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Assessment of Population Dynamics and Fishery Exploitation of Narrow-Barred Spanish Mackerel (*Scomberomorus commerson*) in Iranian Waters

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Abstract

The population dynamics and exploitation ratios of the narrow-barred Spanish mackerel (*Scomberomorus commerson*, Lacépède, 1800) were investigated from August 2020 to February 2023, with data collected from three landing sites (Bushehr, Bandar Abbas, and Chabahar) of Iran waters. During the study period, only length was measured for 6504 specimens and both the length and weight were measured for 504 specimens. The mean fork length of the samples was 86 ± 20 cm, and the mean weight was 6230 ± 3742 g. The relationship between length and weight for the total samples was described by the equation $W = 0.022 \times CL^{2.76}$ (n = 504, $R^2 = 0.90$, 95% C.I. for b = 2.52–2.91). The population dynamics indices for *S. commerson* were as follows: infinite length (Linf) = 173 cm, natural mortality (M) = 0.47 per year, growth coefficient (K) = 0.52 per year, total mortality (Z) = 1.42 ± 0.06 (95% C.I. = 1.36–1.48), fishing mortality (F) = 0.95 per year, and exploitation coefficient (E) = 0.67. The exploitation rate (U) and total stock at the beginning of the year (B_0) were 0.6 and 48,333 tons, respectively. The annual average standing stock (B_t) was estimated at 30,526 tons. The exploitation ratio for maximum sustainable yield (E_{MSY}) was 0.50, and fishing mortality at maximum sustainable yield (F_{MSY}) was 1.5. The estimated range for maximum sustainable yield (MSY, in 1000 tons), the B/B_{MSY} ratio, F/F_{MSY} ratio, and saturation (S) ratio of *S. commerson* in the Iranian part of the Persian Gulf and the Sea of Oman was 20 (17–25), 1.55 (1.25–1.73), 0.90 (0.8–1.12), and 0.45, respectively. The stock of *S. commerson* is approaching overfishing in Iran waters, imposing immediate management actions to reduce catch and fishing effort.

Keywords: length frequency; stock status; maximum sustainable yield; overfishing; Persian Gulf; Sea of Oman

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1. Introduction

Resource conservation is a fundamental principle in fishery management, ensuring the sustainable use of aquatic resources while maintaining ecological balance [1]. Fisheries, as a vital renewable resource, play a crucial role in global food security, economic stability, and biodiversity conservation [2]. Effective fishery management requires a comprehensive understanding of fish population dynamics, growth, and mortality to regulate exploitation levels appropriately. Fishery managers strive to balance resource utilization with

conservation efforts by assessing stock conditions and implementing sustainable fishing practices [3]. One of the widely adopted methods for stock assessment is length-based analysis, which provides valuable insights into fish population structure, particularly in data-limited fisheries where age-based data are scarce [4,5]. Although length-based methods rely on assumptions about growth, mortality, and selectivity, which can affect accuracy, they are useful tools for informing sustainable fishery management [6]. By analyzing size distributions in fish catches, researchers can estimate key biological metrics such as growth, mortality, and exploitation rates, aiding in the formulation of sustainable fishery policies [7].

The genus *Scomberomorus* comprises 18 species, two of which, *Scomberomorus commerson*, Lacépède, 1800 and *Scomberomorus guttatus*, Bloch & Schneider, 1801, are found in the Persian Gulf and the Sea of Oman. *Scomberomorus commerson*, commonly known as the narrow-barred Spanish mackerel, is a migratory epipelagic species inhabiting tropical and subtropical waters across the Pacific and Indian Oceans [8]. This species primarily occupies depths of up to 100 m, with adults typically residing in deeper offshore waters compared to juveniles. It has a recorded maximum lifespan of 16 years, reaching lengths of up to 240 cm and weights of up to 70 kg, although most individuals measure around 90 cm [9,10]. The distribution and migration patterns of *S. commerson* are influenced by various environmental factors, including temperature fluctuations, ocean currents, and food availability, highlighting the necessity of continuous monitoring to understand stock dynamics [11].

Extensive research on the biological traits, population dynamics, and stock status of *S. commerson* has been conducted worldwide. Notable studies include those by Newman et al. [12], Johnson et al. [13], Niamaimandi et al. [14], Lee and Mann [15], Yuliana and Nurhasanah [16], and Mallawa and Amir [17]. In the Persian Gulf and the Sea of Oman, specific assessments have been undertaken by Ghodrati Shojaei et al. [18], Taghavi Motlagh et al. [19], Darvishi et al. [20], Kaymaram et al. [11], Niamaimandi et al. [14], and Al-Shehhi et al. [8]. However, despite these efforts, critical gaps remain in biomass estimation and stock assessment methodologies for *S. commerson* in Iranian waters.

This study makes the hypothesis that the long-term survival of the stock is in risk because the current rate of *S. commerson* exploitation in Iranian seas is higher than sustainable levels. The objective of this study is to evaluate the biological characteristics, population dynamics, and stock status of *S. commerson* in the Persian Gulf and the Sea of Oman off the coast of Iran. Specifically, the research aims to estimate key growth parameters, assess total, natural, and fishing mortality rates, and determine exploitation indicators such as the B/B_{MSY} and F/F_{MSY} ratio and the exploitation coefficient. Biomass will be estimated using models including CMSY and yield-per-recruit analysis. Stock health will be further assessed using indicators like the Length-Based Spawning Potential Ratio (LBSPR) and the Spawning Potential Ratio (SPR). The ultimate goal is to identify signs of overfishing and provide evidence-based recommendations for the sustainable management and conservation of this economically valuable species, with comparisons drawn from both regional and global benchmarks.

2. Materials and Methods

The population dynamics and exploitation ratio of the narrow-barred Spanish mackerel (*S. commerson*) were investigated between August 2020 and February 2023 using data collected from three landing locations: Bushehr (50°48′29.24″ E, 28°55′9.52″ N), Bandar Abbas (56°15′53.96″ E, 27°10′15.42″ N), and Chabahar (60°37′17.98″ E, 25°17′45.69″ N) (Figure 1) from Iranian waters. Sampling locations were selected from well-known fishing ports in the Persian Gulf and the Sea of Oman waters of Iran, where gill nets with a mesh

size of 140 mm are frequently used. All samples were collected using the same fishing gear and deployment settings to ensure consistency. This standardized approach provided representative data from active fisheries and allowed for accurate estimation of the adult *S. commerson* population for reliable stock assessments.

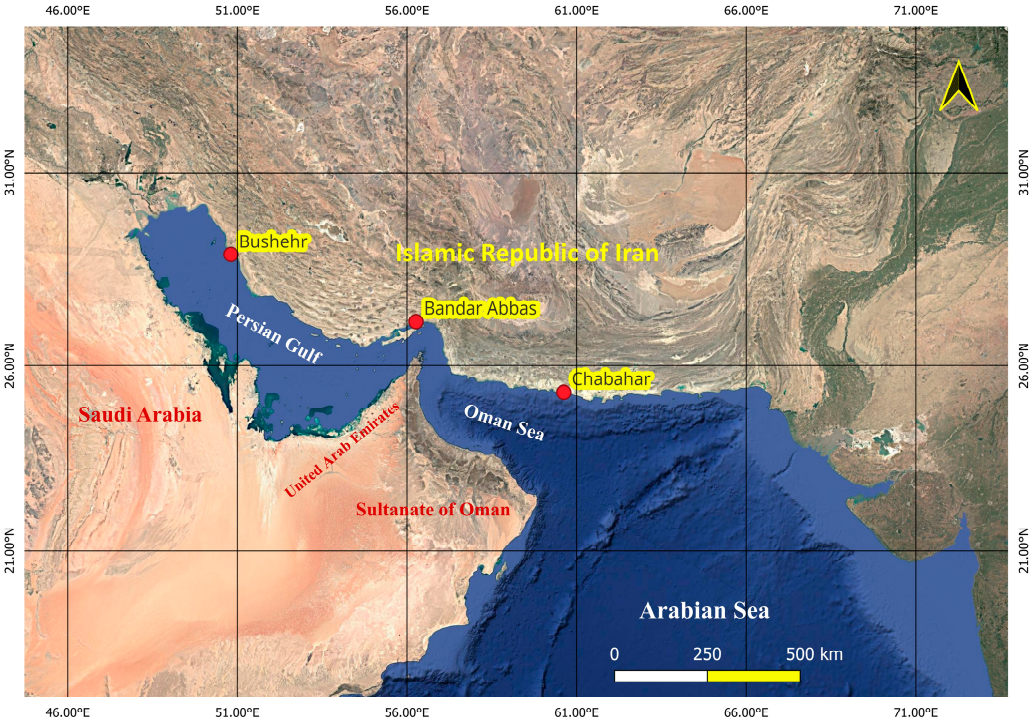

Figure 1. The map illustrates the locations (Bushehr, Bandar Abbas, and Chabahar) of *Scomberomorus commerson* sampling sites within the Iranian waters of the Persian Gulf and the Sea of Oman.

2.1. Length Frequency Distribution

Samples were collected from fish arriving each month at the ports of Bushehr, Bandar Abbas, and Chabahar. Random samples of commercial catches from these ports were gathered between August 2020 and February 2023. The Fork length was measured to the nearest centimeter using a biometric ruler (Mahak Co. Tehran, Iran). A randomly selected subsample was measured both for length and weight to determine the length–weight relationship analysis.

2.2. Biometry

Biometric measures were obtained, including weight and length. A biometric ruler was used to measure the fish fork's length of 6504 fish to within 1 cm. The wet weight and length of a total of 504 fish (mixed sex) was measured using a digital weighing machine (Quanzhou Xixing Machinery Co., Ltd., Quanzhou, China) with an accuracy of 0.1 g. Here, (Wi) represents the total weight (g), (Li) is the fork length (cm), (a) is a constant coefficient, and (b) is the exponent in the equation ($Wi = a \times Li^{b}$). The equation was employed to identify notable differences between the calculated (b) from the equation and ($b = 3$) for a narrow-barred Spanish mackerel with similar growth. The formula used is

$$t = [(s.dx)/(s.dy)] \times [(lb - 3l)/(\sqrt{(l - r^2)}] \times [\sqrt{(n - 2)}]$$

Here, ($s.dx$) represents the standard deviation of the natural log of length, ($s.dy$) denotes the standard deviation of the natural log of weight, (b) is the slope, (r^2) is the coefficient of determination, and (n) is the sample size [21].

2.3. Growth Studies

The TropFishR program and the ELEFAN (Electronic Length Frequency Analysis) approach (optimization model) were used to evaluate L∞ and growth rate [22]. The experimental Pauly equation was used to find the optimal value of (t_0) with the formula (Log ($-t_0$) = $-0.3922 - 0.2752$ Log L∞ $-$ 1.038 Log K) [23]. Additionally, the equation $\Phi' = \text{Log (K)} + 2 \text{ Log (L}\infty\text{)}$ was employed to compare growth parameters, such as infinite length (L∞) and growth factor (K).

2.4. Mortality Estimate

The natural mortality rate (M) was determined using the empirical formula [24] $M = 4.118 \times K^{0.73} \times L\infty^{-0.33}$, where L∞ represents the infinite length of the fish (in cm) and K is the growth curve parameter from the von Bertalanffy equation. Total mortality (Z) was determined using length-converted catch curve data. Fishing mortality (F) was calculated with the formula ($F = Z - M$), where (M) represents natural mortality. The exploitation rate (E), which shows the ratio of fishing mortality to total mortality, was computed using ($E = F/Z$) [25]. Additionally, the formula $t_{max} = t_0 + 3/K$ was used to estimate the maximum lifespan [23].

2.5. Length-Based Reference Point

In the northern Sea of Oman, Iran, the length at maturity (L_{mat}) for this species was found to be 83 cm [11,26]. The ideal fishing length (L_{opt}) is determined using the following formula: $L_{opt} = L\infty \times (3/(3 + M/K))$ [27].

2.6. Fishery Assessment

The exploitation rate (U) was calculated using the formula $U = F\ (1 - e^{-z})/z$. To determine the total biomass of the stock at the beginning of the year, the formula $B_0 = Y/U$ was applied, where Y represents the annual average catch of approximately 29,000 tons for this species in 2023 [28]. Additionally, to evaluate the annual average of the standing stock, the formula $B_t = Y/F$ was utilized.

2.7. Yield per Recruit and Biomass per Recruit

The relative yield per recruit (Y′/R) was determined using the fishing mortality coefficient, sometimes referred to as the exploitation rate. (E) represents the exploitation coefficient, (U) the exploitation rate, (M) the natural mortality coefficient, (F) the fishing mortality coefficient, and (Lc) the Lc50, according to Gayanilo et al. [29]. Additionally, the relative biomass per recruit (B′/Rp) was calculated using the following formulas:

$$Y'/R = EU^{M/K}\ (-3\ U/(1 + m) + 3\ U^2/(1 + 2m) + U^3/(1 + 3m)$$

$$U = 1 - (L_C/L_\infty)$$

$$M = (1 - E)/(M/K) = (K/Z)$$

$$E = F/Z$$

$$B'/R = Y'/R/F$$

2.8. Length-Based SPR Assessment Methodology (LB-SPR)

The main components of the recently developed length-based SPR (LB-SPR) evaluation approach, which was used in this investigation, are technically summarized by Hordyk et al. [30]. Fish size at sexual maturity in relation to their typical maximum size without fishing (L∞) (Lm/L∞), the ratio of fishing mortality to natural mortality (F/M), the ratio of

natural mortality to the von Bertalanffy growth coefficient (M/k), and the variability of length at age (CVL∞) are the five input parameters needed for the LB-SPR approach. The latter value is typically estimated to be around 10%; however, it is challenging to determine with accuracy in the absence of trustworthy length and age data. The LB-SPR package was utilized to perform the LB-SPR analysis [30]. SPR = Total Egg Production (Fished)/Total Egg Production (Unfished).

The data was analyzed using the TropFishR package, Excel application (Microsoft Office 2013), R software (R 4.3.1) [31], and R studio (2023.03.1-446).

2.9. C-MSY (CMSY) Method (Monte Carlo Algorithm)

The C-MSY and Graham–Schaefer models share similarities and both uses catch time series data to estimate maximum sustainable yield and fisheries reference points. C-MSY requires prior distributions for r and k, as well as the biomass at the start of the assessment [32]. Subsequent biomass is then calculated using the Schaefer equation [33].

$$B_{y+1} = B_y + rB_y\,(1 - B_y/k)\,es^1 - Ct\,es^2,$$

The instantaneous population growth rate (r) and carrying capacity (K) based on depletion (d) and resource saturation (S) are determined using formulas in this methodology. B_{MSY} = K/2 and MSY = rk/4 are the formulas used to calculate the maximum sustainable yield (MSY). Stock sustainability determines the initial range for r; highly sustainable equities are given r values in the range of 0.6 to 1.5. Using the IRF formula, which includes 3/r high − r low and the inverse range coefficient, population growth rates were computed [32].

According to Froese et al. [32], the explanatory error must be 0.1 and the preceding process error variance should be set to 0.2 in order to obtain the intended model sampling. The preliminary relative biomass from earlier data ranges from 0.1 to 0.4, whereas the most recent relative biomass ranges from 0.2 to 0.65. The first and final years' exploitation records are used. After a year, the first median relative biomass in 2005 ranged from 0.5 to 0.9. See Martell and Froese [33] and Froese et al. [32] for additional information on CMSY.

3. Results

The fork length (N = 6504) of the species ranged from 30 to 170 cm, with an average fork length of 86 ± 22 cm and an average weight of 6230 ± 3742 g. The fork length data were grouped into 10 cm intervals, with the highest frequency observed in the 80 to 90 cm category, which included 1038 specimens, accounting for approximately 16% of the total (Figure 2).

The relationship between length and weight for the total samples (mixed sex) was described by the equation $W = 0.022 \times CL^{2.76}$ (n = 504, R^2 = 0.90, 95% confidence interval for b = 2.52–2.91) (Figure 3). Significant differences in length and weight were observed between the two sexes ($p < 0.05$). Student's t-test revealed significant differences between the estimated b value and b = 3 at the 0.05 level ($p < 0.05$), indicating an allometric growth pattern for this species in the Iranian section of the Persian Gulf and the Sea of Oman (Figure 3).

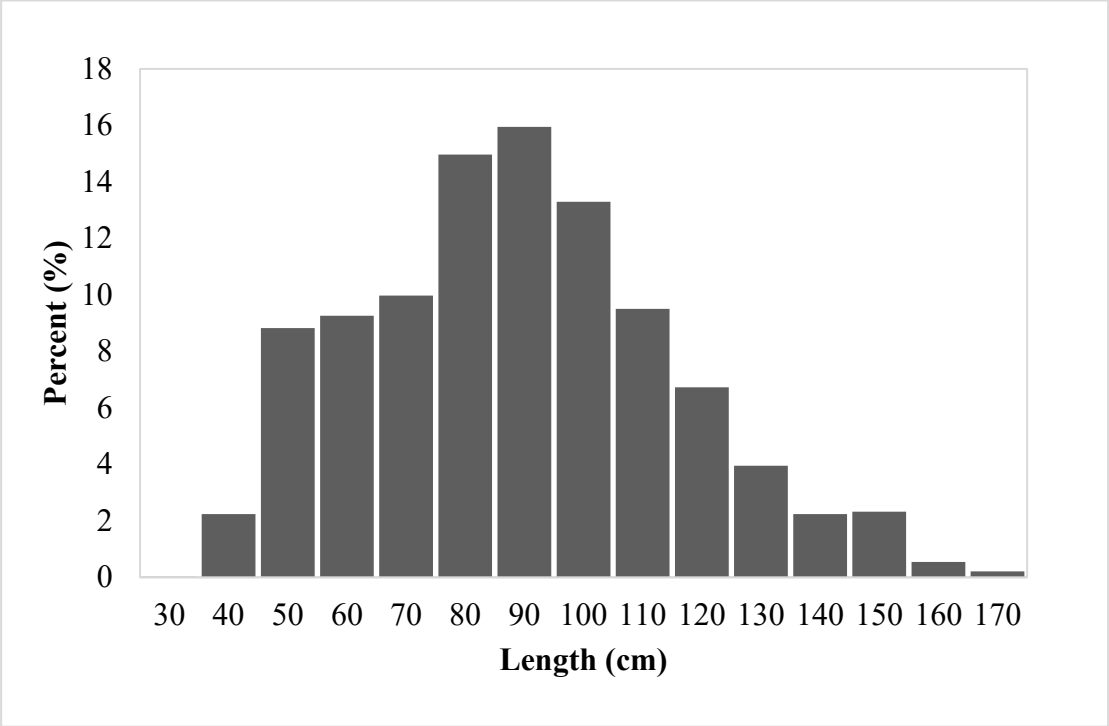

Figure 2. Percentage frequency distribution of *Scomberomorus commerson* across various length classes in the Iranian waters of the Persian Gulf and the Sea of Oman.

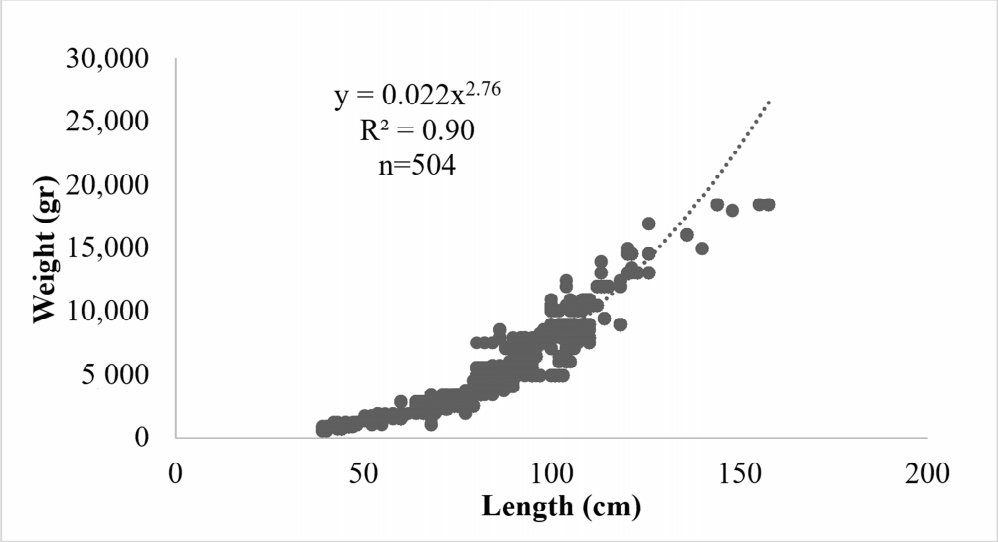

Figure 3. Length–weight relationship (LWR) of *Scomberomorus commerson* in the Iranian waters of the Persian Gulf and the Sea of Oman.

The population dynamics indices for *S. commerson* were as follows: fork length at infinity (L∞) = 173 cm, growth coefficient (K) = 0.52 per year, growth performance index (Φ) = 4.17, natural mortality (M) = 0.47 per year, fishing mortality (F) = 0.95 per year, total mortality (Z) = 1.42 ± 0.06 (95% C.I. = 1.36–1.48), and the exploitation coefficient (E) = 0.67 (Figure 4). The optimal fishing length (Lopt) for this species was estimated to be 120 cm.

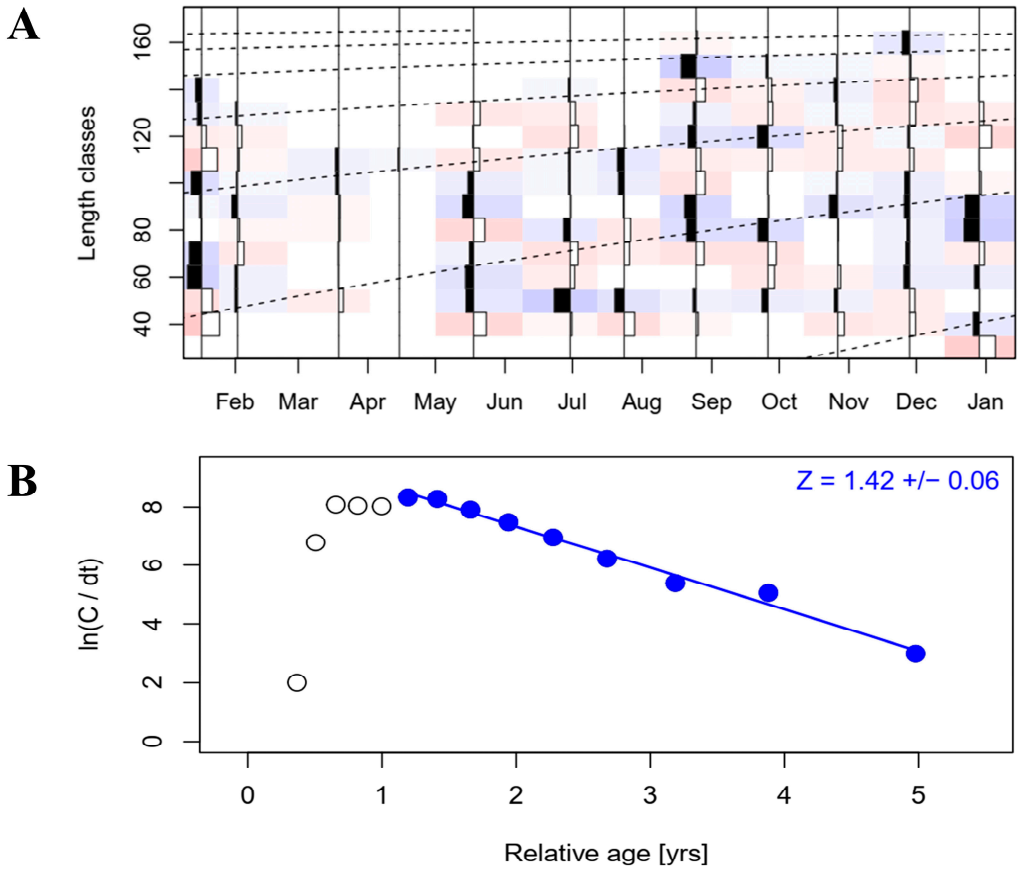

Figure 4. Growth curve and linear catch curve of *Scomberomorus commerson* in the Iranian waters of the Persian Gulf and the Sea of Oman. (**A**) The growth curve represents the estimated growth pattern of the species, while (**B**) the catch curve illustrates the relationship between age and fishing mortality, providing insights into population dynamics and exploitation levels. White circles represent the data excluded from the final analysis, while blue circles represent the data included in the total mortality estimation.

The relative production per recruitment, relative biomass per recruitment, and exploitation rates for both females and males were as follows: $Y'/Rp = 0.07$ and $B'/Rp = 0.67$ (yr^{-1}). The exploitation ratio for maximum sustainable yield (E_{MSY}) was 0.50, while the fishing mortality for maximum sustainable yield (F_{MSY}) was 1.5, indicating that $F/F_{MSY} > 1$ (as shown in Figure 5), which is considered undesirable. Based on the findings, the maximum lifespan of *S. commerson* is approximately 6 years.

The exploitation rate (U) and the total stock at the start of the year were determined to be 0.6 and B_0 = 48,333 T, respectively. The estimated annual average standing stock (B_t) was 30,526 T. The specific parameter for SPR was calculated to be 0.40 per year, as shown in Figure 6. The projected 95% confidence intervals for the assessments of spawning potential, relative fishing pressure, and selectivity are displayed below the estimates.

The Catch–Maximum Sustainable Yield (CMSY) models were used to determine the average (maximum–minimum) values for the population's carrying capacity (K, in 1000 tons) and instantaneous growth rate (r), with estimates of 147 (96–225) and 0.56 (0.40–0.78), respectively. For *S. commerson* in the Iranian portion of the Persian Gulf and the Sea of Oman, the ranges for the maximum sustainable yield (MSY, in 1000 tons), the current biomass to biomass at MSY (B/B_{MSY}), the current fishing mortality to fishing mortality rate at MSY (F/F_{MSY}), and saturation ratio ($S = B/K = 0.5B/B_{MSY}$) were estimated to be 20 (17–25), 1.55 (1.25–1.73), 0.90 (0.8–1.12), and 0.45, respectively (Figure 7).

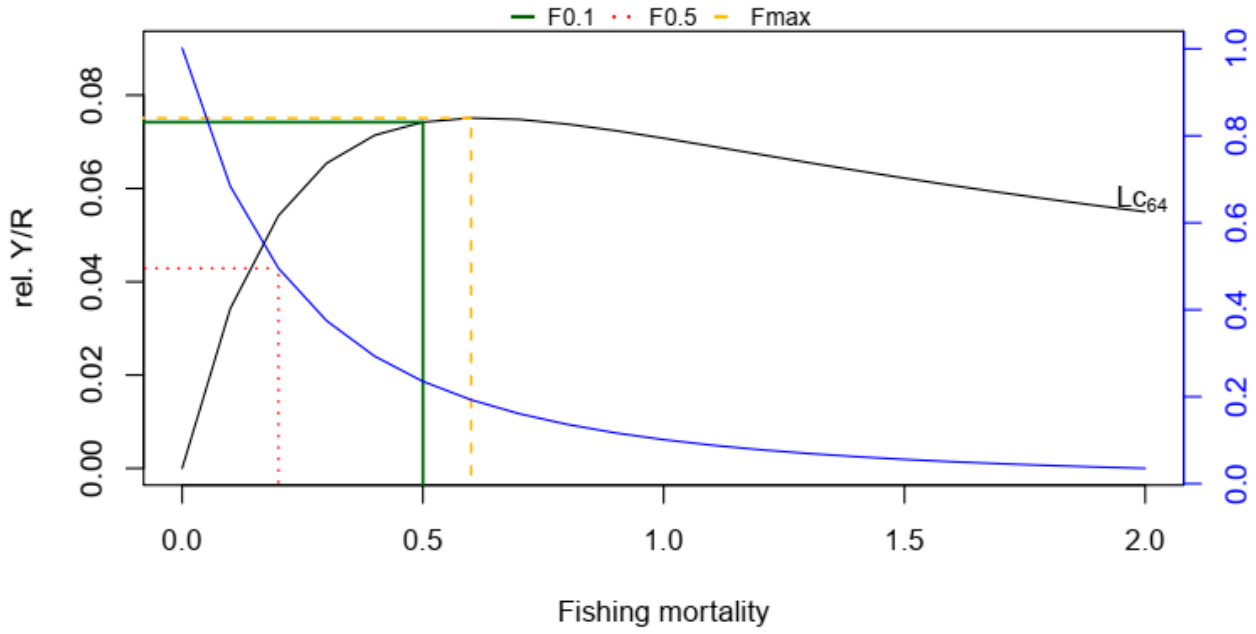

Figure 5. The Y′/R and B′/R derived from frequency data of *Scomberomorus commerson* in the Iranian part of Persian Gulf and the Sea of Oman Waters.

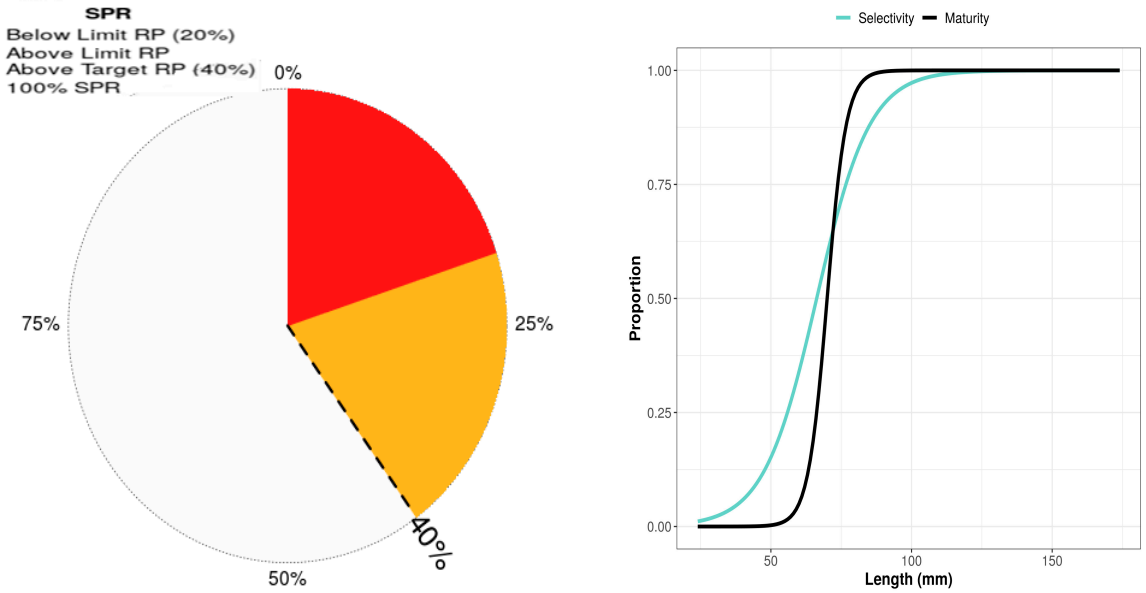

Figure 6. Graphical representation of the estimated SPR quantities derived from frequency data of *Scomberomorus commerson* in the Iranian waters of the Persian Gulf and the Sea of Oman.

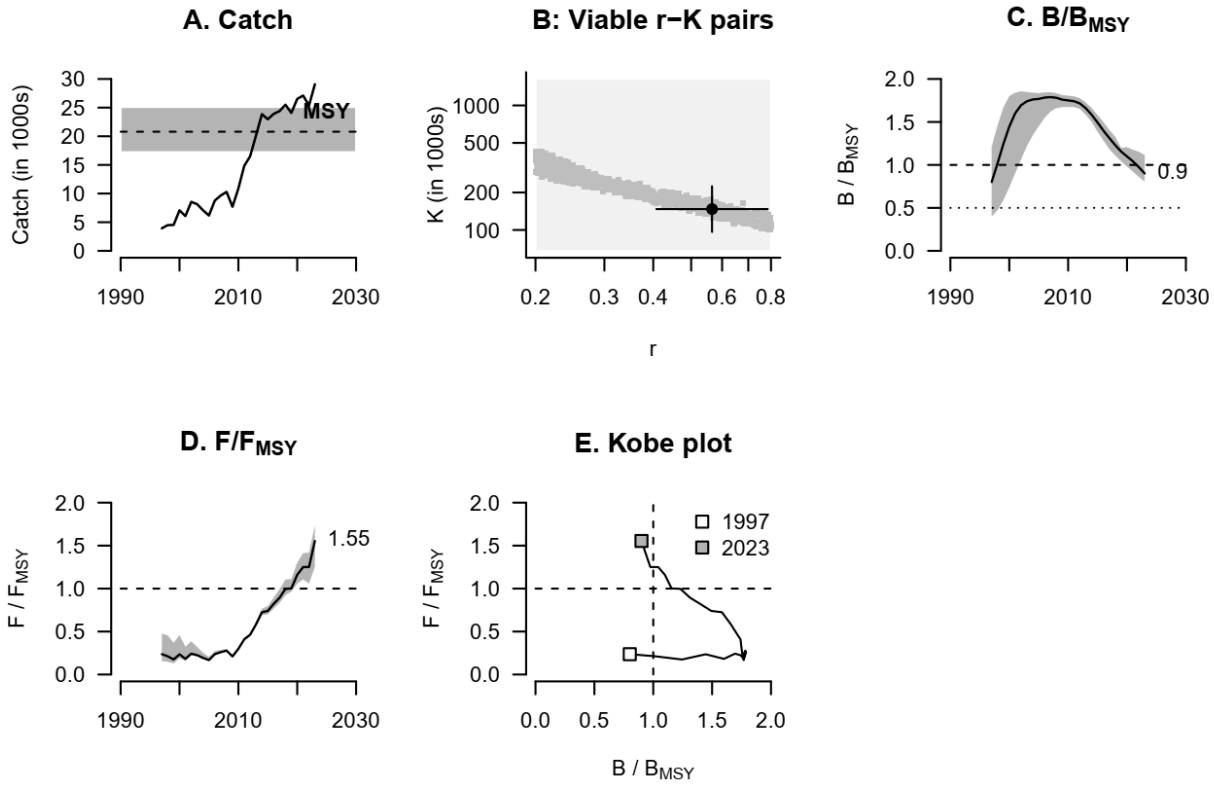

Figure 7. The range of values of maximum sustainable yield (MSY), the ratio of current biomass to MSY biomass (B/B_{MSY}), the ratio of current fishing mortality to MSY fishing mortality (F/F_{MSY}), and the saturation ratio (S) of *Scomberomorus commerson* in the Iranian section of the Persian Gulf and the Sea of Oman.

4. Discussion

In southern Iran, *S. commerson* is a large pelagic fish of considerable economic importance. Its capture in the Iranian waters of the Persian Gulf and the Sea of Oman, particularly in the provinces of Sistan and Baluchistan, has significantly increased in recent years. The southern waters of Iran have yielded approximately 29,000 tons of *S. commerson* in 2023–2024 [28].

According to Biswas [34], the "b" value can vary from 2.5 to 4, while other studies on this species have recorded values ranging from 2.1 to 3.2 [11–17,20]. The "b" value is likely not significantly influenced by seasonal changes in environmental factors, the physiological state of the fish at the time of collection, sex, gonadal development, or the nutritional conditions in its habitat [34]. In fishery biology, length–weight relationships (LWRs) are crucial tools when accurate length measurements are available. In addition to being indicators of the health of fish populations, the LWR enables scientists to quantify fish weight and biomass and makes it easier to compare growth patterns across species and geographical areas [35].

Table 1 compares the biological indicators of *S. commerson* with those from global studies. The infinite length of this species appears to be greater in the Sea of Oman and Persian Gulf than in Australia, South Africa, and Tanzania. Additionally, the infinite length in the Persian Gulf is longer than in the Sea of Oman. These differences in infinite length and growth rate are influenced by the ecological distinctions between regions [36]. Reproductive and morphological characteristics, population size, and genetic diversity vary due to biodiversity and natural selection, resulting in different adaptation patterns throughout the organism's life. The amount and quality of food, together with the climate, are generally responsible for regional differences in infinite duration and growth rate [37].

Fish growth can also be influenced by a number of other parameters, including as age, sex, season, year, feeding style, physiological circumstances, food supply, and reproductive periods [38].

Table 1. Comparison of the biological traits of *Scomberomorus commerson* with global studies (L∞ = asymptotic length; K = growth coefficient; t_0 = hypothetical age at zero length; Φ′ = growth performance index; M = natural mortality rate; F = fishing mortality rate; Z = total mortality rate; E = exploitation rate).

References	Region	L∞ (cm)	K (yr^{-1})	t_o	Φ′	M	F	Z	E
Ghodrati Shojaei et al., [18]	Persian Gulf and Sea of Oman (Iran)	140	0.42	−0.26	3.91	0.49	0.98	1.47	0.66
Taghavi Motlagh et al., [18]	Sea of Oman (Iran)	170	0.24	−0.36	3.94	0.36	0.59	0.95	0.62
Darvishi et al., [20]	Persian Gulf and Sea of Oman (Iran)	175	0.45	–	4.10	0.5	1.48	1.98	0.74
Newman et al., [12]	Australia	122 (M) 133 (F)	0.33 0.38	−1.83 −1.49	8.51 8.77	-	-	-	-
Kaymaram et al., [11]	Persian Gulf and Sea of Oman (Iran)	151	0.46	–	4.02	0.54	1.39	1.93	0.72
Johnson et al., [13]	Tanzania	122	0.68	−0.17	-	0.43	1.01	1.44	0.7
Niamaimandi et al., [14]	Persian Gulf (Iran)	148	0.5	–	-	0.56	0.41	0.97	0.42
Lee and Mann, [15]	South Africa	119 (M) 130 (F)	0.28 0.31	−1.85 −1.35	8.28 8.57	-	-	-	-
Yuliana and Nurhasanah, [16]	Indonesia	97	0.45	−0.26	-	0.79	0.33	1.12	0.29
Present study	Persian Gulf and Sea of Oman (Iran)	173	0.5	−0.2	4.17	0.47	0.95	1.42	0.67

The relationship between infinite length and growth rate is reflected in the growth curve's comparison of Φ′ values, which produces a growth curve with fluctuating growth rates throughout time and across various sizes. Ecological conditions and latitude shifts can impact both infinite length and growth rate, causing fluctuations in Φ′ values. These values may change within the same area over time as a result of changing environmental conditions [36]. Furthermore, the fishing mortality rate for *S. commerson* exceeded its natural mortality rate. Overfishing was indicated by a ratio of fishing mortality to maximum sustainable yield (F/F_{MSY}) greater than one [39]. Furthermore, the exploitation rate and exploitation coefficient were both greater than 0.5, indicating that fisheries' catch exceeded the ideal threshold. Ideally, these metrics should remain below 0.5, and fishing mortality should not exceed natural mortality, as surpassing these thresholds indicates overfishing [36].

In other parts of the world (Table 1), natural mortality, fishing mortality, total mortality, and exploitation coefficients have been reported in the ranges of 0.79 to 0.36 per year, 0.33 to 1.48 per year, 0.95 to 3.24 per year, and 0.29 to 0.75 per year, respectively [11–17]. This study, compared to previous studies in the Persian Gulf and the Sea of Oman region, shows higher fishing mortality, total mortality, and exploitation coefficients, indicating an increase in the capture fisheries of this species in recent years (Table 1). Key factors influencing pressure on fish stocks include (1) the volume of fish caught and harvested and (2) environmental conditions affecting survival and access to fishery resources [40]. To effectively reduce the exploitation rate, it is advisable to decrease fishing activities and limit the issuance of fishing permits, thereby reducing the number of entrants into the fishing community [41].

The findings suggest that the maximum lifespan of *S. commerson* is approximately six years, calculated using the formula $t_{max} = t_0 + 3/K$ [23]. According to the criteria established by the American Fisheries Society [42], and by comparing the current study's results with these benchmarks, the extinction vulnerability of this species was assessed as high. The growth, mortality, and stock condition of *S. commerson* can be greatly impacted by anthropogenic pressures like overfishing and habitat degradation, as well as regional ecological factors like temperature, salinity, and food availability. These variances contribute to the explanation of the regional variations we found in our investigation.

The stock conditions of *S. commerson* are unfavorable based on the methodology and defined parameters; values below 65% indicate poor stock status [43,44]. When the P_{obj} value is less than 1, and both P_{opt} and P_{mega} are greater than 0, it suggests that the fishery is targeting smaller, optimally sized fish or all but the largest individuals, which is undesirable. A P_{obj} value of less than 1 indicates selectivity patterns that do not align with sustainability guidelines [45].

According to the LBSPR index, the stock status is at an average level of 0.4. The LBSPR index estimates the spawning potential ratio (SPR); values below 0.2 ($0.2 \approx B/B_0$) indicate depletion of reserves, while values above 0.6 ($0.6 \approx B/B_0$) reflect a healthy stock condition. Values between 0.2 and 0.6 ($0.2–0.6 \approx B/B_0$) suggest an average stock condition [30,46–49]. It is also important to emphasize the 95% confidence limits provided by LBSPR, as they demonstrate the exceptionally low error associated with these estimates [30].

5. Conclusions

The biological characteristics, population dynamics, and stock status of *Scomberomorus commerson* in the Persian Gulf and the Sea of Oman were evaluated in this study utilizing models for biomass and length-based estimation. The stock is being overfished, as evidenced by key indices such an exploitation coefficient (E) of 0.67, an F/F_{MSY} ratio below 1, a B/B_0 above 0.4, and an LBSPR index above 0.4. The results are consistent with the theory that the rate of exploitation is higher than what is sustainable. This commercially significant species requires rapid management actions, such as lowering fishing effort and catch restrictions, to preserve its long-term survival. These findings give evidence-based conservation and sustainable fishery management in the area a solid scientific foundation.

Author Contributions: S.A.H.: Conceptualization, Data collection, Analysis, Validation, Writing—original draft; M.D.: Conceptualization, Analysis, Writing—review and editing; A.A.K.: Visualization, Writing—review and editing; S.D.: Conceptualization, Analysis, Validation, Investigation, Visualization, Writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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