

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 Long-term Management Strategy (LTMS) is applied, catches in 2019 should be no more than 6163 tonnes and that catches for the first two quarters of 2020 should be no more than 6329 tonnes.

Stock development over time

The spawning-stock biomass (SSB) declined after 2008 and has fluctuated at a lower level since then. SSB in 2019 is close to B_{lim} . Fishing mortality (F) has been above F_{MSY} in all years since 2011, except in 2015. Recruitment has been below average since 2008, except for the 2013 and 2018 year classes.

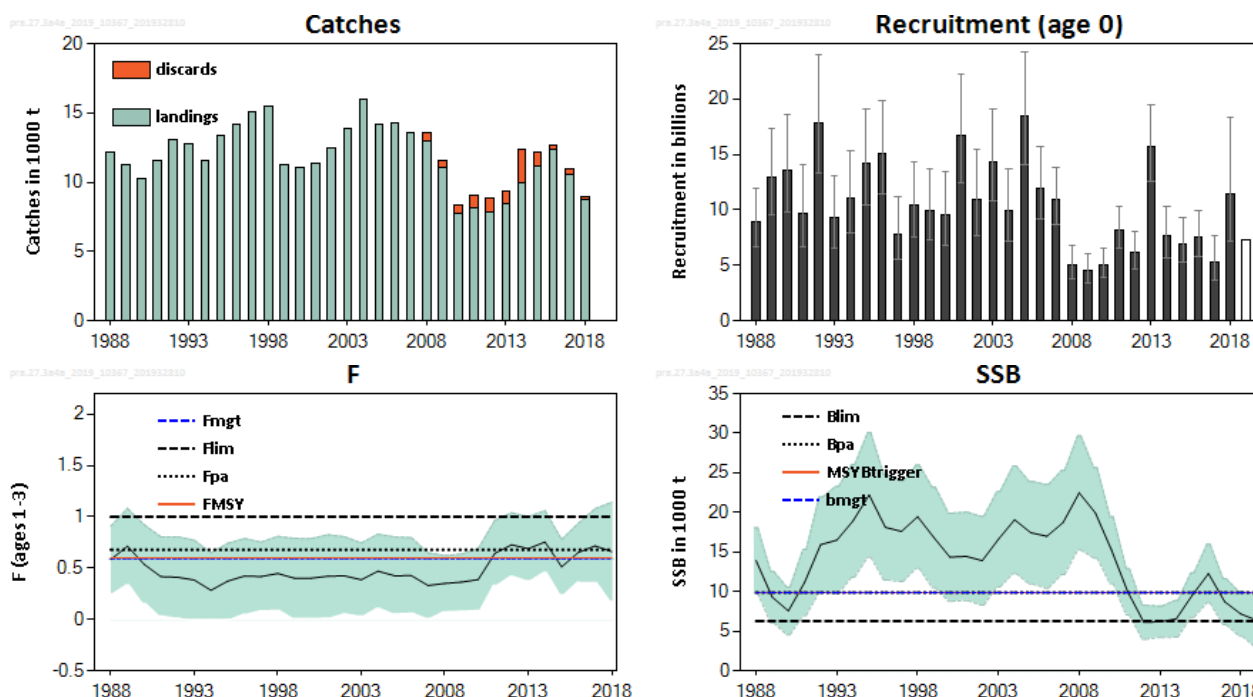


Figure 1 Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Summary of the stock assessment. Recruitment and SSB are presented with 90% confidence intervals. Assumed recruitment is unshaded. [Note $B_{mgt} = B_{PA} = MSY - B_{trigger}$].

Stock and exploitation status

ICES assesses that current fishing pressure on the stock is above F_{MSY} but below F_{pa} and F_{lim} and spawning stock size is below $MSY B_{trigger}$ and between B_{pa} and B_{lim} .

Table 1 Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. State of the stock and fishery relative to reference points.

		Fishing pressure			Stock size					
		2016	2017	2018	2017	2018	2019			
Maximum sustainable yield	F_{MSY}	✗	✗	✗	$MSY B_{trigger}$	✗	✗	✗	Above	Below trigger
Precautionary approach	F_{pa}, F_{lim}	✓	⦿	✓	B_{pa}, B_{lim}	⦿	⦿	⦿	Harvested sustainably	Increased risk
Management plan	F_{MGT}	✗	✗	✗	B_{MGT}	✗	✗	✗	Above	Below

Update for the catch scenarios 2019

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

Variable	Value	Notes
F ₂₀₁₈	0.65	From the assessment
SSB ₂₀₁₉	6377	From the assessment (in tonnes)
R ₂₀₁₉	7339344	Geometric mean (GM) 2009–2018 (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 (2019)	F _{total} (2019)	SSB (2020)	% SSB change *	% TAC change **	% advice change ***
LTMS: $F = F_{MGT} \times (SSB_{2019} / MSY B_{trigger})$	6163	0.38	9952	56.1	-30.8	-28.1
Other scenarios						
MSY approach: $F = F_{MSY} \times (SSB_{2019} / MSY B_{trigger})$	6301	0.39	9872	54.8	-29.2	-26.5
F = 0	0	0	13678	114.5	-100	-100
F _{pa}	9780	0.68	7943	24.6	9.9	14.1
F _{MSY}	8901	0.6	8417	32.0	0.0	3.9
F _{MSY lower}	6954	0.44	9499	49.0	-21.87	-18.9
F _{MSY upper}	10199	0.72	7721	21.1	14.60	19.0
F _{lim}	12810	1	6392	0.2	43.9	49.5
F ₂₀₁₈	9562	0.66	8060	26.4	7.4	11.6
F _{MGT}	8785	0.59	8480	33.0	-1.3	2.5
SSB ₂₀₂₀ = B _{PA} = B _{trigger}	6255	0.39	9900	55.2	-29.7	-27.0
SSB ₂₀₂₀ = B _{lim}	12996	1.02	6300	-1.2	46.0	51.6

* SSB₂₀₂₀ relative to SSB₂₀₁₉.

** Advised catch in 2019 relative to TACs in 2018 (8900 t).

*** Advised catch in 2019 relative to advice value 2018 (8571 t).

The inclusion of the most recent survey data (2019) and catch data (2018) results in decline in SSB₂₀₁₉ close to B_{lim} and the reduction in catches advised.

Catch scenarios for first semester in 2020

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 ₂₀₁₉	0.38	Corresponds to the LTMS advice for 2019
SSB ₂₀₂₀	10050	SSB beginning of 2020 (in tonnes) from assessment model, including 2019 catches
R ₂₀₂₀	7353780	GM 2009–2018 (in thousands) from assessment model, including 2019 catches
Catches 2019	6163	Catch advice for 2019 (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 (2020)	Q1 and Q2 catch (2020) ^	F _{total} (2020)	SSB (2021)	% SSB change *	% TAC change **	% advice change **
LTMS	12439	6329	0.59	10282	2.3	101.8	101.8
Other scenarios							
MSY Approach	12593	6407	0.60	10182	1.3	104.3	104.3
F _{MSY lower}	9950	5063	0.44	11931	18.7	61.4	61.4
F _{MSY upper}	14315	7284	0.72	9071	-9.7	132.3	132.3
F = 0	0	0	0	18878	87.8	-100.0	-100.0
F _{lim}	17640	8975	1.0	7012	-30.2	186.2	186.2
F _{pa}	13760	7001	0.68	9426	-6.2	123.3	123.3
F ₂₀₁₉	8852	4504	0.38	12672	26.1	43.6	43.6
SSB ₂₀₂₁ = B _{pa} = B _{trigger}	13025	6627	0.63	9900	-1.5	111.3	111.3
SSB ₂₀₂₁ = B _{lim}	18844	9588	1.12	6300	-37.3	205.8	205.8

* SSB 2021 relative to predicted SSB₂₀₂₀.

** Advised catch in 2020 relative to advised catch in 2019 (6163 t).

^ Total catch 2020 × average proportion of catch taken in the first two quarters of 2014–2018 (0.51).

The main reason for the increase in the advice is the strong reduction in F assumed for 2019 and the above average 2018 year class that provides catch opportunities while also bringing the SSB₂₀₂₀ above B_{MGT}.

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 EU and Norway (Anon., 2018). ICES has evaluated this strategy and found it to be precautionary (ICES, 2017a). The LTMS was implemented from 2019.

Quality of the assessment

This assessment consistently estimates SSB and F. However, the current year’s assessment shows a lower recruitment in most of the recent years which is taken into account in the forecast.

Since 2017 Norwegian discard estimates have been based on the reference fleet. Prior to 2017, Norwegian discard estimates in the Skagerrak were based on Danish discard ratios.

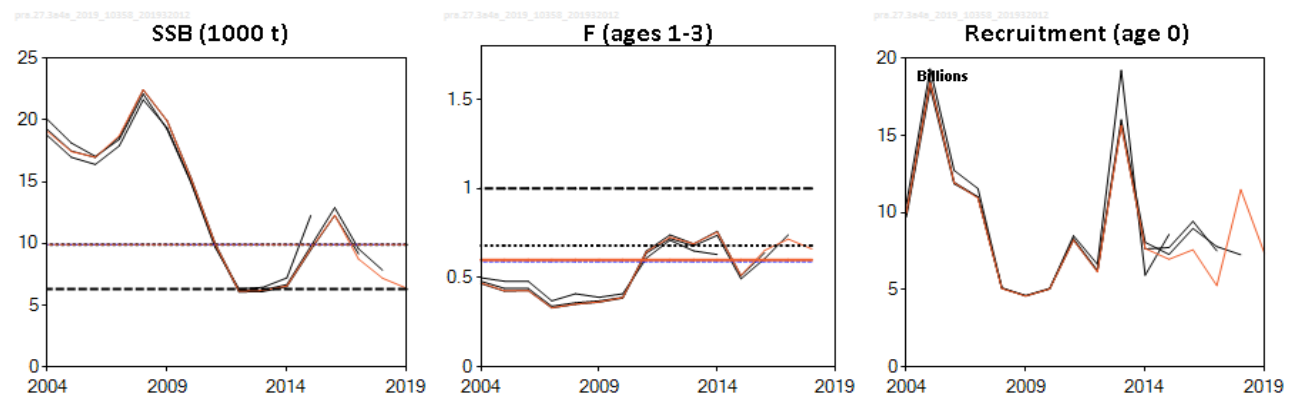


Figure 2 Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Historical assessment results. The autumn 2016 assessment was postponed to March 2017 and therefore does not appear in the graphs (Note: final year R assumptions are included).

Issues relevant for the advice

New year classes of shrimp enter the fishery at age 1 and start to contribute to the SSB at ages 1–2. This means that both the catch options and the SSB of the short-term forecast are strongly dependent on the recruitment estimate of the final year of the assessment model.

In order to produce catch advice for 2020 an additional assessment was made assuming catches in 2019 are consistent with the advice (6163 tonnes). The catch forecast for 2020 will be sensitive to this assumption (this also results in slightly different estimates of SSB₂₀₂₀ between Table 3 and Table 4)

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 5 th percentile of the equilibrium distribution of SSB when fishing at F _{MSY} , constrained to be no less than B _{pa}	ICES (2016a)
	F _{MSY}	0.60	The F that maximizes median equilibrium yield (defining yield as the total catch)	ICES (2017a)
Precautionary approach	B _{lim}	6300 t	B _{loss} (lowest observed SSB in the benchmark assessment 2016)	ICES (2016a)
	B _{pa}	9900 t	B _{lim} × exp(1.645 × σ), where σ = 0.27	ICES (2016a)
	F _{lim}	1.00	The F that leads to 50% probability of SSB < B _{lim}	ICES (2016a)
	F _{pa}	0.68	F _{lim} × exp(-1.645 × σ), where σ = 0.23	ICES (2016a)
Management plan	B _{mgmt}	9900	The 5 th percentile of the equilibrium distribution of SSB when fishing at F _{MSY} , constrained to be no less than B _{pa}	ICES (2017a)
	F _{mgmt}	0.59	The F that maximizes median equilibrium yield (defining yield as the total catch), when banking and borrowing is allowed	ICES (2017a)

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, 2018).
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), Norwegian shrimp survey 1984–2019 (excluding 2003 and 2016).
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 for 2017 and 2018.
Indicators	Swedish, Danish, and Norwegian standardized landings per unit effort (LPUE).
Other information	This stock was benchmarked in January 2016 (ICES, 2016a).
Working group	Joint NAFO/ICES <i>Pandalus</i> Assessment Working Group (NIPAG).

Information from stakeholders

There is no additional available information for this stock.

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 advice	TAC Division 3.a	TAC Norwegian zone Subarea 4	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	
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 advice	TAC Division 3.a	TAC Norwegian zone Subarea 4	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		≤ 8571 ^^	6230	2670	241	8730	8971
2019	Long-term management strategy		≤ 6163 #					
2020	Long-term management strategy		≤ 6329 ##					

* 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.

^^^ Revised from ≤ 10 475 tonnes in March 2018.

Revised from full year advice of ≤ 9036 t (4608 t for Q1 & 2) issued in November 2018.

For quarters 1 and 2 only, based on an annual total of 12 439 tonnes.

The catch estimate in 2017 has been revised in comparison to last year; mainly due to new Norwegian discard estimates (previous estimate was 1854 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 2018 as estimated by ICES.

Catch	Landings	Discards
8971 tonnes	Trawls 100%	Trawls 100%
	8730 tonnes	241 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				
1987	4488	8343	1322	14153				
1988	3240	7659	1278	12177				
1989	3242	6574	1433	11249				
1990	2479	6152	1608	10239				

Year	Denmark *	Norway *	Sweden *	Total landings	Estimated Danish discards	Estimated Norwegian discards **	Estimated Swedish discards	Estimated catch
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

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

** Norwegian discards have been estimated by applying the Danish discard ratio to Norwegian data until 2016, and using data from the Norwegian reference fleet for 2017 and 2018.

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. High and low refers to 90% confidence intervals.

Year	Recruitment Age 0	Recruitment High	Recruitment Low	SSB	SSB High	SSB Low	Landing	Discard	F Ages 1–3	F High	F Low
	thousands										
1988	8929150	11984768	6652588	13924	18054	9794	12177		0.58	0.91	0.25
1989	12899800	17355129	9588222	9306	12550	6062	11249		0.71	1.08	0.34
1990	13510600	18566676	9831394	7574	10584	4563	10239		0.54	0.92	0.157
1991	9736540	14132757	6707836	11158	15329	6987	11595		0.42	0.81	0.035
1992	17879900	24046777	13294539	15943	21933	9953	13081		0.41	0.81	0.0140
1993	9245820	13037972	6556632	16510	23268	9751	12753		0.38	0.77	-0.0128
1994	11058200	15378964	7951367	18930	26037	11822	11549		0.29	0.65	-0.070
1995	14153400	19105810	10484703	22204	30045	14363	13361		0.37	0.74	-0.0017
1996	15071700	19881280	11425630	18121	24763	11479	14149		0.42	0.79	0.051
1997	7827610	11189799	5475655	17612	23939	11286	15074		0.42	0.75	0.086
1998	10402500	14275278	7580378	19460	25981	12940	15504		0.45	0.81	0.090
1999	9941220	13639245	7245845	16837	23171	10504	11254		0.40	0.79	0.0099
2000	9525540	13422597	6759937	14355	19913	8796	11038		0.40	0.79	0.0114
2001	16678900	22261059	12496517	14451	20013	8888	11350		0.42	0.82	0.0150
2002	10942800	15486140	7732390	13913	19521	8305	12484		0.43	0.81	0.054
2003	14322600	19041520	10773135	16618	22642	10594	13845		0.39	0.75	0.034
2004	9970140	13754432	7227030	19082	25866	12297	15956		0.47	0.83	0.109

Year	Recruitment Age 0	Recruitment High	Recruitment Low	SSB	SSB High	SSB Low	Landing	Discard	F Ages 1–3	F High	F Low
	thousands										
2005	18428400	24179775	14045041	17447	23911	10983	14207		0.43	0.80	0.056
2006	11944200	15645159	9118726	16998	23535	10461	14268		0.43	0.80	0.062
2007	10943400	13775631	8693468	18733	25304	12161	13555		0.33	0.65	0.0104
2008	5075420	6788194	3794807	22468	29660	15277	13014	540	0.35	0.62	0.077
2009	4594380	6097327	3461899	19940	25636	14244	11069	467	0.36	0.64	0.083
2010	5052440	6553065	3895452	15249	19454	11043	7754	573	0.39	0.69	0.090
2011	8220640	10256395	6588954	9986	12912	7060	8169	874	0.65	0.97	0.33
2012	6161770	8055338	4713323	6143	8284	4002	7827	1051	0.73	1.04	0.42
2013	15652000	19457807	12590581	6198	8166	4231	8396	909	0.69	1.00	0.38
2014	7677890	10330873	5706197	6556	8871	4241	9952	2388	0.76	1.06	0.46
2015	6977130	9300314	5234269	9573	12365	6782	11161	1005	0.51	0.78	0.24
2016	7594930	9940945	5802563	12286	15979	8593	12397	284	0.65	0.94	0.36
2017	5270360	7657034	3627605	8732	11631	5834	10586	419	0.72	1.08	0.36
2018	11491600	18329945	7204433	7185	9975	4395	8730	241	0.66	1.14	0.178
2019	7339340			6377	9790	2964					

* Geometric mean 2009–2018.

Sources and references

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