**SEYCHELLES FISHING AUTHORITY**

# Stock Assessments of Three Key Demersal Species in the Artisanal Fishery

**FISHERIES RESEARCH**

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Seychelles Fishing Authority, P.O. Box 449, Victoria, Mahé, Seychelles

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### 1.1. Stock assessments

Length-based assessments were undertaken for three key indicator species of the demersal handline fishery; these are *Aprion virescens*, *Epinephelus chlorostigma* and *Lutjanus sebae*. Additionally Yield-per-Recruit (YPR) analyses was conducted for *Lutjanus sebae* only. In 2022, sampling locations were expanded to include other landing sites and fish markets such as Victoria, La Retraite, and Cascade fish markets. In previous years sampling activities were mainly focused on the Victoria and Providence artisanal fishing port.

#### 1.1.1. *Aprion virescens*

In 2022, 1919 fork length samples were taken for this species, compared to 418 samples collected in 2021. Due to errors obtained during the analysis of the data for 2022, such as negative fishing mortality the age-based growth parameters were changed. In previous reports the parameters used were the ones derived from the FMSP Project R6465 (K=0.1, $L_\infty$=89.9, $t_0$ = -2.3), for this report the parameters used were derived by Mees (1992) where K = 0.26, $L_\infty$ = 104cm but $t_0$ remain the same at -2.3. This was used to provide estimates of total mortality (Z), fishing mortality (F) and length at first capture ($L_{c50}$). Two estimates of natural mortality (M) were used, the first (M1) from Pauly (1980) with a temperature of 22°C. Since this method tends to overestimate M for slow growing species, the derivation from Jenson was also used (1996; reviewed in Hoggarth et al., 2006), where M = 1.5K to estimate this parameter (M2).

**Table 1.** *Aprion virescens*: Estimates of fishing mortality, and related parameters, for two different estimates of natural mortality (M1 and M2), and corresponding estimates of length at first capture ($L_{c50}$). Length at first maturity ($L_{m50}$) estimates and sample sizes (N) are also provided.

| Parameter | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Z | 1.62 | 1.77 | 1.08 | 1.17 | 1.18 | 1.01 |
| CI of Z | -5.05-8.30 | -2.63-6.17 | 0.50-1.67 | 0.45-1.89 | 0.46-1.90 | 0.78-1.24 |
| $r^2$ | 0.91 | 0.96 | 0.92 | 0.93 | 0.96 | 0.93 |
| M1 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |
| F | 1.36 | 1.51 | 0.82 | 0.91 | 0.92 | 0.75 |
| E | 0.84 | 0.85 | 0.76 | 0.78 | 0.78 | 0.74 |
| $L_{c50}$ (cm) – Logistic | 69.40 | 73.59 | 74.67 | 59.84 | 86.19 | 45.35 |
| $L_{c50}$ (cm) – Running av. | 68.62 | 68.45 | 57.76 | 67.06 | 72.66 | 43.22 |
| F/M | 5.23 | 5.81 | 3.15 | 3.50 | 3.54 | 2.88 |
| M2 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |

| | | | | | | |
|---|---|---|---|---|---|---|
| F | 1.47 | 1.62 | 0.93 | 1.02 | 1.03 | 0.86 |
| E | 0.91 | 0.92 | 0.86 | 0.87 | 0.87 | 0.85 |
| $L_{c50}$ (cm) – Logistic | 69.43 | 73.67 | 75.07 | 59.75 | 86.76 | 45.35 |
| $L_{c50}$ (cm) – Running av. | 68.61 | 68.45 | 57.76 | 67.01 | 72.64 | 43.21 |
| F/M | 9.80 | 10.80 | 6.20 | 6.80 | 6.87 | 5.73 |
| | | | | | | |
| $L_{m50}$ (Mees 1992; MRAG 1999) | 62-64; 65 cm | | | | | |
| N | 634 | 362 | 408 | 353 | 418 | 1919 |

In 2022, based on both estimate of M, $L_{c50}$ was less than $L_{m50,}$ unlike in previous years where $L_{c50}$ was more than $L_{m50}$ (Table 1). The change in sampling sites could be one reason why there is a notable change in $L_{c50.}$ The new sampling sites increase the possibility of obtaining catch from smaller outboard vessels and therefore the inclusion of catch from nearshore fishing areas.
The ratio F/M was looked at as a possible indicator of over-exploitation, considering that F=M has been suggested as a proxy for F(MSY). The F/M ratio was 3.54 in 2021 and 2.88 in 2022 with M1 = 0.26 and with M2 = 0.15 it was 6.87 in 2021 and 5.73 in 2022 indicating high fishing pressure (Table 1).

1.1.2. *Epinephelus chlorostigma*

The sample size for 2022 was 716 which is a considerable increase from the 209 samples collected in 2021 and 59 in 2020. The same growth parameters were used as in previous years, based on average of three estimates from Grandcourt (2002), Mees (1992) and Sanders et al. (1988), where K=0.21 and $L_{\infty}$=57.19. $L_{c50}$ was assessed against a published maturity estimate for females (Moussac, 1996), rather than for males, since this species is suspected of protogynous hermaphroditism. Size at maturity was also calculated from $0.5L_{\infty}$. As was the case with *Aprion virescens*, two estimates of M were applied in the assessment, the first (M1) the standard Pauly (1980) method with a water temperature of 22°C, and the second (M2) calculated using M=1.5K.

**Table 2.** *Epinephelus chlorostigma*: Estimates of fishing mortality, and related parameters, for two different estimates of natural mortality (M1 and M2), and corresponding estimates of length at first capture ($L_{c50}$). Length at first maturity ($L_{m50}$) estimates, based on $0.5L_{\infty}$ and Moussac (1986), and sample sizes (N) is also provided.

| Parameter | 2017 | 2018 | 2019 | 2021 | 2022 |
|---|---|---|---|---|---|
| Z | 0.53 | 1.25 | 1.24 | 1.5 | 0.82 |
| CI of Z | -3.34-4.4 | 0.18-2.31 | -0.85 - 3.32 | 0.21 - 2.80 | 0.16-1.49 |
| $r^2$ | 0.75 | 0.99 | 0.98 | 0.99 | 0.99 |
| | | | | | |
| M1 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| F | 0.05 | 0.77 | 0.76 | 1.02 | 0.34 |
| E | 0.09 | 0.62 | 0.61 | 0.68 | 0.41 |
| $L_{c50}$ (cm) – Logistic | 30.04 | 34.9 | | 37.82 | 34.16 |
| $L_{c50}$ (cm) – Running av. | 30.55 | 33.73 | 34.76 | 34.51 | 33.38 |
| F/M | 0.1 | 1.6 | 1.58 | 2.13 | 0.71 |
| | | | | | |
| M2 | 0.315 | 0.315 | 0.315 | 0.315 | 0.315 |
| F | 0.22 | 0.94 | 0.93 | 1.19 | 0.51 |
| E | 0.41 | 0.75 | 0.75 | 0.79 | 0.62 |
| $L_{c50}$ (cm) – Logistic | 29.93 | 34.91 | | 37.93 | 34.12 |
| $L_{c50}$ (cm) – Running av. | 30.39 | 33.68 | 34.74 | 34.5 | 33.34 |
| F/M | 0.7 | 2.98 | 2.95 | 3.78 | 1.62 |
| | | | | | |
| $L_{m50}$ ($0.5L_{\infty}$; Moussac, 1986) | 28.59 cm TL; 31 cm TL for females | | | | |
| N | 601 | 216 | 540 | 209 | 716 |

For both estimates of M in 2021 and 2022, the $L_{c50}$ was greater than the $L_{m50}$. For 2022, the F/M ratio were contradictory depending on the estimate of M used. With M1, the F/M ratio is 0.71 indicating low fishing pressure, whilst with M2, the ratio is 1.62 indicating a high fishing pressure. The Z estimate were subject to large range in CI (0.16-1.49) (Table 2).

1.1.3. *Lutjanus sebae*

**Mortality and capture estimates**

In 2022, the sample size was only sufficient to carry out analyses at the plateau level.

Due to problems in obtaining reliable performance of the YPR models in the Yield software using point estimates of growth parameters, an average of 2 age-based estimates was used (Grandcourt et al. 2008 and Newman 2000) and 2 length-based estimates (Mees 1996), where K = 0.163; $L_\infty$ = 88.6; t0 = -0.95. An estimate of natural mortality based on an average derived from two methods; M = 1.5K and an age-based estimate derived by Grandcourt et al. (2008) using the Hoenig (1983) empirical equation was used.

At the plateau level, the estimate of total mortality (Z) was 0.39 in 2022 which was relatively lower compared to estimates in 2021 and 2020. Both the running and logistic estimate of $L_{c50}$ was lower than the $L_{m50}$ (Table 3). The F/M ratio was lower in 2022 (1.15) compared to the previous two years.

**Table 3**. *Lutjanus sebae*: Estimates of mortality and corresponding estimates of length at first capture ($L_{c50}$) from 2017 to 2022. Length at first maturity ($L_{m50}$) estimates, based on Mees (1992), and sample sizes (N) also provided.

| Parameter | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Z | 0.55 | 0.46 | 0.48 | 0.42 | 0.50 | 0.39 |
| CI of Z | 0.45-0.66 | 0.43-0.49 | 0.42 - 0.53 | 0.28 - 0.56 | 0.23-0.77 | 0.33-0.45 |
| $r^2$ | 0.99 | 0.99 | 0.99 | 0.97 | 0.97 | 0.99 |
| M | 0.182 | 0.182 | 0.182 | 0.182 | 0.182 | 0.182 |
| F | 0.37 | 0.28 | 0.3 | 0.24 | 0.32 | 0.21 |
| E | 0.67 | 0.6 | 0.62 | 0.57 | 0.64 | 0.53 |
| $L_{c50}$ (cm) – Logistic | 60.77 | 58.54 | 57.49 | 62.02 | 61.94 | 54.91 |
| $L_{c50}$ (cm) – Running av. | 59.71 | 58.68 | 56.24 | 57.81 | 56.90 | 55.02 |
| F/M | 2.03 | 1.54 | 1.65 | 1.32 | 1.76 | 1.15 |
| Maturity | 62 cm FL | | | | | |
| N | 861 | 413 | 1210 | 768 | 1177 | 1608 |

**Application of Yield software**

*Yield per recruit*

All sectors

A yield-per-recruit analysis was undertaken at the Mahe Plateau level including all fishing sector. The analysis indicated that MSY would occur when F is around 0.52. However, the Spawning Stock Biomass (SSB) would be reduced to less than 20% (a usual limit reference point) when F = 0.25 (CI= 0.16-0.38) (Fig. 1). From the histograms, maximum yield-per-recruit is achieved when F is around 0.45 – 0.65 (median= 0.50, CI=0.18-2.51) (Fig. 2), but at the expense of reducing the spawning stock biomass to unacceptable levels. To maintain SSB per recruit at 20% of unexploited biomass, F should be below in the range of 0.19 – 0.24 (median= 0.25, CI= 0.14 – 0.43) (Fig. 3). The estimate of current F for 2022 (0.21; range = 0.14-0.42) is within the range of $F_{SSB20\ per\ recruit}$, however, the upper range of F exceeds the upper limit.

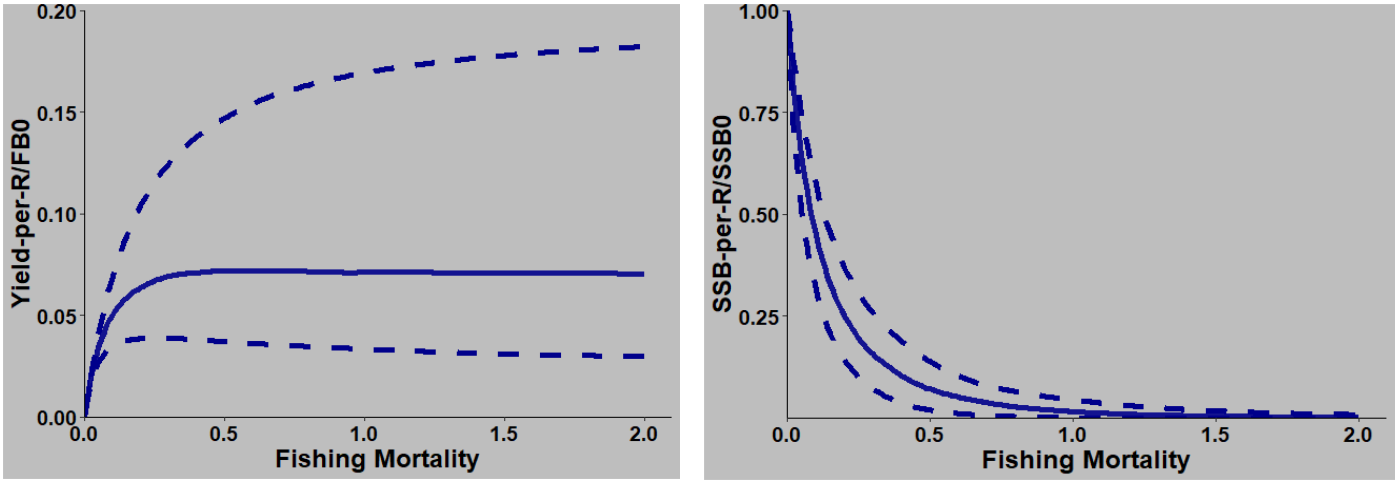


**Figure 1.** Yield-per-recruit and Spawning Stock Biomass per recruit against levels of fishing mortality for all sectors combined

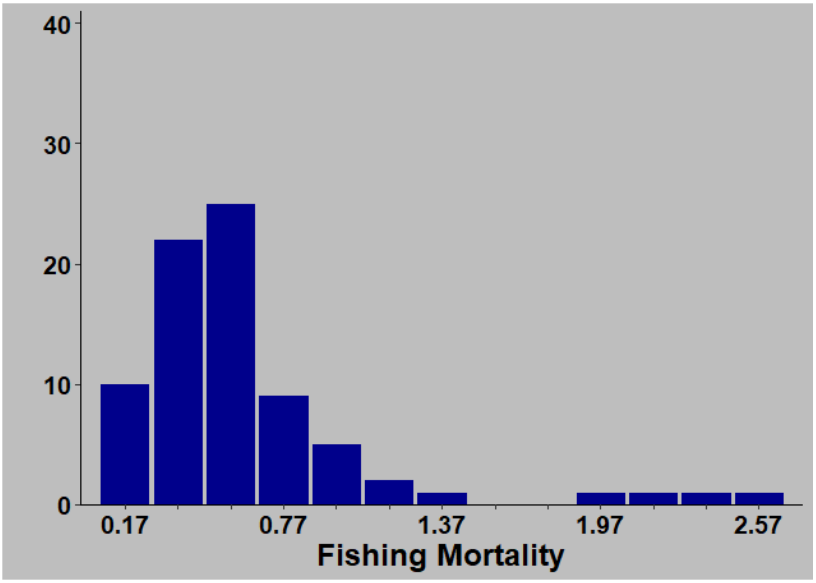


**Figure 2.** Frequency distribution of fishing mortality that produces maximum yield-per-recruit for all sectors combined

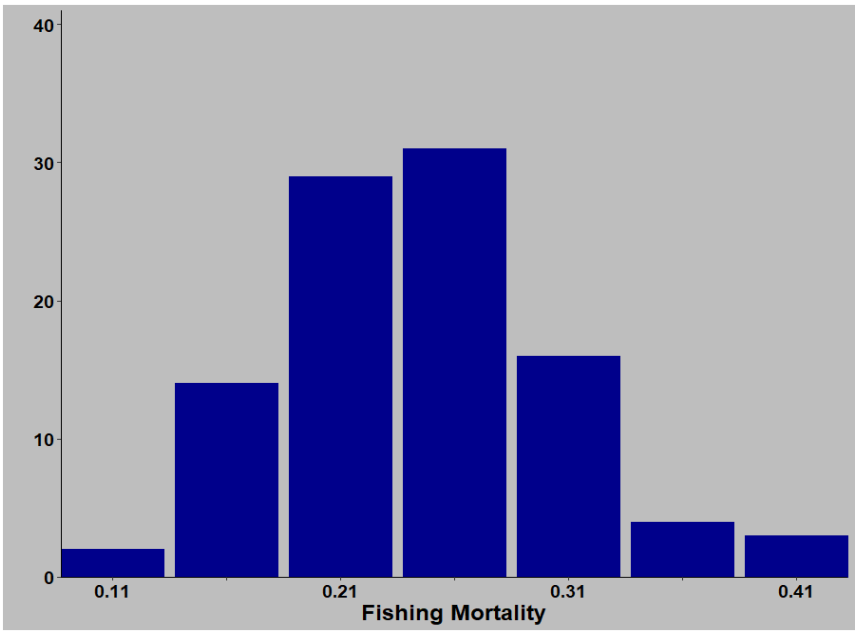


**Figure 3.** Frequency distribution of fishing mortality that maintains Spawning Stock Biomass at 20% of its unexploited value for all sectors combined

In summary, at the Mahe plateau level, $F_{current}$ is within the range of estimates of the limit reference point $F_{SSB20}$, however, the upper limit of F exceeds the range of estimates of $F_{SSB20}$ (Table 5). In addition, considering the mortality estimates derived, it can be concluded that despite a reduction in fishing pressure there is a possibility that this species remains overexploited.

**Table 5.** Summary results of the YPR for *Lutjanus sebae*. Estimates of F required to achieve maximum yield per recruit ($F_{MSYPR}$) and F to maintain spawning stock biomass at 20% of unexploited biomass ($F_{SSB20}$).

| | **All sectors 2020** |
|---|---|
| $F_{MSYPR}$ | 0.52 |
| $F_{SSB20}$ | 0.19 – 0.24 |
| $F_{current}$ (CI) | 0.21 (0.14-0.42) |

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