Report on 2010 Alaska sablefish data and modeling workshop

Auke Bay Laboratories, Ted Stevens Marine Research Institute, Juneau AK

January 26-28th, 2010

Background

A 3-day workshop was held by the authors of the Alaska sablefish assessment to consider recent suggestions made during a 2009 Center for Independent Experts review and an industry-sponsored review. Prior to the workshop, all available relevant information pertaining to the sablefish population was synthesized in order to consider alternative modeling approaches. The workshop participants were provided with high resolution data from available scientific surveys as well as age and length information from observed fishing vessels aggregated by time and management area. Simulated datasets that captured the general characteristics of fishery data, but maintained confidentiality requirements,were also provided in a high-resolution format so that detailed spatial models could be considered. The agenda of topics is shown in Table 1.

Stock assessment experts outside of Auke Bay Laboratories participated in the workshop, as well as scientists from within the lab. The list of participants is shown in Table 2.

Two primary products were expected from the workshop. The first is this report describing the key findings and recommendations for further development of research and modeling of sablefish. The second product, yet to be developed, will be a set of potential models to go forward with in 2010 or 2011 for the sablefish assessment.

Key Findings and Recommendations

1.) Natural Mortality (M)
    a. Natural mortality is one of the most influential parameters in assessment
    b. Considerations:
        i. Fixed estimate agrees with mark-recapture data and current model specification
        ii. ABC is sensitive to M
        iii. Other options include using an age and/or sex-specific M
    c. Recommendation: if major re-specification of model is proposed, examine how M changes, present the likelihood for smaller increments of M, decompose for likelihood components, investigate sex-specific M on next model iteration
2.) Age-error
    a. More known age sablefish data available
    b. Considerations:
        i. Distribution of error from different readers is consistent, pattern well defined
        ii. Incorporating ageing error improves fit to age and length data
    c. Recommendation: Update age-error matrix, use pooled age-readers, consider checking consistency in trend over time
3.) Spatially explicit modeling
    a. CPUE, recruitment, and selectivity may vary between areas
    b. Considerations
        i. Simplest approach is to examine separate fisheries by area
        ii. Next approach would be to model specific sub-populations
    c. Recommendations

        i. If model moves toward spatially explicit model, consider three areas (EGOA, CGOA, and WGOA/AI/BS)
        ii. Once consistency between current sablefish model and an SS3 model is established, explore estimating area-based age availability with sex-specific length based selectivity by gear type (constant between areas)
        iii. Explore sex-specific, area-based fishery availability and if number of age samples is sufficient for spatial models

4.) Migration Models
    a. Issues: Fish do not graduate to larger size groups within the model; comparison of time periods is *ad hoc* based on when data were analyzed
    b. Considerations: wait for SS3 improvements for incorporating tagging data, possible input of migration rates
    c. Recommendations: use time increments that allow fish to grow to different size groups and have different movement probabilities, consider age-specific movement probabilities

5.) Longline survey abundance index
    a. Issues
        i. Depredation
            1. Killer whale – AI, BS, WG – observations by skate – easy to detect
            2. Sperm whale, - EYSE, WY – observations since 1998 – difficult to detect
        ii. Vessel interactions
        iii. Extrapolation of surveyed areas vs unsurveyed areas
    b. *Current ad hoc* adjustments used for survey index
        i. Killer whale depredated skates are removed from calculations
        ii. In 2009, BS area calcs removed due to depredation and estimate was average of trend in other areas
        iii. An averaging technique is applied to surveyed areas to estimate RPN in unsurveyed areas
        iv. No correction factor is used to account for sperm whale depredation
    c. Considerations:
        i. Pursue statistical adjustment for survey CPUE to avoid *ad hoc* methods
            1. Consider zero-inflated Negative Binomial Distribution for data at skate level for killer whale data and more recent sperm whale data
            2. Consider Generalized Linear Models or Generalized Additive Models (GLM, GAM) with effects such as Year, Depth Strata, Depredation, Country

    d. Recommendations:
        i. Use GAMs for exploration and GLMs for modeling survey data, run GLM framework with interactions to estimate missing years in the AI and BS and account for variable effects such as depth, depredation, etc.
        ii. Explore use of model predicted longline survey abundance indices for apportionment

6.) Stock Synthesis 3 Model Alternative
    a. Stock Synthesis 3 is a standard assessment model that could be useful for sablefish assessment
    b. Considerations:

        i. Results and plots of SS3 configuration were consistent with current sablefish model, overall trend of biomass in SS3 was substantially lower than current model
        ii. Unresolved differences: small size bins, selectivity, growth time blocks, sex ratio, recruitment restriction to resolve differences
    c. Recommendation: At author's discretion, use SS3 for exploring/validating new model options such as S/R relationship, time-varying selectivity, incorporating tagging data, and examining growth blocks.

7.) Fishery CPUE abundance index
    a. Ways to model fishery CPUE to better reflect changes in abundance
    b. Considerations:
        i. Target definitions for observer data: maximum catch (current), depth restriction, core vessels, IFQ only
        ii. Effects: vessels, region, depths, performance, hook spacing, season
        iii. Whether to model spatially
        iv. Blend of observer with no target and logbook data with defined target, changes in hook spacing within a vessel, CPUE calculation by vessel or by set, total hooks/missing values
    c. Recommendations
        i. Limit data to only IFQ years (1995 on), eliminate vessels that only sample a few years (potential criteria = # years fished and catch), use same depth restriction as survey
        ii. Evaluate differences between core fleet and total fleet for length and age data, sensitivity analysis on depth restriction, core fleet
        iii. The goal is to develop the best CPUE index by adjusting for factors that are known to affect fishery CPUE,use a GLM or GAM combining all data and using observer/logbook source as a factor in the model

8.) Sex Ratios
    a. Sex ratio currently only influenced by differing fishing mortality by sex
    b. Recommendations:
        i. Consider fixing female natural mortality, estimating male
        ii. Include length / age compositions by sex that sum to 1

9.) Other recommendations:
    a. Use only Relative Population Numbers (RPNs) in model, remove RPW
    b. Use of length and age data from same survey/year: since ages are independent sample, then can use both
    c. Inclusion of trawl survey age data: author's discretion
    d. Use length data from Japanese fisheries
    e. Utilize gully stations that are consistently sampled over time and add to fishery index; consider use of length and ages from this data
    f. Alternate survey data:
        i. Continue to use trawl survey data
        ii. IPHC survey data: consider developing index, continue to monitor
    g. When revising model configuration, improve variance assumptions to achieve better balance between sources and more realistic relative variance among sources.

Workshop Proceedings

Tuesday, January 26, 2010

After introductions were completed, the agenda was approved and priorities for the workshop were established. To help frame the meeting and establish these priorities, Dr. Dana Hanselman reviewed recommendations from the 2009 CIE review as well as concerns raised by a recent industry review. Industry concerns with the survey were highlighted which included lack of age data, whale depredation, and a preference for commercial CPUE data over survey data. The three main priorities established were: 1) The utility of a spatially explicit assessment model; 2) methodology for more appropriately using fishery CPUE data as an index of population abundance; and 3) formulation of a better longline survey abundance index that includes whale depredation and makes statistical predictions for unsurveyed areas. To fully address these priorities, some of the agenda topics were covered briefly.

Dr. Bill Clark led the first topic on natural mortality and ageing error. A history of the calculation of natural mortality (*M*) for sablefish was presented as well as a presentation of the likelihood surface for a grid of natural mortality estimates in the current model. The group thought the fixed estimate in the model agrees with the data and is appropriate given the value of total mortality in the model. It was suggested that there was sufficient contrast in fishing mortality over time and lots of age data, so we might be able to estimate it within the model. Suggestions were to check what parts of likelihood changed with different estimates of *M*, whether *M* changed for different sexes (given differences in growth), and age-specific *M*. One method suggested was to use the Lorenzen method for age-specific M for a model run. It was noted that reference points are quite sensitive to the choice of M. One consideration with examining *M* is that any future changes in model configuration will likely influence the appropriateness of the *M* estimate and this should be revisited if a new model is recommended.

Dr. Jon Heifetz discussed the ageing error matrix used in the model that is calculated from known-age sablefish returns for up to 9 years old and extrapolated up to the pooled age in the model. Preliminary results were shown with updated age data with more readers and known ages to 25 years old. A model was run using no ageing error which did show a degraded fit to the age data. The group recommended updating and including the new age-error data in the next iteration of the model.

Dr. Mark Maunder led the afternoon session on spatially explicit models. Different ways to spatially model a population were presented. One example was having separate fisheries with simultaneous mixing. The group discussed that selectivity by area might be important to capture changes in fishery selectivity when a large cohort moves through areas (e.g. the 2000 year class). Another example is to explicitly model sub-populations with or without movement between them. The first step in determining the utility of a spatially explicit model is to look at the input data first (CPUE, size, age) to see if a spatially explicit model makes sense to pursue. Generally, if size and age differ between regions then we should model fisheries spatially; if survey and fishery CPUE differs spatially, then we should model sub-populations. CPUE differences between areas imply different depletion or productivity. Other important considerations are the extent of movement and the final goals (ABC versus apportionment) of the model.

Some of the data sources were examined by area as presented in SAFE. Some of the observed patterns could be explained by age-based movement and differing recruitment dynamics. Some of these theories should be tested with analysis of the tagging data and movement model. The group also surmised that depth may also be as important of factor as geographic area. However, these differences may be attributed to a number of different reasons, such as price of gas and mixed targets somewhat reflecting changes in a different fishery such as Pacific cod.

Dr. Jon Heifetz provided an overview of an update to the sablefish movement model that was originally used to support the current harvest strategy. The results showed some different patterns of movement, specifically that fish were not moving as westerly as previously reported with more of an even pattern of east-west movement. The group was concerned with a few parts of the model formulation. The group suggested that to use the data for assessment purposes, the tagging model needed to consider growth and age-based movement. Additionally, the periods of comparison for movement should be developed more analytically.

Wednesday, January 27, 2010

Survey data

Chris Lunsford presented an overview of issues related to the longline survey and survey data. The group discussed whale depredation at length. The main depredation from killer whales occurs in the Bering Sea, Aleutian Islands, and Western Gulf of Alaska. This depredation has been consistently recorded since 1996, is obvious when it occurs, and the affected skates are currently removed from data that are used to calculate a relative population index.

The group examined a map of depredation events, which showed that depredation was widespread in the BS especially in an area near Dutch Harbor, throughout the AI, and consistently in an area of the WGOA near Unalaska Island. A list was shown of specific stations that were impacted. The last survey year, 2009, had the largest number of killer whale depredated stations in the BS, at 10. It is common for the whales to find the survey boat even after overnights in bays and when stations are skipped. One other concern is that there are more stations being hit farther east and closer to Kodiak, which may indicate more pods are learning this behavior.

Sperm whale depredation has been recorded since 1998. Most sperm whale depredation has been occurring in the EGOA near Yakutat. Killer whales are more particular in what they eat, preferential to oily fish like sablefish. Sperm whales are more opportunistic and will eat off the line or the offal being released from the stern of the vessel. Compared to killer whales, a sperm whale depredation event is not as distinct, as the whales do not necessarily feed off the line and sometimes are feeding off the head and guts in the back of the boat. When they do depredate off the line, they do not take every fish like killer whales do, so detecting depredation can be difficult. There are no records on sperm whale depredation before 1998. Since 1998 we have information on killer whale depredation unique to the skate level and sperm whale information to the station level.

In 2008, a study was published which compared 1998-2004 longline survey catch rates at stations which had sperm whale depredation to stations that did not. This study found a 1.8% removal rate, which was not significant. Preliminary results of a new study that included the most recent years, 1998-2009, indicate there is now a significant trend over time in depredation and sperm whales remove approximately 4.1 kg of sablefish per 100 hooks. Similar depredation studies have shown an average of about a 1.5% removal rate.

In terms of whale depredation, no known deterrents exist. For sperm whales, the Southeast Alaska Sperm Whale Avoidance Project in collaboration with the AFSC is deploying acoustic receivers on the longline survey to count the number of times a sperm whale creaks, which may be an indication of a depredation event. This project will continue in 2010 to attempt to prove a creak represents a fish removal. If possible, this method of quantifying depredation can also be used to compare survey depredation rates to fishery rates. SEASWAP is also doing some work on deterrents, but any deterrents used could not affect catch rates if they were to be used on the survey.

One problem with the large killer whale depredation event in the BS in 2009 was that the couple of remaining unaffected stations typically had the lowest catches. Because we had high rates of depredation in the BS in 2009, we used the ratio of catch in the BS and the GOA to estimate the catch in 2009 in the BS based on 2009 GOA catch. A problem presented for the workshop was determining a good way to fill in for years and stations when we have depredation events or when the areas are not sampled. Since it is likely to be a continuing problem in future years, a statistically defensible and consistent technique to account for depredation is desirable. The group suggested something else to consider was the effect of this event on length and age frequency data, particularly if the killer whales are attacking a particular part of the set.

The group was concerned with using averages from other areas when areas are not surveyed or when severe depredation could introduce some bias into the index. A related issue is that the trend in Eastern AI biomass is extrapolated to 15% of the area in the Western AI. This is done because the WAI biomass was sampled by the cooperative Japanese survey but is no longer sampled by the domestic survey. If trends in the un-surveyed area are different than the surveyed area of the EAI, this could also introduce bias.

Modeling framework

Dr. Franz Mueter led a discussion of appropriate ways to treat catch-per-unit-effort (CPUE) data. First we are starting with the assumption that abundance is proportional to CPUE. Catchability or abundance may vary, so there can be variability in CPUE as an index of abundance even when true abundance is constant.

He described a generalized modeling approach for both survey and fishery data as follows:

1.) Response variable
    a. Catch rate, CPUE
2.) Explanatory variables

a. Year (categorical, primary variable)
b. Spatial location
    i. Discrete regions, strata or management areas
    ii. Lat/long, spatial surface
    iii. Long only, 2D surface which might make more sense for this instance
c. Day of Year
    i. Because the survey or fishery takes place over a long period
    ii. Confounded with location though, but could examine by area
d. Effort, if response variable is catch
e. Depredation, could be categorical (Y/N)

There are several methods for standardizing CPUE. One method is to use a generalized linear model (GLM), which is a flexible generalization of regression. It allows different explanatory variables with different distributions to be statistically related without the constraints of having normally distributed data. If a spatial surface is desired, often a generalized additive model (GAM) is used which replaces linear predictors with some variety of a smooth function. Another model that could be used is a mixed model (GLMM/GAMM) that includes random effects. Year could be treated as a random effect but it is typically considered a fixed effect because it is the variable of interest. When modeling CPUE with these types of models, a number of choices need to be made which include:

1.) Choices
    a. link function (use log, logit)
    b. error distribution (counts of fish by skate, generally a poisson, if more dispersed than poisson then neg. binomial; if weight Gaussian or log-Gaussian
2.) Issues
    a. Dealing with high proportion of zeros
        i. could aggregate by something like depth strata
        ii. could use a 2-stage model (delta-lognormal, delta-gamma)
        iii. zero-inflated models (ZIP (poisson), or ZINB (neg bionom)
            1. modeling “false zero”, and probability of getting a “true zero”
                a. true zero, sablefish not there
                b. false zero, habitat ok, but happen to miss sablefish
    b. spatial correlation
        iv. model spatial pattern (because how survey is distributed, it is likely best to model location and depth)
        v. model spatial correlation, alternative to modeling the pattern, have smooth pattern and then model the spatial correlation that remains, this only matters if you want to ensure a rigorous confidence interval, and since we just want a good index, may not be as important

In general, we could look at fishery and survey data very similarly, but fishery data will have more nuisance variables. Vessel and gear effects are likely to have a lot of co-linearity so it may be difficult to discern differences between vessel and gear effects. One advantage of these types of approaches is that you can readily include gully stations or depredation and treat these as another categorical variable.

Survey abundance index

Dr. Mueter showed some potential modeling options for survey data. The fit of several models were examined for one area, to decrease model fitting time during the workshop. In the database there are two measures of depth: stratum and interpolated depth. A two-stage logit GAM model was fit using interpolated depth and julian day as explanatory variables, essentially a curve to the depth data which models the probability of catching a fish at a given depth. Data was filtered by depth (100-1000 m only). Generally, GAMs are more exploratory. From examining the data, depth strata would be more useful as a categorical variable than interpolated depth as a continuous variable. In addition, there does not seem to be a real change in the probability of catching a sablefish throughout the survey period.

When fitting a delta-lognormal GLM, the occurrence probability (binomial part) is highest in the depth stratum from 500-700 meters. One suggestion made by the group was to include the country, since Japanese fishing had higher catch rates, and there were five years of overlap. For the presence/absence model portion of the delta-lognormal GLM, the year effect is smaller than the stratum effect, the killer whale effect is large, but the country effect is small. The portion of the delta-lognormal which models sets where catch rates were positive could use a log or log link transformation. Difference in catch rates between countries is a bit more substantial than in the binomial part, and the year effect is larger. The final product of this model is to multiply the probability of occurrence (binomial model of presence absence) by the adjusted catch rate (from the model of positive CPUEs). These adjusted catch rates can then be used to as the survey index.

The group discussed using the modeling approach to examine depredation, and to see if it was occurring at high density stations. One easy way to examine this might be to compare annual CPUE with and without depredation. It was suggested this would be most easily accomplished with a zero inflated negative binomial because it can be fit with one model, unlike the delta-lognormal.

The group discussed whether the strata were sampled in proportion to their area. If not, then the strata-CPUE estimates would need to be expanded to their area sizes. This could be done within the model, but might lead to double-weighting. Since this would be an expansion weight not a statistical weight, it might be better to do this outside the model. In this method, the best estimate of mean CPUE within the depth stratum by year would be determined by the model and then weighted by the area of the depth stratum. Variances are a straightforward calculation from this method.

The group discussed that presently the way the RPN indices are constructed, a model is implicitly used to formulate the index for the assessment model. This model is basically an adjusted mean CPUE for depredation and other effects that do not represent abundance. One concern raised is that a new modeling approach might be quite acceptable to stakeholders when used inside the assessment model, but might be much more scrutinized if used in the apportionment process.

The group discussed that identifying and accounting for killer whales is straightforward, but sperm whale depredation is not so obvious because there are not enough data to analyze. Sperm whale depredation can be difficult to detect and the effect on catch is smaller than for killer whales. One way to deal with sperm whale depredation is to apply an overall adjustment to the index after the data has

been modeled. One useful exercise would be to determine how much sperm whale depredation it would take to account for the current trend in sablefish CPUE in the Eastern Gulf of Alaska. An additional important consideration is that while not accounting for it in the survey, we also are not accounting for the additional mortality in the fishery. While the survey boat cannot avoid sperm whales, it does send out offal, which may keep them from eating off the line. Many of the boats in the fishery do not process on board so when whales do depredate, they may remove more of the catch. Conversely, fishing boats are capable of avoidance by moving when whales occur or fishing earlier in the season. It was also noted that the area affected by sperm whales is around 25% of the population, and if the effect is 4-5% then the effect on the overall population estimate is only around 1%. However, the group agreed that the end-product for the survey index needs to attempt to account for both types of depredation.

Alternatively, a GLM for the survey data could incorporate sperm whale presence/absence and depredation by station as a categorical variable. Although we have this only since 1998, we could model with and without this variable to see what the effect is and use this number to make an overall adjustment to the survey index.

The group discussed that relative population weight (RPW) should be omitted from the assessment model since we are accounting for length and weight in the model already and because relative population number (PRN) is also used as an index in the model. The group was divided on whether to use length data from the survey and fishery when age data is available. While the ages provide information on year class strength, the lengths are taken from a much larger sample size of sablefish. This information might also be useful if we chose to model growth in time blocks or as a random effect.

The group discussed some specifics of modeling survey data using a GLM. There is various information that is available by skate that might be useful to model, and choosing the resolution of data analysis (i.e., by skate or by depth strata) will need to be tested. Some of the whale related factors by skate that could be incorporated include, empty and ineffective hooks, and depredated/damaged sablefish.

The group examined some results from using a zero-inflated negative binomial package in R to model the count data (number of fish per skate). For the purposes of the workshop a thinned data set from the Central GOA was modeled using a GLM with year, depth strata, and depredation as effects. The proportion of area by depth strata was added (2-7) to combine strata estimates and make one index to compare to current RPNs of survey. When the standard survey RPN was compared with the GLM model the results were quite consistent.

Stock Synthesis 3 model

Dr. Mark Maunder led a discussion regarding Stock Synthesis 3, which is an official product of the NOAA Fisheries Toolbox (http://nft.nefsc.noaa.gov). SS3 is coded in AD Model Builder (as is the current sablefish model) and has numerous modeling options. In theory, it should be able to emulate the current sablefish model and then could be used to test hypotheses without having to write a lot of additional code.

Some of these options and how they are configured in the current assessment model:

1) Initial conditions: virgin or exploited, currently lightly exploited
2) Can also allow parameters to change over time and seasons. Currently starting in 1960 with low catch, similar to virgin year, and no seasons.
3) Fleets: can split up by method, area, depth, vessel size, and season. Currently: derby, trawl, IFQ
4) Areas: can explicitly model different areas, may need to model movement, currently one area
5) Growth morphs: allow different groups to have different growth parameters, currently two time blocks
6) Different ways to use age, weight and length compositions such as just age, age and length, age conditioned on length and length (needed if age is sampled in length bins)
7) Many selectivity options (but not the ones currently used in the model)
8) Can include data that is not sex specific
9) Tagging data can be included, not currently
10) Environmental data, not currently included

The group discussed some of the advantages and disadvantages of using SS3 for sablefish. Some advantages are the availability of many options to test hypotheses, and SS3 can be easier for outside people to review because of the standard nature of the files and inputs. Disadvantages include not being able to make custom options based on the needs of a specific stock, and being reliant on a highly complex code to calculate things correctly. An author's own model coded in ADMB might be less transparent to another author, but usually the author knows the architecture of the model calculations intimately.

The group compared a test SS3 model with the current assessment model. The SS3 model attempted to emulate the same settings as the current model, but the exact options were unavailable. While patterns were generally similar, the SS3 model estimated current spawning stock to be about 40% lower. Recruitment seems to be less variable but similar year classes emerged.

The group discussed some potential ideas to explore based on comparing the results of the two models. It was recommended that all available data is included in models going forward, even if it is not fit, because it shows the consistency of the data based on fit to other data components. Selectivity can be dealt with in different ways, particularly to deal with male and female selectivity being different and not constraining to have maximum of one. It may necessary to combine both age and size selectivity. There is some potential that the fishery selectivity should be domed shaped (a study was discussed showing halibut fishery selectivity was dome-shaped in some areas). Typically, assessment model tends to behave better if at least one selectivity is assumed to be asymptotic. In the test SS3 configuration, only length based selectivity is used (current sablefish model uses age-based selectivity), where trawl

methods are dome shaped, others are asymptotic, and all parameters are estimated with no temporal variability.

It was recommended that the effective sample sizes for compositional data reflect annual sample size or variability. For the survey, this is not necessarily a problem because it is similar from year to year, but the fishery has much more variable sample sizes. The group decided that the best first approach is to see if an SS3 model can be configured that very nearly emulates the current sablefish estimates of stock status, and then see what options and assumptions change this view.

Thursday, January 28, 2010

Fishery CPUE abundance index

Dr. Mueter led the group in considering methods for using fishery CPUE as an index of abundance. The group thought it would be good to use the same general approach as the survey. The point was raised that there were some differences between logbook and observer data, such as the availability of hook spacing data, how a target is defined, and whether information on the vessel name, skipper, and size are available. This could be dealt with in a GLM framework with logbook and observer data as a categorical variable. Indices for both data sets could be done independently, but there is then an issue of using some data twice since vessels over 60 feet turn in logbooks and can be observed.

One issue of concern for the group was using maximum catch of the set as the primary indicator of a sablefish target for observer data. An alternative method is to only use data from a core set of vessels that have fished consistently over the domestic fishery. If a core set of boats can be identified that fish through the whole time series and their behavior is consistent, then they should be a better reflection of sablefish CPUE than boats that sporadically fish sablefish. One drawback is that there could be different captains and different behavior between years on the same vessel. In addition, a core vessel group must exist for all management regions. There is a captain code available in the observer data that is not relatable to the code in logbooks. It was noted that most of the catch is caught by a small number of vessels and that about 10-12 boats that are taking nearly 25% of catch. One concern raised is that screening this way would look primarily at large boats that are observed 100% of the time.

Spatial distribution could also be included in models of fishery CPUE. One benefit of fitting a spatial model is that if the vessel is fishing consistently, the trend should reflect the change in sablefish population, regardless of target. Some issues with the spatial model, if fitting over a number of years, is that you have to assume that the general pattern stays the same over all years. If fitting across all years, you don't have to worry about the regional issues. If simple annual means are desired, then the spatial surface is much easier to model. The only requirement is that spatial surface is detailed enough that it captures the spatial pattern.

The group agreed that there were enough data to fit a global surface across years. If you do this across years, assuming the same spatial pattern each year, residuals will be spatially autocorrelated because things fluctuate a bit from year to year, and variances will be overly small. This analysis could be done

with a generalized additive model if the primary interest is to get a good index, and the variance could be inflated later in the stock assessment model.

It was noted that observed catch on some sets, particularly in the Bering Sea, is dominated by other species and therefore may not be a sablefish target. Since sablefish are a deepwater species, limiting the analysis to a practical depth range may be a reasonable thing to do. A good way to proceed might be to filter the fishery data to the depth range of the survey, limiting from 200-1000 meters. It was suggested that we run three data sets for estimating a CPUE index for observer data: 1) The current approach (target defined by sablefish being the maximum catch of a set); 2) Depth cut off from 200-1000 meters; and 3) Look at the core vessels (e.g. top 25 boats). Then we apply the GLM to these data looking at vessel effects, region, depth, season, and IFQ holders. On initial analysis, seasonal effects seemed unimportant. Initial analyses using the "core vessel" group showed the most promise at the workshop.

The group further discussed the blending of observer and logbook data. Observer and logbook data are very similar in some areas, but diverge in regions where the data is poor (e.g. Aleutian Islands). One suggestion was to consider the two data sources independently. The two CPUE sources could be fitted separately in the assessment model. The concern was raised that we were double weighting a particular portion of the fleet (large vessels) because large and small vessels are both represented in the datasets, whereas vessels <60 feet are only represented in logbooks.

In general, the group agreed that it is best to model the things that you know are most important. It is impossible to include all possible multi-way interactions. Since we are trying to compute the best index, the approach should be reasoned rather than merely a statistical model selection approach.

Some remaining concerns that need to be resolved were:

1) Model only the IFQ observer CPUE data and eliminate pre IFQ years (1990-1994).

2) Is using both logbooks and observer data double counting the data?

3) Currently logbooks and observer data have different influences in different regions based on number of logbooks being turned in and the size of vessels operating in different areas (fewer observed vessels in EGOA).

4) Goal is to get individual estimates by area and year of mean CPUE, and CV over all years. Test sensitivity of different combinations of top IFQ vessels and then omit the ones that were not fishing most years.

5) Test for a difference between small and large vessels in catch rate by comparing logbook and observer data for different vessel sizes. The hypothesis might be that small boats will tend to stay closer to port, and not travel far while large boats will move to wherever the fish are.

6) Hook spacing can change based on the density of fish available or when mixed targets are sought (halibut and sablefish sets), and can dramatically change the CPUE. Hook spacing is not available for all observed vessels.

7) Currently the CPUE data from observer program and logbooks used in the assessment are the average of the mean vessel CPUE's. This may be biasing the results as it gives vessels that catch very little sablefish a disproportionate effect on catch rate, rather than calculating by skate or set.

8) Logbook data does not include vessel name or size. Observer data does not include a target.

Other modeling issues

The group discussed the best way to model the sex ratio of the population. Currently in the model, the sex ratio is only influenced by the differing fishing mortality by sex. However, data exist that could be used to better estimate this ratio. The group recommended that the age and length compositions by sex total to a sum of one and then fit in a joint multinomial likelihood. The selectivity of one gender should not max at 1, or different catchability could be estimated for each sex.

The group discussed using historic unsexed trawl and longline fishery length compositions from the foreign fleets. There were questions about what is gained modeling from 1960, if we are making our benchmarks from 1977 on; whether the historic data is reliable; and whether estimates from good data might be contaminated with bad data. One suggestion was to make an exploratory run from 1977 on and compare with the reference model. In general the group suggested it is good to use whole time series to set up the population and also keeps nuisance recruitments from being estimated near the beginning of the data. If the historic data is less reliable, it can be given a higher variance in the model. The assessment should also show the sensitivity of the model to a stock-recruitment relationship.

The group also discussed whether it was best to use model predicted CPUE indices in the apportionment strategy or continue to use the standard method of computing RPWs. It was suggested that to promote stability in the apportionment, it would be best to add in new model estimates each year while dropping the old estimates out each subsequent year.

The workshop reached the end of the discussion and summarized the recommendations.

Agenda

Table 1.		Presenter
Tuesday February 26th Data inputs		
9:00	Welcome, introductions, workshop plan, background	Hanselman
9:00	Discussion of data provided, any other data needed for workshop	Hanselman
10:30	*Break*	
10:45	Natural mortality and ageing error	Clark
12:00	*Lunch*	Lunsford
1:00	Spatial models (Session leader, **Maunder**)	Maunder
3:00	*Break*	
3:15	Sablefish movement model and updated estimates	Heifetz
4:00	Discussion or application of spatial models	Maunder
Wednesday February 27th Modeling the data		
	Modeling survey data (Session leader, **Mueter**)	Mueter
9:00	Longline survey data use and depredation	Lunsford
9:45	Approaches to modeling the longline survey data	Mueter
10:30	*Break*	
	Incorporating depredation	
10:45	Filling in for off-years in AI and BS	Mueter
12:00	*Lunch*	Hanselman
	Modeling fishery CPUE data (Session leader, **Mueter**)	Mueter
1:00	Current use of fishery CPUE in model and apportionment	Hanselman
1:15	Pros and cons of using fishery CPUE data	Mueter
3:00	*Break*	
3:15	Open for modeling work	
Thursday February 28th Improvements to the assessment approach		
	Model comparisons (Session leader, **Ianelli**)	Ianelli
9:00	Stock Synthesis 3 model runs	Maunder
10:30	*Break*	
10:45	Current assessment approach details, and requested runs during meeting	Hanselman
12:00	*Lunch*	Rodgveller
1:00	Other alternative model runs or modeling work	TBA
3:00	*Break*	
3:15	Recommendations, findings, synthesis	Ianelli

Workshop participants

Table 2.			Specialty/relevant experience
Hanselman	Dana	AFSC	Sablefish and assessment
Lunsford	Chris	AFSC	Sablefish and surveys
Rodgveller	Cara	AFSC	Sablefish and fishery data
Fujioka	Jeff	AFSC	Sablefish and assessment
Maunder	Mark	IATTC	Assessment, ADMB, SS3
Mueter	Franz	UAF/SSC	Modeling, R, GLMs
Clark	Bill	Plan Team, IPHC (retired)	Halibut and assessment
Ianelli	Jim	AFSC	Assessment, modeling, Plan Team chair
Shotwell	Kalei	AFSC	Ecosystem, GIS, rapporteur
Heifetz	Jon	AFSC	Sablefish, assessment, movement modeling
Sigler	Mike	AFSC	Sablefish assessment, ecosystems
Rigby	Phil	AFSC	Groundfish, management