9 Horse Mackerel in Division 9.a (Atlantic Iberian waters)

9.1 ACOM Advice Applicable to 2022, STECF advice and Political decisions

The fishing mortality (F) has been below F_{MSY} over the Bwhole time-series and the spawning–stock biomass (SSB) is above MSY $B_{trigger}$, relatively stable over the entire time-series and with a steep increase in the last years. Recruitment (R) in 2011–2020 has been above the time-series average.

The ICES advice was based on the MSY approach with a revised $F_{MSY} = 0.15$. ICES therefore recommended that catches in 2022 should not exceed 143 505 t. ICES also recommended that the TAC for this stock should only apply to *Trachurus trachurus*. The TAC of 143 505 t in 2022 has been set for *Trachurus spp*.

In 2019 and 2020 the Portuguese survey was not carried out. Because this survey represents 87% of the total coverage and traverses the majority of the stock area, the combined survey index could not be estimated. The assessment was performed without fishery-independent data. Estimated recruitment since 2018 is considered uncertain.

There has been a continued and significant shift in relative catch contribution from bottom trawls to purse-seines in the last few years. This has led to a change in the age composition of catches, with an increase in the proportion of age-1 individuals. This may lead to inconsistency in estimating selectivity in the last period of the assessment.

9.2 The fishery in 2021

9.2.1 Fishing fleets in 2021

The southern horse mackerel fisheries in Division 9.a are composed by six fleets. These fleets are defined by the gear type (bottom trawl, purse-seine and artisanal) and country (Portugal and Spain). Portuguese bottom-trawl and purse-seine fleets and Spanish purse-seine fleet show a similar exploitation pattern with a great presence of juveniles and lesser abundance of adults. In the last years the Spanish purse-seine fleet had a significant increase of individuals from ages 1 and 2 in the catches. In 2021 overall landings and catches-at-age 1 from the Spanish purse-seine fleet decreased. Portuguese purse-seiners had an increase in catches for 2021. The Portuguese artisanal fleet is mainly composed by small size vessels licensed to operate with several gears (gill and trammelnets, purse-seine and lines). Catches of horse mackerel from the Portuguese artisanal fleet are mainly from trips operating with nets showing the presence of larger/adult fish while the catches from trips operating with purse-seine show the presence of small/juveniles. The Spanish bottom trawl fleet catches mainly adults and also showed a decrease in 2021. Horse mackerel is one of the main target species in the Portuguese bottom trawl fleet, in 2021 accounted for 43% of the Portuguese catches, while purse-seine accounted for 50%. In Spain main catches are from the purse-seine fleet (87%). Portuguese catches from the artisanal fleet are very small (7%) and Spanish artisanal fishery is negligible (2%). In recent years, and due to the lower catch opportunities for the Iberian sardine stock (pil27.8c9a), the relative importance in the annual catches of the purse-seine fleet has increased. Description of the Portuguese and Spanish fleets is available in Stock Annex.

9.2.2 Catches by fleet and area

The catches of horse mackerel in Division 9.a comprise the following four subdivisions: 9.aNorth (9.a.n: Spain - Galicia), 9.aCentral-North (9.a.c.n: Portugal – Caminha to Figueira da Foz), 9.aCentral-South (9.a.c.s: Portugal – Nazaré to Sines) and 9.aSouth (9.a.s: Portugal – Sagres to V. Real Santo António) and are allocated to the Southern horse mackerel stock (hom.27.9a). The definition of the ICES subdivisions was set in 1992 and some of the previous catch statistics came from an area that comprises more than one subdivision. In the years before 2004 the catches from Division 8.c were also considered to belong to the southern horse mackerel stock. These catches were removed from previous total catches to obtain the current historical series of stock catches. Previous catch statistics came from areas as the Galician coasts that comprised more than one subdivision, the Subdivision 8.c West and Subdivision 9.a North and that is the reason why the time-series of catch statistics used in the assessment of southern stock is from 1992 onwards. Although Portuguese catches are available since 1927, in the case of Spanish catches the allocation of catches to Subdivision 9.a North and Subdivision 8.c West before 1992, has not yet been possible (Figure 9.2.2.1). Spanish catches from the Gulf of Cádiz (Subdivision 9.a.s) are available since 2002 but they are scarce, representing less than the 1% of the total catch and, therefore, are not included in the assessment to avoid a possible bias in the assessment results.

The catch time-series used in the assessment (1992–2021) shows a peak in 1998, of 41 564 t, a steady increase since 2011 to 2016 and a decrease was observed in 2021 with catches of 26 745 t (Table 9.2.2.1, Figure 9.2.2.2). The minimum catch, of 18 887 t, was observed in 2003. The relative contribution of each gear to the total catch is given in Table 8.2.2.2. Until 2011 the highest contribution to the total catches was, in general, from the trawl fleets. Since 2012 there has been a significant increase in the catches from the purse-seine. The Spanish purse-seine contributions to catches remained high but decreased from last year (-36%). Catches from the Spanish bottom trawl are relatively low and decreased 58% from 2020 to 2021. Catches from the Portuguese purse-seine has a significant 75% increase and bottom trawl decreased in 18% from 2020 to 2021. The contribution of the artisanal fleet from both Portugal and Spain is very small and in 2021 decreased 4% and 47%, respectively, when compared to 2020.

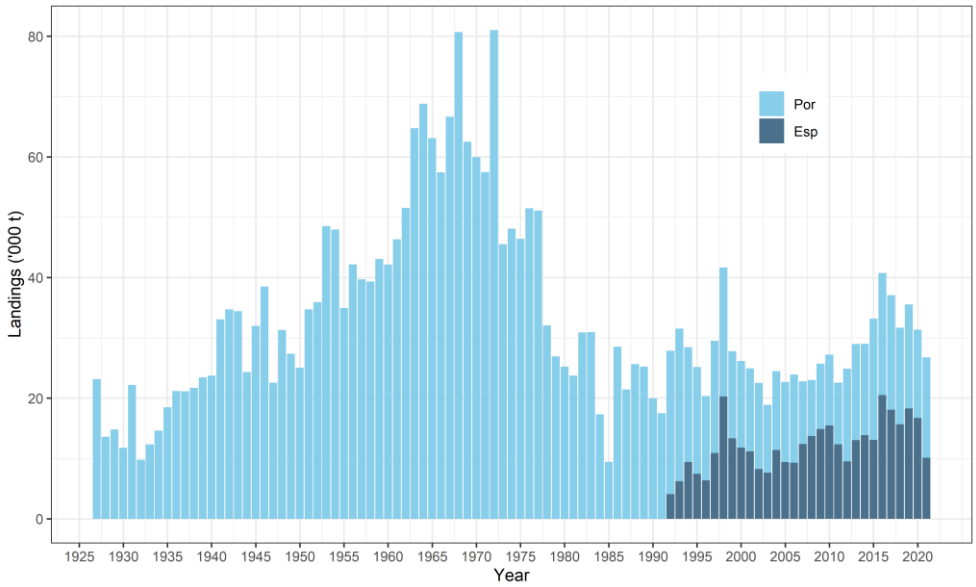


Figure 9.2.2.1. Horse mackerel in Division 9.a. Historical time-series of landings (1927-2021) for southern horse mackerel (Div. 27.9.a). Light blue bars are Portuguese landings and dark blue bars are Spanish landings.

Table 9.2.2.1. Horse mackerel in Division 9.a. Time-series of southern horse mackerel historical catches (in tonnes).

Year	Total Catch
1991	34,992
1992	27,858
1993	31,521
1994	28,4411
1995	25,147
1996	20,4001
1997	29,491
1998	41,564
1999	27,733
2000	26,160
2001	24,910
2002	22,506 // (23,663)*
2003	18,887 // (19,566)*
2004	23,252 // (23,577)*
2005	22,695 // (23,111)*
2006	23,902 // (24,558)*
2007	22,790 // (23,424)*
2008	22,993 // (23,593)*
2009	25,737 // (26,497)*
2010	26,556// (27,216)*
2011	21,875// (22575)*
2012	24,868//(25316)*
2013	28,993//(29,382)*
2014	29,017//(29,205)*
2015	32,723///(33,178)*
2016	40,741////(41,081)*
2017	36,946///(37,088)*
2018	31,661///(31,920)*

Year	Total Catch
2019	35,520///(36,536)*
2020	30,177///(31,344)*
2021	26,320///(26,745)*

(*) In brackets: the Spanish catches from Subdivision 9a South are also included. These catches are only available since 2002 and are not included in the assessment data until the rest of the time-series is completed.

(1) These figures have been revised in 2008.

Table 9.2.2.2. Horse mackerel in Division 9.a. Southern horse mackerel landings by gear in the period 1992–2021 (in tonnes and in percentage, showing the contribution of each gear to total landings).

Year	Bottom trawl	Purse-seine	Artisanal
1992	14,651	9,763	3,445
	52.6%	35.0%	12.4%
1993	20,660	7,004	3,841
	65.6%	22.2%	12.2%
1994	13,121	12,093	3,202
	46.2%	42.6%	11.3%
1995	15,611	7,387	2,137
	62.1%	29.4%	8.5%
1996	13,379	5,727	1,228
	65.8%	28.2%	6.0%
1997	14,576	13,161	1,800
	49.3%	44.6%	6.1%
1998	16,943	22,359	2,287
	40.7%	53.8%	5.5%
1999	10,106	15,781	1,855
	36.4%	56.9%	6.7%
2000	12,697	11,237	2,227
	48.5%	43.0%	8.5%
2001	12,226	11,048	1,637
	49.1%	44.3%	6.6%
2002	12,307	8,230	1,969
	54.7%	36.6%	8.7%
2003	10,116	6,523	2,248
	53.6%	34.5%	11.9%
2004	16,126	5,700	2,658
	65.9%	23.3%	10.9%
2005	14,029	6,040	2,621
	61.8%	26.6%	11.6%

Year	Bottom trawl	Purse-seine	Artisanal
2006	15,019	5,430	3,445
	62.9%	22.7%	14.4%
2007	13,705	6,775	2,308
	60.1%	29.7%	10.1%
2008	12,380	7,670	2,949
	53.8%	33.3%	12.8%
2009	15,075	6,669	3,984
	58.6%	25.9%	15.5%
2010	16,062	6,847	4,308
	59.0%	25.2%	15.8%
2011	11,038	7,301	3,530
	50.40%	33.30%	16.40%
2012	7,839	12,897	4,579
	30.97%	50.95%	18.09%
2013	9,221	16,774	2,687
	33.77%	57.09%	9.14%
2014	12,573	14,114	2,330
	43.33%	48.64%	8.03%
2015	13,310	16,937	2,932
	40.12%	51.05%	8.84%
2016	19,172	19,083	2,485
	47.06%	46.84%	6.10%
2017	16,931	18,038	2,120
	45.65%	48.64%	5.72%
2018	9,824	20,187	1,651
	31.03%	63.76%	5.21%
2019	9,542	24,190	1,788
	26.86%	68.10%	5.03%
2020	10,961	17,588	1,617
	36.34%	58.31%	5.36%

Year	Bottom trawl	Purse-seine	Artisanal
2021	8,074	16,869	1,378
	30.68%	64.09%	5.23%

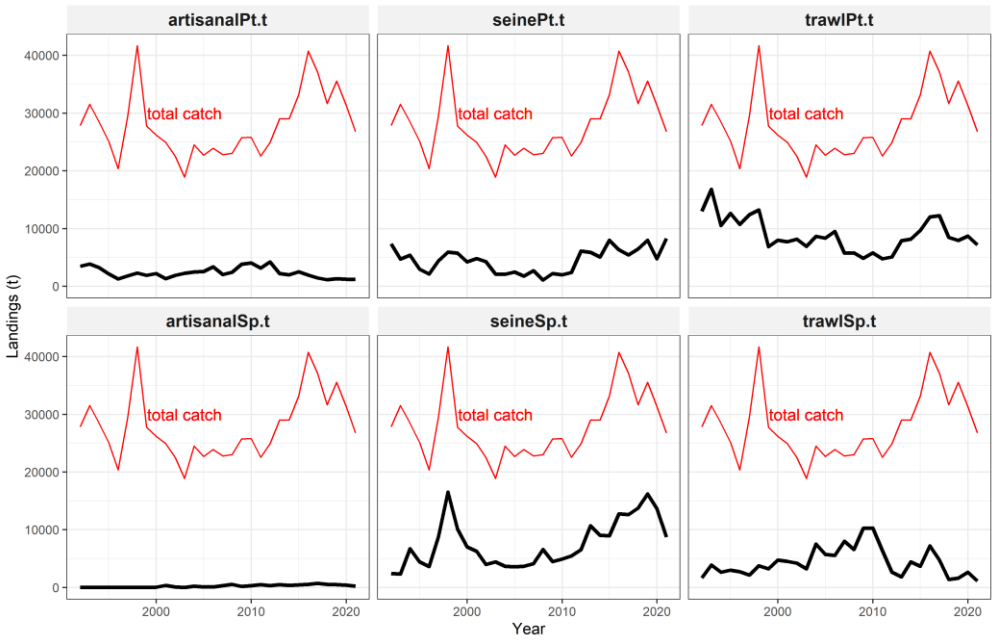


Figure 9.2.2.2. Horse mackerel in Division 9.a. Time-series (1992-2021) of southern horse mackerel catches (in tonnes) by country (Pt – Portugal; Sp – Spain) and gear (artisanal; purse-seine, trawl).

Discards are estimated by both countries (Portugal since 2014, Spain since 2003) from national at-sea sampling programme (DCF) on board commercial vessels operating in ICES Division 9a. Discards for this species are usually very low and not frequent thus being considered negligible. The frequency of occurrence of horse mackerel discards is too low and is considered zero because such low frequency will result in highly biased estimates (Portuguese discards are usually estimated when frequency of species occurrence is above 30%). The horse mackerel Spanish discards come mainly from the bottom trawl fleet operating in ICES subdivision 27.9.a.s (253.7 t), the total discards from the Spanish fleets were estimated at 262 t.

Table 9.2.2.3. Horse mackerel in Division 9.a. Discard estimates (tonnes) of southern horse mackerel in 2021 by country (SP – Spain, PT - Portugal), fleet/métier, ICES subdivision and quarter.

Country	Fleet	Metier	Fishing Area	Quarter_1	Quarter_2	Quarter_3	Quarter_4	Total
SP	artisanal	GNS_DEF_80-99_0_0	27.9.a.n	0.0	0.2	0.0	0.0	0.2
SP	trawl	OTB_DEF_>=55_0_0	27.9.a.n	1.0	0.0	0.0	1.2	2.2
SP	trawl	OTB_MPD_>=55_0_0	27.9.a.n	0.0	5.1	0.0	0.0	5.1
SP	trawl	PTB_MPD_>=55_0_0	27.9.a.n	0.0	0.1	0.0	0.0	0.1
SP	trawl	OTB_MCD_>=55_0_0	27.9.a.s	139.0	40.3	32.0	42.3	253.7
SP	purse seine	PS_SPF_0_0_0	27.9.a.s	0.0	0.0	0.0	0.7	0.7
PT	trawl	OTB_CRU_>=55_0_0 (Loa >=12m)	27.9.a	0.0	0.0	0.0	0.0	0.0
PT	trawl	OTB_DEF_>=55_0_0 (Loa >=24m)	27.9.a	0.0	0.0	0.0	0.0	0.0

9.2.3 Effort and catch per unit of effort

A preliminary CPUE (catch per unit effort) is being developed using data from the Portuguese trawl logbooks provided by the Portuguese fisheries administration (Directorate-General for Natural Resources, Safety and Maritime Services – DGRM) for the period 1992-2021. This study estimated a Nominal CPUE and a standardized CPUE for horse mackerel using a Tweedie Generalized Linear Model to handle the null observations and improve the abundance indices available for this stock. This index still needs evaluation under the ICES benchmark procedures. Currently, no series of catch per unit of effort (CPUE) is available to be used for stock assessment.

9.2.4 Catches by length and catches-at-age

Sampling method for the catches by length is described in the Stock Annex. Catch-at-age data have been obtained by applying a semester ALK to each of the catch length distribution estimated by fleet segment (bottom trawl, purse-seine and artisanal) and country from the samples of each subdivision. The catch in numbers-at-age used in the assessment is the combined Portuguese and Spanish catch-at-age from 1992–2021, with age range 0–11+.

In general, catches are dominated by juveniles and young adults in the available time-series (1992-2021). Catches-at-age-1 had a significant decrease in 2021 probably resulting from the steep decrease in Spanish purse-seine catches (Table 9.2.4.1, Figure 9.2.4.1 and Figure 9.2.4.2).

Table 9.2.4.1. Horse mackerel in Division 9.a. Southern horse mackerel catch-at-age data in the period 1992–2021 (thousands).

	AGES											
YEAR	0	1	2	3	4	5	6	7	8	9	10	11+
1992	11684	95186	145732	40736	12171	9102	5018	6864	5155	4761	13973	14354
1993	6480	66211	137089	100515	35418	13367	12938	10495	6597	5552	4497	14442
1994	12713	63230	86718	96253	28761	7628	4398	3433	5209	4834	6047	12264
1995	7230	55380	31265	52030	28199	11010	4003	3139	2720	3352	2530	31343

	AGES											
1996	69651	13798	14021	28125	33937	9861	6611	4501	4164	5504	3306	14243
1997	5056	295329	112210	26236	17168	12886	7780	7169	3938	3867	2425	8847
1998	22917	95950	320721	68438	18770	11317	9712	20627	12760	6686	6212	11323
1999	51659	29795	26231	66704	42960	15700	13840	7555	4175	4790	2475	7417
2000	12246	72936	23547	41618	35968	18643	17254	12118	7915	5227	3124	3557
2001	105759	77364	31261	24104	23721	16794	15391	14964	9795	3310	2023	3989
2002	18444	94402	84379	26482	13161	11396	10263	12501	10156	7525	3607	4433
2003	40033	6830	36754	28559	21931	12790	14751	13582	10631	6492	3531	2333
2004	7101	126797	58054	18243	8328	13586	11836	14878	10542	3876	5258	5318
2005	21015	108070	49197	24289	17877	11334	11179	7927	9124	7445	5502	11420
2006	3329	92563	92896	22665	6738	13176	11892	6029	7303	8070	8947	15322
2007	2885	16419	27667	44357	20534	8187	4459	3563	5975	4748	4943	30001
2008	48380	54167	31951	28058	16616	7194	4782	3660	4579	3975	4537	24990
2009	22618	85415	32416	8482	9774	7162	3289	2860	2791	3579	4236	39096
2010	81048	102016	33906	17496	11979	7569	3847	3942	2452	2671	2977	32284
2011	85973	23285	20987	19082	15047	7199	4272	3511	2885	5250	4639	22097
2012	201691	119136	30060	13964	14547	7693	5322	4373	2731	3218	4373	14562
2013	35849	123495	109557	30511	17468	9670	4085	3600	3123	2763	2488	17864
2014	22723	51727	89258	37772	18645	5573	2493	2899	1886	2137	2533	17588
2015	66497	92922	49067	50211	45753	16675	10529	5163	4253	4730	5149	13182
2016	15223	116079	122297	49145	28523	31170	14561	15087	11210	5823	7138	20703
2017	25212	192125	75227	48553	31124	12862	7701	9156	10323	4694	4846	19138
2018	71977	182113	69396	52508	26314	12485	11555	6753	6050	3463	2517	4554
2019	27706	146270	116225	48796	20638	25280	11293	9325	7943	4022	5208	4361
2020	18471	143836	57686	58352	24715	18078	8181	8553	5985	7025	3035	9365
2021	26901	60128	48825	46934	39919	17747	9263	6191	5077	10801	7100	8451

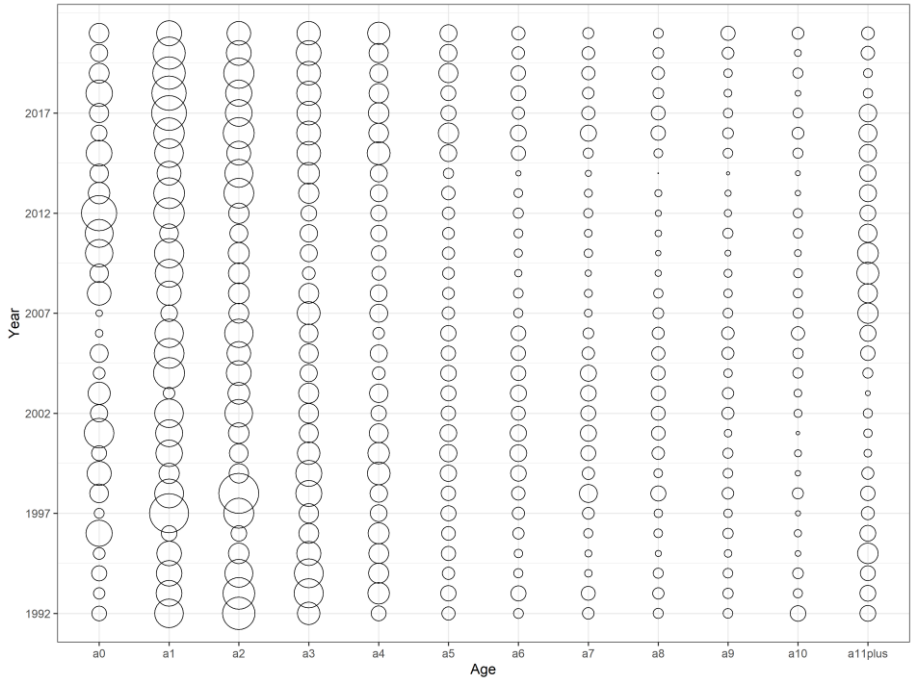


Figure 9.2.4.1. Horse mackerel in Division 9.a. Bubble plot of proportions of southern horse mackerel catch in numbers-at-age in each year (1992–2021).

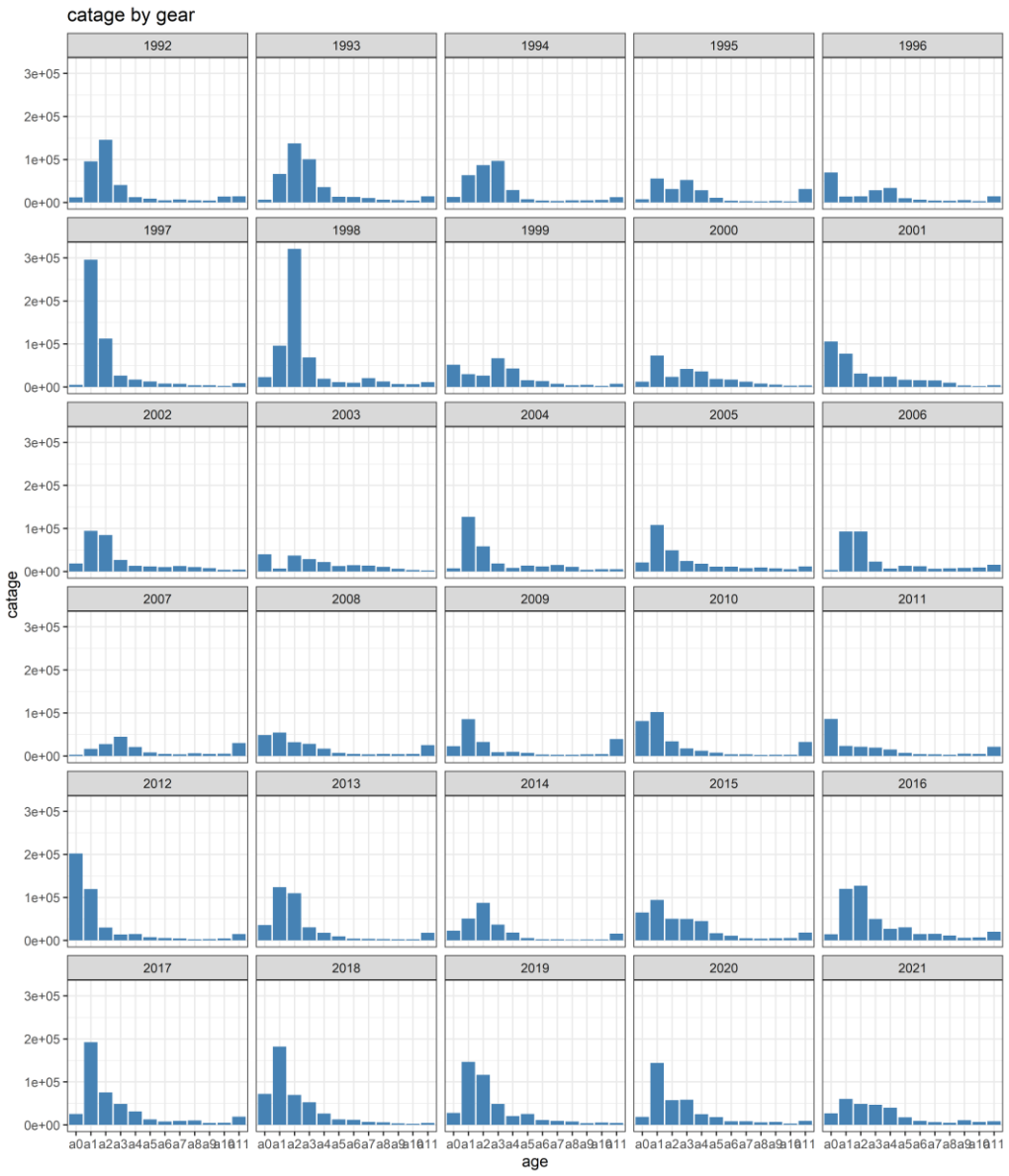


Figure 9.2.4.2. Horse mackerel in Division 9.a. Catch in numbers-at-age in each year (1992–2021).

Table 9.2.4.2 presents the southern horse mackerel catch in numbers-at-age by fishing fleet and Figure 9.2.4.2 shows the proportion of catch-at-age by fleet and country in the period 1992–2021. The Portuguese and Spanish purse-seine fleet and the Portuguese trawl and artisanal fleets caught mainly juveniles and young adults. In 2021, the catch-at-age 1 showed a significant decrease resulting from the lower catches observed in the Spanish purse-seine fleet and a slight increase in age 0 from the Portuguese purse-seine fleet and artisanal fleet (mainly from the "tucas", small seiners from the Portuguese artisanal polyvalent fleet). The pattern for the remainder of ages is similar to other years.

Table 9.2.4.2. Horse mackerel in Division 9.a. Southern horse mackerel catch in numbers-at-age (thousands) by fleet (bottom trawl, purse-seine and artisanal) in the period 1992–2021.

Bottom trawl												
	AGES											
YEAR	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**
1992	98	8739	40094	78016	28660	10904	10401	8174	5166	3923	3319	9412
1993	3413	16252	37679	55079	16322	3926	2138	1559	2530	2200	2207	5223
1994	3917	12983	18292	22807	11447	5375	2541	2280	2299	2739	2138	25610
1995	30763	10340	10123	19245	23331	6326	4524	3063	2772	3245	2211	8611
1996	2828	180543	68330	15055	7846	4536	2087	1216	811	801	608	4360
1997	4444	36544	205609	32994	7151	3427	2487	3562	3100	2418	2724	7225
1998	28176	11492	16059	23745	8653	2914	3643	2570	1650	1932	1614	5525
1999	1106	35946	13685	18085	10763	7890	9180	7657	5546	4146	2544	2516
2000	39871	25245	10861	9401	8291	6329	8686	10261	7644	2630	1556	2606
2001	3572	59041	49402	12288	4796	4461	5100	7280	6068	5197	2671	3156
2002	14581	2077	18079	12556	13025	7525	7410	6940	6045	3966	2255	1526
2003	1352	77529	44171	12649	4758	9114	7787	9616	6875	2366	3823	3958
2004	2956	50643	30389	15100	12246	6636	6997	6190	7047	5546	3710	6705
2005	1666	59477	61175	14915	3798	9822	9492	3762	3871	4302	4908	9981
2006	19	2444	14853	31470	10967	2932	1983	1461	2681	2644	3135	21375
2007	5512	12787	21078	21828	10408	2984	1695	1166	1918	1678	2373	16881
2008	4552	19630	14558	5033	4758	4463	1581	1070	1183	1830	2579	27993
2009	10832	46074	15193	11434	6888	3661	1723	1728	1417	1531	1897	25218
2010	5984	3440	9440	9357	6696	2999	1871	1655	1426	3414	2876	16256
2011	7674	20041	14102	4899	4089	1915	2101	1356	987	1094	1799	7586
2012	6928	23225	29279	11222	3625	1573	903	1283	1357	1233	1170	11420
2013	7734	14850	18232	8434	5210	2040	987	1207	888	1072	1726	13972
2014	7845	18476	19923	11544	12206	5060	3228	2033	2411	3671	4417	13825
2015	4707	43326	72194	19569	7265	6349	3562	4339	3125	2623	7008	6134
2016	2461	26151	47865	29405	9083	11260	6151	5604	4336	4022	6322	16970
2017	2044	15323	21678	22423	15581	6110	3779	5644	6386	3311	3584	14874

Bottom trawl												
2018	2622	23258	19042	20477	8998	4346	5413	3186	3190	1885	1351	2775
2019	494	6704	24021	18825	5382	8234	4354	3588	3030	1533	2064	2593
2020	340	12702	19697	19380	7833	5031	3057	3304	2480	4485	2220	7690
2021	2004	10941	10811	14478	12692	4563	2702	2080	2222	4432	2789	3793

Purse-seine												
	AGES											
YEAR	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**
1992	6977	51859	73537	21162	4860	2677	1362	1973	1299	1204	2572	2402
1993	6293	51337	83236	16597	4355	795	512	819	544	862	667	1842
1994	7634	45429	45987	39236	11267	2838	1379	1036	1640	1691	2550	3530
1995	3311	42111	12457	27030	14822	4224	854	445	163	362	217	2247
1996	38888	3446	3801	8189	8955	2917	1621	1107	1022	2003	891	4301
1997	2211	114184	42908	9797	6407	5775	4380	5300	2707	2831	1539	3672
1998	18294	59225	112386	34393	9893	6028	5838	15381	8920	3621	2760	2041
1999	23481	18237	9440	41032	31471	10684	7777	3835	2092	2465	764	1328
2000	11068	35861	8832	22508	23779	9645	5890	2291	876	338	172	231
2001	65468	51105	20260	14164	14394	9020	5035	3008	1170	290	227	644
2002	13660	32185	34516	13604	7895	6041	3804	3510	2435	1141	359	116
2003	22915	4609	17093	15338	7464	3944	5188	3784	2554	1447	675	260
2004	5258	42114	12332	5137	2673	3042	2600	2603	958	489	980	929
2005	17856	56690	18512	8881	5272	3365	2539	799	904	848	600	1026
2006	1637	27295	29845	7133	2103	2210	1506	1225	1638	1804	2037	1514
2007	2863	13802	12416	11231	8019	3800	1912	1712	2799	1667	1323	4186
2008	42868	41050	9766	4672	3729	2223	2138	1918	2063	1877	1707	3544
2009	18016	65130	17157	2736	3551	2078	1139	1206	1041	1168	1136	3200
2010	70206	41433	11571	2766	2058	1531	1038	904	446	377	561	1598
2011	76225	18619	10553	7915	5197	1941	1480	719	315	707	723	1881
2012	193478	96833	12558	5530	7261	3945	1375	1991	1106	1282	1279	1268

Purse-seine												
2013	28908	98794	77552	17612	12427	7287	2665	1692	1196	1033	730	2644
2014	14794	35667	68564	27850	12383	3078	1272	1316	712	699	384	540
2015	56896	73247	28072	34914	28163	10304	6699	2790	1444	860	524	1110
2016	11898	93528	78720	19246	16407	17104	7090	8488	6186	1451	414	876
2017	18888	172613	50320	23723	13874	6068	3386	2839	3275	1080	880	2560
2018	61071	155490	48838	30137	15822	7290	5295	3079	2427	1288	911	1003
2019	22771	130029	88205	28013	14267	15732	6347	5175	4360	2087	2655	1407
2020	14992	127345	34698	35464	15550	12088	4628	4832	3191	1995	508	962
2021	7867	30985	35744	30786	26247	12552	6161	3864	2678	6008	3993	4077
Artisanal												
	AGES											
YEAR	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**
1992	0	0	1	5	45	76	93	553	731	935	4393	5818
1993	89	6135	13760	5902	2402	1668	2025	1501	886	766	511	3187
1994	1666	1549	3052	1939	1171	863	882	839	1039	943	1290	3511
1995	2	286	516	2193	1929	1410	608	415	258	252	175	3485
1996	0	11	97	692	1651	618	465	331	370	255	205	1330
1997	17	602	972	1384	2915	2575	1313	653	420	235	278	814
1998	180	181	2726	1051	1726	1861	1387	1684	740	647	728	2056
1999	2	67	731	1927	2836	2102	2420	1151	433	394	98	564
2000	73	1129	1030	1024	1425	1108	2184	2171	1494	743	408	810
2001	420	1014	140	539	1036	1445	1671	1695	981	390	240	739
2002	1212	3176	461	591	471	895	1358	1711	1653	1187	578	1161
2003	2537	144	1581	665	1442	1320	2152	2858	2032	1079	601	547
2004	491	7154	1552	457	897	1429	1449	2659	2709	1021	455	431
2005	203	738	295	308	359	1332	1643	938	1174	1051	1193	3689
2006	26	5790	1875	617	837	1144	894	1041	1793	1964	2002	3826
2007	3	173	398	1656	1548	1456	563	390	496	438	486	4440
2008	0	330	1108	1557	2479	1987	948	576	599	420	456	4564

Purse-seine												
2009	49	654	701	713	1465	621	569	585	567	581	521	7903
2010	10	14509	7141	3295	3033	2378	1087	1309	589	763	519	5469
2011	3764	1226	992	1810	3153	2258	920	1137	1144	1126	1039	3156
2012	539	2263	3401	3535	3197	1833	1846	1026	637	843	1295	5708
2013	14	1477	2726	1677	1416	810	516	625	570	497	588	3800
2014	0	73	178	221	350	275	155	195	164	208	242	1399
2015	103	2468	2215	3186	4380	1564	773	404	449	378	424	3072
2016	69	200	520	1265	1511	2037	1391	1164	802	410	453	2431
2017	4280	4189	3229	2407	1669	683	537	673	663	302	382	1704
2018	8284	3365	1516	1894	1495	849	847	488	433	291	255	776
2019	4441	9536	3999	1959	989	1314	591	562	553	402	488	361
2020	3138	3789	3291	3508	1332	959	496	417	315	545	306	713
2021	17031	18202	2270	1670	980	632	400	247	177	361	317	582

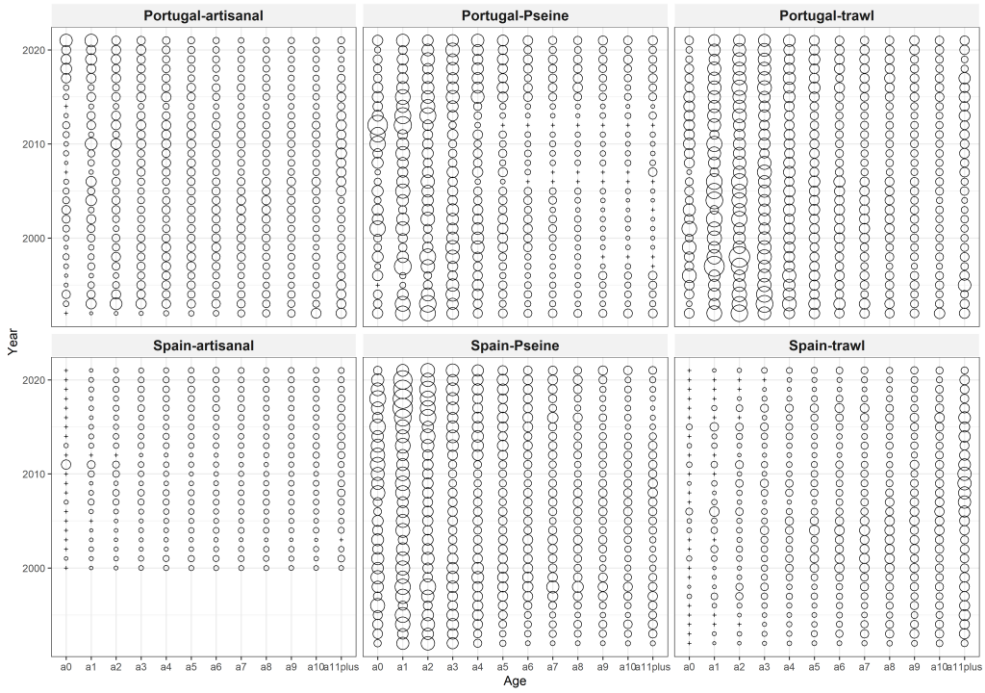


Figure 9.2.4.2. Horse mackerel in Division 9.a. Bubble plot of proportions of southern horse mackerel catch in numbers-at-age by country and fleet in each year (1992-2021).

9.2.5 Mean weight-at-age in the catch

Detailed information on the way to calculate mean weight-at-age and mean length-at-age is provided in the Stock Annex. Tables 9.2.5.1 and 9.2.5.2 show the mean weight-at-age in the catch and the mean length-at-age in catch, respectively, from 1992 to 2021.

The mean weight-at-age is of a similar magnitude to previous years in all ages with a slight decrease in the age 11+ plus group (Figure 9.2.5.1, Table 9.2.5.1) and the variations of mean length-at-age are of a similar scale along the temporal series (Table 9.2.5.2). Otoliths from older fish become thicker with time and thus presenting more difficulties for age determination at groups older than 11. Mean length-at-age from 2019 onward is only shown for 0 to 11+, plus group used for assessment.

Figure 9.2.5.2. shows the observed mean age in the catch (0 to 11+) with 95% confidence intervals and the mean age fitted by the assessment model (AMISH, red line) from 1992-2021. From 2018 to 2021 there was an increase from age 2 to age 3. The mean age composition fluctuates around ages 2 to 4 in the available time-series.

Table 9.2.5.1. Horse mackerel in Division 9.a. Mean weight-at-age (kg) in the catch (1992-2021).

	AGES											
YEAR	0	1	2	3	4	5	6	7	8	9	10	11+
1992	0.03	0.03	0.04	0.07	0.1	0.13	0.15	0.17	0.19	0.2	0.23	0.3
1993	0.02	0.03	0.04	0.07	0.09	0.13	0.17	0.21	0.24	0.24	0.25	0.3
1994	0.04	0.04	0.06	0.07	0.09	0.13	0.16	0.19	0.23	0.25	0.27	0.34
1995	0.04	0.03	0.06	0.08	0.1	0.12	0.16	0.17	0.2	0.22	0.23	0.31
1996	0.02	0.05	0.07	0.09	0.11	0.14	0.17	0.19	0.22	0.24	0.26	0.31
1997	0.03	0.03	0.05	0.07	0.11	0.14	0.17	0.2	0.24	0.26	0.26	0.36
1998	0.03	0.03	0.04	0.07	0.1	0.13	0.17	0.21	0.17	0.24	0.25	0.35
1999	0.02	0.04	0.06	0.08	0.11	0.14	0.16	0.19	0.22	0.25	0.27	0.36
2000	0.02	0.03	0.05	0.09	0.11	0.13	0.16	0.19	0.22	0.24	0.25	0.31
2001	0.02	0.03	0.07	0.08	0.09	0.13	0.16	0.18	0.2	0.23	0.24	0.31
2002	0.03	0.03	0.04	0.07	0.1	0.12	0.15	0.17	0.2	0.23	0.25	0.31
2003	0.02	0.03	0.05	0.06	0.09	0.12	0.15	0.18	0.2	0.23	0.25	0.31
2004	0.04	0.03	0.05	0.08	0.12	0.16	0.18	0.21	0.23	0.25	0.27	0.33
2005	0.02	0.03	0.04	0.07	0.12	0.15	0.17	0.18	0.22	0.24	0.25	0.3
2006	0.03	0.03	0.05	0.06	0.09	0.13	0.14	0.17	0.19	0.23	0.25	0.33
2007	0.03	0.05	0.06	0.07	0.09	0.11	0.16	0.19	0.23	0.22	0.24	0.3
2008	0.02	0.05	0.06	0.08	0.11	0.13	0.15	0.17	0.20	0.21	0.23	0.32
2009	0.02	0.03	0.06	0.09	0.11	0.13	0.15	0.17	0.18	0.21	0.24	0.36
2010	0.02	0.04	0.06	0.08	0.11	0.14	0.16	0.18	0.19	0.2	0.24	0.38
2011	0.03	0.06	0.07	0.08	0.11	0.13	0.17	0.18	0.19	0.22	0.26	0.35
2012	0.02	0.03	0.07	0.10	0.13	0.16	0.18	0.19	0.21	0.24	0.28	0.37
2013	0.05	0.04	0.05	0.09	0.13	0.16	0.18	0.20	0.21	0.23	0.26	0.33
2014	0.03	0.05	0.06	0.09	0.12	0.15	0.18	0.19	0.21	0.23	0.27	0.36
2015	0.03	0.04	0.06	0.09	0.11	0.14	0.17	0.19	0.21	0.24	0.26	0.35
2016	0.02	0.04	0.06	0.08	0.11	0.13	0.16	0.18	0.19	0.22	0.26	0.38
2017	0.02	0.04	0.07	0.09	0.12	0.15	0.18	0.20	0.21	0.25	0.28	0.35
2018	0.02	0.04	0.06	0.09	0.12	0.15	0.19	0.24	0.27	0.30	0.34	0.44

	AGES											
2019	0.02	0.04	0.06	0.08	0.12	0.14	0.17	0.22	0.24	0.34	0.37	0.46
2020	0.02	0.04	0.06	0.07	0.10	0.13	0.16	0.20	0.22	0.25	0.30	0.39
2021	0.01	0.03	0.05	0.08	0.10	0.13	0.15	0.18	0.23	0.25	0.28	0.33

Table 9.2.5.2. Horse mackerel in Division 9.a. Mean length-at-age (cm) in the catch from 1992-2021 (age range: 0–15 and older).* Mean length-at-age from 2019 onward is only shown for 0 to 11+, plus group used for assessment.

Year \ Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1992	14.9	15.6	17.5	19.8	23.2	25.8	27.4	28.6	29.6	31.2	31.5	32.6	33.3	33.9	34.7	36.8
1993	14.0	15.5	17.4	18.9	21.3	28.2	29.6	31.1	31.7	31.7	32.1	32.5	34.1	34.7	35.8	37.2
1994	13.4	14.6	18.1	21.1	22.7	24.8	27.0	29.5	31.2	31.7	32.4	32.2	33.3	34.2	34.4	36.5
1995	16.0	15.4	19.9	21.8	23.1	24.5	28.6	26.5	30.1	30.9	31.6	32.6	33.9	34.0	35.2	36.9
1996	13.3	19.0	19.7	21.8	24.7	26.3	28.0	28.6	30.3	30.7	31.5	32.0	33.4	32.5	36.2	37.0
1997	13.4	15.8	18.9	20.7	24.3	26.3	27.6	29.5	31.2	32.4	31.9	33.1	34.6	34.8	35.4	38.5
1998	14.5	13.9	15.9	20.4	23.5	25.5	28.3	30.3	26.9	31.7	32.0	32.7	33.4	34.5	36.4	39.1
1999	13.4	16.4	19.0	22.3	24.5	26.2	27.5	29.0	30.3	31.7	32.7	33.3	33.9	34.7	37.3	39.6
2000	13.6	16.4	18.4	21.7	24.8	26.0	27.2	28.6	30.2	30.8	31.5	32.3	32.7	34.2	34.5	35.0
2001	14.1	15.6	20.2	21.9	22.5	25.4	27.4	28.7	29.6	30.9	31.2	33.0	32.8	34.0	34.7	38.2
2002	15.0	15.7	17.5	20.3	23.1	25.4	26.6	28.0	29.6	30.9	31.8	32.6	34.2	34.7	35.4	36.9
2003	13.0	15.7	18.8	20.7	23.1	26.1	26.7	29.2	30.0	31.2	32.0	32.9	33.6	33.9	38.9	35.3
2004	16.2	14.4	17.2	21.2	24.0	26.7	28.1	29.4	30.5	31.6	32.3	32.2	33.0	32.2	36.4	35.9
2005	12.5	13.9	16.6	20.1	23.5	25.9	27.1	28.1	30.0	31.1	31.6	32.8	32.6	33.5	32.6	37.2
2006	14.6	14.7	17.0	19.2	22.2	24.6	25.6	27.2	28.7	30.3	31.5	33.2	34.0	35.9	36.7	37.0
2007	14.6	17.5	18.5	20.0	22.1	23.6	26.9	28.7	30.6	30.3	30.9	31.8	33.4	32.2	34.5	35.7
2008	13.0	17.3	20.5	22.3	24.0	25.4	26.5	27.7	28.8	29.6	30.5	31.3	32.2	33.5	35.6	37.2
2009	13.0	17.3	20.5	22.3	24.0	25.4	26.5	27.7	28.8	29.6	30.5	31.3	32.2	33.5	35.6	37.2
2010	13.1	15.8	18.4	20.8	23.4	25.4	26.9	27.8	28.6	29.2	31.2	31.7	33.5	34.7	36.7	38.0
2011	15.1	18.4	19.5	21.3	23.3	25.2	27.4	28.1	28.6	30.2	32.0	33.3	34.2	35.0	36.5	39.0
2012	15.7	15.8	18.4	22.8	24.9	26.5	27.8	28.8	29.9	31.1	33.2	34.4	35.5	36.7	39.4	39.8
2013	16.8	16.8	17.9	21.4	24.6	26.2	27.5	28.3	29.1	29.7	31.0	32.5	34.7	35.7	37.9	36.3
2014	13.9	18.7	20.4	21.4	23.0	25.2	26.5	27.5	28.5	28.9	31.2	32.9	34.5	35.4	36.6	38.0
2015	15.6	15.9	18.3	21.6	23.0	25.4	27.4	27.8	28.7	30.3	31.4	31.6	33.9	34.3	36.2	38.4
2016	13.8	16.1	18.7	20.6	23.1	25.0	26.5	28.0	28.5	30.1	31.9	33.7	36.2	36.8	37.1	39.3
2017	13.2	15.8	19.7	21.9	24.4	25.9	28.2	28.9	29.2	30.9	32.3	33.1	34.2	34.8	36.6	40.6
2018	12.9	16.2	19.4	22.1	24.1	25.9	28.4	30.7	31.7	33.0	34.4	37.3	37.9	38.9	38.5	39.2

Year \ Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
2019*	13.5	16.3	19.2	21.3	24.2	25.5	27.3	29.8	30.7	34.0	35.1	38.5	-	-	-	-
2020	13.7	16.6	19.2	20.9	23.1	25.1	26.6	28.7	29.9	30.8	32.3	36.1	-	-	-	-
2021	12.1	14.5	18.4	20.9	22.7	25.0	26.5	28.2	30.1	31.1	32.4	34.3	-	-	-	-

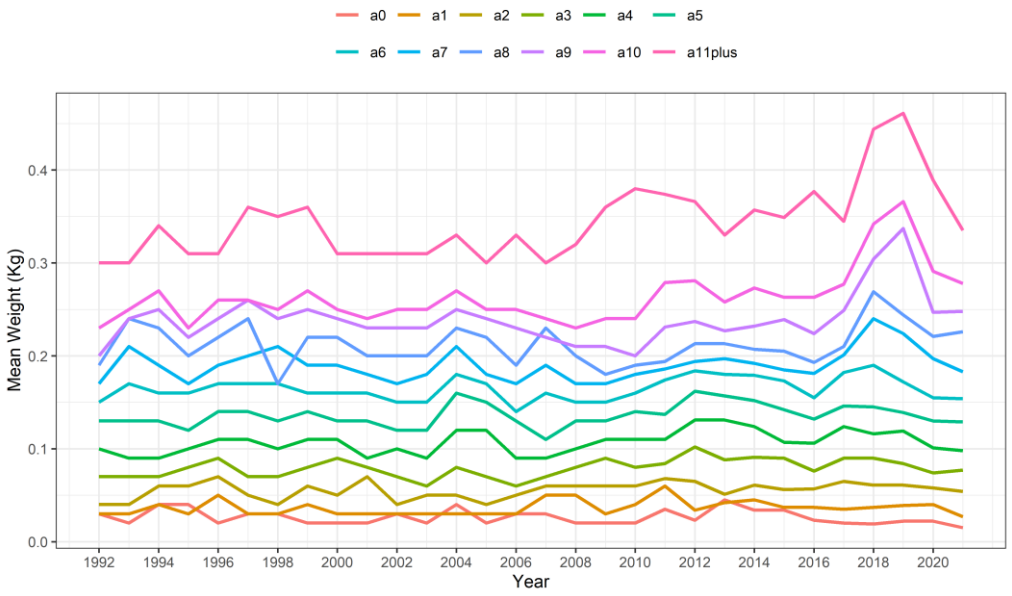


Figure 9.2.5.1. Horse mackerel in Division 9.a. Mean weight-at-age (kg) in the catch (age range: 0 to 11+, plus group; 1992-2021).

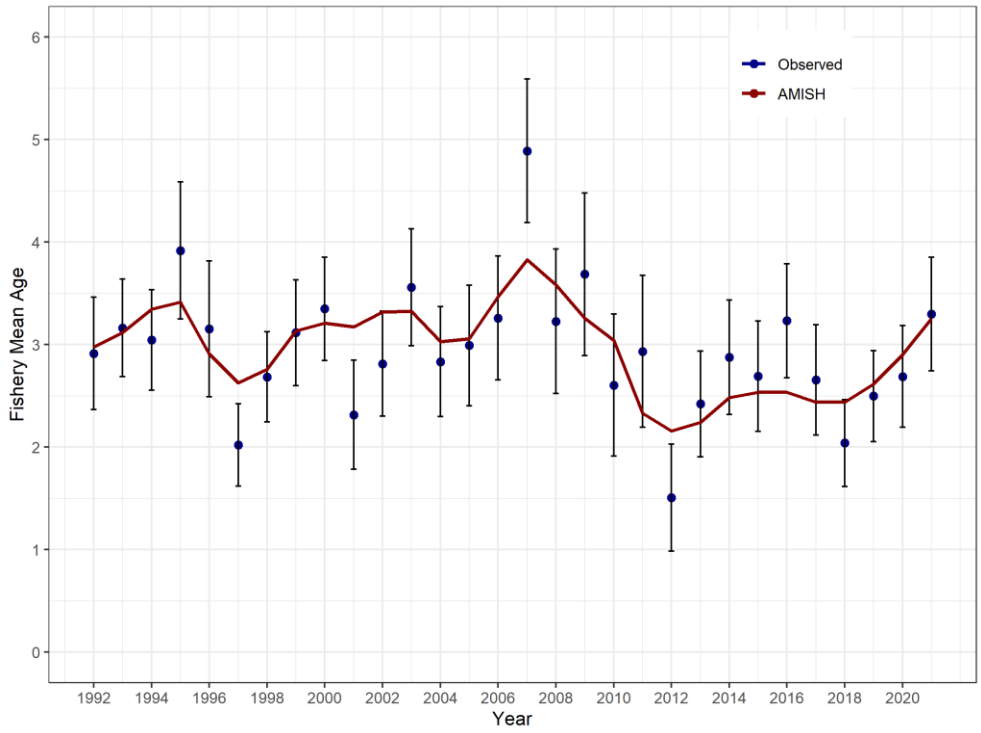


Figure 9.2.5.2. Horse mackerel in Division 9.a. Mean age in the catch in the period 1992–2021 (age range: 0 to 11+, plus group).

9.3 Fishery-independent information

The survey datasets currently available for the assessment of southern horse mackerel are those from the bottom-trawl surveys carried out in the 4th quarter (October) by Portugal (Pt-GFS-WIBTS-Q4 - G8899) and Spain (Sp-GFS-WIBTS-Q4 - G2784) in ICES Division 9.a. Both IBTS surveys cover the bulk of the geographical distribution of the southern horse mackerel stock at the same time but do not cover the southernmost part of the stock distribution area, corresponding to the Spanish part of the Gulf of Cadiz. In that area another bottom-trawl survey is carried out (Sp-GFS-caut-WIBTS-Q4 - G4309), usually in November. As explained in the Stock Annex, the survey series is shorter in time (only since 1998) and the raw data were unavailable in time for the WKPELA benchmark (ICES, 2017) to investigate the effect of merging it with the datasets from the other areas.

During the benchmark horse mackerel estimations from Portuguese spring acoustic surveys were also analysed to investigate the spatial distribution of juveniles and as a possible indicator of the recruitment strength for this species, which could prove to be useful for short-term forecasts (ICES, 2017). However, the analysis did not reveal any relationship between the estimates of recruitment from the acoustic survey and the stock assessment. Acoustic estimates require further analysis to be used as auxiliary information for recruitment strength.

SSB estimates from DEPM surveys require further analysis from ICES WGMEGGS to be used as external auxiliary information according to the Stock Annex.

9.3.1 Bottom-trawl surveys

IBTS data provides a good sampling of this species with valuable information on horse mackerel distribution, abundance, age–length distributions also providing a good signal of cohort dynamics (ICES, 2017). Several alternative methods for calculating indices of abundance-at-age were explored to improve the precision of the current survey tuning index, the diagnostics of stock assessment model fit, the uncertainty in the estimates of the key parameters fishing mortality, recruitment and spawning–stock biomass, as well as to evaluate the stock trends (ICES, 2017).

Different methods of obtaining an abundance index by age and year were explored. The "standard" stratified mean was an acceptable method to deal with the non-normal abundance distribution and the variability of the survey data. This estimator, described in the Stock Annex, was found adequate to deal with the data from the current classical stratified survey methodology applied in IBTS surveys and was thus adopted for tuning the assessment.

The abundance indices from both surveys are shown in Table 9.3.1.1. There is a strong variability of age 0 abundance that may be explained by the greater aggregation tendency of these small fish in dense shoals. This feature results in a rather noisy time-series at age 0. The combined survey abundance-at-age for tuning the assessment excluding age 0 is presented in Table 9.3.1.2.

Figure 9.3.1.1. shows the observed mean age in the survey (with age ranges used in the assessment 1 to 11+) with 95% confidence intervals and the mean age fitted by the assessment model (AMISH, green line) from 1992-2021. The mean age composition in the survey shows lower variability than the catch (Figure 9.2.5.2) as catchability from the survey is expected to be more consistent. The mean age fluctuates around ages 2 to 3 in the available time-series. From 2018 to 2021 (no available information in 2019 and 2020) there is a slight increase in the mean age.

The Portuguese IBTS was not conducted in 2012, 2019 and 2020. Because this survey traverses the majority of the stock area, the combined survey abundance-at-age index could not be estimated for 2012, 2019 and 2020.

Table 9.3.1.1. Horse mackerel in Division 9.a. Southern horse mackerel CPUE-at-age (number/hour) by the Portuguese and Spanish surveys, in the period 1992–2021 (age range: 0 to 11+, plus group). The Portuguese IBTS (October) survey was not conducted in 2012, 2019 and 2020.

Portuguese October Survey

YEAR \ AGES	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1992	452.2	488.2	145.8	26.8	13.2	5.9	4.0	4.3	2.4	2.2	3.0	0.5	0.6	0.2	0.1	0.1
1993	1645.8	183.8	212.2	148.0	32.5	2.0	1.5	0.7	0.5	0.7	0.4	1.0	0.3	0.2	0.0	0.0
1994	3.7	8.0	62.9	36.1	15.2	4.2	2.0	1.7	0.8	0.5	0.3	0.1	0.0	0.0	0.0	0.0
1995	15.8	61.2	89.7	49.7	23.9	6.5	1.4	1.2	0.5	0.2	0.2	0.3	0.3	0.5	0.1	0.1
1996*	1214.1	6.3	8.7	13.5	14.0	3.6	1.7	0.6	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0
1997	2094.7	97.4	69.0	20.4	45.0	55.4	14.9	10.9	4.5	5.3	1.8	0.1	0.0	0.1	0.1	0.0
1998	86.4	33.2	161.7	17.4	2.2	1.4	0.9	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1999*	159.5	20.2	31.8	34.8	2.8	1.0	0.5	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
2000	2.4	13.7	17.1	19.8	11.9	6.6	4.0	1.3	0.7	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2001	1292.7	1.1	8.8	3.9	6.9	13.8	12.2	11.2	6.6	2.5	1.2	0.2	0.1	0.1	0.0	0.0
2002 [1]	21.1	1.5	11.4	10.0	5.5	2.8	1.0	0.7	0.5	0.3	0.6	0.2	0.1	0.1	0.0	0.0
2003*	56.5	9.1	8.2	10.2	8.8	3.3	2.3	1.2	0.7	0.4	0.1	0.0	0.0	0.0	0.0	0.0
2004	58.6	37.1	111.8	38.0	6.7	3.0	1.4	3.5	5.0	0.9	0.2	0.0	0.0	0.0	0.0	0.0
2005	351.9	1188.6	162.2	45.2	21.7	10.4	13.7	14.4	11.7	6.6	4.1	4.6	4.1	0.9	1.0	0.3
2006	65.1	84.6	181.8	46.6	3.4	10.3	7.4	6.6	2.7	1.4	0.4	0.1	0.0	0.0	0.0	0.0
2007	36.2	2.0	22.6	31.5	25.1	9.2	2.5	1.2	0.1	0.4	1.3	1.1	0.5	0.2	0.2	0.4
2008	47.6	28.2	39.7	20.6	26.7	17.3	2.2	0.8	1.2	1.8	1.3	1.0	0.5	0.9	0.5	1.8
2009	1245.2	79.5	147.0	52.4	44.7	11.6	2.8	1.7	1.4	0.9	0.7	0.4	0.7	1.7	0.4	0.8
2010	83.3	36.8	32.8	25.6	38.3	14.1	5.2	7.0	4.7	4.6	1.6	1.8	1.5	1.9	2.1	3.0
2011	132.8	33.1	24.5	16.2	4.7	1.1	0.3	0.4	0.2	0.4	0.5	0.2	0.3	0.4	0.2	0.2
2012	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2013	12.5	363.7	820.0	105.4	18.9	3.0	2.5	2.7	2.2	2.2	1.5	0.8	1.2	0.4	0.3	0.2
2014	53.6	33.3	24.1	69.2	25.6	5.2	1.6	1.5	0.9	1.2	2.2	2.6	3.0	2.5	0.9	0.6
2015	900.2	160.3	112.5	46.6	38.0	4.5	2.3	1.0	0.8	0.9	0.7	0.5	0.4	0.5	0.3	0.5
2016	1.6	17.1	23.1	76.8	53.6	7.6	4.3	6.0	2.4	1.3	1.6	2.0	2.7	1.7	0.2	1.7
2017	68.2	440.0	584.2	263.0	177.1	27.9	3.5	13.5	19.2	2.4	2.1	1.6	1.0	0.9	0.0	0.0
2018	124.5	192.6	177.3	96.7	12.5	14.2	19.9	9.4	10.0	3.5	0.3	0.1	0.1	0.0	0.0	0.0
2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2020	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2021*	180.3	288.5	74.8	123.3	78.4	58.2	29.6	5.5	4.4	3.6	5.4	0.9	0.5	0.0	0.0	0.1

Spanish October Survey (only Subdivision IXa North)

YEAR \ AGES	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1992	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	1.0	0.4	0.5	0.3	0.1	0.6
1993	33.1	0.4	1.2	0.9	0.1	0.0	0.6	2.5	2.6	3.6	2.2	4.2	0.8	0.5	0.1	0.2
1994	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.6	0.0	3.7	3.0	0.3	1.5
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.6	1.0	2.2	0.6	0.5
1996	8.4	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.7	0.2	0.1	0.5	0.7	0.3	1.1
1997**	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.5	0.2	0.1	0.1	0.2	0.3	0.7
1998	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.6	0.9	0.7	1.3	0.5	0.4	0.1
2000	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.8	1.0	0.9	0.2	0.2	0.1	0.1	0.1	0.2
2001	3.4	0.8	0.0	0.0	0.0	0.1	0.1	0.7	1.2	1.1	0.9	0.5	0.3	0.3	0.0	0.1
2002	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.4	2.1	2.0	2.5	2.9	1.0	1.2	0.4	0.6
2003	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.1	0.1	0.0	0.0	0.2
2004	24.1	0.3	0.7	4.3	1.4	1.2	0.5	0.4	0.2	0.1	0.2	0.0	0.1	0.0	0.0	0.0
2005	938.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.2	0.1	0.1	0.0	0.0
2006	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1
2007	0.4	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.4	0.2	0.2	0.2	0.0	0.1	0.1	0.0
2008	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1
2009	23.1	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	0.2	0.1
2010	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.2	0.3	0.3
2011	0.4	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.1	0.3	0.3	0.0	0.0	0.0	0.1	0.2
2012	12.9	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.2
2013	0.1	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
2014	0.3	7.5	1.2	8.5	8.0	2.6	0.4	0.2	0.2	0.2	0.2	0.1	0.9	0.0	0.0	0.0
2015	6.6	0.0	0.1	1.9	2.8	1.0	0.1	0.2	0.0	0.1	0.2	0.0	0.1	0.0	0.1	0.2
2016	11.9	2.8	20.0	3.2	4.0	11.0	4.6	2.2	0.5	0.3	0.1	0.0	0.0	0.0	0.1	0.1
2017	4.9	27.1	171.7	84.1	48.6	13.4	17.7	0.4	0.7	0.1	0.4	0.1	0.0	0.0	0.0	0.0
2018	0.1	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
2019	0.6	0.3	0.1	0.1	0.4	2.1	0.3	0.1	0.1	0.0	0.5	0.2	0.2	0.0	0.0	0.1
2020	12.5	37.4	121.3	32.8	5.1	0.7	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
2021	0.9	0.0	0.1	0.0	0.6	0.8	0.8	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0

(*) The surveys were carried out with a different research vessel.

(**) Since 1997 another stratification design in the Spanish surveys.

([1]) In 2002 the duration of the trawling hauls changed from one hour to 30 minutes.

Table 9.3.1.2. Horse mackerel in Division 9.a. Stratified mean abundance-at-age (number/hour) in the period 1992–2021. There were no Portuguese surveys in 2012, 2019 and 2020 and therefore the combined survey indices for 2012, 2019 and 2020 are not estimated. *age 0 is not used in the stock assessment.

	AGES											
YEAR	0*	1	2	3	4	5	6	7	8	9	10	11+
1992	454.5	488.2	145.8	26.8	13.2	5.9	4.0	4.4	2.4	2.3	4.0	3.4
1993	1678.9	184.2	213.3	148.8	32.6	2.0	2.1	3.2	3.1	4.3	2.6	7.3
1994	3.8	8.0	63.0	36.1	15.2	4.2	2.0	1.7	0.9	0.8	0.9	8.7
1995	15.8	61.2	89.7	49.7	23.9	6.5	1.4	1.2	0.6	0.3	0.4	6.2
1996	1222.5	6.3	8.7	13.5	14.0	3.6	1.7	0.6	0.4	0.8	0.2	2.8
1997	2095.3	97.4	69.0	20.4	45.0	55.4	15.0	11.2	4.8	5.8	2.1	1.7
1998	86.6	33.2	161.7	17.4	2.2	1.4	1.0	1.2	0.3	0.1	0.0	0.1
1999	159.5	20.2	31.8	34.8	2.8	1.0	0.6	0.2	0.2	0.7	0.9	3.0
2000	2.5	13.7	17.1	19.8	11.9	6.6	4.1	2.1	1.7	1.0	0.3	0.9
2001	1296.1	1.8	8.8	3.9	6.9	13.8	12.3	11.9	7.8	3.7	2.1	1.6
2002	21.2	1.5	11.4	10.0	5.5	2.8	1.2	1.1	2.6	2.3	3.1	6.6
2003	58.9	9.1	8.2	10.2	8.8	3.3	2.4	1.3	0.7	0.6	0.4	0.5
2004	82.7	37.4	112.4	42.4	8.1	4.2	1.9	3.8	5.1	1.0	0.4	0.2
2005	1290.0	1188.6	162.2	45.2	21.8	10.5	13.8	14.5	11.8	6.7	4.1	11.3
2006	72.6	84.6	181.8	46.6	3.4	10.4	7.4	6.7	2.7	1.4	0.5	0.3
2007	36.6	2.0	22.6	31.5	25.1	9.2	2.7	1.6	0.6	0.6	1.4	2.9
2008	52.6	28.2	39.7	20.6	26.8	17.3	2.2	0.8	1.3	1.9	1.4	5.0
2009	1268.3	79.5	147.0	52.4	44.7	11.6	2.8	1.7	1.4	0.9	0.7	4.6
2010	83.4	36.8	32.8	25.6	38.3	14.1	5.2	7.0	4.7	4.6	1.8	11.6
2011	133.2	33.1	24.5	16.2	4.7	1.2	0.4	0.6	0.4	0.7	0.8	1.6
2012	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2013	12.6	363.8	820.0	105.4	18.9	3.0	2.5	2.7	2.2	2.2	1.5	2.9
2014	53.9	40.8	25.4	77.7	33.6	7.8	2.1	1.7	1.2	1.4	2.4	10.5
2015	906.8	160.3	112.6	48.5	40.9	5.5	2.4	1.2	0.9	1.0	0.9	2.6
2016	13.6	19.9	43.1	80.0	57.6	18.6	8.8	8.1	3.0	1.6	1.7	8.6
2017	73.04	467.1	755.9	347.1	225.7	41.3	21.1	13.9	19.9	2.5	2.5	3.7

	AGES											
2018	124.5	192.6	177.3	96.7	12.5	14.2	19.9	9.4	10.0	3.5	0.3	0.1
2019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2020	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2021	178.6	276.6	92.5	120.2	79.00	59.01	30.4	5.4	4.4	4.3	5.2	1.6

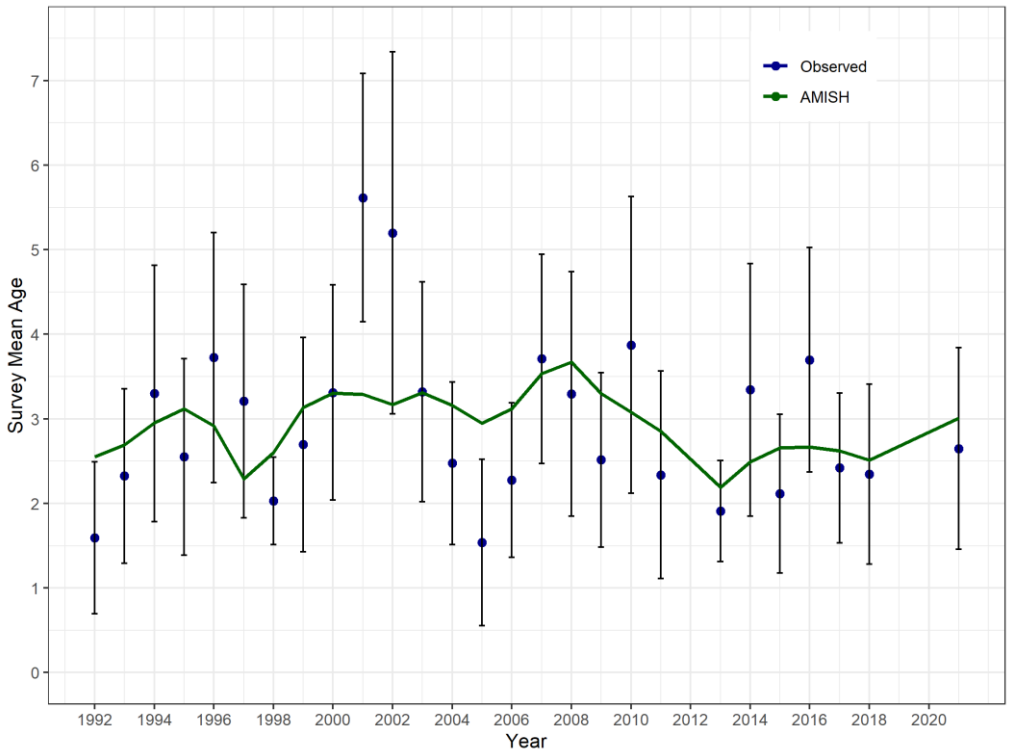


Figure 9.3.1.1. Horse mackerel in Division 9.a. Mean age in the survey in the period 1992–2021 (age range used in the assessment uses only age 1 to 11+, plus group).

9.3.2 Mean length and mean weight-at-age in the stock

Taking into consideration that the spawning season is very long, from September to June, and that the whole length range of the species has commercial interest in the Iberian Peninsula, with scarce discards, there is no special reason to consider that the mean weight-at-age in the catch is significantly different from the mean weight-at-age in the stock.

9.3.3 Maturity-at-age

The maturity ogive corresponds to females. Horse mackerel is a multiple spawner (ICES, 2008) and hence maturity ogives should be based on histological analysis of the gonads which provide a correct and precise means to follow the development of both ovaries and testes (Costa, 2009). Maturity ogive estimation procedures are detailed in Stock Annex. The predicted proportion-at-age is given in the text table below (7+: age 7 and older fish) and was adopted by WKPELA for the assessment period (1992–2021).

Age	0	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.36	0.82	0.95	0.97	0.99	1.0

During the benchmark it was also agreed to estimate a maturity ogive every three years with the data collected during the triennial DEPM surveys. The maturity ogive will be updated only in the case there is strong evidence that the proportion of fish mature at age has changed.

9.3.4 Natural mortality

The natural mortality (M) used in the assessment is presented in the text table below (5+: age 5 and older fish).

Age	0	1	2	3	4	5+
M	0.9	0.6	0.4	0.3	0.2	0.15

The procedure in the estimation of natural mortality rate and considerations for adopting the current values are detailed in Stock Annex.

9.4 Stock assessment

9.4.1 Model assumptions and settings and parameter estimates

The stock assessment has been performed for the period 1992–2021 with the method and settings agreed during the benchmark (ICES, WKPELA 2017) and described in the Stock Annex. Table 9.4.1.1 presents the input data type, model assumptions and settings adopted by the benchmark.

The assessment was tuned with the stratified mean abundance-at-age estimated for the combined Portuguese and Spanish IBTS survey for the age range 1–11+. In 2012, 2019 and 2020 the Portuguese survey was not carried and, hence, the combined survey indices for 2012, 2019 and 2020 could not be estimated. Benchmark discussions also concluded that it was appropriate to adopt only one time-block for the survey selectivity given that the survey characteristics (e.g. survey design, surveyed area, Research vessels and fishing gear) were relatively unchanged along the assessment period.

The three time-blocks for the catch selectivity accommodates the recent changes in the fishery due to the strong year classes of 2011, 2012, 2015 and subsequent years, and the increase of horse mackerel catches by purse-seiners, following the Iberian sardine crisis. This pattern is persistent in the recent years being more pronounced in the Portuguese and Spanish purse-seine fleets.

Table 9.4.1.1. Horse mackerel in Division 9.a. Input data type, model assumptions and settings for the assessment of southern horse mackerel with dataseries 1992-2021.

Name	Year range	Age range	Assumptions/settings
Catch in weight	1992–2021		Variable in time
Catch-at-age	1992–2021	0–11+	Variable by age and time; assuming a constant CV of 5%
IBTS (Spanish-Portuguese) mean stratified abundance-at-age	1992–2021 (except 2012, 2019,2020)	1–11+	Variable by age and time; assuming a constant CV of 30%
Mean weight-at-age (catch and stock)	1992–2021	0–11+	Variable by age and time
Proportion of F and M before spawning	1992–2021	0–11+	Fixed at 0.04 (mid-January)
Natural Mortality	1992–2021	0–11+	Age-dependent; time invariant
Catch-at-age selectivity	1992–2021	0–11+	Dome-shaped; constant at age 7+ Three blocks 1992–1997; 1998–2011; 2012–2020
Initial parameter vector		0–11+	0.2,0.7,1,1,0.8,0.5,0.5,0.2,0.2,0.2,0.2,0.2
Survey abundance-at-age selectivity	1992–2021 (except 2012, 2019,2020)	1–11+	Dome-shaped; constant at age 7+ One time-block 1992–2019 (no survey index in 2012, 2019 and 2020)
Initial parameter vector		1–11+	1,1,0.7,0.5,0.4,0.3,0.2,0.2,0.2,0.2,0.2
Proportion-at-age in the catch	1992–2021	0–11+	Multinomial distribution
Proportion-at-age in the survey	1992–2021	1–11+	Multinomial distribution
Effective sample size catch			100
Effective sample size survey			10

Figure 9.4.1.1 presents the estimated selectivity in the survey (age range 1–11+) and in the catch-at-age (age range 0–11+) for the period 1992–2021.

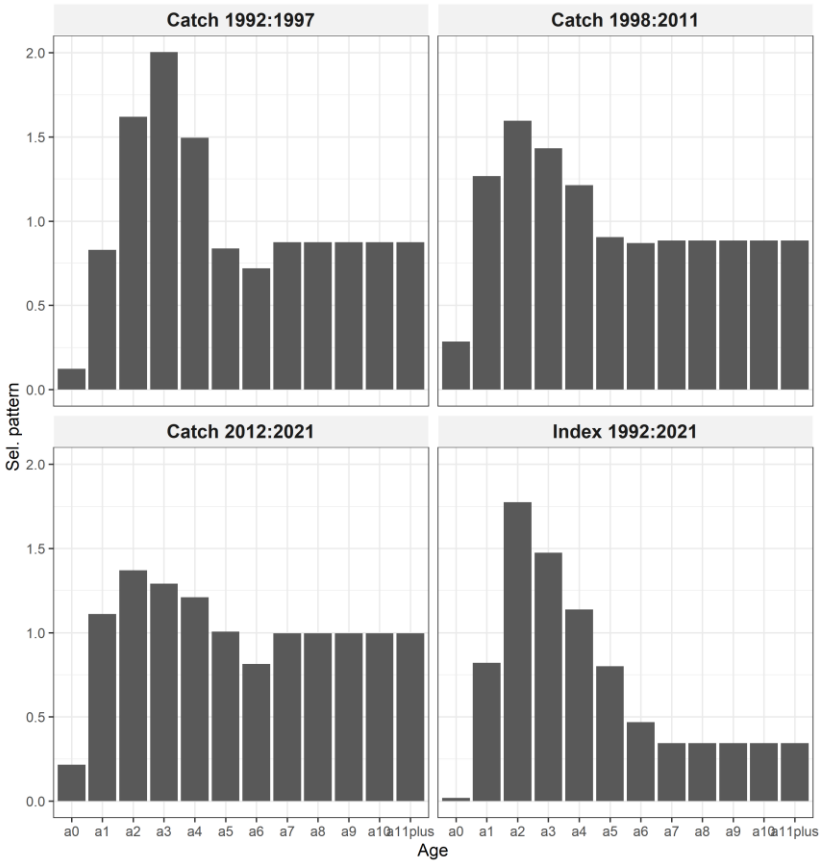
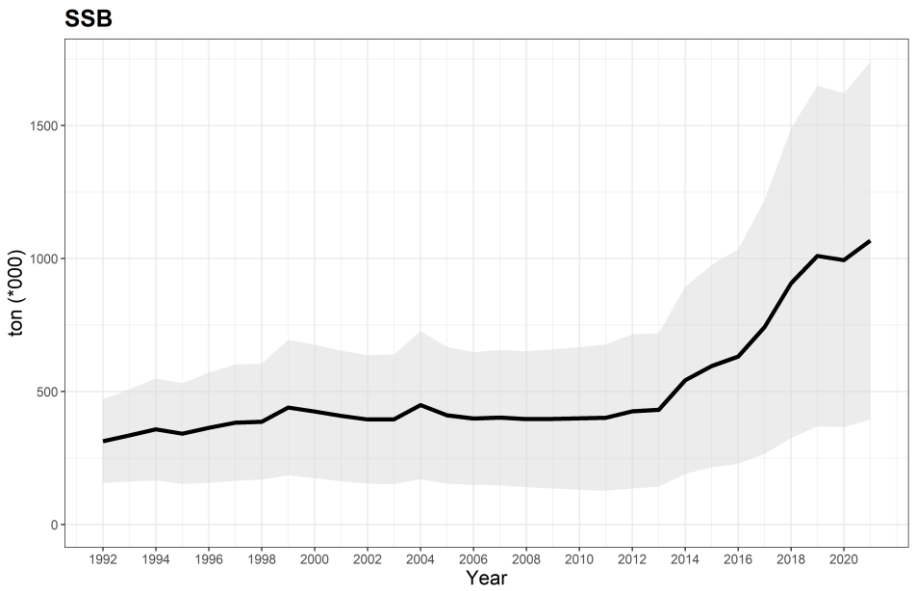


Figure 9.4.1.1. Horse mackerel in Division 9.a. Estimated selectivity for the catch-at-age (three time-blocks) and for the IBTS combined stratified mean abundance-at-age (one time block).

The summarized results of the stock assessment are shown in Table 9.4.1.2 and Figure 9.4.1.2.

Table 9.4.1.2. Horse mackerel in Division 9.a. Final assessment (1992-2021). Stock summary table (SSB at spawning time in mid-January).

Year	Recruits (10*3)	SD	CV	SSB (t)	SD	CV	mean F_{2-10}	SD	CV	Catch (t)
1992	4511750	934423	0.21	312644	80063	0.26	0.082	0.021	0.25	27858
1993	3157140	686762	0.22	334915	88192	0.26	0.088	0.023	0.26	31521
1994	3116640	683905	0.22	357692	97896	0.27	0.071	0.019	0.26	28441
1995	4262840	910077	0.21	341582	96540	0.28	0.068	0.018	0.27	25147
1996	11485300	2241050	0.2	363614	105623	0.29	0.050	0.013	0.27	20400
1997	3776370	802118	0.21	382830	111404	0.29	0.069	0.019	0.27	29491
1998	2422560	548789	0.23	386496	110971	0.29	0.092	0.025	0.27	41564
1999	3698310	800907	0.22	439734	129696	0.29	0.056	0.016	0.28	27733
2000	3376760	749361	0.22	424627	127836	0.30	0.058	0.016	0.28	26160
2001	3990810	880863	0.22	407941	125201	0.31	0.057	0.016	0.28	24910
2002	2255730	538408	0.24	395041	122940	0.31	0.056	0.016	0.29	22506
2003	4477560	998960	0.22	395506	124369	0.31	0.047	0.013	0.28	18887
2004	4941720	1101440	0.22	448590	141937	0.32	0.051	0.014	0.28	23252
2005	3106400	727188	0.23	410485	130863	0.32	0.052	0.015	0.29	22695
2006	1619040	418725	0.26	398318	127110	0.32	0.057	0.017	0.29	23902
2007	2400310	600235	0.25	401867	129840	0.32	0.055	0.016	0.29	22790
2008	3804480	938670	0.25	396024	130331	0.33	0.057	0.017	0.3	22993
2009	3549020	917780	0.26	396981	133406	0.34	0.064	0.020	0.31	25737
2010	4443340	1180210	0.27	398639	136785	0.34	0.063	0.020	0.32	26556
2011	11032300	2844830	0.26	401282	140131	0.35	0.040	0.013	0.32	21875
2012	13050500	3370780	0.26	425006	147861	0.35	0.043	0.014	0.33	24868
2013	7131340	1940760	0.27	430724	146927	0.34	0.042	0.014	0.33	28993
2014	9551120	2584930	0.27	541959	179353	0.33	0.037	0.012	0.33	29017
2015	10503000	2900760	0.28	595386	194130	0.33	0.041	0.014	0.33	32723
2016	11724300	3344990	0.29	630963	205517	0.33	0.050	0.016	0.33	40741
2017	15568400	4560440	0.29	742574	243441	0.33	0.039	0.013	0.33	36946
2018	14186700	4345030	0.31	907062	296806	0.33	0.028	0.009	0.32	31661
2019	12849300	4145040	0.32	1009547	326679	0.32	0.028	0.009	0.32	35520
2020	8679670	3165230	0.36	993801	319950	0.32	0.024	0.008	0.32	30177
2021	9009310	4280480	0.48	1066959	343328	0.32	0.022	0.007	0.32	26320
Average	6589401	1804771	0.26	504626	159838	0.31	0.053	0.015	0.30	27713



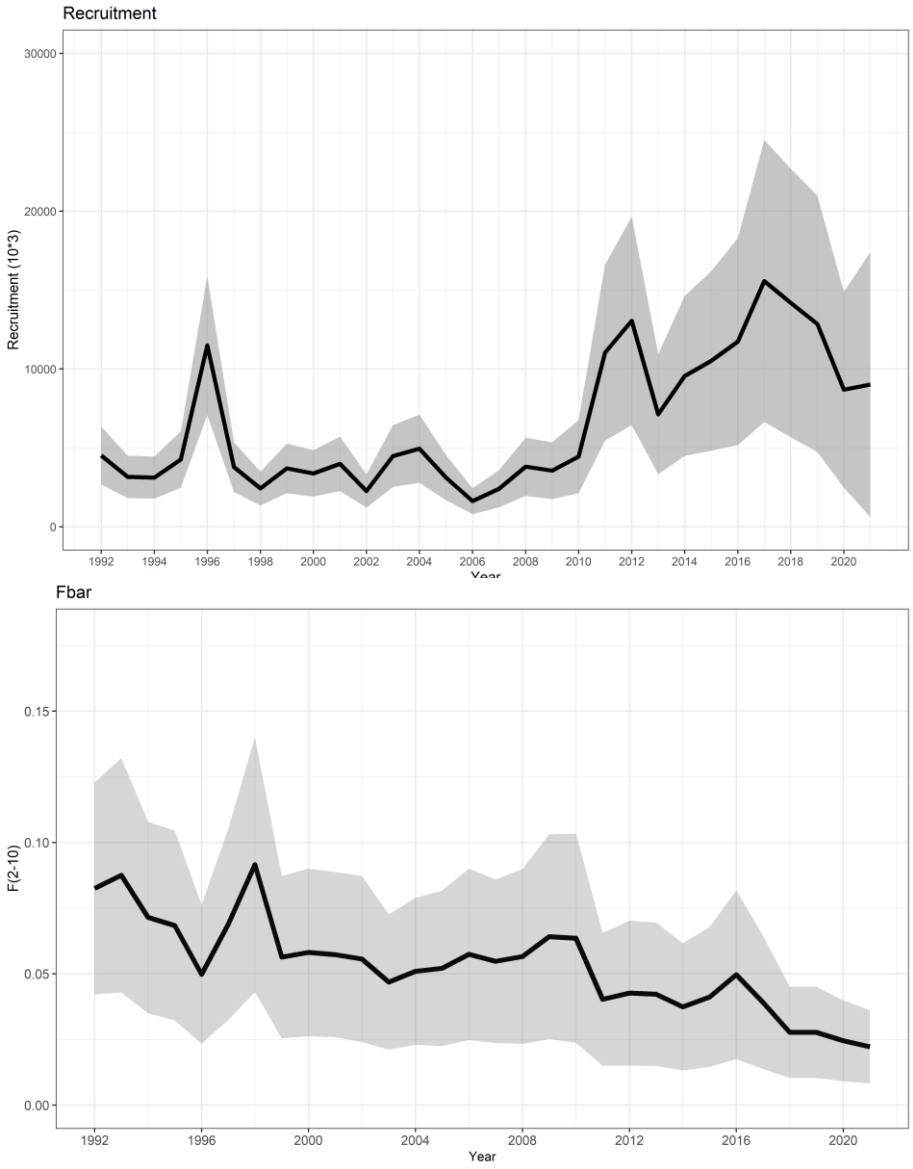


Figure 9.4.1.2. Horse mackerel in Division 9.a. Final assessment (1992-2021). Plots of SSB (top), Recruitment (middle) and Fishing mortality (bottom, mean $F_{2–10}$). Grey shaded area shows 95% confidence bounds and average CV is 32% for SSB, 32% for $F_{2–10}$ and 48% for Recruitment. SSB and are in thousand tonnes and recruitment in thousands.

The estimated SSB shows a significant increase from 2013 to 2021 from 431 thousand tonnes to 1 066 959 thousand tonnes. Confidence intervals of SSB are in the range 26-35% with an average 31%. The fishing mortality has been below F_{MSY} over the whole time-series and after the slight increase in 2016, showed a decrease in 2017-2021. F_{2-10} in 2021 was estimated at 0.0.022 lower than the observed value in 2020. Confidence intervals of F are in the range 25-33%.

The stock showed a strong recruitment in 1996 and above average recruitments in the most recent years, with high values in 2011, 2012, 2017 and 2018. Recruitment estimates present a high uncertainty showed in the wide confidence intervals (Figure 9.4.1.2). In 2021, recruitment was estimated at 9009 million individuals but with high uncertainty.

Figure 9.4.1.3 shows the scatterplot of the estimated spawning–stock biomass and recruitment in the period 1992–2021.

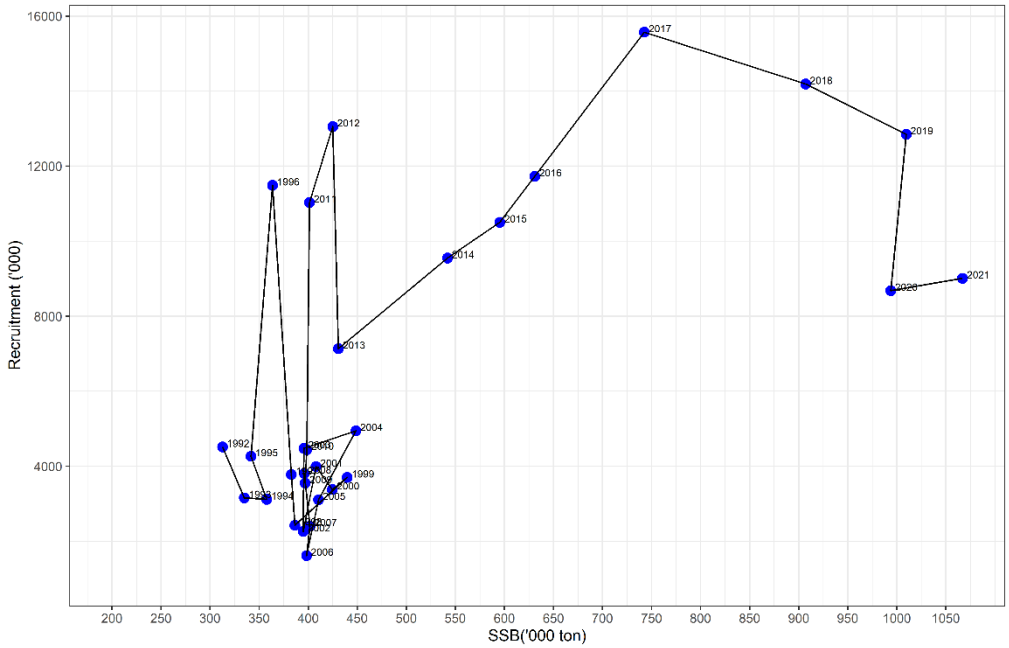


Figure 9.4.1.3. Horse mackerel in Division 9.a. Stock–recruitment data for southern horse mackerel (1992-2021).

9.4.2 Reliability of the assessment

The landings of this stock are believed to be fairly accurate, given the good sampling coverage, few discards (according to on-board observers) and the existence of well-defined ageing criteria. Therefore, a higher weight is given to the dataseries of landings in weight, which was very well fitted by the model (Figure 9.4.2.1).

The assessment is also tuned with the stratified mean abundance-at-age estimated for the combined Portuguese and Spanish IBTS surveys. The model down-weighted the high biomass observed in 2005. However, the 2013 and 2017 survey index were the highest in the time-series which contributed for a steady increase of the fitted survey biomass index from 2013 to 2018, reaching values 2 times above the average (Figure 9.4.2.1). In 2019 and 2020 the survey was not carried out in the Portuguese area of Division 9.a. As this part of the survey covers 87% of the total stock area, the combined survey index could not be estimated. Because of this, the stock assessment was performed without the 2019 and 2020 survey index values. In 2021, the Portuguese Bottom Trawl Survey was carried out and the combined survey index estimate was used in the assessment. However, the assessment still shows high uncertainty, reflected in the large confidence intervals for SSB and recruitment (Figure 9.4.1.2).

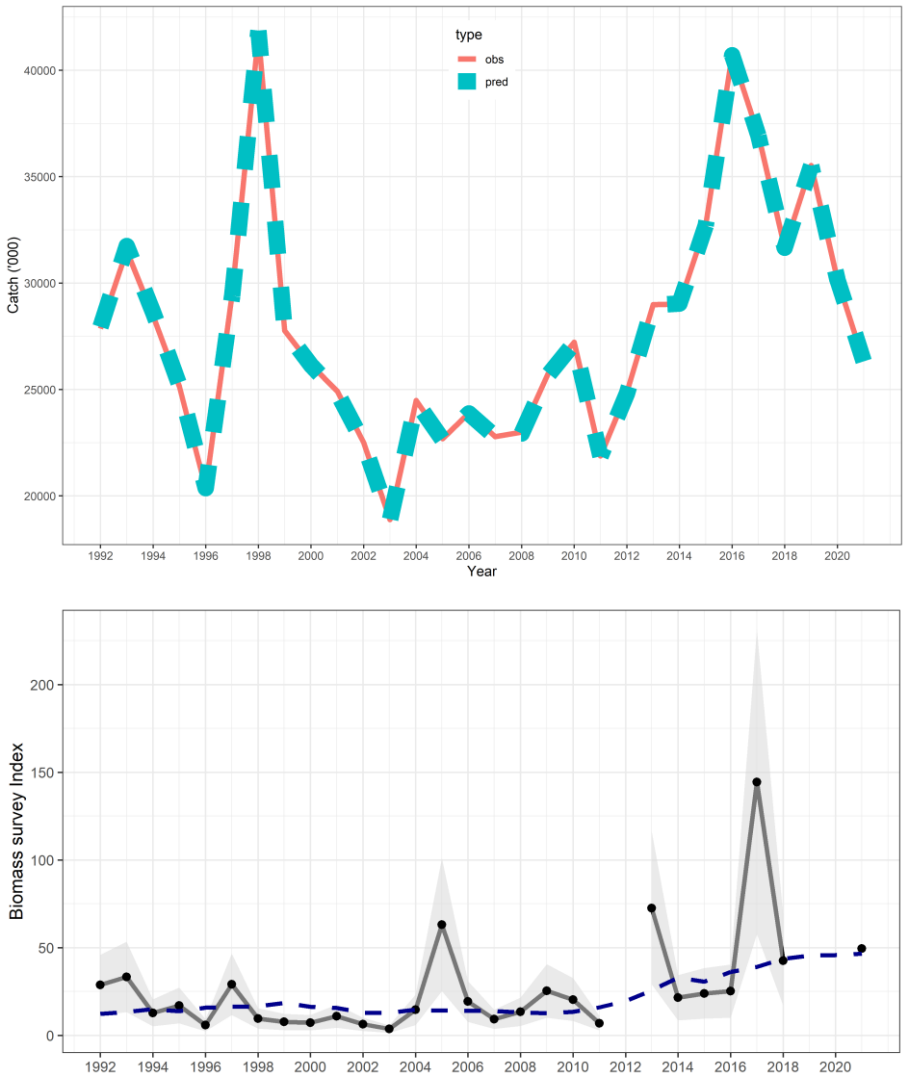


Figure 9.4.2.1. Horse mackerel in Division 9.a. . Catch biomass (top) and survey biomass index (bottom) for the period 1992-2021: observed (solid black line) and estimated values (dashed blue line). The grey shaded area shows 95% confidence bounds of survey biomass index.

A good fit was obtained for the proportions-at-age of the catch in numbers (Figure 9.4.2.2) and overall for the abundance indices in number/hour from the IBTS combined survey (Figure 9.4.2.3). The bubble plots of the residuals corresponding to the fitting of those data are shown in Figure 9.4.2.4.

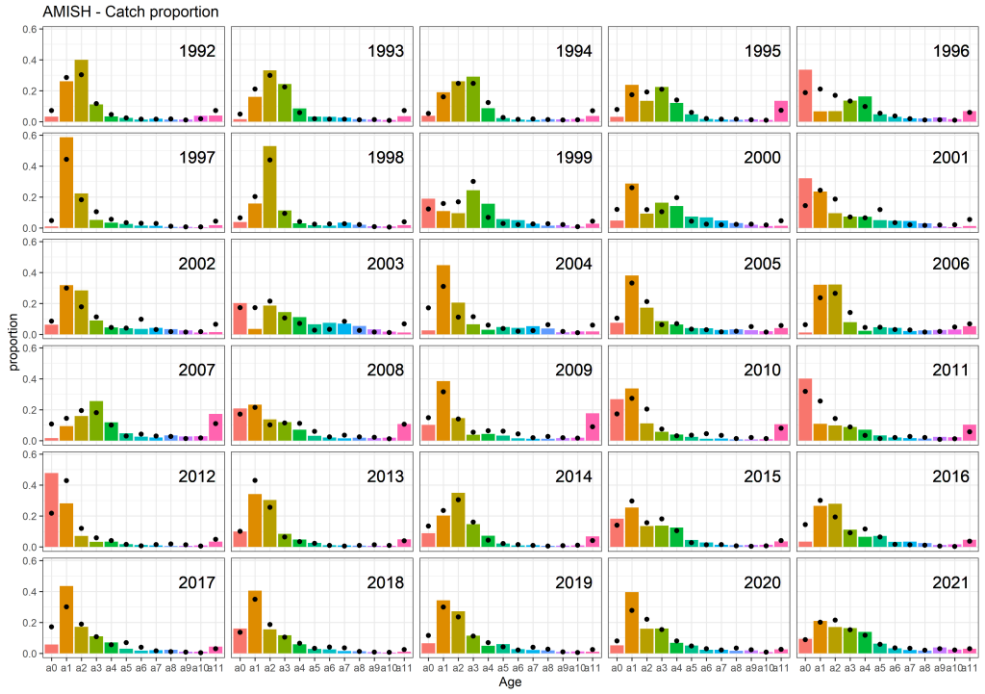


Figure 9.4.2.2. Horse mackerel in Division 9.a. Comparison of proportions-at-age of the observed and fitted catch data (observed values=dots; fitted values=solid lines).

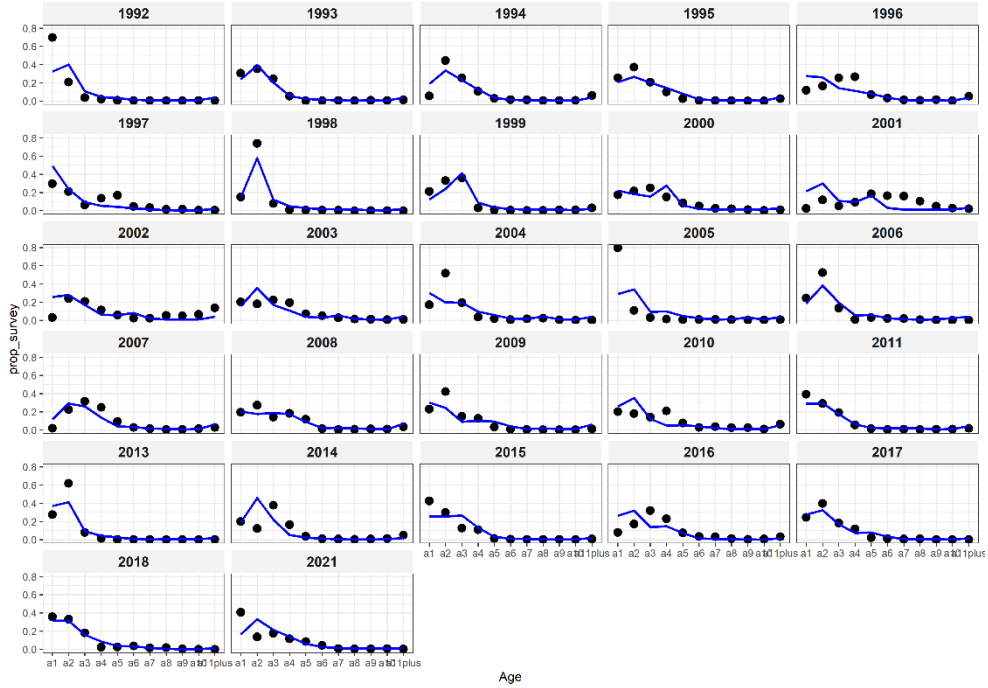


Figure 9.4.2.3. Horse mackerel in Division 9.a. . Comparison of proportions-at-age of the observed and fitted survey data (observed values=dots; fitted values=solid lines).

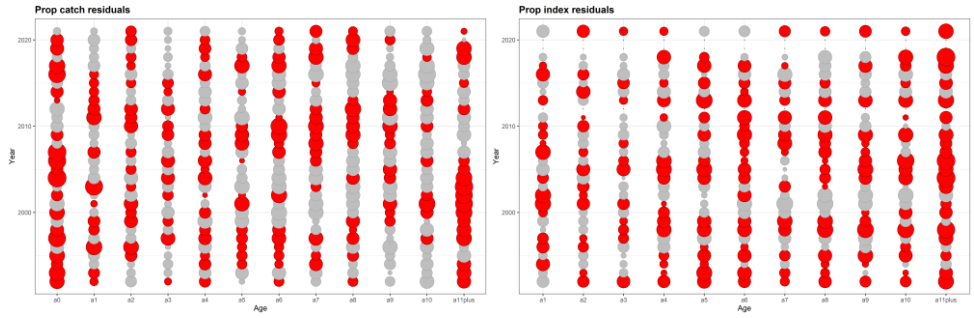


Figure 9.4.2.4. Horse mackerel in Division 9.a. . Bubble plot of catch (left, age range 0–11+) and survey (right, age range: 1–11+) proportion-at-age residuals (negative residuals=red bubbles).

The significant increase in SSB in recent years is reflecting the contribution of the survivors of the above average recruitment in recent years. The uncertainty in SSB in most recent years is around 32% (coefficient of variation). The slight decrease in catches observed in 2021 and the continuous increase in estimated stock abundance in the last few years resulted in a lower estimate of F_{bar} in 2021 than in the previous year. The uncertainty in the estimated F_{bar} is of similar magnitude around 32% (coefficient of variation). In 2019 and 2020 the survey was not carried out in the Portuguese area of Division 9.a. Because of this, the stock assessment was performed without the 2019 and 2020 survey index values. In 2021, the combined survey index estimate was used in the assessment. However, the assessment still shows high uncertainty, reflected in the large confidence intervals recruitment in 2020 and 2021 with 36% and 48%, respectively (Table 9.4.1.2).

Besides the above mentioned issues, there has also been a continued and significant shift in relative catch contribution from bottom trawls to purse-seines in recent years which has led to a change in the age composition of catches, with an increase in the proportion of 1-2 year old fish (juveniles and young immature fish). In 2021, the catch-at-age 1 showed a contrasting behaviour with a significant decrease resulting from the lower catches observed in the Spanish purse-seine fleet. Changes in the relative contribution to the catch from bottom trawls and purse-seines have led to changes in the age composition of catches (Figure 9.4.2.5). This may lead to inconsistency in estimating selectivity for the last period of the assessment. WGHANSA performed exploratory analysis using different selectivity patterns to explore if the assumptions of selectivity for the last period of the assessment (2012-2021 selectivity block) were incorrect. The results were inconclusive and require continued monitoring and further exploration.

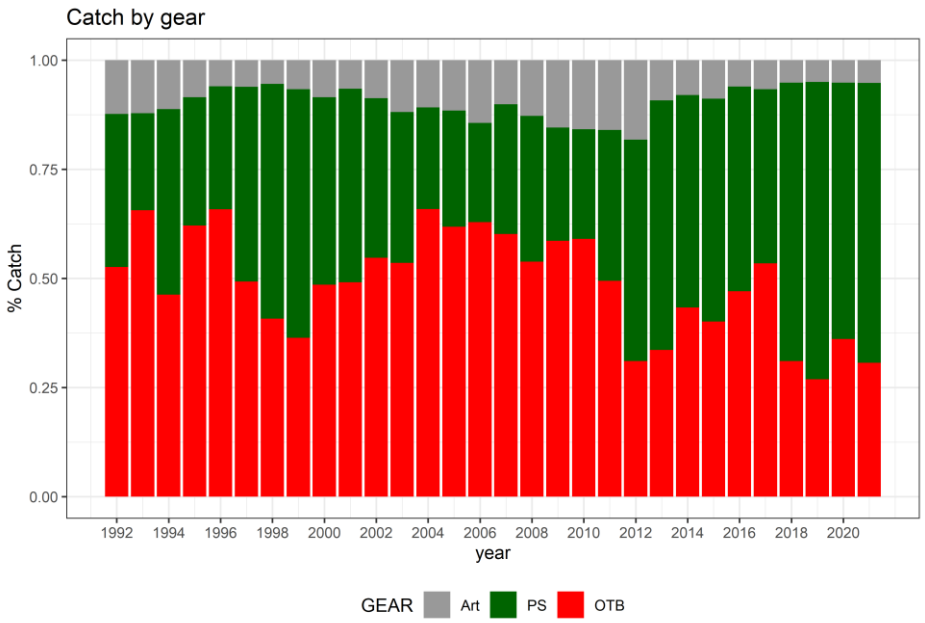


Figure 9.4.2.5. Horse mackerel in Division 9.a. Contribution of southern horse mackerel catches by gear (PS – Purse-seine, OTB – bottom trawl, Art - Artisanal) from 1992-2021.

The retrospective analysis on SSB, recruitment and F_{bar} (mean F ages 2–10) was performed for a five-year period, from 1992–2016 to 1992–2021 time-series. The Mohn´s rho estimated for each retrospective peel and the average Mohn´s rho are shown in Table 9.4.2.1. They indicate a negligible overestimation of the SSB (0.06), a slight overestimation of F (0.15) and a minor underestimation of Recruitment (-0.08). Because of the very high uncertainty observed in the last recruitment estimate, the Mohn´s rho for recruitment is calculated without the terminal year. The Mohn´s rho results are below the critical value (± 0.30) and the observed retrospectives are mostly inside the confidence intervals of the last assessment estimates (Figure 9.4.2.5).

Table 9.4.2.1 Horse mackerel in Division 9.a. Input to the calculations of Mohn's rho from the most recent assessments and 5 retrospective assessments. The last assessment estimates (*base*) compared to each retrospective assessment (*retro*) and the relative bias in each year (*relbias*). The adopted Monh´s rho is the average of the five last year bias.

F Mohn's rho

	base	retro	relbias
2016	0.0496	0.07735548	0.558853612
2017	0.03907	0.04404278	0.127262003
2018	0.02767	0.02939894	0.062519853
2019	0.02768	0.02832511	0.023151612
2020	0.02447	0.02432783	-0.005849108

F average rho

0.1531876

SSB Mohn's rho

	base	retro	relbias
2016	605.806	487.950	-0.19454413
2017	663.872	737.556	0.11099128
2018	738.490	888.422	0.20302509
2019	846.726	992.092	0.17168009
2020	963.126	983.374	0.02102321

SSB average rho

0.06243511

Recruitment Mohn's rho (last year removed)

	base	retro	relbias
2015	10503.0	4875.99	-0.53575264
2016	11724.3	11141.40	-0.04971725
2017	15568.4	13087.80	-0.15933558
2018	14186.7	16394.60	0.15563168
2019	12849.3	15326.40	0.19278093

R average rho

-0.07927857

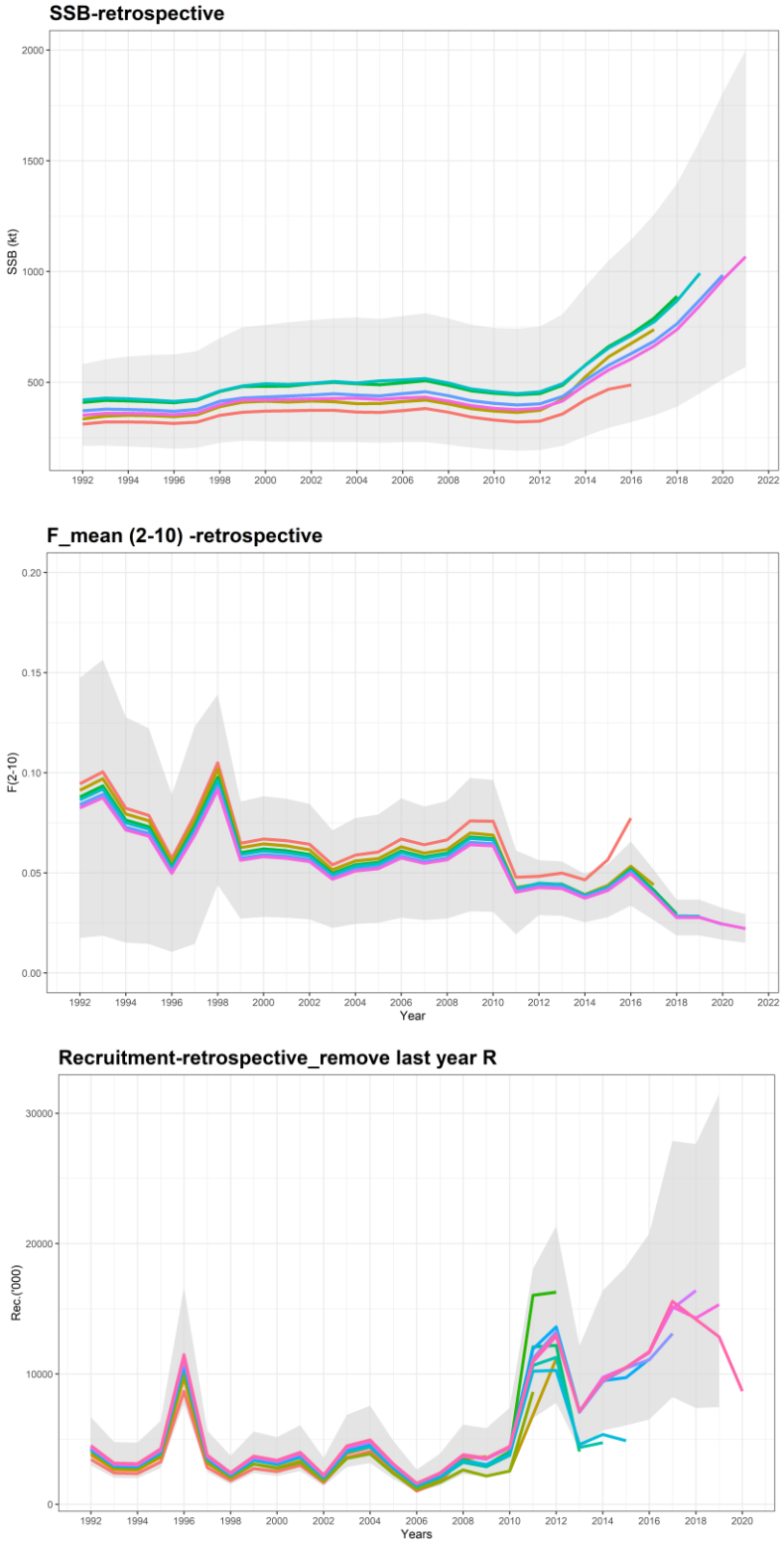


Figure 9.4.2.5. Horse mackerel in Division 9.a. Retrospective analysis results. Trajectories of SSB, Recruitment and Fbar (grey=95% confidence intervals for the current assessment and the retrospective assessments.

9.5 Short-term predictions

Deterministic short-term forecasts were carried out with R using the Fisheries Library in R (FLR) "FLAssess" (Version 2.6.3) and "Flash" (Version 2.5.1), following assumptions and settings agreed during the benchmark (ICES, 2017) and described in the Stock Annex. Recruitment is assumed for 2021 and 2022, corresponding to the geometric mean recruitment of 1992–2020 (5 310 million fish). The abundance-at-age-1 in 2022 are the survivors of the geometric mean recruitment assumed for 2021. Weight-at-age in the catch and in the stock and fishing mortality of the last assessment year are assumed for the interim year. The input data used for the forecasts are presented in Table 9.5.1.

Table 9.5.2 shows the management options table from the deterministic short-term forecasts at fishing mortalities levels used for the different catch scenario options in the advice. The management options table include forecasts of SSB at spawning time (assumed mid-January) and catch at current fishing mortality (F_{bar} of 0.022), F_{MSY}, F_{lim}, the F based on the management plan and the F_{pa} as the maximum value of F applied when SSB > MSY Btrigger that will result in SSB ≥ Blim with a 95% probability in a stochastic long term simulation. Forecast of catches at the F level that produces SSB=B_{lim} and SSB=MSY $B_{trigger}$ are also showed.

The forecasts are deterministic and, therefore, no estimates of uncertainty are calculated. Sources of uncertainty in the outcomes are the recruitment assumed for 2020-2022, the assumptions on a stable mean fishing mortality and the likely changes in the fishery selection pattern in most recent years (see section 9.4.2).

Table 9.5.1. Horse mackerel in Division 9.a. Input for southern horse mackerel short-term forecast (2022–2024) scenarios. N – number of fish;(in thousands), Sel – Selectivity (F-at-age), SWt and CWt – mean weight in the stock and in the catch (in kg).

2022						
Age	N	M	Mat	SWt	Sel	CWt
0	5309945	0.9	0	0.015	0.004	0.015
1	2149252	0.6	0	0.027	0.023	0.027
2	1883495	0.4	0.36	0.054	0.028	0.054
3	1811502	0.3	0.82	0.077	0.027	0.077
4	1433753	0.2	0.95	0.098	0.025	0.098
5	1245009	0.15	0.97	0.129	0.021	0.129
6	774518	0.15	0.99	0.154	0.017	0.154
7	570179	0.15	1	0.183	0.021	0.183
8	427534	0.15	1	0.226	0.021	0.226
9	264801	0.15	1	0.248	0.021	0.248
10	401431	0.15	1	0.278	0.021	0.278
11	682284	0.15	1	0.335	0.021	0.335
2023						
Age	N	M	Mat	SWt	Sel	CWt
0	5309945	0.9	0	0.015	0.004	0.015
1	-	0.6	0	0.027	0.023	0.027
2	-	0.4	0.36	0.054	0.028	0.054
3	-	0.3	0.82	0.077	0.027	0.077
4	-	0.2	0.95	0.098	0.025	0.098
5	-	0.15	0.97	0.129	0.021	0.129
6	-	0.15	0.99	0.154	0.017	0.154
7	-	0.15	1	0.183	0.021	0.183
8	-	0.15	1	0.226	0.021	0.226
9	-	0.15	1	0.248	0.021	0.248
10	-	0.15	1	0.278	0.021	0.278
11	-	0.15	1	0.335	0.021	0.335

2022						
2024						
Age	N	M	Mat	SWt	Sel	CWt
0	5309945	0.9	0	0.015	0.004	0.015
1	-	0.6	0	0.027	0.023	0.027
2	-	0.4	0.36	0.054	0.028	0.054
3	-	0.3	0.82	0.077	0.027	0.077
4	-	0.2	0.95	0.098	0.025	0.098
5	-	0.15	0.97	0.129	0.021	0.129
6	-	0.15	0.99	0.154	0.017	0.154
7	-	0.15	1	0.183	0.021	0.183
8	-	0.15	1	0.226	0.021	0.226
9	-	0.15	1	0.248	0.021	0.248
10	-	0.15	1	0.278	0.021	0.278
11	-	0.15	1	0.335	0.021	0.335

Table 9.5.2. Horse mackerel in Division 9.a. Short-term forecast (2022–2024) for southern horse mackerel. Catch and SSB (at spawning time) in tonnes.

			2022		2023		2024
	Fmult	Fbar	SSB	Catch	SSB	Catch	SSB
F=0	0.00	0.00			1202540	0	1241548
$F_{sq} = F_{2020}$	1.00	0.02	1155488	24155	1201486	25956	1214321
F_{sq}*1.2	1.20	0.03			1201275	31083	1208949
F_{sq}*1.6	1.60	0.04			1200854	41273	1198277
F_{sq}*2.0	2.00	0.04			1200432	51378	1187701
F_MP	4.95	0.11			1197330	123365	1112580
$F_{MSY;}$ F_{pa}	6.75	0.15			1195440	165173	1069137
F_{lim}	8.55	0.19			1193554	205452	1027417
SSB_{2024}=MSY $B_{trigger}$=B_{pa}	88.20	1.96			1113050	1074965	181000
SSB_{2024}=B_{lim}	114.50	2.54			1087697	1169479	103000

9.6 Biological reference points

Biological Reference Points for southern horse mackerel (B_{lim}, B_{pa}, MSY $B_{trigger}$, F_{lim}, F_{pa} and F_{MSY}) were estimated in the 2016 Assessment Working Group (ICES, WGHANSA 2016), were approved by ICES and adopted for the development of the management plan for this stock in the PELAC October 2016 meeting (Table 9.6.1). The biological reference points were re-evaluated

during the 2017 benchmark (WKPELA). However, the new estimates resulted in very similar values and it was agreed not to revise the previously accepted BRP´s from both ICES and PELAC (ICES, 2017).

ICES redefined F_{pa} as $F_{p0.5}$ (the F that leads to SSB ≥ Blim with 95% probability) in 2021 and this lead to a change in F_{MSY} value that is no longer constrained by F_{pa} from 0.11 to 0.15 (ICES, 2021).

Table 9.6.1. Horse mackerel in Division 9.a. Biological Reference points for southern horse mackerel. Values and the technical basis (weights in thousand tonnes).

BRP	Value	Technical basis
B_{lim}	103	$B_{lim} = B_{pa} * \exp(-1.645\ \sigma)$ $\sigma = 0.32\ (0.34)$
B_{pa}	181	$B_{pa} = B_{trigger}$
MSY $B_{trigger}$	181	Lower bound (average) of 90%CI of $SSB_{1992\text{-}2015}$
F_{lim}	0.19	Stochastic long-term simulations (50% probability SSB > B_{lim})
F_{pa}	0.15	F that leads to SSB ≥ Blim with 95% probability (update ICES, 2021).
F_{MSY}	0.15	Stochastic long-term simulations

9.7 Management considerations

The traditional fishery across several fleets has for a long time targeted juvenile age classes. This exploitation pattern combined with a fishing mortality well below F_{MSY} over the whole time-series does not seem to have been detrimental to the dynamics of the stock. Spawning–stock biomass has been above MSY $B_{trigger}$ over the whole time-series with a continuous increase in the last five years and is currently at its highest level. Recruitment since 2011 has been above the time-series average.

The basis for the advice is the same as last year: the MSY approach (F=0.15) and gives estimated catches in 2022 of 165 173 tonnes. The catch advice for 2023 under the MSY approach, represents a significant increase of 528% compared with catches observed in 2021. The difference between the advised TAC and the observed catches is notably dissimilar in recent years (Figure 9.7.1).

There is a MP for this stock based on Ftarget=0.11 (previous F_{MSY}), developed within the PELAC-SWWAC framework, that has been evaluated as precautionary by ICES(ICES, 2018). The management strategy includes a +/- 15% stability clause which is only implemented after the first year of the plan being applied. Since the plan has not previously been applied, the 2023 TAC is not based on the plan and the stability clause does not apply. Last year, ICES has redefined Fpa as Fp0.5 (the F that leads to SSB ≥ Blim with 95% probability) (ICES, 2021) and this lead to a redefinition of F_{MSY} to 0.15. This updated F_{MSY} differs from the Ftarget considered in the management plan that was evaluated in ICES (2018).

The advice pertains to *T. trachurus*, while the total allowable catch (TAC) is set for all *Trachurus* species, including *T. picturatus* (blue jack mackerel) and *T. mediterraneus* (Mediterranean horse mackerel). Part of the catches consist of other *Trachurus* spp. than *T. trachurus*, and this percentage can vary from year to year. Estimates indicate that in 2021, 21% of the catch consisted of

Trachurus spp. (5757 t, mostly *T. picturatus*) other than *T. trachurus*. ICES considers that management of several species under a combined TAC prevents effective control of the single-species exploitation rates, and could lead to overexploitation of any of the species.

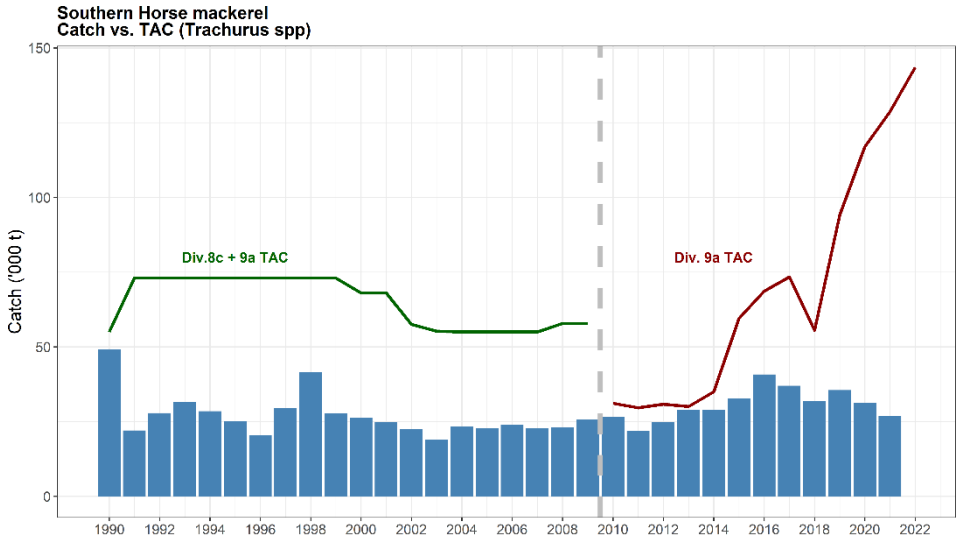


Figure 9.7.1. Horse mackerel in Division 9.a. Catch and TAC for southern horse mackerel. Blue bars show catches for southern horse mackerel, green line shows combined TAC for horse mackerel in division 8c and 9a and red line shows TAC for horse mackerel in division 9a.

9.8 References

Costa, A. M. 2009. Macroscopic vs. microscopic identification of the maturity stages of female horse mackerel. – ICES Journal of MarineScience, 66: 509–516.

ICES. 2008. Report of the Workshop on Sexual Maturity Staging of Mackerel and Horse Mackerel (WKMSMAC), 26-29 November 2007, Lisbon, Portugal. ICES CM 2007/ACFM:26. 52 pp.

ICES. 2016. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA), 24–29 June 2016, Lorient, France. ICES CM 2016/ACOM:17.

ICES. 2017. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA), 6–10 February 2017, Lisbon, Portugal. ICES CM 2017/ACOM:35. 294 pp.

ICES. 2018. Report on the Assessment of a Long-term Management Strategy for Southern Horse Mackerel (hom27.9a), 15–16 February 2018. Manuela Azevedo, Hugo Mendes, Gersom Costas, Ernesto Jardim, Iago Mosqueira, Finlay Scott. ICES CM 2018/ACOM:42. 36 pp.

ICES. 2021. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA). ICES Scientific Reports 3:55. 689 pp. https://doi.org/10.17895/icces.pub.8138.