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NATIONAL MARINE FISHERIES SERVICE
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Dear Brian,

Thank you for your detailed letter of August 19, 2013 regarding our August 9 presentations on TRAC species status. In response to your questions, we have provided detailed answers.

Q1. The natural mortality of cod appeared to quadruple. I asked how this affected management regulations. Normally, an increasing natural mortality would suggest a smaller optimal mesh size and higher fishing mortality reference points. How is the quadrupling of natural mortality taken into account in management?

A1. A natural mortality rate (M) of 0.8 per year was applied to the Eastern Georges Bank (EGB) cod VPA model for ages 6 and older from 1994 onward. A value of M=0.2 was applied to the younger age groups (ages 1-5) in these years, and to all age groups in years prior to 1994. Thus, the quadrupling of natural mortality is only for older fish in recent years. In contrast, the Georges Bank (GB) cod assessment vetted at the December 2012 Stock Assessment Workshop (SAW) is based on an ASAP model using M=0.2 for all age groups in all years.

In the EGB cod VPA, the range of years and ages for M=0.8 was primarily determined by model fit rather than by evidence of a mechanism for such high mortality on the older ages. Seals are present on Georges Bank during the spawning season as indicated by satellite tagging; however, the residence time on the Bank of these animals is unknown. Moreover, there is no quantitative information regarding the amount and frequency of seal predation on cod on the Bank that would justify such a high M based on predator/prey dynamics.

The quadrupling of natural mortality on cod aged 6 or older in recent years is only partially accounted for in the management advice. The issue is complex and requires some background information. EGB cod is managed by the Transboundary Management Guidance Committee (TMGC) using a harvest policy of maintaining a low to neutral risk of exceeding Fref = 0.18. This value of Fref was negotiated by TMGC in 2000 when both the GB and EGB cod were assessed using a VPA model with M = 0.2. Results were generally consistent between the two assessments at that time. At the 2013 TRAC EGB cod model benchmark meeting, preliminary analyses used to estimate a new Fref

consistent with the VPA 0.8 M model were presented, but the TRAC reviewers were critical of these analyses and did not accept the results. Apart from the TRAC decision, it is the prerogative of the TMGC to determine whether any proposed changes to Fref are appropriate and acceptable as a basis for quota decisions.
Although the April 2013 TRAC cod benchmark did not accept the analyses for a new Fref value, the TRAC recognized that the current Fref=0.18 was biologically inconsistent with the VPA 0.8M model, and that Fref values lower than 0.18 would be more consistent with this model. The TRAC therefore recommended that catch advice for 2014 should be based on an F value that was less than Fref =0.18. In the discussions on whether to apply a lower or higher F relative to the current Fref for catch advice, TRAC took into consideration the working paper "What direction should the fishing mortality target change when natural mortality increases within an assessment ?" by C. Legault and M. Palmer (attached). TRAC also agreed to present a consequence analysis to indicate the uncertainties in model assumptions between the VPA 0.8 M and ASAP M=0.2 model.

To summarize, the TRAC recommended applying an F value lower than the current Fref value to provide catch advice until a new Fref is available that is appropriate for both the EGB cod and GB cod management units is accepted by the TMGC. The increase in M in the EGB cod assessment is taken into account in the recommendation by the TRAC for a 2014 quota coincident with an F lower than Fref.

Q.2. Alternative models. I asked why alternative models were not considered. I think the answer was that many alternative models were considered and lead to the same catch advice for yellowtail. We wrote a paper comparing standard production models to age structured production models. We found that standard production models gave a much more favorable view of the status of the stock than the age structured production models that are presently used. When Steve Cadrin showed his results from multiple model applications, these showed that the standard production model gave a better perception of the status of the stock than the age structured model. My conclusion is that the models give different results, and this is supported by earlier calculations and simulations (see Rothschild, B.J. and Y. Jiao. 2013. Comparison between maximum sustained yield proxies and maximum sustained yield. The Open Fish Science Journal 6:1-9. doi:10.2174/1874401X01306010001). How are these observations factored into the stock assessment process?

A. We agree with your conclusion that different models give different results. The central question is whether the model assumptions are justified. Surplus production models have much less realism, and much stronger assumptions about the dynamics of the population. In particular, the assumption that the rate of change is proportional to the difference between current population size and a theoretical carrying capacity depends largely on the degree of contrast in the fishery and population trajectories. When the population is characterized by a continuous decline in abundance (*i.e.*, indicating a unidirectional trend or one with minimal contrast), the parameters will be highly biased and MSY estimates will be approximately equal to the long-term average catch.

Various alternative assessment models were applied to the Georges Bank yellowtail flounder data sets at the 2-day workshop that preceded the World Conference on Stock Assessment Methods (WCSAM) held in Boston in July of this year. None of the models was found to provide a suitable alternative for the current VPA. The surplus production

models applied at the workshop on the Georges Bank yellowtail flounder data generated total mortality estimates inconsistent with those from the three bottom trawl surveys and the recently published Wood and Cadrin (2013) evaluation of tagging data. For the most part, all of the alternative models highlighted problems with the catch data and/or the natural mortality rate. When reconstructed cohorts are smaller than swept-area estimates, this implies that catches (landing and/or discards) are underreported or natural mortality is higher than assumed and may be changing. Simultaneous changes in these processes are also possible.

Lacking understanding of the underlying causes for poor model fit, finding a model that does not demonstrate a retrospective pattern may simply mean that the model has no predictive ability. This would be the case if real changes in observations or processes are subsumed within parameters that ignore important determinants of stock dynamics. For example, investigating potential underreporting, underestimation of discards, and environmental predictors of increased natural mortality are relevant follow-up activities for models that exhibit strong retrospective patterns.

Q3. The $F_{40\%}$ criterion. We have pointed out many times that simply by reducing 40 to a lesser number, say, 30 or 20, we would get a much more optimistic picture of the status of the stock. Since 40 is chosen arbitrarily, why not determine the value that best meets our management objectives (see Rothschild, B.J., Y. Jiao and S. Hyun. 2012. Simulation study of biological reference points for the summer flounder. Trans. Am. Fish. Soc. 141:426-436.)?

A3. You are correct that reducing the target fraction of Maximum Spawning Potential (MSP) can lead to increased yield, depending on the shape of the yield per recruit curve. Similarly, because target spawning stock biomass decreases monotonically as F increases (or %MSP decreases), contemporary stock status will usually appear more optimistic at a lower %MSP criterion. In some cases, reducing the %MSP would allow us to reclassify an overfished stock as no longer overfished. However, this would not necessarily mean that the stock was in better shape, or that risks to the stock had been reduced. On the contrary, stocks with lower target biomasses will be more sensitive to the variability of incoming recruitment because recruitment will constitute a larger fraction of current population size. Similarly, yield fluctuations might be greater as smaller stocks often oscillate at a higher frequency than larger stocks. Finally, higher Fs associated with lower %MSP values could exceed Fmax. In this situation, the high fishing rate would also be uneconomical because overall yields from a cohort could increase by reducing F. Basic economic theory suggests that increases in yield with lower effort should increase total revenue (holding prices constant). Hence, setting a lower %MSP target has potential to increase variability in stock size and landings and also reduce economic efficiency.

This response does not directly address your question about the consequences of choosing F30% instead of F40%. Here it is valuable to consider some of the arguments posed at Groundfish Assessment Review Meeting (GARM III) and summary arguments in Legault and Brooks (2013). While the choice of F40% is not based on an algorithm (as is the Fmsy in a Ricker stock recruitment curve), the choice is not totally arbitrary. Clark's (1991, 1993, 2002) work found strong support for F35% and F40% as harvest strategies that would provide a large fraction of the true MSY over a broad range of

life-history parameters. As you know, selection of a stock recruitment (SR) function ranges from difficult to impossible in most stock assessments. "Successful" fits of SR functions are typically conditioned on the use of strong prior distributions on the steepness parameter. As Brooks et al. (2010) have shown, priors on steepness are equivalent to priors on percent of MSP, so the desirable logic of independent estimation is missing in most assessments that fit SR functions.

Your suggestion of selecting a %MSP that "best meets our management objectives" could be tested with additional simulation studies of alternative proxies harvest values over a range of assumed SR functions and population states. There may well be alternatives that perform better than F40%, but a simple increase in F from setting a low %MSP target is unlikely to achieve the desired properties of the fishery. It would be unwise to simply jump to a new value because it gives a more optimistic picture of stock status. As noted above, the biological attributes of the stock under higher Fs and the consequences for harvest variability need to be considered.

As noted in our response to your first question (Q1), although a benchmark assessment of eastern Georges Bank cod was conducted in April 2013, only the assessment model was modified and the fishing mortality reference point was not changed. Given the increase in the M value used for ages 6+, the assessment scientists were very much aware that the existing reference point was inconsistent with the model assumptions. However, in the TRAC, reference points are negotiated between the US and Canada, and further negotiations would need to occur before new reference points could be specified. In recognition of this process issue, the TRAC assessment scientists agreed that, although a new reference point could not be specified, an F value lower than the existing F=0.18 would be more appropriate as an F limit reference point. Hence, a straw man value of F=0.11 was used for illustration in the projections.

Q.4. Asymmetry of acceptance. The SMAST tagging studies seem to be rejected out of hand. I can see why one might be skeptical. On the other hand, it seems like the overall assessment is laced with problems, the biggest of which may be stock structure. Yet, the overall assessment is accepted without blinking an eye. Why are the SMAST estimates totally discarded?

A4.The SMAST tagging study report was received immediately before the TRAC meeting began and was reviewed by the TRAC. Among the concerns expressed by the reviewers were the low rate of recovery (<4%), under dispersion of recoveries suggesting lack of adequate post-capture mixing, and post-capture mortality of the released fish. Discard mortality rates of commercially caught fish have been estimated at about 90%. The tagging study, while based on shorter tows, did not record fish condition prior to release.

The seasonal bycatch survey conducted by SMAST was also reviewed at the TRAC. The committee expressed concern about lack of details on the survey design, and the absence of variability estimates for the dredge efficiency estimates. Total variance of the seasonal bycatch estimates appeared to be large, but the age 1+ estimate of biomass was only 22% higher than the assessment model results.

Hence, in both instances, the TRAC identified key sources of uncertainty and concluded that the SMAST estimates could not be directly used in the assessment.

Stock structure does not appear to be an issue for yellowtail flounder in this region based on the work conducted by Dan Goethel (as part of his PhD dissertation) and presented at WCSAM last month. Dan demonstrated low movement rates among the three USA yellowtail flounder stocks with no strong differences between stock-specific assessments and a combined assessment which estimated the movement rate among the stocks.

Q5. By the way, it appears that the allocation by the TRAC is based on both distribution and "utilization." It seems that utilization is an economic factor that is difficult to control. I don't see why utilization should play an important part in allocation. The degree of utilization should vary among years and be driven by a variety of factors that may be independent of the resource. Also, the distribution issue depends on the same survey results that have been arguable.

A5. If the contemporary "utilization" rates were the basis for the sharing arrangement, you would be correct in asserting that this would not be a fair basis for allocation. However, the allocation ratio is based on historical patterns of landings by each country from 1967 to 1994. The negotiated and agreed allocation algorithm was designed to smooth the transition from an allocation based on historical utilization to one based on the current distribution of the resources. The approach was believed to promote sound stewardship of the resource by both countries while minimizing the disruption of harvest allocations that might occur under a "distribution" only algorithm. The sharing agreement was negotiated by the TMGC in 2000. The text below is directly from the allocation working paper:

"*The initial sharing formula was based on the weighting of resource distribution from surveys by 60% and country utilization by 40%. Thereafter, the percentage weighting was changed in 5% annual increments until the weightings reached 90% resource distribution from surveys and 10% country utilization from landings. This agreement was implemented in 2003, with the end of the transition to a 90/10 weighting in the 2010 fishing year according to the following schedule:*

2003	2004	2005	2006	2007	2008	2009	2010
60/40	60/40	65/35	70/30	75/25	80/20	85/15	90/10

From 2010 onward, historical utilization is weighted only by 10% in the sharing formula.

Q6. Consistent with adoption of best available science and the magnitude of the stock assessment results, it seems that we should not change regulations until we have more information. This information should come from field studies and an immediate review of the assessment.

A6. This is a matter of policy but we should note that a pilot cooperative flatfish survey took place this summer and cooperative work on survey flatfish catchability will take place later this year. Preliminary results should be available by early 2014.

Q7. I don't see why the TRAC has the authority to bar stock assessment alternatives, particularly when the assessments are so very problematic and controversial. What is the basis of the TRAC authority?

A7. The US and Canada have a mutual understanding on the role of the TRAC in providing scientific results for management. Although the understanding does not have a formal basis in a treaty, the agreement has been valuable to managers on both sides as it establishes a process for vetting scientific information. In the absence of the TMGC and TRAC, the US would have to reduce its catches in response to anticipated Canadian catches. Such uncertainty in ACL determinations would be undesirable and possibly detrimental to US industry.

I hope we have been responsive to your questions but please let me know if you would like to follow up on any of these issues.

Sincerely,

Bill

William A. Karp, Ph.D.
Science and Research Director, NEFSC

Appendix: References

Brooks, E.N., J.E. Powers, and E. Cortez. 2010. Analytical reference points for age-structured models: application to data-poor fisheries. ICES J. Mar. Sci. 67:165-175.

Clark, W.G. 1991. Groundfish exploitation rates based on life history parameters. Can. J. Fish. Aquat. Sci. 48:734-750

Clark, W.G. 1993. The effect of recruitment variability on the choice of a target level of spawning biomass per recruit. IN: Proceedings of the International Symposium on Management Strategies for Exploited Fish Populations, pp. 233–246. Ed. by G. Kruse, R. J. Marasco, C. Pautzke, and T. J. Quinn, II. University of Alaska, Alaska Sea Grant College Program Report 93-02, Fairbanks.

Clark, W.G. 2002. F35% revisited ten years later. No. Amer. J. Fish. Mgt, 22: 251–257.

Legault, C.M., and E.N. Brooks. 2013. Can stock-recruitment points determine which spawning potential ratio is the best proxy for maximum sustainable yield reference points. ICES J. Mar. Sci. 70:1075-1080.

Wood, A. D. and S.X. Cadrin. 2013. Mortality and movement of yellowtail flounder (*Limanda ferruginea*) tagged off New England. Fish. Bull. 111: 279-287.