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COMMENT AND REPLY

Worrisome trends in global stock status continue unabated: a response to a comment by R.M. Cook on "What catch data can tell us about the status of global fisheries"

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In a previous contribution to this journal (Froese et al. 2012), we refuted criticism of a simple method (Froese and Kesner-Reyes 2002) that derives information about the status of global stocks from global catch data. This method assumes that, for a given stock, the ratio of current catches to previous maximum catches (C_{max}) is indicative of the likely current exploitation status of the stock. For example, the method considers a stock as "collapsed" if current catch is <10 % of the previous maximum catch.

The method also assumes that current catches in the range of 0.5–1.0 C_{max} are indicative of fully exploited stocks, implying that the maximum sustainable yield (MSY) would also fall into that range. This assumption was supported by the observation (Froese et al. 2012) that the median MSY/C_{max} ratio in 50 fully assessed stocks of the Northeast Atlantic was 0.62 (95 % confidence limits 0.56–0.70). Also, a plot of log(C_{max}) over log(MSY) for these stocks showed a high correlation with little variance around the regression line. Such correlation has also been found by other studies for other stocks (Srinivasan et al. 2010; Halpern et al. 2012). Thus, in our previous paper, we concluded that "it seems justified to assume that in a majority of fisheries, catch levels of 0.5–1.0 C_{max} are indicative of fully exploited stocks" (Froese et al. 2012).

A comment by Cook (2013) challenges this assumption, asserting that "Unfortunately, these analyses do not support their contention that MSY for a particular stock is related to maximum catch in a predictable way···" In support of this statement, Cook (2013) points out that the 95 % range of MSY/C_{max} ratios for the 50 analyzed stocks spans from 0.34 to 1.19, thus exceeding the assumed range of 0.5–1.0. However, given that we expected our method to make correct classifications not for 95 % but only for a majority of stocks, the fact that our range is located at the very center of the wider 95 % range does not contradict, but rather supports our assumption. Also, Figure 1d in Cook (2013), which presents the frequency distribution of MSY/C_{max} ratios, shows sharp drop-offs in frequency below 0.5 and above 1.0, further confirming that the range we selected is reasonable.

Cook (2013) also criticizes our regression of log(C_{max}) over log(MSY), pointing out that such a relationship was trivial, because "It is obvious that small stocks will have a low MSY and large stocks will have a high MSY." Because of this scale effect, "[…] any random catch […] is highly correlated with MSY when examined across stocks of widely differing magnitude." We agree with this point, because it leads to the logical conclusion that the maximum catch that can be taken from a stock is related to its size. However, if we assume that the maximum catches that fisheries can take in the real world are approximated by the reported maximum catches of stocks that are exploited sufficiently to be included in global statistics, then it also follows that these observed maximum catches (C_{max}) are related to their respective stock sizes and their corresponding MSY values, a point that was disputed by our critics (e.g., Daan et al. 2011). This inference is confirmed by Figure 1a in Cook (2013), which shows regressions of maximum and random catch over MSY, on log-scales. Consistent with the above reasoning, the regression line representing C_{max} lies above the regression line with

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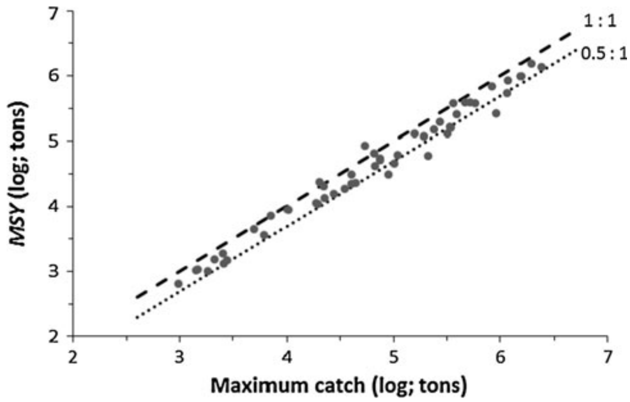

Fig. 1 Plot of maximum sustainable yield (MSY) over maximum reported catch (C_{max}) for 50 stocks in the Northeast Atlantic. *Note* that most points fall between the lines representing 0.5–1.0 C_{max}. [File: BiomasMarBio2.xls]

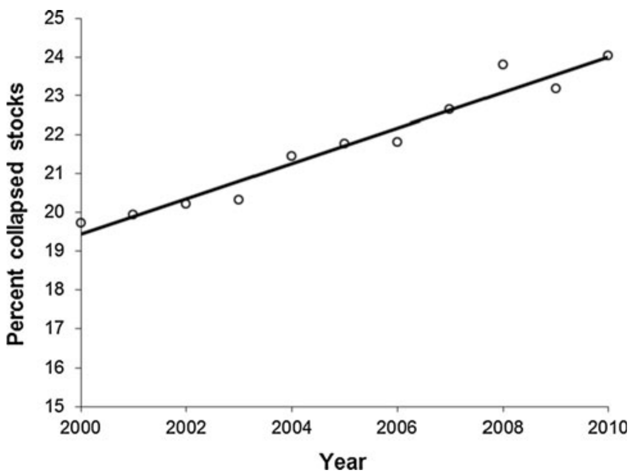

Fig. 2 Percentage of global stocks that produce <10 % of previous catches [File: FAO2010.xls]

random data, and it accounts for more of the variability in the data. Note that Cook (2013) in his Figure 1a does not present a random or median run of random data, but rather the run that produced the highest r^2 value. Thus, the true difference between C_{max} and random catch data would be larger than that shown in his Figure 1a.

We agree with Cook (2013) that plotting of log-transformed data visually reduces the existing variability and that, if scale effects occur, the coefficient of determination in a regression analysis overrepresents the variation in *Y* that is accounted for by *X*. Thus, we reproduce here Figure 1 of Froese et al. (2012), replacing the regression line with lines representing 0.5 and 1.0 ratios between MSY and C_{max}, respectively (here also Fig. 1). In this presentation, it becomes clear that over a wide range of maximum catches, most MSY estimates fall between 0.5 and 1.0 C_{max}.

Figure 1c of Cook (2013) shows a cloud of points of normalized maximum catches plotted over normalized MSY values. Cook (2013) uses this figure to argue that "there is no relationship between C_{max} and MSY." However, if this figure is augmented by diagonal lines representing the 0.5–1.0 C_{max} range, then it becomes clear that a majority of about 80 % of the points falls into that range and thus shows the behavior assumed by our method.

In conclusion, we thank Cook (2013) for pointing out that the coefficient of determination between log-transformed data of MSY and C_{max} overrepresents their correlation, due to effects of scale stemming from very different stock sizes. However, MSY and C_{max} are related, despite Cook's (2013) assertions to the contrary; indeed, MSY will typically fall within the range of 0.5–1.0 C_{max}, as originally stated by Froese and Kesner-Reyes (2002), and as illustrated by Cook's (2013) own analysis.

We use this opportunity to point out that the status and trends in global fish stocks as presented by Froese et al. (2012), based on the method discussed here, have been confirmed by subsequent publications using similar (Kleisner et al. 2012) and different methods (Costello et al. 2012; Pikitch 2012). Froese and Kesner-Reyes (2002) were the first to point out the worrisome high proportion and continuing increase in collapsed stocks, which in their analysis stood at 19 % in 1998. Here, we show the subsequent development, using the latest official data downloaded from www.fao.org in January 2013 (Fig. 2). As can be seen, the increase in collapsed stocks continues unabated, reaching 24 % in 2010 and confirming that rebuilding efforts are still insufficient on a global scale (FAO 2012).

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