15 June 2016

Dr Robert J. Trumble
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Dear Bob,

Information in Response to WWF's Submission on Orange Roughy Assessments

Thank you for providing the Deepwater Group (DWG) with an opportunity to respond to WWF's submission to you, dated 8 June 2015.

This letter and the attached report serves to provide you with our response in regard to the the matters that WWF have raised on the P1 aspects of the orange roughy assessments.

Our written response to WWF's concerns with P2 matters will be provided to you within the next two weeks. We will work to the deadlines you provided on 9 June 2015.

Should you require further information on any pertinent matters, please ask.

Regards,

Victoria Jollands
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Comments on WWF's 8 June submission on MSC assessment of New Zealand Orange Roughy

P.L. Cordue, ISL

9 June 2015

Introduction

As the research provider which performed the 2014 orange roughy stock assessments and a subsequent Management Strategy Evaluation (MSE), I was asked by DWG to comment on WWF's submission to MRAG on the MSC assessment of three NZ orange roughy stocks. I have restricted my comments to P1 issues.

WWF's latest submission is dated 8 June 2015. The earlier WWF submission dated 30 July 2014 appears to pre-date the orange roughy MSE and I provide no specific comments on that submission. However, I note that once it is known that a fish species has very low natural mortality, and catches are reduced accordingly, it is possible to manage to lower targets and reference points than it is for species with much higher natural mortality. It is not a question of "productivity" but has to do with how many cohorts are present in the spawning biomass when it is maintained at target levels. For species with high natural mortality, spawning biomass contains few cohorts and is therefore naturally highly variable. The opposite is true for species with low natural mortality. It is because of orange roughy's low natural mortality that there are many cohorts present when spawning biomass is in the target range of 30–50% B_0 and consequently spawning biomass changes relatively slowly when catches are at appropriate levels.

WWF's P1 comments and my responses

The comments from WWF's 8 June 2015 submission are given in italics below. My responses to each are given immediately below each comment.

1. *An implicit assumption in the stock analysis is that spawning biomass at age is proportional to the number of eggs spawned by fish at that age. This is a standard initial assumption in many assessments. However, if fecundity changes disproportionally as the fish ages, the contributions to recruitment may be altered. This may be especially important for OR where older ages and their spawning contributions may be significantly affecting recovery, depletion, etc. We suggest that fecundity ogives be developed to determine whether the initial assumption regarding spawning biomass and eggs spawned holds true for slow-growing, long-lived orange roughy, as this could have a large impact on the population productivity parameters.*

The use of spawning stock biomass (SSB) as a proxy for fertilized egg production is the standard approach in most New Zealand fish stock assessments, including those for orange roughy. The approach of using a mean fecundity to age relationship could not be used at this stage as there are few or no data on fecundity at age for fish aged under the latest protocol (Tracey et al. 2007). However, there is a suggestion that there may be reduced fecundity at older ages (Koslow 1995) and that there may be increased fecundity at length in depleted stocks (Pitman 2014). Minto and Nolan (2006) show increasing total fecundity for increasing length, weight, and age for a Northeast Atlantic stock. They dispute the reduction in fecundity at age suggested by Koslow (1995) but their data do not suggest an increase in relative fecundity with age (although they did not explicitly test for this).

Ignoring a possible reduction in relative fecundity with age and a possible increase in fecundity at length (or age) over time, for depleted stocks, may introduce a negative bias in the estimation of stock status for the current assessments (that is, the spawning potential of the stocks is higher than is estimated by using SSB as a time-invariant proxy for fertilized egg production). Thus, the current approach is precautionary.

2. *Another life history consideration is natural mortality and how it is distributed across ages. In the assessment and in the management strategy evaluation, M was assumed to be constant for all ages. The model is assuming that somewhere between spawning and recruitment (one year) the natural mortality reduces from a*

high rate implied by the stock recruitment relationship to an M at age one of 0.04. Alternative M-at-age schedules likely would not impact the general dynamics over time for the stock, but could change the rate of trend and the perceptions of B0. We would generally expect Bmsy/B0 to be higher than 25% for a slow-growing, long-lived species and wonder if this might have to do with the selectivity curves mentioned above.

Natural mortality (M) is very unlikely to be constant at age but the models use an average adult natural mortality that was estimated from the right-hand limb of catch curves from near virgin populations. Assuming the adult M for juvenile ages is not a problem in the assessments because there are no juvenile data fitted. It will make very little difference to the MSE because, again, all of the action is for spawning biomass. It will also make very little difference to B_{MSY}/B_0 because this is a spawning biomass ratio. Putting in higher Ms for juveniles would be expected to have almost no impact on the assessments or the MSE results.

3. *In an analysis done for WWF of Bmsy/B0 it was found that the yield at Bmsy/B0 is very similar to that at a rather wide range of values of B/B0 (from 10 to 40%). Thus, foregone yield is relatively small within this range of risk. Therefore, accepting B40 (or higher) would minimize risk without sacrificing yield. We believe that the value used for management should be at least 40% under the precautionary principle.*

The target range is 30–50% B_0. The MSE shows that the stock can be managed adequately within this range with the given HCR. The HCR performs well over a wide range of productivity parameters (steepness and natural mortality).

4. *As with all Bayesian analyses, the structure of the priors can be important. In this case the difference between the prior and posterior for M and for the catchability quotients (q's) is relatively large. This suggests that these priors have influence on the analysis. In these cases, the priors were defined by a modal distribution over a relatively restricted range of the variable (M or q's). We would argue for more uniform distributions for these priors.*

One of the advantages of Bayesian estimation is that ancillary information can be included in an assessment through an informed prior developed using observed data. The priors for the acoustic *q*s and M used in the assessments are informative. The prior on M incorporates the point estimate (mean) and associated uncertainty (CV) from the catch curve estimates of Z from near virgin stocks. The priors on the acoustic *q*s likewise contain the available information on potential biases in target strength estimation and assumed availability. Uniform priors would ignore this valuable information.

5. *The survey data are weak: some surveys are not conducted annually, many only index a portion of each stock, and size data are spotty, sometimes pooled over several years. These affect the estimates of q. This again accentuates the importance of the priors on those q's, which we believe should be developed further.*

There is no need to conduct annual surveys as SSB can be expected to change slowly over time given the low natural mortality and now that fishing mortality is at appropriately low levels. The priors will be developed further as more information becomes available. Making them uniform would be a retrograde step.

6. *We note that several of our earlier concerns presented to the assessment team were addressed to some extent in the MSE document (Cordue, P.L. 2014. A management strategy evaluation for orange roughy. ISL Client Report for Deepwater Group Ltd., 42 p) and its development of harvest control rules (HCRs). A remaining issue, however, is the selection of reference points. The current management scheme seems to have arisen from a generic management approach and not specifically for orange roughy. As far as limit reference points, there can be no "limit" without a consequence of exceeding that limit (hence the difference between hard and soft limits). Therefore, one can argue that a more appropriate limit for orange roughy is 25% since Bmsy/B0 is about 25%. Such an action implies Bmsy is a limit and is consistent with international agreements.*

The current management scheme has arisen out of the MSE. It is specifically designed for orange roughy. The limit reference point was also a product of the MSE and was estimated to be 20% B_0 (using the definition of being the greater of 20% B_0 or 50% B_{MSY}). While B_{MSY} may be used elsewhere as a LRP, the requirements of the MSC standard explicitly permits a stock to fluctuate around B_{MSY}, hence there is no requirement to have B_{MSY} as a LRP as proposed by WWF.

7. *In the original management scheme the aforementioned consequences were not very well evaluated. To some extent the MSE report addressed this by evaluating probabilities of exceeding various B/B0s. Nevertheless, as the MSE document points out, the consequences of unforeseen reductions in B/B0 can have ramifications for many years. The MSE report used the current limit/target reference points, depletions below them, and recovery to them as indicators in defining the HCR. But because they arose from the original management scheme, then arguably these should be modified to reflect alternate schemes.*

The original management scheme has been replaced and the consequences of breaching thresholds are now clear. The LRP was estimated as part of the MSE. The lower bound of the target biomass range was then set at 30% B_0 because this was “well above” the LRP and in conjunction with the HCR allowed SSB to be maintained above the LRP almost all of the time (and above the lower bound of the target biomass range most of the time). It is somewhat coincidental that the lower bound of the target biomass range was equal to the previous target.

8. *It is unclear to WWF whether the HCR has been implemented and is deserving of a score of 80. Since the assessment indicates that the orange roughy stock was depleted, then there should have been a recovery plan implemented to recover to the target. The more ad hoc recovery has been marginally successful in that the target 40% is just now being reached. One might argue that median recovery is now 40%, which means that there is a 50-50 chance that recovery has occurred. This supports the need for formally implementing the HCR, and suggests that scoring of the harvest strategy or HCR at 80 or above is problematic.*

The HCR developed through the MSE has been implemented for the three orange roughy stocks under consideration[1] (except that for ESCR a lesser TACC has been set). For the MEC, it was the 2014 stock assessment that indicated that the stock had previously been depleted, it is not possible to implement a rebuilding plan in the past. For one of the stocks (7A) the fishery was closed from 2000-01 to permit rebuilding and the fishery was reopened in 2010 with a relatively small TACC (500 t) when evidence of rebuilding had been evaluated including a series of biomass surveys conducted from 2005 (MPI, 2014). The target biomass range is 30–50% B_0. Rebuilding means getting the SBB into the target biomass range with a 70% probability, not getting it above the mid-point of the range. Once within the target biomass range the HCR will maintain the stock within this range most of the time.

References

Clark MR, Fincham DJ, Tracey DM (1994). Fecundity of orange roughy (*Hoplostethus atlanticus*) in New Zealand waters. *N.Z. J. Marine Freshwater Res. 28*:193–200.

Koslow JA, Bell J, Virtue P, Smith DC (1995) Fecundity and its variability in orange roughy: effects of population density, condition, egg size and senescence. *J. Fish Biol 47*:1063–1080.

MPI (2014). Ministry for Primary Industries 2014. Fisheries Assessment Plenary, May 2014: stock assessments and stock status. Complied by the Fisheries Science Group, Ministry for Primary Industries , Wellington, New Zealand. 1381 p.

Minto C, Nolan CP (2006). Fecundity and Maturity of Orange Roughy (*Hoplostethus atlanticus* Collett 1889) on the Porcupine Bank, Northeast Atlantic. *Environmental biology of fishes 77*: 39–50.

Pitman LR, Haddy JA, Kloser R (2014). Fishing and fecundity: the impact of exploitation on the reproductive potential of a deep-water fish, orange roughy (*Hoplostethus atlanticus*) *Fisheries Research 155*:196–197.

Tracey D, Horn P, Marriott P, Krusic-Golub K, Gren C, Gili R, Mieres LC (2007). Orange Roughy Ageing Workshop: otolith preparation and interpretation. Draft report to DWFAWG.

[1] See documents showing implementation of the HCR:

ISL (2014). A Management Strategy Evaluation for Orange Rougy. Wellington, New Zealand

DWG (2014). Summary Paper – ORH Harvest Strategy. Auckland, New Zealand

DWG (2014). ORH3B NWCR Catch Limit 2014-15

MPI (2014) Support for Harvest Control Rule