Northern shrimp (*Pandalus borealis*) in subareas 1 and 2 (Northeast Arctic)

ICES advice on fishing opportunities

ICES advises that when the MSY approach is applied, catches in 2021 should be no more than 140 000 tonnes.

Stock development over time

Throughout the history of the fishery, estimates of spawning-stock biomass (SSB) have remained above MSY $B_{trigger}$ and fishing mortality (F) has been well below F_{MSY}.

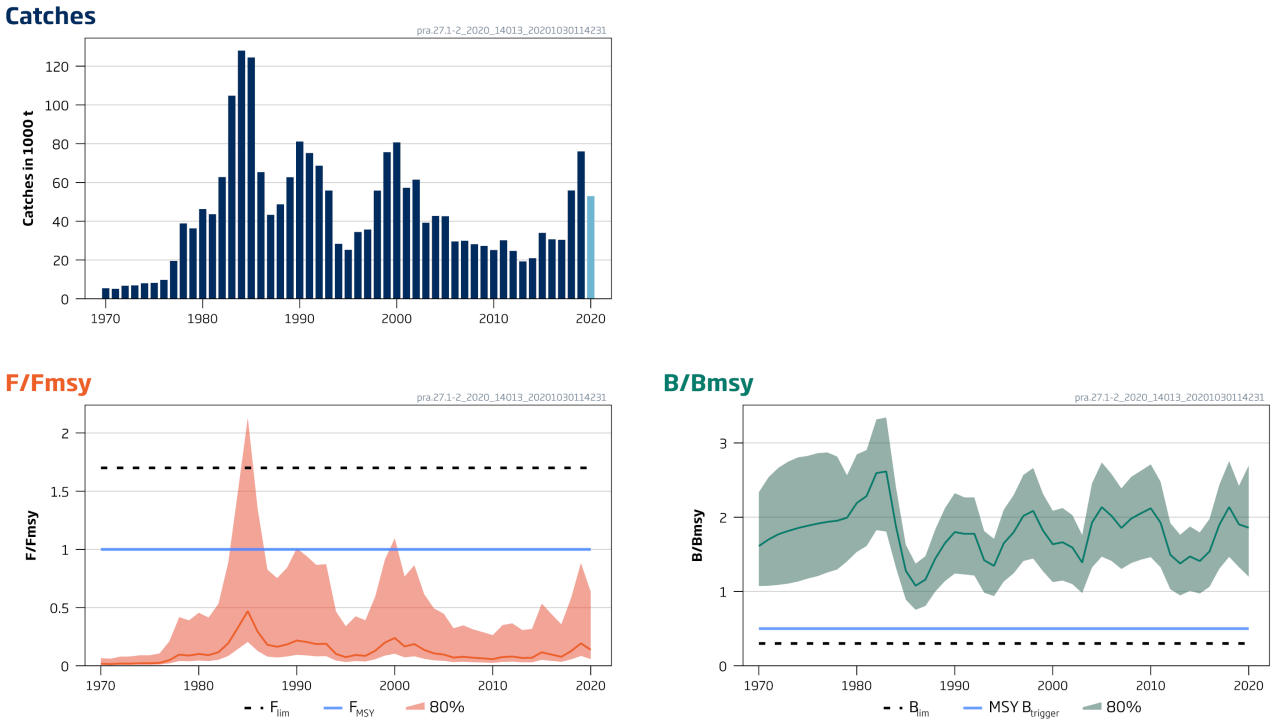

Figure 1 Northern shrimp in subareas 1 and 2. Summary of the stock assessment. Top: total catches (the 2020 paler bar is preliminary estimation). Bottom: biomass and fishing mortality relative to B_{MSY} and F_{MSY}, respectively, and with 80% probability intervals.

Stock and exploitation status

ICES assesses that fishing pressure on the stock is below F_{MSY} and F_{lim}. Biomass is above MSY $B_{trigger}$ and B_{lim}.

Table 1 Northern shrimp in subareas 1 and 2. State of the stock and fishery relative to reference points.

	Fishing pressure				Stock size			
		2018	2019	2020		2018	2019	2020
Maximum sustainable yield	F_{MSY}	✓	✓	✓ Below	MSY $B_{trigger}$	✓	✓	✓ Above trigger
Precautionary approach	F_{pa},F_{lim}	✓	✓	✓ Below possible reference points	B_{pa},B_{lim}	✓	✓	✓ Above possible reference points
Management plan	F_{MGT}	–	–	– Not applicable	B_{MGT}	–	–	– Not applicable

Catch scenarios

Table 2 Northern shrimp in subareas 1 and 2. The basis for the catch scenarios.

Variable	Value	Notes
Median F_{2020}/F_{MSY}	0.14	Corresponds to the estimated catch in 2020.
Median B_{2020}/B_{MSY}	1.86	B_{2020} is the biomass at the end of 2020, considering the estimated catch in 2020.
Catch (2020)	53000	Based on catch data until August and information from the industry. All catches are assumed to be landed;in tonnes.

Table 3 Northern shrimp in subareas 1 and 2. Annual catch scenarios for 2021.

Basis	Catch scenarios in 2021				
	70 000 t	80 000 t	90 000 t	100 000 t	140 000 t (F_{MSY} mode)
Stock size (B_{2021}/B_{MSY}), median	1.83	1.83	1.81	1.80	1.74
Fishing mortality (F_{2021}/F_{MSY}), median	0.19	0.21	0.24	0.27	0.41
Probability of B_{2021} falling below B_{lim}	< 0.1%	< 0.1%	< 0.1%	< 0.1%	0.4%
Probability of B_{2021} falling below MSY $B_{trigger}$	0.2%	0.2%	0.2%	0.2%	0.9%
Probability of F_{2021} exceeding F_{lim}	1.7%	2.1%	2.5%	3.1%	6.4%
Probability of F_{2021} exceeding F_{MSY}	4.1%	5.0%	6.3%	7.5%	15.2%
% Advice change *	−53%	−47%	−40%	−33%	−7%

* Advice value 2021 relative to the advice value 2020.

The change in advice is mainly due to a reduction in estimated stock size.

Basis of the advice

Table 4 Northern shrimp in subareas 1 and 2. The basis of the advice.

Advice basis	MSY approach using the mode of F_{MSY}.
Management plan	ICES is not aware of any agreed precautionary management plan for northern shrimp in this area.

Quality of the assessment

A revision of the catch per unit of effort (CPUE) index in this year's assessment has resulted in a downward revision of stock biomass compared with last year's assessment (Figure 2, left). The assessment of stock status and the advice are robust to this revision. Last year's assessment with the revised index would have modified last year's advice from 150 000 tonnes to 148 000 tonnes, which represents a change of approximately 1%.

In the 2020 survey, technical issues led to the Russian part of the survey area (about 50%) not being completely surveyed in time for the stock assessment. Therefore, for input to the assessment model, the Joint NAFO/ICES *Pandalus* Assessment Working Group (NIPAG) used the mean proportions (from the entire survey series) of the total biomass within the partially surveyed area to estimate the total survey biomass for 2020. The incomplete survey coverage seen in 2020 adds uncertainty to the assessment.

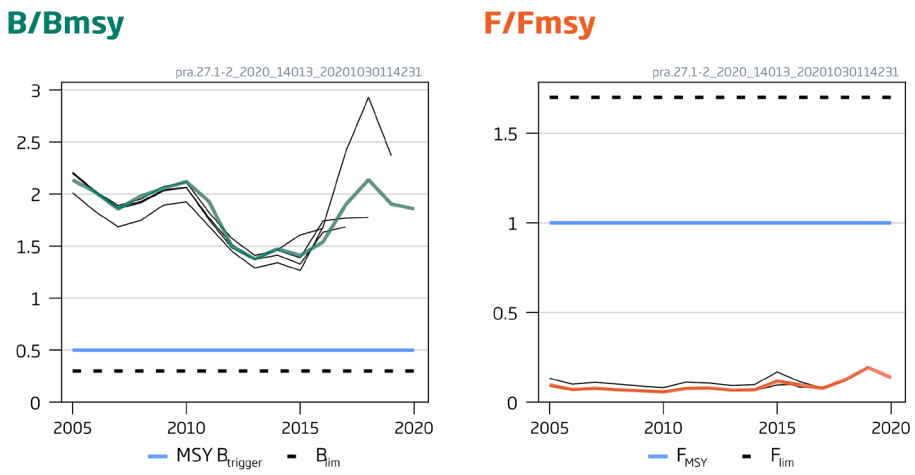

Figure 2 Northern shrimp in subareas 1 and 2. Historical assessment results.

Issues relevant for the advice

The stock is well above MSY $B_{trigger}$ and has always been exploited below F_{MSY}. The mode of the probability distribution of F_{MSY} is used as the basis for the advice, because the distribution of F_{MSY} is skewed (heavy right tail). The forecast indicates that the advised catch is sustainable; however, it is above the historical maximum of landings. Catches corresponding to the fishing mortality at median/F_{MSY} would imply catches of over 265 000 tonnes in 2021, constituting a very large extrapolation beyond catches observed in the past. In this context the mode is the preferred basis for the advice.

Increasing effort in this *Pandalus* fishery could lead to increased bycatch of juvenile fish in the 5–25 cm size range, including redfish, cod, haddock, and Greenland halibut.

Reference points

Table 5 Northern shrimp in subareas 1 and 2. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	$0.5 \times B_{MSY} = 0.25 \times K$ *	Relative value. B_{MSY} is estimated directly from the assessment model and changes when the assessment is updated.	ICES (2013)
	F_{MSY}	$r/2$ *	Relative value. F_{MSY} is estimated directly from the assessment model and changes when the assessment is updated.	ICES (2013)
Precautionary approach	B_{lim}	$0.3 \times B_{MSY}$	Relative value (equilibrium yield at this biomass is 50% of MSY).	ICES (2013)
	B_{pa}	Not defined	**	
	F_{lim}	$1.7 \times F_{MSY}$	Relative value (the F that drives the stock to B_{lim}) *	ICES (2013)
	F_{pa}	Not defined	**	
Management plan	B_{MGT}	Not defined		
	F_{MGT}	Not defined		

* Fishing mortality is presented only in relation to F_{MSY}, and total stock biomass is presented only in relation to B_{MSY}. *K* is the carrying capacity and *r* is the intrinsic biomass growth rate. These values are directly estimated from the stock assessment and change when the assessment is updated.

** B_{pa} and F_{pa} are not defined. The assessment provides probability distributions for B and F, so it is possible to directly estimate the probabilities of $B < B_{lim}$ and of $F > F_{lim}$.

Basis of the assessment

Table 6 Northern shrimp in subareas 1 and 2. Basis of the assessment and advice.

ICES stock data category	1 (ICES, 2019).
Assessment type	Bayesian fitting of a surplus-production model.
Input data	Fishery catches 1970–2020. Three survey indices: the Norwegian shrimp survey 1982–2004, the Russian shrimp survey 1984–2005, and the Norwegian–Russian ecosystem survey (Eco-Norw-Q3) 2004–2020; one fishery-based index (standardized CPUE from Norwegian logbooks, 1980–2020).
Discards and bycatch	Discarding is considered to be negligible.
Indicators	None.
Other information	None.
Working group	Joint NAFO/ICES *Pandalus* Assessment Working Group (NIPAG).

Information from stakeholders

No additional information is available for this stock.

History of the advice, catch, and management

Table 7 Northern shrimp in subareas 1 and 2. ICES advice and official landings. All weights are in tonnes.

Year	ICES advice / Single-stock exploitation boundaries	Catches corresponding to single-stock exploitation boundaries	Agreed TAC	ICES catches
2005	No increase compared to 2004	43600	-	42618
2006	No increase in catch above recent level	40000	-	29627
2007	Catch that will prevent exceeding F_{lim} in the long term	50000	-	29931
2008	Catch that will prevent exceeding F_{lim} in the long term	50000	-	28188
2009	Catch that will prevent exceeding F_{lim} in the long term	50000	-	27272
2010	Catch that will prevent exceeding F_{lim} in the long term	50000	-	25198
2011	Catch that will prevent exceeding F_{MSY} in the long term	60000	-	30226
2012	Catch that will prevent exceeding F_{MSY} in the long term	60000	-	24756
2013	Catch that will maintain stock at current high biomass	60000	-	19249
2014	No new advice, same as for 2013	60000	-	20964
2015	Move exploitation towards F_{MSY}	< 70000	-	34022
2016	Move exploitation towards F_{MSY}	< 70000	-	30745
2017	Move exploitation towards F_{MSY}	≤ 70000	-	30441
2018	MSY approach: move exploitation towards F_{MSY}	≤ 70000	-	55911
2019	MSY approach: move exploitation towards F_{MSY}	≤ 70000		76086
2020	MSY approach: mode of the F_{MSY} distribution as basis of advice	≤ 150000	-	53000 *
2021	MSY approach: mode of the F_{MSY} distribution as basis of advice	≤ 140000		

* Based on catch data until August, and on information from the industry.

History of the catch and landings

Table 8 Northern shrimp in subareas 1 and 2. Catch distribution by fleet in 2019 as estimated by ICES.

Catch	Landings	Discards
76086 tonnes	100% trawl	Discarding is considered negligible
	76086 tonnes	

Table 9 Northern shrimp in subareas 1 and 2. ICES catches (tonnes). "Others" are EU, Iceland, Faroes, and Greenland.

Year	Norway	Russia	Others	Total
1970	5508	0	0	5508
1971	5116	0	26	5142
1972	6772	0	0	6772
1973	6921	0	0	6921
1974	8008	0	0	8008
1975	8197	0	2	8199
1976	9752	0	0	9752
1977	14700	0	4854	19554
1978	20484	18270	189	38943
1979	25435	10474	390	36299
1980	35061	11219	0	46280
1981	32713	9886	1011	43610
1982	43451	15552	3835	62838
1983	70798	29105	4903	104806
1984	76636	43180	8246	128062
1985	82123	32104	10262	124489
1986	48569	10216	6538	65323
1987	31353	6690	5324	43367
1988	32021	12320	4348	48689
1989	47064	12252	3432	62748
1990	54182	20295	6687	81164
1991	39663	29434	6156	75253
1992	39657	20944	8021	68622
1993	32663	22397	806	55866
1994	20162	7108	1063	28333
1995	19337	3564	2319	25220
1996	25445	5747	3320	34512
1997	29079	1493	5163	35735
1998	44792	4895	6103	55790
1999	52612	10765	12293	75670
2000	55333	19596	5768	80697
2001	43031	5846	8408	57285
2002	48799	3790	8899	61488
2003	34172	2776	2277	39225
2004	35918	2410	4406	42734
2005	37253	435	4930	42618
2006	27352	4	2271	29627
2007	25558	192	4181	29931
2008	20662	417	7109	28188
2009	19784	0	7488	27272
2010	16779	0	8419	25198
2011	19928	0	10298	30226
2012	14158	0	10598	24756
2013	8846	1067	9336	19249
2014	10234	741	9989	20964
2015	16618	1151	16253	34022
2016	10898	2491	17359	30749
2017	7010	3849	19582	30442
2018	23126	12561	20654	56341
2019 *	23925	28078	24083	76086
2020 *	16500	21000	15500	53000

*Preliminary.

Summary of the assessment

Table 10 Northern shrimp in subareas 1 and 2. Assessment summary. Biomass is relative to B_{MSY} at the end of the year and fishing mortality relative to F_{MSY}. High and low values are the 80% probability intervals of the distribution. Catches are in tonnes.

Year	B/B_{MSY}			Total catch	F/F_{MSY}		
	Low	Value	High		Low	Value	High
1970	1.07	1.61	2.34	5508	0.0070	0.0169	0.065
1971	1.08	1.7	2.54	5142	0.0060	0.0149	0.061
1972	1.09	1.77	2.67	6772	0.0076	0.0189	0.079
1973	1.11	1.82	2.75	6921	0.0076	0.0187	0.080
1974	1.13	1.85	2.81	8008	0.0087	0.021	0.090
1975	1.17	1.89	2.83	8199	0.0088	0.021	0.090
1976	1.21	1.91	2.86	9752	0.0103	0.025	0.107
1977	1.26	1.94	2.87	19554	0.020	0.049	0.21
1978	1.3	1.95	2.82	38943	0.041	0.096	0.42
1979	1.41	1.99	2.56	36299	0.039	0.088	0.39
1980	1.53	2.19	2.85	46280	0.045	0.102	0.46
1981	1.61	2.29	2.9	43610	0.040	0.092	0.41
1982	1.83	2.59	3.32	62838	0.051	0.116	0.53
1983	1.81	2.62	3.34	104806	0.084	0.193	0.89
1984	1.32	1.87	2.4	128062	0.144	0.33	1.50
1985	0.89	1.28	1.63	124489	0.20	0.47	2.1
1986	0.75	1.08	1.38	65323	0.127	0.29	1.35
1987	0.8	1.16	1.48	43367	0.079	0.181	0.83
1988	1	1.44	1.83	48689	0.071	0.164	0.75
1989	1.14	1.65	2.12	62748	0.080	0.183	0.84
1990	1.24	1.8	2.32	81164	0.094	0.22	1.01
1991	1.23	1.78	2.27	75253	0.089	0.20	0.94
1992	1.21	1.78	2.27	68622	0.081	0.187	0.87
1993	0.98	1.42	1.81	55866	0.083	0.190	0.87
1994	0.94	1.35	1.71	28333	0.044	0.102	0.47
1995	1.13	1.65	2.1	25220	0.032	0.074	0.34
1996	1.24	1.8	2.3	34512	0.040	0.093	0.43
1997	1.41	2.02	2.57	35735	0.037	0.085	0.39
1998	1.44	2.08	2.66	55790	0.056	0.129	0.59
1999	1.27	1.82	2.32	75670	0.087	0.20	0.91
2000	1.13	1.64	2.09	80697	0.104	0.24	1.10
2001	1.15	1.66	2.12	57285	0.072	0.166	0.77
2002	1.1	1.59	2.03	61488	0.081	0.186	0.86
2003	0.98	1.39	1.76	39225	0.060	0.136	0.62
2004	1.32	1.93	2.45	42734	0.047	0.107	0.49
2005	1.47	2.13	2.74	42618	0.042	0.096	0.45
2006	1.41	2.02	2.58	29627	0.031	0.071	0.32
2007	1.3	1.86	2.39	29931	0.034	0.078	0.35
2008	1.38	1.98	2.54	28188	0.030	0.069	0.31
2009	1.43	2.05	2.63	27272	0.028	0.064	0.29
2010	1.46	2.12	2.71	25198	0.025	0.057	0.26
2011	1.33	1.93	2.48	30226	0.033	0.076	0.35
2012	1.03	1.49	1.92	24756	0.035	0.080	0.37
2013	0.95	1.38	1.76	19249	0.029	0.067	0.31

Year	B/B_{MSY}			Total catch	F/F_{MSY}		
	Low	Value	High		Low	Value	High
2014	1.01	1.47	1.88	20964	0.030	0.069	0.32
2015	0.97	1.41	1.8	34022	0.051	0.116	0.53
2016	1.06	1.54	1.98	30745	0.042	0.096	0.44
2017	1.31	1.9	2.44	30441	0.034	0.077	0.36
2018	1.47	2.14	2.76	55911	0.055	0.127	0.58
2019	1.33	1.9	2.42	76086	0.085	0.192	0.88
2020 *	1.2	1.86	2.7	53000	0.057	0.137	0.64

* The 2020 data are a prediction, assuming a catch of 53 000 tonnes.

Sources and references

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