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EVALUATION OF THE RELATIVE FISHING MORTALITY IMPACT BY MAIN FLEET GEAR ON BLUE MARLIN AND THE WEST SAILFISH STOCK

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SUMMARY

Based on the 2024 Blue Marlin and the 2023 Western Sailfish Stock Synthesis stock assessment results, this document describes the fishing mortality impact by the main fleet-gear components currently operating in the fishery. Blue marlin is mainly caught as bycatch in longline fleets, and they represent the major source of impact in terms of fishing mortality as well for the western sailfish stock.

RÉSUMÉ

Sur la base des résultats de l'évaluation du stock de makaire bleu de 2024 et de l'évaluation du voilier de l'Ouest de 2023 au moyen de Stock Synthesis, le présent document décrit l'impact de la mortalité par pêche pour les principales composantes flottille-engin qui opèrent actuellement dans la pêcherie. Le makaire bleu est principalement capturé en tant que prise accessoire par les flottilles palangrières, et celles-ci représentent la principale source d'impact en termes de mortalité par pêche pour le stock de voilier de l'Ouest.

RESUMEN

Basándose en los resultados de la evaluación de stock de Stock Synthesis del pez vela occidental de 2023 y del de aguja azul de 2024, este documento describe el impacto de la mortalidad por pesca de los principales componentes de artes-flotas que operan actualmente en la pesquería. La aguja azul se captura principalmente como captura fortuita en las flotas de palangre, y representa la principal fuente de impacto en términos de mortalidad por pesca también para el stock occidental de pez vela.

KEYWORDS

Blue marlin; sailfish; stock assessment; fishing mortality

1. Introduction

The ICCAT Commission has requested the SCRS to "review and determine the feasibility of estimating fishing mortality by commercial fisheries, recreational fisheries, and artisanal fisheries" Rec. 16-11 para 2. This document presents further analyses of the fishing by main fleet gear types based on the recent stock assessments of western sailfish in 2023 and Atlantic blue marlin in 2024 stocks using the final runs from the catch integrate model Stock Synthesis (Methot and Wetzel 2013).

These analyses used the results from the Stock Synthesis models as this framework allows the specification of different fleet components fishing on the assessed species and inputting associated information like fleet(s) indices of abundance, size, and or age distribution of the catch, seasonality, or area-specific distributions. It also allows specifying an age structure model with specific growth, maturity, and reproductive characteristics that permit evaluate the potential impacts of fishing mortality on the stocks given the differences among fleets associated with fishing gear and selectivity.

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In the case of Atlantic blue marlin, the Stock Synthesis model was used for the stock assessment evaluation and status in 2024 as concluded by the SCRS (Anon., 2024a). In the case of Atlantic sailfish in 2023, the Stock Synthesis model was applied to only the western stock, but the final stock status in 2023 for both western and eastern sailfish was based on a surplus production model (JABBA) (Anon. 2024b).

2. Materials and methods

The Atlantic blue marlin 2024 stock assessment and status were based on the combined results from the Stock Synthesis runs and a Surplus Production model (JABBA) of a grid approach considering four scenarios of steepness (0.4, 0.5, 0.6, and 0.7) from each platform as the best representation of the uncertainty in the assessment (Anon., 2024a). The analyses of fishing mortality impact in this document were based on the Stock Synthesis result with a steepness value of 0.6 (Anon., 2024a). The western sailfish 2023 stock assessment and status were based on a Surplus Production model (JABBA) (model S5) (Anon., 2024b), and the result from the Stock Synthesis run (model 6) was used as supplemental information, and this model was applied to the analyses of fishing mortality impact in this document. Model results were extracted and summarized using the R package r4ss ver. 1.49.3 (Taylor *et al*., 2021).

The model settings for the Atlantic blue marlin Stock Synthesis run are provided in Schirripa (2024) and the meeting report (Anon., 2024a). **Figure 1** shows the landings of blue marlin reported by main fleet/gear type as used in the stock assessment evaluation. The fleet structure in the Stock Synthesis model included 5 main fleets artisanal gillnets, commercial longlines, purse-seine, rod and reel, and moored FADs. Rod and reel included mainly recreational and sport fisheries, but also some catch with hand lines where blue marlin is a target species. Moored FADs are relatively "new" fishing-type operations fixed to the seabed fish attracting floating objects commonly used in the Caribbean region that target several pelagic species, including billfish. Artisanal gillnets have been commonly used on the western African coast, but also in small-scale coastal fisheries with multiple target species that also catch billfish. By comparison, longline and industrial purse seine catches of blue marlin are caught as bycatch.

The model settings for the western Sailfish Stock Synthesis run are provided in the meeting report (Anon., 2023), and **Figure 2** shows the reported landing of western sailfish as used in the stock assessment. In this case, the fleet structure included 4 main fleets/gears artisanal gillnets, commercial longlines, rod and reel/sport fisheries, and other gears. In the case of sailfish also, rod and reel and sport fisheries target west sailfish primarily, while artisanal gillnets represent mostly small-scale fisheries throughout the western Atlantic (the Caribbean, central and south American coast), and other gears are a mix of several fishing gear types with relative low catches reported.

With Stock Synthesis a particular fleet is normally associated with catches (landings and discards), a size frequency distribution of the catch to inform on the gear selectivity, and one or more associated indices of relative abundance. The model based on the biological characteristics of the species, recreates the time series of catches, estimating a given selectivity of the gear and an assumption regarding catchability in time (constant versus non-constant or variable catchability). In an age/size structure model with biological differential growth (e.g. sex growth patterns) and season or area differential distributions, a single concept of fishing mortality is not straightforward or comparable among different fleets.

Stock Synthesis estimates the apical fishing mortality for a fleet ($F'_{t,f}$) that is the rate for the age that has selectivity equal to 1.0 by fleet (*f*) and time (*t*) step. As F' is fleet-specific, Stock Synthesis also provides a relative F, relF'_f, among fleets, where $relF_f = F'_{t,f} / \sum_f F'_{t,f}$ for a single time period *t*. It also provides a single annual value of $annF_y$ across all fleets and areas which is a measure of the total fishing intensity for a year but is based on user-specified options. If there are many fleets with very different selectivity patterns, $annF_y$ can have a complex relationship with apical F'. The options for user-specified $annF'$ are based on i) exploitation in biomass, ii) exploitation in numbers, iii) sum of F rates, iv) true F for a range of ages, or v) unweighted average F for a range of ages (Taylor *et al*., 2021).

The estimated selectivity by fleets for blue marlin and western sailfish are shown in **Figures 3** and **4**. Model settings for blue marlin specified a different growth pattern for males and females, while for western sailfish growth pattern was the same among sexes. The estimated selectivities for the different fleets that catch blue marlin indicated that the longline gear has the widest selectivity of size range with a 50% selection at about 40 cm straight lower jaw fork length (SLJFL) and logistic top for sizes above 95 cm SLJFL, while purse seine catches in general larger size fish. All fleet gears catching blue marlin have an estimated top full selectivity. An important feature of the assessment model for blue marlin was the estimation of discards in the rod and reel fleets in recent years in

response to the implementation of catch-and-release management features of the recreational fisheries especially. Noting that a large portion of the discarded fish survives. For western sailfish, the model estimated a domed shape selectivity for the gillnet, while for the longline fleets, time selectivity blocks were applied, where some of the blocks indicated a partial dome shape selectivity for some longline associated indices. Rod and reel selectivity were estimated as top full selectivity.

Given the complexity of fleets, selectivity, and biological features of the blue marlin and western sailfish stocks for the comparison of fishing mortality impacts it was decided to use a simple annual estimate of fishing mortality-based exploitation rate (*h*).

The exploitation rate by year was calculated as the sum of the catch by age (*a*) of all fleets (*f*) divided by the overall biomass for that age (*a*) class in biomass units. The catch included both landings and dead discards.

$$h_{a,\,y} = \sum_{a=0,\,i=1}^{\max a,\,f} Catch_{a,\,i} \Big/ Biomass_a$$

Then, the overall annual exploitation rate is simply the total catch by year over the biomass. The estimated exploitation rate associated with each fleet is proportional to the annual catch of each fleet. An overall fishing mortality (*F'*) was estimated also as:

$$F' = -\ln(1 - h)$$

3. Results and discussions

Tables 1 and **2** and **Figures 5** and **6** show the estimated relative fishing mortality (*F'*) by fleet for Atlantic blue marlin and western sailfish, respectively. Not surprisingly, the highest fishing mortality is exerted by the fleet with the highest catches. For both blue marlin and western sailfish, the longline fleet/gear accounts for the larger proportion of the assessment estimated fishing mortality. For blue marlin, bycatch on the longline fleet accounts for about 70% of total fishing mortality, followed by rod and reel fleet (12%), then gillnet, purse seine, and other gears. In the case of western sailfish, longline accounts for 70% of fishing mortality, followed by rod and reel (21%), other gears, and gillnets.

Figure 7 shows the average exploitation rates for the last 5 years of the assessment for blue marlin and western sailfish by age. For blue marlin fishing mortality is apparent for all ages starting on age 0, primarily by the longline gear but also from the moored FADs, purse seine, and the artisanal gillnets, for ages 2 and older the rod and reel fisheries become an important source of mortality, but overall, in the latest years longline bycatch still account for about 50% of the fishing mortality. For the western sailfish, peak exploitation rates are seen for ages 5 and older, with about 90% of the mortality exerted by the longline fleets, for ages 1 and 2 other gears account for some mortality while rod and reel are impacting mostly ages 3 and older but with comparatively lower percent mortality compared to the longline.

In response to the Commission's request, the recent assessments of western sailfish and Atlantic blue marlin using the Stock Synthesis model with fleet/gear structure allowed the estimation of exerted fishing mortality by main fleet/gears. In both blue marlin and sailfish, and in general, for billfish the main source of fishing mortality is associated with the bycatch from longline gears through the time series, for blue marlin it accounts for about 70% of the fishing mortality overall, although in recent years this proportion shows a decrease (**Table 3**). With western sailfish, the proportion is higher, although historically the gillnet fleets were an important source of fishing mortality. The mortality rates by age are similar in the case of blue marlin, for sailfish there is a peak at age 5 and older.

For eastern sailfish, there was no attempt to apply the Stock Synthesis model run by the SCRS, only the surplus production model (JABBA) results were provided. However, considering the distribution of catches (**Figure 8**), for this stock is more evenly distributed among different fleets/gears expecting that estimation of fishing mortality impact by fleet/gear is similar as shown for the blue marlin and west sailfish stock.

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Table 1. Estimated overall fishing mortality from exploitation rate by year and fleet/gear for Atlantic Blue Marlin.

Yr	Art_Gillnet	LongLine_2	Purse_Seine_3	RR_4	mFAD_5	Total
1956	0	0.000433	0	0	0	0.000433
1957	0	0.00852	0	0	0	0.00852
1958	0	0.008686	0	0	0	0.008686
1959	0	0.009545	0	0	0	0.009545
1960	0	0.03139	0	0.002168	0	0.033559
1961	0	0.047704	0	0.002652	0	0.050356
1962	0	0.092714	0	0.002756	0	0.09547
1963	0	0.127814	1.20921E-05	0.003264	0	0.13109
1964	0	0.126771	1.3611E-05	0.004607	0	0.131392
1965	0	0.106901	1.51629E-05	0.005171	0	0.112086
1966	0	0.070263	6.5555E-05	0.005289	0	0.075617
1967	0	0.039379	0.000101553	0.007118	0	0.046599
1968	0	0.045333	0.000202543	0.006082	0	0.051617
1969	0	0.056154	0.000253551	0.007498	0	0.063906
1970	0	0.052357	0.000376476	0.007486	0	0.060219
1971	0	0.06366	0.000534252	0.006535	0	0.07073
1972	0	0.043778	0.00084168	0.007015	0	0.051635
1973	0	0.060025	0.000855685	0.007604	0	0.068484
1974	0	0.053041	0.004642805	0.008661	0	0.066345
1975	0	0.057692	0.00421933	0.009002	0	0.070913
1976	0	0.039642	0.004345498	0.01006	0	0.054048
1977	0	0.033193	0.004804907	0.011159	0	0.049157
1978	0	0.021801	0.004624413	0.011177	0	0.037602
1979	0	0.019136	0.004468423	0.010815	0	0.03442
1980	0.002129	0.023253	0.005070049	0.011181	0	0.041633
1981	0.002403	0.024698	0.006640306	0.011203	0	0.044945
1982	0.001027	0.039151	0.006023476	0.01068	0	0.056881
1983	0.003825	0.027412	0.006508435	0.007269	0	0.045015
1984	0.007128	0.038637	0.006418088	0.007568	0	0.059751
1985	0.006039	0.053476	0.005104521	0.006292	0.000197	0.071107
1986	0.002885	0.02418	0.003888909	0.006817	0.000164	0.037935
1987	0.002958	0.026311	0.00441059	0.004736	0.000526	0.038942
1988	0.003031	0.038192	0.003453545	0.005732	0.000542	0.05095
1989	0.010853	0.060107	0.003162071	0.004705	0.000734	0.079562
1990	0.007187	0.073418	0.004215755	0.001995	0.001069	0.087886
1991	0.004316	0.075234	0.003504954	0.002586	0.001329	0.08697
1992	0.004493	0.052038	0.003091275	0.003609	0.001618	0.064849
1993	0.007388	0.052384	0.003785982	0.004852	0.002759	0.071169
1994	0.013718	0.074112	0.003650904	0.005205	0.00309	0.099776
1995	0.015175	0.070295	0.003579666	0.003603	0.003114	0.095766
1996	0.021953	0.090803	0.002908764	0.003411	0.003954	0.12303
1997	0.020269	0.1106	0.003225254	0.005849	0.005095	0.145039
1998	0.035011	0.103578	0.007630693	0.006417	0.006363	0.158999
1999	0.03911	0.100688	0.003250543	0.003702	0.007309	0.15406
2000	0.053448	0.105544	0.006007526	0.004189	0.008966	0.178155
2001	0.047496	0.087816	0.005318058	0.007254	0.010697	0.158581
2002	0.047831	0.062709	0.004711132	0.013162	0.011238	0.139651
2003	0.052325	0.075463	0.004990929	0.018301	0.011382	0.162463
2004	0.030478	0.065036	0.006296036	0.012341	0.012559	0.126711
2005	0.036958	0.058748	0.004575572	0.005924	0.010999	0.117204
2006	0.021066	0.058273	0.005943457	0.008527	0.010888	0.104698
2007	0.040929	0.0782	0.007830867	0.014402	0.011165	0.152527
2008	0.015601	0.090628	0.007663555	0.02083	0.013566	0.148289
2009	0.012773	0.089142	0.015168315	0.017758	0.010424	0.145265
2010	0.012814	0.087202	0.016728283	0.01778	0.010045	0.144569
2011	0.023945	0.062521	0.01420596	0.022708	0.011231	0.134612
2012	0.021751	0.063365	0.017539836	0.030426	0.010092	0.143174
2013	0.020689	0.047698	0.01461038	0.019986	0.006578	0.109561
2014	0.034833	0.059717	0.013475889	0.025274	0.012814	0.146114
2015	0.009849	0.063711	0.013108705	0.011241	0.007	0.104909
2016	0.014675	0.05869	0.006713636	0.022572	0.005052	0.107703
2017	0.014541	0.06897	0.011041257	0.0247	0.006394	0.125645
2018	0.006641	0.053621	0.008197076	0.019862	0.004459	0.092781
2019	0.005273	0.057455	0.009621042	0.011992	0.005127	0.089468
2020	0.015423	0.03978	0.007091292	0.010609	0.008914	0.081818
2021	0.019499	0.034734	0.008605704	0.010118	0.003082	0.076038
2022	0.00681	0.029692	0.007850233	0.01044	0.003991	0.058784

Yr	Art_Gillnet	LongLine_2	Purse_Seine_3	RR_4	mFAD_5
1956	0.0%	100.0%	0.0%	0.0%	0.0%
1957	0.0%	100.0%	0.0%	0.0%	0.0%
1958	0.0%	100.0%	0.0%	0.0%	0.0%
1959	0.0%	100.0%	0.0%	0.0%	0.0%
1960	0.0%	93.5%	0.0%	6.5%	0.0%
1961	0.0%	94.7%	0.0%	5.3%	0.0%
1962	0.0%	97.1%	0.0%	2.9%	0.0%
1963	0.0%	97.5%	0.0%	2.5%	0.0%
1964	0.0%	96.5%	0.0%	3.5%	0.0%
1965	0.0%	95.4%	0.0%	4.6%	0.0%
1966	0.0%	92.9%	0.1%	7.0%	0.0%
1967	0.0%	84.5%	0.2%	15.3%	0.0%
1968	0.0%	87.8%	0.4%	11.8%	0.0%
1969	0.0%	87.9%	0.4%	11.7%	0.0%
1970	0.0%	86.9%	0.6%	12.4%	0.0%
1971	0.0%	90.0%	0.8%	9.2%	0.0%
1972	0.0%	84.8%	1.6%	13.6%	0.0%
1973	0.0%	87.6%	1.2%	11.1%	0.0%
1974	0.0%	79.9%	7.0%	13.1%	0.0%
1975	0.0%	81.4%	5.9%	12.7%	0.0%
1976	0.0%	73.3%	8.0%	18.6%	0.0%
1977	0.0%	67.5%	9.8%	22.7%	0.0%
1978	0.0%	58.0%	12.3%	29.7%	0.0%
1979	0.0%	55.6%	13.0%	31.4%	0.0%
1980	5.1%	55.9%	12.2%	26.9%	0.0%
1981	5.3%	55.0%	14.8%	24.9%	0.0%
1982	1.8%	68.8%	10.6%	18.8%	0.0%
1983	8.5%	60.9%	14.5%	16.1%	0.0%
1984	11.9%	64.7%	10.7%	12.7%	0.0%
1985	8.5%	75.2%	7.2%	8.8%	0.3%
1986	7.6%	63.7%	10.3%	18.0%	0.4%
1987	7.6%	67.6%	11.3%	12.2%	1.4%
1988	5.9%	75.0%	6.8%	11.3%	1.1%
1989	13.6%	75.5%	4.0%	5.9%	0.9%
1990	8.2%	83.5%	4.8%	2.3%	1.2%
1991	5.0%	86.5%	4.0%	3.0%	1.5%
1992	6.9%	80.2%	4.8%	5.6%	2.5%
1993	10.4%	73.6%	5.3%	6.8%	3.9%
1994	13.7%	74.3%	3.7%	5.2%	3.1%
1995	15.8%	73.4%	3.7%	3.8%	3.3%
1996	17.8%	73.8%	2.4%	2.8%	3.2%
1997	14.0%	76.3%	2.2%	4.0%	3.5%
1998	22.0%	65.1%	4.8%	4.0%	4.0%
1999	25.4%	65.4%	2.1%	2.4%	4.7%
2000	30.0%	59.2%	3.4%	2.4%	5.0%
2001	30.0%	55.4%	3.4%	4.6%	6.7%
2002	34.3%	44.9%	3.4%	9.4%	8.0%
2003	32.2%	46.4%	3.1%	11.3%	7.0%
2004	24.1%	51.3%	5.0%	9.7%	9.9%
2005	31.5%	50.1%	3.9%	5.1%	9.4%
2006	20.1%	55.7%	5.7%	8.1%	10.4%
2007	26.8%	51.3%	5.1%	9.4%	7.3%
2008	10.5%	61.1%	5.2%	14.0%	9.1%
2009	8.8%	61.4%	10.4%	12.2%	7.2%
2010	8.9%	60.3%	11.6%	12.3%	6.9%
2011	17.8%	46.4%	10.6%	16.9%	8.3%
2012	15.2%	44.3%	12.3%	21.3%	7.0%
2013	18.9%	43.5%	13.3%	18.2%	6.0%
2014	23.8%	40.9%	9.2%	17.3%	8.8%
2015	9.4%	60.7%	12.5%	10.7%	6.7%
2016	13.6%	54.5%	6.2%	21.0%	4.7%
2017	11.6%	54.9%	8.8%	19.7%	5.1%
2018	7.2%	57.8%	8.8%	21.4%	4.8%
2019	5.9%	64.2%	10.8%	13.4%	5.7%
2020	18.9%	48.6%	8.7%	13.0%	10.9%
2021	25.6%	45.7%	11.3%	13.3%	4.1%
2022	11.6%	50.5%	13.4%	17.8%	6.8%

Table 2. Estimated overall fishing mortality from exploitation rate by year and fleet/gear for western sailfish.

Yr	Art_Gillnet	LongLine_2	Rod_Reel_	Others_4	Total		Yr	Art_Gillnet	LongLine_2	Rod_Reel_	Others_4
1950	0	0	0	0	0		1950				
1951	0	0	0	0	0		1951				
1952	0	0	0	0	0		1952				
1953	0	0	0	0	0		1953				
1954	0	0	0	0	0		1954				
1955	0	0	0	0	0		1955				
1956	0	6.85741E-05	0	0	6.85741E-05		1956	0.0%	100.0%	0.0%	0.0%
1957	0	0.001647196	0	0	0.001647196		1957	0.0%	100.0%	0.0%	0.0%
1958	0	0.004543328	0	0	0.004543328		1958	0.0%	100.0%	0.0%	0.0%
1959	0	0.000344778	0	0	0.000344778		1959	0.0%	100.0%	0.0%	0.0%
1960	0	0.004486833	0.007697	0	0.012183687		1960	0.0%	36.8%	63.2%	0.0%
1961	0	0.015214323	0.009326	0	0.024540063		1961	0.0%	62.0%	38.0%	0.0%
1962	0	0.015510504	0.010513	0	0.026023883		1962	0.0%	59.6%	40.4%	0.0%
1963	0	0.01414851	0.011556	0	0.025704072		1963	0.0%	55.0%	45.0%	0.0%
1964	0	0.026292201	0.013023	0	0.039315009		1964	0.0%	66.9%	33.1%	0.0%
1965	0	0.060487132	0.014373	0	0.07486056		1965	0.0%	80.8%	19.2%	0.0%
1966	0	0.035344094	0.016212	0	0.051556282		1966	0.0%	68.6%	31.4%	0.0%
1967	0	0.038999684	0.016927	0	0.055926225		1967	0.0%	69.7%	30.3%	0.0%
1968	0	0.054066256	0.017765	0	0.071831413		1968	0.0%	75.3%	24.7%	0.0%
1969	0	0.04365884	0.01977	0	0.063428359		1969	0.0%	68.8%	31.2%	0.0%
1970	0	0.08732708	0.019669	0.002114	0.109109316		1970	0.0%	80.0%	18.0%	1.9%
1971	0	0.090030562	0.021353	0.002232	0.113614843		1971	0.0%	79.2%	18.8%	2.0%
1972	0	0.050623111	0.022794	0.002373	0.075790318		1972	0.0%	66.8%	30.1%	3.1%
1973	0	0.036540679	0.023656	0.002475	0.062671724		1973	0.0%	58.3%	37.7%	3.9%
1974	0	0.047711059	0.02613	0.003506	0.077347225		1974	0.0%	61.7%	33.8%	4.5%
1975	0	0.049194578	0.028821	0.003694	0.081709428		1975	0.0%	60.2%	35.3%	4.5%
1976	0	0.055847351	0.030986	0.011236	0.098069446		1976	0.0%	56.9%	31.6%	11.5%
1977	0	0.047927098	0.041229	0.018201	0.107357309		1977	0.0%	44.6%	38.4%	17.0%
1978	0	0.038734507	0.043745	0.015927	0.098406198		1978	0.0%	39.4%	44.5%	16.2%
1979	0	0.049503925	0.045378	0.01502	0.109901475		1979	0.0%	45.0%	41.3%	13.7%
1980	0	0.039376744	0.044913	0.016373	0.100662005		1980	0.0%	39.1%	44.6%	16.3%
1981	0	0.042688464	0.067894	0.005497	0.116079406		1981	0.0%	36.8%	58.5%	4.7%
1982	0	0.051672094	0.058271	0.016105	0.126048407		1982	0.0%	41.0%	46.2%	12.8%
1983	0	0.043827672	0.095243	0.012115	0.151185796		1983	0.0%	29.0%	63.0%	8.0%
1984	0	0.073788072	0.077587	0.013296	0.164671714		1984	0.0%	44.8%	47.1%	8.1%
1985	0	0.088946618	0.047144	0.014283	0.150373761		1985	0.0%	59.2%	31.4%	9.5%
1986	0.003453	0.100483436	0.073518	0.00803	0.185484751		1986	1.9%	54.2%	39.6%	4.3%
1987	0	0.101499896	0.079361	0.012382	0.193242145		1987	0.0%	52.5%	41.1%	6.4%
1988	0	0.11219278	0.087184	0.016113	0.215490114		1988	0.0%	52.1%	40.5%	7.5%
1989	0	0.145676045	0.076275	0.013275	0.23522599		1989	0.0%	61.9%	32.4%	5.6%
1990	0	0.169013674	0.059152	0.046844	0.275009173		1990	0.0%	61.5%	21.5%	17.0%
1991	0.008093	0.158436271	0.073985	0.009609	0.250123969		1991	3.2%	63.3%	29.6%	3.8%
1992	0.004507	0.193467026	0.062732	0.028383	0.289089029		1992	1.6%	66.9%	21.7%	9.8%
1993	0.012369	0.240542494	0.050032	0.0207	0.323644051		1993	3.8%	74.3%	15.5%	6.4%
1994	0.015775	0.179364352	0.054199	0.037946	0.287284599		1994	5.5%	62.4%	18.9%	13.2%
1995	0.01061	0.171144061	0.094265	0.052016	0.328034572		1995	3.2%	52.2%	28.7%	15.9%
1996	0.025861	0.146139409	0.062199	0.072713	0.306912808		1996	8.4%	47.6%	20.3%	23.7%
1997	0.027038	0.180276026	0.085617	0.020296	0.313225982		1997	8.6%	57.6%	27.3%	6.5%
1998	0.035692	0.231182481	0.05386	0.019432	0.340166412		1998	10.5%	68.0%	15.8%	5.7%
1999	0.022733	0.220330103	0.026169	0.019018	0.288249569		1999	7.9%	76.4%	9.1%	6.6%
2000	0.012253	0.380117192	0.012659	0.01642	0.42144867		2000	2.9%	90.2%	3.0%	3.9%
2001	0.012949	0.416039591	0.01165	0	0.440638127		2001	2.9%	94.4%	2.6%	0.0%
2002	0.018395	0.430835921	0.021647	0.047246	0.518124738		2002	3.6%	83.2%	4.2%	9.1%
2003	0.021985	0.329778547	0	0.053441	0.405204782		2003	5.4%	81.4%	0.0%	13.2%
2004	0.024386	0.299481823	0	0.064782	0.388650549		2004	6.3%	77.1%	0.0%	16.7%
2005	0.022711	0.36607911	0	0	0.388789675		2005	5.8%	94.2%	0.0%	0.0%
2006	0.02377	0.387217697	0.000339	0.010813	0.422140341		2006	5.6%	91.7%	0.1%	2.6%
2007	0.036583	0.302364465	0.001116	0.011523	0.351586431		2007	10.4%	86.0%	0.3%	3.3%
2008	0.020653	0.305640575	0.001234	0.036336	0.363862553		2008	5.7%	84.0%	0.3%	10.0%
2009	0.018058	0.254406495	0.000721	0.069937	0.343122777		2009	5.3%	74.1%	0.2%	20.4%
2010	0.017543	0.25668612	0.000377	0.000198	0.274803625		2010	6.4%	93.4%	0.1%	0.1%
2011	0.018705	0.277859528	0.001865	0.001383	0.299812422		2011	6.2%	92.7%	0.6%	0.5%
2012	0.031371	0.272055435	0.003857	0.002574	0.309857704		2012	10.1%	87.8%	1.2%	0.8%
2013	0.020161	0.248394909	0.001628	0.001456	0.271639689		2013	7.4%	91.4%	0.6%	0.5%
2014	0.028075	0.226327081	0.003065	0.001513	0.258980105		2014	10.8%	87.4%	1.2%	0.6%
2015	0.016782	0.278501194	0.001263	0	0.296546123		2015	5.7%	93.9%	0.4%	0.0%
2016	0.011182	0.351050134	0.00329	0.001262	0.366784445		2016	3.0%	95.7%	0.9%	0.3%
2017	0.02739	0.30579124	0.002597	0.001287	0.337065406		2017	8.1%	90.7%	0.8%	0.4%
2018	0.028691	0.39929136	0.001222	0.001219	0.430423563		2018	6.7%	92.8%	0.3%	0.3%
2019	0.020455	0.34799394	0.001039	0.00125	0.370737817		2019	5.5%	93.9%	0.3%	0.3%
2020	0.005304	0.41375911	0.000378	0.001689	0.421130997		2020	1.3%	98.2%	0.1%	0.4%
2021	0.024644	0.209193272	0.001756	0	0.235593098		2021	10.5%	88.8%	0.7%	0.0%

Table 3. Estimated average 2018 - 2022 relative exploitation (*h*) rate by age (columns) and fleet (rows) for blue marlin (top) and sailfish 2017 – 2021 (bottom).

	Avg 2018-2022 relative Exploitation rate by age and fleet										
Flee \ Age	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Ag10+**
Art_Gillnet_1	0.501%	0.814%	1.020%	1.146%	1.225%	1.276%	1.309%	1.328%	1.340%	1.345%	1.341%
LongLine_2	4.252%	4.234%	4.219%	4.207%	4.197%	4.189%	4.184%	4.181%	4.179%	4.177%	4.178%
Purse_Seine_3	0.385%	0.626%	0.785%	0.882%	0.943%	0.982%	1.007%	1.022%	1.031%	1.036%	1.032%
RR_4	0.000%	0.189%	0.583%	1.095%	1.583%	1.979%	2.273%	2.474%	2.600%	2.672%	2.617%
mFAD_5	0.238%	0.388%	0.486%	0.546%	0.584%	0.608%	0.623%	0.632%	0.638%	0.640%	0.638%

	Avg 2017-2021 relative Exploitation rate by age and fleet										
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Ag10+**
Art_Gillnet_1	0.000%	0.002%	0.028%	1.802%	3.624%	3.423%	2.785%	2.254%	1.886%	1.642%	1.416%
LongLine_2	0.000%	0.370%	2.396%	24.469%	44.421%	49.902%	49.939%	48.744%	47.561%	46.648%	45.711%
Rod_Reel_3	0.000%	0.002%	0.003%	0.060%	0.229%	0.347%	0.412%	0.450%	0.472%	0.485%	0.497%
Others_4	0.000%	0.137%	0.135%	0.113%	0.091%	0.085%	0.086%	0.088%	0.089%	0.091%	0.092%

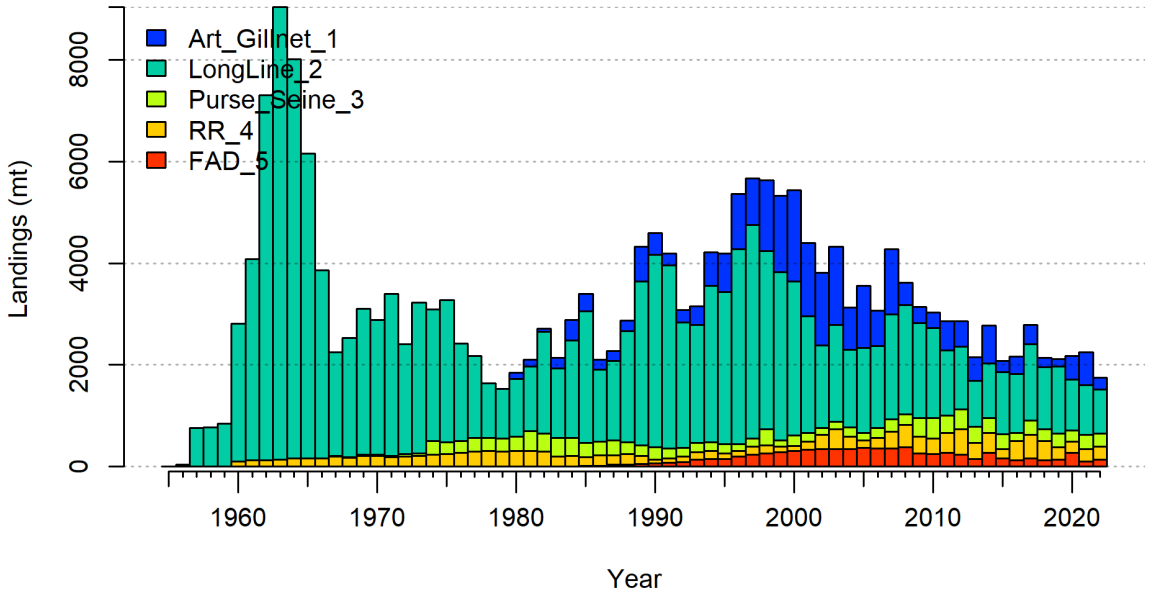

Figure 1. Time series of Atlantic blue marlin landings (mt) used as input in the stock assessment by main fleet/gear structure.

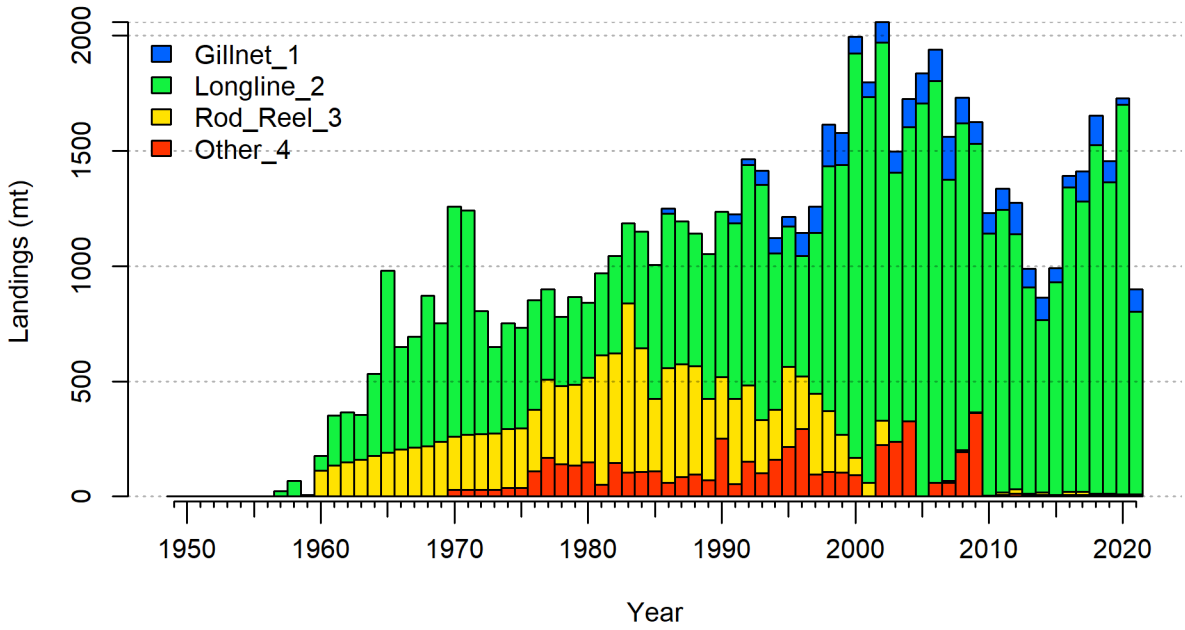

Figure 2. Time series of western sailfish landings (mt) used as input in the stock assessment by main fleet/gear structure.

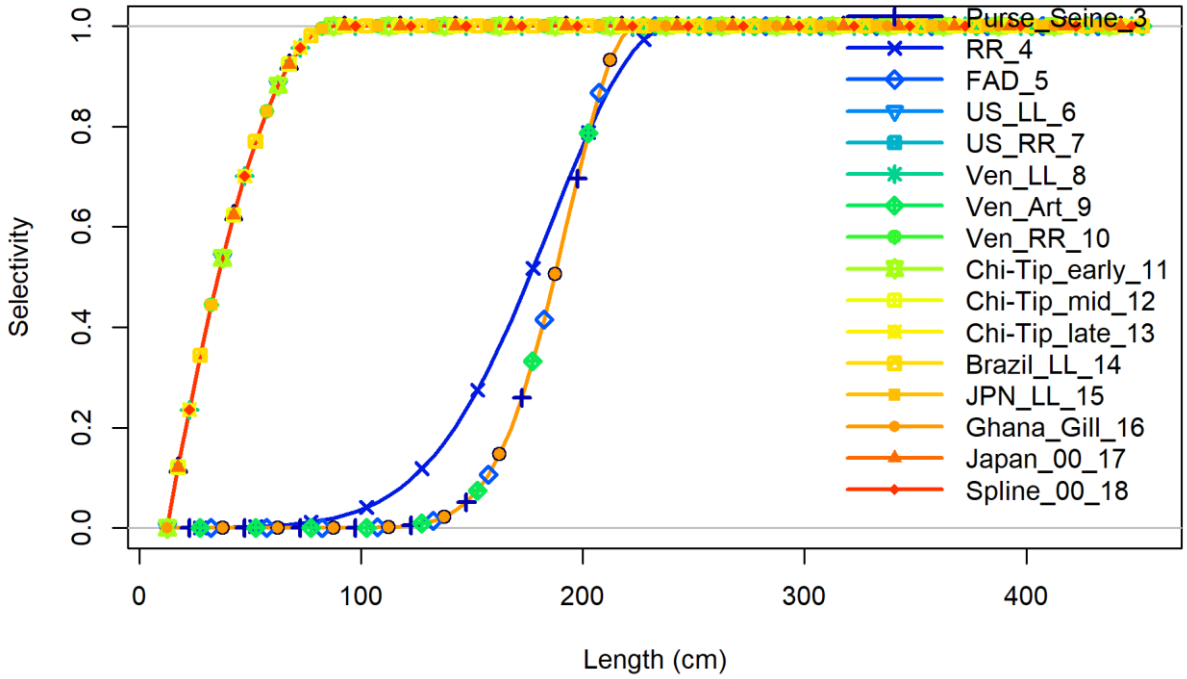

Figure 3. Estimated fleet/gear selectivity at size for the blue marlin by Stock Synthesis model 2024.

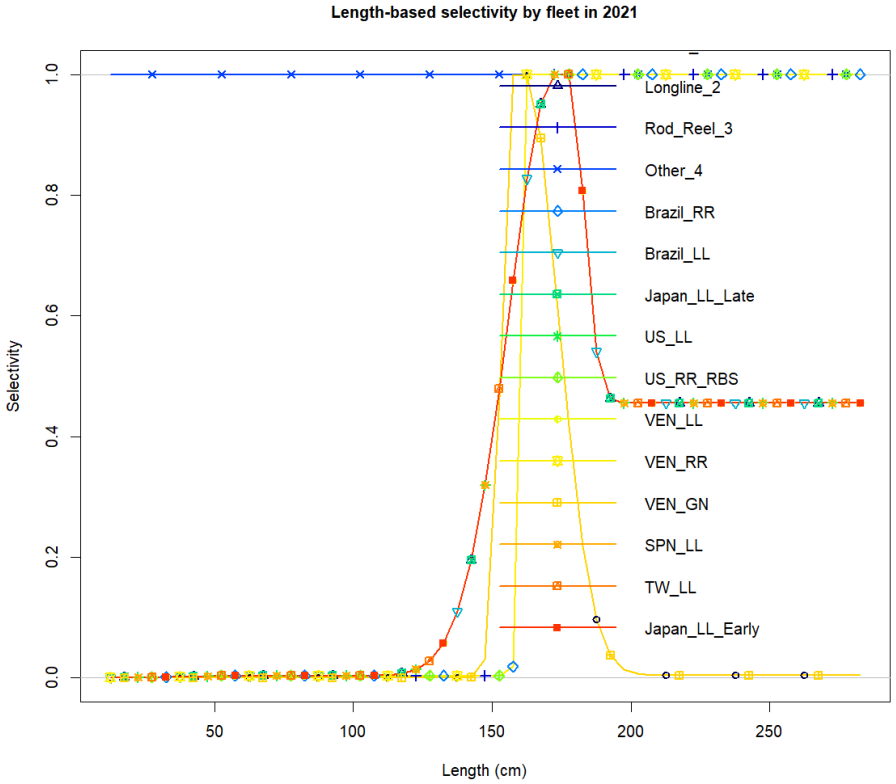

Figure 4. Estimated fleet/gear selectivity at size for the western sailfish by Stock Synthesis model 2023.

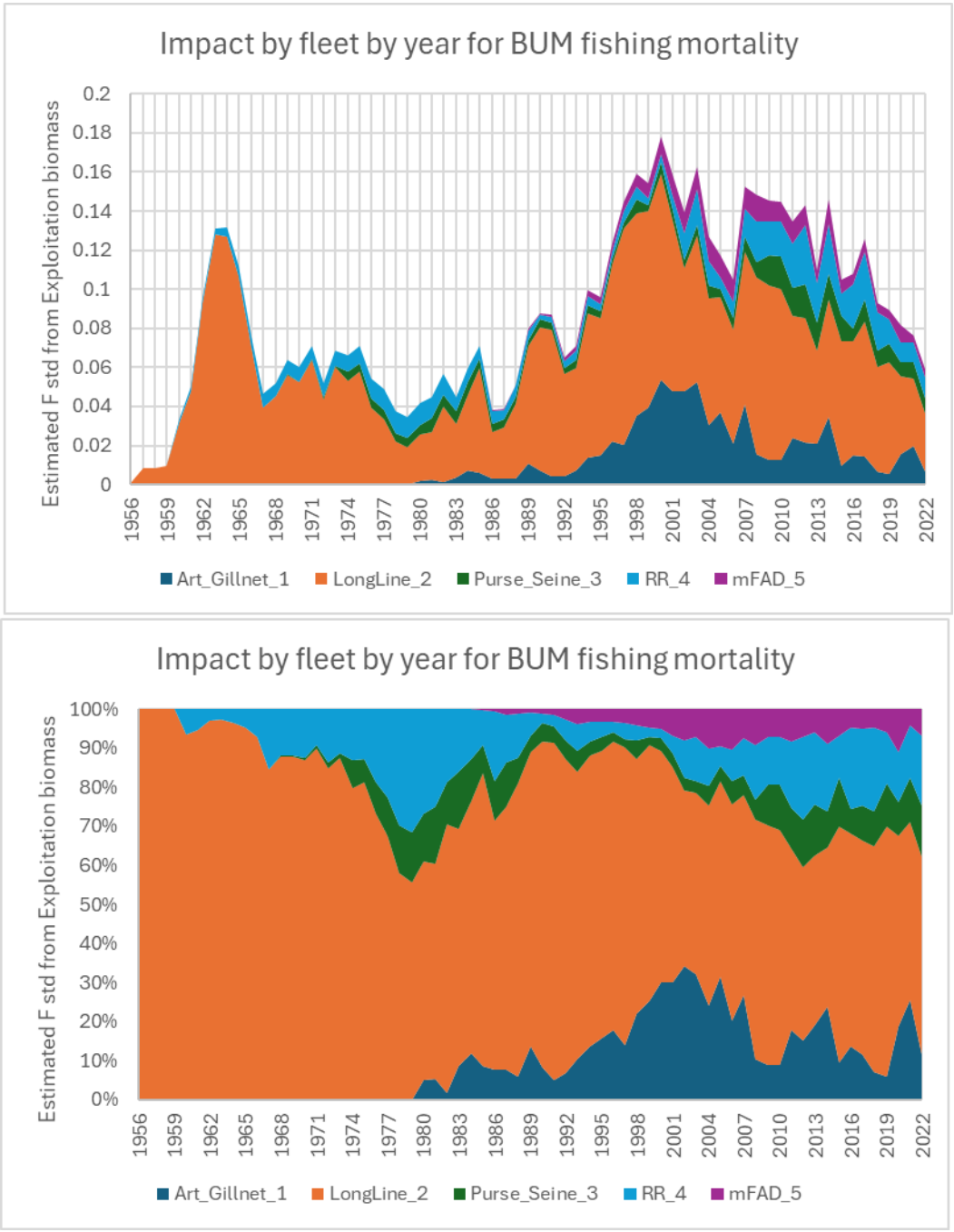

Figure 5. Estimated annual overall fishing mortality by fleet/gear selectivity at size for the Atlantic blue marlin (top panel). The bottom panel shows the relative annual percent of fishing mortality by fleet/gear.

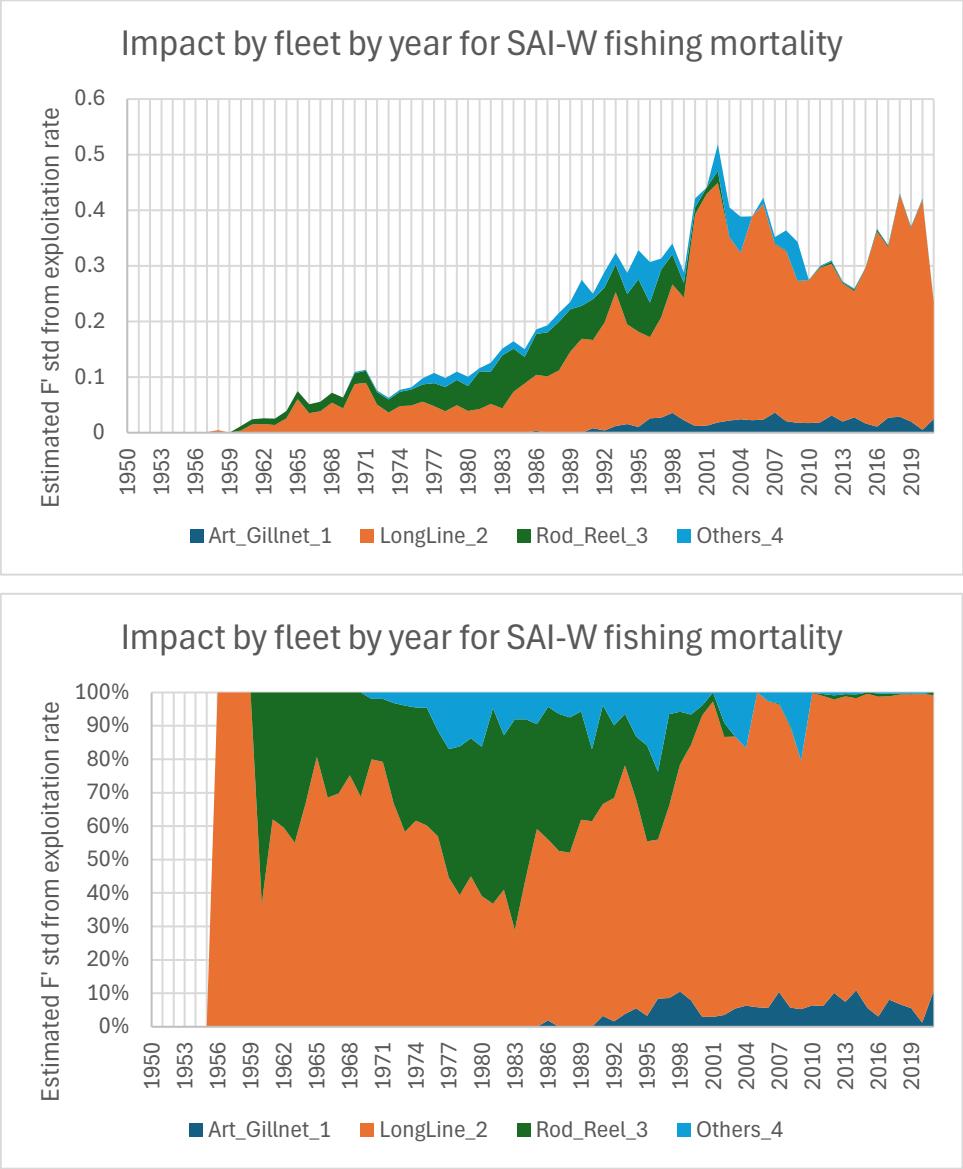

Figure 6. Estimated annual overall fishing mortality by fleet/gear selectivity at size for the western sailfish (top panel). The bottom panel shows the relative annual percent of fishing mortality by fleet/gear.

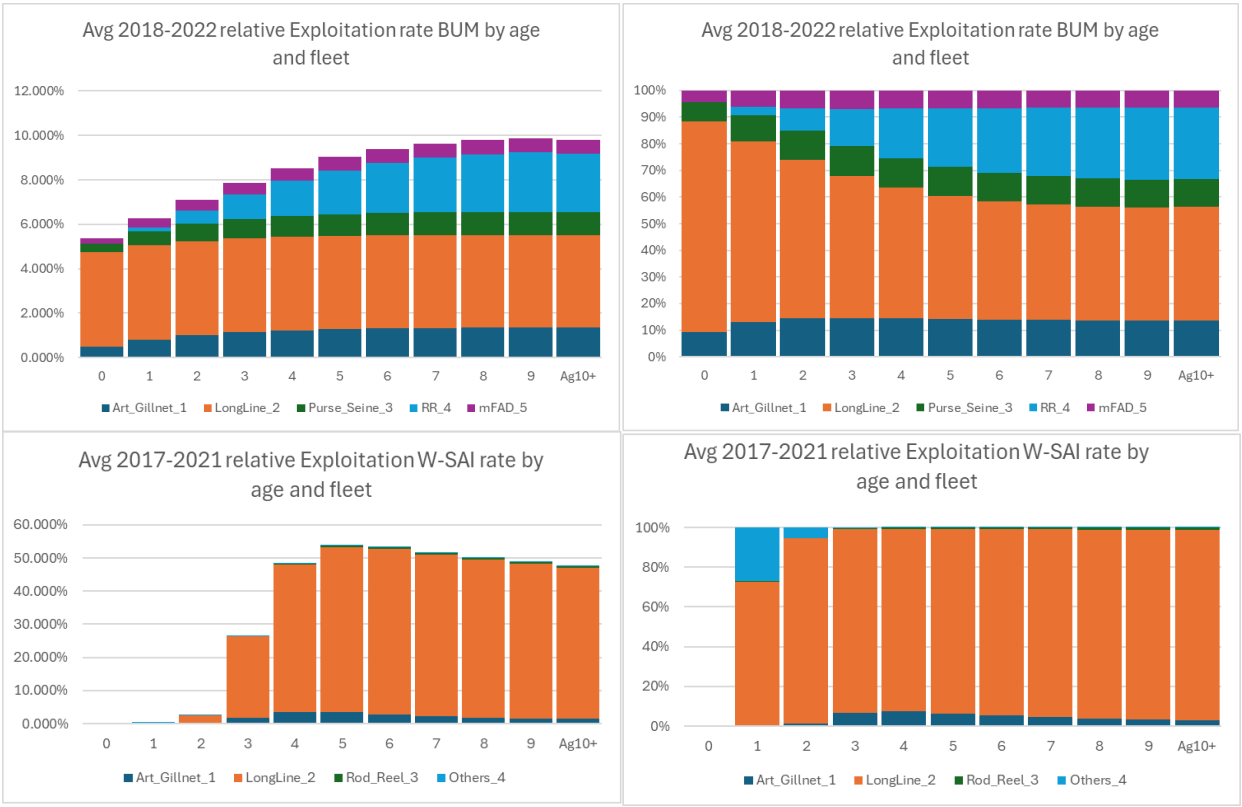

Figure 7. Estimated last 5 years' average of relative exploitation rates (left column) by age and fleet for Atlantic blue marlin (top row) and western sailfish (bottom row) stocks. Right column plots show the relative proportions of exploitation rates by age and fleet/gear.

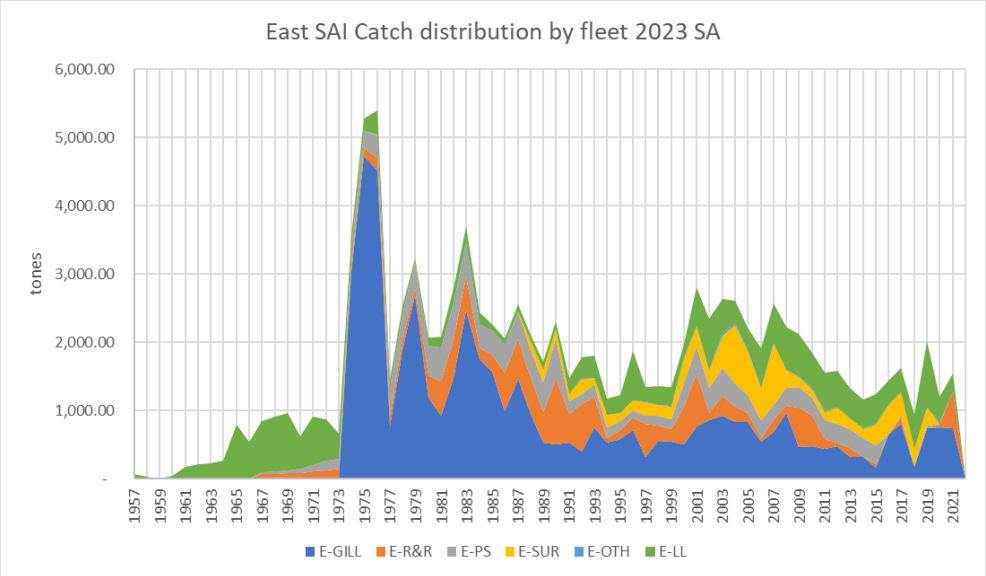

Figure 8. Eastern sailfish stock catch by fleet used in the 2023 stock assessment. Six fleet/gears were defined including gillnets, rod and reel, purse seine, longline, surface gears (trolling,) and other gears.