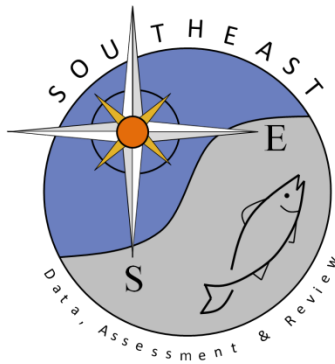


**Information to help interpret results from the data limited toolkit for Atlantic  
Blueline Tilefish north and south of Cape Hatteras**

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The following document is intended to provide additional information to help interpret of the results from the data limited toolkit for the Atlantic Blueline Tilefish for north and south of Cape Hatteras. Each section has the main references for the methods used, a summary of the methods, and when available a MSE performance evaluation of the methods. Table 1 at the end of the document summarized the 'quality' of the data used in the methods.

### ***Average catch methods***

#### ***Methods applied***

*AvC: Average catch over entire catch time series*

*CC1: Average catch over most recent 5 years of catch time series*

*CC4: 70% of average catch over most recent 5 years of catch time series*

#### **References**

Carruthers, T. R., Punt, A. E., Walters, C. J., MacCall, A., McAllister, M. K., Dick, E. J., and Cope, J. 2014. Evaluating methods for setting catch limits in data-limited fisheries. *Fisheries Research*, 153: 48–68.

Restrepo, V.R., Thompson, G.G., Mace, P.M., Gabriel, W.L., Low, L.L., MacCall, A.D., Methot, R.D., Powers, J.E., Taylor, B.L., Wade, P.R. and Witzig, J.F., 1998. Technical guidance on the use of precautionary approaches to implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. *NOAA Technical Memorandum NMFS-F/SPO-31*, pp.1-54.

#### **Method Description**

Self explanatory

#### **MSE evaluation**

MSE evaluation of average catch methods can be found in Carruthers et al. (2014). Carruthers et al. (2014) indicate then when **biomass ratios are moderate to low**, all average catch methods performed the worst (in terms of yield and potential for stock collapse) of all data poor a simple assessment method evaluated. This result suggest that average catch methods should be used with caution if the stock in question is assumed to be overfished. For stock not overfished the average catch methods performed as well as other methods. These were developed assuming a period of stable catch such that the population is near an equilibrium.

The following is an excerpt from Restrepo et al. 1998 that provides recommendation on how to provide catch advice using and average catch method based on the assumed status of the stock.

If there is no reliable information available to estimate fishing mortality or biomass

reference points, it may be reasonable to use the historical average catch as a proxy for MSY, taking care to select a period when there is no evidence that abundance was declining.

#### *Recommended data-poor defaults*

In data-poor cases it is recommended that the default limit control rule be implemented by multiplying the average catch from a time period when there is no quantitative or qualitative evidence of declining abundance ("Recent Catch") by a factor depending on a qualitative estimate of relative stock size:

Above *BMSY*: Limit catch =  $1.00 \times (\text{Recent catch})$

Above MSST but below *BMSY*: Limit catch =  $0.67 \times (\text{Recent catch})$

Below MSST (i.e., overfished): Limit catch =  $0.33 \times (\text{Recent catch})$

The multipliers 1.0, 0.67 and 0.33 were derived by dividing the default precautionary target multipliers below, in order to maintain the 0.75 ratio recommended as the default distance between the limit and target reference points for stocks above  $(1-M) \times BMSY$ . Since it probably will not be possible to determine stock status relative to *BMSY* analytically, an approach based on "informed judgement" (e.g., a Delphi approach) may be necessary.

In data-poor cases, the default policy may be interpreted qualitatively as follows:

Above *BMSY* : Target catch =  $0.75 \times (\text{Recent catch})$

Above MSST but below *BMSY*: Target catch =  $0.50 \times (\text{Recent catch})$ .

Below MSST (i.e., overfished): Target catch =  $0.25 \times (\text{Recent catch})$ .

#### ***SPMSY - Catch Trend Surplus Production MSY***

#### **References**

Martell, S. and Froese, R. 2012. A simple method for estimating MSY from catch and resilience. *Fish and Fisheries*.14, 504–514

#### **Method Description**

SPMSY - Catch Trend Surplus Production MSY uses Martell and Froese (2012) method for estimating MSY to determine the OFL. Their approach estimates stock trajectories based on catches and a rule for a Schaefer production model intrinsic rate of increase and assumed depletion levels. Given their surplus production model predicts  $K$ ,  $r$  and depletion it is straight forward to calculate the OFL for any replicate based on the Schaefer productivity curve as, the estimated level of depletion in the final year of the catch time series times the associated carrying capacity and half the associated intrinsic rate of increase. This method requires max age, the von Bertalanffy  $k$  parameters and age at maturity to determine the range of  $r$  values to use. For blueline tilefish the default range for  $r$  given the input life history parameters is 0.05-0.5. The default range for  $K$  depends on  $r$  and has a lower bound of the

mean of the catch time series divided by  $r$  and an upper bound of 10 times the mean of the catch time series divided by  $r$ . Given assumed depletion levels at the start and the end of the time series, catch is removed for each  $r$  and  $K$  combination and  $r$  and  $K$  are selected if the stock falls within the specified depletion range at the end of the time series of catch. The default value for the stock depletion are based on catch. For south of Cape Hatteras, the catch in the first year (1993) is the max observed catch so the range of values used for initial depletion is 0.3-0.6. The catch in the final year is lower than 50% of the max catch so the final year depletion values used are 0.01-0.4. For north of Cape Hatteras, the catch in the first year (1978) lower than half the max observed catch so the range of values used for initial depletion is 0.5-0.9. The catch in the final year is lower than 50% of the max catch so the final year depletion values used are 0.01-0.4.

## **MSE evaluation**

Martell and Froese (2012) found reasonable agreement between MSY estimates produced from stock assessment and those from the SPMSY methods with most estimates falling between 0.5 and 1.5 of those from stock assessment. It is unclear how the default depletion levels in the DML tool kit relate to those used in Martell and Froese (2012).

## ***Mean length methods***

### *Methods used*

*Fdem\_ML: Demographic FMSY and Mean Length*

*YPR\_ML: Yield Per Recruit F0.1 and Mean Length*

## **References**

Gedamke, T. and Hoenig, J.M., 2006. Estimating mortality from mean length data in nonequilibrium situations, with application to the assessment of goosfish. *Transactions of the American Fisheries Society*, 135(2), pp.476-487.

## **Method description**

Both *Fdem\_ML* and *YPR\_ML* utilize the Gedamke and Hoenig (2006) non-equilibrium method for determining instantaneous total mortality rate ( $Z$ ). Within the DLM tool kit a single break point is identified within a time series of mean length creating period 1 and period 2. Total mortality is then estimated for each period ( $Z_1$ ,  $Z_2$ ) based on the minimization of a negative lognormal likelihood between the observed mean length and those predicted using the Gedamke and Hoenig (2006) equation. Instantaneous mortality ( $M$ ) is then subtracted from  $Z$  to estimate instantaneous fishing mortality ( $F$ ). Exploitation rate ( $hr$ ) in the final year is calculated as  $hr=1-\exp(-F)$  and biomass ( $B$ ) in the final year is estimated from the catch ( $C$ ) in the final year

over the estimated exploitation rate  $B=C/hr$ . Both methods then use this biomass to determine the OFL as  $(1-\exp(-Fmsy))*B$ .

The methods differ in how  $Fmsy$  is estimated. *Fdem\_ML* uses demographic information and a range of steepness( $h$ ) within routines that solve the Euler-Lotka equation for the instantaneous rate of population increase ( $r$ ) and then estimate  $Fmsy$  as  $r/2$ . Note that steepness is needed to back calculate recruits-per-spawner assuming a Beverton-Holt stock recruitment curve. estimate YPR\_ML uses  $F 0.1$  as a proxy for  $Fmsy$  which requires the estimation of yield-per-recruit.

### MSE evaluation

There has been no formal evaluation of the performance of data limited mean length methods. Some work at the Northwest center indicate poor performance of the methods when mean length data has no clear trend and is noisy. The main issue with noisy data is the difficulty in defining breakpoints and the estimation of negative  $F$  values when the trend in the mean length is determined to be positive. For Blueline Tilefish both north and south of Cape Hatteras there is a clear trend in the mean length of the catch suggesting that poor performance of the method may not be an issue.

Table 1 - Data requirements for data limited methods. Filled boxes indicate data is required for the method. X indicates confidence in the data. M indicates data estimated form meta-analysis. O indicates weak confidence in the data.

Method	Catch	Growth	L-W	Maturity	Selectivity	Steepness	Max age/M
AvC	X						
CC1	X						
CC4	X						
SPMSY	X	M		O			O
Fdem_ML	X	M	X	O	X		O
YPR_ML	X	M	X	O	X	M	O