

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 MSY approach is applied, catches in 2018 should be no more than 8571 tonnes.

Stock development over time

The spawning-stock biomass (SSB) declined after 2010 and has fluctuated at a lower level since then. SSB in 2018 is below $MSY B_{trigger}$. Fishing mortality has been above F_{MSY} since 2011, except in 2015 and 2016. Recruitment has been below average since 2008, except for the 2013 year class.

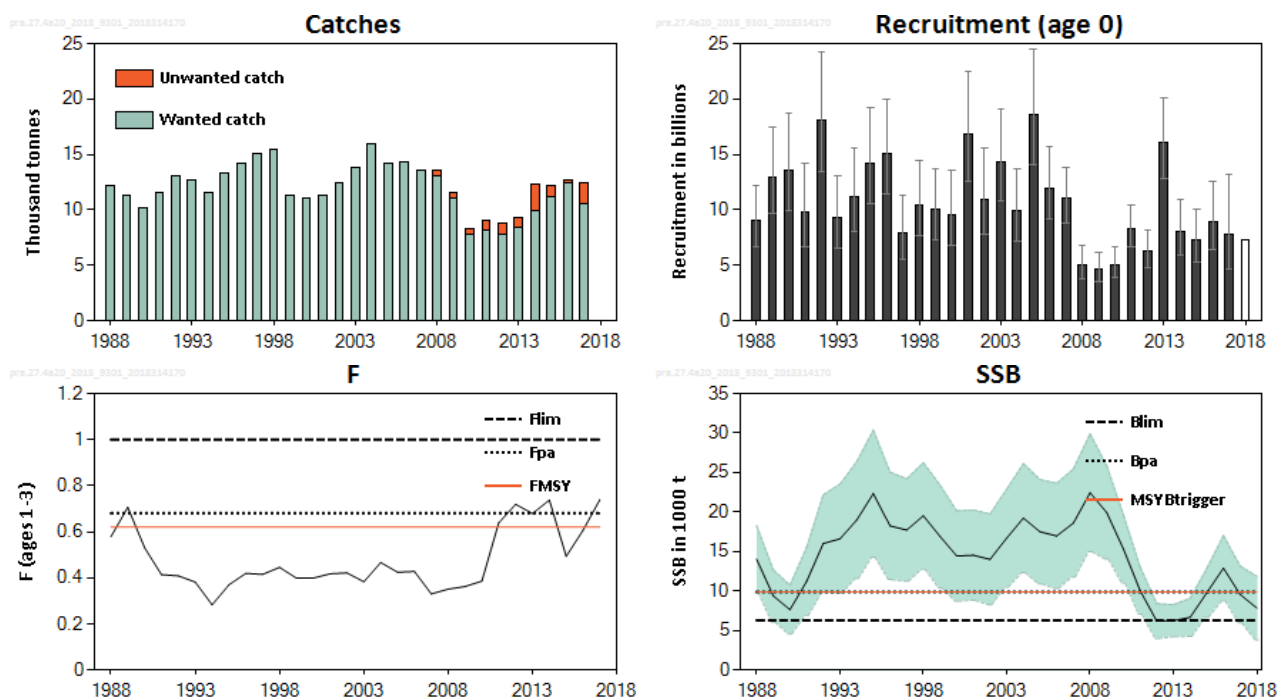


Figure 1 Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Summary of the stock assessment. Recruitment and SSB are presented with 90% confidence intervals.

Stock and exploitation status

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		
		2015	2016	2017	2016	2017	2018
Maximum sustainable yield	F_{MSY}	✓	✓	✗ Above	$MSY B_{trigger}$	✓	✗ Below trigger
Precautionary approach	F_{pa}, F_{lim}	✓	✓	○ Increased risk	B_{pa}, B_{lim}	✓	○ Increased risk
Management plan	F_{MGT}	—	—	— Not applicable	B_{MGT}	—	— Not applicable

Catch scenarios

Table 2 Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. The basis for the catch scenarios.

Variable	Value	Notes
F ₂₀₁₇	0.74	Corresponds to the estimated catches in 2017
SSB ₂₀₁₈	7844	In tonnes
R ₂₀₁₈	7269781	GM 2008–2017 (in thousands)
Catch (2017)	12439	In tonnes

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 (2018)	F _{total} (2018)	SSB (2019)	% SSB change *	% TAC change **	% advice change ***
ICES advice basis						
MSY approach: F = F _{MSY} × (SSB ₂₀₁₈ / MSY B _{trigger})	8571	0.49	9291	18.4	-16.9	-16.9
Other scenarios						
F = 0	0	0	15013	91.4	-100.0	-100.0
F _{pa}	10935	0.68	7821	-0.3	6.0	6.0
F _{MSY}	10233	0.62	8251	5.2	-0.8	-0.8
F = F ₂₀₁₇	11600	0.74	7420	-5.4	12.4	12.4
SSB(2019) = B _{pa} = B _{trigger}	7616	0.42	9900	26.2	-26.2	-26.2
SSB(2019) = B _{lim}	13503	0.93	6300	-19.7	30.9	30.9
F _{MGT} = 0.48 × (SSB ₂₀₁₈ / 12000 [^])	5954	0.31	10981	40.0	-42.3	-42.3
F _{MGT} = 0.45 ^{^^} × (SSB ₂₀₁₈ / 12000 [^])	5644	0.29	11185	42.6	-45.3	-45.3

* SSB 2019 relative to SSB 2018.

** Catch in 2018 relative to TACs in 2017.

*** Advice value 2018 relative to advice value 2017.

[^] Value of B_{trigger} in the evaluated management plan (ICES, 2017a).

^{^^} F target in the evaluated management plan where there is interannual quota flexibility of ±10% (ICES, 2017a).

The main reasons for the reduction in the advice is that the catches in 2017, particularly the discards, were higher than assumed in the 2017 assessment and because SSB₂₀₁₈ is below MSY B_{trigger}.

Basis of the advice

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

Advice basis	MSY approach
Management plan	There is no agreed management plan for Northern shrimp in this area. A proposed harvest control rule was evaluated by ICES in 2017 (ICES, 2017a) and was found to be precautionary. The management plan is under consideration and not yet adopted.

Quality of the assessment

A benchmark in January 2016 (ICES, 2016a) resulted in the adoption of a quarterly length-based model as the basis for the assessment and the provision of catch advice for this *Pandalus* stock. The length-based model is preferred over the previous surplus production model because it uses more of the available data, including observed length distributions and a quarterly time step to achieve a better representation of the population structure and dynamics. The length-based model accounts for variation in recruitment and how these changes influence catch scenarios in the short term.

Discarding practices in the Norwegian fishery have been unknown, and Norwegian discards in Skagerrak have been estimated by applying the Danish discard ratio to the Norwegian data up to 2016. In 2017, Norwegian discards were estimated using Norwegian samples of landings and catches. The Norwegian discard rate in 2017 was considerably higher than previously assumed.

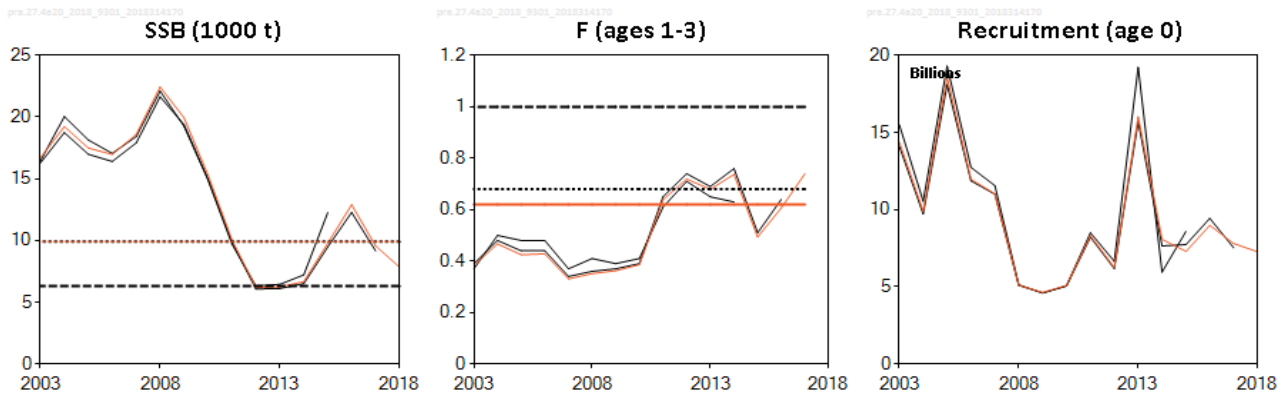


Figure 2 Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Historical assessment results. The autumn 2016 assessment was postponed to March 2017 and therefore does not appear in the graphs.

Issues relevant for the advice

The present advice is based on an assessment that includes the results of the Norwegian shrimp survey in the current TAC year (2018) and full catch statistics from the previous calendar year (2017; ICES, 2017b). In December 2017 (ICES, 2017a), ICES advised that the advice on catch opportunities should be based on an assessment conducted in February just after the January survey with advice available in March for the current year. The performance of a TAC year from January 1 to December 31 is similar to that of a TAC year from 1 May to the 30 April. However, SSB and biomass reference points for this stock correspond to January 1. Therefore, ICES advises that the TAC year should be kept from January 1 to December 31. This also implies that a preliminary TAC should be set for the first part of the advice year.

ICES previously advised 10 475 tonnes of catch for 2018. The total catch in 2017 was higher than assumed in the previous assessment. This resulted in a higher F in 2017 and an SSB in 2018 which was further below $MSY B_{trigger}$. Therefore, ICES advises an F in 2018 of 0.49 which is below F_{MSY} and the previously advised $F(0.57)$.

ICES provides catch advice since the Norwegian discard ban and the EU landings obligation apply. Average observed discard rates in the first year of the implementation of the EU landings obligation for this stock (2016) were 2.2%. The estimated discard rate in 2017 was 14.9% (mainly due to the inclusion of new Norwegian discard estimates).

ICES conducted an evaluation of a proposed harvest control rule (HCR) in November 2017 (ICES, 2017a). ICES has evaluated a range of harvest control rules, consisting of F_{target} , $B_{trigger}$ combinations. ICES advises that the option that maximizes the median long-term yield while resulting in no more than 5% probability of the spawning-stock biomass (SSB) falling below B_{lim} in any 20-year period, was identified as F_{target} , $B_{trigger}$ at 0.48, 12 000 tonnes. If an interannual quota flexibility of $\pm 10\%$ is allowed, with $B_{trigger} = 12\ 000$ tonnes then the F_{target} should be reduced to 0.45 in order for the probability of the SSB falling below B_{lim} not to increase above 5% in any 20-year period. The proposed management plan F target and $MSY B_{trigger}$ are therefore different from the current $F_{MSY} (= 0.62)$ and $MSY B_{trigger} (= 9900\ t)$ for the stock. The current advice uses the ICES MSY advice rule which implies $F_{MSY} = 0.62$ and $B_{trigger} = 9900\ t$. ICES also notes that recruitment in the last decade has been lower than in earlier years. If recruitment in the next three to five years continues to be low, a lower F_{target} would be necessary in the harvest control rule in order not to exceed a 5% probability of the SSB falling below B_{lim} in any 20-year period.

Reference points

Table 5 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}	0.62	The F that maximizes median equilibrium yield (defining yield as the total catch)	ICES (2016a)
Precautionary approach	B_{lim}	6300 t	B_{loss} (lowest observed SSB in the benchmark assessment 2016)	ICES (2016a)
	B_{pa}	9900 t	$B_{lim} \times \exp(1.645 \times \sigma)$, where $\sigma = 0.27$	ICES (2016a)
	F_{lim}	1.00	The F that leads to 50% probability of $SSB < B_{lim}$	ICES (2016a)
	F_{pa}	0.68	$F_{lim} \times \exp(-1.645 \times \sigma)$, where $\sigma = 0.23$	ICES (2016a)
Management plan	SSB_{mgt}		There is no management plan adopted	
	F_{mgt}		There is no management plan adopted	

Basis of the assessment

Table 6 Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Basis of assessment and advice.

ICES stock data category	1 (ICES, 2016b)
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 1984–2018 (excluding 2003 and 2016).
Discards and bycatch	Discards are included in the assessment (Swedish fleet since 2008, Norwegian and Danish fleets since 2009). Norwegian discards were estimated using the Danish discard ratio until 2016 and using Norwegian data for 2017.
Indicators	Swedish, Danish, and Norwegian standardized 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 7 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	Predicted landings corresp. to advice	Predicted catch corresp. to advice	TAC Div. 3a	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	3a: F as F(pre-1985); 4a 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
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	1854	10585	12439
2018	MSY approach		≤ 8571 ^^					

* TACs in the Norwegian zone of Subarea 4.

** 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 in March 2018.

History of the catch and landings

Table 8 Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Catch distribution by fleet in 2017 as estimated by ICES.

Catch (2017)	Landings	Discards
12439 tonnes	Trawls 100 %	1854 tonnes
	10585 tonnes	

Table 9 Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. History of commercial catch and landings; ICES estimated values are presented by area for each country participating in the fishery. 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				
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	11536
2010	1301	4673	1781	7754	53	133	386	8326
2011	1601	4800	1768	8169	123	247	504	9043

Year	Denmark*	Norway*	Sweden*	Total landings	Estimated Danish discards	Estimated Norwegian discards**	Estimated Swedish discards	Estimated catch
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	12339
2015	2709	6808	1644	11161	204	476	325	12166
2016	1997	8305	2095	12397	35	161	87	12680
2017	2173	6778	1634	10585	206	1549	99	12439

* 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 Norwegian data for 2017.

Summary of the assessment

Table 10 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 thousands	High	Low	SSB tonnes	High	Low	F Ages 1–3
1988	9031760	12139604	6719551	14036	18261	9811	0.58
1989	12978400	17505803	9621887	9381	12685	6078	0.71
1990	13622100	18738265	9902817	7635	10716	4555	0.53
1991	9779230	14215839	6727238	11216	15514	6917	0.41
1992	18030500	24289985	13384073	16010	22179	9840	0.41
1993	9299280	13116833	6592796	16608	23532	9685	0.38
1994	11178800	15558730	8031862	18968	26351	11586	0.28
1995	14238500	19230909	10542137	22331	30367	14296	0.37
1996	15118900	19994510	11432195	18245	25043	11446	0.42
1997	7895770	11292020	5520995	17722	24206	11238	0.41
1998	10485800	14405043	7632883	19517	26243	12792	0.45
1999	10008400	13750974	7284435	16923	23417	10430	0.40
2000	9613900	13564069	6814111	14436	20147	8725	0.40
2001	16851900	22502396	12620280	14537	20246	8828	0.42
2002	10974600	15537249	7751813	14009	19749	8269	0.42
2003	14375600	19139703	10797340	16706	22894	10518	0.38
2004	9897350	13696155	7152192	19229	26125	12332	0.47
2005	18580800	24468934	14109570	17498	24095	10901	0.42
2006	11977700	15702466	9136482	16976	23640	10311	0.43
2007	11024200	13880198	8755854	18609	25452	11766	0.33
2008	5096260	6822258	3806931	22444	29895	14993	0.35
2009	4634430	6169257	3481447	19939	25834	14044	0.36
2010	5084360	6612698	3909254	15312	19615	11008	0.39
2011	8310650	10410943	6634068	10047	13037	7057	0.64
2012	6251260	8207061	4761540	6193	8390	3997	0.72
2013	16017100	20091520	12768944	6241	8283	4199	0.68
2014	8077820	10958952	5954144	6665	9080	4249	0.74
2015	7293140	10101782	5265397	9775	12857	6693	0.49
2016	8981830	12555002	6425588	12901	17019	8782	0.61
2017	7797750	13149850	4624000	9563	13158	5967	0.74
2018	7269781*			7844	11867	3821	

*Geometric mean 2008–2017.

Sources and references

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