



**WESTERN  
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MANAGEMENT  
COUNCIL**

## **Annual Catch Limit (ACL) Science Need Workshop Report**

*Crowne Plaza Hotel, Silver Spring, Maryland*

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### **State of NMFS Assessment Science**

**Rick Methot** gave an overview of the requirements of the National Standard 1 (NS1) Guidelines for setting an overfishing limit (OFL) based on some measure of maximum sustainable yield (MSY), then formulating an acceptable biological catch (ABC) from the OFL. The ABC should incorporate scientific uncertainties, while annual catch limits (ACLs) should account for management uncertainties.

NMFS evaluates fisheries performances by monitoring the number of stocks with assessments (of various level of quality); currently 230 stocks are listed in the Fishery Sustainability Stock Index (FSSI). Each region has a different level of stock assessment status - the North Pacific has the highest number followed by the Northeast, and the Western Pacific and Caribbean regions have the lowest.

The National ACL Science Needs Workshop aimed to: 1) determine what is achievable in the next 5 years in terms of moving towards ACL-based management; 2) identify some cost-effective and new approaches in managing the fisheries; 3) determine feasibility for a revised and standardized protocol to improve assessment throughput, communication, and transparency; and 4) identify science issues to bring forward in the next Managing Our Nation's Fisheries conference. The workshop is divided into eight topics: 1) data needed for assessments; 2) improving monitoring programs; 3) bringing socio-econ considerations into OY specifications; 4) bringing ecosystem knowledge into assessments and OY; 5) data limited approaches; 6) role of cooperative research for supplying data for ACL management; 7) quantifying uncertainties in forecasting; and 8) peer review of stock assessments.

### **Assessment Data Needs**

**Martin Dorn** provided an overview of the stock assessment process. He identified various data required to conduct stock assessments, including catch data, abundance trends, and life history information. The complexity of the model will depend on the type of data available that ranges from simple catch data to age structured data with spatial and ecosystem parameters. The uncertainties associated with the model will depend on the data as well as the model. The more complex the model, the less uncertainties it contains.

The quality of a stock assessment depends on the type and quality of input data. FSSI data showed the majority of the assessments have a data quality level of 4 (52% used age structured data). Stocks assessed using ecosystem based models (level 5) have decreased over the last 5 year period. There was a latitudinal pattern in the adequacy in stock assessments: the further

north you go, the greater the number of adequate stock assessments. This was attributed to decreasing species diversity as latitude increases and that ecosystems are relatively young. In the tropics or subtropical areas, there is high species diversity and mature ecosystems. Additionally, trawl surveys are not as effective due to the dominance of hard bottom and reef areas, and fish aging is more difficult due to diffused growth rings. Standard tools of fisheries science, resource surveys, and quantitative stock assessments were developed for temperate and subarctic marine ecosystems, therefore legislation and NS1 guidance may be crafted more to fit temperate fisheries.

In order to move forward, it may be worthwhile to establish a minimum standard for stock assessments. Stocks assessed below standard (levels 1 and 2), we need to upgrade the standard. For unassessed species, the Science Centers should develop and apply simple assessment tools that could be used to set ACLs, but not necessarily be used for status determinations. Stocks that are at risk of overfishing should be elevated to high priority for a more detailed assessment. Also, for multi-species fisheries, it was suggested that indicator species could be identified that could represent the stock complex.

A single methodology applied to all stocks is not going to work. With the advancement in optical and acoustic technology, there is a large potential in broadening data gathering for stock assessments. This will answer some of the hard questions like gear-specific selectivity, species-habitat relationships, and catchability.

**Joseph Powers** presented an overview of the stock assessment needs in a changing fishery. Stock assessment methodologies and data collection should be flexible and adapt to rapid changes in the fishery in order for the assessments to be reliable for management. Some changes identified were: 1) stock reproductive potential brought about by degradation and climate change; 2) increased sector disaggregation due to increasing stakeholders and fishery constituents; 3) increased spatial and temporal management using marine protected areas and marine spatial planning; 4) use of ecosystem-based management (EBM); 5) habitat concerns particularly for spawning aggregation areas; 6) close monitoring of bycatch and protected species; 7) allocation conflict between various resource users; and 8) anthropogenic and natural perturbations that directly or indirectly influence the reproductive potential of the stock.

Some of the data needs identified were: 1) standardization of fishery independent and dependent surveys to determine absolute abundance estimates for key components (i.e. genetics using DNA markers, tagging, aerial surveys); 2) defining reproductive function without observing stock abundance over entire range; and 3) effects of regulatory implementation on effort redistribution, investment decisions, new incentives, and strategies.

This new management strategy will likely result in increased sector disaggregation and allocation conflicts. Virtually every management strategy has allocation conflicts, and these conflicts enter every phase including science. Example: Accountability Measures (AMs) – imprecise recreational catch estimates is widely accepted by the recreational fishing community. Impacts of AMs will lead to the recreational community demanding better estimates of OFL and ACLs because it will affect their allocation, as well as when the fishing season closes.

## Highlights of the discussion on data needs for stock assessment

- We should refocus our stock assessment priorities on not just high value stocks, but stocks that affect the harvest of high value stocks. Bycatch poses impediments to achieving maximum economic yield because high bycatch can cap the harvest of target stocks (e.g., skate harvest in the NE fishery). These bycatch species have low economic values, but can significantly affect fisheries that are more economically valuable.
- Tradeoffs and economic gains of the fishery should be examined, for example, the herring fishery in which it is hard to measure bycatch. Expected loss of a cohort can be calculated based on SPR, YPR, and average price. However, the tradeoff may be a couple million dollars versus the gains in the herring population. When under considerable uncertainty, these types of tradeoffs can be put into a decision table for Councils and SSCs considerations of potential ramifications at different levels of bycatch.
- There is discontinuity in the temporal scale in which the minor stocks influence the major fishery and the time it takes to address it the bycatch issue. The influence of the small bycatch can be resolved in a short time period, but an assessment usually takes longer. The species influencing the fishery the first year may not be important in a subsequent year, and scientific response time is typically inadequate to address the next problematic species in a timely fashion such that management is effective.
- It is not only the state of science that feeds into the decision but also social and economic considerations. When setting a certain level (catch or effort or size) for management, tradeoffs must be addressed, which is a policy decision.
- Every decision needs the full range of data from biological and socio-economic to make informed decisions.
- Any discussions on ACLs should be done in light of catch shares and marine spatial planning because both are major initiatives the agency is pushing. These are going to have impacts on how, when, and where fishermen will fish. CPUE will need to be looked at because it will change. New models will have to be developed that will be responsive to impacts of catch shares management and marine spatial planning.
- While data needs are important, the data is useless if there is no stock assessment scientist to work on it. The scientific ability may be lacking because of the shortage of scientists, primarily in the Western Pacific and Caribbean regions, and to some extent in the Northeast as well. There is a report released by NOAA on the decline of fishery scientists. Some efforts are underway to partially address this. The SEFSC runs a Population Dynamics Recruitment Program. Recent survey of students in program indicates that 33-40% of the students go to graduate school in the fishery science discipline and 75-80% of students didn't know anything about the field prior to the program. However, this is only done on a small scale but can be used as a model to enhance the staffing of much needed modeling scientist.

- Every fishery management decision has socio-economic ramifications. The dichotomy is an issue between development and implementation of policy. If there is bycatch in the fishery, the bycatch numbers are tabulated and can affect the AMs imposed on the target species. More clarity is needed from the agency or the guidance document on how these bycatch numbers affect the AMs of the target fishery. Keep in mind if public makes demands it will always be based on the socio economic reality.
- It does not always hold true that uncertainties decrease the more complex the model. This is only true if the data reflects the true dynamics of the stock. In fact, retrospective analysis can have a high influence in the model results. A rugged calculation for some species/stocks can be done for ACL purposes without making any status determination, which is obtained from more complex modeling.
- Common sense approaches are better than doing nothing or pretending that we know a lot. The problem with the U.S. is that the rules are rigid, as dictated in the MSA and NS1 Guidelines, which makes these commonsense approaches not useful.
- Two important factors that may have a direct influence in stock assessments that needs to be considered are: 1) spatial management; and 2) climate change. They are going to demand a different type of data that stock assessment groups haven't even started to think about. Data on adult and larval movements should be factored in. Changes in life history strategies will have to be given closer attention because life history strategies will deviate from what we already know due to climate change. Species distribution and spatial changes that change fishery behavior will have an influence in the stock assessments.
- Habitat and ecosystem data are needed and their influence the stock dynamics needs to be elucidated.
- Quantifying uncertainties is a major challenge. What kind of data does one use to quantify uncertainties? How are uncertainties parsed out into sampling, projections, assessment, and the natural inter-annual variabilities in the stocks. At the SSC of the Mid-Atlantic Fishery Management Council, guidance has been offered when setting the ABC where biological information will be used to reduce the uncertainties for black sea bass (i.e. sex change, maturity... basically utilize ten life history characteristics). Additional funding is needed to determine life history characteristics.
- The important data needs, from a stock assessment scientist perspective, are estimates of natural mortality, fishing mortality, fish selectivity, fleet selectivity, and catchability.
- Determining absolute estimates are the ultimate way forward. It is time to move away from using indices and proxies.
- Fishery independent surveys are always in question year to year, but SSCs always expressed that these are important to get a handle on the comprehensive information on the fishery stocks. It would be a good output for this meeting to reinforce this need.

- Major prioritization is needed in the fishery independent surveys because of the looming budget cuts. Surveys will have to be streamlined and redesigned to achieve the basic objective of establishing ACLs for species that do not have any data.
- The agency-based surveys are always a base necessity; if there is a push for the industry to take a lead on funding and conducting these surveys, there may be pushback from the industry and NGOs, and it may not be prudent. Industry-based surveys can be supplementary data sources, but should never be a substitute for agency-based surveys. However, industry-based surveys, like charter surveys, have increased the trust of the constituents for the science the agency produces.

### **Fishery Monitoring**

**John Witzig** presented about the role of fishery monitoring with regards to ACL management. The purpose of monitoring is to 1) determine catch with respect to ACL, 2) provide advance warning of changes in fishing in order to avoid invoking AMs, and 3) provide year-end landing estimates. Monitoring is subject to timeliness, meets a certain level of data quality, and has a degree of accessibility. Monitoring data is subject to analysis, imputations, and forecasting.

Historic data can be used to project trajectories of cumulative catches. However, there are other factors affecting cumulative catch estimates, such as fishery behavior, catchability, fleet behavior, and whether data collection is in sync with the changes in the fishery. These can be treated as uncertainties, therefore management must create sufficient buffers to ensure ACLs are not exceeded.

Factors affecting the monitoring program include:

- Syncing data collection capabilities, ACL level, fleet capacity and management requirements
- Desire to get the last fish
- Varying levels of temporal resolution in data collection
- Changes in the fishing activities
- Observer effects (discard information)

Current forms of data collection includes at-sea observers, logbooks, dealer reporting, VMS, IVR, recreational fisheries surveys, 7) E-monitoring. Not just one monitoring type can effectively inform management. Integration of systems and capabilities are needed, which could be in the form of one stop shops of fishery information, closely linked shore side processors, reporting using eLandings, and an interagency repository database.

The enormity of the recreational fisheries where some species catches are significant presents challenges for survey-based data collection. The Marine Recreational Information Program is developing protocols, standards, and needs that are similar to commercial fisheries (data timeliness, spatial resolution, data quality including survey design, data accessibility).

To improve timeliness, the use of electronic reporting, electronic monitoring, and data access systems must be increased. The use of paper-based surveys should be limited because it entails

significant human resources to process the data. For recreational fisheries, there is a need for more frequent updates to catch statistics. Also, survey designs should be scalable for temporal resolution with more timely delivery of data and survey estimates.

When the data are to be used for ACLs, data quality must be improved, including validating self-reported data thru independent monitoring, enhance compliance with mandatory reporting requirements in commercial fisheries, capturing data at its source, developing metrics for assessing quality and accurate data, and promoting data ownership of data by providers. However, there should be a balance between the cost of monitoring and the value of the fishery being monitored.

**Carolyn Belcher** presented a state perspective to fishery monitoring. Georgia implemented a myopic approach recognizing that a one-size fits all approach doesn't work for all states. Belcher outlined the challenges for commercial fisheries: 1) there is an over-reporting requirement for dealers because federally-permitted dealers are required to report weekly, but the State requires a monthly landing report (but does not issue dealer permits); 2) enforcement can be problematic due to lack of personnel, 3) landings reporting infractions are not a high priority at the enforcement agency nor the judicial system (fines are also reported to be low and many cases are dismissed because they are prosecuted in criminal court with rape, child molester, and domestic violence cases so jugest tend to not care about a small overfishing or illegal fishing infraction); 4) under reporting (lack of catch verification); and 5) a flat-lined budget.

The challenges in monitoring the recreational fisheries include: 1) fixed federal and state budgets; 2) the recreational fishery is regionally managed so state specificity is lacking; 3) there is a large number of species to monitor and there are species identification issues; 4) estimates are imprecise for many offshore species; 5) and participation is not mandatory.

Challenges for management includes: 1) the State lacks the ability to be reactive to fishery closures; and 2) the government management framework takes time. The largest challenges identified across the board are the lack of constituent buy-in and increased distrust within the industries, and tradeoffs between timeliness, precision, and accuracy.

### **Highlights of the discussion on fishery monitoring**

- The ability to monitor a stock at an appropriate temporal and spatial scale is limited by the availability of funding.
- Any revision in the monitoring activities will have to take into consideration ACLs, marine spatial planning, and catch shares. To properly execute the provisions of ACLs, MSP, and CS, monitoring should be conducted on almost real-time, and could be done more efficiently if the areas are subdivided based on the level of fishing activity. Monitoring under catch shares is different since it will have to be done on a per individual basis, as opposed to the whole fleet, industry, or fishery. The situation where there is a race to the fish no longer exists with catch shares, but it is substituted by a situation in which the higher CPUE generated by CS due to individuals streamlining their operations leads to new data that must be incorporated into stock assessments. However,

the data will be imprecise with a lot of uncertainty because it is a new management regime.

- Georgia has a better data collection system. It was suggested that coherence be improved between the state and feds. Having states involved is beneficial, but there are difficulties in merging state and federal data collection systems.
- There have been no assessments that have used sector information, so no delays have been experienced in the NE fishery. A fundamental issue is the inherent difference between real-time data and end-of-year estimations. By definition, there is more uncertainty and an increased ability to make the wrong decision with real-time data. With the need to further subdivide into more entities, uncertainties increase, and there is no system that can deal with that yet.
- Monitoring is easier the higher the latitude because the scale and type of fishery changes as you go north – artisanal, small hard-to-monitor fisheries with many species dominate the south, whereas factory trawlers and large fisheries with single or few species dominate the more northern latitudes. Additionally, the farther north you go, the worse the weather, thus larger boats are safer. There are fewer large boats in Alaska than small boats in the Gulf of Mexico, so monitoring is much more straightforward.
- The recreational fishery is harder to monitor than the commercial fishery because it is a huge fishery with millions of stakeholders and is very diffused spatially. Another issue with the recreational fishery is the refresh rate for recreational sampling. The turn-around time for 2 months worth of data creates an inability to do in-season closures based on the current season's data, therefore CPUE from the previous year is used.

### **Data-limited approaches**

**Jim Berkson and Luis Barbieri** gave a tandem presentation about limited data in the different regions and what the options are for these data poor situations. Different approaches for data poor situations include: Restrepo et al., modified methods, and the new Only Reliable Catch Species (ORCS) approach (a refinement of Restrepo). There is movement towards more sophisticated methods, including Depletion Based – Stock Reduction Analysis (DB-SRA) and Depletion Corrected Average Catch (DCAC). It is unreasonable to aim to make data-limited stocks data-rich because most regions do not have the resources, data, or time, and many species are too rare in the available sampling protocols. Most of the stocks have to be worked on “as they are” without the expectation of developing any stock assessment models for each species.

A “triage” approach was suggested for data-limited stocks. Unassessed stocks could be separated into stocks that are assessable now with data and methods, stocks that would be assessable in 3-5 yrs if we take action now, and stocks that would not be assessable even in 5 years. Stocks should be prioritized within categories based on: 1) economic value, 2) productivity and vulnerability using Productivity-Susceptibility Analyses (PSA) or other risk ranking methods, and 3) value to the ecosystem.

For stocks not assessable within 5 years, it should be identified if any assessment methods exist with long term potential given the data that can realistically be collected with the resources available. Until and unless a reliable time series exist, the ORCS method could be used.

For many data-limited stocks, life history information is desperately needed to support development of PSAs; other uses of life history include guiding risk assessment and vulnerability analyses. This information can be obtained by aging the 10 largest fish caught; ex. rosy rockfish <4” actually have a max age of 40 yrs. Growth, size, and age-at-maturity information is lacking, as well as reproductive periodicity and reproductive pattern for many species.

The group was asked, for discussion purposes, which of the following could most realistically and beneficially be implemented over the next 3-5 years:

1. Reconstruct catch data for DB-SRA/DCAC approaches;
2. Collect length data for length based approaches
3. Collect density data for density based approaches
4. MSE work to test effectiveness of alternative methods
5. Collect life history information
6. Develop and apply triage criteria to prioritize stocks
7. Improve criteria for stock complexes
8. Improve overall data collection

### **Highlights of the discussion on data-limited approaches**

- Reconstruction of catch data using DB-SRA (a dynamic approach) and DCAC (a stochastic approach) was endorsed for data poor situations.
- For data-poor stocks, the purpose of management measures must be examined: is the stock being managed for yield or conservation (i.e., preventing extinction or another ecological reason)? From here, stocks can be grouped into complexes if managed for yield or considered ecosystem components if being managed for conservation.
- When using the ORCS approach, all methods used with these types of stocks were analyzed. A commonality of all methods is the large numbers of assumptions that must be made (e.g., biomass in relation to  $B_{MSY}$ ). Most of these decisions are based on expert judgments.
- For identifying which stocks are vulnerable to being overfished, the PSA analysis is a useful tool. Australia is using this strategy to prioritize their stocks.
- ORCS – relies on expert opinion; there is a need to have a workshop comprised of fishery experts from each region in order to have a collective opinion on the status of the stock.
- There are lots of unknowns in most of the data poor stocks. There are inherent risks associated with managing at a species complex level instead of the individual species level and scientists are typically uncomfortable with these risks. However, to move

forward, the risks need to be accepted or a better solution must be identified. Another suggestion was to seek an exemption from the ACL requirement.

- Species could be grouped into complexes if stocks have identical productivity and vulnerability to a particular fishing gear, and the species occur in a similar habitat and niche. A stock complex is more a requirement of management to deal with stocks that comeingle. Grouping species into complexes has an inherent uncertainty associated with the groupings that must be recognized and accounted for.
- NOAA pushes for the Agency to be honest and move forward with scientific integrity, but scientists are pushed to move forward with establishing ACLs with no credible data available. Scientist should say that the data is not there to produce these numbers in an honest way, instead of making up numbers to fulfill a mandate that was written by people who did not understand the implications of the requirement.
- Not doing an ACL is not an option. Doing triage on data limited stocks is the best way given the current circumstances. Listing all limitations is better than nothing. Also, it is better than the assumption that every stock needs a high-end assessment when that's not possible or applicable.

### **Role of Cooperative Research**

**John Hoey** described a number of cooperative research programs, but did not focus specifically on the MSA-described Cooperative Research. He primarily described Research Set-Aside (RSA) funded projects. The largest investment categories across regions are projects focusing on determining abundance indices (using fishery dependent gears and new technologies) for highly targeted stocks. Other RSAs also included tagging studies and life history studies. Five and half months and 188 stations on the West Coast were completed for abundance estimation of the gray flounder using bottom trawl surveys. Hook and line surveys were used for non-trawlable areas (e.g., Southern California Bight). New communication technologies are being used to upgrade the data reporting and fishery dependent data gathering. In the NE Study Fleet, their system is wired into VMS and GPS that record in 90sec intervals and also poll GPSs in 20 second intervals to gather simultaneous temp-depth data, location and timing of fishing effort for time of day, haul duration and location, distance fished, haul depth, and water temp. Thus, a record is created of spatial environmental variations and provides fishermen with bottom temperatures from modelers weekly.

**Sarah Pautzke** provided a background on the cooperative research programs under the auspices of the MSA for the different regions and enumerated some projects that have aided ACL determinations. It is noteworthy to point out that some of the Councils are not aware that they have a direct influence on the Cooperative Research priorities; only the Western Pacific Fishery Management Council has established a formal review process and prioritization for Cooperative Research (other Councils prioritize cooperative research, but not through a formal process that includes the input of Council members and approval at a Council meeting).

## Highlights of the discussion on the role of cooperative research

- On the utility of Cooperative Research in aiding stock assessments – NE fishermen and scientists together conducted myriad optical surveys for the scallop fishery that resulted in numerous biological reference points and georeferences. The industry contributed a significant portion of the research (\$250,000) through set-asides, and there was intensive field sampling and significant fisherman input. However, the scallop data was not used because the Science Center stated it was more interested in habitat data. Trust is an issue as a result, because although excellent data was collected legitimately, the data was not used because it is difficult to get the data into the stock assessment system and different data was asked for after the survey was completed.
- There are several cooperative research projects that are on-going, but it is unclear how the objectives of the Program are being balanced between stock assessment work and life history determination.
- The main caveats for Cooperative Research are establishing partnerships between the industry and the Science Centers, and conducting robust scientific research. There is a need to conduct QA/QC on the Agency side of the partnership. Trust building is based on how well the industry generates accurate data and how well the Agency feeds that data into management that will affect the respective partners.
- On data ownership, Schwaab signed a policy that addressed data ownership. There is a grey line between fully-funded and cooperative partnerships, which determines data ownership and data sharing across institutions and agencies. “All data collected through funding with NMFS...belong to the U.S. Government and the people of the United States.”
- In New England, the “cooperation” under cooperative research should be set in day 1 when the proposals are being drafted, which sets the stage for the scientific robustness of the proposal (by the Agency) and the logistic extent and feasibility of conducting the research in an efficient manner (by the industry). The primary issue is that because the Science Center reviews proposals for the Research Set-Aside program, the Center scientists cannot participate in proposal development.
- With respect to the cooperative research grants process, industry occasionally proposes projects that the Agency disagrees with as being high priority. However, the Agency does discuss potential projects that are high priority in which the industry could participate and should convey those priorities to industry prior to proposal submission.
- Because the fundamental aspect of science is repeatability, cooperative research can be used to repeat projects to confirm data used to calculate ACLs. The reason scallops are doing well in New England is because of two independent surveys that can be compared to each other.

## **Quantifying Uncertainty in ABC Forecasts**

**Erik Williams** laid out options for quantifying uncertainties in forecasting ABCs. ACL management begins with the OFL designation, for which there is no need to assign any uncertainties or incorporate precaution because they are accounted for in the ABC determination. The OFL should be risk neutral and driven by the choice of data and model.

P\* is one way to formalize characterization of uncertainty, but it only focuses on a single metric (probability of overfishing) and does not deal with the consequences of overfishing. Aside from P\*, flat rates could be used that imply variable risk tolerances (i.e. ACL = 75%  $F_{MSY}$ ). A third option is to use decision theory.

When forecasting in an ACL setting, the feedback loop must be considered. Setting catch levels for multiple years would require a projection model because of feedback among catch levels and stock. The feedback should look back into the stock structure after several years of catch limit management.

To improve current forecasting ability, the following must be improved: 1) data collection (increase sample sizes of input data, new data sources, new surveys, more timely data); and 2) monitoring of fishery systems (realize unaccounted uncertainty and better understanding of what works).

To improve modeling, we must: 1) identify socio-economic linkages; 2) use model ensembles; 3) improve use of environmental linkages; 4) improve predictive accuracy from more realistic models; and 5) improve treatment of uncertainty in parameter values.

To improve uncertainty and forecasting, we must: 1) move beyond probabilities to more explicit talk about consequences; 2) present tradeoffs to managers; and 3) understand the limits to reducing uncertainty and communicate these uncertainties and limitations to managers and constituents.

**Steve Cadrin** provided an overview of the precautionary approach to  $F_{MSY}$  proxies from an SSC perspective. The NS1 guidelines allow for using  $F_{MSY}$  proxies when MSY cannot be estimated directly. If ABC is to represent the Council's desired risk tolerance of overfishing, OFL should be based on  $F_{MSY}$  whenever possible rather than a proxy for  $F_{MSY}$ . If  $F_{MSY}$  is poorly defined, uncertainty can be evaluated rather than replacing it with a precautionary proxy. An  $F_{0.1}$  can be considered a conservative or cautious proxy for  $F_{MSY}$ . Commonly used  $F_{MSY}$  proxies range from  $F_{30}$  to  $F_{40}$ . Species with wide ranging life histories have estimated MSYs at approximately 36% of maximum. Other approaches like %SPR proxies are also considered precautionary.

In conclusion, new technical guidance is needed to express precaution in with respect to acceptable risks of overfishing, rather than using precautionary OFL proxies or stock assessment decisions. OFL should be based on direct estimates of  $F_{MSY}$  whenever possible and be risk-neutral so that the ABC can be risk-adverse.

## **Highlights of discussion on quantifying uncertainty in ABC forecasts**

- Reference points have been overused because of a desire for stability. Many times there is other information available to estimate  $F_{MSY}$ ; scientists on the West Coast have done that in a risk-neutral manner. But, when estimating  $F_{MSY}$ , you are going to get a broad distribution with point estimates. The approach to use must be evaluated and may not necessarily be dictated by the language of the MSA itself.
- Projections are vulnerable to retrospective patterns and can have a major effect on the capital outputs.
- There is a need to investigate whether  $F_{40\%}$  is risk neutral. Because it usually tends to be more risk-adverse. When used, the SSC should advise the Council about whether  $F_{40\%}$  is risk neutral or adverse.
- Environmental factors should be incorporated into assessments when determining  $F_{MSY}$ , but they must be used with caution because environmental conditions change and the relationships of species to their environment are complex. Sardines, for example, were thought to have a strong environmental correlation, but when 17 years of data were input into the model, the relationship broke down.
- One cannot know exactly what the OFL is and it will always be an estimate. The retrospective approach is useful when setting ABCs and AMs because OFLs are not precise.
- In the recreational fishery, the catch is driven by abundance. Uncertainties are compounded as one computes towards the OFL. This is aggravated when the data are expanded and accommodate the adjustment factors.
- Creating a model is a substantial ordeal. It entails setting up diagnostics that will ultimately lead to an approximation of the true population parameter. The magnitude of the uncertainties will depend on how true the estimated parameters are.

### **Including Economics in Risk Analysis and Optimum Yield**

**David Tomberlin** presented on the application of maximum economic yield (MEY) as a proxy for optimum yield because it reflects the benefits to society better than MSY. This is a number that can be calculated (subject to any constraints), is the basis for estimating opportunity costs, and can reflect specific uncertainties and risk preferences. The NPFMC crab ACL determination is a situation in which MEY was assessed to identify short-run implications of different risks of overfishing.

**Lee Anderson** presented on the possible role of economics in elucidating uncertainties when setting ACLs. The main reason for the buffer between OFL and ABC is to reduce the probability of overfishing to an acceptable level; the same concept applies to setting ACL relative to ABC. Reducing the probability of overfishing is good, and the generally-accepted view is that a little

reduction is good and a bigger reduction is better. However, there is little or no consideration of opportunity costs associated with the reduction. More importantly, it is not clear what is gained by a bigger reduction. At a minimum, fishermen are giving up potential current harvest and the potential of maximizing economic gains out of the current harvest.

Economic valuations for each fishery or species within a fishery are not equal. One ton of herring does not have the same value as a ton of tuna. Moreover, percent reduction of ABC from OFL using a certain risk specification will vary by the species being harvested. A potential rule that could be used is to choose a suite of ABCs such that the marginal cost (MC) of reducing the cost of  $P^*$  is same in all stocks. Technically,  $P^*$  is being replaced with  $MC^*$ .

What is gained and what are the effects of lowering the probability of overfishing? In a strict sense, the probability is lowered of having the catch be higher than MFFM times the estimate of current stock size. Overfishing gives the impression that all fishing is damaging and nothing can be recovered from beyond the OFL. Potential damage would depend upon many things, not the least of which is the size of the existing stock relative to an estimate of MSY. To avoid the doomsday scenario of economic overfishing, the general rule is to keep increasing the buffer until the marginal benefit, in terms of expected increased discounted value of future production due to reduced risk of overfishing, equals the marginal cost of loss of current output. the goal of fisheries is to maximize their value. To do so, the formal difference between risk and uncertainty must be understood; both are important in efficiently maximizing the economic gains of the fishery. Lower risk results in greater flexibility in managing the fishery. Risk is defined as randomness with knowable probabilities while uncertainty is randomness with unknowable probabilities. In a data poor situation, risk analysis cannot be used to determine uncertainties because there are no probabilities associated with it, therefore it is necessary to use game theory.

### **Highlights of discussion on including economics in risk analysis and optimum yield**

- Data confidentiality serves as an impediment in economic analyses.
- Instead of determining what the MSY is and determining economic gains at a particular harvest level, an industry-agreed-to economic yield could be used from which the harvest biomass is determined that is associated with that MEY.
- In a situation where the industry is footing most of the bill, there is funding freed up from the Cooperative Research Program that can potentially go to conducting research for smaller valued fisheries. Typically, the high value fishery requires an updated assessment annually, thus the lesser value fisheries are left out/ignored.
- Buffer is an ill-defined probability in an economic context. The difficulty is translating MSA language into guidance because what MSA defines as overfishing is a fishing rate that jeopardizes MSY on a continuing basis; the way overfishing is operationalized is  $F > F_{MSY}$  on an annual basis. If you started off with an abstract definition of overfishing in the Act, you could interpret that differently and potentially lead to wrong approaches of evaluating what the buffer should be.

## **Linkage to Ecosystem and Habitat**

**Pat Livingston** described national programs and plans, including integrated ecosystem assessments, and habitat science and assessment. There are two methods for using ecosystem information in an ACL context: 1) tactical, which is a quantitative incorporation into a single species assessment model; and 2) strategic, which is a management strategy evaluation to examine the robustness of a stock assessment. Some examples of ecosystem-based management actions that involve ACLs include the OY cap on total ground fish yield, no target fisheries allowed for forage (EC designation), a minimum biomass threshold in the harvest control rule for sea lion prey species, trawl closures, and single species FMPs converted to place-based or multispecies FMPs or FEPs. Another tool is the Integrated Ocean Observing System that informed habitat science in supporting marine ecosystem management, particularly for determining connectivity of larvae to nursery grounds. These have the potential to aid spatially-explicit stock assessments and help understand variables influencing recruitment.

The utility of an ecosystem assessment is to provide a spatially-explicit modeling and tracking impacts of fishing and climate change on the ecosystem structure and function at multiple scales. This can help in the understanding of ecosystem thresholds, productivity, and carrying capacity.

Short term objectives for incorporating ecosystem objectives into ACL development would include: 1) continue to address ecosystem Terms of Reference in stock assessments (drivers of recruitment, etc); 2) continue development of integrated ecosystem assessment frameworks; 3) develop more explicit rules or processes for defining where ecosystem considerations should play into the ACL decision process; and 4) continue and enhance funding for National programs that focus on ecosystem data collection and integration.

**John Boreman** provided an overview of the status of habitat science. The majority of information available is still at level 1, which is comprised of presence-absence of the habitats and mapping of essential fish habitats. Level 2 information includes habitat related fish densities; level 3 includes information on vital rates within habitats; and level 4 includes information on productivity within each type of habitat. Current scientific information falls in the first level because some species are only incidentally caught; there are significant knowledge gaps in life cycle, habitat preference or lower predation rate; and a range extension in relation to abundance.

The fishery management councils (councils) have an important role in linking habitat science to management. Habitat science is conducted by many federal and state agencies and non-government organizations. Being on the receiving end of habitat science information, councils can serve as a direct line for determining fishery management needs and can provide meaningful coordination between agencies and resource users. The councils can continually request for improvements in the science products and set up an end-to-end information management architecture.

The Mid-Atlantic Fishery Management Council (MAFMC) Scientific and Statistical Committee (SSC) created an Ecosystem Subcommittee that provides the MAFMC with scientific advice to

support and inform development of ecosystem level goals, objectives, and policies. They provide advice to address and incorporate ecosystem structure and function in its FMPs and quota specification process. The subcommittee describes scientific info the Council could consider to anticipate or respond to shifts in ecological conditions. They summarize what other regions and countries are doing to incorporate ecosystem-based fishery management principles in FMPs and describe how ecosystem principles could be used by the Council in the long term to evolve its single species and multispecies FMPs into regional FEPs. Ecosystem issues confronting the MAFMC include accounting for forage species and handling bycatch caps (squid, butterfish), which will be the topic for next national SSC workshop.

The MSA requires input of habitat and ecosystem advice into the management process; habitat assessment advice should be expressed in common currency that can be input directly into stock assessments; species that have no habitat information should be grouped with other species with similar life history traits.

### **Highlights of discussion on linkage to ecosystem and habitat**

- There is a potential for double counting ecosystem importance in the ACL process. The first stage is the incorporation of ecosystem parameters in the stock assessment and the second is in integrating ecosystem and habitat considerations into ABC determination. Close examination of the process is needed to ensure this situation is avoided. The potential third layer will occur if this is applied to the buffer when considering management uncertainties.
- Closer attention should be given to stocks that are known to be declining even if there is no fishery for them. This is true for butterfish – takes are prohibited but the stock continues to decline due to environmental impacts. In contrast, equal attention should be given on the impacts of fishing on prey species that impact the predator population.
- Some regions are shifting to use of spatial models in stock assessments regardless of whether it is a funded mandate or not.
- Given the limited funding situation, incorporation of ecosystem and habitat data in stock assessments has to be balanced with the cost of data gathering. The benefits of spatially structured assessments are indeed important, but must consider the funding requirement for such a high level assessment.
- The single species assessment must be right first before attempting to engage in more complex modeling.
- In the context of ACL setting, ecosystem information can provide more basis for ACL setting, but there is concern about inference with multiple causes. While including ecosystem models in ACL development with respect to setting thresholds is a positive action, the system has to be adaptive from the beginning. Additionally, with more scenarios, it will take managers longer to decide. Lastly, predator-prey dynamics have

limited information at this point.

- Currently, the data or technology does not exist to build ecosystem models that would automatically set ACLs. That said, it is a false dichotomy to segregate development of ecosystem models and improvements of single species assessments. The pursuit to build ecosystem knowledge from ecosystem models should be continued. As MSP advances, fishery managers must incorporate other objectives alongside fisheries objectives, both of which can be guided by understanding the impacted ecosystems.
- Care must be taken when making assumptions that MPAs will solve the uncertainty issues. MPAs may reduce the implementation uncertainty because the fishing mortality was reduced to 0 in that area, but whether the fish are going to persist in MPAs will depend on other factors (i.e. habitat quality, reproductive potential, recruitment success, differential effects of protection to different species, differential predatory rates).

### **Assessment Tempo and Review**

**Steve Ralston** presented a background on the stock assessment review process and the status of stock assessments in various regions. Stock assessments are just a small part of a larger process that includes stock assessment review, SSC review, Council adoption, fishery regulation, implementation, and off-year assessments. Fishery management performance is based on a point system, the Fish Stock Status Index (FSSI) of 230 stocks and stock complexes. Each stock can receive a maximum of 4 points. Knowledge about whether it is overfished is worth half a point, knowledge about its overfishing status is worth half a point, 1 point for overfishing not occurring, 1 point if the stock biomass is above the overfished definition, and 1 point for a stock biomass at or above 80%  $B_{MSY}$ . There are five levels of stock assessment depending on the approach and complexity of modeling. Most are level 4 assessments with age and size-based models, with fewer at level 2 or 3. Level 3 is the minimum for status determination. Level 1 assessment does not affect the FSSI score because the overfished and overfishing statuses cannot be determined at this level. The Alaska Fisheries Science Center had the highest number of assessments done per year (45 assessments), while the Caribbean and Pacific Islands regions have the lowest assessment rate. This trend is due to the following factors: 1) the number of species being assessed – the tropical region has a several orders of magnitude greater number of species in the fishery versus the temperate sub-Arctic region; 2) size of fleet and fishery; and 3) number of stock assessment scientist available. Assessments are prioritized based on: 1) intensity of fishing; 2) stock status; 3) assessment age; 4) stock importance; 5) synergistic factors; and 6) FSSI versus non-FSSI stocks. To maintain an active status in the FSSI, stock assessments must be repeated at least once in 5 years.

Some elements of acceptable peer review include: 1) transparency to public; 2) conducted early in process; 3) not be duplicative; 4) clear Terms of Reference developed; 5) reviewer selection should provide appropriate expertise and balance; 6) reviewers must be independent; and 7) reviewers must not have conflicts of interest.

**John Carmichael** provided an overview of the peer review throughput process. The problems in the peer review process include many unassessed stocks, long delays between assessments, and

that it is cumbersome and burdensome. The peer review process is subject to three conditions: 1) transparency; 2) timeliness; and 3) thoroughness. To improve on the peer review process, only two parameters can be chosen. The review can be enhanced to be very transparent and thorough, but will sacrifice timely production of assessments. The current situations call for a more timely assessment and improved thoroughness, which could reduce the transparency with less public input (in terms of numbers of times the public sees the assessment).

There are significant impediments to improving on the review process: 1) resources are fixed or slow to change; 2) managers have expectations of scientific sophistication; 3) constituents are becoming accustomed to transparency and “voice”; 4) critics know that delays are often favorable; 5) procedures become institutionalized (so cannot change even if necessary – there is a need to be responsive to changes); and 6) peer reviews are required.

Tradeoffs in transparency or thoroughness are required in order to enhance the timeliness of the stock assessment process. . In the case of transparency, all who attended a review proceeding may not have understood the stock assessment analysis, but that does not mean the assessment is wrong. In the case for thoroughness: evaluation of data sources and consideration of appropriate models and prior assessments is a significant task, but does not mean that all data are to be included, multiple models must be pursued, all stocks must use the most advanced models, and all issues must be discussed at every stage.

Some of these issues in the stock assessment process can be address with more standardized models and streamlined data access. Different states and jurisdictions produce different data and yield different assessment results. Setting the stock benchmarks and simply providing updates to these benchmarks will reduce the time consumed in redoing the model every assessment. It is simply a matter of getting the assessment right the first time and updating it as new data comes in. It was also suggested to rely more on analysts and less on committees. This would reduce the back and forth argument on which data are better and which model is more appropriate.

Focusing on benchmarks would lead to fewer peer reviews (i.e. the initial stock assessment to determine benchmarks is peer reviewed, but subsequent updates are not), hastening the stock assessment process. Less intensive peer reviews could handle more stocks, which may be feasible for mature programs. A tiered system of reviews was suggested because the data needs for benchmarks differ from assessment updates.

Expectations should be managed – managers may need to accept a lower level of scientific advice depending on the stocks being assessed (not all stocks require a high-end assessment and not all stocks need to have age-based models). Managers and policy makers need to endorse and support tradeoffs in transparency and thoroughness that are necessary to increase the tempo of stock assessments and improve timeliness and productivity.

### **Discussion highlights on assessment tempo and review**

- National Standard 2 Guidelines require the use of best available scientific information. This was revised after the MSA was reauthorized such that best available scientific information now should include an evaluation of uncertainty, however this evaluation

should not be used to delay action. This is overly prescriptive and results in forcing the use of inappropriate information just to meet the requirement.

- The key to throughput is knowing what is being reviewed. While reviewing an end result may be difficult, even a new species inevitably has components that build upon or are similar to those of familiar species' assessments, which can hasten the review process.
- Reviewer uncertainty, such as a rogue reviewer, is a non-trivial parameter that can influence the peer-review process. It should be assured that the assessment and review process is driven by the best scientific information available and not by reviewer behavior. The chair of the review panel will be the best person to detect if such influence is a factor in the process.
- Independent reviewers must be used judiciously because most of them are not familiar with the data sets and the history of the data. There must be a consistent core reviewer so that there is continuity in the results and the quality of the review is maintained.
- Stakeholder input can be highly informative, but also can be detrimental because it can sway a review. There needs to be a way to keep stakeholder involvement informative, but limit its ability to unduly influence the results.

### **ACL workshop wrap-up session**

On assessment and data needs:

- All regions need more data;
- Consider different types of abundance surveys (not only industry based surveys);
- Need more data on important processes (i.e. natural mortality, degree of recruitment compensation, life history, etc.)

On fishery monitoring:

- Improve timeliness of data submissions and reporting;
- Improve data quality through validation (i.e. dock side interviews for recreational fishery and volunteer log books);
- One stop shops (synchronize data submission by using electronic means and create centralized database fed by all regions);
- Improve forecasting (i.e. models and model assumptions)

On data limited approaches:

- ID stocks that have enough data for data limited assessments (which stocks must use catch-only approach);
- In a data limited situation, use DB-SRA, DCAC, or ORCS;
- Improve data collection on data poor stocks to step up to at least level 3 assessment;
- Start gathering data for “no-data” stocks to achieve at least a level 1 assessment.

On cooperative research:

- Provide a clear direction on where Cooperative Research should be headed (balance between stock assessments and life history determination);
- Improve on “cooperation” by involving all parties at ALL stages of the research (from proposal to feedback of results to management);

On uncertainties in forecasting:

- Develop models for the right capabilities instead of forcing inappropriate data just to achieve forecasting needs;
- Improve on communicating the technicalities of uncertainties to Council and general public

On economics in risk analysis and OY:

- Conduct risk analysis with socio-economic components;
- Explore the use of marginal cost benefit in light of setting buffers

On linking ecosystems and habitat:

- Continue to bring ecosystem, habitat, and environmental research directly into ACL context;
- Mesh above with Integrated Environmental Assessment and focus on habitat usage by life stage and forage species

On assessment and review tempo:

- Need to use best practice approach;
- Adjust throughput to meet management needs of each region;
- Look into improving quality, timeliness and transparency;
- If not, examine trade-offs that will apply for each region;
- Aiming for a level 4 assessment might be too ambitious, thus evaluate what level is applicable for what stock.

On other overall comments about the workshop:

- To improve stock assessment, do not rely only on hiring more stock assessment scientists, but improve data collection surveys, increase aging and growth studies, and improve QA/QC of the observer programs. All these are part of the whole process.
- Most people involved in the fishery management process spend a lot of time looking at the demands of the MSRA and its implications on science decisions. It is more important to be able to set deliverables and have the negotiated project show up on time instead of having unrealistic expectations.
- There should be an opportunity for SSC and council staff exchanges during different regions’ SSC meetings to facilitate learning and sharing experiences from both successful and deprived regions, and those that may be having similar experiences.
- Someone has to do analytical work to inform tradeoffs, which should not be done by a number of ad hoc efforts by individual SSCs. It should come from NMFS. The idea of

exchanging between SSCs so we can learn is good, but the SSCs can be an efficient way of getting through some of the independent review process.