

JOINT NAFO/ICES PANDALUS ASSESSMENT WORKING GROUP (NIPAG outputs from 2022 meeting)

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i Executive Summary

The NAFO/ICES *Pandalus* Assessment Group (NIPAG), met online to assess the Northern shrimp (*Pandalus borealis*) stock in Division 4.a West (northern North Sea, Fladen Ground). The objective was to assess the stock status in light of updated 2022 catch data and stock indices. Overall, the different sources of new and updated information (Norwegian survey data, Danish LPUE-index, and a Danish bycatch-based index), indicate that the shrimp stock on Fladen Ground has increased since 2018.

A Danish observer and self-sampling program for the targeted shrimp fishery was initiated in 2021, which provided biological data of the stock (weight, length, and sex). If a commercial shrimp fishery is continued on Fladen Ground, these 2021 data may form the start of a new commercially based time-series that together with biological data from the Norwegian survey may enable a full analytical assessment of the stock. Due to likely irregular visits to Fladen Ground by the annual IMR shrimp survey an analytical assessment will have to be based mainly on data collected by the commercial fishery.

ii Expert group information

Expert group name	Joint NAFO/ICES Pandalus Assessment Working Group (NIPAG)
Expert group cycle	Annual
Year cycle started	2022
Reporting year in cycle	1/1
Chairs	Ole Ritzau Eigaard, Denmark
	Mark Simpson, Canada
Meeting venue and date	November 2022, online meeting (3 participants)

1 Northern shrimp (*Pandalus borealis*) in the Fladen Ground (western part of ICES Division 27.4a)

Background documentation is found in NAFO SCR Doc. 21/046.

a) Introduction

From the 1960s up to around 2000, a significant shrimp fishery exploited the shrimp stock on Fladen Ground in the northern North Sea. Landings from Fladen Ground have been recorded since 1970, and total landings have fluctuated between zero and a maximum of around 9000 t in 1987 (Figure 1, Table 1). Historically, the Danish fleet accounted for the greatest share of these landings, while the Scottish fleet landed a smaller portion. Norway landed minor catches in some years. The fishery took place mainly during the first half of the year, with the highest activity in the second quarter. Since 1995, landings decreased steadily and since 2004, the Fladen Ground shrimp fishery has been virtually non-existent. Interview information from the fishing industry obtained in 2004 gave the explanation that the decline was caused by high fuel prices, low shrimp abundance and low prices on the small shrimp which are characteristic of the Fladen Ground. Since 2011, there have been minor Danish and Norwegian landings of shrimp from Fladen Ground, mainly taken as bycatch in the Norway pout fishery.

The Fladen Ground shrimp stock was surveyed as part of the annual Norwegian shrimp survey in the Skagerrak and Norwegian Deep in the late 1980s and early 1990s. The stock was surveyed again in January 2021. For many years, due to lack of both fishery and survey data, it was not known if the decline in the fishery reflected a decline in the stock. The last ICES advice given in 2021 advised no targeted fishery (ICES; 2021). In 2022, there is an agreed quota of 990 tonnes, which is exclusively for bycatches (no directed fisheries for Northern prawn are permitted; Table 2). This TAC applies to the UK and European Union waters of Area 4, and the UK waters of Division 2.a.

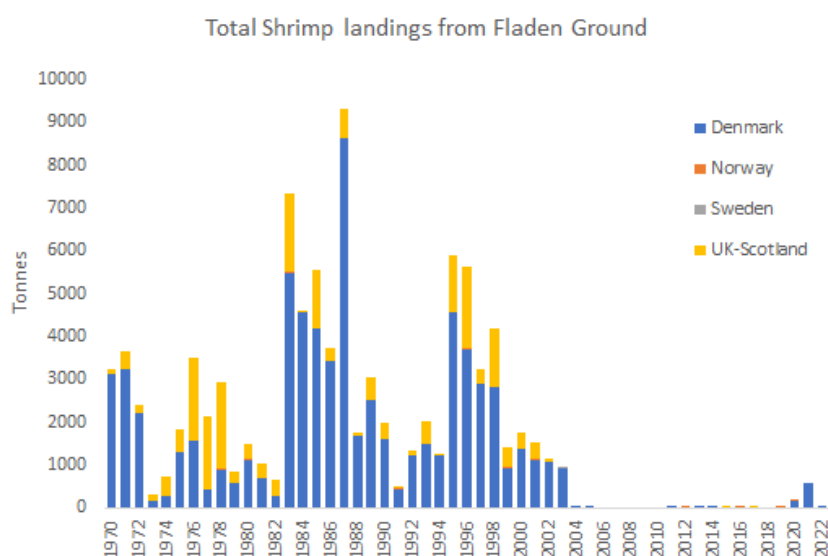


Figure 1. Shrimp in ICES Division 4.a West: Official landings by country, 1970-2022. The 2022-numbers are until the 25th of August.

Table 1. Official landings of shrimp from the Fladen Ground, by country and total, 1970-2022. The 2022 data are until the 25th of August.

Year	Denmark	Norway	Sweden	UK-Scotland	Total
1970	3115			104	3219
1971	3216			436	3652
1972	2204			187	2391
1973	157			163	320
1974	282			434	716
1975	1308			525	1833
1976	1552			1937	3489
1977	425			1692	2117
1978	890	9		2027	2926
1979	565	10		268	843
1980	1122	4		377	1503
1981	685			347	1032
1982	283			352	635
1983	5492	8		1827	7327
1984	4553	13		25	4591
1985	4188	7		1341	5536
1986	3416			301	3717
1987	8620			686	9306
1988	1662			84	1746
1989	2495			547	3042
1990	1604		4	365	1973
1991	421	25		53	499
1992	1212			116	1328
1993	1499			509	2008
1994	1202			35	1237
1995	4549	30		1298	5877
1996	3689	32		1893	5614
1997	2886			365	3251
1998	2801			1365	4166
1999	934	9		456	1399
2000	1358			378	1736
2001	1117	18		397	1532
2002	1060	9		70	1139
2003	935		1		936
2004	21				21
2005	0.3				0.3
2006					
2007					
2008					
2009					
2010					
2011	0.3				0.3
2012		0.5			0.5
2013	0.1				0.1
2014	1				1
2015	19			1	20
2016	0.1	10			10
2017		6		4	10
2018					
2019		6			6
2020	142	66			208
2021	564				564
2022	10				10

Table 2. Shrimp in ICES Division 4.a West: Recent landings in metric tonnes, as used by NIPAG for the assessment.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022 ¹
Recommended TAC	*	*	*	*	*	*	*	0	0	0	0
Actual TAC	3058	3058	2446	2446	2446	2446	1957	1566	1200	660	990 ²
Denmark	0	0.1	1	19	0.1	0	0	0	142	564	10
UK (Scotland)	0	0	0	1	0	4	0	0	0	0	0
Sweden	0	0	0	0	0	0	0	0	0	0	0
Norway	0.5	0	0	0	10	6	0	6	66	0	0
Total	0.5	0.1	1	20	10	10	0	6	208	564	10

¹ Landings until 25th of August 2022.

* ICES catch advice for 2012-2018 was “no increase in catch”.

² Exclusively for bycatches. No directed fisheries for Northern prawn are permitted under this quota.

b) Input data

i) Commercial fishery data

The Fladen Ground shrimp stock supported a targeted fishery from 1970 to 2003 with Denmark and Scotland landing the largest share (Table 1). Total landings peaked in 1987 with 9306 tonnes, but since 2004, only sporadic targeted fishery has taken place, 1 ton in 2014, 13 tons in 2015 and 24 tons in 2021. In recent years, the largest volumes of shrimp are by-caught in other small-meshed trawl fisheries such as the fishery for Norway pout (codend mesh size 16-31 mm). Especially in 2020 and 2021, total Danish shrimp bycatches were substantial, resembling the values experienced during the primary period of the targeted shrimp fishery in the 1990s. For the targeted Danish shrimp fishery on Fladen Ground (codend mesh size 32-69 mm) a landings-per-unit-effort (LPUE) time-series has been calculated by dividing the total annual landings with the total annual kilowatt days in the fishery (Figure 2). This index of stock size shows that in the only two years with a significant targeted fishery since the stop in 2004, the LPUE values have been approx. twice the average of the time-series (2015) and half the average (2021).

The Danish Norway pout landings from Fladen Ground have been sampled in harbour by the Danish Control Agency since 1989. Each catch sample consists of approx. 5 kg of unsorted landings, taken with a bucket from the storage rooms of the trawlers. The data included here cover the period from 1990 to April 2020, except for 2005 and 2007 when there was no quota and therefore no fishery. The main purpose of the harbour sampling has been to estimate total species composition of the landings in weight. In April 2020, a change in the bycatch monitoring of the Danish Norway pout fishery was implemented, increasing the sampling coverage (mainly more samples taken from each vessel, increasing in numbers with increasing landing size), thus for the two most recent years the data and estimates are considered to be more precise.

Based on the harbour sampling scheme for the Norway pout fishery, a shrimp bycatch index was defined. The yearly index values were calculated as the average weight percentage of shrimp to total catch in samples from the 20 ICES squares which make up the distributional area of the Fladen Ground shrimp stock. The index time-series may potentially be biased by the introduction of a mandatory sorting grid in the Norway pout fishery in 2012 but given the small size of shrimp compared to Norway pout, it is very unlikely that the grid has sorted out a significant amount of shrimp. The index time-series demonstrated a substantial increase in the most recent years with the 2022 value being the highest of the time-series (Figure 3).

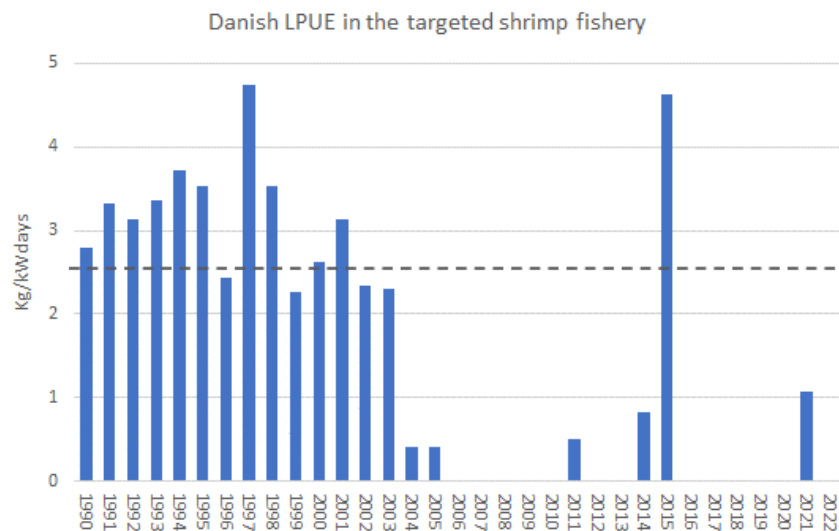


Figure 2. Landings-per-unit-effort (LPUE) time-series (kg/kWday) for the targeted Danish shrimp fishery on Fladen Ground (OTB_CRU or PTB_CRU and codend mesh size 32-69 mm informed in logbooks), 1990-2022. The numbers for 2022 are until August 25th. The dashed grey line indicates the average of the time-series (2.55 kg/kWday).

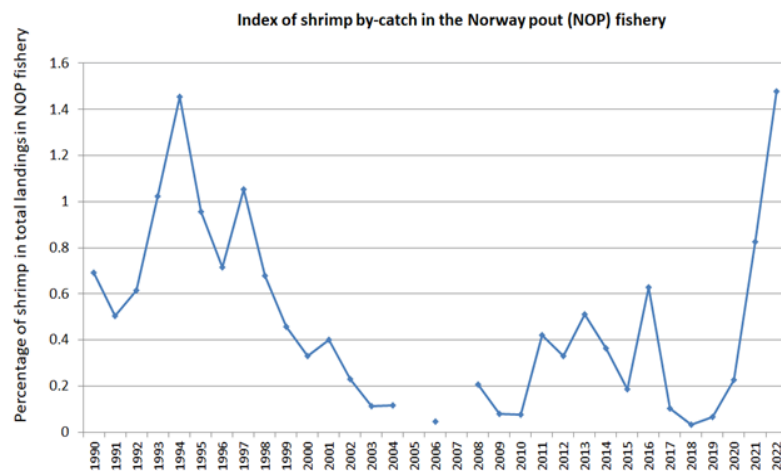


Figure 3. Time-series of a shrimp stock size index based on harbour sampling of bycatch in the landings from the Danish small-meshed trawl fishery (codend mesh size 16-31 mm) for Norway pout.

ii) Research survey data

Abundance and density. A trawl survey for shrimp in Skagerrak and the Norwegian Deep (ICES divisions 3a and 4a East) has since 1984 been conducted annually by the Norwegian Institute of Marine Research (IMR) with the objective of assessing the distribution, biomass, abundance, and length distribution of the shrimp stock (Søvik and Thangstad; 2021). In the late 1980s and early 1990s, IMR also surveyed the shrimp stock on the Fladen Ground. A total of six cruises were conducted in October/November, as part of the first time-series from 1984–2002 using R/V Michael Sars and the Campelen-trawl. No scientific survey has covered the shrimp stock on Fladen Ground since the mid-1990s. However, as recent bycatches of shrimp in the Danish and

Norwegian Norway pout fisheries have indicated increasing densities of shrimp on the Fladen Ground, a cruise was again conducted by IMR, in January 2021. The timing of the annual shrimp survey shifted to the 1st quarter in 2006 (Søvik and Thangstad; 2021). There have also been changes in the vessel used, but the gear is still the standard Campelen-trawl.

In 2022, errors in the longitudes of six trawl stations from the 1986 survey were discovered, which erroneously had placed the stations on Fladen Ground. The survey time-series figures have been corrected in this year's report (Figure 5). The high abundance of shrimp on the Fladen Ground perceived from the fisheries data were confirmed by the 2021-survey, where the two highest trawl catches of shrimp in the whole survey (191 and 141 kg/nm) were from Fladen Ground (Figure 4, left). Two other trawl hauls also gave good catches (18 and 26 kg/nm). Mean abundance in 2021 was considerably higher compared with the time-series 1987-1994, mainly due to the two high trawl catches, while the median was on the same level as the earlier years (Figure 5). The same pattern is seen for the density of shrimp (kg per trawled nautical mile).

Recruitment. The Fladen Ground stock in the first quarter consists mainly of three year-classes (Figure 6; 2021-plot). The size of the 1-group in 2021 (2020-year class) was relatively large, indicating good recruitment to the stock in the near future. This age-group recruited to the fishable biomass in the second half of 2021. Length frequency distributions from the 1980s and 1990s indicate that the shrimp stock in the fourth quarter consists mainly of two age-groups, the 1- and 2-year old shrimp. The 0-group is visible in some of the plots.

Due to fast growth, the Fladen Ground shrimp stock depends on a high frequency of good year-classes to sustain high densities. It should be noted that recruitment to the neighboring stock Skagerrak and the Norwegian Deep has been low for many years and SSB is currently at B_{lim} , but the 2021-year class is good (ICES; 2022). However, stock dynamics might be different on the Fladen Ground compared with in the Norwegian Deep and Skagerrak (SCR Doc. 21/46). Results from genetic investigations suggest two separate populations (Knutsen et al. 2015).

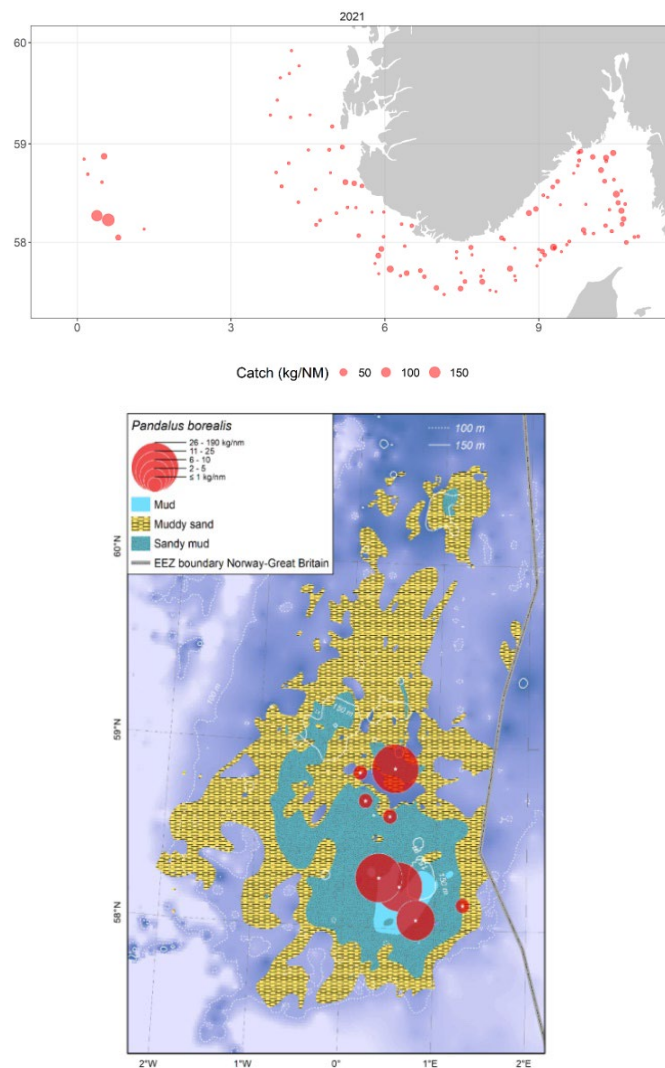


Figure 4. Shrimp in ICES Division 4.a west: i) the left-hand panel shows the distribution and size of trawl catches on the full IMR annual shrimp survey (both the Fladen and the Skagerrak and Norwegian Deep stocks) in January 2021, and ii) the right-hand figure shows the distribution of trawl catches on Fladen Ground overlaid with sediment information, where the muddy areas give an indication of the extent of the shrimp stock.

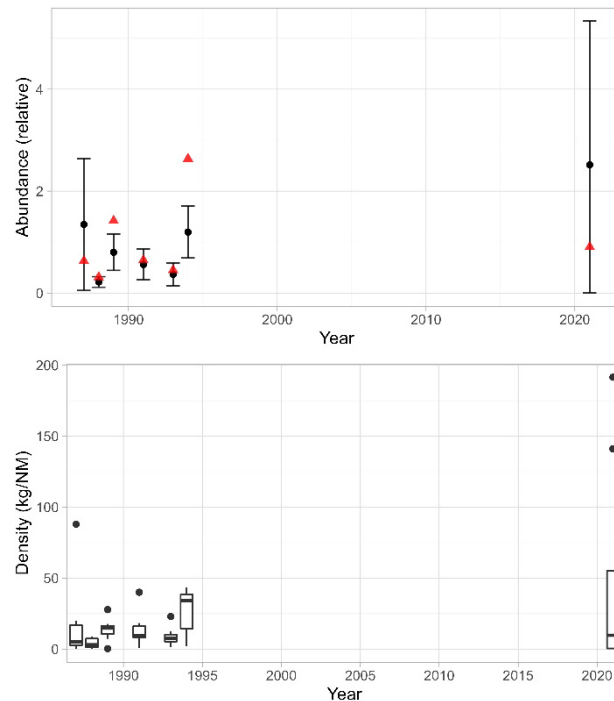


Figure 5. Shrimp in ICES Division 4.a West: Survey time-series, 1987-1994 and 2021, abundance (relative design-based index based on density), mean \pm 95 % confidence interval (black dots) and median (red triangles) (left), and density (kg/nm) (right), boxplot showing median (bold line), first and third quartiles (hinges, the 25th and 75th percentiles), and whiskers spanning 1.5 times the inter-quartile range above and below the hinges. Dots indicate outliers outside the inter-quartile range.

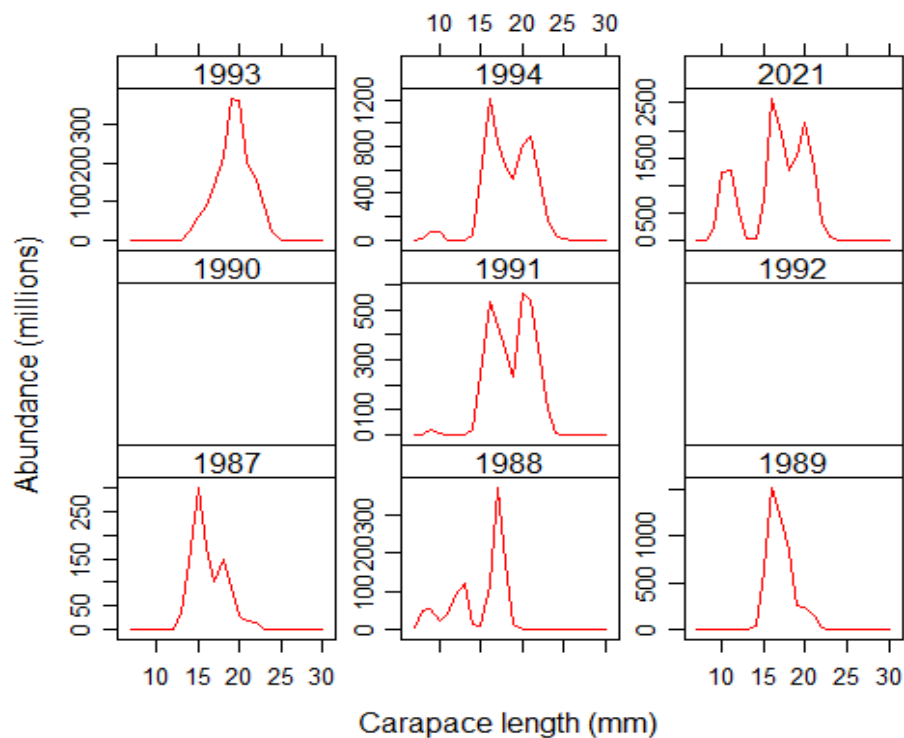


Figure 6. Shrimp in ICES Division 4.a West: Length frequency distributions from the annual IMR surveys in October/November 1987-1994 (no surveys in 1990 and 1992), and in January 2021. Note different y-axes.

c) Assessment

New information and analyses of historical data have substantially improved the knowledge basis for assessing the stock status of the Fladen Ground shrimp stock. Overall, the different sources of new information: Norwegian survey data, a new Danish LPUE-index, and a new Danish bycatch-based stock index, indicate that the shrimp stock on Fladen Ground has increased since 2018.

A Danish observer and self-sampling program for the targeted shrimp fishery was initiated in 2021, which provided biological data of the stock (weight, length and sex). If a commercial shrimp fishery is continued on Fladen Ground, these 2021 data may form the start of a new commercially based time-series that together with biological data from the Norwegian survey may enable a full analytical assessment of the stock. Due to likely irregular visits to Fladen Ground by the annual IMR shrimp survey an analytical assessment will have to be based mainly on fishery data.

Reference points. There are no reference points defined for this stock.

Stock size and fishing mortality. Stock size is likely at a relatively high level and fishing mortality at a relatively low level.

Projections. There are no projections for this stock.

d) Additional considerations

Environmental conditions. The Fladen Ground is a rather shallow area with depths between 100 and 150 m. The area of suitable muddy shrimp habitat is limited and surrounded by sandy bottom.

Temperature. Measurements of bottom temperature in January 2021 at the annual Norwegian shrimp survey gave values between 7.9 and 8.2 °C, indicating warm bottom water.

e) State of the stock

State of the Stock. The state of the stock relative to reference points is unknown. However, new information from the fisheries and the Norwegian shrimp survey indicate that the stock size has increased since 2018 and currently is at a relatively high level.

f) Research recommendations

NIPAG **recommends** that a commercial trial fishery including compulsory sampling of catches is initiated on the Fladen Ground.

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Annex 1: List of participants

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