Seychelles Fisheries Authority

Stock Assessments of Three Key Demersal Species in the Artisanal Fishery

Fisheries Research Department

2025
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1. Stock Assessment

This report presents length-based stock assessments for three key indicator species of the demersal handline fishery; these are *Aprion virescens* (Green jobfsh, zob gri), *Epinephelus chlorostigma* (Brownspotted grouper, vyey makonde) and *Lutjanus sebae* (Emperor red snapper, bourzwa). Additionally Yield-per-Recruit (YPR) analyses were conducted for *Lutjanus sebae* only. Since 2022, sampling locations have expanded to include additional 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 Aprion Virescens

In 2024, 2994 fork length samples were taken for this species, which is another increase from the 2652 samples collected in 2023 and 1919 in 2022 (Table 1). The age-based growth parameters used were derived by Mees (1992) where K = 0.26, $L\infty$ = 104cm, however t_0 =-2.3 was derived from the FMSP Project R6465 (MRAG, 1999). 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 Jensen was also used (Jensen (1996); reviewed in Hoggarth et al. (2006)), where M = 1.5K to estimate the second mortality (M2). For 2024, the L_{m50} was changed from 62-64cm FL estimated by Mees (1992) and 65cm FL determined by MRAG (1999) to 40.2 cm FL as calculated by SFA (2025)

Table 1: Aprion virescens: Estimates of fishing mortality, and related parameters, for two different estimates of natural mortality (M1 and M2) estimates. Sample sizes (N) is also provided

Parameter	2019	2020	2021	2022	2023	2024
Z	1.08	1.17	1.18	1.01	1.19	0.82
CI of Z	0.50-1.67	0.45-1.89	0.46-1.90	0.78-1.24	1.12-1.27	0.77-0.88
R^2	0.92	0.93	0.96	0.93	0.99	0.99
M1	0.26	0.26	0.26	0.26	0.26	0.26
F	0.82	0.91	0.92	0.75	0.93	0.56
E	0.76	0.78	0.78	0.74	0.78	0.68

Parameter	2019	2020	2021	2022	2023	2024
M2	0.39	0.39	0.39	0.39	0.39	0.39
F	0.69	0.78	0.79	0.62	0.8	0.67
E	0.64	0.67	0.67	0.61	0.67	0.82
L_{m50}(SFA, 2025)	40.2 cm FL					
N	408	353	418	1919	2652	2994

In both 2023 and 2024, based on both estimate of M, L_{c50} was less than L_{m50}, unlike the earlier years (until 2022) where L_{c50} was more than L_{m50} (Figure 1). As with 2023, the change in sampling sites could be one reason why there is a notable change in L_{c50}. The new sampling sites increased the possibility of obtaining catch from smaller outboard vessels and therefore the inclusion of catch from areas previously not covered by the sampling programme. The F/M ratio 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 3.58 in 2023 and 2.15 in 2024 with M1 (0.26) and with M2 (0.39) it was 2.05 in 2023 and 1.72 in 2024. With both estimates of M, the ratio is indicating high fishing pressure (Figure 2).

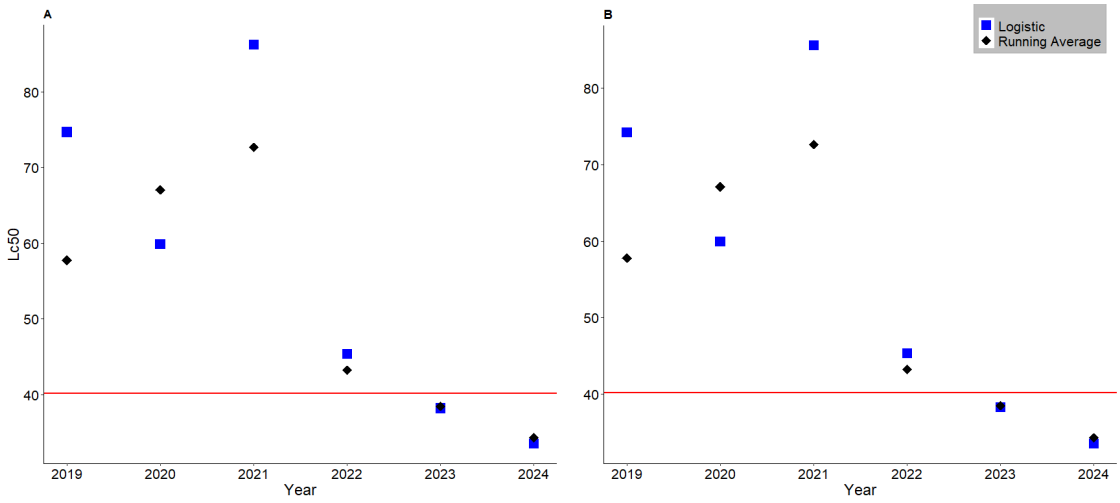

Figure 1: Estimates of L_{c50} for Aprion virescens calculated using logistic and running average models for M1 (A) and M2 (B). Red line is indicating L_{m50}

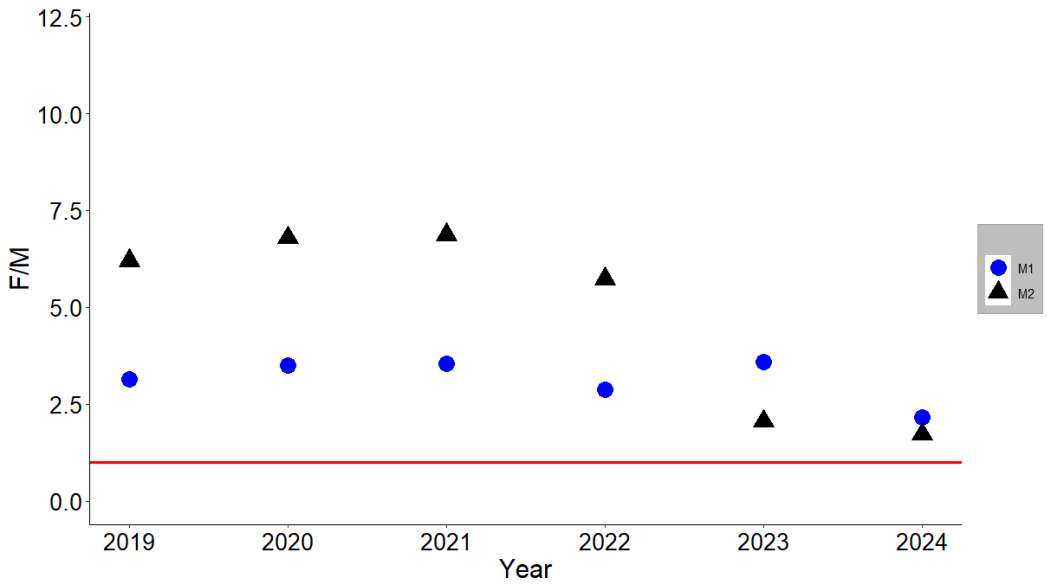

Figure 2: F/M ratio for Aprion virescens calculated from the estimates of Fishing mortality and for two estimates of natural mortality (M1 and M2). Red line is indicating F_{MSY}

1.2 Epinephelus chlorostigma

The sample size for 2024 was 1674 which is a considerable increase from the 1077 samples collected in 2023 and 716 in 2022. 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∞=57.19. L_{c50} was assessed against a published maturity estimate for females (De Moussac, 1986), rather than for males, since this species is suspected of protogynous hermaphroditism. Size at maturity was also calculated from 0.5L∞. As was the case with *Aprion virescens*, two estimates of M were applied in the assessment, the first (M1) being the standard Pauly (1980) method with a water temperature of 22°C, and the second (M2) was 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) based on the 0.5L∞ and Moussac (1986). Sample sizes (N) are also provided.

Parameter	2019	2020	2021	2022	2023	2024
Z	1.24	1.56	1.5	0.82	1.21	1.21
CI of Z	-4.17	-6.92	0.21 - 2.80	0.16-1.49	0.75-1.67	-4.25
R^2	0.98	0.97	0.99	0.99	0.99	0.98

Parameter	2019	2020	2021	2022	2023	2024
M1	0.48	0.48	0.48	0.48	0.48	0.48
F	0.76	1.08	1.02	0.34	0.73	0.85
E	0.61	0.69	0.68	0.41	0.6	0.7
M2	0.315	0.315	0.315	0.315	0.315	0.315
F	0.93	1.25	1.19	0.51	0.9	0.87
E	0.75	0.8	0.79	0.62	0.74	0.72
L_{m50}(0.5L_∞; Moussac, 1986)	28.60 cm TL; 31 cm TL for females					
N	540	59	209	716	1077	1674

For both estimates of M in 2023 and 2024, the L_{c50} was greater than the L_{m50} (Figure 3). For 2024, the F/M ratio for both M1 and M2 indicated slightly high fishing pressure, 1.77 and 2.76 respectively. This is similar to what was observed in 2023 with both estimated ratios also indicating a slightly high fishing pressure (Figure 4).

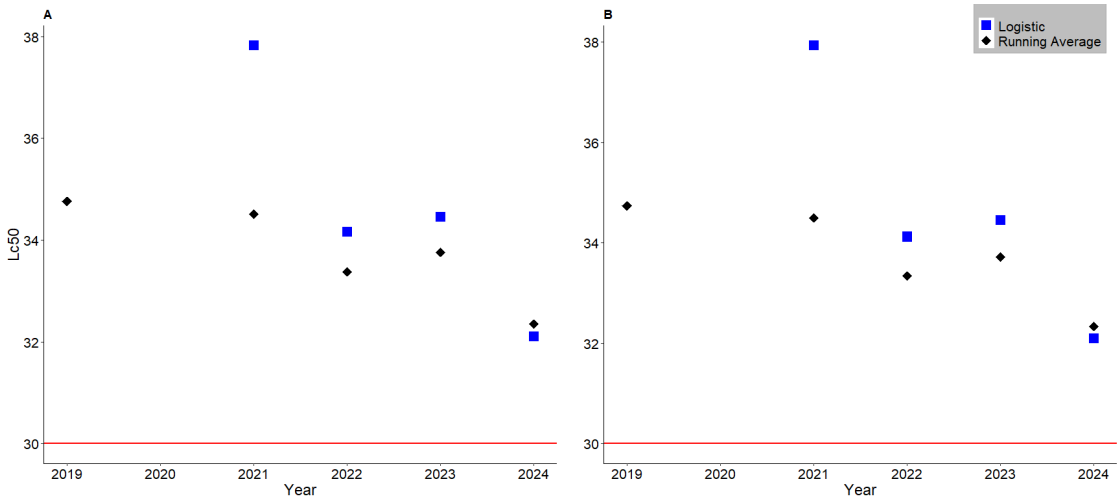

Figure 3: Estimates of L_{c50} for Epinephelus chlorostigma calculated using logistic and running average models for M1 (A) and M2 (B). Red line is indicating L_{m50}

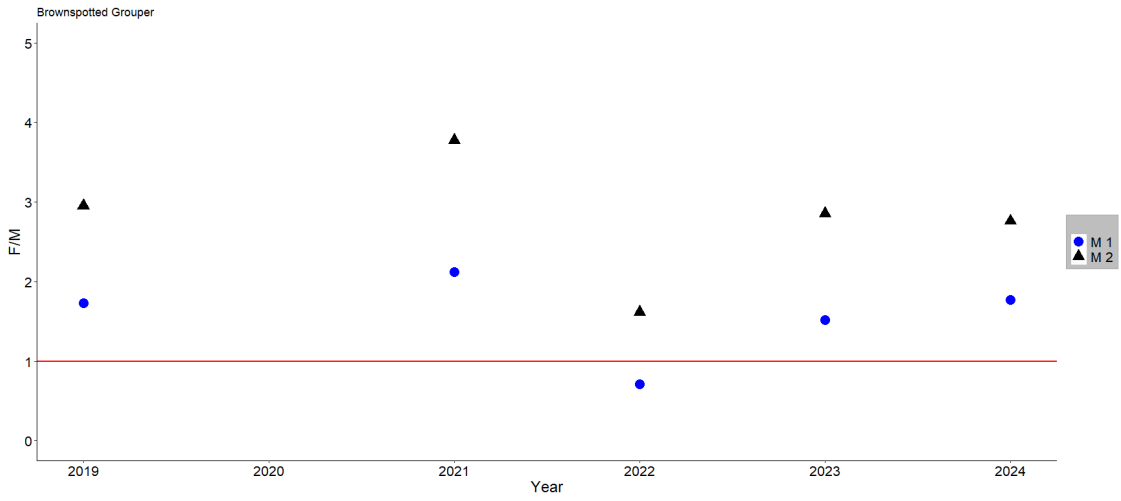

Figure 4: F/M ratio for Epinephelus chlorostigma calculated from the estimates of Fishing mortality and for two estimates of natural mortality (M1 and M2). Red line is indicating F_{MSY}

1.3 Lutjanus sebae

1.3.1 Mortality and capture estimates

An average of 2 age-based estimates was used (Grandcourt et al., 2008; Newman et al., 2000) and 2 length-based estimates (Mees, 1992), where K = 0.163; L_∞ = 88.6; t_0 = -0.95 were used as growth parameters for the analysis. Additionally, 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.

The estimate of total mortality (Z) was 0.35 in 2024 which was lower compared to estimates in 2023 and 2022. Both the running and logistic estimate of Lc_{50} was lower than the Lm_{50} of 62cm FL (Figure 5). Compared to previous years the F/M ratio indicated low fishing pressure (<1) (Figure 6).

Table 3. Lutjanus sebae: Mortality estimates based on Mees 1992. Sample sizes (N) also provided

Parameters	2019	2020	2021	2022	2023	2024
Z	0.48	0.42	0.5	0.39	0.45	0.35
CI of Z	0.42 - 0.53	0.28 - 0.56	0.23 - 0.77	0.33 - 0.45	0.24 - 0.56	0.16-0.54
R^2	0.99	0.97	0.97	0.99	0.98	0.92
M	0.182	0.182	0.182	0.182	0.182	0.182
F	0.3	0.24	0.32	0.21	0.22	0.17

Parameters	2019	2020	2021	2022	2023	2024
E	0.62	0.57	0.64	0.53	0.55	0.48
L_{m50}	62 cm FL					
N	1210	768	1177	1608	1255	3132

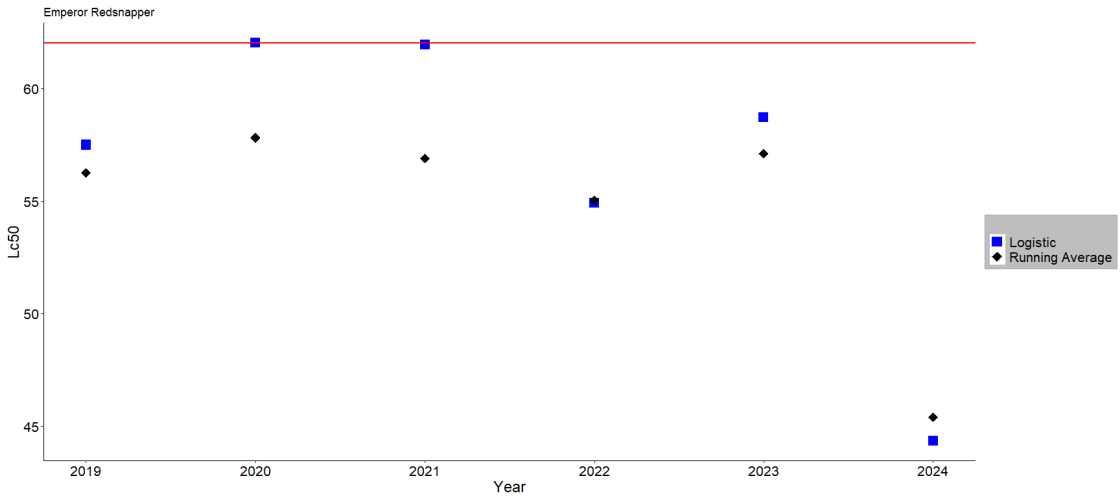

Figure 5: Estimates of L_{c50} for Lutjanus sebae calculated using logistic and running average model. Red line is indicating L_{m50}

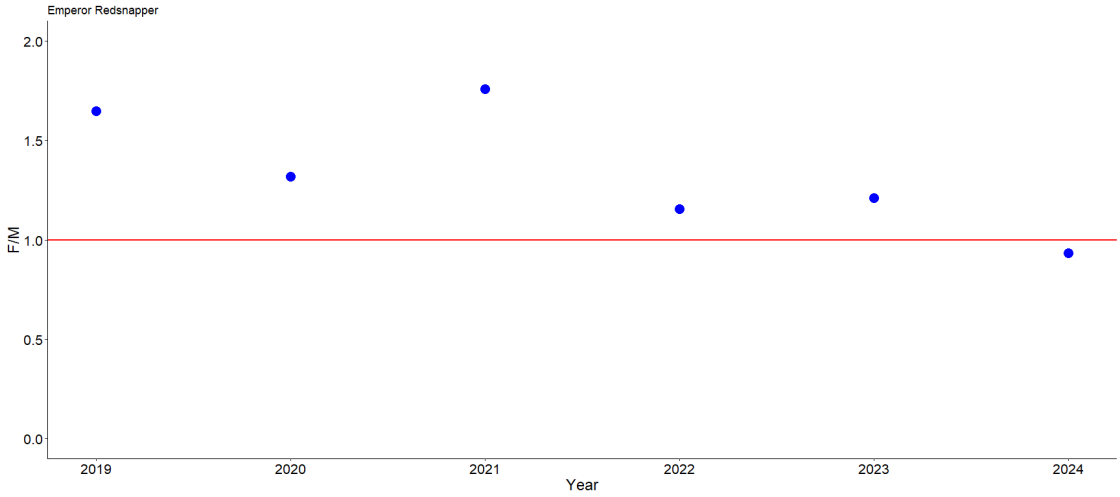

Figure 6: F/M ratio for Lutjanus sebae calculated from the estimates of Fishing mortality and for two estimates of natural mortality (M1 and M2). Red line is indicating F_{MSY}

1.3.2 Yield per recruit

A yield-per-recruit analysis was undertaken at the Mahe Plateau level including all fishing sector using the Yield Version 1.0 Software (MRAG, 2001). The results from the Yield software were imported into R Statistical software (RCoreTeam (2024)) for further processing.

The analysis indicated that MSY would occur when F is around 0.34. However, the Spawning Stock Biomass (SSB) would be reduced to less than 20% (a usual limit reference point) when F = 0.18 (CI= 0.12-0.28) (Fig. 7). For both MSY and SSB the estimate of current F (0.17) does not indicate overfishing (Table 4). From the histograms, maximum yield-per-recruit is achieved when F is around 0.19 - 0.49 (median = 0.31, CI=0.13-1.64) (Fig. 8), 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 the range of 0.13 - 0.21 (median= 0.18, 0.12-0.31) (Fig. 9). The estimate of current F for 2023, (0.17; range =-0.02 - 0.36) is within the range of $F_{SSB20\ per\ recruit}$, though the upper range of F (0.36) exceeds the upper confidence interval (0.31).

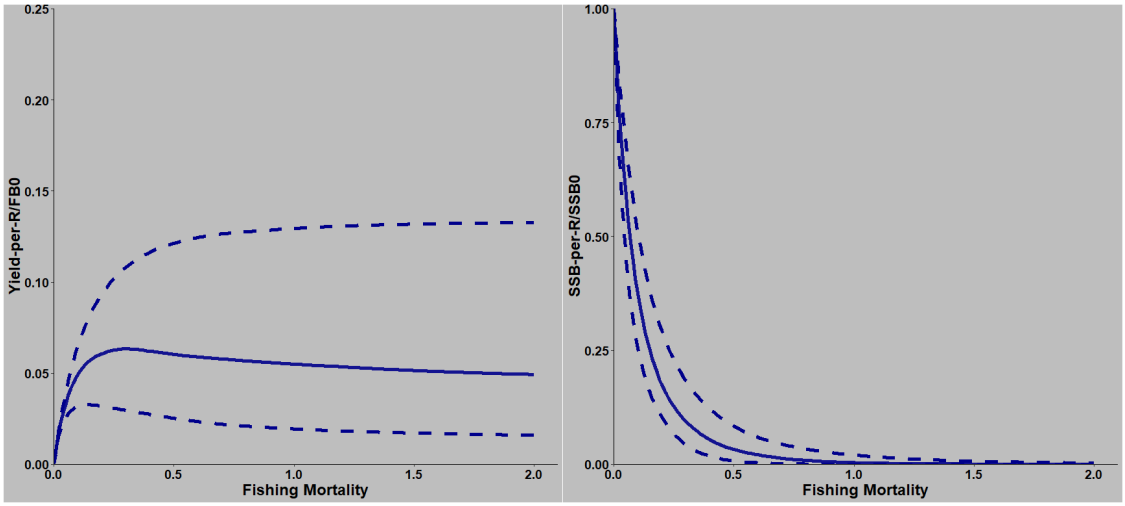

Figure 7: Yield-per-recruit and Spawning Stock Biomass per recruit against levels of fishing mortality for all sectors combined

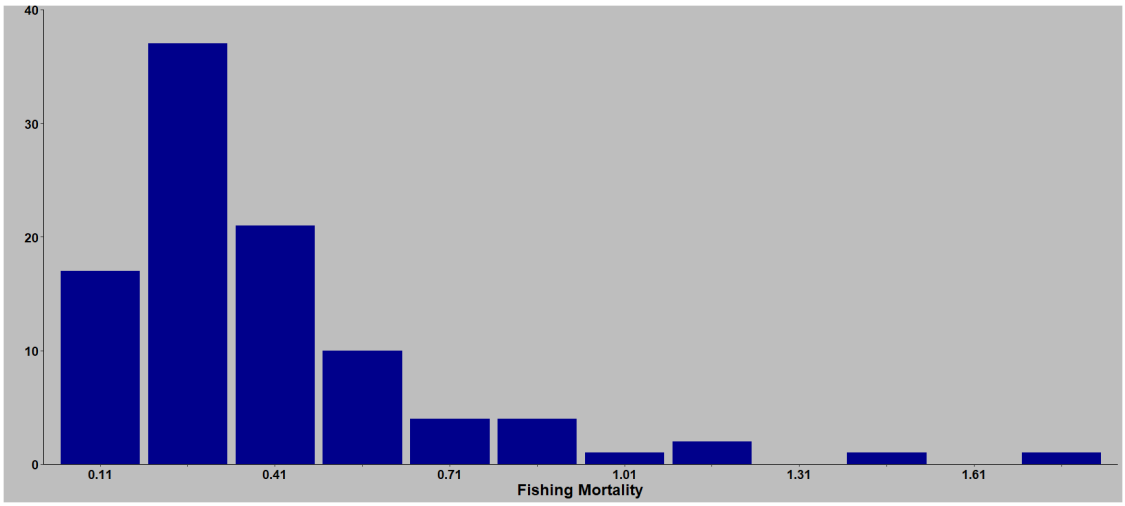

Figure 8: Frequency distribution of fishing mortality that produces maximum yield-per-recruit for all sectors combined

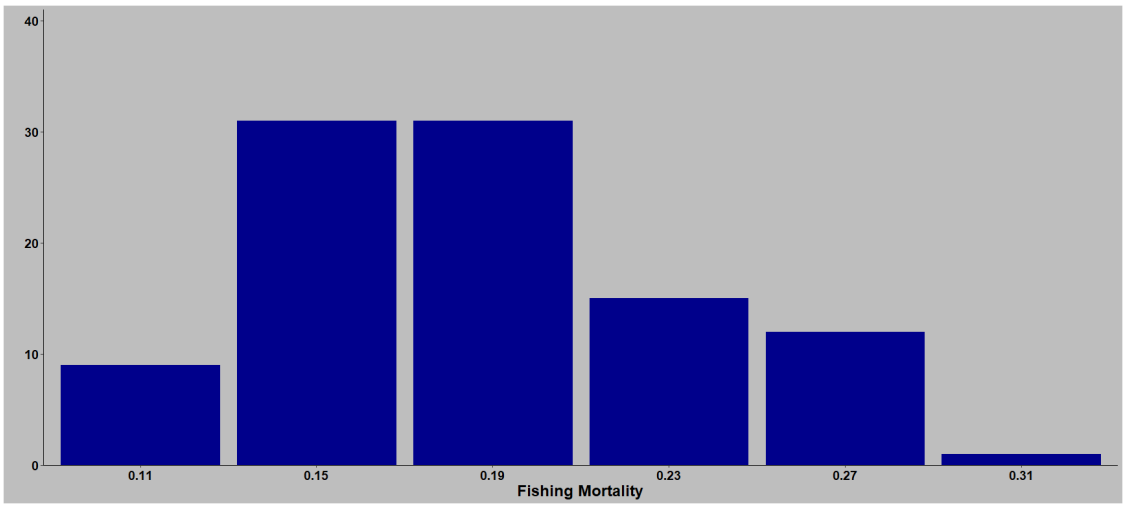

Figure 9. Frequency distribution of fishing mortality that maintains Spawning Stock Biomass at 20% of its unexploited value for all sectors combined

In summary, $F_{current}$ is within the range of estimates of the limit reference point F_{SSB20}, however, the upper confidence interval of F exceeds the range of estimates of F_{SSB20} (Table 4). In addition, considering the mortality estimates and estimate of F/M ratio it is indicating that there has been a reduction in fishing for the species

Table 4. 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}).

	2024
F_{MSYPR}	0.34
F_{SSB20}	0.12 - 0.28
$F_{current}$ (CI)	0.17 (-0.022-0.358)

2. Conclusions

There has been notable increase in sample size as well as sampling location in the last couple of years leading to a more robust analysis. However, the growth parameters being used contributes to significant uncertainty in the estimations. The current level of F should be maintained for *Lutjanus sebae* while for both *Aprion virescens* and *Epinephelus chlorostigma*, a reduction of fishing pressure is required.

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