MANUSCRIPT TYPE – TECHNICAL NOTE
NAMMCO Scientific Publications

ESTIMATES OF PINNIPED ABUNDANCE IN THE NORTH ATLANTIC OF RELEVANCE TO NAMMCO

Marina Metić[1*] & Maria Garagouni[1]

[1] NAMMCO-North Atlantic Marine Mammal Commission
* Corresponding author, email: marinametic@gmail.com

INTRODUCTION

This document presents the best available abundance estimates for pinniped species in areas of relevance to the work of NAMMCO, spanning the years 1964–2023. It can be used as a quick, citable reference point by researchers, and all original sources are provided in the table if additional information is needed.

New abundance estimates for pinniped species in the NAMMCO area are initially presented at a Working Group (WG) or Workshop (WS) meeting. There are several WGs dealing with pinnipeds, and each of the working groups deals with species sharing similar traits: NAMMCO has separate WGs for Coastal (harbour and grey) seals, Bearded and Ringed seals, and Walrus, while also participating in the joint ICES/NAFO/NAMMCO WG on Harp and Hooded seals (WGHARP). The reports of the Working Groups and Workshops are then presented to the NAMMCO Scientific Committee, the body that formally endorses the abundance estimates. In the case of the abundance estimate of harp and hooded seals, the estimates are presented to the WGHARP and endorsed by ICES.

For some species that are easy to spot from air or ship, there is enough information to generate abundance estimates just from the survey numbers, correcting the initial survey numbers for biases when possible. For other species, the estimates are generated with models that are based on abundance survey numbers and incorporate different biological or physical aspects, such as fecundity, human removals, and environmental conditions, to improve on the estimates. The models for harp and hooded seals have been updated since the first models and first pup count surveys in the 1970s. The abundance estimates for harp and hooded seals for 2019, generated at the latest WGHARP meeting, are not fit for use in stock assessments. Due to the lack of catch-at-age data as well as assumptions about the initial population size, the estimates were deemed unreliable by the WG.

Some species are difficult to survey, due to different factors. Bearded seals, for instance, haul out in inaccessible places, so it is physically hard to survey them. Ringed seals hide in lairs under the snow, so they are not visible from the survey vessel. For such species, the abundance estimates are limited and patchy.

In the table of estimates, the rows containing pup counts for harp and hooded seals are coloured grey for easier differentiation from total population abundance estimates.

Column definitions and abbreviations

Some columns require no explanation (e.g., species) and are not included below.

Region

Species-specific region. Note that a survey may cover all or part of a region, management area or sub-area, so comparisons between surveys must take this into consideration.

Management area/Subarea

Management areas as defined by NAMMCO.

Survey

Area – Which specific part of the management area was covered during the survey.

Name – name of the survey if applicable.

Type – type of survey that was performed:

- A – Aerial surveys from planes, helicopters or with drones
- S – Ship surveys from boats and dinghies
- L – Land based surveys
- P – Counting pup production
- M – Surveys in the moulting period
- Model based abundance estimate – Model estimates based on survey numbers, and other biological factors that improve the estimates.

Uncorrected abundance estimate (UAE)

Abundance estimates uncorrected for biases.

CV – Coefficient of variation

95 % – 95% confidence interval

Corrected abundance (CAE)

Abundance estimates corrected for different kinds of biases. Different species are corrected for different types of biases.

Bias – systematic error that causes the abundance estimate to differ from the actual population size. Biases can be positive or negative, and can lead to either over- or underestimation.

Metić, M., & Garagouni, M. (2024). Estimates of Pinniped abundance in the North Atlantic of relevance to NAMMCO. *NAMMCO Scientific Publications 13*. https://doi.org/10.7557/3.7974

- a – availability bias: This occurs when seals are not available for sampling, i.e., the seals are not visible to the observer for whatever reason.
- i – interference bias: This occurs when the presence of observers affects the behaviour of the animals, e.g., the seals avoid the presence of people.
- o – observer or detection bias: This occurs when the experience and knowledge of observers varies. Those differences can lead to inconsistencies in counts within the same survey.
- p – perception bias: This refers to the animals that were available to be counted, but were missed due to a variety of reasons, such as poor environmental conditions, observer fatigue or inexperience.
- s – sampling bias: This occurs when the sampling method does not adequately represent the entire population. The bias can be either spatial, choosing only easily accessible areas, or temporal, if the counts are not done in the period when most or all seals are hauled out.

Understanding and mitigating these biases is crucial for robust abundance estimates.

Endorsed by

Organisational endorsement of the abundance estimate, usually the NAMMCO Scientific Committee, NAMMCO Working Groups, and, in the case of harp and hooded seals, the Joint ICES/NAFO/NAMMCO Working Group.

Sources

Citations of research papers, meeting documents or meeting reports where the abundance estimates were first published.

ACKNOWLEDGEMENTS

We are very grateful to all those who ensured that the content in this document is correct, namely, Aqqalu Rosing-Asvid, Garry Stenson, Christian Lydersen, Mads Peter Heide-Jørgensen, Rikke Guldborg Hansen, and Sandra Granquist. MM would like to especially thank NAMMCO for providing her with the time and resources to compile this manuscript during her internship.

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Atlantic walrus	Arctic	Baffin Bay (BB)	Baffin Bay	*"Winter Greenland - North Water"*	2018 (Apr)	A				1.279	0,16	938-1,744	p, a	NAMMCO SC/25		NAMMCO 2018 (WWG Report), Hansen and Heide-Jørgensen 2018
			Baffin Bay	*"Summer Greenland - North Water"*	2014	A				2.544	0,27	1,513-4,279	p, a	NAMMCO SC/22		Heide Jørgensen et al 2016, NAMMCO 2015
			Baffin Bay	The North Water Polynya	2010	A				1.759	0,29		p, a	WWG 2013		Heide-Jørgensen et al. 2014
			Baffin Bay	The North Water Polynya	2009	A				1.238	0,19		p, a	WWG 2013	All walruses on ice assumed available, availability correction for animals in water only	Heide-Jørgensen et al. 2014
			Baffin Bay		2009	A				1.251	1,00	1	a		adjusted by the proportion of tags 'dry' at the time of the survey	Stewart at al. 2014
										1.249	1,12	1.370			adjusted by the average time tags were dry	
			Baffin Bay		2009 (Aug)	A				1.616	0,32	876-2,980	a	WWG 2009		NAMMCO 2009 (WWG Report)
			Baffin Bay		2009 (May)					2.676	0,32	1,140-4,920	a	WWG 2009		
			North Water		1999	A				~1,500	0,35		a	WWG 2005	NAMMCO SC/13 accepted the estimate for information but noted that it should not be used directly in assessments without further work and documentation.	Witting and Born 2005
		West Greenland-Southeast Baffin Bay (WGSBI)	WG-SE Baffin Bay	Hudson Strait	2012 (Mar-Apr)	A				4.675	0,45	1,845-11,842	a, p, o	WWG 2013	Replicate 1	Elliot et al. 2013
			WG-SE Baffin Bay							6.020	0,40	2,485-14,585			Replicate 2	
			WG-SE Baffin Island	Baffin Bay	2012 (Mar-Apr)	A				1.408	0,22	922-2,150	a	WWG 2013	All walruses on ice assumed available, availability correction for animals in water only	Heide-Jørgensen et al. 2014
			Penny Strait-Lancaster Sound		2009 (Aug)	A				2.010	0,18	1,416-2,852	a	WWG 2009	The WG accepted the estimates and agreed with the recommendation to use caution in the use of these figures.	NAMMCO 2009 (WWG report)
			WG-SE Baffin Island	Baffin Bay	2008	A				1.137	0,48		a	WWG 2013	All walruses on ice assumed available, availability correction for animals in water only	Heide-Jørgensen et al. 2014
			West Greenland		2008 (Apr)	A				3.240	0,78	863-12,170	a	WWG 2009		NAMMCO 2009 (WWG report)
			Western Jones Sound		2008 (Aug)	A				1415 (1,450)	0,18	997-2,008	a	WWG 2009	The WG accepted the estimates and agreed with the recommendation to use caution in the use of these figures.	NAMMCO 2009 (WWG report)
			SE Baffin Island		2007 (Sep)	A				1.056			a	WWG 2009		NAMMCO 2009 (WWG report)
			WG-SE Baffin Island	Hoare Bay	2007 (Sep)	S				2.502		1,600-3,345	a	WWG 2013	Negatively biased estimator of the population of walrus around SE Baffin Island and in the Hudson Bay–Davis Strait stock as a whole.	Stewart, Born, Dietz, & Ryan 2014
			West Greenland		2006 (Mar-Apr)	A				2.791	0,54	1,036-7,522	a	WWG 2009		NAMMCO 2009 (WWG report)
			WG-SE Baffin Island	Baffin Bay	2006 (Mar-Apr)	A				1.105	0,31	610-2,002	a	WWG 2013	All walruses on ice assumed available, availability correction for animals in water only	Heide-Jørgensen et al. 2014
			West Greenland		1990-1991	A				938	0,48		(p), a	WWG 2005	About 1000 walruses were within the surveyed areas. To include walruses in areas not surveyed, this estimate was raised for the simulations and the CV of this estimate was arbitrarily set	Witting and Born 2005
		East Greenland	Northeast Water Polynya	Summer survey	2017 (Aug-Sep)	A				203	0,17	146-284	p, a	WWG 2018		Hansen et al. 2018 (SC/25/14-WWG/07)
				Winter survey	2017 (Mar-Apr)	A				279	0,34	147-533				
			Northeast Greenland	Northeast Water	2017	A				350	0,12	277-442	p, a		Combined estimates of walruses on ice and in the water in Northeast Water with those estimated to be at the haul-out sites gives a total abundance in Northeast Greenland	

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Atlantic walrus	Arctic	East Greenland	East Greenland		2009	A				559		365-856	p, a		Revised from Born et al. 2009 using the different correction factors.	Hansen et al. 2018
			East Greenland		2009	A				1.429	0,45	90% CI = 705-2,896	p, a	WWG 2009, SC/17	The WG welcomed this abundance estimate, which is the first of its kind for the area, but also recognized that the results may be negatively biased and therefore the stock size is likely higher.	Born et al. 2009 (SC/17/WWG/07)
			East Greenland		1984-1990	Opportunistic counts				500-1,000	0,35			WWG 2005	Cautious estimate based on opportunistic and systematic observations; not of sufficient quality to be used in assessments	Born et al. 1997
			Nordostrundingen (c. 81°N) to Scoresby Sound (c.70°30'N)		1984					329				WWG 1995	Report from two sport kayakers	NAMMCO 1995 (WWG Report)
		Svalbard - Franz Josef Land	Svalbard		2018					5.503		5,031-6,036		NAMMCO SC/26		NAMMCO 2019
			Svalbard		2012	A				3.886		3,553-4,262		NAMMCO SC/21		Kovacs et al. 2014
			Svalbard		2006 (Aug)	A				2.629		2,318-2,998	p, a	WWG 2009		Lydersen et al. 2008
			Svalbard - Franz Josef Land		1993	A/L	741			1.450				NAMMCO SC/4 (AWWG 1995)	Walruses observed (741) were mostly males, as walruses tend to segregate sexually for a large part of the year. The 1450 animals estimate is the most conservative estimate based on the sex ratio of 1:1.	Gjertz and Wiig 1995
		Foxe Basin	Foxe Basin		1989	A	5.500		900-30 500					NAMMCO SC/4 (AWWG 1995)	Not corrected for submerged animals or those surface animals missed by observers. Estimates of stock size given here are considered to represent an index, not an absolute measure of abundance.	Cosens et al. 1993
			Foxe Basin		1988	A	5.200		2,700-11,200							
Bearded seal	Arctic	West Greenland	West Greenland												Data on bearded seal sightings from winter surveys in West Greenland available from 2022, 2012, 2006, and probably from 1999,1998, 1994, 1993, 1991, 1990, 1982, and 1981, but no attempts have been made to generate abundance estimates.	Hansen 2022
			Melville Bay												Data on bearded seal sightings from summer surveys for narwhals in Augus/September available for 2012 and 2014, abundance estimates could be attempted	Hansen 2023
			East part of North Water Polynya		2014					6.005	0,20	4,070-8,858	p,a			Heide-Jørgensen et al. 2016b
			North Water		2010					6.016	0,31	3,322-10,893	p, a			Heide-Jørgensen et al. 2013
		Southwest and East Greenland	Southwest and East Greenland							Unknown						Laidre et al. 2015
		Svalbard and Barents Sea	Svalbard and Barents Sea	*"Svalbard"*						Unknown						Laidre et al. 2015
Grey seal	Northeast Atlantic Coast	Greenland	No established population; visited by strays													
		Iceland	Iceland		2017	P/A				6.269		5375-7181	a, o, s	NAMMCO SC/26 (CSWG 2023)		Granquist and Hauksson 2019
										1452 (pups)		1,385-1,529				
			Iceland		2012	P/A				4.206		3,400-5,000	a, o, s	NAMMCO SC/23 (CSWG 2016)		Hauksson et al., 2014
										992 (pups)		900-1,070				
		Iceland	Iceland		2008/2009	P/A				6.104		4,578-7,630	a, o, s	NAMMCO SC/18 (CSWG 2016)		Hauksson 2011
					2009	P/A				1,539 (pups)		1,483-1,575				
					2008	P/A				1,677 (pups)		1,629-1,703				
			Iceland		2008/2009	P/A				6.156				NAMMCO SC/26 (CSWG 2023)		Granquist and Hauksson 2019
			Iceland		2005	P/A				5.544		4,158-6,930	a, o, s	NAMMCO SC/18 (CSWG 2016)		Hauksson 2011
										1,392 (pups)		1,348-1,468				
			Iceland		2005	P/A				5.568				NAMMCO SC/26 (CSWG 2023)		Granquist and Hauksson 2019
			Iceland		2002	P/A				4.731			a, o, s	NAMMCO SC/26 (CSWG 2023)	Correction for availability, hunted pups, natural mortality	Granquist and Hauksson 2019

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Grey seal	Northeast Atlantic Coast	Iceland	Iceland		2002	P/A				1,180 (pups)		966-1,587	a, o, s			Hauksson 2007
			Iceland		1998	P/A				5.612			a, o, s	NAMMCO SC/26 (CSWG 2023)		Granquist and Hauksson 2019
			Iceland		1998	P/A				1,400 (pups)		1,147-1,882	a, o, s			Hauksson 2007
			Iceland		1995	P/A				7.772		6,335-9,259	a, o, s	NAMMCO SC/4 (GSWG 1996)		Hauksson 1996
										1,886 (pups)		1,538-2,247				
			Iceland		1995	P/A				1,934 (pups)		1,585-2,600	a, o, s			Hauksson 2007
			Iceland		1995	P/A				7.758			a, o, s	NAMMCO SC/26 (CSWG 2023)		Granquist and Hauksson 2019
			Iceland		1992	P/A				8.788		6,679-10,061	a, o, s	NAMMCO SC/4 (GSWG 1996)		Hauksson 1996
										2,133 (pups)		1,621-2,422				
			Iceland		1992	P/A				1,901 (pups)		1,556-2,558	a, o, s			Hauksson 2007
			Iceland		1992	P/A				7.624			a, o, s	NAMMCO SC/26 (CSWG 2023)		Granquist and Hauksson 2019
			Iceland		1990	P/A				12.500		9,501-14313	a, o, s	NAMMCO SC/4 (GSWG 1996)		Hauksson 1996
										3,034 (pups)		2,306-3,474				
			Iceland		1990	P/A				2,632 (pups)		2,155-3,542	a, o, s			Hauksson 2007
			Iceland		1990	P/A				10.557			a, o, s	NAMMCO SC/26 (CSWG 2023)		Granquist and Hauksson 2019
			Iceland		1986	P/A				13.847		10,358-15,602	a, o, s	NAMMCO SC/4 (GSWG 1996)		Hauksson 1996
										2,965 (pups)		2,218-3,341				
			Iceland		1986	P/A				2,153 (pups)		1,764-2,892	a, o, s			Hauksson 2007
			Iceland		1985/6	P/A				8.632			a, o, s	NAMMCO SC/26 (CSWG 2023)		Granquist and Hauksson 2019
			Iceland		1982	P/A				12.558		9,574-14,384	a, o, s	NAMMCO SC/4 (GSWG 1996)		Hauksson 1996
			Iceland		1982	P/A				2,689 (pups)		2,050-3,080	a, o, s	NAMMCO SC/4 (GSWG 1996)		Hauksson 1996
			Iceland		1982	P/A				2,298 (pups)		1,884-3,086	a, o, s			Hauksson 2007
			Iceland		1982	P/A				9.216				NAMMCO SC/26 (CSWG 2023)		Granquist and Hauksson 2019
		Faroe Islands	Northeast		2021	S/A*	44								*drone survey; must be considered as minimum numbers, since they do not correct for the animals outside the coastline area during the	Mikkelsen, 2023
			West				171									
			Central/South				178									
			Total				393									
			Northeast		2019	S/A*	105								*drone survey; must be considered as minimum numbers, since they do not correct for the animals outside the coastline area during the	Mikkelsen, 2023
			West				233									
			Central/South				217									
			Total				555									
			Northeast		2018	S/A*	91								*drone survey; must be considered as minimum numbers, since they do not correct for the animals outside the coastline area during the	Mikkelsen, 2023
			West				176									
			Central/South				137									
			Total				404									
		NO / Lista - Stad	Lista-Stad		2020-2023	L	36 (pups)									Nilssen et al. 2023
			Lista-Stad		2014-2018	L/P	34 (pups)									Nilssen et al. 2023
			Lista-Stad		2010	Model based total abundance				246						Øigård et al. 2012
			Lista-Stad		2006-2008	L/S/P	43 (pups)									Nilssen et al. 2009, Øigård et al. 2012
			Lista-Stad							215-245						Nilssen et al. 2023
			Rogland		2001-2003		28-35 (pups)									Nilssen and Haug 2007
										140-170						
					1994-1998	L/S/P	478									Bjørge and Øien 1999
					1986					120			o			Wiig 1986
		NO / Stad-Vesterålen	Stad-Vesterålen		2020-2023					324 (pups)						Nilssen et al. 2023
			Sør-Trøndelag		2014-2018					453 (pups)		300-606				Nilssen et al. 2016
			Nord-Trøndelag		2016					263		108-418		CSWG 2016		Nilssen et al. 2016
			Nordland		2016					1.128		685-1,571				Nilssen et al. 2016
			Trøndelag and Nordland		2014/2015	L/S/P				332? (decline)				NAMMCO SC/23 (CSWG 2016)		NAMMCO 2016 (CSWG Report)
			Stad-Vesterålen		2010	Model based total abundance				6.496						Øigard et al.2012
			Stad-Vesterålen		2006-2008	L/S/P	943 (pups)									Øigard et al.2012
			Stad-Vesterålen							4715-5375						
			Stad-Vesterålen		2001-2003					4700-5350						Nilssen et al. 2023
			Stad-Vesterålen			S/P	940 (pups)									Nilssen and Haug 2007
			Sør-Trøndelag				283 (pups)							NAMMCO SC/11 (GSWG 2003)		
										1,130-1,330						
			Nord-Trøndelag				84 (pups)									
										330-400						
			Nordland				573									
										2,300-2,700						
			Sør Trøndelag - Lofoten		1996-1998	L/S/P				728 (pups)						Bjørge and Øien 1999
										3.276						
			Stad-Vesterålen							3,600-4,150						Nilssen et al. 2023
			Nordland		1979					140 (pups)			o		pups counted	Wiig 1986
										860			o		estimate	
		NO / Troms-Finmark	Troms-Finmark		2020-2023	L/P	275 (pups)									Nilssen et al. 2023
			Finmark		2016	Model based total abundance				1.328		914-1,742		CSWG 2016		Nilssen et al. 2016

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Grey seal	Northeast Atlantic Coast	NO / Troms-Finmark	Finmark		2015	L/P	206 (pups)									Nilssen et al. 2023
			Troms		2015	L/P	65 (pups)									Nilssen et al. 2023
			Troms-Finmark		2014-2018					275 (pups)						Nilssen et al. 2023
			Troms-Finmark		2010	Model based total abundance				2.001						Øigård et al. 2012
			Troms-Finmark		2006-2008					283 (pups)						Nilssen et al. 2023
			Troms-Finmark							1,400-1,600						
			Finnmark			L/S/P				206 (stable)				NAMMCO SC/23 (CSWG 2016)		NAMMCO 2016 (CSWG Report)
			Troms-Finmark		2001-2003		184 (pups)									Nilssen et al. 2023
			Troms-Finmark							900-1050						
			Troms				41 (pups)							NAMMCO SC/11 (GSWG 2003)		Nilssen and Haug 2007
										160-190						
			Finnmark				142-143 (pups)									
										570-670						
			Troms		1998	L/S/P	135									Bjørge and Øien 1999
			Finnmark			L/S/P				1.002						
			Troms		1986		150						o			Wiig 1986
			Finnmark							350			o			
		NO/All	All		2015/2017	Model based total abundance				3.850		3,504-4,196		NAMMCO SC/26 (CSWG 2016)		Nilssen et al. 2016
			All		2011	Model based total abundance				8.740		7,320-10,170		NAMMCO SC/23 (CSWG 2016)	total abundance estimate	Øigård et al. 2012
										7.120		5,710-5,840			1+ and older	
										1,620 (pups)		1,410-3,050			pup production	
			All		2006-2009	L/S/P				5,100-6,000				NAMMCO SC/23 (CSWG 2016)	1+ and older	Øigård et al. 2012
										1,275 (pups)					pup production	
			All		2001-2003	S/P	1,159 (pups)							NAMMCO SC/11 (GSWG 2003)	minimum annual grey seal pup production	Nilssen and Haug 2007
							4,600-5,500								1+ and older	
			All		1996-1999	L/S/P				4.413						Bjørge and Øien 1999
			All		1979-1986	L/S/P				3.110			o		minimum estimate	Wiig 1986
Harbour seal	North Atlantic Coast	GL / Northwest	Northwest Greenland		2006					166					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (3\%$ replacement yield $(N_t) - catch_t$)	Rosing-Asvid 2010
										100					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (5\%$ replacement yield $(N_t) - catch_t$)	
										50					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (10\%$ replacement yield $(N_t) - catch_t$)	
					1950					176					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (3\%$ replacement yield $(N_t) - catch_t$)	
										110					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (5\%$ replacement yield $(N_t) - catch_t$)	
										58					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (10\%$ replacement yield $(N_t) - catch_t$)	
		GL / Central West	Central West Greenland		2006					166-333					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (3\%$ replacement yield $(N_t) - catch_t$)	Rosing-Asvid 2010

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Harbour seal	North Atlantic Coast	GL / Central West	Central West Greenland		2006					100-200					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (5\%$ replacement yield $(N_t) - catch_t)$	Rosing-Asvid 2010
										50-100					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (10\%$ replacement yield $(N_t) - catch_t)$	
					1950					1523-1587					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (3\%$ replacement yield $(N_t) - catch_t)$	
										1260-1280					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (5\%$ replacement yield $(N_t) - catch_t)$	
										878-880					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (10\%$ replacement yield $(N_t) - catch_t)$	
		GL / Southwest	Southwest Greenland		2006					166					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (3\%$ replacement yield $(N_t) - catch_t)$	Rosing-Asvid 2010
			Southwest Greenland							100					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (5\%$ replacement yield $(N_t) - catch_t)$	
			Southwest Greenland							50					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (10\%$ replacement yield $(N_t) - catch_t)$	
			Southwest Greenland		1950					1.026					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (3\%$ replacement yield $(N_t) - catch_t)$	
			Southwest Greenland							821					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (5\%$ replacement yield $(N_t) - catch_t)$	
			Southwest Greenland							549					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (10\%$ replacement yield $(N_t) - catch_t)$	
		GL / South	South Greenland		2006					100-600					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (3\%$ replacement yield $(N_t) - catch_t)$	Rosing-Asvid 2010
			South Greenland							100-600					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (5\%$ replacement yield $(N_t) - catch_t)$	
			South Greenland							100-600					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (10\%$ replacement yield $(N_t) - catch_t)$	

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Harbour seal	North Atlantic Coast	GL / South	South Greenland		1950					710-803					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (3\%$ replacement yield $(N_t) - catch_t)$	Rosing-Asvid 2010
			South Greenland							426-457					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (5\%$ replacement yield $(N_t) - catch_t)$	
			South Greenland							186-189					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (10\%$ replacement yield $(N_t) - catch_t)$	
		GL / Total	Total		2006					598-1265					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (3\%$ replacement yield $(N_t) - catch_t)$	Rosing-Asvid 2010
			Total							400-1000					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (5\%$ replacement yield $(N_t) - catch_t)$	
			Total							250-800					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (10\%$ replacement yield $(N_t) - catch_t)$	
			Total		1950					3435-3592					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (3\%$ replacement yield $(N_t) - catch_t)$	
			Total							2617-2662					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (5\%$ replacement yield $(N_t) - catch_t)$	
			Total							1671-1676					Estimated harbour seal numbers in 1950 and 2006 based on back calculations ($N_{t+1} = N_t + (10\%$ replacement yield $(N_t) - catch_t)$	
		Iceland	The whole coast		2020	A/M				10.319		6,733-13,906	a	NAMMCO SC/28 NAMMCO SC/30 (CSWG 2023)		Granquist 2021
					2018	A/M				9.434		6.149-12.726	a	NAMMCO SC/26		Granquist and Hauksson 2019b
					2016	A/M				7.652		4,995-10,310	a	NAMMCO SC/24 (CSWG 2016)		Þorbjörnsson et al. 2017
			Vatnsnes peninsula		2012	A/M				618				NAMMCO SC/20		NAMMCO 2013
			Partial coverage		2014	A/M				~8000				NAMMCO SC/23 (CSWG 2016)	This abundance is calculated assuming that the populations are stable in the other parts of the country that were not surveyed in 2014 and therefore should be used with caution.	Granquist & Sigurjonsdottir 2014, NAMMCO 2016
			The whole coast		2011	A/M				11.272		8,000-16,000	a	NAMMCO SC/19		Granquist et al. 2011, Granquist 2022
			Vatnsnes peninsula		2011	A/M				1.033				NAMMCO SC/20		NAMMCO 2013
			The whole coast		2006	A/M				12.122		90% CI = 9,187–15,867	a	NAMMCO SC/14 (HSWG)		Hauksson 2010, Hauksson and Einarsson 2010
					2003	A/M				9.972		90% CI = 7,559–13,336	a	NAMMCO SC/14 (HSWG)		
					1998	A/M				13.887		90% CI = 10,670–18,477	a	NAMMCO SC/14 (HSWG)		
					1995	A/M				13.578		90% CI = 10,484 – 18,135	a	NAMMCO SC/14 (HSWG)		Hauksson 2010, Hauksson and Einarsson 2010
					1992	A/M				15.731		90% CI = 11,902–20,567	a	NAMMCO SC/14 (HSWG)		
					1990	A/M				17.026		90% CI = 13,079–21,718	a	NAMMCO SC/14 (HSWG)	The whole coast. Survey was difficult due to bad weather and finished in late September	

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Harbour seal	North Atlantic Coast	Iceland	The whole coast		1989	A/M				15.298		90% CI = 11,696–20,050	a	NAMMCO SC/14 (HSWG)	Northwest coast and south coast surveyed 4 times, in May, June, July and August or September	Hauksson 2010, Hauksson and Einarsson 2010
					1985	A/M				27.871		90% CI = 21,241–36,988	a	NAMMCO SC/14 (HSWG)		
					1980	A/M				33.327		90% CI = 25,492–43,779	a	NAMMCO SC/14 (HSWG)		
		Faroe Islands	Extirpated in the 19th century (~1850)													Mikkelsen 2010
		NO / Østfold	Østfold		2022	A/S/M	694							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Østfold		2016-2021	A/S/M	325							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Østfold		2011-2015	A/S/M	363							NAMMCO SC/23 (CSWG 2016)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen, Bjørge, et al. 2016
			Østfold		2008-2015	A/S/M	281							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Østfold		2003-2006	A/S/L/M	266							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			Østfold		1996-1999	A/S/M	289			506				NAMMCO SC/18 (HSWG 2011)		Bjørge et al., 2007
			Østfold		1994-1998	A/S/M	176									Bjørge and Øien 1999
		NO / Vestfold	Vestfold		2022	A/S/M	663							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Vestfold		2016-2021	A/S/M	292							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Vestfold		2011-2015	A/S/M	183							NAMMCO SC/23 (CSWG 2016)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen, Bjørge, et al. 2016
			Vestfold		2008-2015	A/S/M	183							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Vestfold		2003-2006	A/S/L/M	7							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			Vestfold		1996-1999	A/S/M	61			107				NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Bjørge et al., 2007
			Vestfold		1994-1999	A/S/M	35									Bjørge and Øien 1999
		NO / Telemark	Telemark		2022	A/S/M	234							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Telemark		2016-2021	A/S/M	175							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Telemark		2011-2015	A/S/M	148							NAMMCO SC/23 (CSWG 2016)		Nilssen, Bjørge, et al. 2016
			Telemark		2008-2015	A/S/M	148							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Telemark		2003-2006	A/S/L/M	45							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			Telemark		1996-1999	A/S/M	0							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Bjørge et al., 2007
		NO / Aust-Agder	Aust-Agder		2022	A/S/M	46							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Aust-Agder		2016-2021	A/S/M	41							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Aust-Agder		2011-2015	A/S/M	39							NAMMCO SC/23 (CSWG 2016)		Nilssen, Bjørge, et al. 2016
			Aust-Agder		2008-2015	A/S/M	36							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Aust-Agder		2003-2006	A/S/L/M	10							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Harbour seal	North Atlantic Coast	NO / Vest-Agder	Vest-Agder		2022	A/S/M	52							NAMMCO SC/30	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Vest-Agder		2016-2021	A/S/M	35							NAMMCO SC/30	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Vest-Agder		2011-2015	A/S/M	0							NAMMCO SC/23 (CSWG 2016)		Nilssen, Bjørge, et al. 2016
		NO / Rogland	Rogland		2022	A/S/M	665 (*117)							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Rogland		2016-2021	A/S/M	393 (*105)							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	
			Rogland		2011-2015	A/S/M	475							NAMMCO SC/23 (CSWG 2016)		Nilssen, Bjørge, et al. 2016
			Rogland		2008-2015	A/S/M	389 (*92)							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Rogland		2003-2006	A/S/L/M	360							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			Rogland		1996-1999	A/S/M	513			693				NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Bjørge et al., 2007
			Rogland		1994-1998	A/S/M	478									Bjørge and Øien 1999
		NO / Vestland (Sogn og Fhjordane)	Vestland		2022	A/S/M	581 (**146)							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Vestland		2016-2021	A/S/M	620 (**121)							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	
			Vestland		2011-2015	A/S/M	659							NAMMCO SC/23 (CSWG 2016)		Nilssen, Bjørge, et al. 2016
			Vestland		2008-2015	A/S/M	471 (**188)							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Vestland		2003-2006	A/S/L/M	325							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			Vestland		1996-1999	A/S/M	714			964				NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Bjørge et al., 2007
			Vestland		1994-1998	A/S/M	725									Bjørge and Øien 1999
		NO / Møre & Romsdal	Møre og Romsdal		2016-2021	A/S/M	634							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Møre og Romsdal		2011-2015	A/S/M	636							NAMMCO SC/23 (CSWG 2016)		Nilssen, Bjørge, et al. 2016
			Møre og Romsdal		2008-2015	A/S/M	689							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Møre og Romsdal		2003-2006	A/S/L/M	477							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			Møre og Romsdal		1996-1999	A/S/M	1.072			1.447				NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Bjørge et al., 2007
			Møre og Romsdal		1994-1998	A/S/M	871									Bjørge and Øien 1999
		NO / S-Trøndelag	Sør-Trøndelag		2016-2021	A/S/M	790							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Sør-Trøndelag		2011-2015		556							NAMMCO SC/23 (CSWG 2016)		Nilssen, Bjørge, et al. 2016
			Sør-Trøndelag		2008-2015	A/S/M	632							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Sør-Trøndelag		2003-2006	A/S/L/M	1.527							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			Sør-Trøndelag		1996-1999	A/S/M	1.296			1.750				NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Bjørge et al., 2007
			Sør-Trøndelag		1994-1998	A/S/M	690									Bjørge and Øien 1999
		NO / N-Trøndelag	Nord-Trøndelag		2016-2021	A/S/M	124							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Nord-Trøndelag		2011-2015		100							NAMMCO SC/23 (CSWG 2016)		Nilssen, Bjørge, et al. 2016

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Harbour seal	North Atlantic Coast	NO / N-Trøndelag	Nord-Trøndelag		2008-2015	A/S/M	100							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen, Henden and Biuw, 2023
			Nord-Trøndelag		2003-2006	A/S/L/M	138							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			Nord-Trøndelag		1996-1999	A/S/M	173			234				NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Bjørge et al., 2007
			Nord-Trøndelag		1994-1998	A/S/M	173									Bjørge and Øien 1999
		NO / Nordland	Nordland		2016-2021	A/S/M	1.549							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Nordland		2011-2015	A/S/M	2.510							NAMMCO SC/23 (CSWG 2016)		Nilssen, Bjørge, et al. 2016
			Nordland		2008-2015	A/S/M	2.465							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Nordland		2003-2006	A/S/L/M	2.466							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			Nordland		1996-1999	A/S/M	2.129			2.874				NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Bjørge et al., 2007
			Nordland		1994-1998	A/S/M	2.267									Bjørge and Øien 1999
		NO / Troms-Finmark	Troms-Finmark		2016-2021	A/S/M	760							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Troms-Finmark		2011-2015	A/S/M	986							NAMMCO SC/23 (CSWG 2016)		Nilssen, Bjørge, et al. 2016
			Troms-Finmark		2008-2015	A/S/M	986							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Troms-Finmark		2003-2006	A/S/L/M	727							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			Troms-Finmark		1996-1999	A/S/M	557			752				NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Bjørge et al., 2007
			Troms-Finmark		1994-1998	A/S/M	557									Bjørge and Øien 1999
		NO / Finmark	Finmark		2016-2021	A/S/M	1.119							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Finmark		2011-2015	A/S/M	981							NAMMCO SC/23 (CSWG 2016)		Nilssen, Bjørge, et al. 2016
			Finmark		2008-2015	A/S/M	981							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			Finmark		2003-2006	A/S/L/M	357							NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			Finmark		1996-1999	A/S/M	661			826				NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Bjørge et al., 2007
			Finmark		1994-1998	A/S/M	712									Bjørge and Øien 1999
		NO / All	All		2016-2021	A/S/M	6.857							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			All			A/S/M	6.960							NAMMCO SC/28		NAMMCO 2022
			All		2011-2015	A/S/M	7.642							NAMMCO SC/23 (CSWG 2016)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen, Bjørge, et al. 2016
			All			A/S/M	7.594							NAMMCO SC/22		NAMMCO 2015
			All		2008-2015	A/S/M	7364 (7644)							NAMMCO SC/30 (CSWG 2023)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al. 2023
			All		2003-2006	A/S/L/M	6.668							NAMMCO SC/14 (HSWG)	working document	Nilssen et al., 2006
			All			A/S/L/M	6.705			10.000				NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Nilssen et al., 2010
			All		1996-1999	A/S/M	7.465			10.153				NAMMCO SC/18 (HSWG 2011)	The highest counted number of harbour seal counts along the Norwegian coast	Bjørge et al., 2007
			All		1994-1998	A/S/M	6.684									Bjørge and Øien 1999
		NO / Svalbard	Svalbard		2010	A/M				1.812		1,656-4,418	a	NAMMCO SC/20		Merkel et al. 2013
					2010	A/M				1.742		1,381-3,549	a			
					2009	A/M				1.888		1,660-3,023	a			

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Harbour seal	NA Coast	NO / Svalbard	Svalbard		1975-1987	A/S/L				~500-600					A compilation of various opportunistic counts of animals hauled out on Prins Karls Forland from walking, boat, helicopter or snowmobile surveys over several years	Prestrud and Gjertz 1990
Harp seal	North Atlantic	NW Atlantic	Northwest Atlantic		2019a	Model based total abundance				4.667.000		3,712,000-5,679,000	o, a, s	WGHARP 2023	Stochastic model - improves upon the Deterministic model allowing for flexibility and variability of multiple parameters	ICES 2023, Tinker et al. 2023
						Model based pup production				776.000		558,000-1,011,000			Pup production, Stochastic model	ICES 2023
					2019b	Model based total abundance				7.600.000		6,600,000-8,800,000			Deterministic model	Hamill et al. 2021
					2017	Model based total abundance				6.800.000		5,800,000-8,000,000	o, a, s		Deterministic model; Total population size estimate	
						Model based pup production				1.039.000		927,000-1,1000			Deterministic model; Pup production	
						A/P				746.500	0,12					Stenson et al. 2020
			Northwest Atlantic		2014	Model based total abundance				7.411.000				WGHARP 2014		ICES 2014, Hammill el al. 2014
						Model based pup production				853.000						
			Northwest Atlantic		2012	Model based total abundance				7.445.000			s	WGHARP 2013 in report from SC/21	Modelled from pup production survey	Hammill et al. 2014
						Model based pup production				929.000						
						A/P				815.900			o, a		Revised estimate of previously reported due to additional analysis of survey transects that had not been completed at the time of the 2013 assessment	Stenson et al. 2020
										791.000	0,88					Stenson et al. 2014
			Northwest Atlantic		2010a	Model based total abundance				9.100.000		7,500,000-10,000,000		WGHARP 2011	Under the assumption that the population is continuing to grow exponentially	ICES 2011
					2010b	Model based total abundance				8.600.000		7,800,000-9,400,000			Under the assumption that density-dependent population growth	
					2008a	Model based total abundance				8.000.000		6,800,000-9,300,000			Under the assumption that the population is continuing to grow exponentially	
					2008b	Model based total abundance				8.100.000		7,3000,000-8,900,000			Under the assumption that density-dependent population growth	
					2008	Model based pup production				1.630.300	0,68		s		Significantly higher than estimated previously and is inconsistent with previous predictions obtained from the harp seal population model.	
					2008	A/P				1.644.500						Stenson et al. 2014
		NW Atlantic	Northwest Atlantic		2005	Model based total abundance				~5,900,000				WGHARP 2005		ICES 2005, Stenson et al. 2005
					2004	A/P				991.400	0,59		o, s			
			Northwest Atlantic		2000	Model based total abundance				~5,200,000		4,000,000-6,400,000	o, s	WGHARP 2000		ICES 2000
			Gulf of St. Lawrence and Front		1999	A/P				997.900			o, s	WGHARP 2000		Stenson et al. 2003
			Northwest Atlantic		1994	Model based total abundance				4.800.000		4,100,000-5,000,000	a, o	WGHARP 1995		ICES 1995
						A/P				708.400	0,95				Correction from previous estimate in which a mistake was made by averaging multiple surveys	Stenson et al. 2003
			Gulf of St. Lawrence and Front							702.900	0,90					Stenson et al. 2002

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Harp seal	North Atlantic	NW Atlantic	Northwest Atlantic		1990	Model based total abundance				3.120.000		2,580,000-3,660,000	o, s	WGHARP 1993	The results of this model must be viewed with caution due to the possible lack of comparability between mark- recapture and aerial surveys and uncertainties about the catch and pregnancy data, model trajectories show little change over time	ICES 1993
			Gulf of St. Lawrence and Front			A/P				577.900			o, s			Stenson et al. 1993, ICES 1993
		Greenland Sea (West Ice)	Greenland Sea		2023a	Model based total abundance				2.180.866		210,080 – 29,653,499	a, o, s	WGHARP 2023	high prior for standard deviation	ICES 2023
					2023b	Model based total abundance				1.137.370		547,536 – 2,391,889	a, o, s		low prior for standard deviation; both of these models (2023a and b) differ from the type used in previous years	
					2022	A/P				92.767	0,20		a, o, s		Pup production	
			Greenland Sea		2019	aerial and mark-recapture model				426.808	0,14	313,005-540-612	a, o, s	WGHARP 2019		ICES 2019
						aerial only model				422.688	0,15		a, o, s			
						aerial only model with constant Fecundity				452.117	0,14		a, o, s			
						Average scenario				384.948	0,14		a, o, s			
						Model based pup production				66.407		51,605-81,209	a, o, s			
					2018	A/P				54.181		38,884-75,494	a, o, s			
			Greenland Sea		2017	aerial and mark-recapture model				650.300		471,200 – 829,300	a, o, s	WGHARP 2016		ICES 2016
										106 500 (pups)		76,500-136,400	a, o, s			
			Greenland Sea		2013	Model based total abundance				627.410		470,540 – 784,280	a, o, s	WGHARP 2013		ICES 2013
						Model based pup production				93.010		70,210-115,810	a, o, s			
					2012	A/P				89 590 (pups)	0,14		o, s, i			Øigård et al. 2014
			Greenland Sea		2011	Model based total abundance				649.566		379,031-920,101	a, s	WGHARP 2011	Time variant NE model	ICES 2011
						Model based pup production				96.470						
			Greenland Sea		2009	Model based total abundance				810.600				WGHARP 2009		ICES 2009
						Model based pup production				116.600						
			Greenland Sea		2008	Model based total abundance				756.200			o, s	WGHARP 2008		ICES 2008
						Model based pup production				109.800						
			Greenland Sea		2005	Model based total abundance				741.670			o, s	WGHARP 2005		ICES 2005
			Greenland Sea		2003	Model based total abundance for M1+=0.10				603.690				WGHARP 2003	The variance estimates provided by this model are negatively biased (because estimation of mortality and birth rate mature females are not built into the model) and caution should be taken when evaluating the uncertainty associated with the output	ICES 2003
						Model based total abundance for M1+=0.11				503.280						
						Model based total abundance for M1+=0.12				417.060						
						Model based pup production for M1+=0.10				97.190		89,135-105,239				
						Model based pup production for M1+=0.11				81.680		74,838-88,514				
						Model based pup production for M1+=0.12				68.260		62,468-74,052				
					2002	A/P				98.467	0,18		o, s		The total estimate of pup production	Haug et al. 2006

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Harp seal	North Atlantic	Greenland Sea (West Ice)	Greenland Sea		2000	Model based total abundance				437.700				WGHARP 2000	Population model that estimates the development of future population size, for which statistical uncertainty is provided for each set of catch options.	ICES 2000
						Model based pup production				76.700		48,000-105,000				
			Greenland Sea		1991	Pup production estimate				67.300		56,400-78,113		WGHARP 1997		ICES 1997
			Greenland Sea		1991	Model based total abundance				345.600		267,000-418,100		WGHARP 1993		ICES 1993
						A/P				55.270	0,14	44,500-68,500			Estimates of harp seal pup production in four separate breeding patches in the Greenland Sea uncorrected for bias	Øien and Øritsland 1995
						Mark-recapture				57.815	0,10	46,000-69,000			The WG concluded that violations of the randomness assumptions could give the most serious problems; The WG chose to base the best estimate on this method.	Øien 1993, ICES 1993
			breeding patch 1	Norwegian West Ice survey	1991	A/P	50,500 ± 16,000							WGHARP 1991	Pups in one of four breeding patches. The other 3 were estimated to have approx. 3,800, 7,000, and 12,000 pups.	ICES 1991
			Greenland Sea		1988	A				27,500-31,500 pups				WGHARP 1989	Correction factors derived from field investigations of the survey area	ICES 1989
			Greenland Sea		1983	Mark-recapture				46.018				WGHARP 1987	the reliability of these estimates was uncertain as the underlying model assumptions have not been	ICES 1987
					1978					52.752						
					1977					40.560						
		White Sea/Barents Sea (East Ice)	White Sea/Barent Sea		2023	Model based total abundance				1.361.993		456,582 – 4,161,381	a, o, s	WGHARP 2023	"no new pup production estimates are available for this stock since 2013, and as a result, the model could not reliably assess current levels of this population" (WGHARP 2023)	ICES 2023
			White Sea/Barent Sea		2019	Model based total abundance				1.497.190		1,292,939 – 1,701,440	a, o, s	WGHARP 2019		ICES 2019
						Model based pup production				220.291		191,193-249,389	a, o, s			
			White Sea/Barent Sea		2017	Model based total abundance				1.408.000		1,251,680-1,564,320	a, o, s	ICES WGHARP 2016		ICES 2016
						Model based pup production				211.000		185,100-236,900				
			White Sea/Barent Sea		2015	Model based total abundance				1.368.200		1,226,300-1,506,378		WGHARP 2014	a deterministic age-structured population dynamics model with 3 unknown parameters (pup mortality, mortality of 1 year and older seals, initial population size).	ICES 2014
			White Sea/Barent Sea			Model based pup production				205.200		122,630-1,509,378				
			White Sea/Barent Sea		2013	Model based total abundance				1.419.800		1,266,910-1,572,690		WGHARP 2013	population model was fitted to the pup production surveys (March 2013) and reproductive rate information as used in previous assessments, and with harvest data updated to 2013 (SC/20)	ICES 2013
						Model based total abundance				1.221.000		1,069,800-1,372,200				
			White Sea/Barent Sea		2011a	Model based total abundance				1.627.700		1,435,426-1,820,074	a, s	WGHARP 2011	Model with best fit, i.e. the model with condition modulated pregnancy rate. Under this scenario the model indicates a 14% reduction of the abundance of 1+ animals in the next 10 years assuming that the pregnancy rate remains low and there is no hunt.	ICES 2011
						Model based pup production				142.700						
					2011b	Model based total abundance				1.364.700		1,230,384-1,498,916			Model with poor fit, i.e. the model scenario using historical reproductive data; the WG felt that this option provided a more reasonable future prediction	
						Model based pup production				192.700						

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Harp seal	North Atlantic	White Sea/Barents Sea (East Ice)	White Sea/Barent Sea		2009	Model based total abundance				1,100,000-1,300,000				WGHARP 2009	a cohort model allowing for uncertainty in model parameter estimation using Bayesian stochastic analyses and a production model based on the Schaefer's equation of logistic production growth	ICES 2009
			White Sea/Barent Sea			Model based pup production				157.000	0,11					
			White Sea/Barent Sea		2008	Model based total abundance				861.728				WGHARP 2008	The model was used for obtaining a multiplier for scaling the pup production in order to obtain the population size.	ICES 2008
			White Sea/Barent Sea			Model based pup production				123.104					The WG expressed concern about various aspects of the survey, which could have biased the result, and therefore the accuracy of the pup production estimate	
			White Sea/Barent Sea		2005	Model based total abundance				2.425.480				WGHARP 2005		ICES 2005
			White Sea/Barent Sea		2004	Model based pup production				231.812					WG was concerned about biases resulting from the late and incomplete coverage surveys, that they recommended that the 2004 estimate not be used.	
			White Sea/Barent Sea		2003	Model based total abundance estimate for M0=3M1+ and M=0.09				2.399.900				WGHARP 2003	The model used natural mortality: M1+ = 0.09, 0.10 and 0.11, and pup mortality: M0 = 3M1+ (fixed) and M0 = 5M1+ (fixed)	ICES 2003
						Model based total abundance estimate for M0=3M1+ and M=0.10				2.289.900						
						Model based total abundance estimate for M0=3M1+ and M=0.11				2.183.100						
						Model based total abundance estimate for M0=5M1+ and M=0.09				2.158.600						
						Model based total abundance estimate for M0=5M1+ and M=0.10				2.035.600						
						Model based total abundance estimate for M0=5M1+ and M=0.11				1.917.600						
						Model based pup production estimate for M0=3M1+ and M=0.09				341.900		310,348-373,472				
						Model based pup production estimate for M0=3M1+ and M=0.10				328.900		298,540-359,260				
						Model based pup production estimate for M0=3M1+ and M=0.11				316.100		286,921-345,298				
						Model based pup production estimate for M0=5M1+ and M=0.09				329.600		299,189-360,011				

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Harp seal	North Atlantic	White Sea/Barents Sea (East Ice)	White Sea/Barent Sea		2003	Model based pup production estimate for M0=5M1+ and M=0.10				315.600		286,436-344,683		WGHARP 2003	The model used natural mortality: M1+ = 0.09, 0.10 and 0.11, and pup mortality: M0 = 3M1+ (fixed) and M0 = 5M1+ (fixed)	ICES 2003
						Model based pup production estimate for M0=5M1+ and M=0.11				301.600		273,955-329,705				
						A/P				328.000						
					2002	A/P				330,000-334,000						
			White Sea/Barent Sea		2000	Model based total abundance estimate for M0/M1+=3.0				2.046.000				WGHARP 2000	The WG noted that these estimates of pup production are uncorrected and that the degree of correction that should be applied to each survey may not be the same. The model was fit to data under two different assumptions about the ratio M0/ M1+	ICES 2000
						Model based total abundance estimate for M0/M1+=5.0				1.990.300						
						Model based pup production estimate for M0/M1+=3.0				319.000		286,000-351,000				
						Model based pup production estimate for M0/M1+=5.0				314.000		283,000-346,000				
					2000	A/P	322,474/346,200/339,710								Uncorrected estimates from two surveys using different analysis method; The estimates from both year 2000 surveys give strong evidence of a harp seal pup production of at least 300,000.	
					1998	A/P	286.260								Uncorrected pup counts; minimum estimate of pup production.	
			White Sea/Barent Sea		1997	A/P				~96,000				WGHARP 1997	Potelov et al. - strip transect survey pup production estimate	ICES 1997
										~193,000					Potelov et al. - isoline method pup production estimate	
					1997	A/P				100,000-120,000					Chernook et al. - photographic surveys pup production estimate	
			White Sea/Barent Sea		1991	A				141.600				WGHARP 1993	Estimate of breeding females	ICES 1993
Hooded seal	North Atlantic	Northwest Atlantic	Northwest Atlantic		2005	Model based total abundance				593.500		465,600-728,300	a, o, s	ICES 2006		Hammill and Stenson 2006
						Model based pup production				120.100		94,100-147,900				
						A/P				116.900	0,68					Hammill and Stenson 2006
						Model based total abundance				592.100		404,400-779,800	o, s	WGHARP 2006	considerable uncertainty associated with these estimates which results from: 1) a lack of understanding of the relationship between the Davis Strait, Front, and Gulf pupping areas, 2) the limited number of surveys of all three areas, 3) the limited reproductive data, and 4) uncertain harvest statistics.	ICES 2006
						Model based pup production				119.800		81,800-157,800				
			Gulf of St. Lawrence, Front, Davis Strait		2004/2005	Model based total abundance				116.900	0,68		o, s		Estimated pup production in the three northwest Atlantic whelping areas (Front, Gulf of St. Lawrence and Davis Strait)	Stenson et al. 2006
			Northwest Atlantic		1995	Estimated pup production				min 84,000				WGHARP 1995	Minimum estimates of pup production are obtained by combining estimates obtained from the Front and Davis Strait in 1984 and Front and Gulf in 1990, respectively. This does not account for possible whelping in Davis Strait in 1990 or changes in the total pup production since these surveys.	ICES 1995

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Hooded seal	North Atlantic	Northwest Atlantic	Northwest Atlantic		1993					400,000-450,000				WGHARP 1995	No population model is available for hooded seals; Estimate made from assumption of a ratio of pups to total population of 1:5and pup production in the Gulf and at the Front in 1990	ICES 1993
			Gulf of St. Lawrence		1991	A/P				2.006			o, a			Hammill et al. 1992
			Front		1990	A/P				82.182			o, s			Stenson et al. 1996, ICES 1995
					1984	A/P				62.400		43,700-89,400	o, s			Bowen et al., 1987
			Davis Strait		1984	A/P				18.590		14,000-23,000	o, s			
			Northwest Atlantic		1965	Model based total abundance				478.000		400,500-564,301	o, s			Hammill and Stenson 2006
						Model based pup production				73.400		56,400-92,400				
		Greenland Sea (West Ice)	Greenland Sea (West Ice)		2023	Model based total abundance				76.832		60,262 – 98,009	a, o, s	WGHARP 2023	a deterministic age-structured population dynamics model	ICES 2023
						Model based pup production				12.875		10,617-15,613				
			Greenland Sea (West Ice)		2019	Model based total abundance				76 623*		58,299 – 94,947	o, s	WGHARP 2019	modelled from pup production survey which was corrected for readers missing pups in photos and staging based on previous years	ICES 2019
			Greenland Sea (West Ice)		2017	Model based total abundance				80.460		59,020-101,900	a, o, s	WGHARP 2016		ICES 2016
						Model based pup production				13.600		9,250-17,950				
			Greenland Sea (West Ice)		2013	Model based total abundance				82.830			a, s	WGHARP 2013		ICES 2013
						Model based pup production				14.010						
					2012	Model based pup production				13 655 (pups)	0,14					
			Greenland Sea (West Ice)		2011	Model based total abundance				88.680				WGHARP 2011	All model indicate a population currently well below Nlim of 172,580	ICES 2011
						Model based total abundance				106.350						
						Model based total abundance				91.450						
						Model based total abundance				85.790						
			Greenland Sea (West Ice)		2005	Model based total abundance				88.300				WGHARP 2006		ICES 2006
						Model based pup production				16.900						
			Greenland Sea (West Ice)		2003	Model based total abundance for M1+=0.10				175.950				WGHARP 2003		ICES 2003
						Model based total abundance for M1+=0.11				162.450						
						Model based total abundance for M1+=0.12				149.060						
						Model based pup production for M1+=0.10				33.250		19,371-47,083				
						Model based pup production for M1+=0.11				30.950		18,012-43,830				
						Model based pup production for M1+=0.12				28.660		16,747-40,801				
			Greenland Sea (West Ice)		2000	Model based total abundance				130.100				WGHARP 2000		ICES 2000
						Model based pup production				28.100		16,000-40,000				
					1998	A/P				23.762		14,819-32,702			Re-calculation of 1998 survey pup production estimate (excluding K04 patch); minimal uncorrected estimate	
			Greenland Sea (West Ice)		1997	A/P				25.300		18,200-35,100		WGHARP 1997	Not corrected for the temporal distribution of births or for scattered pups.	ICES 1997

Species	Regions	Management area/subareas	Survey				Uncorrected Abundance Estimate			Corrected Abundance Estimate			Bias	Endorsed by (initial estimate)	Comments	Sources
			Area	Name	Year	Type	UAE	CV	95% CI	Corrected Abundance Estimate	CV	95% CI				
Ringed seal	Arctic	(1) Svalbard**	Spitsbergen		2002-2003	A/M				7.642		6,440-9,069	a, s			Lydersen and Kovacs, from Kovacs 2014
										7.585		6,332-9,085	a, s		Estimated total number of seals in the surveyed area	Krafft et al 2006
										3.254		3,071-3,449	s		Estimated number of seals hauled out on the fast ice during the survey	
			Svalbard		1980s	model based abundance estimate; trained dogs which detected the lairs by olfaction				19,625 (pups)				RSWG 1996	Flat fast ice areas pup production estimated from the number of breathing holes belonging to adult females; should be regarded only as a first approximation of ringed seal production in Svalbard.	Smith and Lydersenn 1991
										~100,000						
		(2) East Greenland**	Scoresbysund and Kong Oscars Fjord		1984	A/M				28.882					Estimate of population through the number of polar bears	Born et al 1998.
		(3) West Greenland and Eastern Canadian waters**	Tuvaijuittuq Marine Protected Area		2019		30								aerial photographs	National Marine Fisheries Service & Alaska Fisheries Science Center 2024
			Eclipse Sound, Milne Inlet, and		2016-2017	A/M				1.069				RSWG 2023	Infrared imagery	Young et al. 2019, Yurkowski et al. 2019
										1.268					Aircraft imagery	
			North Water		2010	A/M				9.529	0,29	6,460-16,632	p, a			Heide-Jørgensen et al. 2013
			Fast ice along the W Greenland							185.000				RSWG 1996	The number supposedly from Miller at al. 1982 but was unable to find it	NAMMCO 1996 (RSWG Report)
			Fjord fast ice in NE Baff Isl. (1978), Shelf fast ice and	*part "Eastern Arctic Marine Environmental Studies (EAMES)*	1978-1979	A/M	67.000								Ringed seals on fast ice	Finley et al 1983
							417.000			550,000 (o) 787,000 (a)			a, o		Ringed seals on pack ice	
			SW Baffin Island		1964		68.900								summary from Reeves 1998	Reeves 1998
			Frobisher Bay				66.300									
			Cape Dorset		1950s		49.900									
			Pond Inlet				20.400									
			Wakeham Bay													
		(4) Hudson Bay**	NW Quebec		1964		5.000								summary from Reeves 1998	
			Hudson Bay				203.000									
							227.500									
			James Bay				28.000									
							30.500									
		(5) West Canada, Beufort Sea, Chukchi and Bering Sea**														
		Kangia ecotype**	Ilulissat Ice fjord		2018					1.641	0,23	1,030-2,616	a	NAMMCO SC/30 (RSWG 2023)	total of hauled-out animals	Rosing-Asvid et al. 2023
										3.000			a		total population estimate	
		Area 1* ((3)+(4)+(5))	West Greenland and Eastern Canadian waters		Estimate	A/M				~1 300 000				NAMMCO SC/4 (RSWG 1996)	Many uncertainties were associated with this approach, and the total figure should be regarded as only a very crude approximation.	NAMMCO 1996
										1,100,000-1,600,000					Estimation of ringed seals in Area 1 from take by predators (polar bears and human hunt)	

REFERENCES

Bjørge, A., & Øien, N. (1999). *Statusrapport for Havforskningsinstituttets overvåkning av kystsel* (No. SPS-9904; p. 35). Havforskningsinstituttet.

Bjørge, A., Øien, N., & Fagerheim, K.-A. (2007). Abundance of Harbour Seals (*Phoca vitulina*) in Norway Based on Aerial Surveys and Photographic Documentation of Hauled-Out Seals During the Moulting Season, 1996 to 1999. *Aquatic Mammals*, *33*(3), 269–275. https://doi.org/10.1578/AM.33.3.2007.269

Born, E. W., Boerthamnn, D. M., Heide-Jørgensen, M.-P., Dietz, R., Witting, L., Kyhn, L. A., Fossette, S., Rigét, F. F., Laidre, K. L., & Ugarte, F. (2009, November). *Abundance of Atlantic Walrus (*Odobenus rosmarus rosmarus*) in East Greenland*.

Born, E. W., Dietz, R., Heide-Jørgensen, M. P., & Knutsen, L. Ø. (1997). Historical and present distribution, abundance and exploitation of Atlantic walruses (Odobenus rosmarus rosmarus L.) in eastern Greenland. *Meddelelser Om Grønland. Bioscience*, *46*. https://doi.org/10.7146/mogbiosci.v46.142585

Born, E. W., Teilmann, J., & Riget, F. (1998). Abundance of ringed seals (*Phoca hispida*) in the Kong Oscars Fjord, Scoresby Sund and adjacent areas in eastern Greenland. *NAMMCO Scientific Publications*, *1*, 152. https://doi.org/10.7557/3.2985

Bowen, W. D., Myers, R. A., & Hay, K. (1987). Abundance Estimation of a Dispersed, Dynamic Population: Hooded Seals (*Cystophora cristata*) in the Northwest Atlantic. *Canadian Journal of Fisheries and Aquatic Sciences*, *44*(2), 282–295. https://doi.org/10.1139/f87-037

Cosens, S. E., Crawford, R., de March, B. G. E., & Shortt, T. A. (1993). *Report of the Arctic Fisheries Scientific Advisory Committee for 1991/92 and 1992/93* (Manuscript Report No. Cat. no. Fs 97-410000E; p. iv + 51 p). Central and Arctic Region Department of Fisheries and Oceans.

Elliot, R. E., Moulton, V. D., Raborn, S. W., & Davis, R. A. (2013). *Hudson Strait Marine Mammal Surveys* (LGL Report No. No. TA8129-2; p. 87 p).

Finley, K. J., Miller, G. W., Davis, R. A., & Koski, W. R. (1983). A Distinctive Large Breeding Population of Ringed Seals (*Phoca hispida*) Inhabiting the Baffin Bay Pack Ice. *ARCTIC*, *36*(2), 162–173. https://doi.org/10.14430/arctic2259

Gjertz, I., & Wiig, Ø. (1995). The number of walruses (Odobenus rosmarus) in Svalbard in summer. *Polar Biology*, *15*(7). https://doi.org/10.1007/BF00237468

Granquist, S. M. (2021). *The Icelandic harbour seal (*Phoca vitulina*): Population estimate in 2020, summary of trends and the current status* (Technical Report No. HV 2021-53). Hafrannsóknastofnun.

Granquist, S. M. (2022). The Icelandic harbour seal (*Phoca vitulina*) population: Trends over 40 years (1980–2020) and current threats to the population. *NAMMCO Scientific Publications*, *12*. https://doi.org/10.7557/3.6328

Granquist, S. M., & Hauksson, E. (2019a). *Aerial census of the Icelandic grey seal (*Halichoerus grypus*) population in 2017: Pup production, population estimate, trends and current status* (No. HV 2019-02; p. 28). Marine and Freshwater Research in Iceland.

Granquist, S. M., & Hauksson, E. (2019b). *Population estimate, trends and current status of the Icelandic harbour seal (*Phoca vitulina*) population in 2018 / Landselstalning 2018: Stofnstærðarmat, sveiflur og ástand stofns* (Technical Report No. HV 2019-36; p. 22). Marine and Freshwater Research in Iceland.

Granquist, S. M., Hauksson, E., Árnadóttir, A. B., & Kasper, J. (2011). *Landselstalning úr lofti árið 2011: Framvinda og niðurstöður. (Aerial harbour seal census 2011: Process and results)* (Technical Report No. VMST/11051). Institute of Freshwater Fisheries.

Granquist, S. M., & Sigurjonsdottir, H. (2014). The effect of land based seal watching tourism on the haul-out behaviour of harbour seals (*Phoca vitulina*) in Iceland. *Applied Animal Behaviour Science*, *156*, 85–93. https://doi.org/10.1016/j.applanim.2014.04.004

Hammill, M. O., & Stenson, G. (2006). *Abundance of Northwest Atlantic hooded seals (1960 – 2005)* (Research Document 2006/068). Canadian Science Advisory Secretariat. https://www.dfo-mpo.gc.ca/csas-sccs/publications/resdocs-docrech/2006/2006_068-eng.htm

Hammill, M. O., Stenson, G. B., Mosnier, A., & Doniol-Valcroze, T. (2014). *Abundance Estimates of Northwest Atlantic Harp seals and Management advice for 2014* (Research Document 2014/022). Canadian Science Advisory Secretariat. https://publications.gc.ca/site/eng/473933/publication.html

Hammill, M. O., Stenson, G. B., Mosnier, A., & Doniol-Valcroze, T. (2021). *Trends in abundance of harp seals,* Pagophilus groenlandicus*, in the Northwest Atlantic, 1952-2019* (Research Document 2021/006). Canadian Science Advisory Secretariat. https://publications.gc.ca/site/eng/9.898973/publication.htmlhttps://publications.gc.ca/site/eng/9.898973/publication.html

Hammill, M. O., Stenson, G. B., & Myers, R. A. (1992). Hooded Seal (*Cystophora cristata*) Pup Production in the Gulf of St. Lawrence. *Canadian Journal of Fisheries and Aquatic Sciences*, *49*(12), 2546–2550. https://doi.org/10.1139/f92-281

Hansen, R. G. (2022). *Abundance of bearded seal in Greenland waters*.

Hansen, R. G., & Heide-Jørgensen, M. P. (2018). *Abundance of walrus in the North Water 2018*.

Haug, T., Stenson, G. B., Corkeron, P. J., & Nilssen, K. T. (2006). Estimation of harp seal (*Pagophilus groenlandicus*) pup production in the North Atlantic completed: Results from surveys in the Greenland Sea in 2002. *ICES Journal of Marine Science*, *63*(1), 95–104. https://doi.org/10.1016/j.icesjms.2005.07.005

Hauksson, E. (1996). *Studies on the Icelandic grey seal (*Halichorerus grypus*); population status, food preference, interaction with fisheries, and as a source of nematode infections in fish.*

Hauksson, E. (2007). Abundance of grey seals in Icelandic waters, based on trends of pup-counts from aerial surveys. *NAMMCO Scientific Publications*, *6*, 85. https://doi.org/10.7557/3.2725

Hauksson, E. (2010). Monitoring trends in the abundance of harbour seals (*Phoca vitulina*) in Icelandic waters. *NAMMCO Scientific Publications*, *8*, 227. https://doi.org/10.7557/3.2687

Hauksson, E. (2011). *Results of aerial surveys of grey seal pups, in 2005, 2008 and 2009, and estimated changes in the abundance of grey seals in Icelandic waters.*

Hauksson, E., & Einarsson, S. T. (2010). Historical trend in harbour seal (*Phoca vitulina*) abundance in Iceland back to the year 1912. *NAMMCO Scientific Publications*, *8*, 147. https://doi.org/10.7557/3.2682

Hauksson, E., Ólafsson, H. G., & Granquist, S. M. (2014). *Talning útselskópa úr lofti haustið 2012 (Aerial count of grey seals in the fall of 2012)* (Technical Report No. VMST/14050; p. 25). Veiðimálastofnun.

Heide-Jørgensen, M. P., Burt, L. M., Hansen, R. G., Nielsen, N. H., Rasmussen, M., Fossette, S., & Stern, H. (2013). The Significance of the North Water Polynya to Arctic Top Predators. *AMBIO*, *42*(5), 596–610. https://doi.org/10.1007/s13280-012-0357-3

Heide-Jørgensen, M. P., Laidre, K., Fossette, S., Rasmussen, M. H., Nielsen, N. H., & Hansen, R. G. (2014). Abundance of walruses in Eastern Baffin Bay and Davis Strait. *NAMMCO Scientific Publications*, *9*, 159. https://doi.org/10.7557/3.2606

Heide-Jørgensen, M. P., Sinding, M.-H. S., Nielsen, N. H., Rosing-Asvid, A., & Hansen, R. G. (2016a). Large numbers of marine mammals winter in the North Water polynya. *Polar Biology*, *39*(9), 1605–1614. https://doi.org/10.1007/s00300-015-1885-7

Heide-Jørgensen, M. P., Sinding, M.-H. S., Nielsen, N. H., Rosing-Asvid, A., & Hansen, R. G. (2016b). Large numbers of marine mammals winter in the North Water polynya. *Polar Biology*, *39*(9), 1605–1614. https://doi.org/10.1007/s00300-015-1885-7

ICES. (1987). *Report of the ICES Working Group on Harp and Hooded Seals (WGHARP)* (No. C.M.1988/Assess:8; ICES Scientific Reports, p. 21). https://ices-library.figshare.com/articles/report/Report_of_the_Working_Group_on_Harp_and_Hooded_Seals_in_the_Greenland_Sea/19261241?file=34217834

ICES. (1989). *Report of the ICES Working Group on Harp and Hooded Seals (WGHARP)* (No. C.M.1990/Assess:8; ICES Scientific Reports, p. 29). https://ices-library.figshare.com/articles/report/Report_of_the_Working_Group_on_Harp_and_Hooded_Seals_WGHARP_/19261427?file=34218026

ICES. (1991). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. C.M.1992/Assess:5; ICES Scientific Reports, p. 104). https://ices-library.figshare.com/articles/report/Report_of_the_Joint_ICES_NAFO_Working_Group_on_Harp_and_Hooded_Seals/19261712?file=34218344

ICES. (1993). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. C.M.1994/Assess:5; ICES Scientific Reports, p. 37). https://ices-library.figshare.com/articles/report/Report_of_the_Joint_ICES_NAFO_Working_Group_on_Harp_and_Hooded_Seals_Copenhagen_15-21_September_1993_WGHARP_/19262111?file=34218755

ICES. (1995). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. ICES CM 1995/Assess:2; ICES Scientific Reports, p. 44). https://ices-library.figshare.com/articles/report/Report_of_the_Joint_ICES_NAFO_Working_Group_on_Harp_and_Hooded_Seals_WGHARP_/19262411?file=34219097

ICES. (1997). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. ICES CM 1998/Assess:3; ICES Scientific Reports, p. 37). https://ices-library.figshare.com/articles/report/Report_of_the_Joint_ICES_NAFO_Working_Group_on_Harp_and_Hooded_Seals/19263326?file=34220045

ICES. (2000). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. ICES CM 2001/ACFM:08; ICES Scientific Reports, p. 42). https://ices-library.figshare.com/articles/report/Report_of_the_ICES_NAFO_Working_Group_on_Harp_and_Hooded_Seals_WGHARP_/19263986?file=34220720

ICES. (2003). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. ICES CM 2004/ACFM::06; ICES Scientific Reports, p. 59). https://ices-library.figshare.com/articles/report/Report_of_the_ICES_NAFO_Working_Group_on_Harp_and_Hooded_Seals_WGHARP_/19265603?file=34222622

ICES. (2005). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. ICES C.M. 2006/ACFM:06; ICES Scientific Reports, p. 54). https://ices-library.figshare.com/articles/report/Report_of_the_ICES_NAFO_Working_Group_on_Harp_and_Hooded_Seals_WGHARP_/19267178?file=34224236

ICES. (2008). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. ICES CM 2008/ACOM:17; ICES Scientific Reports, p. 63). https://ices-library.figshare.com/articles/report/Report_of_the_Working_Group_on_Harp_and_Hooded_Seals_WGHARP_/19280339?file=34238669

ICES. (2009). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. ICES CM 2009/ACOM:17; ICES Scientific Reports, p. 51 pp). https://ices-library.figshare.com/articles/report/Report_of_the_Working_Group_on_Harp_and_Hooded_Seals_WGHARP_/19280489?file=34238825

ICES. (2011). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. ICES CM 2011/ACOM:20; ICES Scientific Reports, p. 78). https://ices-library.figshare.com/articles/report/Report_of_the_Working_Group_on_Harp_and_Hooded_Seals_WGHARP_/19280828?file=34239197

ICES. (2013). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. ICES CM 2013/ACOM:20; ICES Scientific Reports, p. 2794651 Bytes). https://doi.org/10.17895/ICES.PUB.19282244

ICES. (2014). *Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP)* (No. ICES CM 2014/ACOM:20; ICES Scientific Reports, p. 62). https://ices-library.figshare.com/articles/report/Report_of_the_ICES_NAFO_Working_Group_on_Harp_and_Hooded_Seals_WGHARP_/19282976?file=34241408

ICES. (2016). *Report of the Joint ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WGHARP)* (No. CES CM 2016/ACOM:21; ICES Scientific Reports, p. 85). https://ices-library.figshare.com/articles/report/ICES_NAFO_NAMMCO_Working_group_on_harp_and_Hooded_Seals_WGHARP_/18620666?file=33399128

ICES. (2019). *Report of the Joint ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WGHARP)* (ICES

Scientific Reports). ICES. https://ices-library.figshare.com/articles/_/18620666

ICES. (2023). *Report of the Joint ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WGHARP)* (ICES Scientific Reports, p. 75) [PDF]. https://doi.org/10.17895/ICES.PUB.24306100

Kovacs, K. M. (2014). *Circumpolar ringed seal (*Pusa hispida*) monitoring: CAFF's Ringed Seal Monitoring Network* (Research Report Nos. 978-82-7666-300–6; Rapport;143, p. 48). Norwegian Polar Institute. http://hdl.handle.net/11250/191472

Kovacs, K. M., Aars, J., & Lydersen, C. (2014). Walruses recovering after 60+ years of protection in Svalbard, Norway. *Polar Research*, *33*(1), 26034. https://doi.org/10.3402/polar.v33.26034

Krafft, B. A., Kovacs, K. M., Andersen, M., Aars, J., Lydersen, C., Ergon, T., & Haug, T. (2006). Abundance of Ringed Seals (*Pusa hispida*) in the Fjords of Spitsbergen, Svalbard, During the Peak Molting Period. *Marine Mammal Science*, *22*(2), 394–412. https://doi.org/10.1111/j.1748-7692.2006.00035.x

Laidre, K. L., Stern, H., Kovacs, K. M., Lowry, L., Moore, S. E., Regehr, E. V., Ferguson, S. H., Wiig, Ø., Boveng, P., Angliss, R. P., Born, E. W., Litovka, D., Quakenbush, L., Lydersen, C., Vongraven, D., & Ugarte, F. (2015). Arctic marine mammal population status, sea ice habitat loss, and conservation recommendations for the 21st century: Arctic Marine Mammal Conservation. *Conservation Biology*, *29*(3), 724–737. https://doi.org/10.1111/cobi.12474

Lydersen, C., Aars, J., & Kovacs, K. M. (2008). Estimating the Number of Walruses in Svalbard from Aerial Surveys and Behavioural Data from Satellite Telemetry. *ARCTIC*, *61*(2), 119–128. https://doi.org/10.14430/arctic31

Merkel, B., Lydersen, C., Yoccoz, N. G., & Kovacs, K. M. (2013). The World's Northernmost Harbour Seal Population–How Many Are There? *PLoS ONE*, *8*(7), e67576. https://doi.org/10.1371/journal.pone.0067576

Mikkelsen, B. (2010). A note on the harbour seal (*Phoca vitulina*) in the Faroe Islands. *NAMMCO Scientific Publications*, *8*, 143. https://doi.org/10.7557/3.2681

Mikkelsen, B. (2023, May). *Update on the status of grey seals in the Faroe Islands*.

NAMMCO-North Atlantic Marine Mammal Commission. (1995). *Report of the* ad hoc *Working Group on Atlantic Walrus* (Working Group Report No. NAMMCO/5/6; p. 25). https://nammco.no/wp-content/uploads/2019/04/report_wwg_1995.pdf

NAMMCO-North Atlantic Marine Mammal Commission. (1996). *Report of the NAMMCO Scientific Committee* ad hoc *Working Group on Ringed Seals* (Working Group Report No. NAMMCO/SC/4/8; p. 18). https://nammco.wpengine.com/wp-content/uploads/2016/09/WG-Ringed-Seals-1996-FINAL-Report.pdf

NAMMCO-North Atlantic Marine Mammal Commission. (2009). *Report of the NAMMCO Scientific Committee Working Group on Walrus—Stock Status of Walrus in Greenland and Adjacent Seas* [Working Group Report]. https://nammco.wpengine.com/wp-content/uploads/2016/09/WWG-2009-Final-Report.pdf

NAMMCO-North Atlantic Marine Mammal Commission. (2013). *Report of the 20th meeting of the NAMMCO Scientific Committee* [Scientific Committee Meeting Report]. https://nammco.wpengine.com/wp-content/uploads/2016/10/scientific-committee-20-2013-report.pdf

NAMMCO-North Atlantic Marine Mammal Commission. (2015). *Report of the 22nd meeting of the NAMMCO Scientific Committee. 9 – 12 November 2015* [Meeting report]. https://nammco.wpengine.com/wp-content/uploads/2016/10/scientific-committee-22-2015-report.pdf

NAMMCO-North Atlantic Marine Mammal Commission. (2016). *Report of the Scientific Committee Working Group on Coastal Seals*. https://nammco.wpengine.com/wp-content/uploads/2016/09/report-of-the-cswg-march-2016.pdf

NAMMCO-North Atlantic Marine Mammal Commission. (2018). *Report of the NAMMCO Scientific Committee Working Group on Walrus* (p. 23) [Working Group Report]. https://nammco.no/wp-content/uploads/2019/02/final-report_wwg2018_071118_corrected250619-recall-rr3-.pdf

NAMMCO-North Atlantic Marine Mammal Commission. (2019). *Report of the 26th Meeting of the NAMMCO Scientific Committee* [Meeting Report]. https://nammco.no/wp-content/uploads/2017/01/final-report_sc26-2019_rev230120.pdf

NAMMCO-North Atlantic Marine Mammal Commission. (2022). *Report of the 28th meeting of the NAMMCO Scientific Committee. 24 – 28 January 2022* [Meeting report]. https://nammco.no/wp-content/uploads/2022/06/final_report-sc28-2022.pdf

National Marine Fisheries Service, & Alaska Fisheries Science Center. (2024, February). *Endangered Species Act 5-year review: Ringed seal (*Phoca hispida*)*. https://www.fisheries.noaa.gov/s3//2024-02/5YrReview-RingedSeal-508-FINAL-SIGNED.pdf

Nilssen, K. T., Bjørge, A., & Härkönen, T. (2016). *Status of harbour seals along the Norwegian coast in 2011-2015*.

Nilssen, K. T., & Haug, T. (2007). Status of grey seals (*Halichoerus grypus*) in Norway. *NAMMCO Scientific Publications*, *6*, 23. https://doi.org/10.7557/3.2719

Nilssen, K. T., Henden, J.-A., & Biuw, M. (2023, November 7). *Status for Kystsel og Anbefaling av Jaktkvoter For 2024*. Havforskningsinstituttet.

Nilssen, K. T., Øigård, T. A., Lindstrøm, U., Haug, T., Poltermann, M., & Skavberg, N.-E. (2016). *Status of grey seals in Norway 2016*.

Nilssen, K. T., Poltermann, M., Skavberg, N.-E., Øigård, T. A., Lindstrøm, U., Heggebakken, L., & Fagerheim, K. A. (2009). *Grey seal (*Halichoerus grypus*) pup production along the Norwegian coast in 2006-2008*.

Nilssen, K. T., Skavberg, N.-E., Poltermann, M., Haug, T., Härkönen, T., & Henriksen, G. (2010). Status of harbour seals (*Phoca vitulina*) in mainland Norway. *NAMMCO Scientific Publications*, *8*, 61. https://doi.org/10.7557/3.2672

Øien, N. (1993). *Update of Mark-Recapture Estimates of Harp Seal Pup Production in the Greenland Sea*.

Øien, N., & Øritsland, T. (1995). Use of mark-recapture experiments to monitor seal populations subject to catching. In *Developments in Marine Biology* (Vol. 4, pp. 35–45). Elsevier. https://doi.org/10.1016/S0163-6995(06)80007-7

Øigård, T. A., Frie, A. K., Nilssen, K. T., & Hammill, M. O. (2012). Modelling the abundance of grey seals (*Halichoerus grypus*) along the Norwegian coast. *ICES Journal of Marine Science*, *69*(8), 1436–1447. https://doi.org/10.1093/icesjms/fss103

Øigård, T. A., Haug, T., & Nilssen, K. T. (2014). From pup production to quotas: Current status of harp seals in the Greenland Sea. *ICES Journal of Marine Science*, *71*(3), 537–545. https://doi.org/10.1093/icesjms/fst155

Prestrud, P., & Gjertz, I. (1990). The Most Northerly Harbor Seal (*Phoca vitulina*) at Prins Karls Forland, Svalbard. *Marine Mammal Science*, *6*(3), 215–220. https://doi.org/10.1111/j.1748-7692.1990.tb00245.x

Reeves, R. R. (1998). Distribution, abundance and biology of ringed seals (*Phoca hispida*): An overview. *NAMMCO Scientific Publications*, *1*, 9. https://doi.org/10.7557/3.2979

Rosving-Asvid, A. (2010). Catch history and status of the harbour seal (*Phoca vitulina*) in Greenland. *NAMMCO Scientific Publications*, *8*, 161. https://doi.org/10.7557/3.2683

Rosving-Asvid, A., Löytynoja, A., Momigliano, P., Guldborg Hansen, R., Scharff-Olsen, C. H., Valtone, M., Kammonen, J., Dietz, R., Rigét, F. F., Ferguson, S. H., Lydersen, C., Kovacs, K. M., Holland, D. M., Jernvall, J., Auvinen, P., & Tange Olsen, M. (2023). An evolutionarily distinct ringed seal in the Ilulissat Icefjord. *Molecular Ecology*, *32*, 12. https://doi.org/10.1111/mec.17163

Smith, T. G., & Lydersen, C. (1991). Availability of suitable land-fast ice and predation as factors limiting ringed seal populations (*Phoca hispida*) in Svalbard. *Polar Research*, *10*(2), 10. https://doi.org/10.3402/polar.v10i2.6769

Stenson, G. B., Gosselin, J.-F., Lawson, J. W., Buren, A., Goulet, P., Lang, S. L. C., Nilssen, K., & M O Hammill. (2020). *Estimating Pup Production of Northwest Atlantic Harp Seals, Pagophilus groenlandicus, in 2017* (Research Document 2020/056). Canadian Science Advisory Secretariat.

Stenson, G. B., Hammill, M. O., Kingsley, M. C. S., Sjare, B., Warren, W. G., & Myers, R. A. (2002). Is there evidence of increased pup production in northwest Atlantic harp seals, *Pagophilus groenlandicus*? *ICES Journal of Marine Science*, *59*(1), 81–92. https://doi.org/10.1006/jmsc.2001.1129

Stenson, G. B., Hammill, M. O., Lawson, J., & Gosselin, J. F. (2006). *2005 Pup Production of Hooded Seals,* Cystophora cristata, *in the Northwest Atlantic* (Research Document 2006/067). Canadian Science Advisory Secretariat. https://www.dfo-mpo.gc.ca/csas-sccs/publications/resdocs-docrech/2006/2006_067-eng.htm

Stenson, G. B., Hammill, M. O., Lawson, J., Gosselin, J. F., & Haug, T. (2005). *2004 Pup Production of Harp Seals,* Pagophilus groenlandicus*, in the Northwest Atlantic* (Research Document 2005/037). Canadian Science Advisory Secretariat. https://www.dfo-mpo.gc.ca/csas-sccs/publications/resdocs-docrech/2005/2005_037-eng.htm

Stenson, G. B., Hammill, M. O., Lawson, J. W., & Gosselin, J.-F. (2014). *Estimating Pup Production of Northwest Atlantic Harp Seals,* Pagophilus groenlandicus*, in 2012* (Research Document 2014/057). Canadian Science Advisory Secretariat.

Stenson, G. B., Myers, R. A., Hammill, M. O., Ni, I.-H., Warren, W. G., & Kingsley, M. C. S. (1993). Pup Production of Harp Seals, *Phoca groenlandica*, in the Northwest Atlantic. *Canadian Journal of Fisheries and Aquatic Sciences*, *50*(11), 2429–2439. https://doi.org/10.1139/f93-267

Stenson, G. B., Myers, R. A., Warren, & Ni, I- H. (1996). *Pup production of hooded seals (*Cystophora cristata*) in the Northwest Atlantic* (No. Doc. 95/16; pp. 105–114).

Stenson, G. B., Rivest, L.-P., Hammill, M. O., & Gosselin, J.-F. (2003). Estimating Pup Production of Harp Seals, *Pagophilus Groenlandicus*, in The Northwest Atlantic. *Marine Mammal Science*, *19*(1), 141–160. https://doi.org/10.1111/j.1748-7692.2003.tb01098.x

Stewart, R. E., Born, E. W., Dietz, R., Heide-Jørgensen, M. P., Rigét, F. F., Laidre, K., Jensen, M. V., Knutsen, L. Ø., Fossette, S., & Dunn, J. B. (2014). Abundance of Atlantic walrus in Western Nares Strait, Baffin Bay Stock, during summer. *NAMMCO Scientific Publications*, *9*, 123. https://doi.org/10.7557/3.2611

Stewart, R. E., Born, E. W., Dietz, R., & Ryan, A. K. (2014). Estimates of Minimum Population Size for Walrus near Southeast Baffin Island, Nunavut. *NAMMCO Scientific Publications*, *9*, 141. https://doi.org/10.7557/3.2615

Tinker, M. T., Stenson, G. B., Mosnier, A., & Hammill, M. O. (2023). *Estimating Abundance of Northwest Atlantic Harp Seal Using a Bayesian Modelling Approach* (Research Document 2023/068). Canadian Science Advisory Secretariat. https://publications.gc.ca/site/eng/9.930578/publication.html

Wiig, O. (1986). The Status of the Grey Seal *Halichoerus grypus* in Norway. *Biological Conservation*, *38*(4), 339–349. https://doi.org/10.1016/0006-3207(86)90059-5

Witting, L., & Born, E. W. (2005). An assessment of Greenland walrus populations. *ICES Journal of Marine Science*, *62*(2), 266–284. https://doi.org/10.1016/j.icesjms.2004.11.001

Young, B. G., Yurkowski, D. J., Dunn, J. B., & Ferguson, S. H. (2019). Comparing infrared imagery to traditional methods for estimating ringed seal density. *Wildlife Society Bulletin*, *43*(1), 121–130. https://doi.org/10.1002/wsb.958

Yurkowski, D. J., Young, B. G., Dunn, J. B., & Ferguson, S. H. (2019). Spring distribution of ringed seals (*Pusa hispida*) in Eclipse Sound and Milne Inlet, Nunavut: Implications for potential ice-breaking activities. *Arctic Science*, *5*(1), 54–61. https://doi.org/10.1139/as-2018-0020

Þorbjörnsson, J. G., Hauksson, E., Sigurðsson, G. M., & Granquist, S. M. (2017). *Aerial census of the Icelandic harbour seal (*Phoca vitulina*) population in 2016: Population estimate, trends and current status* (Technical Report No. HV 2017-009; p. 22). Marine and Freshwater Research in Iceland.