# THE RELATIONSHIP BETWEEN $F_{0.1}$ AND $F_{MSY}$ VALUES FOR THE NORTH ATLANTIC BLUEFIN ASSESSMENTS AND ITS DEPENDENCE ON THE BEVERTON-HOLT STOCK RECRUITMENT STEEPNESS PARAMETER $H$

R.A. Rademeyer and D.S. Butterworth

Values of the demographic and fishery parameters being used for projections for the current assessments of North Atlantic bluefin tuna were kindly provided Matt Lauretta (Western stock) and Tristan Rouyer and Rishi Sharma (Eastern stock), and are shown in Table 1. These values have been used in applying standard methods to compute $F_{0.1}$ for each set of values, together with $F_{MSY}$ values as a function of the value of steepness $h$ for a Beverton-Holt stock recruitment relationship. Note that the F values reported refer to apical F, i.e. the age at which selectivity is highest, being age 13 for the Western and age10+ for the Eastern stock.

The results are shown in Table 2 and Figure 1. For high values of $h$, $F_{MSY}$ exceeds $F_{0.1}$, but the reverse is true for low values. The values of $h$ at which the two values are equal are 0.70 and 0.80 for the Western stock for the low and high maturity vectors respectively, and 0.68 for the Eastern stock.

**Table 1**: Values of the demographic and fishery parameters used for projections for the current assessments of North Atlantic bluefin tuna for the Western stock (courtesy Matt Lauretta) and the Eastern stock (courtesy Tristan Rouyer and Rishi Sharma).

**Western stock**

| Plus group age | 16 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Selectivity-at-age | 0.003 | 0.072 | 0.219 | 0.518 | 0.284 | 0.352 | 0.283 | 0.680 | 0.777 | 0.935 | 0.851 | 0.914 | 1.000 | 0.979 | 0.810 | 0.810 |
| Weight-at-age (kg) | 3.10 | 9.80 | 15.10 | 19.90 | 43.30 | 60.50 | 89.90 | 111.60 | 144.80 | 174.00 | 201.10 | 225.50 | 247.70 | 264.00 | 283.50 | 340.00 |
| Maturity-at-age: low | 0.00 | 0.00 | 0.25 | 0.50 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| high | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.19 | 0.56 | 0.88 | 0.98 | 1.00 | 1.00 | 1.00 | 1.00 |
| Natural mortality-at-age | 0.38 | 0.30 | 0.24 | 0.20 | 0.18 | 0.16 | 0.14 | 0.13 | 0.12 | 0.12 | 0.11 | 0.11 | 0.11 | 0.10 | 0.10 | 0.10 |

**Eastern stock**

| Plus group age | 10 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Selectivity-at-age | 0.000 | 0.142 | 0.225 | 0.676 | 0.700 | 0.293 | 0.236 | 0.311 | 0.585 | 1.000 |
| Weight-at-age (kg) | 3.03 | 9.94 | 19.51 | 33.88 | 48.97 | 66.33 | 90.82 | 113.78 | 137.72 | 202.52 |
| Maturity-at-age | 0.00 | 0.00 | 0.25 | 0.50 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Natural mortality-at-age | 0.38 | 0.30 | 0.24 | 0.20 | 0.18 | 0.16 | 0.14 | 0.13 | 0.12 | 0.10 |

**Table 2**: $F_{0.1}$ and $F_{MSY}$ values for different steepness values for the Western stock (for the low and high maturity vectors) and for the Eastern stock (single maturity vector). The F values reported refer to apical F.

| stock | West | | East |
|---|---|---|---|
| maturity | low | high | |
| F0.1 | 0.114 | 0.113 | 0.128 |
| h | FMSY | FMSY | FMSY |
| 0.98 | 0.189 | 0.180 | 0.228 |
| 0.95 | 0.179 | 0.162 | 0.215 |
| 0.90 | 0.164 | 0.141 | 0.196 |
| 0.85 | 0.150 | 0.126 | 0.179 |
| 0.80 | 0.138 | 0.113 | 0.163 |
| 0.75 | 0.126 | 0.102 | 0.148 |
| 0.70 | 0.114 | 0.092 | 0.133 |
| 0.65 | 0.103 | 0.082 | 0.120 |
| 0.60 | 0.092 | 0.073 | 0.106 |
| 0.55 | 0.081 | 0.065 | 0.093 |
| 0.50 | 0.071 | 0.056 | 0.080 |
| 0.45 | 0.060 | 0.048 | 0.067 |
| 0.40 | 0.049 | 0.039 | 0.055 |
| 0.35 | 0.038 | 0.031 | 0.042 |
| 0.30 | 0.026 | 0.021 | 0.028 |
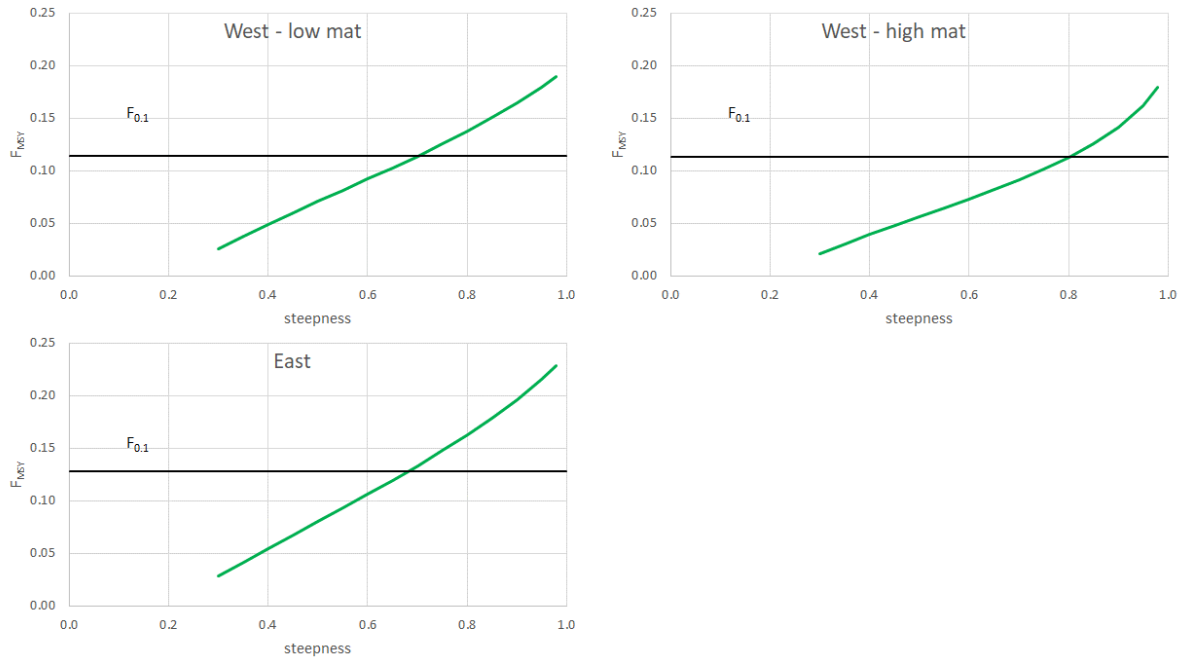
**Figure 1**: $F_{0.1}$ and $F_{MSY}$ (green curve) values for different steepness $h$ values for the Western stock (for the low and high maturity vectors) and for the Eastern stock (single maturity vector). The F values reported refer to apical F.