

Sardine (*Sardina pilchardus*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)

ICES advice on fishing opportunities

ICES advises that when the MSY approach is applied, catches in 2021 should be no more than 10 871 tonnes.

Stock development over time

The biomass of age 1 and older fish (biomass 1+ or B1+) is above MSY $B_{trigger}$ for the first time since 2009. Recruitment in 2019 is the highest since 2004 and above the long-term geometric mean. Fishing mortality has been declining since 2012 and is the lowest in the time-series, but still above F_{MSY} .

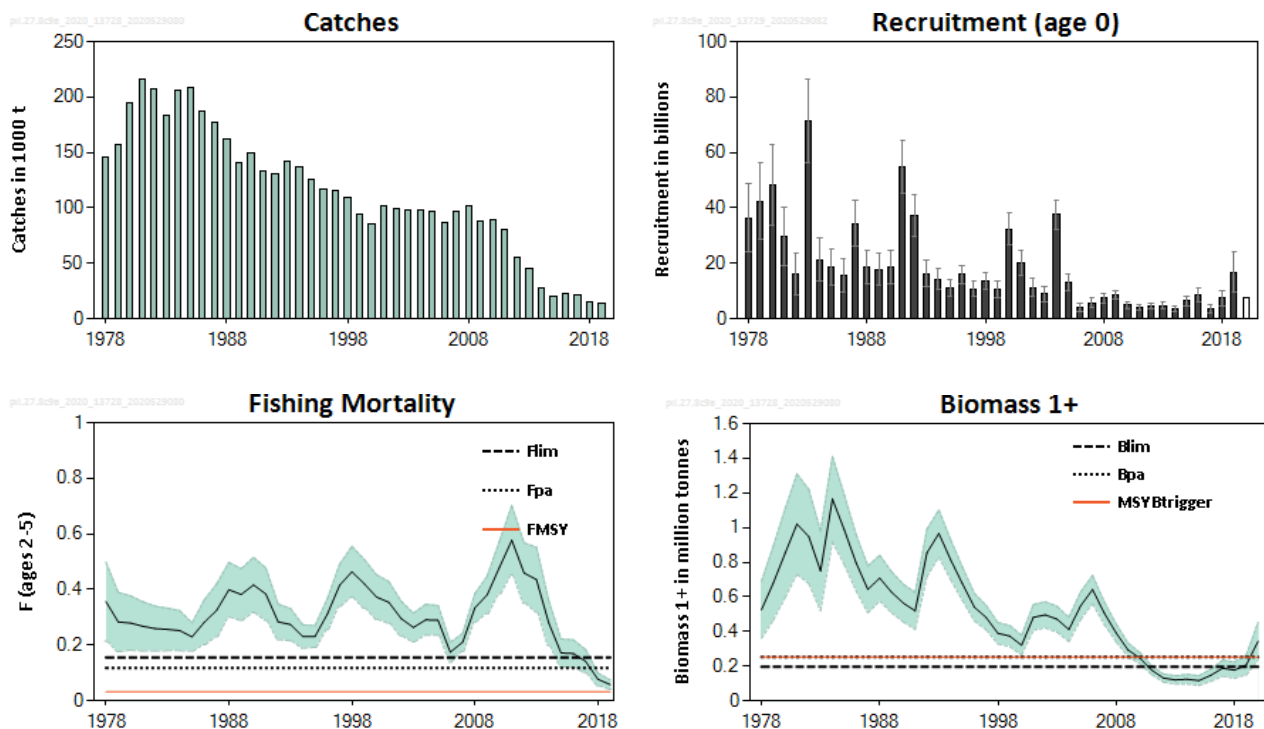


Figure 1 Sardine in divisions 8.c and 9.a. Summary of the stock assessment. Assumed recruitment is unshaded. Recruitment, fishing mortality, and biomass are indicated with 95% confidence intervals. The current reference points reflect the low productivity regime since 2006.

Stock and exploitation status

ICES assesses that fishing pressure on the stock is above F_{MSY} , but below F_{pa} and F_{lim} . The biomass 1+ is above $MSY B_{trigger}$, B_{pa} , and B_{lim} .

Table 1 Sardine in divisions 8.c and 9.a. State of the stock and the fishery relative to reference points.

	Fishing pressure			Stock size				
	2017	2018	2019	2018	2019	2020		
Maximum sustainable yield	F_{MSY}	✘	✘	✘ Above	MSY $B_{trigger}$	✘	✘	✔ Above trigger
Precautionary approach	F_{pa} , F_{lim}	○	✔	✔ Harvested sustainably	B_{pa} , B_{lim}	✘	○	✔ Full reproductive capacity
Management plan	F_{MGT}	–	–	– Not applicable	B_{MGT}	–	–	– Not applicable

Catch scenarios

Table 2 Sardine in divisions 8.c and 9.a. Basis for the catch scenarios. Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
$F_{ages\ 2-5}$ (2020)	0.064	The F that corresponds to the assumed catch in 2020 (19106 t)
B1+ (2021)	351159	Tonnes; obtained from the short-term forecast
$R_{age\ 0}$ (2020)	7584483	Thousands; geometric mean (2015–2019)
$R_{age\ 0}$ (2021)	7584483	Thousands; geometric mean (2015–2019)
Total catch (2020)	19106	Tonnes; assumed catch in 2020 based on the use of HCR12
Discards (2020)	Negligible	-

Table 3 Sardine in divisions 8.c and 9.a. Annual catch scenarios. All weights are in tonnes.

Basis	Catch (2021)	F (2021)	Biomass 1+ (2022)	% Biomass 1+ change *	% Catch change **	% advice change ***
ICES advice basis						
MSY approach: F_{MSY}	10871	0.032	357223	2	-21	13
Other scenarios						
$F = F_{MSY}$	10871	0.032	357223	2	-21	13
$F_{2021} = F_{2020}$	21472	0.064	349386	-1	56	122
F_{HCR12}^{\wedge}	21472	0.064	349386	-1	56	122
F_{pa}	38767	0.118	336640	-4	182	301
F_{lim}	50506	0.156	328016	-7	267	423
B1+ (2022) = B_{lim} (196334)	235355	0.97	196334	-44	1610	2336
B1+ (2022) = B_{pa} (252523)	154932	0.554	252523	-28	1026	1504
B1+ (2022) = MSY $B_{trigger}$ (252523)	154932	0.554	252523	-28	1026	1504

* Biomass 1+ in 2022 relative to biomass 1+ in 2021 (351 159 tonnes).

** Advised catches in 2021 compared to 2019 catches (13 760 tonnes).

*** Advised catches in 2021 compared to advised catches for 2020 (9660 tonnes)

\wedge Precautionary harvest control rule (ICES, 2019a).

The advised catch for 2021 has increased by 13% compared with the advice for 2020, due to an increase in the estimated stock size.

Basis of the advice

Table 4 Sardine in divisions 8.c and 9.a. The basis of the advice.

Advice basis	MSY approach.
Management plan	A bilateral agreement between Portugal and Spain (Despacho 5713-A/2020 [Ministério do Mar, 2020]; BOE-A-2020-4947 [Ministerio de Agricultura, Pesca y Alimentación, 2020]) states that the two countries will manage the fishery in 2020 according to a harvest control rule, HCR12, which has been evaluated by ICES as precautionary (ICES, 2019a). For 2021, the EU Commission requested ICES to provide advice based on the MSY approach.

Quality of the assessment

Data from the Spanish (PELACUS) and Portuguese (PELAGO) acoustic surveys inform a joint index in the assessment model. The PELACUS survey in 2020 could not be carried out due to the COVID-19 disruption. As the PELAGO survey represents the majority of the population in numbers (mean = 91%) and a significant correlation exists between sardine abundance of the two surveys, the PELAGO index was adjusted to account for the lack of the PELACUS estimation.

The assessment of 2020 shows a poor fit to the 2020 point estimate of the acoustic survey index (ICES, 2020a). The model has a tendency to underestimate abundance in years when the survey index is large.

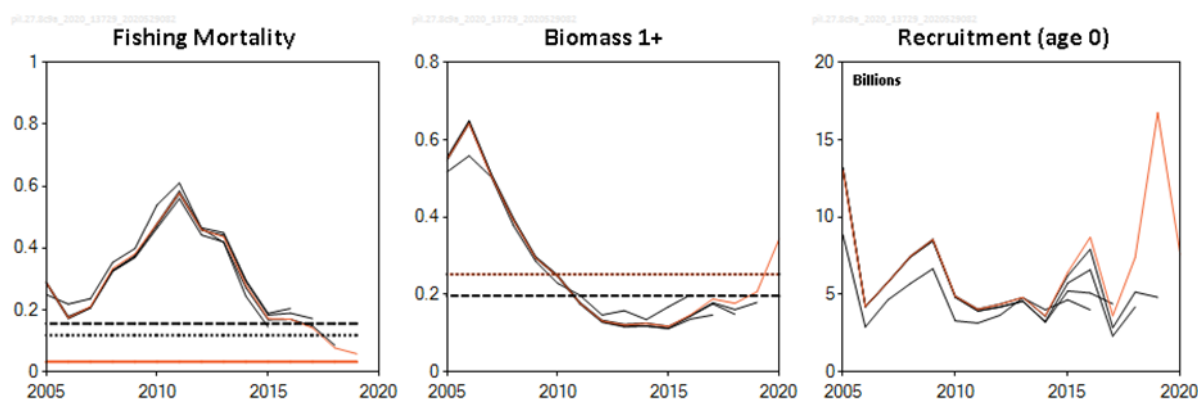


Figure 2 Sardine in divisions 8.c and 9.a. Historical assessment results. For each line in the recruitment plot, the last value is an assumption. Biomass 1+ in million tonnes. Horizontal lines refer to reference points shown in Figure 1.

Issues relevant for the advice

National quotas and effort limitations have contributed to a reduction in fishing mortality of 90% since 2011. In 2020, the sardine fishery was closed until 3 May in Spain and until 31 May in Portugal. According to a bilateral agreement between Portugal and Spain (Despacho 5713-A/2020 [Ministério do Mar, 2020]; BOE-A-2020-4947 [Ministerio de Agricultura, Pesca y Alimentación, 2020]) the fishery will be managed in 2020 according to the harvest control rule, HCR12.

The forecast for 2021 uses the assumption that catch in 2020 corresponds to 19 106 tonnes, the value given by the application of harvest control rule HCR12.

Reference points

Table 5 Sardine in divisions 8.c and 9.a. Reference points, values, and their technical basis.

Framework	Reference	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	252523 tonnes	B_{pa}	ICES (2019b)
	F_{MSY}	0.032	The F that maximizes long-term yield under the constraint that the long-term P ($SSB < B_{lim}$) \leq 5% when applying the ICES MSY advice rule ($F_{p0.5}$); this is calculated by stochastic simulation (EQsim).	ICES (2019b)
Precautionary approach	B_{lim}	196334 tonnes	Break point of segmented regression fitted to stock–recruitment estimates for 2006–2017.	ICES (2019b)
	B_{pa}	252523 tonnes	$B_{pa} = B_{lim} \times \exp(1.645 \times \sigma)$, with $\sigma = 0.153$ (coefficient of variation of SSB_{2017} , from the 2018 assessment).	ICES (2019b)
	F_{lim}	0.156	The F that results in long-term P ($SSB < B_{lim}$) = 50%; this is calculated by stochastic simulation.	ICES (2019b)
	F_{pa}	0.118	$F_{pa} = F_{lim} / \exp(1.645 \times \sigma)$, with $\sigma = 0.233$.	ICES (2019b)
Management plan	SSB_{mgt}	Not defined		
	F_{mgt}	Not defined		

Basis of the assessment

Table 6 Sardine in divisions 8.c and 9.a. Basis of the assessment and advice.

ICES stock data category	1 (ICES, 2019c).
Assessment type	Age-based analytical assessment (Stock Synthesis) that uses catches in the model and in the forecast (ICES, 2020a).
Input data	Commercial catches (international landings, ages from catch sampling); annual acoustic spring survey indices (ages from PELAGO and PELACUS [1996–2019]), triennial spawning–stock biomass (SSB) indices (PT-DEPM and SP-DEPM); triennial stock weights and maturity data from DEPM (PT-DEPM and SP-DEPM [1997–2017]), interpolated for other years; natural mortalities based on the Gislason formula (Gislason <i>et al.</i> , 2010).
Discards and bycatch	Discarding and bycatch are considered negligible and are not included in the assessment.
Indicators	None.
Other information	This stock was benchmarked in February 2017 (WKPELA; ICES, 2017). Biological reference points were updated in 2019 (ICES, 2019b).
Working group	Working Group on Southern Horse Mackerel, Anchovy, and Sardine (WGHANSA)

Information from stakeholders

There is no additional available information.

History of the advice, catch, and management

Table 7 Sardine in divisions 8.c and 9.a. ICES advice and official landings. All weights are in tonnes. No official TAC is set for this stock.

Year	ICES advice	Catch corresponding to advice	Official landings in subareas 8 and 9	ICES catch*
1987	No increase in F; TAC	140000	n/a	177696
1988	No increase in F; TAC	150000	167000	161531
1989	No increase in F; TAC	212000	146000	140961
1990	Room for increased F	-	150000	149429
1991	Precautionary TAC	176000	135000	132587
1992	No advice	-	139000	130250
1993	Precautionary TAC	135000	153000	142495
1994	No advice	-	147000	136582
1995	No advice; apparently stable stock	-	137000	125280
1996	Lowest possible level	-	134000	116736
1997	Lowest possible level	-	n/a	115814
1998	Significant reduction	-	n/a	108924
1999	Reduce F to 0.2	38000	n/a	94091
2000	F below 0.2	< 81000	n/a	85786
2001	F below 0.2	< 88000	n/a	101957
2002	F below 0.25	< 95000	n/a	99673
2003	No increase in F	100000	n/a	97831
2004	No increase in F	128000	n/a	98020
2005	No increase in F	106000	n/a	97345
2006	No increase in F	96000	n/a	87023
2007	No increase in F	114000	n/a	96469
2008	No increase in F	92000	n/a	101464
2009	No increase in F	71000	n/a	87740
2010	No increase in F	75000	n/a	89571
2011	Maintain F at the 2002–2007 level	75000	77000	80403
2012	Reduce F to the 2002–2007 level	36000	52000	54857
2013	Reduce F to the 2002–2007 level	< 55000	46000	45818
2014	Reduce F to the 2002–2007 level, adjusted to low biomass	< 17000	27937	27937

Year	ICES advice	Catch corresponding to advice	Official landings in subareas 8 and 9	ICES catch*
2015	Reduce F to the 2002–2007 level, adjusted to low biomass	< 16000	20595	20595
2016**	Management plan	≤ 12000	22704	22704
2017	Management plan	≤ 23000	21911	21911
2018	MSY approach	0	15062	15062
2019	MSY approach	0	13760	13760
2020***	MSY approach	≤ 9660		
2021	MSY approach	≤ 10871		

n/a = not available.

* Includes only divisions 8.c and 9.a.

** Catch advice for 2016 updated in July 2016.

*** Catch advice for 2020 updated in June 2020.

History of the catch and landings

Table 8 Sardine in divisions 8.c and 9.a. Catch distribution by fleet in 2019, as estimated by ICES.

Catch	Landings		Discards
13760 tonnes	Purse-seine 99%	Other gear types 1%	Discarding is considered negligible
	13760 tonnes		

Table 9 Sardine in divisions 8.c and 9.a. History of ICES catch; values are presented by area. All weights are in tonnes.

Year	Division 8.c	Division 9.a					Total 9.a	Total catch (divisions 8.c and 9.a)
		North	Central North	Central South	South Algarve	South Cadiz		
1940	66816		42132	33275	23724	99131	165947	
1941	27801		26599	34423	9391	70413	98214	
1942	47208		40969	31957	8739	81665	128873	
1943	46348		85692	31362	15871	132925	179273	
1944	76147		88643	31135	8450	128228	204375	
1945	67998		64313	37289	7426	109028	177026	
1946	32280	1231	68787	26430	12237	107454	139734	
1947	43459	21855	55407	25003	15667	117932	161391	
1948	10945	17320	50288	17060	10674	95342	106287	
1949	11519	19504	37868	12077	8952	78401	89920	
1950	13201	27121	47388	17025	17963	109497	122698	
1951	12713	27959	43906	15056	19269	106190	118903	
1952	7765	30485	40938	22687	25331	119441	127206	
1953	4969	27569	68145	16969	12051	124734	129703	
1954	8836	28816	62467	25736	24084	141103	149939	
1955	6851	30804	55618	15191	21150	122763	129614	
1956	12074	29614	58128	24069	14475	126286	138360	
1957	15624	37170	75896	20231	15010	148307	163931	
1958	29743	41143	92790	33937	12554	180424	210167	
1959	42005	36055	87845	23754	11680	159334	201339	
1960	38244	60713	83331	24384	24062	192490	230734	
1961	51212	59570	96105	22872	16528	195075	246287	
1962	28891	46381	77701	29643	23528	177253	206144	
1963	33796	51979	86859	17595	12397	168830	202626	
1964	36390	40897	108065	27636	22035	198633	235023	
1965	31732	47036	82354	35003	18797	183190	214922	
1966	32196	44154	66929	34153	20855	166091	198287	
1967	23480	45595	64210	31576	16635	158016	181496	
1968	24690	51828	46215	16671	14993	129707	154397	
1969	38254	40732	37782	13852	9350	101716	139970	
1970	28934	32306	37608	12989	14257	97160	126094	
1971	41691	48637	36728	16917	16534	118816	160507	
1972	33800	45275	34889	18007	19200	117371	151171	

Year	Division 8.c	Division 9.a						Total catch (divisions 8.c and 9.a)
		North	Central North	Central South	South Algarve	South Cadiz	Total 9.a	
1973	44768	18523	46984	27688	19570		112765	157533
1974	34536	13894	36339	18717	14244		83194	117730
1975	50260	12236	54819	19295	16714		103064	153324
1976	51901	10140	43435	16548	12538		82661	134562
1977	36149	9782	37064	17496	20745		85087	121236
1978	43522	12915	34246	25974	23333	5619	102087	145609
1979	18271	43876	39651	27532	24111	3800	138970	157241
1980	35787	49593	59290	29433	17579	3120	159015	194802
1981	35550	65330	61150	37054	15048	2384	180967	216517
1982	31756	71889	45865	38082	16912	2442	175190	206946
1983	32374	62843	33163	31163	21607	2688	151463	183837
1984	27970	79606	42798	35032	17280	3319	178035	206005
1985	25907	66491	61755	31535	18418	4333	182532	208439
1986	39195	37960	57360	31737	14354	6757	148168	187363
1987	36377	42234	44806	27795	17613	8870	141319	177696
1988	40944	24005	52779	27420	13393	2990	120587	161531
1989	29856	16179	52585	26783	11723	3835	111105	140961
1990	27500	19253	52212	24723	19238	6503	121929	149429
1991	20735	14383	44379	26150	22106	4834	111852	132587
1992	26160	16579	41681	29968	11666	4196	104090	130250
1993	24486	23905	47284	29995	13160	3664	118009	142495
1994	22181	16151	49136	30390	14942	3782	114401	136582
1995	19538	13928	41444	27270	19104	3996	105742	125280
1996	14423	11251	34761	31117	19880	5304	102313	116736
1997	15587	12291	34156	25863	21137	6780	100227	115814
1998	16177	3263	32584	29564	20743	6594	92747	108924
1999	11862	2563	31574	21747	18499	7846	82229	94091
2000	11697	2866	23311	23701	19129	5081	74089	85786
2001	16798	8398	32726	25619	13350	5066	85159	101957
2002	15885	4562	33585	22969	10982	11689	83787	99673
2003	16436	6383	33293	24635	8600	8484	81395	97831
2004	18306	8573	29488	24370	8107	9176	79714	98020
2005	19800	11663	25696	24619	7175	8391	77545	97345
2006	15377	10856	30152	19061	5798	5779	71646	87023
2007	13380	12402	41090	19142	4266	6188	83088	96469
2008	13636	9409	45210	20858	4928	7423	87828	101464
2009	11963	7226	36212	20838	4785	6716	75777	87740
2010	13772	7409	40923	17623	5181	4662	75798	89571
2011	8536	5621	37152	13685	6387	9023	71867	80403
2012	13090	4154	19647	9045	2891	6031	41768	54857
2013	5272	2128	15065	9084	4112	10157	40546	45818
2014	4344	1924	6889	6747	2398	5635	23593	27937
2015	1916	1946	7117	4848	1812	2956	18679	20595
2016	2886	2887	7695	4031	1972	3233	19818	22704
2017	2251	2225	5182	6676	2836	2741	19660	21911
2018	2724	856	3579	4759	1400	1704	12298	15062
2019	1608	1076	3520	4290	1986	1280	12152	13760

Summary of the assessment

Table 10 Sardine in divisions 8.c and 9.a. Assessment summary. High and low refer to 95% confidence intervals.

Year	Recruitment			Spawning-stock biomass			Total catch	Fishing mortality		
	R (age 0)	High	Low	Biomass 1+	High	Low		F (ages 2–5)	High	Low
	thousands			tonnes						
1978	36335400	48595140	24075660	525270	690322	360218	145609	0.36	0.50	0.21
1979	42353800	56148480	28559120	679205	892885	465525	157241	0.28	0.39	0.18
1980	48342900	63040020	33645780	851997	1107841	596153	194802	0.28	0.38	0.182
1981	29883600	40406360	19360840	1020440	1309917	730963	216517	0.27	0.36	0.180
1982	16032600	23648440	8416760	948606	1220537	676675	206946	0.26	0.34	0.179
1983	71372800	86635280	56110320	749471	979106	519836	183837	0.26	0.33	0.180
1984	21226100	29027560	13424640	1164890	1410434	919346	206005	0.25	0.32	0.180
1985	18567800	25135220	12000380	987886	1188961	786811	208439	0.23	0.28	0.179
1986	15784900	21733140	9836660	797581	959835	635327	187363	0.28	0.36	0.20
1987	34409600	42743460	26075740	643032	778613	507451	177696	0.33	0.42	0.23
1988	18648100	24575220	12720980	708401	840533	576269	161531	0.40	0.50	0.30
1989	17802900	23405220	12200580	627011	745655	508367	140961	0.38	0.47	0.29
1990	18636600	24414280	12858920	564403	673162	455644	149429	0.42	0.52	0.32
1991	54591300	64155400	45027200	519087	625358	412816	132587	0.38	0.48	0.29
1992	37160500	44536300	29784700	854665	991481	717849	130250	0.28	0.35	0.22
1993	16281000	20903800	11658200	965980	1101697	830263	142495	0.27	0.33	0.22
1994	14176800	17989260	10364340	814387	929478	699296	136582	0.23	0.27	0.189
1995	11111600	14149980	8073220	675491	771890	579092	125280	0.23	0.27	0.192
1996	15882600	19336280	12428920	541599	621307	461891	116736	0.31	0.37	0.26
1997	10681400	13493840	7868960	480904	551613	410195	115814	0.42	0.49	0.34
1998	13608800	16767740	10449860	389821	451459	328183	108924	0.46	0.56	0.37
1999	10498300	13405920	7590680	374177	435058	313296	94091	0.42	0.51	0.33
2000	32421200	38042460	26799940	320952	378152	263752	85786	0.37	0.45	0.29
2001	20078900	24473400	15684400	482236	556351	408121	101957	0.35	0.43	0.28
2002	11308600	14526260	8090940	496151	571747	420555	99673	0.30	0.36	0.23
2003	8846560	11803000	5890120	471352	545823	396881	97831	0.26	0.32	0.21
2004	37483400	42825020	32141780	411770	481791	341749	98020	0.29	0.35	0.24
2005	13038500	15917040	10159960	549140	629270	469010	97345	0.29	0.34	0.24
2006	4218910	5704028	2733792	642250	723583	560917	87023	0.175	0.21	0.140
2007	5792920	7360426	4225414	505661	570408	440914	96469	0.21	0.24	0.179
2008	7465130	9114586	5815674	391812	443299	340325	101464	0.33	0.39	0.28
2009	8552260	10140256	6964264	294249	334189	254309	87740	0.38	0.45	0.31
2010	4882040	6036218	3727862	247185	279326	215044	89571	0.48	0.57	0.39
2011	4035500	5047068	3023932	177463	203423	151503	80403	0.58	0.70	0.45
2012	4362330	5378508	3346152	131517	155181	107853	54857	0.46	0.57	0.35
2013	4806300	5966384	3646216	121258	145500	97016	45818	0.44	0.55	0.32
2014	3616920	4669052	2564788	124827	152600	97054	27937	0.28	0.36	0.20
2015	6428580	8162712	4694448	117277	145775	88779	20595	0.172	0.22	0.122
2016	8705750	11101370	6310130	147564	182958	112170	22704	0.170	0.22	0.121
2017	3619580	5028420	2210740	188281	234413	142149	21911	0.142	0.184	0.100
2018	7391850	10181550	4602150	177274	224116	130432	15062	0.077	0.100	0.055
2019	16760900	23967740	9554060	207412	264842	149982	13760	0.058	0.075	0.041
2020	7584483*			344114	452644	235584				

* Geometric mean (2015–2019).

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