

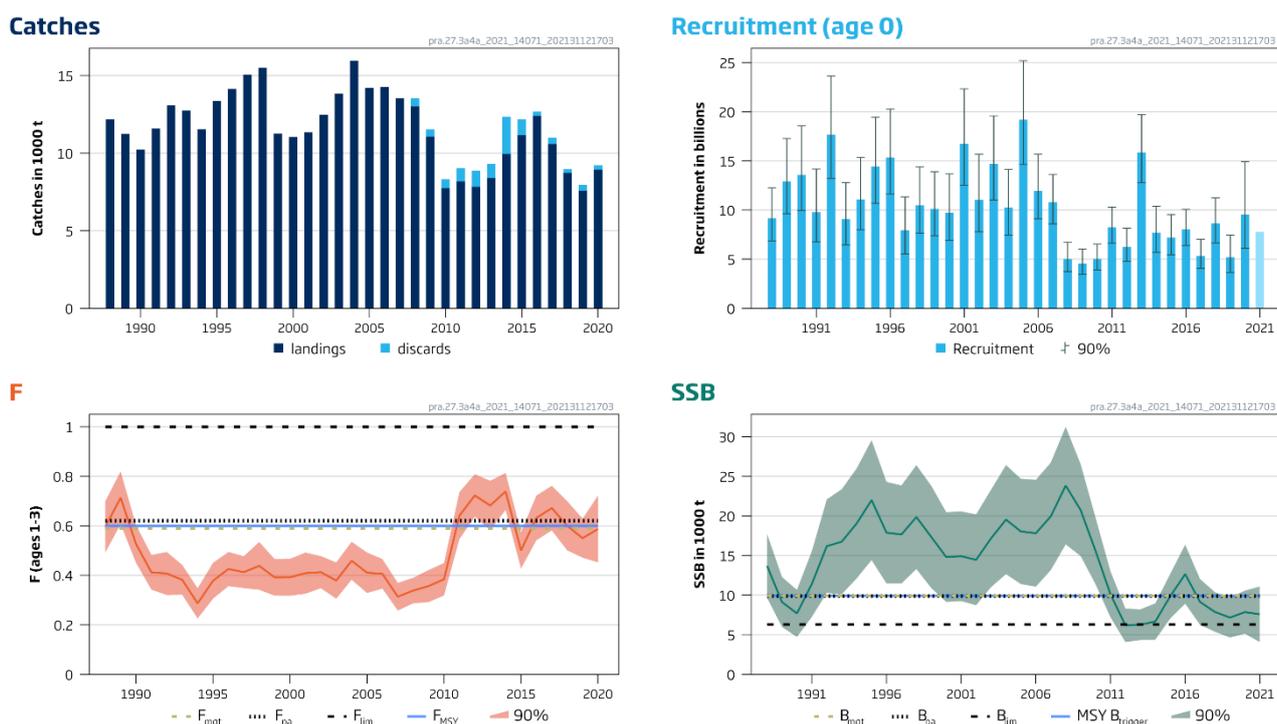
## Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East (Skagerrak and Kattegat and northern North Sea in the Norwegian Deep)

### ICES advice on fishing opportunities

ICES advises that when the EU and Norway long-term management strategy (LTMS) is applied, catches in 2021 should be no more than 7166 tonnes and catches for the first six months of 2022 should be no more than 5554 tonnes.

### Stock development over time

Fishing pressure on the stock is below  $F_{MSY}$  and spawning–stock size is below  $MSY B_{trigger}$  and between  $B_{pa}$  and  $B_{lim}$ .



**Figure 1** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Summary of the stock assessment. Assumed recruitment is shown in a lighter shade of blue. [Note:  $B_{mgt} = B_{pa} = MSY B_{trigger}$ ].

### Update for the catch scenarios 2021

**Table 2** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Assumptions made in the forecast.

Variable	Value	Notes
$F_{2020}$	0.59	From the assessment
$SSB_{2021}$	7581	From the assessment; in tonnes.
$R_{2021}$	7799223	Geometric mean (GM) 2011–2020; in thousands.

**Table 3** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2021)	F <sub>total</sub> (2021)	SSB (2022)	% SSB change *	% TAC change **	% advice change ***
LTMS: $F = F_{\text{mgt}} \times (\text{SSB}_{2021} / \text{MSY } B_{\text{trigger}})$	7166	0.45	9041	19.3	-18.0	-18.0
<b>Other scenarios</b>						
MSY approach: $F = F_{\text{MSY}} \times (\text{SSB}_{2021} / \text{MSY } B_{\text{trigger}})$	7291	0.46	8967	18.3	-16.5	-16.5
F = 0	0	0	13555	79	-100	-100
F <sub>pa</sub>	9182	0.62	7864	3.7	5.1	5.1
F <sub>MSY</sub>	8958	0.60	7993	5.4	2.5	2.5
F <sub>MSY lower</sub>	7040	0.44	9117	20	-19.4	-19.4
F <sub>MSY upper</sub>	9182	0.62	7864	3.7	5.1	5.1
F <sub>lim</sub>	12751	1.00	5918	-22	46	46
F <sub>2020</sub>	8815	0.59	8075	6.5	0.9	0.9
F <sub>mgt</sub>	8847	0.59	8056	6.3	1.27	1.27
SSB <sub>2022</sub> = B <sub>pa</sub> = B <sub>trigger</sub>	5744	0.34	9900	31	-34	-34
SSB <sub>2022</sub> = B <sub>lim</sub>	12020	0.91	6300	-16.9	38	38

\* SSB<sub>2022</sub> relative to SSB<sub>2021</sub>.

\*\* Advised catch in 2021 relative to TACs in 2020 (8736 tonnes).

\*\*\* Advised catch in 2021 relative to advice value in 2020 (8736 tonnes).

The inclusion of the most recent survey data (2021) and catch data (2020) results in a downwards revision of the 2021 biomass estimate and therefore a reduction in advised catch for 2021 relative to the catch initially advised for 2021.

### Catch scenarios for the first six months of 2022

In order to provide catch advice for 2022, an additional assessment was conducted that assumes catches in 2021 are consistent with the present advice (7166 tonnes). Due to the estimation procedure in the assessment model, this results in slightly different estimates of SSB<sub>2022</sub> between tables 3 and 4.

**Table 4** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
F <sub>2021</sub>	0.44	From an assessment assuming catches correspond to the LTMS advice for 2021
SSB <sub>2022</sub>	9358	SSB at the beginning of 2022 from assessment model, including 2021 catches; in tonnes
R <sub>2022</sub>	7840856	GM 2011–2020 from assessment model, including 2021 catches; in thousands
Catches 2021	7166	Catch advice for 2021; in tonnes

**Table 5** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2022)	Q1 and Q2 catch (2022) <sup>^</sup>	F <sub>total</sub> (2022)	SSB (2023)	% SSB change *	% TAC change **	% advice change **
LTMS: $F = F_{\text{mgt}} \times (\text{SSB}_{2022} / \text{MSY } B_{\text{trigger}})$	10890	5554	0.56	9819	4.9	52	52
<b>Other scenarios</b>							
MSY approach: $F = F_{\text{MSY}} \times (\text{SSB}_{2022} / \text{MSY } B_{\text{trigger}})$	11033	5627	0.57	9728	4.0	54	54
F = 0	0	0	0	17176	84	-100	-100
F <sub>pa</sub>	11729	5982	0.62	9286	-0.8	64	64
F <sub>MSY</sub>	11455	5842	0.60	9460	1.09	60	60
F <sub>MSY lower</sub>	9048	4614	0.44	11009	17.6	26	26
F <sub>MSY upper</sub>	11729	5982	0.62	9286	-0.8	64	64
F <sub>lim</sub>	16095	8208	1.00	6636	-29	125	125
F <sub>2021</sub>	9378	4783	0.44	10794	15.3	31	31
F <sub>mgt</sub>	11316	5771	0.59	9548	2.0	58	58
SSB <sub>2023</sub> = B <sub>pa</sub> = B <sub>trigger</sub>	10763	5489	0.55	9900	5.8	50	50
SSB <sub>2023</sub> = B <sub>lim</sub>	16681	8507	1.06	6300	-33	133	133

\* SSB<sub>2023</sub> relative to predicted SSB<sub>2022</sub>.

\*\* Advised catch in 2022 relative to advised catch in 2021 (7166 t).

<sup>^</sup> Total catch 2022 × average proportion of catch taken in the first six months of each of the years 2016–2020 (0.51).

The preliminary advised catch for 2022 is 52% larger than the advised catch for 2021 mainly because the 2020 and 2021 year classes are estimated to be higher than the 2019 year class which results in a higher stock biomass and higher advised fishing mortality for 2022.

### Basis of the advice

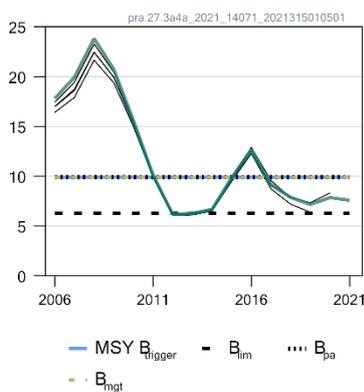
**Table 6** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. The basis of the advice.

Advice basis	EU and Norway long-term management strategy (Anon., 2018)
Management plan	In April 2018, a long-term management strategy (LTMS) was agreed by the EU and Norway (Anon., 2018). ICES has evaluated this strategy and found it to be precautionary (ICES, 2017a). The LTMS has been applied since 2019.

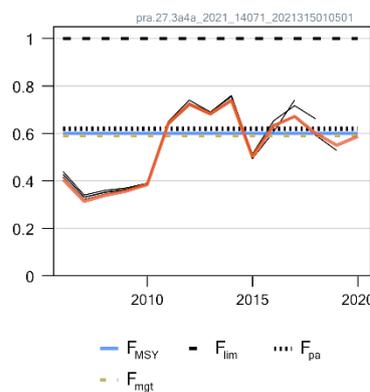
### Quality of the assessment

Due to COVID-19 the Swedish on-board observer sampling in quarters 2–4 of 2020 was cancelled, and estimates of discard rates from the corresponding quarters in 2019 were used as replacements. The missing data are assessed to have minor influence on the assessment and advice as Swedish discard data are combined with Danish and Norwegian data to provide one integrated estimate per quarter.

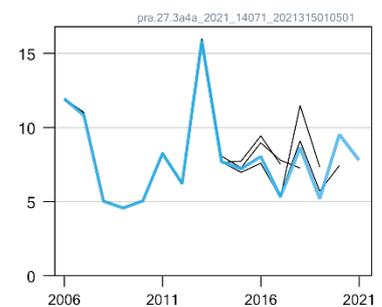
#### SSB (1000 t)



#### F (ages 1-3)



#### Rec (age 0; Billions)



**Figure 2** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Historical assessment results. Final-year recruitment assumptions are included.

### Issues relevant for the advice

The updated catch advice for 2021 is 18% lower than the initial catch advice (7166 tonnes compared to 8753 tonnes). This change is partly explained by the realized catches in 2020 (9226 tonnes) being higher than the advised catches (8736 tonnes). National quota management should take account of the loss in landed weight compared to live weight due to on-board boiling.

The LTMS assumes that all catches are based on live weight. National catch statistics should be adjusted to take account of the loss in weight due to on-board boiling.

The catch forecast for 2022 depends on the 2021 uptake, which is assumed to be equal to the advised catch (7166 tonnes).

## Reference points

**Table 7** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	9900 t	The 5th percentile of the equilibrium distribution of SSB when fishing at $F_{MSY}$ , constrained to be no less than $B_{pa}$	ICES (2016)
	$F_{MSY}$	0.60	The F that maximizes median equilibrium yield (defining yield as the total catch)	ICES (2017)
Precautionary approach	$B_{lim}$	6300 t	$B_{loss}$ (lowest observed SSB in the benchmark assessment 2016)	ICES (2016)
	$B_{pa}$	9900 t	$B_{lim} \times \exp(1.645 \times \sigma)$ , where $\sigma = 0.27$	ICES (2016)
	$F_{lim}$	1.00	The F that leads to 50% probability of SSB < $B_{lim}$	ICES (2016)
	$F_{pa}$	0.62	$F_{p0.5}$ . The F that leads to SSB $\geq B_{lim}$ with 95% probability	ICES (2017)
Management plan	$B_{mgt}$	9900	The 5th percentile of the equilibrium distribution of SSB when fishing at $F_{MSY}$ , constrained to be no less than $B_{pa}$	ICES (2017)
	$F_{mgt}$	0.59	The F that maximizes median equilibrium yield (defining yield as the total catch) when banking and borrowing is allowed	ICES (2017)

## Basis of the assessment

**Table 8** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Basis of the assessment and advice.

ICES stock data category	1 (ICES, 2021).
Assessment type	Quarterly length-based analytical assessment (Stock Synthesis 3) that uses catches in the model and in the forecast
Input data	Length–frequency distributions from commercial catches and survey. Commercial landings (until 2007), commercial catches (since 2008), three survey indices derived from Norwegian shrimp surveys (1984–2002; 2004–2005, and 2006–onwards (2016 missing) (G7438, G7635, and G1758). Boiled landings have been corrected for loss in weight by a factor of 1.13.
Discards and bycatch	Discards are included in the assessment (Swedish values since 2008, Norwegian and Danish values since 2009). Norwegian discards were estimated using the Danish discard ratio until 2016 and using data from the Norwegian reference fleet since 2017.
Indicators	Swedish, Danish, and Norwegian standardized landings per unit of effort (LPUE).
Other information	This stock was benchmarked in January 2016 (ICES, 2016).
Working group	Joint NAFO/ICES <i>Pandalus</i> Assessment Working Group (NIPAG).

## History of the advice, catch, and management

**Table 9** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. ICES advice and official landings. All weights are in tonnes.

Year	ICES advice	Landings corresponding to advice	Catch corresponding to initial advice	Catch corresponding to final advice	TAC Division 3.a	TAC Norwegian zone Subarea 4	ICES discard estimates	ICES landings	ICES catch (discards and landings)
1987	Not assessed							14153	
1988	Catches significantly below 1985–1986 catch							12177	
1989	No advice				3100 *			11249	
1990	3.a: F as F (pre-1985); 4.a East: No increase in F	10000			2750 *			10239	
1991	No increase in F; TAC	12000			8550			11595	
1992	Within safe biological limits	15000 **			10500	4500		13081	
1993	Within safe biological limits	13000 **			10500	4500		12753	
1994	Within safe biological limits	19000 **			12600	5400		11549	

Year	ICES advice	Landings corresponding to advice	Catch corresponding to initial advice	Catch corresponding to final advice	TAC Division 3.a	TAC Norwegian zone Subarea 4	ICES discard estimates	ICES landings	ICES catch (discards and landings)
1995	Within safe biological limits	13000 **			11200	4800		13361	
1996	No advice	11000 **			10500	4500		14149	
1997	No advice	13000 **			10500	4500		15074	
1998	No increase in F; TAC	19000 **			13160	5640		15504	
1999	Maintain F	19000 **			13160	5640		11254	
2000	Maintain F	< 11500 **			9100	3900		11038	
2001	Maintain F	13400			10150	4350		11350	
2002	Long-term average landings	12600			10150	4350		12484	
2003	Maintain F	14700			10150	4425		13845	
2004	No increase in F	15300 ^			10710	4590		15956	
2005	No increase in catch above recent level	~13000 ^			10710	4590		14207	
2006	No increase in catch above recent level	~13500 ^			11200	4800		14268	
2007	No increase in landings above recent level	~14000 ^			11620	4980		13555	
2008	No increase in landings above recent level	~15000 ^			11620	4980	540	13014	13554
2009	Same advice as last year	~15000 ^			11620	4980	467	11069	11536
2010	No increase in landings above 2008 level	~13000 ^			9800	4200	572	7754	8326
2011	At least 30% decrease in landings of 2007–2009, reduce discards, mandatory sorting grids	< 8800			8300	3570	874	8169	9043
2012	Reduce catches and reduce discards	-			7100	3035	1051	7827	8878
2013	Reduce landings by 36% and reduce discards	≤ 5800			6650	2850	909	8396	9305
2014	MSY considerations, reduce discards	≤ 5426		≤ 6000	6650	2850	2387	9952	12339

Year	ICES advice	Landings corresponding to advice	Catch corresponding to initial advice	Catch corresponding to final advice	TAC Division 3.a	TAC Norwegian zone Subarea 4	ICES discard estimates	ICES landings	ICES catch (discards and landings)
2015	MSY considerations, no increase in F, reduce discards	≤ 9777		≤ 10900	7630	3270	1005	11161	12166
2016	MSY approach	≤ 11869 ^^		≤ 13721	10987	4709	283	12397	12680
2017	MSY approach			≤ 10316	7221	3095	419	10585	11004
2018	MSY approach		≤ 10475	≤ 8571	6230	2670	241	8730	8971
2019	Long-term management strategy		≤ 9036	≤ 6163	4314	1849	368	7577	7944
2020	Long-term management strategy		≤ 12439	≤ 8736	6116	2620	285	8941	9226
2021	Long-term management strategy		≤ 8753	≤ 7166					
2022	Long-term management strategy		≤ 5554#						

\* EU zone only.

\*\* Catch at *status quo* F.

^ Single-stock boundaries and the exploitation of this stock should be conducted in the context of mixed fisheries, protecting stocks outside safe biological limits.

^^ Wanted catch.

# For quarters 1 and 2 only, based on an annual total of 10 890 tonnes.

## History of the catch and landings

**Table 10** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Catch distribution by fleet in 2020 as estimated by ICES.

Catch	Landings		Discards	
	Trawls 100%	Trawls 100%	Trawls 100%	Trawls 100%
9226 tonnes	8941 tonnes		285 tonnes	

**Table 11** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. History of commercial catch and landings; ICES estimated values are presented by country. All weights are in tonnes.

Year	Denmark *^	Norway *	Sweden *	Total landings	Estimated Danish discards	Estimated Norwegian discards **	Estimated Swedish discards	Estimated catch
1970	1102	1729	2742	5573				
1971	1190	2486	2906	6582				
1972	1017	2477	2524	6018				
1973	755	2333	2130	5218				
1974	530	1809	2003	4342				
1975	817	2339	2003	5159				
1976	1204	3348	2529	7081				
1977	1120	3004	2019	6143				
1978	1459	2440	1609	5508				
1979	1062	3040	1787	5889				
1980	1678	4562	2159	8399				
1981	2593	5187	2241	10021				
1982	3766	5422	1450	10638				
1983	1804	5370	1136	8310				
1984	1800	4770	1022	7592				
1985	4498	6550	1571	12619				
1986	4866	6492	1463	12821				

Year	Denmark *^	Norway *	Sweden *	Total landings	Estimated Danish discards	Estimated Norwegian discards **	Estimated Swedish discards	Estimated catch
1987	4488	8343	1322	14153				
1988	3240	7659	1278	12177				
1989	3242	6574	1433	11249				
1990	2479	6152	1608	10239				
1991	3583	6104	1908	11595				
1992	3725	7202	2154	13081				
1993	2915	7538	2300	12753				
1994	2134	6814	2601	11549				
1995	2460	8019	2882	13361				
1996	3868	7910	2371	14149				
1997	3909	8568	2597	15074				
1998	3330	9704	2469	15504				
1999	2072	6737	2445	11254				
2000	2371	6442	2225	11038				
2001	1954	7288	2108	11350				
2002	2470	7713	2301	12484				
2003	3270	8186	2389	13845				
2004	3944	9548	2464	15956				
2005	2992	8958	2257	14207				
2006	3111	8669	2488	14268				
2007	2422	8688	2445	13555				
2008	2274	8261	2479	13014			540	13554
2009	2224	6362	2483	11069	36	94	337	11537
2010	1301	4673	1781	7754	53	133	386	8328
2011	1601	4800	1768	8169	123	247	504	9043
2012	1454	4852	1521	7827	88	292	671	8878
2013	2026	5179	1191	8396	185	459	265	9305
2014	2432	6123	1397	9952	526	1289	572	12340
2015	2709	6808	1644	11161	204	476	325	12166
2016	1997	8305	2095	12397	35	161	87	12680
2017	2173	6778	1634	10586	206	114	99	11004
2018	1863	5493	1374	8730	12	115	114	8971
2019	2058	4414	1105	7577	83	178	106	7944
2020	2301	5349	1291	8941	59	82	143	9226

\* Swedish (all years), Norwegian (since 2000), and Danish (since 2001) landings have been corrected for loss in weight due to boiling.

\*\* Norwegian discard estimates until 2016 are obtained by applying the Danish discard ratio to Norwegian data and since 2017 by using data from the Norwegian reference fleet.

^ Danish estimates include smaller catches from the most north-eastern parts of Division 4.b. *Pandalus* from this area are considered to belong to the *Pandalus* stock in divisions 3.a and 4.a East.

Summary of the assessment

**Table 12** Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Assessment summary. All weights are in tonnes and recruitment in thousands. High and Low refers to 90% confidence intervals.

Year	Recruitment age 0			SSB**			Landings	Discards	F Ages 1–3		
	Low	Estimate	High	Low	Estimate	High			Low	Estimate	High
1988	6852884	9167000	12262559	9668	13701	17735	12177		0.49	0.60	0.70
1989	9618943	12889100	17271013	5974	9131	12289	11249		0.61	0.71	0.82
1990	9933573	13581400	18568789	4721	7693	10664	10239		0.45	0.53	0.60
1991	6763783	9790900	14172797	7252	11413	15575	11595		0.34	0.41	0.48
1992	13208941	17670100	23637961	10279	16182	22084	13081		0.32	0.41	0.49
1993	6442815	9080570	12798249	10112	16742	23373	12753		0.32	0.38	0.44
1994	8000805	11084900	15357831	12101	19044	25988	11549		0.23	0.29	0.35
1995	10684045	14411300	19438853	14422	21994	29565	13361		0.31	0.38	0.45
1996	11618764	15349600	20278424	11469	17881	24294	14149		0.36	0.43	0.49
1997	5539050	7921470	11328601	11463	17656	23850	15074		0.35	0.41	0.48
1998	7636917	10480800	14383707	13300	19855	26411	15504		0.34	0.44	0.53
1999	7376712	10126700	13901865	10885	17339	23793	11254		0.32	0.39	0.47
2000	6905562	9721700	13686280	9138	14806	20473	11038		0.32	0.39	0.47
2001	12520494	16721200	22331270	9244	14909	20573	11350		0.33	0.41	0.49
2002	7776689	11041800	15677796	8723	14458	20192	12484		0.35	0.41	0.48
2003	11021598	14688900	19576452	11015	17166	23316	13845		0.31	0.38	0.45
2004	7441984	10258000	14139585	12644	19533	26422	15956		0.38	0.46	0.54
2005	14623228	19192100	25188467	11393	18038	24684	14207		0.33	0.41	0.49
2006	9097705	11945100	15683671	11067	17810	24553	14268		0.35	0.41	0.47
2007	8575744	10808200	13621814	13148	19937	26727	13555		0.26	0.31	0.37
2008	3750772	5019750	6718054	16397	23824	31251	13014	540	0.29	0.34	0.39
2009	3443282	4563180	6047316	14937	20741	26544	11069	467	0.29	0.36	0.42
2010	3898024	5046760	6534026	11365	15577	19790	7754	573	0.32	0.38	0.45
2011	6629530	8251970	10271469	7198	10104	13010	8169	874	0.55	0.64	0.74
2012	4772167	6233550	8142452	4075	6188	8302	7827	1051	0.64	0.72	0.81
2013	12765245	15858400	19701059	4322	6266	8209	8396	909	0.58	0.68	0.78
2014	5710469	7704790	10395607	4379	6672	8964	9952	2388	0.66	0.74	0.81
2015	5451347	7213100	9544212	7045	9862	12680	11161	1005	0.43	0.50	0.57
2016	6403306	8032360	10075858	8920	12645	16371	12397	284	0.54	0.63	0.72
2017	4048775	5330960	7019193	6250	9139	12027	10586	419	0.58	0.67	0.76
2018	6647995	8642490	11235363	5369	7867	10366	8730	241	0.50	0.60	0.70
2019	3634382	5204980	7454313	4650	7165	9680	7577	368	0.47	0.55	0.63
2020	6090464	9536120	14931142	5128	7851	10574	8941	285	0.45	0.59	0.72
2021		7799223*		4072	7581	11090					

\* Geometric mean 2011–2020.

\*\* The spawning–stock biomass constitutes a small fraction of the total exploitable biomass.

## Sources and references

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