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From: Paul Howard
Sent: Friday, December 16, 2011 9:25 AM
To: Council
Cc: TechStaff
Subject: FW: Follow up on GOM Cod
Attachments: 2010 Gulf of Maine Cod WG Assessment Notes.docx; letter to Sam Rauch Cod assessment Dec 2011.docx

To Council Members:

FYI. The attached are copies of the cover letter and notes that David Goethel sent to Sam Rauch, Deputy Assistant Administrator, as requested at Friday's Cod Working Group meeting in Portsmouth, NH.

Paul

Hi Sam,

Enclosed is a list of issues related to the current Gulf of Maine Cod stock assessment. Daniel and I have arranged it so that it outlines the issues and offers some possible solutions. We both agree that these are the major problems, but the list is not all-inclusive. As you can see, we feel that many of the assumptions made in this model are erroneous. In most cases assumptions were based on improving statistical fit at the cost of biological reality. Additionally, a change in almost any one of these assumptions will change the output of the model. However, altering all or some of these incorrect assumptions simultaneously will drastically increase estimates of spawning stock biomass and reduce fishing mortality. This is one aspect not considered within the working group because sensitivity runs are carried out incrementally and not simultaneously. Thus, reviewers are not given a chance to view how model outputs are altered when, for instance, survey selectivity is allowed to be domed AND catchability is bounded at reasonable levels (considering domed selectivity alone results in a 21% increase in biomass, it is easy to speculate that the combined effect would be even greater). Since the working group already feels that it has provided the best available science to the peer review, I see no sense in forwarding it to them alone. Rather I would send this to each member of the peer review committee and request that they detail a response in writing in their peer review report. Until these issues are resolved to everyone's satisfaction, we cannot and will not, accept the current assessment as the best available science.

I remain concerned that the terms of reference were too narrowly defined and specifically excluded the findings of the Cod Tagging Working Group, which requested a reexamination of the Cod Stock boundaries in the Gulf of Maine and Georges Bank. Also, there are many peer reviewed cooperative research projects available on Gulf of Maine Cod which should also be reviewed. Further, the Study Fleet Data on GOM vessels should be examined for trends in CPUE. Chad Demerast and Tom Nies worked at the eleventh hour to provide CPUE data which was also not examined by the Peer Review Team. Such data indicates a strong increasing trend in CPUE that counters recent declines in survey abundance. NEFSC has claimed that such increases are indicative of a contracting stock, however this hypothesis goes against what is being seen across the Gulf of Maine and this data clearly show that biomass is expanding not contracting. The fact that the science center is avoiding using this data in even an exploratory run (by arguing that it demonstrates cod contraction and would give a falsely optimistic output and/or claiming that CPUE is too unreliable due to difficulty in standardizing effort statistics despite using CPUE in the GARM III assessment and initial ASAP runs) clearly portrays the lack of objectivity of assessment scientists. All of these studies and bodies of work should be forwarded to the Peer Review Team or the Peer Review Team should be reconvened before their final report is delivered.

While I think that Friday's meeting was a good first step in identifying the issues, I remain concerned that some people are falling back on well worn scientific clichés that have not been examined as they relate to the Gulf of Maine Ecosystem. Thus, in my view, these arguments have no scientific validity in the current debate. For example, the cod collapse in Newfoundland took place in an entirely different ecosystem. It was driven by the invention of ice breaking trawl vessels which could tow through the ice where the cod had been previously protected. Yes, the cod did aggregate into very dense schools in Newfoundland. However, this was a phenomenon which probably occurred for thousands of years as cod sought warm pockets of water in a very cold regime, but had not been documented by scientists until the dawn of the icebreakers. The excuse that the cod are aggregating as their numbers dwindle has been used over and over again in the GOM whenever the models do not reflect with what fishermen are experiencing.

I was greatly disturbed by the constant referral to sensitivity runs which in themselves only determine how many incremental changes you have to make until you turn an apple into a watermelon. Sensitivity analyses are being used in public presentations inappropriately to give the appearance of a high degree of certainty of the results.

Due to all of my concerns above, as a matter of conscience, I will not be able to accept this assessment, as currently written, for use in management advice.

I look forward to a resolution of these issues so that we can move forward jointly in order to do what is best for the fish and the fishermen in the Gulf of Maine.

Thank you,
David Goethel

2010 Gulf of Maine Cod WG Assessment Notes

Biology

- Stock identification is incorrect for cod in New England
 - Tagging evidence suggests that cod stock boundaries should be separated into: eastern Gulf of Maine-Eastern Georges Bank, and western Gulf of Maine-Cape Cod-Southern New England
 - Information regarding stock structure and discussions regarding proper stock boundaries were explicitly avoided during the assessment meetings for Gulf of Maine cod even though the current boundaries are highly questionable in light of the last decade of scientific research
 - It is widely believed that the recent expansion of cod into Southern New England (a region with historically low cod abundance in recent decades) is due to a 'spillover' migration effect of cod from the Gulf of Maine
 - This suggests that the Gulf of Maine cod stock is actually expanding and contradicts the stock contraction hypothesis being presented by NEFSC
- The length-weight relation and catch weight-at-age matrix are unreliable
 - The length-weight relation is based on survey catch and not on the commercial catch
 - Catch weight-at-age matrix is averaged over the recreational and commercial fisheries and over discard and landed catch
 - This acts to blur the signals in the catch because the weight of recreationally caught fish are lower than that of commercial fish thereby decreasing the weight of 'caught' fish in the model
- There is an apparent under-sampling of older fish in the catch-at-age, which gives the appearance of a truncated age-structure and increased F-at-age
 - Observer samples do not accurately reflect the actual catch, perhaps due to focusing on measuring smaller discarded fish
 - Large, older fish are not being properly sampled and this has led to a lack of old (age-7+) fish being 'seen'
 - Very few otoliths of fish greater than age -7 are being taken during surveys (which is used for determining the length-weight equation) and it is likely that port samples of cod otoliths are also biased towards smaller fish (reported samples are divided by market category and not age; it is likely that samplers are taking a majority of otoliths from smaller fish within each market category and sampling at times of year and ports where large fish are not being landed, thereby violating the random stratified sampling design)
 - Use of external data sources could help to verify age-structure information (e.g., gear studies and tagging studies that have information on age or length structure could be used as an exploratory check)
- The age-9+ formulation is invalid and underutilizes the flexibility of the Age-Structured Assessment Program (ASAP) framework
 - The length-weight relation clearly shows that fish continue to grow past age-16, yet the age-structure used implicitly assumes no growth after age-9 by assuming a plus group at this age and an associated average weight of fish in this group

- Considering cod's ability to put on significant weight after age-9, this formulation inherently underestimates SSB and biomass if even a few older fish survive out to ages greater than age-9
- Constant natural mortality ($M=0.2$) assumption is biologically unrealistic
 - This estimate is based on a maximum age of 15-17 years, yet the length-weight relation indicates cod continue growing past this age so it seems unlikely that the fish would continue to grow up until the maximum age
 - Additionally, changes in the ecosystem over the last 3 decades would indicate the necessity for a time-varying natural mortality rate and also an age-varying natural mortality
 - Juveniles are well documented to inhabit different habitats from adults and predation is much heavier on juveniles (e.g., seal and dog fish predation)
 - Lack of 2007 year class recruiting to fishery as predicted in GARM III might be an indication of high predation on age-1 fish meaning a higher M is supported for juvenile cod

Catch

- Observed catch is split by recreational/commercial and landed/discarded but models fitted to these more 'complex' data sets were deemed too unstable and showed results "similar to the simple (lumped catch) model"
 - Although the model might be more statistically stable, it is much less biologically realistic due to the severe differences in selectivity and weight of the commercial and recreational catch
 - **Tradeoffs between biological realism and statistical assumptions must be made, however this assessment always errs on the side of statistics instead of actual, proven biology**
- Fishery selectivity was broken down into two time blocks (pre and post 1991) based on statistical fit, yet no management actions or fishery changes support this choice
- Due to lumping of fishery catch across recreational and commercial fleets it is impossible to gain any biological insight into what the estimated selectivity patterns indicate (i.e., is one fleet fishing more heavily on older fish, etc...) and it is impossible to determine the individual effects of each fleet (i.e., is the fishing mortality greater from the recreational or commercial component, which is an important facet when determining possible future management scenarios)
 - This is another indication that degradation of the data in order to simply increase statistical fit at the cost of biological insight is inappropriate
- Marine Recreational Fishery Statistic Survey (MRFSS) data is used to estimate recreational catch-at-age by imputation based on MRFSS estimates of numbers caught at length and applying the NEFSC survey length-weight equations
 - Uncertainty in MRFSS data is well known and estimates in recent years counter data from other sources and common sense
 - Vessel trip reports (VTR) from recreational head boats indicate catch estimates 75% lower than MRFSS data
 - It is difficult to believe that recreational vessels accounted for the same level of catch (~5500mt) as commercial vessels in 2010

- This is the first time that recreational discard levels have been included in the assessment, however estimates are basically guesses with extremely high and ever increasing levels (~2300mt in 2010)
- Discard mortality is assumed 100% for all fisheries because the literature does not provide a comprehensive estimate of mortality rates for all gear type and seasonal combinations
 - Most literature proves that discard mortality is less than 100%, which considering levels of assumed discard rates could provide substantial sources of biomass that are being falsely accounted as mortality within the model, yet no sensitivity runs were undertaken to look at the affect of the assumed discard mortality rate

Surveys

- Inshore strata of the NEFSC surveys were excluded from the assessment due to inconsistent sampling even though they provide indications of higher age-0 to 2 indices of abundance
- Massachusetts Division of Marine Fisheries (MADMF) surveys are the only reliable estimators of juvenile fish abundance because they survey inshore juvenile habitat, however they are consistently down weighted and the MADMF fall survey was completely removed from the final model
- Surveys supposedly cover all areas of major cod catch and accurately represent abundance trends, yet years with high catch rates are consistently considered outliers
 - Over the entire time series the NEFSC may cover all areas of major cod catches, but not on a consistent year to year basis (i.e., major areas of cod concentration are sampled sporadically over the last 15 years, however on a year to year basis many concentrations are missed which is likely one contribution to seeing large tows dominate survey catch and cause jumps in catch from year to year)
 - It is entirely possible that years with high catch rates are actually representative of the population and that the low catches are outliers due to survey locations in areas where cod are not found (e.g., due to the surveys avoiding hard-bottom habitats which cod often inhabit)
- NEFSC survey catchability is approaching 1.0 and back-transformed catchabilities for R/V Bigelow are above 1.0, indicating that the two research boats are approaching or above 100% efficiency even though almost no catch of fish older than age 7 are reported and area swept estimates of stock biomass approach model estimates of biomass for the entire stock
 - Regardless of statistical arguments provided by NEFSC these values indicate poor model performance and should not be treated lightly
- Survey selectivity is flat topped and fixed at 100% for ages 6+
 - Assessment claims “little biological evidence” for domed selectivity, however allowing for domed selectivity increases SSB by 21%
 - Tagging evidence indicates that shorter tows allow older, larger fish to more easily escape the net than younger fish
 - Survey tow times average between 20-30 minutes and therefore present a very high probability that older fish are able to out swim the net and escape
 - It is therefore more likely that the survey selectivity is heavily domed and that is why few fish older than age-7 are seen in it, as opposed to the current assumption that

fishery selectivity is domed (where commercial tows are often upwards of 3-5 hours) and survey selectivity is flat-topped

- In combination with the survey catchability estimates around 1.0, it appears that there is an issue within the model with the survey time series
 - The assumptions used to fit this data consistently err on the side of a pessimistic instead of optimistic stock status (e.g., allowing for domed survey selectivity and bounding catchabilities around .7 would greatly increase abundance estimates)

Catch-per-Unit Effort

- NEFSC claim that incorporating CPUE data is not possible due to problems standardizing effort statistics, however the final GARM III model used a CPUE data set and initial ASAP runs made use of this same data set until it was determined that the model was insensitive to its inclusion
- Recently calculated CPUE data from NEFSC scientists indicate that CPUE has been consistently and drastically increasing since 2000 with large decreases in effort and increases in cod landings, however NEFSC refuses to attempt any exploratory runs with this data set due to the 'difficulty' in incorporating CPUE data
 - If old CPUE data sets were possible to incorporate there should be no reason that new data cannot be used
 - The data shows that the increasing CPUE trend is robust to multiple effort statistics and greatly contradicts the notion that the stock is decreasing as demonstrated by recent survey data
 - NEFSC argue that this data supports the stock contraction theory (because CPUE will increase as fish concentrate together at smaller population sizes making them easier to catch) and thus do not want to include it because it would inherently force the model to estimate higher biomass
 - However, taken in context with observations from around New England that cod are being caught in locations that they have not been seen for decades, it indicates the opposite of what the NEFSC is portraying; cod appear to be expanding and higher CPUE is due to an enormous cod biomass throughout the region and not just at small, concentrated locales

Historical VPA Bridge Assessment

- Updated data used from the previous assessment (i.e., new length-weight equation, updated weight-at-age, updated catch-at-age, inclusion of discards-at-age, and a revised maturity schedule) have caused a complete change in stock status from the GARM III assessment without changing any of the model formulation or adding new data since 2007 (i.e., the change in historic data since 2007 has changed stock status without adding the last 3 years of data or changing any of the model framework)
 - F in 2007 has increased by .1 (21.7%) to $F=.56$ and SSB has decreased by 14,428mt (42.6%) to $SSB=19,445$

Final ASAP Model Results

- Current estimates of fishing mortality and spawning stock biomass go against all information from the fishery (decreasing effort and increasing CPUE) and management actions (increasingly stringent measures over the last 2 decades)
- Current instantaneous fishing mortality rates on fully selected fish of 1.14 indicates that 68% of these age classes are harvested in a given year and total mortality (i.e., including a natural mortality of 0.2) indicates that almost 74% of these age classes die
 - Such estimates are absurd and if correct this stock should have collapsed long ago
 - Under this mortality regime only .056% of fish live to age-9, which means that the 2010 age-class of 4.286 million fish would yield only 2418 age-9 fish
 - Such results are difficult to believe in the face of current catch compositions and catch rates
- Lack of diagnostics (coefficient of variations) for all model parameters makes it impossible to objectively assess model fit and performance; only CVs are given for selectivity parameters and indicate the model is poorly estimating these parameters
- The use of incremental sensitivity analysis to look at how changing a single assumption at a time affects stock status does not necessarily portray these affects accurately
 - In reality the base assessment has a number of assumptions that go against the basic biology of the fishery and results should be given showing the effects of changing multiple assumptions simultaneously
 - For example, what is the effect of allowing domed survey selectivity, bounding catchability at reasonable levels, calculating age-structure out to ~age-16, splitting commercial and recreational catch, incorporating CPUE data, decreasing discard mortality, and decreasing unrealistic recreational catch levels?
 - No single change will greatly alter the output of a model, however when numerous assumptions do not reflect reality it makes sense to change all simultaneously and see how the model responds, something that was never considered in the development of the Gulf of Maine cod assessment
- Biological Reference Points are based on an ASAP run back to 1970 (longer timeseries than the actual assessment) assuming a Beverton and Holt stock-recruit function
 - However, analysis by Butterworth and Raddenmeyer (2011) demonstrate that if the model is extended into the late 1960s a decline in recruitment at extremely high stock sizes is present (possibly due to cannibalism on juveniles by adult cod, etc...) indicating that a Ricker style stock-recruit curve is more appropriate and model estimates indicate that GoM cod is NOT overfished

Summary

- Observations throughout New England indicate cod are expanding their range and not contracting as NEFSC hypothesize
- Under-sampling of catch has led to a perceived age-structure truncation that does not match large numbers of old, large cod being caught by commercial fishermen
- Recreational catch is highly overestimated by MRFSS data
- Flat topped survey selectivity is unrealistic and allowing the model to estimate domed selectivity causes a large increase in biomass and SSB

- The purposeful avoidance of exploratory analysis of recent NEFSC CPUE data within the assessment indicates a lack of objectivity by the assessment scientists as this data clearly counters recent trends in NEFSC survey abundance and indicates an expansion of cod biomass in the Gulf of Maine
- Model results go against all recent management actions and observed biology and are based solely on noisy, unreliable surveys (since catch trends do not reflect the biomass under a hard total allowable catch system, they simply reflect management expectations regarding stock abundance assuming the TAC is fully harvested; CPUE is the only real indication of biomass levels that can be garnered from catch data in this instance)
- Tradeoffs between biological realism and statistical assumptions must be made, however this assessment always errs on the side of statistical fit instead of actual, proven biology resulting in many biologically unrealistic modeling assumptions often causing a more pessimistic view of stock status