ECOREGION   **Barents and Greenland seas**
SUBJECT   **Status and harvest potential of the harp seal stocks in the Greenland Sea and the White Sea/Barents Sea, and of the hooded seal stock in the Greenland Sea**

Advice summary

The estimates of harp seal abundance in the Greenland Sea and the White Sea/Barents Sea continue to show an increase, and advice on different catch scenarios is provided for both stocks. The hooded seal stock in the Greenland Sea is well below 30% of the largest estimated population size, and ICES advises that no catch be allowed from this stock.

Based on the experience from the Northwest Atlantic, ICES advises that future catch scenarios are explored over a 15-year time horizon, rather than the current ten-year period.

Request

The Norwegian Royal Ministry of Fisheries and Coastal Affairs requested ICES to:

Assess the status and harvest potential of harp seal stocks in the Greenland Sea and White Sea/Barents Sea and of the hooded seal stocks in the Greenland Sea, and

Assess the impact on the harp seal stocks in the Greenland Sea and the White Sea/Barents Sea of an annual harvest of:

1. *Current harvest levels,*
2. *Sustainable catches (defined as the fixed annual catches that stabilizes the future age 1+ population),*
3. *Catches that would reduce the population over a 10-year period in such a manner that it would remain above a level of 70% of current level with 80% probability.*

ICES advice

The advice is structured as an update of relevant parts of the advice provided by ICES in 2011 (ICES, 2011a).

The request concerns three seal stocks: Greenland Sea harp seals, White Sea/Barents Sea harp seals, and Greenland Sea hooded seals. The distribution of the stocks is shown in Figure 3.3.3.1.1.

Figure 3.3.3.1.1   Locations of North Atlantic harp and hooded seal stocks. Green spots indicate the whelping and moulting areas for the White Sea (also called the East Ice) stock of harp seals, the Greenland Sea (or West Ice) stocks of harp and hooded seals, and the northwest Atlantic (Front and Gulf areas) stocks of harp and hooded seals. Dark blue indicates the entire distributional area.

Greenland Sea harp seals

The estimated size of the Greenland Sea harp seal stock in 2013 is 627 410 (470 540–784 280)[1] animals, comprising 534 400 (379 200–689 600) age 1+ seals and 93 010 (70 210–115 800) young of the year. In 2013, the existing population model incorporated historical reproductive rate data and the new pup production estimate for 2012. Updating the time series resulted in a reduced estimated growth rate and smaller stock than that reported in 2011. However, the revised 2013 estimate is still the largest in the time-series.

The Greenland Sea harp seal stock is considered to be 'data-rich' and estimated to be above the N_{70} level (i.e., more than 70% of the known maximum stock size measured). Thus, it is appropriate to provide catch advice using the assessment model.

The analysis of catch options indicates the following:

- If the recent average catch (2008–2012) of 5941 animals (59.9% pups) is maintained, then the age 1+ population is expected to increase by 21% over the next ten years.
- The equilibrium catch levels are 20 429 animals (of which 59.9% are pups) or 14 600 (100% age 1+ animals).
- Annual catches that would reduce the population over a 10-year period but would still maintain the stock above 70% of the current level with 80% probability are 30 988 animals (of which 59.9% are pups) or 21 270 (100% age 1+ animals).

The current size of the Greeland Sea harp seal stock (i.e. 627 410 animals) is estimated to be at a record-high. N_{lim} (equal to 30% of the largest estimated population size) is estimated at 188 223 animals. ICES advises that this estimate of N_{lim} be regarded as the minimum sustainable size of the Greenland Sea harp seal stock and that below this stock size there should be no catch.

ICES regards 70% of the unexploited population size as the stock size associated with the maximum sustainable long-term average catch. This stock size (N_{70}) is estimated at 439 187 animals. The maximum sustainable long-term average catch is about 20 400 animals (of which 59.9% are pups) annually.

Simulation work conducted on the Northwest Atlantic harp seal population suggests that catches should be projected over a period of at least 15 years to determine their impact on the population. Therefore, ICES advises that future catch scenarios are explored over a 15-year period, rather than the current ten-year period. This advice applies to all of the seal populations considered by ICES.

White Sea/Barents Sea harp seals

No new data on stock size or number of pups has been available since the last advice was provided in 2011. The same model was run with two more projected years. The estimated size of the White Sea/Barents Sea stock in 2013 is 1 419 800 (1 266 910–1 572 690) animals. The stock is estimated to be above the N_{70} level. The 2013 predicted pup production is estimated at 198 800 (177 483–220 117) animals. Since 2004 aerial surveys have shown pup production estimates that are much lower than estimates obtained from surveys flown between 1998 and 2004. This could be due to a change in fecundity and/or changes in survival.

New pup surveys were conducted in 2013. The data are currently being analysed and it is anticipated that the estimates will be available in 2014. Taking into account the uncertainties in the trend of pup production for this population, ICES recommends that the results should be reviewed as soon as possible.

The original population model for the White Sea/Barents Sea harp seal stock provides a poor fit to the pup production survey data. Based on the lack of recent data on reproduction rates and the previously agreed criteria[2], the Barents Sea/White Sea harp seal stock is considered to be 'data-poor'. Therefore, the potential biological removal (PBR) was also calculated. However, catch advice is provided using the modified assessment model, which is more conservative than the PBR approach.

- If the recent average catch (2008–2012) of 2732 animals (97.6% pups) is maintained, the stock is expected to increase by 13% over ten years. However, ICES notes that the catches in 2009–2012 have been 200 animals or lower, and the actual stock increase rate will be higher if catches continue at this level.
- Sustainable catches are 32 736 animals (of which 97.6% are pups) or 17 400 (100% age 1+ animals).

---

[1] Lower and upper bound in a 95% confidence interval
[2] Three surveys within the past 15 years; one survey within the past five years; recent data on reproductive rates.

- Annual catches that would reduce the population over a ten-year period but would still maintain the stock above 70% of the current level with 80% probability are 49 775 animals (of which 97.6% are pups) or 26 650 (100% age 1+ animals).

Greenland Sea hooded seals

A population model, incorporating a reproduction rate of $F = 0.7$, produced a 2013 stock estimate of 68 820 age 1+ animals and 14 010 pups. The estimated total stock size of hooded seals in the Greenland Sea is therefore 82 830 animals (SE = 8028). All model runs indicate a declining population which is currently well below N_{30} (30% of the largest observed population size).

- Following the precautionary harvest strategy previously developed by ICES and given that the current stock size of 82 830 animals is well below N_{lim} (233 700 animals), ICES recommends that no harvest be allowed from the Greenland Sea hooded seal stock.

Background

Greenland Sea harp seals

State of stock/exploitation

The estimated adult population is at its highest level since the 1940s. Based on the population model using mark–recapture data (1983–1991) and recent aerial survey data, the stock in 2013 was estimated at 627 410 (470 540–784 280) seals. This is down slightly, but not significantly from the 2007 estimate of 649 566 (SE = 138 028) seals. The Greenland Sea harp seal stock is considered data rich, and above the N_{70} level.

The recent average annual catch (2008–2012) is 5941. Total catches in 2012 were 5593 harp seals (including 3740 pups), whereas 16 033 harp seals were taken in 2013 (including 13 911 pups; Table 3.3.3.1.1). These catches represented 22% and 54% of the 2012 and 2013 TAC[3] which was set at 25 000 age 1+ animals (where two pups balance one age 1+ animal). Russia has not participated in this hunt since 1994.

Population estimates

In the period 18 March to 1 April 2012 IMR conducted aerial surveys in the Greenland Sea pack-ice (the West Ice), to assess the pup production of the Greenland Sea populations of harp and hooded seals. The total pup production estimate obtained for harp seals was 89 590 (SE = 12 310; Table 3.3.3.1.2). This estimate is slightly, but not significantly lower than estimates obtained during similar surveys of the area in 2002 and 2007.

The population model is similar to the model used to assess the abundance of the White Sea/Barents Sea harp seal population. The model uses pregnancy rates from a Russian data-set for 1959–1991 and Norwegian data for 2008 and 2009 (Table 3.3.3.1.3; ICES, 2011b). In periods where data are missing, a linear transition between estimates was assumed. The model also incorporates a maturity curve based upon data collected in 1959–1990 and in 2009 (Table 3.3.3.1.4). A linear transition between the two curves was assumed.

The estimated population sizes are presented in Table 3.3.3.1.5, along with the parameters for the priors used in the model. The model indicates an increasing population from the 1970s up to the present time (Figure 3.3.3.1.2).However, the population model had difficulty in capturing the dynamics of the pup production estimates. The predicted population trajectories from the model are driven by the mark–recapture estimates of pup production from the 1980s and early 1990s. There is considerable uncertainty associated with these estimates.

The estimated size of the Greenland Sea harp seal stock in 2013 is 627 410 (470 540–784 280) animals, comprising 534 400 (379 200–689 600) age 1+ seals, and 93 010 (70 210–115 800) young of the year. In 2013, the existing population model incorporated historical reproductive rate data together with the new pup production estimate for 2012. Updating the time-series resulted in a reduced estimated growth rate and smaller stock than that reported in 2011. However, the revised 2013 estimate is still the largest in the time-series.

---

[3] The TAC is the estimated level of removals that would reduce the population by less than 30% with a probability of more than 80% over the next ten-year period. The quota has been implemented such that parts of, or the whole quota, could be taken as weaned pups, assuming two pups equaled one age 1+ animal.

Catch options

The projected stock sizes at different catch options are given in Table 3.3.3.1.6.

At current catch levels, the model indicates an increase of 21% in the age 1+ population over the next ten years. The equilibrium catch level is 14 600 (100% age 1+ animals). A catch level of 21 270 animals (100% age 1+) is estimated to reduce the population but keep it above N_{70} with a probability of 80%.
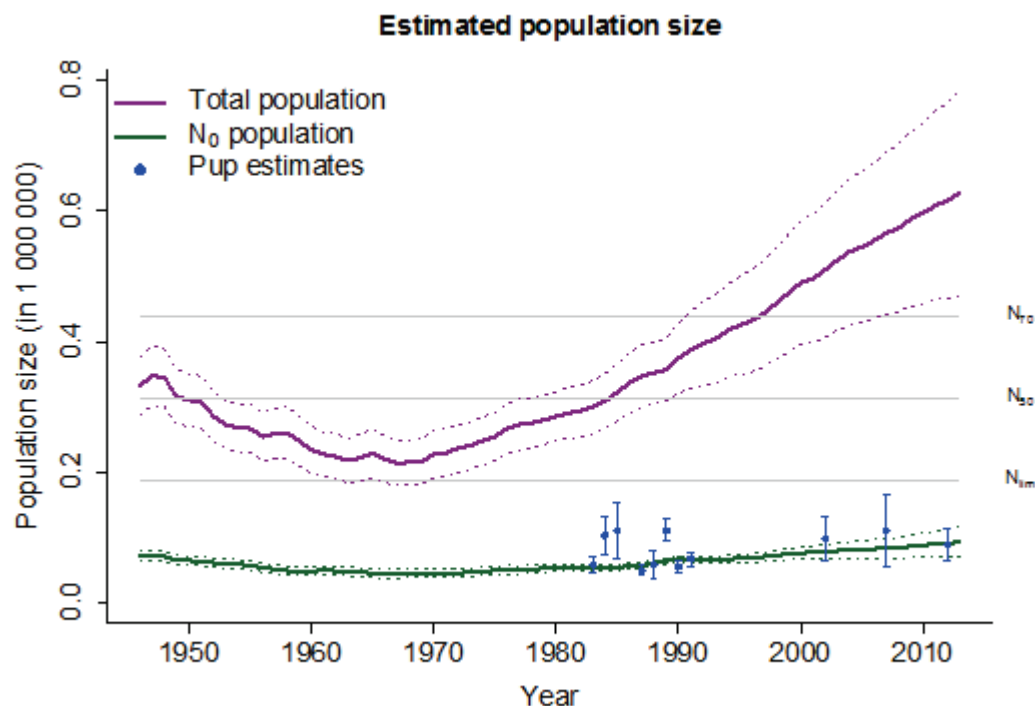

Figure 3.3.3.1.2   Modelled population trajectories for Greenland Sea harp seal pups and total population (full lines) and 95% confidence intervals (dashed lines). N_{70}, N_{50}, and N_{lim} denote the 70%, 50%, and 30% of the estimated maximum population size, respectively."

Table 3.3.3.1.1   Catches of harp seals in the Greenland Sea ("West Ice") from 1946 through 2013[a]. Totals include catches for scientific purposes.

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	pups	1 year and older	Total	Pups	1 year and older	Total
1946–50	26606	9464	36070	-	-	-	26606	9464	36070
1951–55	30465	9125	39590	-	-	-[b]	30465	9125	39590
1956–60	18887	6171	25058	1148	1217	2365[b]	20035	7388	27423
1961–65	15477	3143	18620	2752	1898	4650	18229	5041	23270
1966–70	16817	1641	18458	1	47	48	16818	1688	18506
1971	11149	0	11149	-	-	-	11149	0	11149
1972	15100	82	15182	-	-	-	15100	82	15182
1973	11858	0	11858	-	-	-	11858	0	11858
1974	14628	74	14702	-	-	-	14628	74	14702
1975	3742	1080	4822	239	0	239	3981	1080	5061
1976	7019	5249	12268	253	34	287	7272	5283	12555
1977	13305	1541	14846	2000	252	2252	15305	1793	17098
1978	14424	57	14481	2000	0	2000	16424	57	16481
1979	11947	889	12836	2424	0	2424	14371	889	15260
1980	2336	7647	9983	3000	539	3539	5336	8186	13522
1981	8932	2850	11782	3693	0	3693	12625	2850	15475
1982	6602	3090	9692	1961	243	2204	8563	3333	11896

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	pups	1 year and older	Total	Pups	1 year and older	Total
1983	742	2576	3318	4263	0	4263	5005	2576	7581
1984	199	1779	1978	-	-	-	199	1779	1978
1985	532	25	557	3	6	9	535	31	566
1986	15	6	21	4490	250	4740	4505	256	4761
1987	7961	3483	11444	-	3300	3300	7961	6783	14744
1988	4493	5170	9663[c]	7000	500	7500	11493	5670	17163
1989	37	4392	4429	-	-	-	37	4392	4429
1990	26	5482	5508	0	784	784	26	6266	6292
1991	0	4867	4867	500	1328	1828	500	6195	6695
1992	0	7750	7750	590	1293	1883	590	9043	9633
1993	0	3520	3520	-	-	-	0	3520	3520
1994	0	8121	8121	0	72	72	0	8193	8193
1995	317	7889	8206	-	-	-	317	7889	8206
1996	5649	778	6427	-	-	-	5649	778	6427
1997	1962	199	2161	-	-	-	1962	199	2161
1998	1707	177	1884	-	-	-	1707	177	1884
1999	608	195	803	-	-	-	608	195	803
2000	6328	6015	12343	-	-	-	6328	6015	12343
2001	2267	725	2992	-	-	-	2267	725	2992
2002	1118	114	1232	-	-	-	1118	114	1232
2003	161	2116	2277				161	2116	2277
2004	8288	1607	9895				8288	1607	9895
2005	4680	2525	7205				4680	2525	7205
2006	2343	961	3304				2343	961	3304
2007	6188	1640	7828				6188	1640	7828
2008	744	519	1263				744	519	1263
2009	5177	2918	8035				5177	2918	8035
2010	2823	1855	4678				2823	1855	4678
2011	5361	4773	10134				5361	4773	10134
2012	3740	1853	5593	-	-	-	3740	1853	5593
2013	13911	2122	16033	-	-	-	13911	2122	16033

[a] The period 1946–1970 shows only five-year averages.
[b] For 1955, 1956, and 1957 Soviet catches of harp and hooded seals were reported at 3900, 11 600, and 12 900, respectively. These catches are not included.
[c] Including 1431 pups and one adult caught by a ship which was lost.

Table 3.3.3.1.2   Survey estimates of Greenland Sea harp seal pup production.

YEAR	ESTIMATE	C.V.
1983	58 539	0.10
1984	103 250	0.15
1985	111 084	0.20
1987	49 970	0.08
1988	58 697	0.18
1989	110 614	0.08
1990	55 625	0.08
1991	67 271	0.08
2002	98 500	0.18
2007	110 530	0.25
2012	89 590	0.137

Table 3.3.3.1.3   Reproduction rates, F_t, for harp seals in the Greenland Sea.

Year	Pregnancy rate	Standard Deviation
1964	0.92	0.04
1978	0.88	0.03
1987	0.78	0.03
1990	0.86	0.04
1991	0.83	0.05
2008	0.80	0.06
2009	0.81	0.03

Table 3.3.3.1.4   Estimates of proportions of mature females ($p_{i,t}$). The P_1 estimates are from the period 1959–1990 and the P_2 estimates are from 2009.

AGE	1	2	3	4	5	6	7	8	9	10	11	12	13
P_1	0	0	0.06	0.29	0.55	0.74	0.86	0.93	0.96	0.98	0.99	1.00	1.00
P_2	0	0	0	0	0.06	0.28	0.55	0.76	0.88	0.95	0.98	0.99	1.00

Table 3.3.3.1.5   Greenland Sea harp seals. Model estimates and standard deviation of the parameters used in the model for various choices of the reproduction rate F. Priors used are shown in brackets.

Parameters	Model estimates	
	Mean	SD
N_{t_0}	260 167 (900 000)	22 268 (900 000)
M_0	0.28 (0.24)	0.19 (0.2)
M_{1+}	0.11 (0.08)	0.02 (0.1)
$N_{0,2013}$	93 010	11 631
$N_{1+,2013}$	534 300	79 186
$N_{Total,2013}$	627 410	80 036

Table 3.3.3.1.6   Catch options with relative population size (D1+) and 95% confidence intervals over 10 years for harp seals in the Greenland Sea. The model with historical reproduction parameters is used when evaluating these catch options.

Catch option	Proportion pups in catches	Pup catch	Age 1+ catch	Total catch	D_{1+} (95% CI)		
Current level	59.9%	3 557	2 384	5 941	1.06	1.21	1.36
Equilibrium	59.9%	12 237	8 192	20 429	0.82	1.00	1.18
Equilibrium	0%	0	14 600	14 600	0.82	1.00	1.18
Reduce to N_{70} [a]	59.9%	18 562	12 426	30 988	0.64	0.85	1.06
Reduce to N_{70} [a]	0%	0	21 270	21 270	0.67	0.87	1.07

White Sea/Barents Sea harp seals

State of stock/exploitation

Due to concern over the decline in harp seal pup production in the White Sea since 2004, ICES (2011a) recommended that removals be restricted to a level predicted to maintain a stable population size. This sustainable equilibrium catch number was estimated at 15 827 age 1+ animals (where two pups balance one age 1+ animal) in the White and Barents seas in 2012 and 2013. The Joint Norwegian–Russian Fisheries Commission followed this request and allocated 7000 seals of this TAC to Norway in both years. The Russian hunt was intending to focus on beaters but as a result of the Russian ban on catches of harp seals less than 1 year of age that has been in place since 2009, there were no commercial Russian harp seal catches in the White Sea in 2012 or 2013. Local hunters caught nine adult seals for subsistence use in 2012. No Norwegian vessels hunted in this area in 2012 or 2013 (Table 3.3.3.1.7).

Population assessment

Pup production

Aerial surveys were conducted in 2013 to estimate pup production in the White Sea using the same multi-spectral methods that have been used in the past (Figure 3.3.3.1.3; ICES, 2013). Six survey flights produced two independent estimates. Ice conditions in 2013 were typical, corresponding to long-term, mean ice conditions. Pup production estimates will be available in 2014. Taking into account the uncertainties in the trend of pup production for this population, ICES **recommends** that the results should be presented for review as soon as possible.

Population estimates

An age-structured population dynamics model developed to estimate abundance and provide catch options for harp seals in the White Sea/Barents Sea was presented to the working group (ICES, 2013). It incorporates time-varying reproductive rates (Tables 3.3.3.1.8 and 3.3.3.1.9; Figure 3.3.3.1.4) , estimates of pup production (Table 3.3.3.1.10) and historical catch data (Table 3.3.3.1.7) to estimate the current total population. The model also estimates the initial population size (N_0), pup mortality (M_0), and mortality of all seals aged 1 year and older (M_{1+}).

The estimated population sizes, along with the parameters for the priors used are presented in Table 3.3.3.1.11, and the modelled population trajectory is shown in Figure 3.3.3.1.5. The model fit to the observed pup production estimates is poor. The modelled total population indicates that the harp seal abundance in the White Sea decreased from 1946 to the early 1960s, but has generally increased since then. The modelled total population in 2013 is estimated to be about 83% of N_{max}, which is the historical maximum population size estimated.

Catch options

The estimates for the various catch options are given in Table 3.3.3.1.12. If the recent average catch (2008–2012) of 2732 animals (97.6% pups) is maintained, the stock is expected to increase by 13% over ten years. However, ICES notes that the catches in 2009–2012 have been 200 animals or lower, and the actual increase rate will be higher if catches continue at this level.

The estimated equilibrium (sustainable) catch level would be 32 736 animals (97.6% pups) or 17 400 (100% age 1+ animals). A catch level of 49 775 (97.6% pups) or 26 650 (100% age1+ animals) will reduce the population size to N_{70} with a probability of 80% within ten years. Because the stock is considered to be data poor, PBR was also calculated. The PBR removals are estimated at 40 430 animals (14% pups). This catch option indicates a 16% reduction of the age 1+ population in ten years.

ICES is concerned about the high removals and declining population that would result from using the PBR approach and also the lack of fit of the model to the pup production estimates. In conclusion ICES advises that the estimated equilibrium catches are the preferred option and that additional modelling approaches should be explored to improve the fit. The current equilibrium option is slightly higher than the option given in 2011. This is likely a result of the minimal catches in 2012 and 2013.

Simulation work conducted on the Northwest Atlantic harp seal population suggests that catches should be projected over a period of at least 15 years to determine their impact on the population. Therefore, ICES advises that future catch scenarios are explored over a 15-year period, rather than the current ten years. This advice applies to all of the populations considered by ICES.
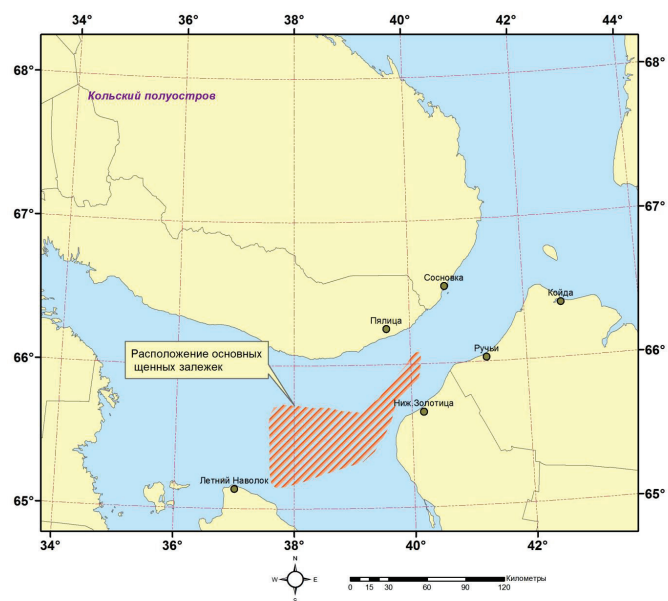
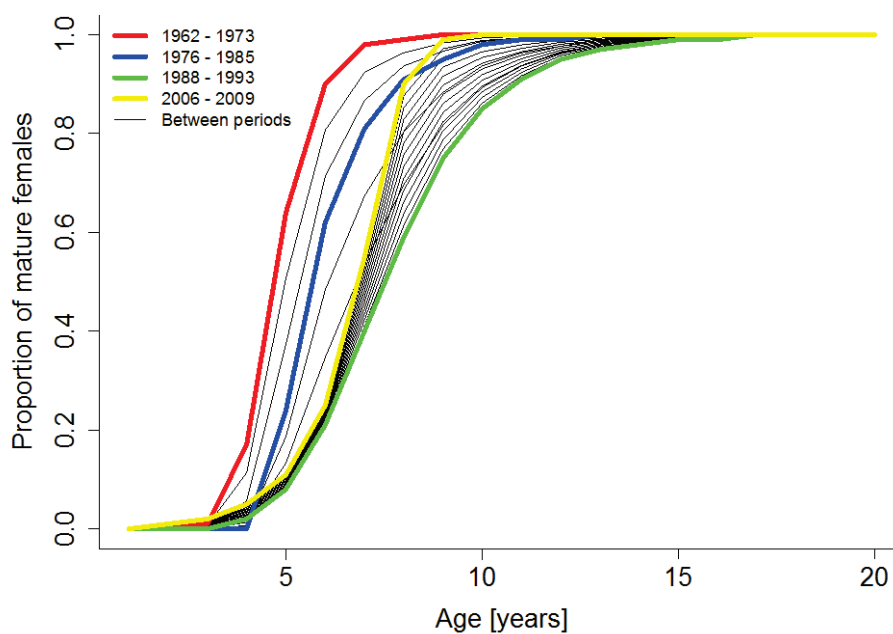**Figure 3.3.3.1.3**   **Location of the harp seal whelping patch in the White Sea.**

Figure 3.3.3.1.4   **Proportion of mature females among harp seals in the East Ice in four periods. Values are taken from Table 3.3.3.1.1.**
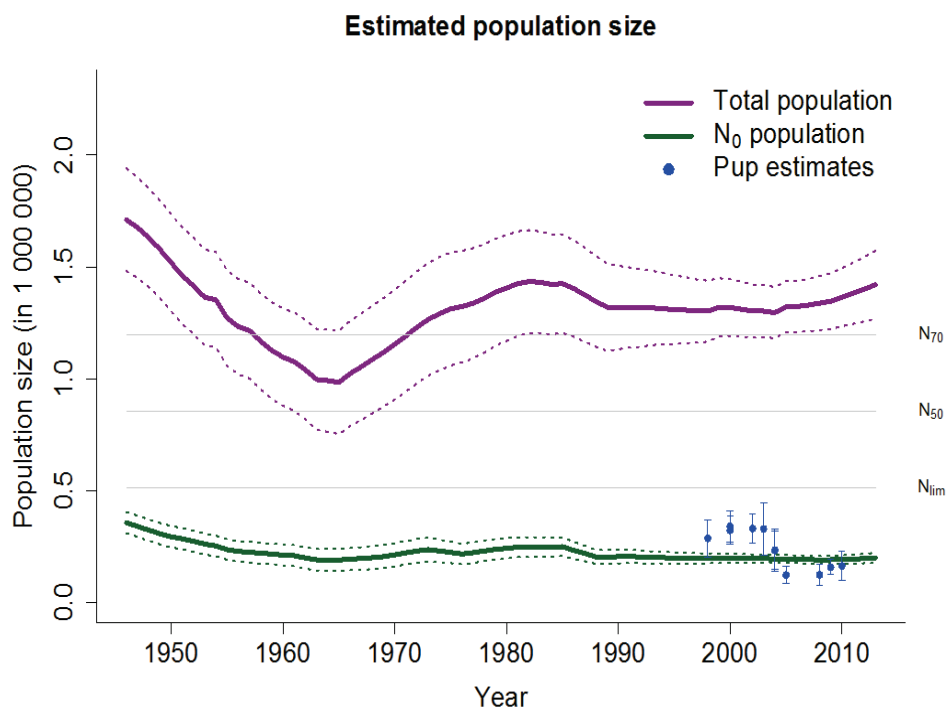
Estimated population size

Figure 3.3.3.1.5   Modelled Barents Sea/White Sea harp seal population trajectories for pups and total population (full lines) and 95% confidence intervals (dashed lines). N_{70}, N_{50}, and N_{lim} denote the 70%, 50%, and 30% of the historical maximum population size, respectively.

Table 3.3.3.1.7   Annual catches of harp seals in the White and Barents seas ("East Ice"), 1946–2008[a,b].

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	Pups	1 year and older	Total	Pups	1 year and older	Total
1946–50			25057	90031	55285	145316			170373
1951–55			19590	59190	65463	124653			144243
1956–60	2278	14093	16371	58824	34605	93429	61102	48698	109800
1961–65	2456	8311	10767	46293	22875	69168	48749	31186	79935
1966–70			12783	21186	410	21596			34379
1971	7028	1596	8624	26666	1002	27668	33694	2598	36292
1972	4229	8209	12438	30635	500	31135	34864	8709	43573
1973	5657	6661	12318	29950	813	30763	35607	7474	43081
1974	2323	5054	7377	29006	500	29506	31329	5554	36883
1975	2255	8692	10947	29000	500	29500	31255	9192	40447
1976	6742	6375	13117	29050	498	29548	35792	6873	42665
1977	3429	2783	6212[c]	34007	1488	35495	37436	4271	41707
1978	1693	3109	4802	30548	994	31542	32341	4103	36344
1979	1326	12205	13531	34000	1000	35000	35326	13205	48531
1980	13894	1308	15202	34500	2000	36500	48394	3308	51702
1981	2304	15161	17465[d]	39700	3866	43566	42004	19027	61031
1982	6090	11366	17456	48504	10000	58504	54594	21366	75960
1983	431	17658	18089	54000	10000	64000	54431	27658	82089
1984	2091	6785	8876	58153	6942	65095	60244	13727	73971
1985	348	18659	19007	52000	9043	61043	52348	27702	80050
1986	12859	6158	19017	53000	8132	61132	65859	14290	80149
1987	12	18988	19000	42400	3397	45797	42412	22385	64797
1988	18	16580	16598	51990	2501[e]	54401	51918	19081	70999

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	Pups	1 year and older	Total	Pups	1 year and older	Total
1989	0	9413	9413	30989	2475	33464	30989	11888	42877
1990	0	9522	9522	30500	1957	32457	30500	11479	41979
1991	0	9500	9500	30500	1980	32480	30500	11480	41980
1992	0	5571	5571	28351	2739	31090	28351	8310	36661
1993	0	8758[f]	8758	31000	500	31500	31000	9258	40258
1994	0	9500	9500	30500	2000	32500	30500	11500	42000
1995	260	6582	6842	29144	500	29644	29404	7082	36486
1996	2910	6611	9521	31000	528	31528	33910	7139	41049
1997	15	5004	5019	31319	61	31380	31334	5065	36399
1998	18	814	832	13350	20	13370	13368	834	14202
1999	173	977	1150	34850	0	34850	35023	977	36000
2000	2253	4104	6357	38302	111	38413	40555	4215	44770
2001	330	4870	5200	39111	5	39116	39441	4875	44316
2002	411	1937	2348	34187	0	34187	34598	1937	36535
2003	2343	2955	5298	37936	0	37936	40279	2955	43234
2004	0	33	33	0	0	0	0	33	33
2005	1162	7035	8197	14258	19	14277	15488	9405	22474
2006	147	9939	10086	7005	102	7107	7152	10041	17193
2007	242	5911	6153	5276	200	5476	5518	6111	11629
2008	0	0	0	13331	0	13331	13331	0	13331
2009	0	0	0	0	0	0	0	0	0
2010	0	105	105	5	5	10	5	110	115
2011	0	200	200	0	0	0	0	200	200
2012	0	0	0	0	9	9	0	9	9
2013	0	0	0	0	0	0	0	0	0

[a] The period 1946–1970 shows only five-year averages.
[b] Incidental catches of harp seals in fishing gear on Norwegian and Murmansk coasts are not included.
[c] Approx. 1300 harp seals (unspecified age) caught by a ship which was lost are not included.
[d] An additional 250–300 animals were shot but lost as they drifted into Soviet territorial waters.
[e] Russian catches of age 1+ animals after 1987 selected by scientific sampling protocols.
[f] Included 717 seals caught to the south of Spitsbergen, east of 14°E, by a ship operating mainly in the Greenland Sea.

Table 3.3.3.1.8   Estimates of proportion of mature females giving birth. Data from ICES (2011a).

Year	Estimated F
1990–1993	0.84
2006	0.68

Table 3.3.3.1.9   Estimates of proportions of mature females (p) at ages 4–13 in four historical periods: P_1 = 1962–1972; P_2 = 1976–1985; P_3 = 1988–1993; P_4 = 2006–2009. Data from ICES (2011a).

Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15
P_1	0	0.01	0.17	0.64	0.90	0.98	0.99	1.0	1.0	1.0	1.0	1.0	1.0	1.0
P_2	0	0	0	0.24	0.62	0.81	0.81	0.95	0.98	0.99	0.99	1.0	1.0	1.0
P_3	0	0	0.02	0.08	0.21	0.40	0.59	0.75	0.85	0.91	0.95	0.97	0.98	0.99
P_4	0.01	0.02	0.05	0.11	0.25	0.55	0.90	0.99	1.0	1.0	1.0	1.0	1.0	1.0

Table 3.3.3.1.10   Timing of Russian surveys, estimated numbers of pups and coefficients of variation (CV) in the White Sea/Barents Sea. Numbers and CVs are drawn from ICES (2011b).

Year	Survey period	Estimated number of pups	Coefficient of variation
1998	12 & 16 March	286 260	0.150
2000	10–12 March-photo	322 474[a]	0.098
	18 March-multispectral	339 710[b]	0.105
2002	20 March	330 000	0.103
2003	18 & 21 March	328 000[c]	0.181
2004	22 March – photo	231 811	0.190
	22 March-multispectral	234 000	0.205
2005	23 March	122 658	0.162
2008	19–20 March	123 104	0.199
2009	14–16 March	157 000	0.108
2010	20–23 March	163 022	0.198

[a]First 2000 estimates represented the sum of 291 745 pups (SE = 28 708) counted plus a catch 30 729 prior to the survey for a total pup production of 322 474.

[b]Second 2000 estimate represents the sum of 308 981 pups (SE = 32 400) counted plus a catch of 30 729 prior to the survey for a total pup production of 339 710.

[c]2003 estimate represents the sum of 298 000 pups (SE = 53 000) counted, plus a catch of 35 000 prior to the survey for a total pup production of 328 000.

Table 3.3.3.1.11   Estimated mean values and standard deviations of the parameters used in the model. Priors used are shown in brackets.

Parameters	Model estimates	
	Mean	SD
N_{t_0}	1 354 376 (1 000 000)	116 050 (2 000 000)
M_0	0.33 (0.27)	0.05 (0.05)
M_{1+}	0.11 (0.09)	0.01 (0.008)
$N_{0,2013}$	198 800	11 565
$N_{1+,2013}$	1 221 000	77 143
$N_{Total,2013}$	1 419 800	78 005

Table 3.3.3.1.12   Catch options with relative age 1+ population size (D1+) in ten years (2023) for harp seals in the White Sea.

Catch option	Proportion pups in catches	Pup catch	Age 1+ catch	Total catch	D_{1+} (95% CI)		
Current level	97.6%	2 667	65	2 732	1.01	1.13	1.25
Equilibrium	97.6%	31 950	786	32 736	0.88	1.00	1.12
Equilibrium	0%	0	17 400	17 400	0.88	1.00	1.12
Reduce to N_{70} [a]	97.6%	48 580	1 195	49 775	0.81	0.93	1.05
Reduce to N_{70} [a]	0%	0	26 650	26 650	0.81	0.93	1.05
PBR[b]	14.0%	5 660	34 770	40 430	0.71	0.84	0.96

[a]Catches that would reduce the population to 70% of current level with a 0.8 probability over ten years.

[b]PBR catch is evenly distributed across all age groups.

Greenland Sea hooded seals

State of stock/exploitation

Concerns over low pup production estimates resulted in advice from ICES that no harvest of Greenland Sea hooded seals should be permitted, with the exception of catches for scientific purposes, since 2007. This advice was immediately implemented. Total catches for scientific purposes (all taken by Norway) in 2012 and 2013 (Table 3.3.3.1.13) were 21 (including 15 pups) and 22 (including 15 pups), respectively. Subsistence catches from northeast Greenland have only averaged five animals per year during 2006–2011, which is about 20% of the 1993–2005 average.

Population estimates

No distinct hooded seal whelping concentrations were detected during the Norwegian survey of the Greenland Sea carried out in 2012. Covering a relatively large area the survey detected only scattered hooded seal families and, subsequently, solitary bluebacks. The hooded seals were mixed with harp seals in the whelping patch covered by the photographic survey carried out 28 March. Results from the staging flights suggest that the majority of hooded seal females whelped between 20 and 29 March, peaking on 24 March 2012. After correcting for the estimated temporal distribution of births the total estimate of hooded seal pup production was 13 655 (SE = 1 900), which is lower than estimates obtained from comparable surveys in 2005 and 2007, but the differences were not significant. The extensive reconnaissance surveys of all areas historically used by hooded seals in the Greenland Sea reduced the likelihood of missing major whelping concentrations in 2012. Difficult weather conditions meant that a small number of pups may not have been surveyed in the very open ice fringes northeast of the survey area, but this is not considered to be significant.

Results from the 2012 pup survey suggest that pup production remains low and that production in 2012 was significantly lower than observed in the 1997 survey (23 762 pups, SE = 4562; Table 3.3.3.1.14). ICES noted that the estimates reported for the 1997 and 2005 surveys in previous WG reports were incorrect.

The population model used to assess the stock size is similar to the model used to assess the Barents Sea/White Sea harp seal population. The model uses empirically derived maturity curves and was run for three different scenarios of pregnancy rates, F = 0.5, F = 0.7, and F = 0.9 (Table 3.3.3.1.15; Figure 3.3.3.1.6). Recent analyses indicate that pregnancy rates remained constant around F = 0.7 in the period 1958–1999. This is lower than the estimate of F = 0.9 used by ICES in its 2011 report (ICES, 2011b). The difference resulted from a change in the method used to determine pregnancy rates. Under the scenario of F = 0.7 the model estimates a 2013 pup production of 14 010 (SE = 1622) and an age 1+ population of 68 820 (SE = 7862), giving a total population of 82 830 (SE = 8028), and the model furthermore predicts a 7% decrease of the age 1+ population over the next ten years. As a result of incorporating the most recent pup production estimates, the population estimates from the model were lower than the ones obtained in 2011 (ICES, 2011b).

Catch options

The stock is estimated to be well below N_{lim}. Since 2008 ICES has recommended that there be no catch of Greenland Sea hooded seals. ICES continues to advise that there should be no catch of Greenland Sea hooded seals.
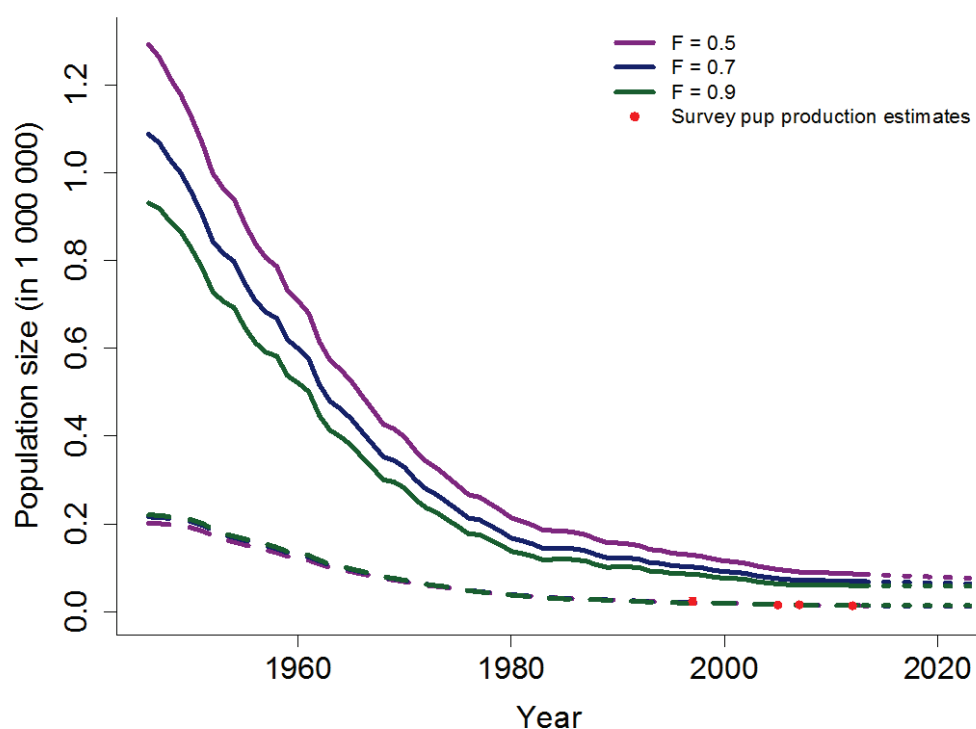
Figure 3.3.3.1.6   Modelled hoodel seal population trajectories for pups (dashed lines) and age 1+ population (full lines) and 95% confidence intervals (dotted lines). Red dots represent pup survey estimates.

Table 3.3.3.1.13   Catches of hooded seals in the Greenland Sea ("West Ice") from 1946 through 2013[a]. Totals include catches for scientific purposes.

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	Pups	1 year and older	total	Pups	1 year and older	Total
1946–50	31152	10257	41409	-	-	-	31152	10257	41409
1951–55	37207	17222	54429	-	-	-[b]	37207	17222	54429
1956–60	26738	9601	36339	825	1063	1888[b]	27563	10664	38227
1961–65	27793	14074	41867	2143	2794	4937	29936	16868	46804
1966–70	21495	9769	31264	160	62	222	21655	9831	31486
1971	19572	10678	30250	-	-	-	19572	10678	30250
1972	16052	4164	20216	-	-	-	16052	4164	20216
1973	22455	3994	26449	-	-	-	22455	3994	26449
1974	16595	9800	26395	-	-	-	16595	9800	26395
1975	18273	7683	25956	632	607	1239	18905	8290	27195
1976	4632	2271	6903	199	194	393	4831	2465	7296
1977	11626	3744	15370	2572	891	3463	14198	4635	18833
1978	13899	2144	16043	2457	536	2993	16356	2680	19036
1979	16147	4115	20262	2064	1219	3283	18211	5334	23545
1980	8375	1393	9768	1066	399	1465	9441	1792	11233
1981	10569	1169	11738	167	169	336	10736	1338	12074
1982	11069	2382	13451	1524	862	2386	12593	3244	15837
1983	0	86	86	419	107	526	419	193	612
1984	99	483	582	-	-	-	99	483	582
1985	254	84	338	1632	149	1781	1886	233	2119
1986	2738	161	2899	1072	799	1871	3810	960	4770
1987	6221	1573	7794	2890	953	3843	9111	2526	11637
1988	4873	1276	6149[c]	2162	876	3038	7035	2152	9187

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	Pups	1 year and older	total	Pups	1 year and older	Total
1989	34	147	181	-	-	-	34	147	181
1990	26	397	423	0	813	813	26	1210	1236
1991	0	352	352	458	1732	2190	458	2084	2542
1992	0	755	755	500	7538	8038	500	8293	8793
1993	0	384	384	-	-	-	0	384	384
1994	0	492	492	23	4229	4252	23	4721	4744
1995	368	565	933	-	-	-	368	565	933
1996	575	236	811	-	-	-	575	236	811
1997	2765	169	2934	-	-	-	2765	169	2934
1998	5597	754	6351	-	-	-	5597	754	6351
1999	3525	921	4446	-	-	-	3525	921	4446
2000	1346	590	1936	-	-	-	1346	590	1936
2001	3129	691	3820	-	-	-	3129	691	3820
2002	6456	735	7191	-	-	-	6456	735	7191
2003	5206	89	5295	-	-	-	5206	89	5295
2004	4217	664	4881	-	-	-	4217	664	4881
2005	3633	193	3826	-	-	-	3633	193	3826
2006	3079	568	3647				3079	568	3647
2007	27	35	62				27	35	62
2008	9	35	44				9	35	44
2009	396	17	413				396	17	413
2010	14	164	178				14	164	178
2011	15	4	19				15	4	19
2012	15	6	21				15	6	21
2013	15	7	22				15	7	22

[a] The period 1946–1970 shows only five-year averages.
[b] For 1955, 1956, and 1957 Soviet catches of harp and hooded seals combined are reported at 3900, 11 600, and 12 900, respectively. These catches are not included.
[c] Including 1048 pups and 435 adults caught by a ship which was lost.

Table 3.3.3.1.14   Survey estimates of Greenland Sea hooded seal pup production.

Year	Estimate	c.v.
1997	23 762	0.192
2005	15 250	0.228
2007	16 140	0.133
2012	13 655	0.138

Table 3.3.3.1.15 Model estimates and standard deviation of the parameters used in the model for the original and for various choices of the reproductive rate F. Priors used are shown in brackets. D is the ratio of the projected 2021 population to the current population.

Parameters	F = 0.5		F = 0.7		F = 0.9	
	Mean	SD	Mean	SD	Mean	SD
N_{t_0}	1 290 620 (90000)	459 220 (90000)	1 086 890	394 940	930 610	337 060
M_0	0.33 (0.33)	0.05 (0.05)	0.34	0.02	0.34	0.05
M_{1+}	0.14 (0.11)	0.02 (0.05)	0.17	0.05	0.19	0.02
$N_{0,2013}$	13 850	1 548	14 010	1 622	14 230	1 680
$N_{1+,2013}$	85 220	9 427	68 820	7 862	59 700	6 937
$N_{Total,2013}$	99 070	9 553	82 830	8 028	73 930	7 137

Sources of information

ICES. 2011a. Norwegian request on status and harvest potential of the Harp seal stocks in the Greenland Sea and the White Sea/Barents Sea, and of the Hooded seal stock in the Greenland Sea. *In* Report of the ICES Advisory Committee, 2011. Section 3.3.3.2 in ICES Advice 2011, Book 3: 7–21.

ICES. 2011b. Report of the Working Group on Harp and Hooded Seals (WGHARP), 15–19 August 2011, St Andrews, Scotland, UK. ICES CM 2011/ACOM:22. 78 pp.

ICES. 2013. Report of the Working Group on Harp and Hooded Seals (WGHARP), 26–30 August 2013, PINRO, Murmansk, Russia. ICES CM 2013/ACOM:20. 59 pp.