of analytical methods presently used in Tier 5 assessments. Evaluation may include: methods for estimating natural mortality (M), alternative biomass estimates (e.g. Kalman filter and survey biomass averaging, and consumption-based models.*

General comments on Tier 5 assessments

The use of F_{msy} equal to natural mortality (M) is fraught with difficulties. Despite the reference presented, it is well known that for highly fecund forage species F=M underestimates potential removals when based on life history, while F=M is disastrous for slower going species in deeper waters (i.e. Orange Roughy and Atlantic Cod). As such, managers should be more precautionary with longer-lived stocks by building in a larger buffer between OFL and ABC than the standard 25% (See Recommendation 1).

Sculpins

In this review a variety of sculpin species were examined. These included Threaded, Yellow Irish Lord, Big mouthed, Greater, Plain, and Warty Sculpins. Each of these species has differing life history parameters and centers of abundance in the BSAI/GOA area, with different species inhabiting different depth strata, temperature regimes and geographic locations. Because of the identification issues, this species in US waters have been grouped into a complex for management purposes and the complexes have been split between BSAI and GOA areas.

To get at an appropriate level of removals, the complex was assessed as a unit within each geographic area. Swept area biomass from the trawl surveys (above) was used to both estimate total biomass of the complex as well as species-specific contributions to that overall biomass. Catch was estimated from both industry landings reports as well as at-sea observers. To calculate the appropriate removals, natural mortality was estimated for each of the main species using longevity and fecundity, and then weighted by the survey biomass to calculate a biomass weighted average natural mortality. This value was taken overfishing removal rate (F_{OFL}) which was then further reduced for scientific uncertainty/precaution to the maximum rate of removal (F_{ABC}). The biomass of the surveys was then multiplied by F_{ABC} to produce the maximum catch allowed.

This seems on the surface to be a reasonable approach. The weighting of the natural mortality by biomass encountered in the surveys works because the incidental catch of sculpin also reflects that same general proportion. Natural mortality among the species varies considerably however, ranging from 0.45 to 0.21. As such, managers should be aware that if sculpin composition changes in the catch that some of the more slowly growing species maybe overexploited using a method such as this.

The main difficulty in this assessment, however, is the estimation of biomass to apply the weighed mortality to. As mentioned above, these estimates of biomass are from bottom trawl surveys and are highly uncertain. Further, there were no error bounds placed on this estimate of biomass in the document, so managers do not have the ability to gauge the variability around the estimates of biomass, and subsequent removals.

In keeping with the conclusion stated above, the lack of a robust estimated biomass from the trawl surveys precluded the use of these estimates in a management context. Should the issues with the trawl survey and its analysis be resolved, the application of this method should be appropriate for this complex, provided adequate precaution in quota setting is used.

Skates

Alaska skate

During this meeting an analytical assessment for Alaska skate was reviewed. While not a tier 5 assessment, it has been included here with the other BSAI/GOA skates for simplicity. The model presented was a variant of SS3 which uses catch, age, survey and other information in keeping with other Tier 3-like assessments. Four alternative model runs were conducted as outlined below:

Model 1 previous (2011) model using updated catch and survey data
Model 2 revised model using only the most recent length-at-age dataset & growth parameters fixed
Model 3 revised model using only the most recent length-at-age dataset, but with growth parameters estimated within the model
Model 4 revised model using all available length-at-age datasets, and growth parameters estimated within the model

All of the runs presented had serious difficulties. Examination of the fits revealed a continual overestimation of smaller Alaskan skates and an over estimation of larger older skates; no doubt due in part to a double logistic curve for catchablities in the surveys at length or age. Also during the review, it was indicated that the surveys prior to 1992 were not used in fitting, despite the relatively large increase in the skate biomass prior to 1992. Further, few, if any, diagnostics were provided to examine such things as fits to age/length in the commercial catch, potential retrospective patterns, or likelihood profiles on steepness.

Given the time constraints during this review it simply was not possible to make multiple request of the analyst for a reworking of the model and its diagnostics. Further, an entire review meeting of multiple days would be best to help explore this model further and revise the parameters and assumptions.

Recommendation 8: That the Alaskan skate model as presented be further explored and reviewed. Such explorations should include examination of selectivity assumptions, likelihood profiles on natural mortality, sensitivity analysis on key parameters, and a full suite of diagnostics.

Conclusion 2: Until this model is substantial reworked and reviewed, the approach as outlined in this review is not useful for management purposes. As such, another method of estimating OFL and ABC for Alaska skate should be explored in the near term.

Other Skates

Like sculpin, the "Other skates" in the BSAI and GOA area utilize a similar approach. To get at an appropriate level of removals, the complex was assessed as a unit within the BSAI area while three complexes exist in the GOA area (big, long nosed, and "Other"). Swept area biomass from the trawl surveys (above) was used to both estimate total biomass. Catch was estimated from both industry landings reports as well as at-sea observers. To calculate the appropriate removals, natural mortality was estimated for each of the main species using longevity and fecundity from various published sources as well as estimates based on Hoenig method locally. This value was taken at the overfishing removal rate (FOFL), which was then further reduced for scientific uncertainty/precaution, to the maximum rate of removal (FABC). The biomass of the surveys was then multiplied by FABC to produce the maximum catch allowed.

Like sculpin, this seems to be a reasonable approach. Natural mortality among the species varies considerably however, ranging from 0.45 to 0.1. In this case, a weighted biomass average was not used, but instead the minimum (0.1) was used instead as a "precautionary approach". However, direct methods using the Hoenig method for skates in the GOA are available, and it was surprising to see these values replaced from stocks thousands of miles away and in a different biome. As such, the use of the minimum value is probably not the best available information.

In keeping with Recommendation 1,

<u>Recommendation 9</u>: That alternative methods of deriving natural mortality be explored for the BSAI/GOA complex of skates; in particular weighted averaging by biomass, median values across the board, direct Hoenig estimation, etc.

The main difficulty in this assessment, however, is the estimation of biomass to which to apply the weighed mortality. As mentioned above these estimates of biomass are from bottom trawl surveys (above) and are highly uncertain given the difficulties in assumed efficiencies and extrapolation to untrawlable areas.

In keeping with the Conclusion 1 as stated above, the lack of a robust estimated biomass from the trawl surveys precluded the use of these estimates in a management context. Should the issues with the trawl survey and its analysis be resolved, the application of this method should be appropriate for this complex, provided alternative methods for estimating natural mortality are employed.

Octopus & consumption model

Octopus represents a conundrum in setting appropriate removal levels. They are not well represented in the catch, survey information is not a good estimate of biomass, and targeting of octopus seems unlikely in the near term. As such neither the classic Tier 5 nor the "catch only" methods of Tier 6 seem to work.

To get around these issues, the AFSC put forth a novel approach, to estimate natural mortality removals as consumption by Pacific cod. The idea is if the consumption of a key predator is known then appropriate removals by fishing can be calculated.

To estimate removals, the analysts utilized food habits information form the trawl surveys to get the weight of the octopus consumed; then, they used a bioenergetics approach to estimate total removals when consumption was scaled up to the biomass of Pacific cod caught in the trawl surveys, such that:

$$M * B \text{ (cod eating octopus, t/year)} = \text{Cod Ration}_{length} \text{ (g/fish/year)} * \text{Cod Nsurvey}_{length,strata,year} \text{ (fish)} * \text{Diet Comp survey}_{length\ bin,strata,year} \text{ (proportion)}$$

Unfortunately, utilization of this method is fraught with difficulties, though the analysts should be praised for their creativity. One difficulty is the use of a bioenergetics approach, which assumes that the bulk of the growth of Pacific cod occurs during the sampling of the food habits. A second difficulty is the rather small occurrence of octopus in the diets of cod (roughly 10%). A third difficulty is the scaling of consumption to the swept abundance of cod in the surveys, rather than to the peer reviewed assessment.

However, given that the surveys and catch information for this stock are entirely inadequate, a method similar to this might be the only alternative until a directed survey is available. As such a number of suggestions are outlined below to help potentially improve that estimate.

These include,

Recommendation 10:

a. Scaling the consumption estimates to the abundance as outlined in the peer reviewed assessment for Pacific cod
b. Exploring gut evacuation as an alternative to bioenergetics
c. Using Pacific cod fishery dependent sampling of lengths at different times of the year to ensure that the bulk of the growth coincides with food habit sampling if a bioenergetics approach is used
d. Boot strapping confidence intervals of the aggregated removals given that the data are probably non-normal
e. Showing the variability in those estimates and the final product

Once completed as outlined above, the SSC can then use this uncertainty to estimate the ABC as outlined in Recommendation 1.

3. *Evaluation, findings and recommendations on the analytic approach used for "data-poor" stocks that have no reliable estimate of biomass, specifically, Tier 6 species/stock complexes.*

General comments on Tier 6 assessments

Tier 6 assessments represent the most data poor group in the BSAI area. For these stocks the idea is to set catch roughly equal over a time when the stock was stable in abundance and then to reduce the removals from there based on scientific uncertainty.

The difficulty in doing so relies on the methods which are employed to both record the historical catch or to get an estimate of the relative abundance of the population. Often catches can stay stable for reasons other than stability in abundance, such as increased effort. Further, such methods do not generally account for increased or decreased stock abundance. In short, the average catch maybe too high for stocks that are in decline, or highly precautionary should stock sizes increase or fishing grounds expand. These issues are even more difficult to deal with when the stocks in question are only incidentally caught, or when discards make up the bulk of the removals.

Sharks

Sharks are a difficult complex to assess in the BSAI/GOA area. In the BSAI area sharks are assessed as a tier 6 complex and share the OFL/ABC among the 4 species (Spiny dogfish, Pacific sleeper sharks, and salmon sharks). In this region, max catch 1997- 2007 is used and then reduced by scientific uncertainty to produce an ABC. In the GOA, dogfish use a tier 5 approach (biomass * natural mortality) and is managed under its own ABC. Sleeper and salmon sharks use an average catch 1997-2007 to produce an ABC which is split between stocks.

The idea of using a complex approach is generally related to species identification issues, such as sculpins and skates. It is difficult to see how such an issue could be the case here, given how very different the shark species are and how easily identified they are.

As such,

Recommendation 11: That all shark stocks in the BSAI/GOA area are split to have a separate OFL/ABC by species and region, and that the OFL be based on the Tier 6 approach as the average catch of each species individually.

Dogfish

Dogfish presents an interesting problem. Clearly there is some connection to the stock of dogfish residing in the Pacific Northwest region just to the south. However, tagging data suggests both resident and migratory components, indicating some independence. Nonetheless, the connection with the assessed unit to the south should be explored further. One method of doing so would be to simply treat the BSAI through the NWP as a single unit.

In the interim, average catch in the 1997-2007 should be feasible for both components. It is recognized that the GOA dogfish uses a biomass*M approach. However, in keeping with conclusion 1 (and especially in light of possible herding as occurs in other dogfish stocks) the average catch is probably a more robust measure.

Salmon shark

Salmon sharks also present a problem. In general they seem to be highly mobile apex predators which range into both inshore and off-shore waters. One wonders if they might be better off being assessed outside of the AFMC jurisdiction as a highly migratory species. Regardless, catches and encounters with inshore fisheries needs to be addressed sooner rather than later for this stock. In the interim, average catch can serve as a good proxy, but that suggestion is made grudgingly given how little is known about this stock.

Pacific sleeper shark

Pacific sleeper sharks are a deep-water large species not regularly encountered. They are long lived species which probably roam over vast areas at deep depths with some suggestion of intermixing with Greenland Sharks. Given their life history (long lived, low fecundity, low mortality) and frequency of occurrence, adults are not well recorded in the BSAI/GOA area.

What data are available is disturbing. While most of the individuals encountered are juveniles, the overall fishery dependent and independent data suggests a declining trend. As such, while average catch is probably the only measure available for informing an OFL, SSC and managers should be aware that more precaution is warranted until further information is gathered.

Squids

Squids in the BSAI and GOA are unlike other squid fisheries found in many other locations. Here the catch seems to be incidental and located in much deeper waters than usual. The main species encountered is *Berryteuthis magister,* but other species are encountered. Typical of squids there are multiple cohorts per year and they have a life span of 1-2 years. While there was a directed fishery in late 70's to late 80's, a directed fishery has not been seen since. During the directed fisheries, catch

exceeded 6,000 t for each of the two areas. Since the directed fishery ended catches have generally been $\geq$ 1,000 t for each area.

The analytical approach to squids is to use the mean catch 1978-1995 in the BSAI area and to use the maximum catch for 1997-2007 in the GOA area. These values are then reduced by scientific uncertainty (25%) to produce an ABC.

It is difficult to understand why two adjacent stocks, with very similar catch histories, would use different periods and different metrics to set an OFL. Further, a productive fishery for both these stocks occurred in the 1977-1987 time frame.

As such, it is recommended that (Recommendation 12) the average catch 1977-1987 be used as a basis of seeing the OFL for both squid complexes separately.

The question on whether or not to manage squids as a forage stock is more policy than science. Clearly squids serve an important forager role in the ecosystem. Here however, many of these species are found at great depths, and may not play as important a role for the stocks in the NPFMC realm. Further productive squid fisheries occur in many other parts of the world. If closely monitored, managed with an eye towards it's ecosystem role, and adequate catch controls are employed.

4. *Review of the grenadier assessment and the reliability of the estimation of biomass.*

Grenadier

Like sculpin, grenadier in the BSAI and GOA area utilize a similar approach. To get at an appropriate level of removals, the complex was assessed as a unit within each area. Swept area biomass from the trawl surveys (above) was used to estimate total biomass. Catch was estimated from both industry landings reports as well as at-sea observers. To calculate the appropriate removals, natural mortality was estimated for each of the main species using longevity and fecundity. This value was taken overfishing removal rate (F_{OFL}) which was then further reduced for scientific uncertainty/precaution to the maximum rate of removal (F_{ABC}). The biomass of the surveys was then multiplied by F_{ABC} to produce the maximum catch allowed.

Like sculpin, this seems to be a reasonable approach until one recognizes that much of the biomass of grenadier lies deeper than 1000 m. And as such probably does not capture the full extent of the stocks under review. This fact is supported by the long line survey information. In fact, of the fishery independent surveys, the long line survey is perhaps the best at covering the habitat in which grenadiers reside. One possible approach would be to use the long line survey and the overlapping strata with the bottom trawl in a GLM or GAM model using factors such as depth, area, bottom type, or temperature to fully estimate those deeper areas where the bottom trawls do not survey.

In keeping with the Conclusion 1 as stated above, the lack of a robust estimated biomass from the trawl surveys precluded the use of these estimates in a management context. Given that using long line information to extrapolate to deeper depths would most likely not prove useful until the issues with the bottom trawl survey are resolved. Should those issues be resolved, the Kalman Filter does hold promise in reducing some of the variability associated with grenadier and is a much better approach that should be explored for other stocks.

5. *Review age information that is available for a number of the Alaska "non-target" species, including spiny dogfish, giant grenadier, yellow Irish lord, great sculpin, and plain sculpin. Age of maturity information is also available for giant grenadier. Although the ages have not been validated, use of these age data in the assessment process could result in moving these species to a higher assessment tier. Provide recommendations on how to proceed with the age data.*

Aging is a vital component of any fishery independent or dependent monitoring. In more data rich assessments, tracking of year class strength and assessment of stock recruitment relationships can only happen when ageing data are available. For less data rich assessments, aging information can allow for estimation of maximum age, which in turn can be used to estimate total mortality or natural mortality depending on the situation. Furthermore, growth is another way in which aging data can be used in less than data rich assessments.

Overall, the aging of the stocks in question seems reasonable. The programs in place seem to be adequate and where possible should be included in the assessments of the stocks under review. Key problems exist however, of which the first is the validation of yearly increments. While it would be hard to imagine increments being anything but yearly for most of these stocks, some of the deeper residing species could be slower growing and may have increment deposition of less than one per year. As such, future validation or at least making the case via other published work is important. Further, correct identification of structures and consistence among readers is also important. The ageing program under review is relatively new for some of the stocks in question. Other labs in the US and around the world have probably examined similar species. As such, cross comparison between labs would be helpful in ensuring that structures are identified correctly, and that age interpretations are at least as precise as possible.

Recommendation 13: Prepared ageing structures be swapped with at least two other laboratories to confirm the correct reading of structures and that preparation is adequate.

6. *Recommendations for further improvements*

Overall, 13 recommendations have been made in this report to help improve the data collection and analysis for the stocks under review. These include:

Recommendation 1: That the SSC explore other approaches (such as P*) to set the buffer between the OFL and ABC rather than a fixed value as is currently done.

Recommendation 2: That survey, observer (if any), and catch (if any) information available from the State of Alaska be reviewed for their utility for some of the more shallow stocks under this review.

Recommendation 3: Concise documents be made available to the reviewers at least 2 weeks prior to the review, and that presentations of all relevant information and data sources be made at the review meeting.

Recommendation 4: A cross check between fishery dependent reporting systems (at-sea observer, dockside observer, and harvester reports) be conducted to measure variability among them.

Recommendation 5: A full programmatic review of the at-sea observing program and the analytical approach for estimating discards be conducted in the near future, and before these stocks are again peer reviewed.

Recommendation 6: Full programmatic review of the bottom trawl surveys be conducted individually. Such a review should also include the analysis of data, in particularly the use of q=1 and extrapolation to "un-fishable" areas.

Recommendation 7: That a study be conducted to examine the feasibility of incorporating a fix/random design in the long line survey to account for changes in both target and non-target stock movements from year to year.

Recommendation 8: That the Alaskan skate model as presented be further explored and reviewed. Such explorations should include examination of selectivity assumptions, likelihood profiles on natural mortality, sensitivity analysis on key parameters, and a full suite of diagnostics.

Recommendation 9: That alternative methods of deriving natural mortality be explored for the BSAI/GOA complex of Skates; in particular weighted averaging by biomass, median values across the board, direct Hoenig estimation, etc.

Recommendation 10: that the Octopus consumption model as presented be re-analyzed to include:

a. Scaling the consumption estimates to the abundance as outlined in the peer reviewed assessment for Pacific cod
b. Exploring gut evacuation as an alternative to bioenergetics
c. Using Pacific cod fishery dependent sampling of lengths at different times of the year to ensure that the bulk of the growth coincides with food habit sampling if a bioenergetics approach is used
d. Boot strapping confidence intervals of the aggregated removals given that the data are probably non-normal
e. Showing the variability in those estimates in the final product of OFL

Recommendation 11: That all shark stocks in the BSAI/GOA area are split to have a separate OFL/ABC by species and region, and that the OFL be based on the Tier 6 approach as the *average* catch of each species individually.

Recommendation 12: That the *average* catch 1977-1987 be used as a basis of seeing the OFL for both squid complexes separately.

Recommendation 13: Prepared ageing structures be swapped with at least two other laboratories to confirm the correct reading of structures and that preparation is adequate.

Conclusions and Recommendations

Recommendations are outlined under TOR 6 (above) and throughout the document.

Two conclusions were reached; Conclusion 1, that until Recommendation 6 is addressed, the bottom trawl surveys as combined are not generally useful as an absolute estimate of stock biomass; and

further should not be used for management purposes until these issues are successfully resolved; and Conclusion 2, that until the Alaska Skate model is substantially reworked and reviewed, the approach as outlined in this review is not useful for management purposes. As such another method of estimating OFL and ABC for Alaska skate should be explored in the near term.

The suggestion of Conclusion 1 is that the current bottom trawl surveys should not be used in calculation of OFL for Tier 5 stocks. This is exactly the case.

Using trawl efficiencies set equal to 1 and expansion to untrawlable areas are major concerns. Defending the practice simply because it is a "precautionary approach that estimates a minimum population size" is not tenable. While it is understandable why it was done this way, the simple fact of the matter is that this is not good science as it's based on little, if any, scientific study. This is particularly important for data poor stocks unlike those where an analytical model is present. The less data available the more important those data are to the assessment, and the more opportunities to run afoul if it is not handled correctly.

While certain stocks may be better assessed by the current trawl survey analysis (such as skate), overall most of the Tier 5 stocks would be better assessed using Tier 6 methods. Ultimately, the choice of using Tier 5 vs. Tier 6 approaches is up to the SSC on a stock by stock basis. However, a rigorous justification should be provided which explicitly points out how the catch information is far worse than flawed assumptions on trawl survey efficiency and the expansion to untrawlable areas.

The implications of conclusion 2 is that the current AFSC model for Alaska skate should not be used for status determination or setting OFL. Again this is exactly the case. To be clear, the current model is simply not ready, despite the analyst's best efforts, for use by management at this time. Further work and further review of that work is needed prior to it being useful.

General comments

Overall the analysts performed well and were thorough in their work during this review. Their hard work especially given budgetary and resource constraints is admirable. This cannot be stressed enough; they were very creative in making the most of very poor data to produce estimates of appropriate removals; generally in keeping with scientific rigor. Where data and analysis were lacking, or when criticized, they were very professional and strove to meet the reviewers' needs and answer questions. In short they did an excellent job given what they had to work with.

The meeting was well set up despite network problems on the first day. The meeting was well organized, and the staff friendly and very helpful. While it would have been better to have some of the materials in hand much sooner prior to the meeting; given the federal government sequester and the multiple roles staff have, it is understandable and proved to not be too much of a burden.

Overall, it was a productive and fun meeting.

Appendix 1: Bibliography of materials provided for review

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C. Tribuzio, K, Echave, Cara Rodgveller, & P.J. Hulson. 2012. Assessment of the Shark stock complex in the Bering Sea and Aleutian Islands. National Marine Fisheries Service Alaska Fisheries Science Center.

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Appendix 2: A copy of the CIE Statement of Work

Attachment A: Statement of Work for Dr. Matthew Cieri

External Independent Peer Review by the Center for Independent Experts

Review of Assessment Methods for Non-Target Species in the North Pacific

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 Representative (COR), 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. The CIE reviewer is selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance with the predetermined Terms of Reference (ToRs) of the peer review. The 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 Alaska Fisheries Science Center (AFSC) is responsible for stock assessment for 10 stocks/complexes in the Gulf of Alaska (GOA) and Bering Sea/Aleutian Islands (BSAI) which are considered "non-target", as well as two species complexes which are currently not included in the fishery management plan (FMP). The requirement in the re-authorized Magnuson-Stevens Act (2007) to set annual catch limits (ACLs) based on science recommendations implies some kind of basic assessment is required for all species in the FMPs. In response to these new requirements, the North Pacific Fishery Management Council divided the non-target species formerly managed as "other species" complex into five species complexes: squid, skates, sharks, sculpins and octopus. Assessments were developed for each species group. Grenadiers were not in the other species complex and are not currently in either of the FMPs; however, an unofficial stock assessment has been done since 2006 and grenadiers are under consideration for inclusion in the FMPs. The amount and quality of fishery dependent and fishery independent data available to conduct the assessment varies by complex. Existing fishery independent surveys adequately assesses some species such as skates, sculpins, and giant grenadier; the key challenge for skates and sculpins has been to improve species identification of the catch. Other species such as squid, sharks and octopus lack reliable fishery independent data and have imprecise fishery dependent data. Further, bycatch in unobserved fisheries may be significant, such as in Alaska state-managed salmon fisheries. Scientists at the AFSC have developed techniques to assign annual catch limits and overfishing levels to these non-target species groups. In some cases (e.g. sharks) these annual catch limits could limit commercial harvest of target species. Because of this potential interaction with commercially targeted species and the key role of these non-target species within the Bering Sea/Aleutian Islands and Gulf of Alaska ecosystems, the methodology used to derive biological reference points for non-

target species has been the focus of considerable attention by the public and scientific community. A variety of assessment techniques are used, from simple historical catch to estimation of natural mortality based on predation.

While these species/complexes are considered as non-targets, there are commercial concerns to be considered. Some species/complexes have either been targeted or have some market value (e.g. skates, grenadier), promoting retention of the catch. In the case of grenadier, because they are not included in the FMP, there are no catch limits in place. Further, some of these non-target species are highly migratory (e.g. sharks and skates) and move between Alaska state, federal and international waters. Catch of these species outside of the FMPs may be relevant to the assessments.

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**.

Requirements for CIE Reviewer: Two CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. The CIE reviewers shall have working knowledge and recent experience in the application of fishery stock assessment methods, especially for data-limited stocks. One reviewer should have expertise in length or –age based stock assessment modeling. Two reviewers should have expertise in population dynamics, survey design and abundance estimation. 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 scheduled in Seattle, Washington during 28-31 May 2013.

Statement of Tasks: The 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, and contact details) to the COR, who forwards this information to the NMFS Project Contact no later than 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 reviewer with the background documents, report, foreign national security clearance, and 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 COR prior to the commencement of the peer review.

Foreign National Security Clearance: When the 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 each CIE reviewer if a non-US citizens. For this reason, each CIE reviewer 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 each CIE reviewer the necessary background information and report 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. Each CIE reviewer is responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. Each CIE reviewer shall read all documents in preparation for the peer review.

AFSC will provide copies of the statement of work, stock assessment documents, prior CIE review documents, and other background materials to include both primary and grey literature.

This list of pre-review documents may be updated up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process, including a SoW modification to the schedule of milestones and deliverables.

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 cannot be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR 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 reviewer 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 Report: 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 Reviewer: The following chronological list of tasks shall be completed by the CIE reviewers 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 report provided by the NMFS Project Contact in advance of the peer review.

2) Participate during the panel review meeting at the AFSC in Seattle, WA during 28-31 May 2013 as called for in the SoW.
3) During the review meeting in Seattle, WA during 28-31 May 2013 as specified herein, each CIE reviewer shall conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than 14 June 2013, 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.

3 May 2013	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
14 May 2013	NMFS Project Contact sends the CIE Reviewer the pre-review documents
28-31 May 2013	The reviewer participates and conducts an independent peer review during the panel review meeting
14 June 2013	The CIE reviewer submits draft CIE independent peer review report to the CIE Lead Coordinator and CIE Regional Coordinator
28 June 2013	The CIE submits CIE independent peer review report to the COR
5 July 2013	The COR distributes the final CIE report 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 COR within 10 working days after receipt of all required information of the decision on substitutions. The COR 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 report by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, this report shall be sent to the COR 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 report) to the COR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COR 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) each CIE report shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

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

Key Personnel:

William Michaels, Program Manager, COR
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M. Elizabeth Conners (NMFS Project Contact)
NMFS Alaska Fisheries Science Center,
7600 Sand Point Way NE, Seattle, WA 98115
Liz.conners@noaa.gov Phone: 206-526-4465

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. The reviewer 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. The reviewer 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. The reviewer should elaborate on any points raised in the Summary Report that they feel might require further clarification.

   d. The reviewer 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 of Assessment Methods for Data-Moderate Stocks

The reviewers will participate in the Panel review meeting to conduct independent peer reviews of the non-target species assessment methods to apply to groundfish stocks managed by the North Pacific Fishery Management Council. The review solely concerns technical aspects of the methods, and addresses the following ToR:

1. Evaluation of data used in the assessments, specifically trawl and longline survey, abundance estimates, survey indices and recommendations for processing data for use in assessments, and whether available age data should be used in the assessments.
2. Evaluation of analytical methods presently used in Tier 5 assessments. Evaluation may include: methods for estimating natural mortality (M), alternative biomass estimates (e.g. Kalman filter and survey biomass averaging, and consumption-based models.
3. Evaluation, findings and recommendations on the analytic approach used for "data-poor" stocks that have no reliable estimate of biomass, specifically, Tier 6 species/stock complexes.
4. Review of the grenadier assessment and the reliability of the estimation of biomass.
5. Review age information that is available for a number of the Alaska "non-target" species, including spiny dogfish, giant grenadier, yellow Irish lord, great sculpin, and plain sculpin. Age of maturity information is also available for giant grenadier. Although the ages have not been validated, use of these age data in the assessment process could result in moving these species to a higher assessment tier. Provide recommendations on how to proceed with the age data.
6. Recommendations for further improvements

Annex 3: Tentative Agenda

2013 CIE Review of Non-target Species Groups in Alaska

Alaska Fisheries Science Center, Building 4 room 2143
7600 Sand Point Way NE, Seattle, WA 98115
Phone: (206) 526-4000

Contact for security and check-in: Julie Pearce
Contacts for additional documents: Elizabeth Conners

Tuesday, May 28

9:00 Introductions, agenda, and meeting format. *Sandra Lowe, AFSC, meeting chair*
9:15 Structure of NPFMC and regulatory history of non-target species in Alaska. *Jane DiCosimo, North Pacific Fishery Management Council*
9:40 Overview of models for setting catch limits with limited data. *Olav Ormseth, AFSC*
10:00 Discussion
10:30 Break
10:45 Fishery-dependent data collection for non-target species and observer program restructuring. *Martin Loefflad, AFSC, FMA Division*
11:15 Catch accounting and catch estimation for non-target species. TBD*, NMFS AK Regional Office*
11:30 Discussion
12:00 LUNCH
1:00 AFSC bottom trawl surveys and biomass estimates, Bering Sea, Gulf of Alaska, and Aleutian islands. *Wayne Palsson and Robert Lauth, AFSC RACE Division*
1:45 Discussion
2:15 Overview of AFSC longline survey. *Cara Rodgveller, AFSC*
2:30 Discussion
2:45 Break
3:00 Averaging and smoothing methods for trawl biomass time series. *Paul Spencer, AFSC*
3:20 Discussion
3:40 Aging methods for selected non-target species in Alaska. *Tom Helser, AFSC*
4:10 Discussion
5:00 Conclude

CIE Review of Non-target Species Groups in Alaska

Wednesday, May 29

9:00 Stock assessment of sculpins in the BSAI and GOA. *Ingrid Spies, AFSC*
9:30 Mortality rate estimation for sculpins in the BSAI and GOA – *Todd TenBrink, AFSC*
10:00 Discussion
10:30 Break
10:45 Stock assessment of skates in the BSAI and GOA. *Olav Ormseth, AFSC*
11:30 Discussion
12:00 LUNCH
1:00 Stock assessment model for Alaskan skate. *Olav Ormseth, AFSC*
1:30 Discussion
2:00 Stock assessment of sharks in the BSAI and GOA. *Cindy Tribuzio, AFSC*
3:00 Discussion
4:00 Analysis requests from panel, panel deliberations
5:00 Conclude

Thursday, May 30
9:00 Stock assessment of grenadiers in the BSAI and GOA. *Cara Rodgveller, AFSC*
9:45 Discussion
10:30 Break
10:45 Stock assessment of squids in the BSAI and GOA. *Olav Ormseth, AFSC*
11:15 Discussion
12:00 LUNCH
1:00 Stock assessment of octopus in the BSAI and GOA. *Elizabeth Conners, AFSC*
1:45 Discussion
2:30 Estimating octopus mortality from predator consumption models. *Kerim Aydin, AFSC*
3:00 Break
3:15 Discussion
4:00 Analysis requests from panel, panel deliberations
5:00 Conclude

Friday, May 31
9:00 Panel deliberations, panel and reviewer reports.
12:00 LUNCH
1:00 Panel deliberations, panel and reviewer reports
4:00 Conclude