CATCH ESTIMTES OF INDIAN OCEAN BLUE SHARK *(PRIONACE GLAUCA)*

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ABSTRACT

Catch histories form an important component of stock assessments and so having a reliable and believable catch series is a key part in gauging the level of stock depletion. In data-limited situations, reported nominal catches are often not considered reliable and so reconstruction of catch histories plays an important role. The first Indian Ocean stock assessment of blue shark took place in 2015, however, due to the amount of uncertainty in the assessments, the conclusion regarding stock status remained as uncertain. The historic catch series was considered to be one of the key sources of uncertainty and the Working Party requested that participants develop approaches to reconstructing historic catches to be used as alternate series for assessment. Nominal catch of blue shark was revised in 2025 by some CPCs and this has altered the historical reported catch.

This paper uses the available nominal catch data held by the IOTC and two methods to reconstruct historic blue shark catches in the Indian Ocean, the first a generalized additive model (GAM) and the second a ratio-based estimator approach. Both estimates based on based on the reported data as of 2024 with data for 2023 supplied by the 2025 nominal catch,

The procedure used to estimate catch for both the ratio and GAM based models assumes that target catches can be used to predict the unreported catches in the case where there are zero reported catches. The accuracy of all of these methods is entirely dependent on the quality of the original data on which they are based. The underlying dataset that was used was a combination of the 2024 nominal catch and the final year from the 2025 nominal catch data. The working party is encouraged to discuss this combination of the data as well as any preferred alternatives.

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KEYWORDS: Catch reconstruction, catch estimation, GAM, catch history, data-limited stocks, nominal catch, blue shark, stock assessment.

1 Introduction

Catch histories form an important component of stock assessments and so having a reliable and believable catch series is a key part in developing a good estimate of the level of stock depletion. In data-limited situations, reported nominal catches are often not considered reliable and so reconstruction of catch histories plays an important role. This is particularly important for bycatch species where data are often sparse and of varying quality. Nominal catches of blue sharks in the Indian Ocean held by the IOTC (IOTC 2021) are considered to be highly uncertain, and are likely to be 'severe underestimates' of the actual catches taken as concluded by the Working Party on Ecosystem and Bycatch in 2015, 2017 and again in 2021.

The first Indian Ocean stock assessment of blue shark took place in 2015, however, due to the amount of uncertainty in the assessments, the conclusion regarding stock status remained as uncertain (Rice and Sharma 2015). The historic catch series was considered to be one of the key sources of uncertainty and so the Working Party requested that participants develop new approaches to reconstructing historic catches to be used as alternate series for assessment. There a number of approaches that may be used to produce catch history reconstructions. One method that has been used previously for Indian Ocean blue shark was based on information obtained from the shark fin trade (Clarke 2015), providing estimates used in the 2015 assessment (Rice and Sharma 2015) that were approximately four times higher than the IOTC nominal catches (Clarke 2015). In 2017 an attempt at recreating the estimates based on the shark fin trade was undertaken, however this was unsuccessful due to changes in the fin trade, shifts major markets, and data availability. There was not sufficient data to estimate catch in recent years from the shark fin trade. Another method has been developed which is based on expert knowledge of Indian Ocean fisheries to determine catch rates of sharks to target species and separating out the different shark species using a proportioning method (Murua et al 2013). Yet another approach that has been applied for southern bluefin tuna in the southern Ocean involved the use of random forests to predict CPUE of non-members based on the reported CPUE of members (Chambers and Hoyle, 2015).

There are two main sources of error in reported blue shark catches: (i) not reporting to species, and (ii) not reporting at all. A rule-based method to identify proxy fleets was used to disaggregate reports of 'sharks NEI' to address the limited reporting to species level, while ratio and GAM based models using target catches were used to predict the expected catches where there are zero reported catches. This paper uses the current and historical (i.e. 2024) nominal catch data held in the IOTC database and explores the use of a ratio based method and a GAM statistical approach to reconstructing historic blue shark catches in the Indian Ocean.

2 Methods

Data sources used: IOTC nominal catches

Estimates of nominal catches of blue shark in the Indian Ocean are published annually by the IOTC (IOTC 2024, 2025). These are based on catches reported directly to IOTC both contracting and non-contracting parties fishing for tunas in the Indian Ocean and include best estimates in some cases where data are particularly poor or lacking altogether. This data is available by flag state, species (including IOTC species and bycatch), fishing gear and area (east or west Indian Ocean) in live weight equivalent. The data set extends back to the 1950s when industrial longlining began in the Indian Ocean. The data are generally considered representative (though the level of accuracy varies by year) of the nominal catch of the main IOTC target species, however, the reporting of sharks over the time period has been somewhat more inconsistent.

Recently the estimates of reported blue shark catch have changed (Figure 1). Prior to the 2025 revision of catches by Indonesia the majority of nominal blue shark catches are taken by the Indonesian fleet (Figure 1). The Indonesian gillnet fleet is responsible for most of the historic catches of blue shark, followed by a transition to coastal longlines in the mid-1980s. In recent years catches taken by the industrial longline fisheries have expanded, predominantly by the swordfish targeting longliners of EU-Spain and EU-Portugal, the deep-freezing longliners of Japan and Taiwan, China and the longliners of Taiwan, China. The data revision that resulted in the 2025 nominal catch data resulted in an order of magnitude difference, no historical catch from some fleets prior to 2010, and has large increases in the final year (2023) of the dataset (Figure 2).

A key issue with this dataset is the presence of the large *"Sharks various nei"* or other categories (SKHS, SKH, SHRK, AG22 and SKX[2]) in the database which is assumed to include unidentified blue sharks. The scale and trend of the 'Sharks NEI' category differs greatly from the reported blue shark catch (Figure 3). However, the extent to which these aggregates are composed of blue sharks relative to other shark species is unknown. Another major issue is the apparent many incidences of 'missing' catch. For example, two fleets fishing in the same vicinity catching the same target species using the same gear type but only one reports any catch of (blue) sharks. This is likely a reporting issue. A third key issue is inaccurate reporting, e.g., a fleet catches substantial quantities of blue shark and only reports a small fraction of this. Note that the ongoing revision of the nominal catch make provides a significant amount of uncertainty.

Three data sets were produced to estimate the total blue shark catch in the Indian Ocean;

1) **Data Set 1.** Dataset 1 is based on the nominal catch (NC) data from the NC 2024 (1950-2022), combined with the 2023 reported catch NC 2025 data, with the exception of BSH from Indonesia, which was copied over from the NC 2024 data for the year of 2022.
2) **Data Set 2.** Dataset 2 is based on the NC 2025 (1950-2023), except for BSH from Indonesia, in 2023 which was copied over from 2022. Reported catch for BSH from Indonesia, prior to 2009 was included based on the NC 2024 dataset.
3) **Data Set 3.** Dataset 2 is based on the NC 2025 (1950-2023), except for BSH from Indonesia, in 2023 which was copied over from 2022.

These datasets differ in scale (Table 1), temporal coverage and gear make up (Figure 4) which underscores the uncertainties inherent in the dataset.

GAM approach to estimate unreported blue shark catches

A statistical modelling approach based on generalized additive models (GAMs) was used to predict unreported catches. The estimate blue shark catches are based on the nominal catches in the IOTC database. The model was set up incorporating a number of explanatory variables thought to be influential in determining whether a fleet catches blue sharks, though in practice the number of variables related to the nominal reported catch is limited. The model was parameterized based on the records where reported blue

[2] These codes are stand for Sharks finned (SHKS), Sharks various nei (SKH, SHRK, AG22) and Sharks rays, skates etc. nei (SKX).

shark and the selected covariates were available and the model was predicted on the remaining dataset where zero blue shark catches were reported, and where sufficient levels of the covariates were available for prediction. Records with levels outside the model, and so for which prediction was not possible, were dropped.

The log transformed nominal blue shark catches were used as the response variable. Outliers were not well predicted by the model so the dataset on which to predict the unreported blue shark catches was also filtered to remove extreme values (the top 1% of the target) which had a disproportionately large effect on the results. The prediction set (in which no blue shark were reported), was also trimmed to remove the top 1% of the target catch.

The explanatory variables year, target species catch, gear, area, and fishing ground (coastal, pelagic or all). Different classifications of non-blue shark species were also explored including separate covariates for temperate tuna species, tropical tunas, other shark species and all other species, added using splines. To avoid over-parameterisation, models were run sequentially starting from the simplest model and incorporating covariates and interactions, where they made sense theoretically (e.g. area-gear interactions) in an iterative manner. Models were evaluated based on AIC values and the amount of deviance explained.

Ratio method to estimate unreported blue shark catches

A second method based on the ratio of blue shark to target species was used in an attempt to estimate the unreported component of blue shark catches. Target species were defined as yellowfin tuna, bigeye tuna, skipjack tuna, albacore and swordfish. Nominal catches of these species are considered to be relatively accurate.

Starting from the nominal, records were separated out into four components where fleets were reporting:

1) Positive catches of target species and positive catches of blue shark where the target species catch is greater than the blue shark catch (used to calculate catch rate)
2) Positive catches of target species but zero blue shark catches (assumed to be non-reporting so were not included in the catch rate calculation)
3) Positive catches of blue shark but zero target species catches or positive catches of target species and positive catches of blue shark where the blue shark catch is greater than the target species catch (it is assumed here that blue sharks are actually the target species in this case and so the reporting is likely to be accurate, hence these records were excluded from the catch rate calculation)
4) Zero catches of both target species and blue sharks reported (these records were not used)

Blue shark catch rates were calculated, defined as the ratio of blue shark to the total target species catch where positive catches of target species and blue shark were caught and where the target species catches were greater than the blue shark catches. These catch rates were calculated by fleet, year and gear type (the finest scale gear classifications stored in the IOTC database). Catch rates were averaged across all fleets reporting blue shark catches for each gear-year combination (**Error! Reference source not found.** shows this for Data Set 1). Fleets reporting zero catches of blue sharks for a year-gear combination where other fleets were reporting positive blue shark catches were assumed to be false zeros and so were not used in calculating the average, while records where catches of blue shark were greater than the target species catches were also not used as in these cases, the blue shark was assumed to be the target species and should be more accurately reported. Unclassified gear types were removed to avoid meaningless predictions from unrelated gear types.

These ratios were then used to estimate the unreported blue shark catch component (defined as fleets reporting zero catches of blue sharks for a year-gear combination where other fleets were reporting positive blue shark catches). Fleets reporting zero blue shark catches were allocated catches by multiplying the average catch rate by the target catch for the fleet.

Although the ratio between blue shark and target catch by gear is variable, it lacks the clear (declining) trend of the reporting of blue shark to various target species that stands out in the 2025 Nominal Catch data set (Figure 6)

3 Results

Estimation of unreported blue shark catches based on GAMs

A range of explanatory variables were explored through the GAM models: Year, Gear, Area, Fishing Ground, Target Catch (YFT+BET+SKJ+ALB+SWO), Tropical tunas (YFT+BET+SKJ), Temperate species (ALB and SWO), Other (not target or shark), Other sharks and BSH catch. Target catch is the sum of Tropical tuna and temperate catch. Given that the aim of the method was to predict the catches of countries that had not reported BSH catches, country was not used as an explanatory variable. The model was set up using only those records where blue shark was reported and the resultant coefficients were estimated. These were then used to estimate the unreported catch component by predicting the missing values based on the records where blue shark was not reported.

For the Data Set 1, two estimates based on the GAM are produced, the first, a minimal estimate based on the prediction of unreported catch, while the second is based on the estimate predicting underreported/not reported to species catch. Stepwise model development resulted in the range of models shown in Figure 5 and 6 for the minimal and maximum catches for Data Set 1. Multiple other models were also fit, however the resulting estimates of catch were often highly variable (with inter-annual fluctuations in the order of 10-20 thousand t), or estimated extremely high catch in the early part of the model when the exploitation was thought to be lightest. The following model was selected as the best based on in part on AIC ranking (Tables 2-5:

gam(log(BSH_catch) ~ as.factor(Year) + s(TAR_catch) + Gear :Area)

The estimated minimal catches are similar to the reported nominal catches (Figure 4) while the maximal catches based on this formula are similar to the previous estimates in annual scale and trend, though some differences exist (Figure 6). The residual diagnostics for the model are shown in Figures 7 -9 for Data Sets 1-3.

Estimation ofs blue shark catches based on target species ratios

The estimated unreported catch component is shown in Figure 11 by data set. The estimates generally track the datasets.

4 Discussion

The methods described in this paper attempt to account for two key sources of error in reported catches: (i) not reporting to species/underreporting, and (ii) not reporting at all. The procedure used to estimate catch for both the ratio and GAM based models assumes that target catches can be used to predict the unreported catches in the case where there are zero reported catches. The accuracy of all of these methods is entirely dependent on the quality of the original data on which they are based. The reported catch of blues sharks and other species is currently being revised and therefore the catch estimates should be considered uncertain.

The ratio and GAM based methods both provide different approaches to the estimation of the 'missing' blue shark catches. Both methods used the nominal catches as a base and estimated the unreported catch. The underlying datasets that were used were recommended by the WPEB to span the range of possible alternatives. The working party is encouraged to discuss this combination of the data as well as any preferred alternatives, for any future assessment.

The results of the GAM modelling provide final estimates that are very similar to the ratio based estimates, by data set, though the scale differs. (**Error! Reference source not found.**9 and 10).

The provision of a minimal and maximal catch estimates from the GAM based estimate from the Data Set 1 is an attempt to develop estimates that may be inline with the currently reported blue shark catch, and span the range of uncertainty.

A key assumption of both of these methods is that all zero reported catches, where there are reported catches of target species present, are false. This might present an overestimation bias in the results by estimating catches where there were actually zero catches. Nevertheless, the data used were based on aggregated annual values and so, given this time period of aggregation, the assumption that reported zero catches are false seems reasonable. These methods also make the assumption that target catches are reported accurately. If target catches are in fact also under-reported, then this may result in an underestimation bias in the results. Nevertheless, as only the five species for which data are deemed to be of reliable quality are used, this should also be a reasonable assumption.

A further assumption these methods make is that those fleets that are reporting positive blue shark catches are doing so accurately. Due to issues with the reporting of processed weight rather than round weights and retained catches rather than total catches, this may also lead to an underestimation bias in the results. Estimated catches will be greatest for gear types for which there are a large number of zero reports (with substantial target catches) and a high average catch rate by the reporting fleets. If there are few zero reports but many under-reporters, this will result in under-inflated catch rates and underestimates for the final catches. A filtering approach was used here to remove fleets which were deemed to be targeting sharks to avoid over-inflated catch rates, however, establishing lower thresholds was more problematic with the data available.

The GAM method uses a statistical approach to fill in the gaps where data are lacking and so provides advantages over the ratio method where simple average catch rates are used. The GAM method also uses a greater number of predictor variables to account for items such as spatial differences in catch rates where the sparse and patchy nature of the data means that this is not appropriate for the ratio method.

Any type of catch reconstruction that is attempted will include some level of error, so in practice it is common to include multiple alternative catch time series in assessments for data limited stocks such as these and to explore the outcomes based on the different sensitivity runs. This paper outlines the methods and results for two new alternative catch series that may be used in the assessment model; a series based on ratio approach to estimation and a GAM estimation method

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6 Tables

Table 1. Reported nominal catches (MT) of BSH based on the Data Sets 1-3.

	Nominal Reported BSH Catch		
Year	Data Set 1	Data Set 2	Data Set 3
1950	47	47	-
1951	269	269	-
1952	293	293	-
1953	297	297	-
1954	367	367	-
1955	367	367	-
1956	389	389	-
1957	372	372	-
1958	371	371	-
1959	372	372	-
1960	367	367	-
1961	394	394	-
1962	488	488	-
1963	497	497	-
1964	3,462	3,462	2,956
1965	2,342	2,342	1,808
1966	2,542	2,542	1,924
1967	3,729	3,729	3,101
1968	2,777	2,777	2,151
1969	3,084	3,084	2,435
1970	1,792	1,792	1,223
1971	1,850	1,850	1,298
1972	1,824	1,824	1,136
1973	1,291	1,291	504
1974	1,753	1,753	852
1975	2,054	2,054	751
1976	1,730	1,730	277
1977	1,953	1,953	236
1978	2,211	2,211	333
1979	2,080	2,080	503
1980	2,205	2,205	448
1981	2,662	2,662	692
1982	3,028	3,028	390
1983	3,133	3,133	547
1984	3,274	3,274	595
1985	3,152	3,152	924
1986	3,194	3,194	882

1987	3,065	3,065	709
1988	3,489	3,489	590
1989	3,903	3,903	709
1990	3,086	3,086	589
1991	3,878	3,878	925
1992	3,657	3,657	955
1993	5,256	5,256	1,232
1994	6,499	6,499	2,061
1995	6,841	6,841	2,299
1996	7,421	7,421	2,165
1997	8,847	8,847	3,351
1998	8,876	8,876	3,551
1999	12,123	12,123	6,554
2000	12,404	12,404	6,553
2001	10,485	10,485	4,411
2002	11,856	11,856	6,245
2003	15,354	15,354	9,215
2004	21,398	21,398	13,777
2005	24,393	24,393	14,028
2006	21,452	21,452	11,601
2007	23,293	23,293	11,020
2008	24,144	24,144	11,443
2009	26,563	26,563	11,221
2010	27,513	14,900	14,900
2011	28,033	15,541	15,541
2012	27,964	14,297	14,297
2013	31,607	13,862	13,862
2014	29,587	14,904	14,904
2015	29,075	13,968	13,968
2016	29,479	14,845	14,845
2017	31,130	12,231	12,231
2018	22,626	12,017	12,017
2019	25,293	12,224	12,224
2020	29,545	9,362	9,362
2021	24,491	9,092	9,092
2022	24,413	8,381	8,381
2023	27,151	11,136	11,136

Table 2. Model information for the various GAM models used. The bolded model (Model 5) is the model recommended for the stock assessment. Data Set 1.

Model Number	Model	Resid. Df	Resid. Dev	Df	Deviance	AIC
1	log(BSH) ~ Year	881.0	5692.9	NA	NA	4565.1
2	+Target Catch	872.1	4007.2	8.9	1685.6	4246.7
3	+Gear	857.0	2452.2	15.0	1555.0	3807.9
4	+Area	856.0	2451.3	1.0	0.9	3809.6
5	**+Gear:Area**	**846.1**	**2284.2**	**10.0**	**167.1**	**3762.1**
6	+Gear * Area	846.1	2284.2	0.0	0.0	3762.1
7	+Fgrounds"	843.0	2089.0	3.0	195.2	3683.0

Table 3. Model information for the various GAM models used. The bolded model (Model 5) is the model recommended for the stock assessment. Data Set 2.

Model Number	Model	Resid. Df	Resid. Dev	Df	Deviance	AIC
1	log(BSH) ~ Year	812	6090	NA	NA	4372
2	+Yr+Target Catch	803	4617	8.9	1472.3	4144
3	+Yr+TarCth+Gear	784	2461	19.1	2156.2	3625
4	+Yr+TarCth+Gear+Area	776	1904	8.0	557.4	3414
5	**+Yr+TarCth+Gear:Area**	**763**	**1505**	**13.0**	**399.0**	**3231**

6	+Yr+TarCth+Gear * Area	763	1505	6.59E-12	2.27E-13	3231
7	+Yr+TarCth+Gear*Area+Fgrounds	763	1505	-1.6E-12	-2.3E-13	3231

Table 4. Model information for the various GAM models used. The bolded model (Model 5) is the model recommended for the stock assessment. Data Set 3.

Model Number	Model	Resid. Df	Resid. Dev	Df	Deviance	AIC
1	log(BSH) ~ Year	759	5944	NA	NA	4064
2	+Yr+Target Catch	750	4586	8.8	1357.4	3868
3	+Yr+TarCth+Gear	731	2140	19.2	2446.5	3283
4	+Yr+TarCth+Gear+Area	723	1774	8.0	365.4	3146
5	**+Yr+TarCth+Gear:Area**	**710**	**1237**	**13.0**	**537.1**	**2877**
6	+Yr+TarCth+Gear * Area	710	1237	5.8E-12	0	2877
7	+Yr+TarCth+Gear*Area+Fgrounds	710	1237	-4E-12	0	2877

Table 5. GAM Estimated total blue shark catch, from 2021 (Est_2021), the minimal and maximal estimates from Data set1, and the Estimates from Data Set 2 and Data Set 3.

Year	Est_2021	DataSet1_MinEst	DataSet1_MaxEst	DataSet_2	Data_Set_3
1950	131	77	123	867	NA
1951	755	417	686	4719	NA
1952	1709	1481	1773	13231	NA
1953	1974	2777	3074	13647	NA
1954	3933	4108	4474	32578	NA
1955	4394	3038	3405	29875	NA
1956	4052	2647	3035	37099	NA
1957	4952	3002	3373	33810	NA

1958	4791	4738	5109	37454	NA
1959	5024	3550	3922	35738	NA
1960	4587	2364	2730	28537	NA
1961	4509	2872	3265	44141	NA
1962	4944	2419	2906	35825	NA
1963	5860	3649	4146	42119	NA
1964	6522	5409	8621	11468	4510
1965	4480	3307	5703	7445	2540
1966	5473	4380	6915	9220	2511
1967	8939	6206	8346	15402	4595
1968	8622	7432	9179	46627	4595
1969	9031	5832	7524	18640	5210
1970	4841	4503	6278	9134	3220
1971	5164	3974	5927	7082	3136
1972	5124	3504	5175	6177	2740
1973	3385	2994	4121	8902	1806
1974	5005	3470	5168	8059	2774
1975	5401	4403	6234	12457	2583
1976	4636	3091	4079	6902	1182
1977	5048	3437	4367	8061	1456
1978	6253	5566	6687	9237	1316
1979	7963	6236	7464	8418	1765
1980	7532	6581	7874	9709	1617
1981	10300	11414	13132	15410	3727
1982	9447	10834	12322	9622	2063
1983	10958	11454	13198	13148	2280
1984	11314	13511	15515	12513	2779
1985	7029	4125	8340	7589	3850
1986	9808	4804	10728	8095	5626
1987	9068	4537	10183	7546	5078
1988	10414	5626	12158	8842	6390
1989	13167	5687	12015	8266	5015

1990	8256	4612	9026	6844	3797
1991	10487	5522	11096	7779	4517
1992	10729	5136	10218	7449	4418
1993	13088	7056	12293	10566	5291
1994	17067	9582	16612	14165	9119
1995	17571	9198	16767	15358	8928
1996	18369	9612	17939	14643	8333
1997	24457	11237	19879	15952	9055
1998	16861	10220	15782	14568	6224
1999	22341	13585	21342	16736	8184
2000	28946	15280	25904	16570	9051
2001	21183	13763	24874	15012	8120
2002	26016	14978	29826	16626	10926
2003	33361	19134	34563	20465	15263
2004	40935	26178	50554	27300	21219
2005	43858	28031	43735	28501	18090
2006	40590	26655	51273	28628	19635
2007	38638	26738	46601	30313	16190
2008	42523	27167	50684	31612	17816
2009	48429	29210	52691	32501	18137
2010	46506	29267	44898	16553	16761
2011	48862	29800	44528	17334	17437
2012	52250	29757	48708	15612	15858
2013	56496	33119	53121	15052	15379
2014	54758	31081	53062	15899	16245
2015	50793	29697	47080	14494	14699
2016	55308	30692	51553	15470	15901
2017	57530	32665	53224	12750	13106
2018	37032	22953	34065	12147	12269
2019	43240	25880	38392	12478	12726
2020	NA	29941	46133	9421	9553
2021	NA	25031	38374	9267	9471

2022	NA	24880	38865	8521	8750
2023	NA	27723	48998	11284	11541

Table 6. Ratio based estimates of total blue shark catch, from Data set1, Data Set 2 and Data Set 3.

Year	RatioEst_DS1	RatioEst_DS2	RatioEst_DS3
1950	468	1475	0
1951	724	1808	0
1952	735	1791	0
1953	805	2019	0
1954	884	2118	0
1955	893	2150	0
1956	901	2122	0
1957	1331	3620	0
1958	979	2430	0
1959	993	2476	0
1960	1093	2826	0
1961	1125	2870	0
1962	1515	3969	0
1963	1926	5339	0
1964	5477	9772	3201
1965	4337	8830	1941
1966	5503	12204	2096
1967	6984	13846	3512
1968	6537	13658	2944
1969	7487	14466	3943
1970	5396	11528	2282
1971	4890	9909	2258
1972	5657	12301	2215
1973	4682	11034	1183
1974	6431	14017	2182
1975	6826	14465	2110

1976	6569	16069	827
1977	6908	16163	1013
1978	11958	14963	1304
1979	12368	15408	2285
1980	10736	13291	1370
1981	13514	16573	2557
1982	14532	17911	1874
1983	10800	13076	1640
1984	10912	13283	1459
1985	6214	7921	2215
1986	7551	8534	2846
1987	6959	8010	2109
1988	8086	9151	2279
1989	8931	10209	2759
1990	7932	8579	1778
1991	10717	12291	4649
1992	10249	11706	4170
1993	13656	15632	6157
1994	12736	14607	4283
1995	17290	19473	7915
1996	18210	19716	8084
1997	18819	20373	7991
1998	16950	17438	8017
1999	22766	23059	13486
2000	29952	31023	18450
2001	25945	25791	15968
2002	21194	20820	11224
2003	29948	31030	15147
2004	32309	32076	19486
2005	37587	39187	19345
2006	31808	32129	17144
2007	32676	33797	16636

2008	40102	37274	17480
2009	35383	35426	14147
2010	39190	20563	20563
2011	36408	19455	19455
2012	38118	17124	17124
2013	41041	16967	16967
2014	34548	17534	17534
2015	32460	15466	15466
2016	38123	19326	19326
2017	40318	15971	15971
2018	31724	14263	14263
2019	33210	14641	14641
2020	35957	10746	10746
2021	31430	12556	12556
2022	31623	11126	11126
2023	33137	14257	14257

7 Figures

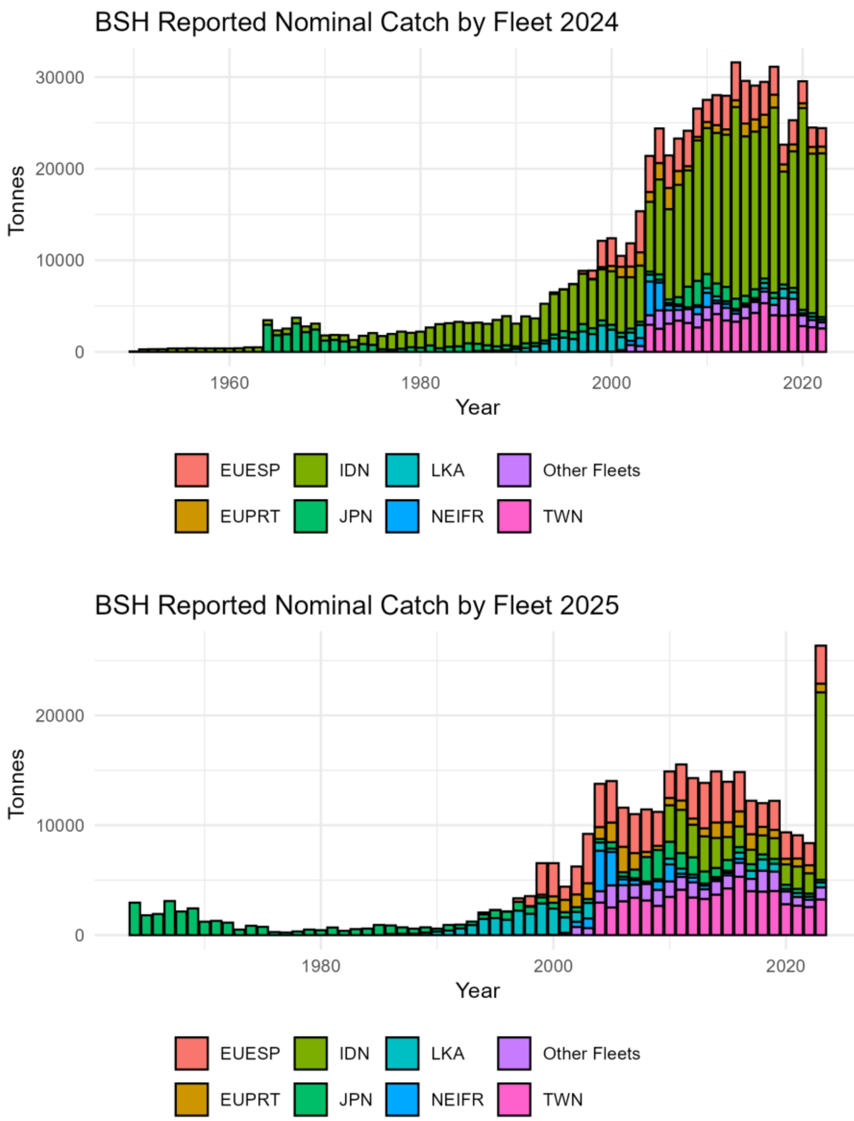

Figure 1. Reported nominal catches of blue sharks in the IOTC area of competence by main fleets, based on reported data in 2024 and 2025 (bottom panel))

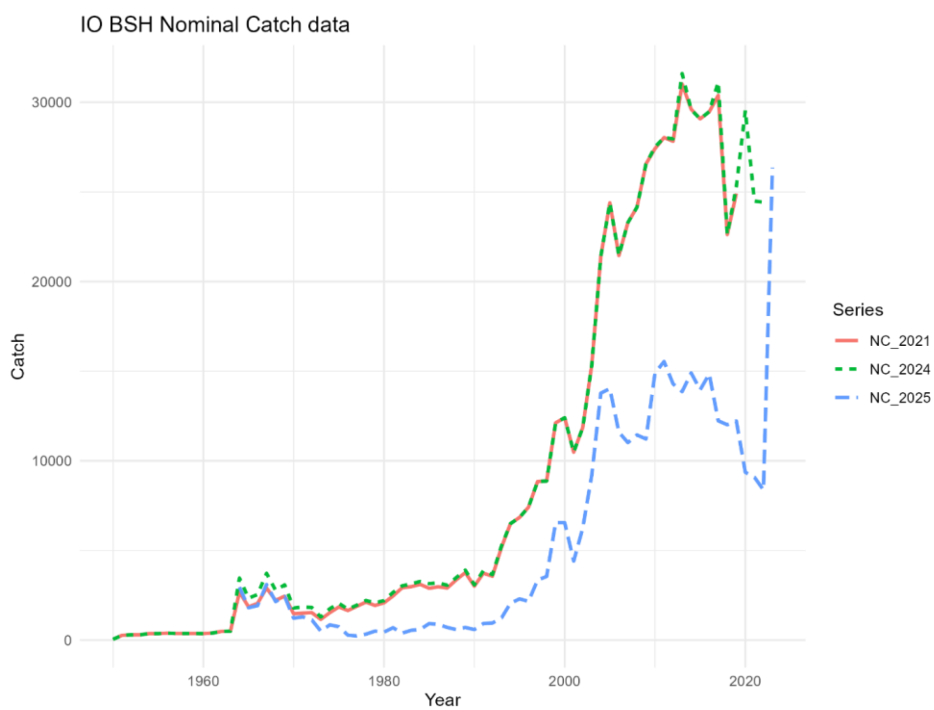

Figure 2. Reported nominal catches (mt) of blue shark in the Indian Ocean, by publication year, the NC_2021 series was used to estimate the catch during the 2021 assessment.

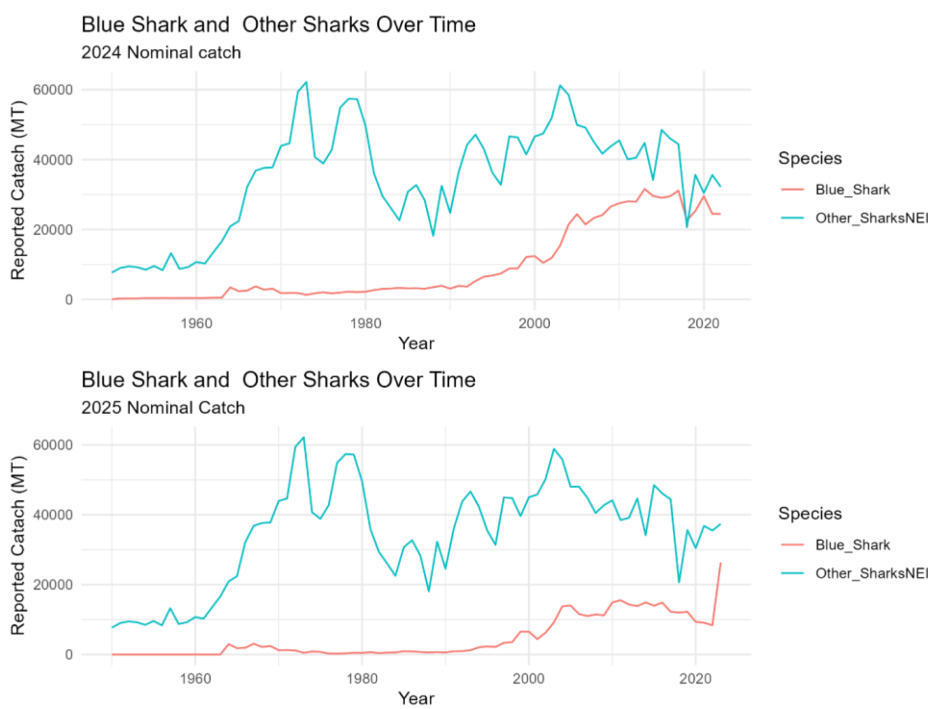

Figure 3. Comparison of reported blue shark catch to unidentified shark catch in the Indian Ocean, both from the Nominal Catch datasets of 2024 (top) and 2025 (bottom).

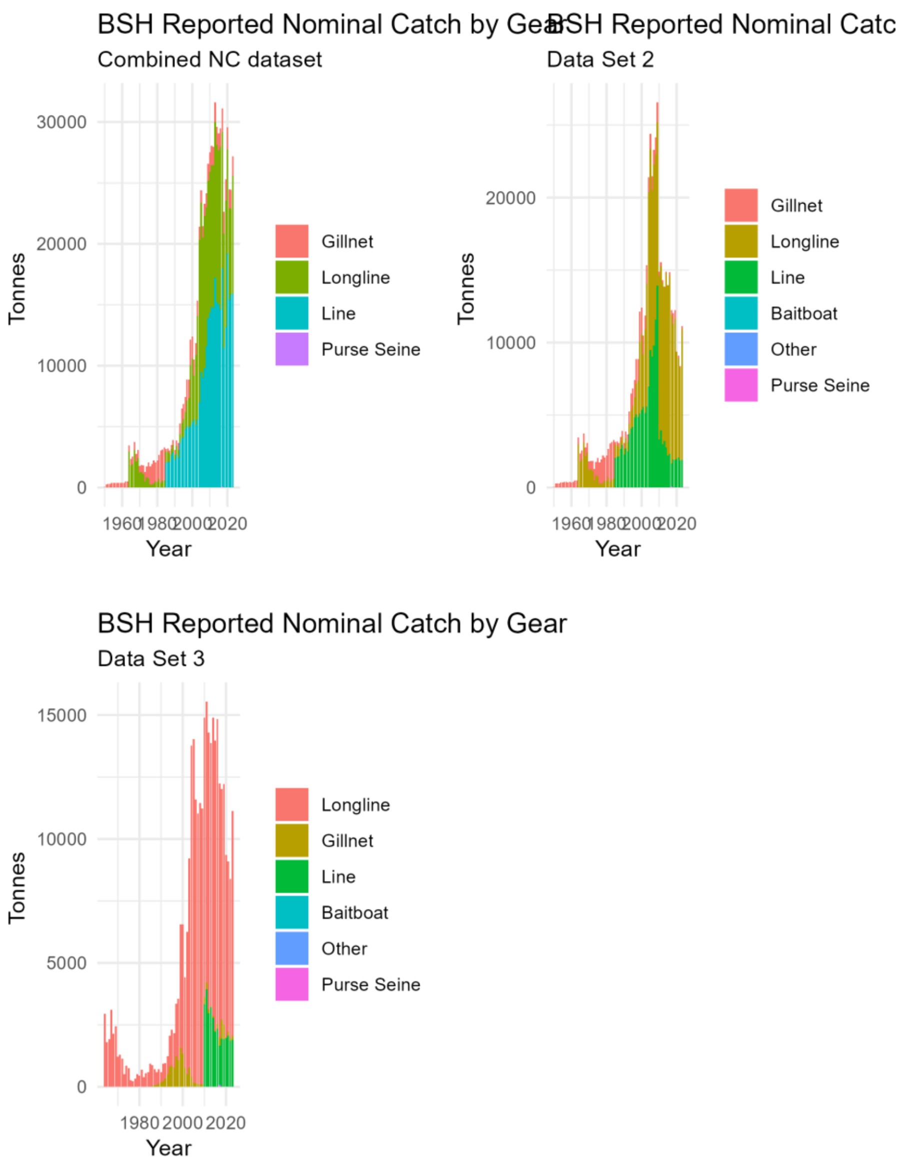

Figure 4. Reported catches of blue sharks Indian Ocean y main gear type, from the three catch data sets, note that x and y axes differ. Note that the colors differ between panels.

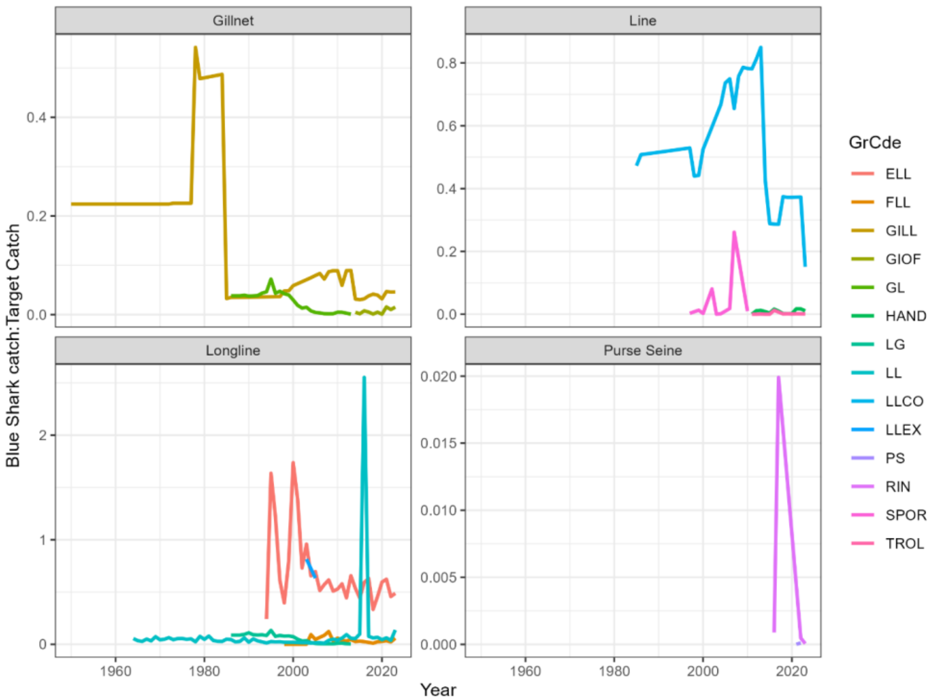

Figure 5. Ratio of reported blue shark catch to target catch by gear over time for gillnet, handline (line), Purse seine and longline fisheries.

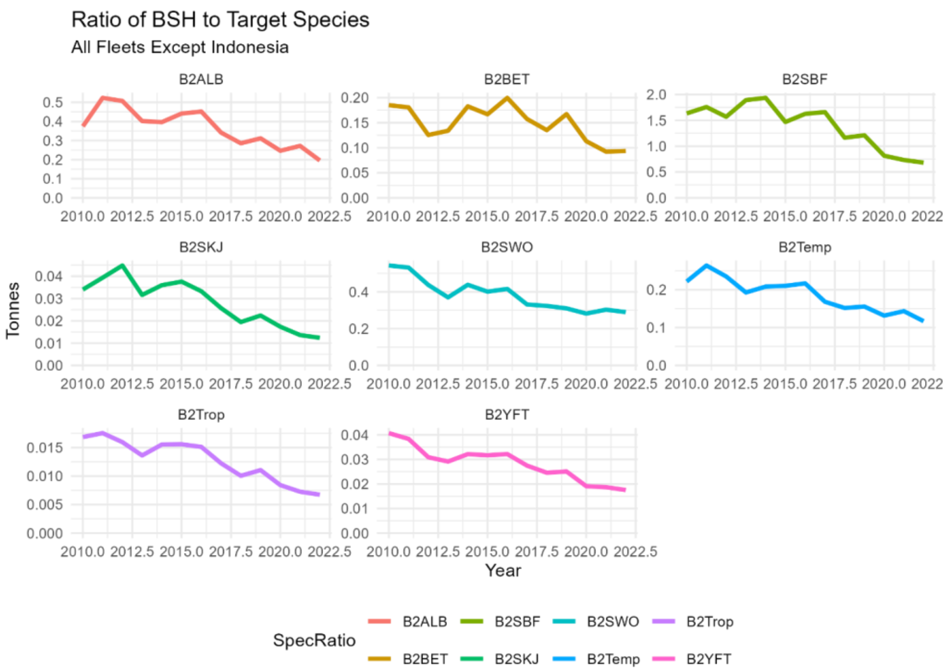

Figure 6. Ratio of reported blues blue shark to various target species and groupings, based on the Nominal Catch Dataset from 2025, excluding Indonesia due to the ongoing revision of that CPC's nominal catch. The labels indicate the ratios between blue shark (BSH) to other target species, where B2YFT = BSH/YFT , B2BET= BSH/BET, B2SWO= BSH/SWO, B2SKJ = BSH/SKJ, B2ALB= BSH/ALB, B2SBF= BSH/SBF, B2Trop= BSH/(YFT+SKJ+BET), and B2Temp= BSH/(SWO+ALB).

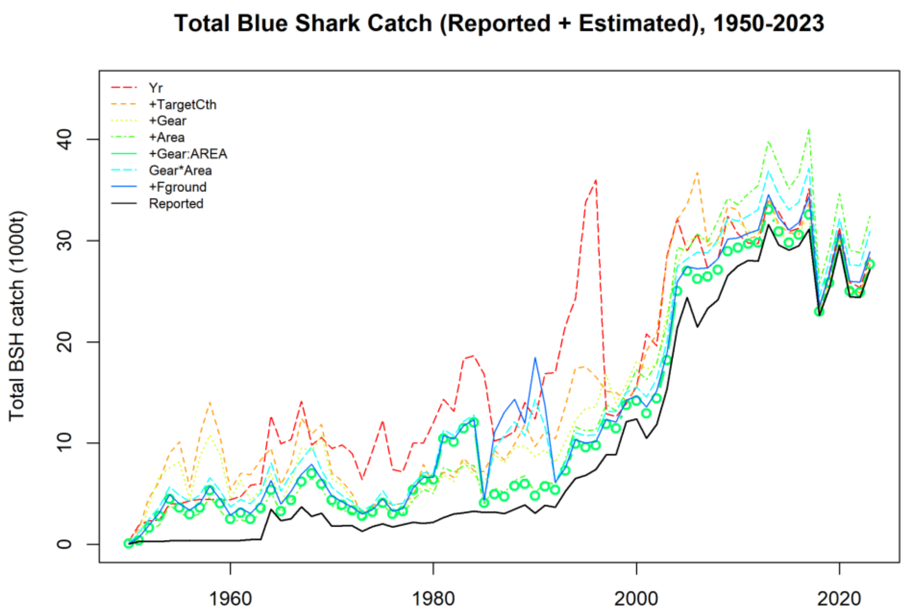

Figure 5. Stepwise results of predicted catch via GAM on the nominal catch based on Data Set 1, for the <u>minimal</u> catch estimates (selected model = green line, the +Gear:Area).

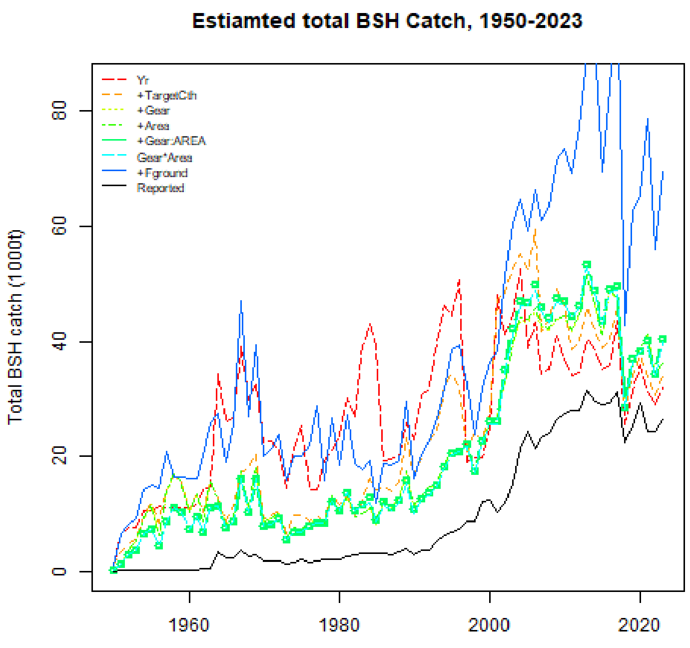

Figure 6. Stepwise results of predicted catch via GAM on the nominal catch based on Data Set 1, for the maximal catch. (selected model = green line, the +Gear:Area).

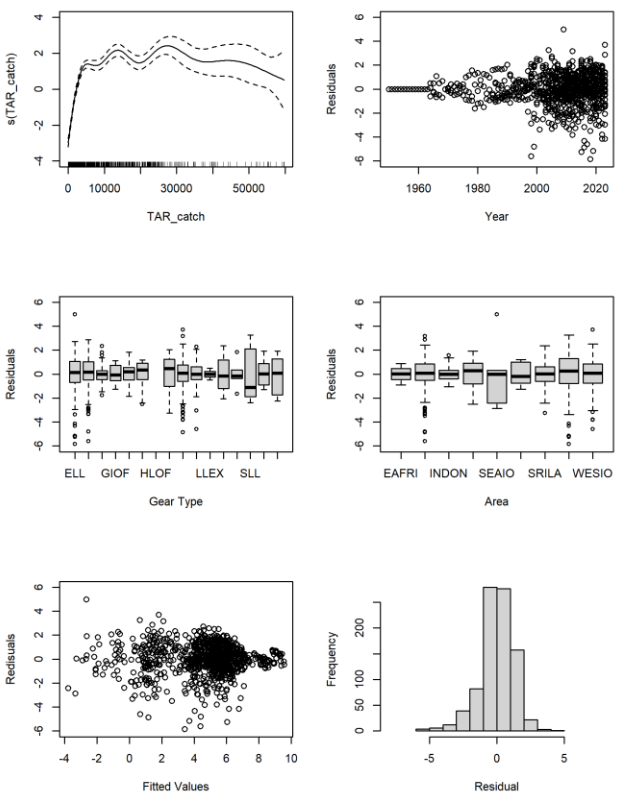

Figure 7. Residual plots of final GAM model, from Data Set 1.

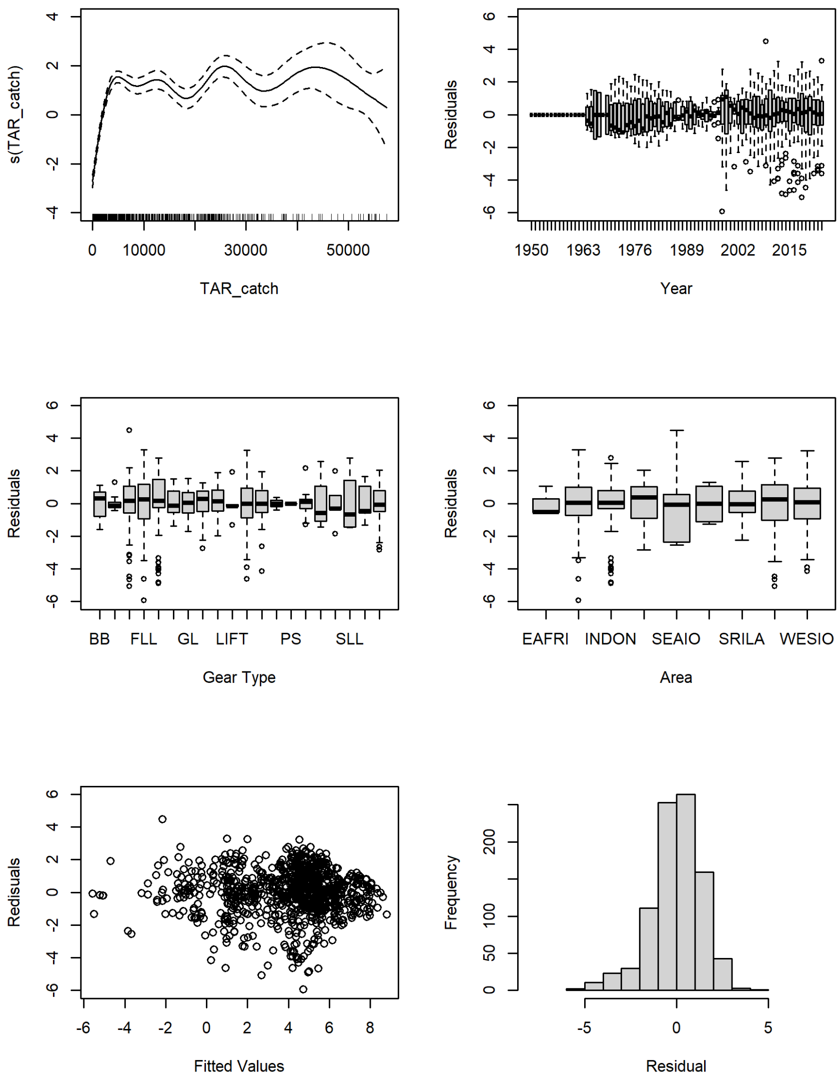

Figure 8. Residual plots of final GAM model, from Data Set 2.

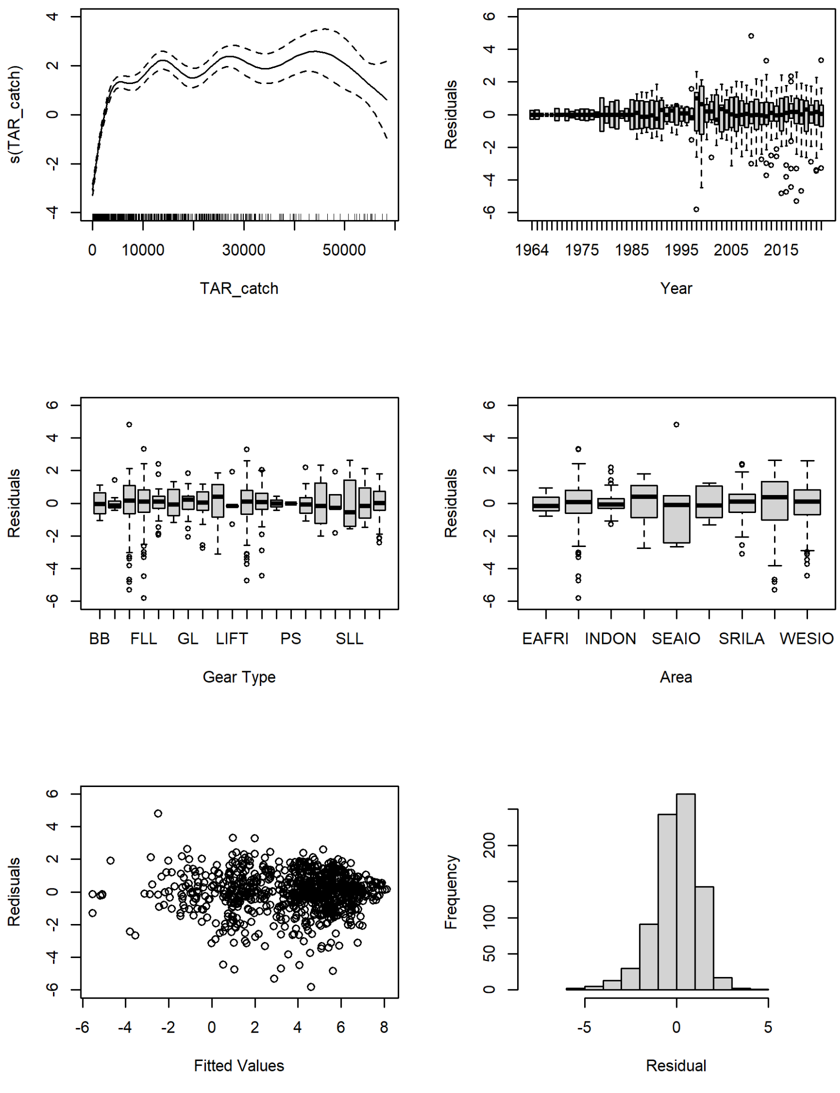

Figure 9. Residual plots of final GAM model, from Data Set 3.

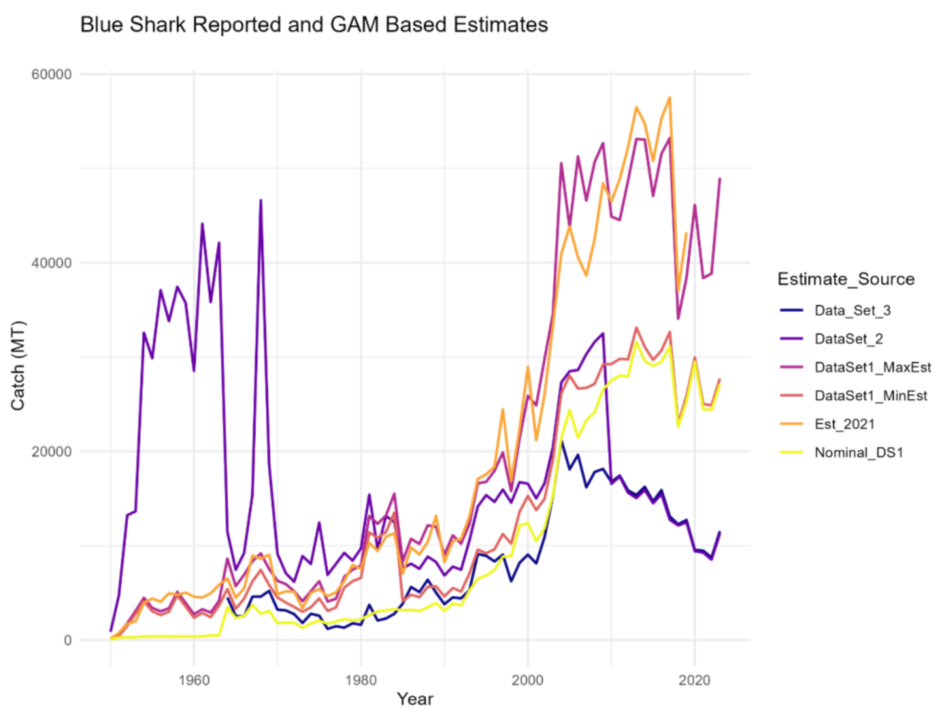

Figure 10. Total catch (reported + estimated) based on the GAM estimated catches, for the minimal and maximal estimates from Data Set 1, the estimates from Data Set 2, Data Set 3, the estimates used in 2021, and the nominal catch estimates from Data Set 3.

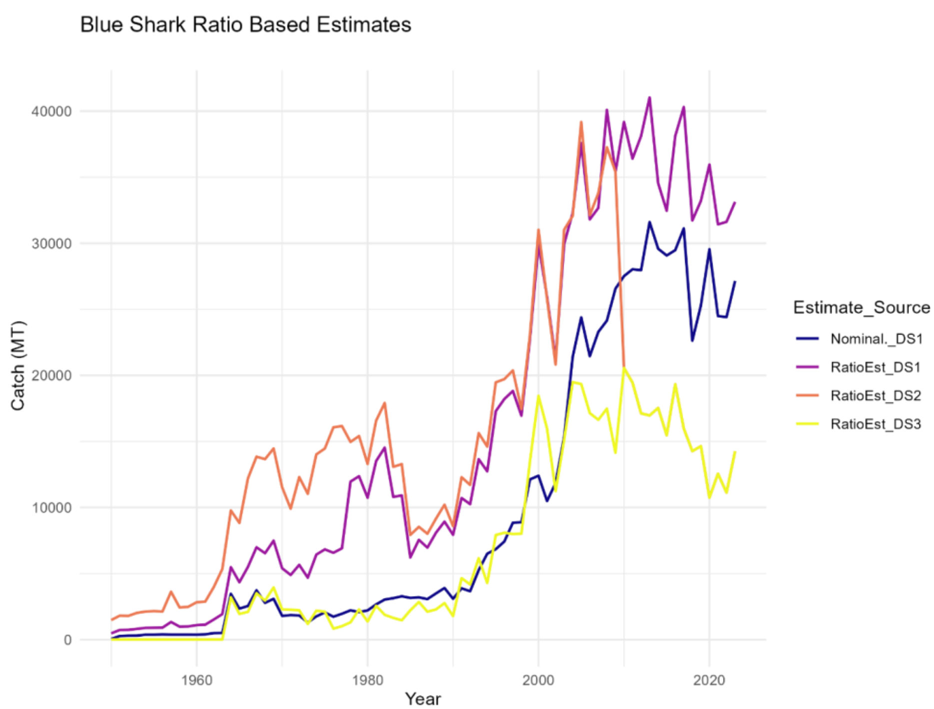

Figure 11. Ratio based catch estimates by dataset (DS1, DS2, DS3) along with the nominal reported catch from Data Set 1. Note that the Ratio based estimated from 2010-2023 are identical from 2010-2023, and thus overlapped (the orange and yellow lines).