

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

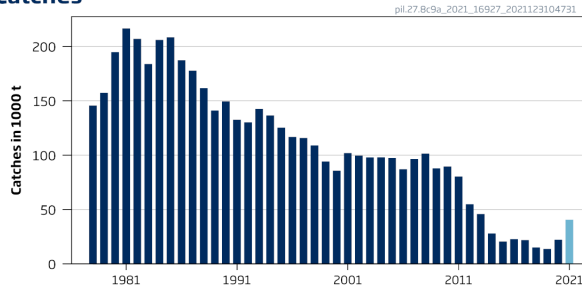
### ICES advice on fishing opportunities

ICES advises that when the MSY approach is applied, catches in 2022 should be no more than 41 777 tonnes.

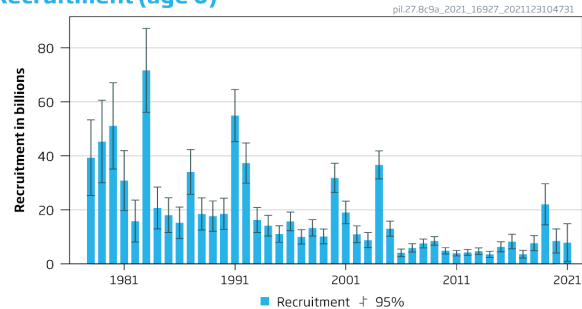
### Stock development over time

Fishing pressure on the stock is above  $F_{MSY}$  and spawning-stock size is above MSY  $B_{trigger}$ ,  $B_{pa}$ , and  $B_{lim}$ .

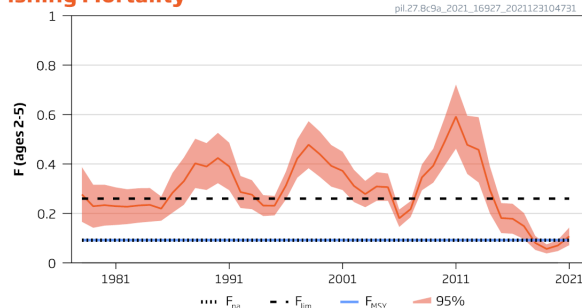
**Catches**



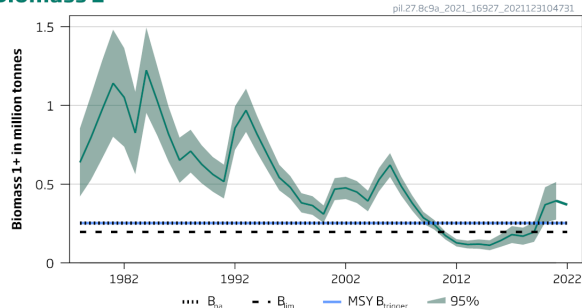
**Recruitment (age 0)**



**Fishing Mortality**



**Biomass 1+**



**Figure 1** Sardine in divisions 8.c and 9.a. Summary of the stock assessment. In the catch plot the 2021 lighter blue bar is a preliminary estimation. The current reference points reflect the low productivity regime since 2006.

### Catch scenarios

**Table 1** Sardine in divisions 8.c and 9.a. Values in the forecast and for the interim year.

Variable	Value	Notes
$F_{ages\ 2-5}$ (2021)	0.107	$F_{ages\ 2-5}$ based on a catch of 40 545 tonnes for 2021.
$B_{1+}$ (2022)	369 328	Short-term forecast; tonnes
$R_{age\ 0}$ (2021)	7 860 940	Recruitment estimated in the assessment; thousands
$R_{age\ 0}$ (2022)	8 333 147	Geometric mean (2017–2021); thousands
Total catch (2021)	40 545	Assumed catch based on national quotas for Portugal and Spain; tonnes
Discards (2021)	Negligible	-

**Table 2** Sardine in divisions 8.c and 9.a. Annual catch scenarios. All weights are in tonnes.

Basis	Catch (2022)	F (2022)	Biomass 1+ (2023)	% Biomass 1+ change *	% Quota change **	% Advice change ***
ICES advice basis						
MSY approach: $F_{MSY}$	41 777	0.092	345 882	-6	3	3
Other scenarios						
$F = F_{MSY} = F_{pa}$	41 777	0.092	345 882	-6	3	3
$F_{2022} = F_{2021}$	48 382	0.107	341 303	-8	19	20
HCR30 ^	30 000	0.065	354 063	-4	-26	-26
HCR35 ^	35 000	0.076	350 588	-5	-14	-13
HCR40 ^	40 000	0.088	347 115	-6	-1	-1
HCR45 ^	44 262	0.098	344 159	-7	9	9
HCR50 ^	44 262	0.098	344 159	-7	9	9
$F_{lim}$	108 784	0.26	299 758	-19	168	169
$B1+ (2023) = B_{lim} (196\ 334)$	264 509	0.81	196 334	-47	552	554
$B1+ (2023) = B_{pa} = MSY B_{trigger} (252\ 523)$	178 738	0.47	252 523	-32	341	342

\* Biomass 1+ in 2023 relative to biomass 1+ in 2022 (369 328 tonnes).

\*\* Advised catches in 2022 compared to the sum of national quotas for Portugal and Spain for 2021 (40 545 tonnes).

\*\*\* Advised catches in 2022 compared to advised catches for 2021 (40 434 tonnes)

^ Precautionary harvest control rule (HCR [ICES, 2021a]). The fishing mortality according to the HCR for the estimated B1+ at the beginning of 2022 would be 0.098 but with the value capped by the maximum allowed catches (e.g. the cap for HCR40 is 40 000 tonnes).

The advice has increased slightly compared to the advice for 2021 due to the increase in the stock biomass.

### Basis of the advice

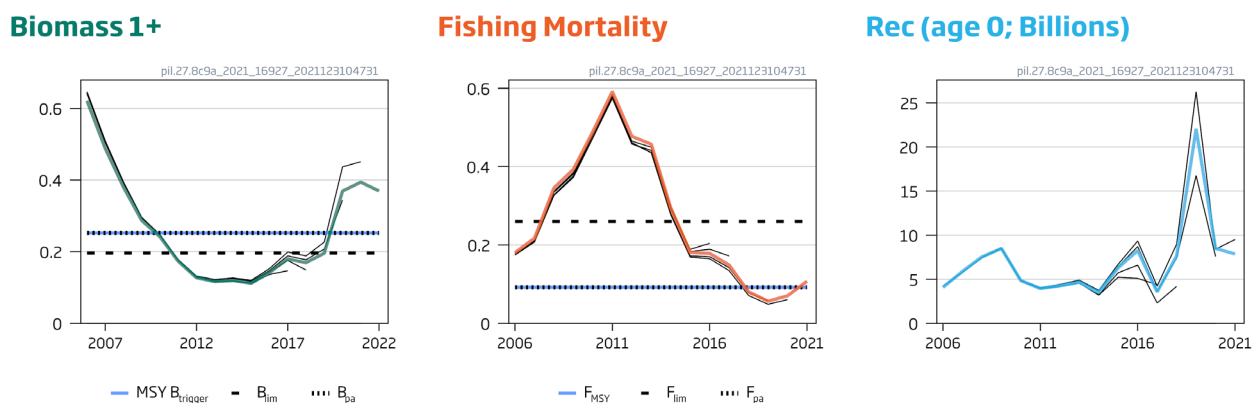
**Table 3** Sardine in divisions 8.c and 9.a. The basis of the advice.

Advice basis	MSY approach
Management plan	ICES evaluated an HCR that is proposed to be part of a management plan for 2021–2026 and found it to be precautionary with maximum allowed catches between 30 000 and 50 000 tonnes (ICES, 2021a). For 2022, the European Commission requested ICES to provide advice based on the MSY approach and include the HCR in other catch scenarios.

### Quality of the assessment

An interbenchmark was carried out in October 2021 (ICES, 2021b) and the revised assessment model was applied (ICES, 2021c). The assessment includes a recruitment index for the first time. The inclusion of this index improves the model estimates, especially the estimation of recruitment in the assessment year. The prediction skill of the new assessment and short-term forecast improved notably (ICES, 2021b).

The collection of data from the commercial fishery and research surveys during 2020 had been affected by COVID-19 restrictions to a varying degree across member states (ICES, 2021c). However, all surveys were fully conducted in 2021.



**Figure 2** Sardine in divisions 8.c and 9.a. Historical assessment results. After the interbenchmark the most recent value for recruitment is estimated within the stock assessment model while previously it was based on the assumption for the short term forecast (geometric mean). Biomass 1+ in million tonnes. Note that the advice for both 2020 and 2021 was updated using in-year assessments.

### Issues relevant for the advice

ICES considers that the stock is in a low productivity regime. The  $F_{MSY}$  corresponding to this regime was re-estimated in 2021 through a management strategy evaluation framework applying the ICES MSY advice rule (ICES, 2021d). As a result, the  $F_{MSY}$  was updated from 0.032 to 0.092.

In 2021 ICES received a request from Portugal and Spain to evaluate a harvest control rule (HCR) that is proposed to be part of a management plan for 2021–2026. The harvest control rules (HCRs) HCR30, HCR35, HCR40, HCR45, and HCR50 are consistent with the ICES precautionary criterion of no more than 5% probability of the spawning–stock biomass ( $B_{1+}$ ) falling below  $B_{lim}$  in both the short and the long term and in both a low (current) and a low–medium (transition) productivity scenarios (ICES, 2021a). A comparison of the performance of the HCRs and the ICES MSY approach in terms of long term yield and stability in catches is available in the advice on the HCR evaluation (ICES, 2021a).

### Reference points

Reference points were revised in 2021 in a management strategy evaluation (MSE) (ICES, 2021d).

**Table 4** Sardine in divisions 8.c and 9.a. Reference points, values, and their technical basis. Weights in tonnes.

Framework	Reference	Value	Technical basis	Source
MSY approach	$MSY B_{trigger}$	252 523	$B_{pa}$	ICES (2021d)
	$F_{MSY}$	0.092	The $F$ that maximizes long-term yield under the constraint that the long-term probability ( $SSB < B_{lim}$ ) $\leq 5\%$ when applying ICES MSY advice rule ( $F_{P05}$ ); calculated by stochastic simulation (MSE)	ICES (2021d)
Precautionary approach	$B_{lim}$	196 334	Break point of segmented regression fitted to stock–recruitment estimates for 2006–2017	ICES (2021d)
	$B_{pa}$	252 523	$B_{pa} = B_{lim} \times \exp(1.645 \times \sigma)$ , with $\sigma = 0.153$ (coefficient of variation of $SSB_{2017}$ , from the 2018 assessment)	ICES (2021d)
	$F_{lim}$	0.26	The $F$ that results in long-term probability ( $SSB < B_{lim}$ ) = 50%; calculated by stochastic simulation (MSE)	ICES (2021d)
	$F_{pa}$	0.092	$F_{P05}$ ; the $F$ that leads to $SSB \geq B_{lim}$ with 95% probability (MSE)	ICES (2021d)
Management plan	$SSB_{mgt}$	Not defined		
	$F_{mgt}$	Not defined		

## Basis of the assessment

**Table 5** Sardine in divisions 8.c and 9.a. Basis of the assessment and advice.

ICES stock data category	1 ( <a href="#">ICES, 2021e</a> )
Assessment type	Age-based analytical assessment (Stock Synthesis) that uses catches in the model and in the forecast (ICES, 2021c)
Input data	Commercial catches (international landings, ages from catch sampling); annual acoustic spring survey indices (ages from PELAGO [A6723] and PELACUS [A2111]; 1996–2021), juvenile index (age 0 abundance in 9aCN from autumn acoustic surveys SAR-PT-AUT [A7387], JUVESAR [A2281] and IBERAS [A4907]; 1997–2021), triennial spawning-stock biomass (SSB) indices from the Sardine Daily Egg Production Method survey (PT-DEPM [I7533] and SP-DEPM [I9787]); triennial stock weights and maturity data from DEPM (PT-DEPM [I7533] and SP-DEPM [I9787]; 1997–2020), 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 2017 (WKPELA; ICES, 2017). Biological reference points were updated in 2021 (ICES, 2021d). The stock had an Interbenchmark in October 2021 to include the autumn acoustic survey as a recruitment index (ICES, 2021b).
Working group	Working Group on Southern Horse Mackerel, Anchovy, and Sardine ( <a href="#">WGHANSA</a> )

## History of the advice, catch, and management

**Table 6** 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	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	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	22143	22143
2021 *	MSY approach	≤ 40434		40545 **
2022	MSY approach	≤ 41777		

n/a = not available.

\* Catch advice was revised in year in 2016, 2020, and 2021.

\*\* Provisional estimate.

### History of the catch and landings

**Table 7** Sardine in divisions 8.c and 9.a. Catch distribution by fleet in 2020, as estimated by ICES.

Catch	Landings		Discards
22 143 tonnes	Purse-seine 99%	Other gear types 1%	Discarding is considered negligible
	22 143 tonnes		

**Table 8** 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	108685	140965	
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	2764	856	3579	4759	1400	1704	12298	15062
2019	1608	1076	3520	4290	1986	1280	12152	13760
2020	2822	1950	5049	7560	2807	1955	19321	22143

**Summary of the assessment**

**Table 9** Sardine in divisions 8.c and 9.a. Assessment summary; 97.5% and 2.5% refer to the confidence interval.

Year	Recruitment			Spawning–stock biomass			Total catch	Fishing Mortality		
	Age 0	97.5%	2.5%	Biomass 1+	97.5%	2.5%		Ages 2–5	97.5%	2.5%
	thousands			tonnes						
1978	39319700	53293240	25346160	637337	853628	421046	145609	0.28	0.39	0.166
1979	45303200	60607540	29998860	795591	1064290	526892	157241	0.23	0.32	0.142
1980	51093900	67042100	35145700	971631	1282083	661179	194802	0.23	0.32	0.151
1981	30856000	41942360	19769640	1140730	1480948	800512	216517	0.23	0.31	0.153
1982	15833600	23609540	8057660	1050850	1364097	737603	206946	0.23	0.30	0.157
1983	71641200	87171020	56111380	824787	1086693	562881	183837	0.23	0.30	0.162
1984	20693800	28427840	12959760	1223480	1494830	952130	206005	0.23	0.30	0.167
1985	18011000	24450080	11571920	1025470	1244817	806123	208439	0.22	0.27	0.170
1986	15218400	21044620	9392180	818643	993438	643848	187363	0.28	0.36	0.20
1987	34025000	42303860	25746140	651679	795322	508036	177696	0.33	0.43	0.23
1988	18484500	24412320	12556680	709402	845620	573184	161531	0.40	0.50	0.30
1989	17675800	23290520	12061080	625741	746677	504805	140961	0.39	0.48	0.29
1990	18533100	24342140	12724060	562026	672301	451751	149429	0.42	0.53	0.32
1991	54912800	64559420	45266180	516150	623758	408542	132587	0.39	0.49	0.29
1992	37336800	44778220	29895380	855649	994284	717014	130250	0.29	0.35	0.22
1993	16246300	20906460	11586140	968715	1106326	831104	142495	0.28	0.33	0.22
1994	14139800	17975880	10303720	816231	933109	699353	136582	0.23	0.27	0.189
1995	11061300	14120400	8002200	676525	774564	578486	125280	0.23	0.27	0.192
1996	15710200	19156580	12263820	541772	623009	460535	116736	0.31	0.37	0.26
1997	10000200	12656460	7343940	479181	551016	407346	115814	0.42	0.50	0.34
1998	13322700	16365740	10279660	381436	442922	319950	108924	0.48	0.57	0.38
1999	10135800	12888840	7382760	363937	423418	304456	94091	0.44	0.53	0.35
2000	31833900	37241340	26426460	309687	364933	254441	85786	0.39	0.48	0.31
2001	19024900	23205500	14844300	468080	538247	397913	101957	0.37	0.45	0.29
2002	10943800	14076720	7810880	475964	546940	404988	99673	0.31	0.38	0.25
2003	8777800	11573960	5981640	450042	519807	380277	97831	0.28	0.33	0.22
2004	36646000	41841680	31450320	392681	458224	327138	98020	0.31	0.37	0.25
2005	13021100	15819300	10222900	527882	601977	453787	97345	0.31	0.36	0.25
2006	4078970	5474906	2683034	621272	697069	545475	87023	0.181	0.22	0.145
2007	5891440	7435410	4347470	488300	548785	427815	96469	0.22	0.25	0.185
2008	7541330	9168914	5913746	379762	428127	331397	101464	0.35	0.40	0.29
2009	8495560	10096428	6894692	286910	324651	249169	87740	0.39	0.46	0.32
2010	4846870	6024242	3669498	241475	271962	210988	89571	0.49	0.59	0.39
2011	3949680	4962254	2937106	173054	198179	147929	80403	0.59	0.72	0.46
2012	4250580	5302274	3198886	127171	150530	103812	54857	0.48	0.60	0.36
2013	4666120	5881320	3450920	116523	141476	91570	45818	0.46	0.59	0.33
2014	3495210	4622626	2367794	119386	149212	89560	27937	0.30	0.39	0.20
2015	6302990	8158898	4447082	111777	143418	80136	20595	0.181	0.24	0.120
2016	8254470	10960010	5548930	142039	182075	102003	22704	0.178	0.24	0.118
2017	3561200	4978274	2144126	179554	233476	125632	21911	0.149	0.20	0.096
2018	7660310	10447450	4873170	169419	223816	115022	15062	0.081	0.109	0.052
2019	22047800	29653420	14442180	195665	257757	133573	13759	0.056	0.075	0.038
2020	8498900	12959820	4037980	369116	480949	257283	22143	0.070	0.093	0.048
2021	7860940	14856560	865320	394227	513737	274717	40545 *			

\* Assumed catch in 2021.

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