9.9 BUM - Blue marlin

The most recent assessment for blue marlin was conducted in 2018 through a process that included a data preparatory meeting in March 2018 (Anon., 2018b) and an assessment meeting in June 2018 (Anon., 2018c). The last year of fishery data used in the assessment was 2016.

BUM-1. Biology

The central and northern Caribbean Sea and northern Bahamas have historically been known as the primary spawning area for blue marlin in the western North Atlantic. Recent reports show that blue marlin spawning can also occur north of The Bahamas in an offshore area near Bermuda at about 32º-34º N. Ovaries of female blue marlin caught by artisanal vessel in Côte d'Ivoire show evidence of pre-spawning and post-spawning, but not of spawning. In this area females are more abundant than males (4:1 female/male ratio). Coastal areas off West Africa have strong seasonal upwelling, and may be feeding areas for blue marlin.

Atlantic blue marlin inhabit the upper parts of the open ocean. Blue marlin spend the majority of their time in the mixed surface layer (58% of daylight and 84% of nighttime hours), however, they regularly make short-duration dives to maximum depths of around 300 m, with some vertical excursions down to 800 m. They do not confine themselves to a narrow range of temperatures but most tend to be found in waters warmer than 17°C. The distribution of time at depth is significantly different between day and night. At night, the fish spent most of their time at or very close to the surface. During daylight hours, they are typically below the surface, often at 40 to 100+ m. These patterns, however, can be highly variable between individuals and also vary depending on the temperature and dissolved oxygen of the surface mixed layer. This variability in the use of habitat by blue marlin indicates that simplistic assumptions about habitat usage made during the standardization of catch per unit effort (CPUE) data may be inappropriate.

BUM-2. Fishery indicators

The decadal geographic distribution of the catches is given in **BUM-Figure 1**. The Committee used Task 1 catches as the basis for the estimation of total removals (**BUM-Figure 2**). Total removals for the period 1990-2016 were obtained during the 2018 blue marlin data preparatory meeting (Anon., 2018b) by modifying Task 1 values with the addition of blue marlin that the Committee estimated from catches reported as billfish unclassified. Additionally, the reporting gaps were filled with estimated values for some fleets.

During the 2018 blue marlin assessment it was noted that catches from 2013, 2014, and 2016 had been above the recommended TAC, and this continues to be the case for 2017. Over the last 20 years, Antillean artisanal fleets have increased the use of Moored Fish Aggregating Devices (MFADs) to capture pelagic fish. Catches of blue marlin caught around MFADs are known to be significant and increasing in some areas, however reports to ICCAT on these catches are incomplete. Although historical catches from some Antillean artisanal fleets have been recently included in Task 1 there is still an unknown number of Antillean artisanal fleets that may have unreported catches of blue marlin caught around MFADs. It is important that the amount of these catches be documented. Recent reports from purse seine fleets in West Africa suggest that blue marlin is more commonly caught with tuna schools associated with FADs than with free tuna schools. It is noted that blue marlin catches continued to decline until 2022. Preliminary Task 1 catches of blue marlin (**BUM-Table 1**) in 2021 and 2022 were 1,762 t and 1,680 t, respectively. These catches are likely underestimated because few CPCs have reported discards.

A series of indices of abundance for blue marlin were presented and discussed during the 2018 Blue Marlin Data Preparatory Meeting (Anon., 2018b). Ten CPUE series were used in the assessment. The standard errors from the CPUE standardized series were applied as weighting factors in all assessment models. All estimated standardized CPUE indices for blue marlin showed a sharp decline during the period 1960-1975, and thereafter have fluctuated around lower levels (**BUM-Figure 3**).

BUM-3. State of the stocks

A full stock assessment was conducted for blue marlin in 2018 (Anon., 2018c), applying to the available data through 2016, using both surplus production and age-structured models. Both models estimated similar annual trends of biomass and fishing mortality (**BUM-Figure 4.1** and **4.2**). The results of the 2018 assessment indicated that the estimated B/B_{MSY} and F/F_{MSY} were such that the current stock status is overfished and undergoing overfishing. Since the mid-2000s, the biomass has ceased to decline and fishing mortality has shown a declining trend since its peak in 2003.

The 2018 results are similar to those of the 2011 assessment. The estimated MSY was determined to be 3,001 t with 10% and 90% confident limits of 2,399 to 3,537 t. The current status of the blue marlin stock is presented in **BUM-Figure 5.** The probability of being in the red quadrant of the Kobe plot was estimated to be 54%. The probability of being in the yellow quadrants of the Kobe plot was estimated to be 42% and that of being in the green quadrant only 4%. However, the Committee recognizes the high uncertainty with regard to data and the productivity of the stock.

BUM-4. Outlook

A combination of projection results from the Bayesian Surplus Production model and the age structure model was used to produce the advice outlook, including the Kobe strategy matrices. Projections were made by assuming the current reported catch for 2016 (2,036 t, estimate available at the time of the assessment) will have also been taken in 2017 and 2018. According to these projections the catches of 2,000 t (close to catches reported in 2015, 2016 and 2017) will only provide a 46% probability of being in the green quadrant by 2028. In contrast, a TAC of 1,750 t will allow the stock to rebuild with more than 50% probability by the year 2028 (**BUM-Figure 6; BUM-Table 2**).

BUM-5. Effect of current regulations

A 2006 recommendation (Rec. 06-09) established that the annual amount harvested by pelagic longline and purse seine vessels and retained for landing must be no more than 33% for white marlin and 50% for blue marlin of the 1996 or 1999 landing levels, whichever is greater. Furthermore, in 2012, the Commission established a TAC for 2013, 2014, and 2015 of 2,000 t (Rec. 12-04), placed additional catch and commerce restrictions in recreational fisheries for blue marlin and white marlin, and requested methods for estimating live and dead discards of blue marlin and white marlin/spearfish. The Commission further strengthened the plan to rebuild blue marlin stock by extending for 2016, 2017, 2018, and 2019 the annual limit of 2,000 t for blue marlin (Rec. 15-05, Rec. 18-04). The Commission established a landings limit of 1,670 t beginning in 2020 (Rec. 19-05). Landings in 2020 and 2021 exceeded the limit in Rec. 19-05 and were below the limit in 2022.

The Committee is concerned with the significant increase in the contribution from non-industrial fisheries to the total blue marlin harvest and that the landings from these fisheries are not fully accounted for in the current ICCAT database. The Committee expressed its serious concern over this limitation on data for future assessments. Such data limitation impairs any analysis of the current regulations.

Currently, ICCAT Rec. 22-12 and four ICCAT Contracting Parties (Brazil, Canada, Mexico, and the United States) mandate or encourage the use of circle hooks on their pelagic longline fleets. Recent research has demonstrated that in some longline fisheries the use of non-offset circle hooks resulted in a reduction of billfish mortality, while the catch rates of several of the target species remained the same or were greater than the catch rates observed with the use of conventional J hooks or offset circle hooks.

More countries have started reporting data on live releases since 2006. Additional information has come about, for some fleets, regarding the potential for modifying gears to reduce the bycatch and increase the survival of marlins. Such studies have also provided information on the rates of live releases for those fleets. However there is not enough information on the proportion of fish being released alive for all fleets, to evaluate the effectiveness of the ICCAT recommendation relating to the live release of marlins.

BUM-6. Management recommendations

The 2018 assessment confirmed the advice provided in 2011 that catches of 2,000 t (current TAC) would have allowed the stock to increase in size. Because the catches have generally exceeded 2,000 t, the stock has not increased at the time of the 2018 assessment. The Committee recommends that the Commission should find ways to make sure that the catches are not allowed to exceed established Landings limit. Because the stock has not rebuilt catches (landings and dead discards) need to be lower than the current landings limit. Catches of 1,750 t or less were expected to provide at least a 50% chance of rebuilding by 2028.

The Committee recommends that if the Commission wants to further reduce fishing mortality and to reduce the chance of exceeding any established limits or TAC, the Commission could consider doing so by modifying Rec. 19-05 para 4 so that fishermen are always required to release all marlins that are alive at haul back through methods that maximize their survival.

ATLANTIC BLUE MARLIN SUMMARY

Maximum Sustainable Yield	3,056 t (2,384 – 3,536 t)[1]
Current (2022) Yield	1,680 t[2]
Relative Biomass (SSB_{2016}/SSB_{MSY})	0.69 (0.52 – 0.91)[1]
Relative Fishing Mortality (F_{2016}/F_{MSY})	1.03 (0.74 -1.50)[1]
Stock Status (2016)	Overfished: Yes [96% prob][3]
	Overfishing: Yes [54% prob][3]
Conservation and Management Measures in Effect:	Rec. 18-05 and Rec. 19-05 Landing limit of 1,670 t beginning in 2020.

[1] Combined Bayesian surplus production model and age structured assessment model results. Values correspond to median estimates, 80% confidence interval values are provided in parenthesis.
[2] 2022 yield should be considered provisional.
[3] Based on the Kobe plot proportions by quadrant.

BUM-Table 1. Estimated catches (t) of Atlantic blue marlin (*Makaira nigricans*) by area, gear and flag.

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL	A+M		3135	4216	4187	5366	5670	5637	5326	5395	4376	3807	4316	3106	3470	3070	4263	3602	3121	3001	2744	2740	2131	2749	2087	2133	2454	1633	1898	1879	1762	1680
Landings		Longline	2306	3115	3088	3983	4450	4422	3933	3965	2829	2083	2342	2013	2267	2102	2643	2555	2125	2023	1571	1432	1169	1593	1309	1334	1539	1148	1398	1042	769	750
		Other surf.	588	870	869	1119	950	1033	1238	1302	1400	1459	1650	884	1126	826	1399	739	782	781	880	944	761	899	554	514	722	360	395	691	791	659
		Sport (HL+RR)	114	120	77	68	132	130	72	69	123	216	305	174	51	103	179	269	152	177	237	289	142	200	112	220	93	64	42	78	151	193
Landings(FP)		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
Discards		Longline	127	111	153	197	139	51	83	60	22	37	19	34	24	38	42	37	40	19	56	70	55	54	106	52	73	44	55	58	46	39
		Other surf.	0	0	0	0	0	1	0	0	2	11	0	1	1	0	0	1	21	1	0	5	4	3	5	13	27	17	9	11	5	8
Landings	CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	**0**
		Barbados	21	19	31	25	30	25	19	19	18	11	11	0	0	25	0	0	0	9	13	14	11	12	34	11	24	21	13	22	12	9
		Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	3	3	7	47	19	8	5	13	1	6	0	2	0	**0**
		Brazil	147	81	180	331	193	486	509	467	780	387	577	195	612	298	262	182	150	130	63	48	114	105	89	79	64	37	20	13	2	3
		Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	**0**
		China PR	0	62	73	62	78	120	201	23	92	88	89	58	96	99	65	13	77	100	99	61	45	40	44	50	40	42	46	37	4	10
		Curaçao	40	40	40	40	40	40	40	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	2	0	15	2	**0**
		Côte d'Ivoire	104	151	134	113	157	66	189	288	208	111	171	115	21	8	132	66	72	54	17	48	48	87	15	72	44	32	163	41	148	6
		EU-España	44	55	40	158	122	195	125	140	94	28	12	51	24	91	38	55	160	257	131	190	147	209	287	225	321	0	0	0	4	95
		EU-France	139	149	154	197	232	257	285	305	329	340	340	345	360	361	358	395	265	281	284	263	162	303	196	167	209	279	386	282	131	170
		EU-Portugal	15	11	10	7	3	61	20	22	18	8	32	27	48	105	135	158	106	140	54	55	25	23	46	50	57	74	18	28	37	36
		El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**0**
		FR-St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Gabon	1	2	0	304	5	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Ghana	236	441	471	422	491	447	624	639	795	999	415	470	759	405	683	191	140	116	332	234	163	236	88	44	162	60	44	53	278	121
		Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Grenada	33	52	50	26	47	60	100	87	104	69	72	45	42	33	49	54	32	69	53	32	63	63	56	53	54	62	69	49	18	45
		Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	23	0	15	0	**0**
		Japan	926	1523	1409	1679	1349	1185	790	883	335	267	442	540	442	490	920	1028	822	731	402	430	189	280	293	296	430	287	357	293	304	335
		Korea Rep	13	56	56	144	56	2	3	1	1	0	0	1	6	33	64	91	36	85	57	34	24	10	3	26	25	25	13	20	12	10
		Liberia	0	0	87	148	148	701	420	712	235	158	115	188	304	162	274	76	56	46	133	94	178	293	35	127	10	1	2	2	9	25
		Maroc	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	4	7	82	0	0	27	0	**0**
		Mexico	3	13	13	13	13	27	35	68	37	50	70	90	86	64	91	81	93	89	68	106	86	67	72	66	60	68	51	39	43	29
		Namibia	0	0	0	0	0	0	0	0	0	3	0	5	9	57	0	50	2	23	10	0	8	36	8	32	57	84	53	51	70	8
		Panama	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	21	0	14	12	**0**
		Philippines	0	0	0	0	0	7	71	38	0	0	0	0	0	0	0	8	0	3	4	1	2	2	0	0	0	0	0	0	0	**0**
		Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		S Tomé e Príncipe	25	28	33	36	35	33	30	32	32	32	32	9	21	26	66	68	70	72	74	76	78	81	11	10	13	5	88	34	109	75
		Senegal	0	9	0	2	5	0	0	0	11	24	32	11	1	5	91	114	61	41	64	164	45	72	10	82	39	25	21	358	73	332
		South Africa	0	0	0	0	0	0	0	0	1	4	0	0	0	0	2	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0
		St Vincent and Grenadines	2	2	2	1	1	0	1	0	0	20	0	0	0	0	1	3	2	1	0	0	2	0	0	0	2	2	1	2	2	**0**
		Trinidad and Tobago	2	16	28	14	50	16	20	51	17	16	9	11	7	14	16	34	26	22	25	46	48	48	35	19	0	0	0	0	1	**0**
		UK-Bermuda	11	15	15	15	3	5	1	2	2	2	2	2	2	2	2	2	0	1	2	2	3	3	3	2	1	2	1	1	1	1
		UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		UK-Sta Helena	0	0	2	2	1	2	4	4	3	4	1	1	2	2	3	4	2	2	2	12	2	1	1	0	0	0	0	0	0	**0**
		UK-Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		USA	80	88	43	43	46	50	37	24	16	17	19	26	16	17	9	13	6	4	6	14	9	1	9	19	13	20	17	17	22	22
		USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Uruguay	0	3	1	1	26	23	0	0	0	1	5	3	2	8	5	0	6	1	0	0	0	0	0	0	0	0	0	0	0	**0**
		Venezuela	86	122	117	148	142	226	240	125	84	88	120	101	160	172	222	130	120	151	116	143	111	139	150	185	194	125	148	125	121	72
	NCC	Chinese Taipei	685	663	467	660	1478	578	486	485	240	294	319	315	151	99	233	148	195	153	199	133	78	62	61	75	73	74	40	70	76	40
		Costa Rica	0	0	0	0	0	0	3	2	2	0	0	2	1	3	2	11	9	12	19	14	19	34	53	48	74	35	27	15	24	11
		Guyana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	128	39	75	**0**
	NCO	Benin	6	5	5	5	5	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Cuba	69	39	85	43	53	12	38	55	56	34	3	4	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Dominica	0	0	0	0	0	0	0	0	64	69	75	36	44	55	58	106	76	76	60	0	0	85	62	49	74	52	45	64	54	54

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
		Dominican Republic	0	0	0	0	41	71	29	23	23	115	207	142	30	38	47	67	60	65	100	98	99	96	73	170	0	0	0	0	0	
		Jamaica	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Mixed flags (FR+ES)	146	133	126	96	82	80	83	147	151	131	148	171	150	136	135	139	164	178	186	181	191	173	176	0	0	0	0	0	0	
		NEI (BIL)	0	0	0	0	0	0	0	53	184	258	167	89	7	160	209	205	177	0	34	0	0	0	0	0	0	0	0	0	0	
		NEI (ETRO)	174	326	362	435	548	803	761	492	274	17	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	8	12	0	2	5	4
		Sta Lucia	0	0	0	0	4	1	0	10	5	9	18	17	21	53	46	70	72	58	64	119	99	111	53	91	134	93	82	78	61	85
		Togo	0	0	0	0	23	0	73	53	141	103	775	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Ukraine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Vanuatu	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	7	8	6	3	2	0	0	0	0	0	0	0	
Landings(FP)	CP	EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19
		EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
Discards	CP	Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
		Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	1	0	**0**
		EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	1	4	3	5	7	6	0	0	2	0	**0**
		EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	0	0	6	11	12	9	5	5	8
		Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	2	0	**0**
		Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	8	16	9	2
		Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	1	0	0	0	0	0	0	**0**
		Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	2	0	**0**
		UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		USA	127	111	153	197	139	52	83	60	25	49	19	35	25	36	42	38	42	19	50	39	55	53	81	25	47	22	24	20	9	18
	NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	24	27	26	16	22	21	20	18

BUM-Table 2. Kobe II matrices for Atlantic blue marlin giving the probability that $F<F_{MSY}$, $B> B_{MSY}$ and the joint probability of $F<F_{MSY}$ and $B>B_{MSY}$, between 2019 and 2028, with various constant catch levels based on Bayesian Surplus Production model and stock synthesis model base case model results.

a) Probability that $F<F_{MSY}$.

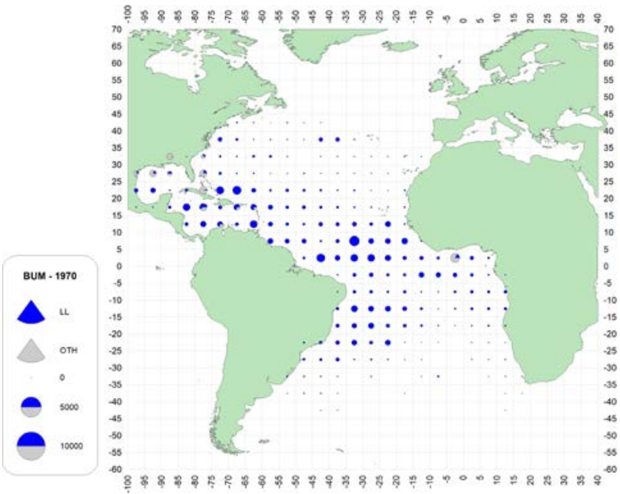
Catch (t)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
0	100	100	100	100	100	100	100	100	100	100
1000	98	98	98	98	98	98	98	98	98	98
1250	92	93	93	93	93	94	94	94	94	94
1500	84	85	85	86	87	87	87	88	88	89
1750	73	74	76	77	78	79	80	80	80	81
2000	60	62	64	66	67	69	70	71	72	73
2250	45	48	51	53	55	57	58	59	61	62
2500	33	36	38	40	42	44	46	48	49	51
2750	23	25	27	29	31	32	34	35	37	39
3000	15	17	18	20	21	23	24	26	27	30
3250	9	10	10	11	12	13	15	17	19	22
3500	6	7	7	7	9	10	12	14	17	19

b) Probability that $B>B_{MSY}$.

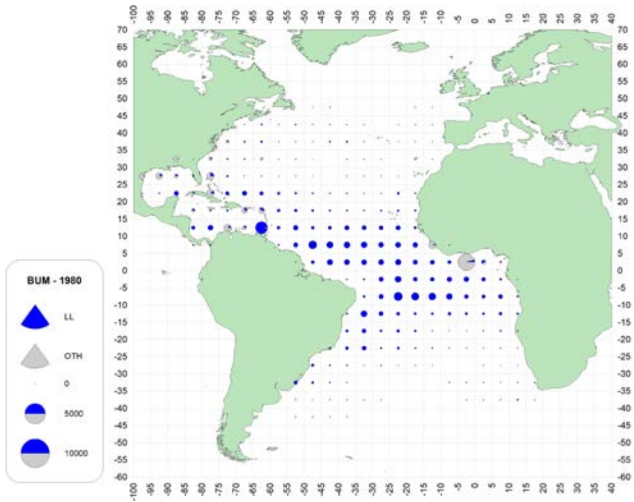
Catch (t)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
0	11	21	34	47	59	68	75	80	84	86
1000	11	18	26	35	43	51	57	63	68	71
1250	11	16	24	31	39	46	52	57	61	66
1500	11	16	22	28	34	40	46	51	56	60
1750	11	15	20	26	31	36	41	46	49	53
2000	11	14	19	24	28	32	36	40	43	46
2250	11	14	17	21	24	27	31	34	37	39
2500	11	13	16	18	21	24	27	29	31	33
2750	11	12	14	17	18	20	21	23	24	26
3000	11	12	13	14	16	17	18	19	19	20
3250	11	11	12	12	13	14	14	14	15	15
3500	11	11	11	11	11	11	11	11	11	11

c) Probability that $F<F_{MSY}$ and $B>B_{MSY}$.

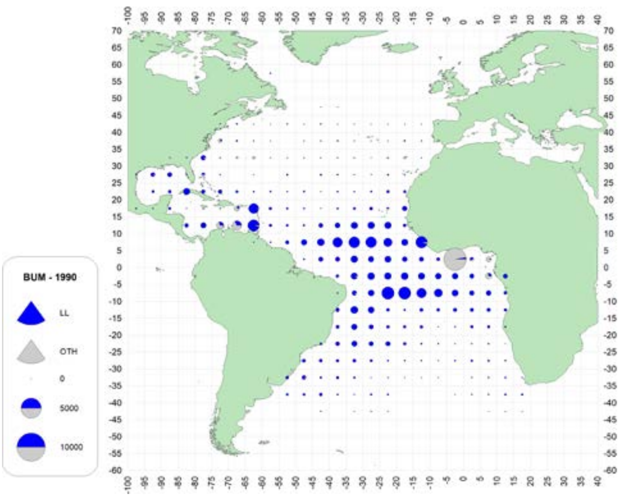
Catch (t)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
0	11	21	34	47	59	68	75	80	84	86
1000	11	18	26	35	43	51	57	63	68	71
1250	11	16	24	31	39	46	52	57	61	66
1500	11	16	22	28	34	40	46	51	56	60
1750	11	15	20	26	31	36	41	46	49	53
2000	11	14	19	24	28	32	36	40	43	46
2250	11	14	17	20	24	27	31	34	36	39
2500	11	13	15	18	20	23	26	28	30	32
2750	11	12	13	15	17	19	20	22	23	25
3000	11	10	12	12	14	15	16	17	18	18
3250	9	8	8	9	10	10	11	11	12	12
3500	6	6	6	6	7	7	7	7	8	8



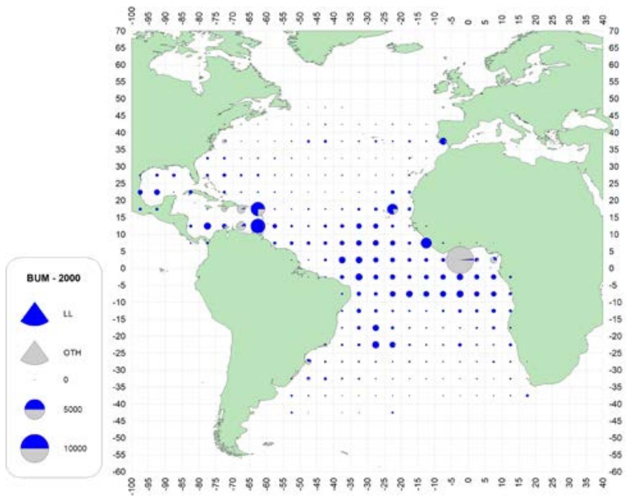
a. BUM (1970-79)



b. BUM (1980-89)

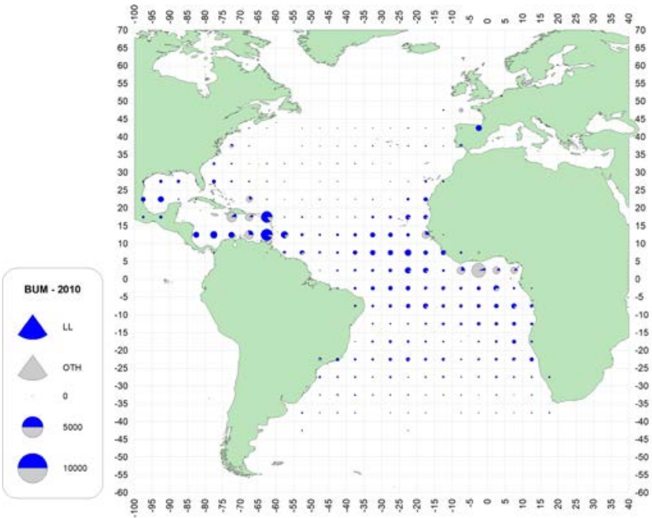


c. BUM (1990-99)

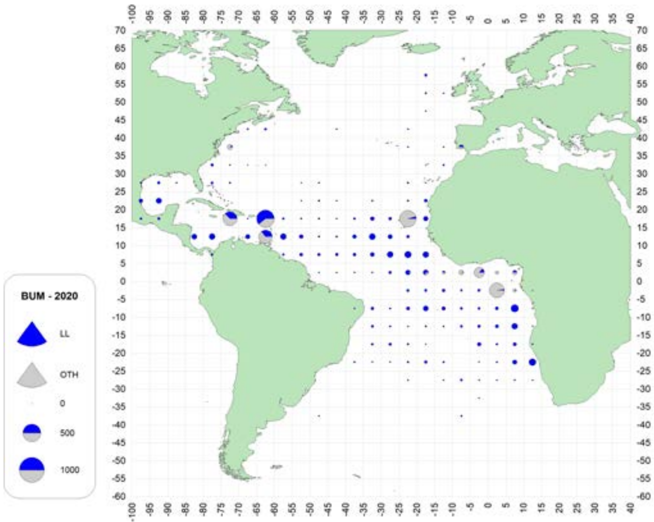


d. BUM (2000-09)

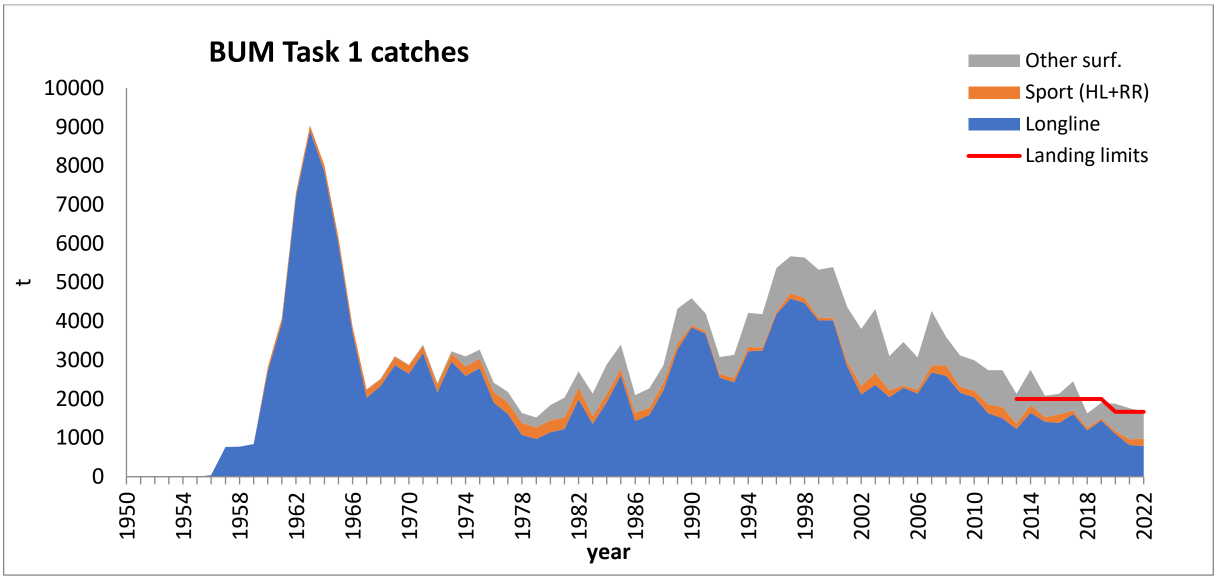
BUM-Figure 1. Geographic distribution of blue marlin total catches by decade (last decade only covers 2 years).



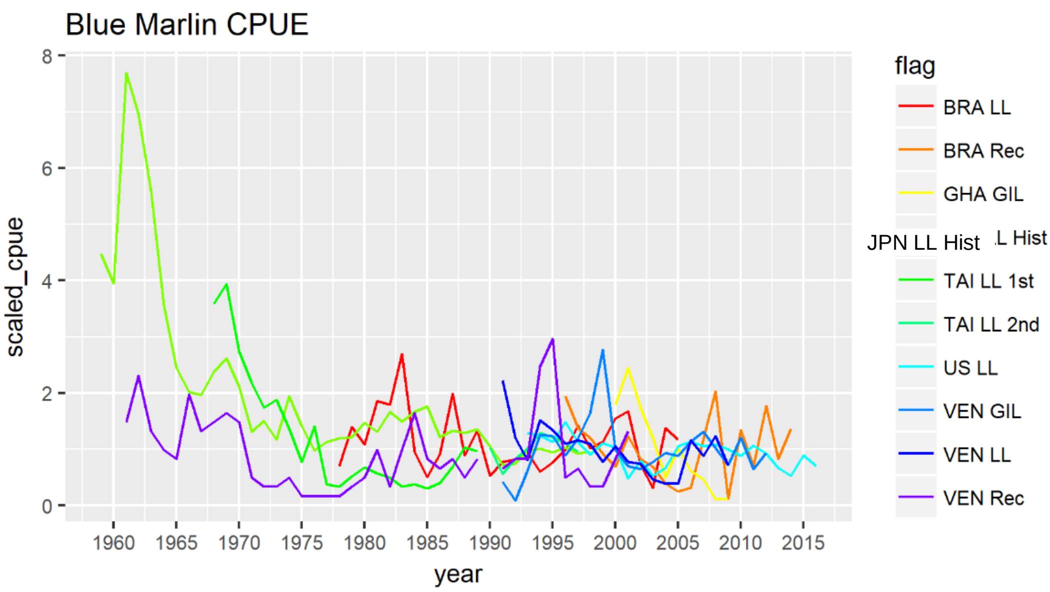
e. BUM (2010-19)



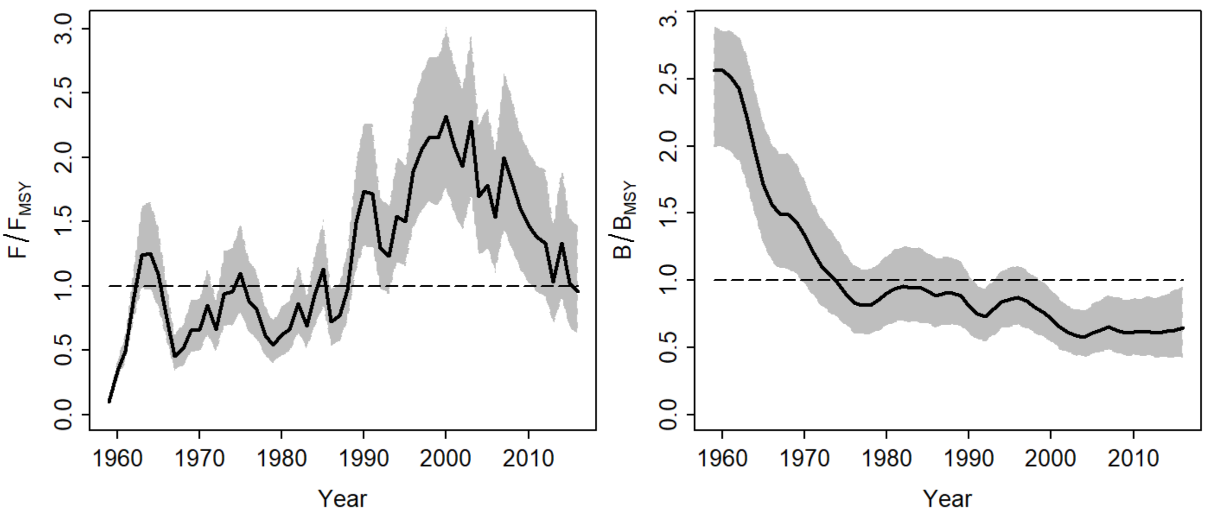
f. BUM (2020-21)



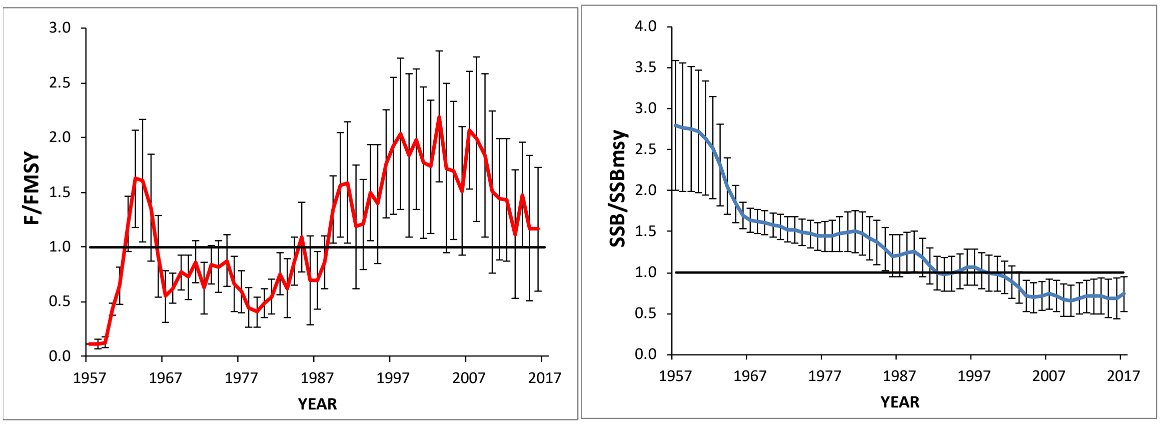
BUM-Figure 2. Atlantic blue marlin (*Makaira nigricans*) Task I catches (landings + dead discards) (t) by gear type between 1950 and 2022.



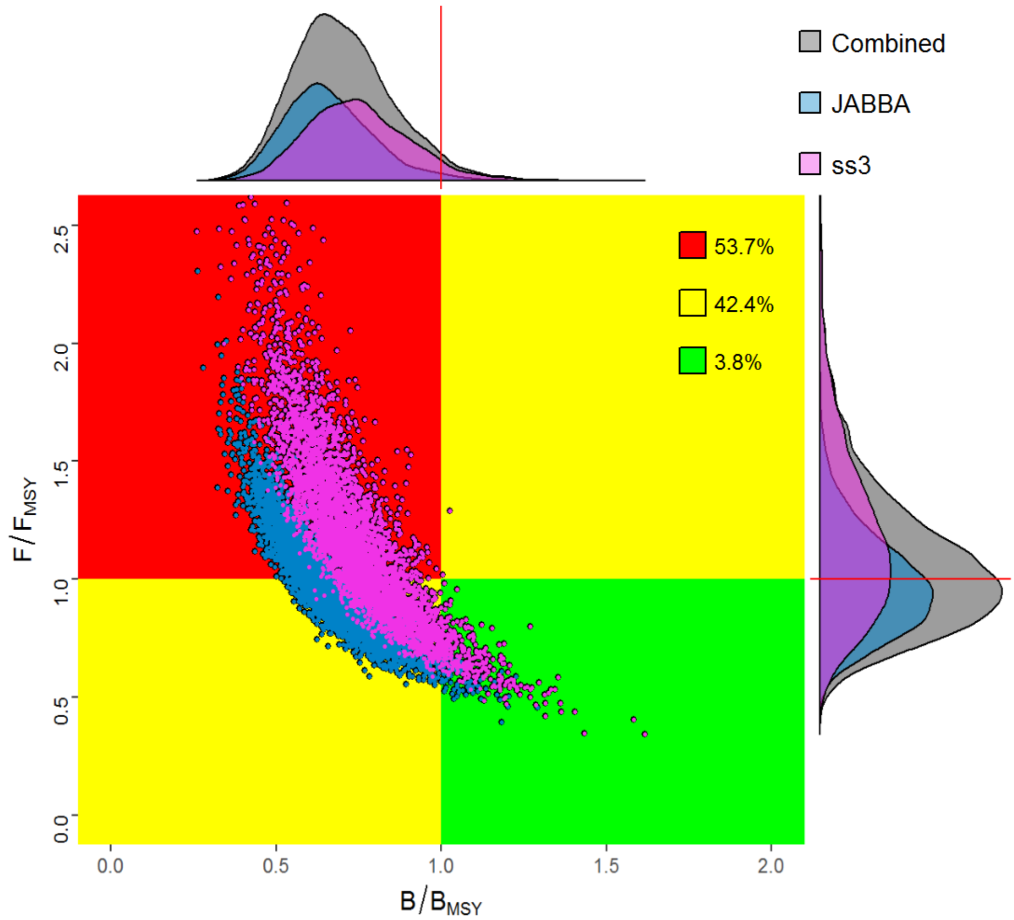
BUM-Figure 3. Plot of the indices of abundance used in the 2018 blue marlin stock assessment.



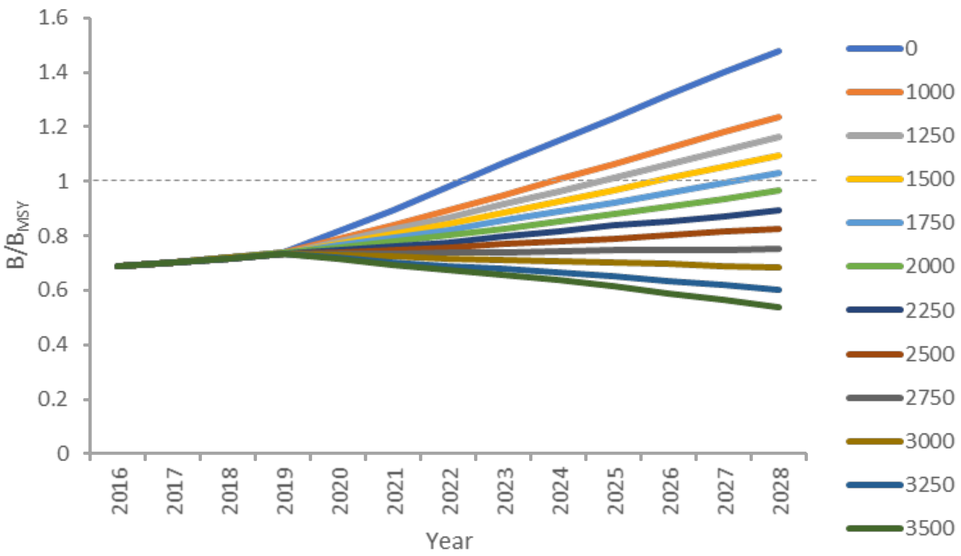
BUM-Figure 4.1. Trends in harvest rate relative to F_{MSY} and biomass relative to B_{MSY} for the Bayesian surplus production model (JABBA) fits to Atlantic blue marlin. Shaded grey area indicates 95% C.I.



BUM-Figure 4.2. Trend in SSB/SSB$_{MSY}$ and F/F$_{MSY}$ for the stock synthesis model, including approximate 95% confidence intervals.



BUM-Figure 5. Combined Kobe plots for the final base cases of Bayesian Surplus Production model (JABBA, blue) and Stock Synthesis model (SS3, pink) models for the Atlantic blue marlin.



BUM-Figure 6. Combined results of projections of B/B_{MSY} for Atlantic blue marlin for both the stock synthesis model and Bayesian Surplus Production model base case models under different constant catch scenarios.