· Article ·
doi: 10.13679/j.advps.2016.2.00117

Advances in Polar Science
June 2016 Vol. 27 No. 2: 117-125

Considerable increase in bowhead, blue, humpback and fin whales numbers in the Greenland Sea and Fram Strait between 1979 and 2014

Claude R. Joiris[1,2*]

[1] Laboratory for Polar Ecology (PolE), 1367 Ramillies, Belgium;
[2] Conservation Biology Unit, Royal Belgian Institute for Natural Sciences, 1000 Brussels, Belgium

Received 16 April 2016; accepted 30 June 2016

Abstract In the frame of our long-term study of cetacean abundance and distribution in polar marine ecosystems begun in 1979, a drastic increase in the bowhead *Balaena mysticetus* North Atlantic "stock" was observed from 2005 on, by a factor 30 and more: from 0.0002 per count between 1979 and 2003 (one individual, *n*=5430 counts) to 0.06 per count from 2005 to 2014 (34 individuals, *n*=6000 counts); the most significant part of the increase occurred from 2007 on. Other large whale species (*Mysticeti*) showed a similar pattern, mainly blue *Balaenoptera musculus*, humpback *Megaptera novaeangliae* and fin whales *Balaenoptera physalus*. This large and abrupt increase cannot logically be due to population growth, nor to survival of a hidden "relic" population, nor to a changing geographical distribution within the European Arctic, taking into account the importance of the coverage during this study. Our interpretation is that individuals passed through the Northwest and/ or Northeast Passages from the larger Pacific stock into the almost depleted North Atlantic populations coinciding with a period of very low ice coverage — at the time the lowest ever recorded. In contrast, no clear evolution was detected neither for sperm whale *Physeter macrocephalus* nor for Minke whale *Balaenoptera acusrostrata*.

Keywords **Greenland Sea, Fram Strait, bowhead whale, blue whale, humpback whale, fin whale**

Citation: Joiris C R. Considerable increase in bowhead, blue, humpback and fin whales numbers in the Greenland Sea and Fram Strait between 1979 and 2014. Adv Polar Sci, 2016, 27: 117-125, doi:10.13679/j.advps.2016.2.00117

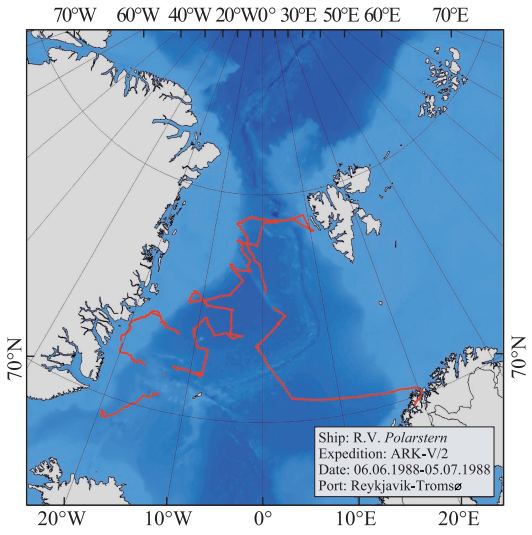
1 Introduction

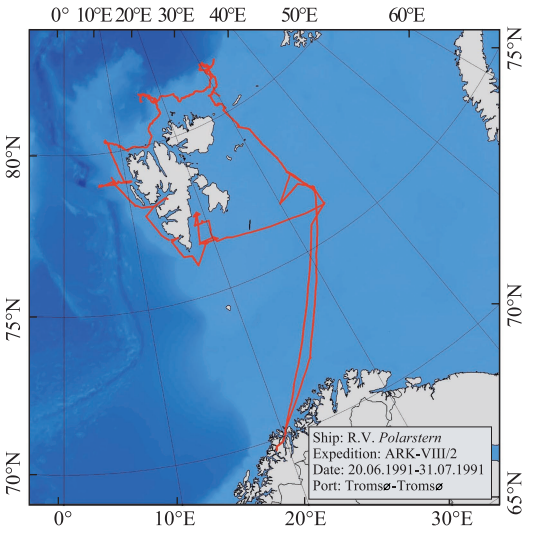
Populations of large whales in the North (N) Atlantic and N Pacific used to be separated, probably by high ice coverage closing the Northeast and Northwest Passages. Both stocks were submitted to different whaling pressure, the Atlantic one being much more severely exploited than the Pacific one, which resulted in much lower densities in the Atlantic. Most striking is the case of Atlantic bowheads *Balaena mysticetus* (the "Spitsbergen stock"), very close to depletion with a population level reduced to tens of individuals in the 20th century. Similarly, important differences in population level were noted for blue *Balaenoptera musculus*, humpback *Megaptera novaeangliae* and fin whales *Balaenoptera physalus*[1-5]. In the frame of our long-term study on seabird and marine mammal distribution in polar marine ecosystems, our data have allowed us to note possible temporal evolution in these cetacean numbers.

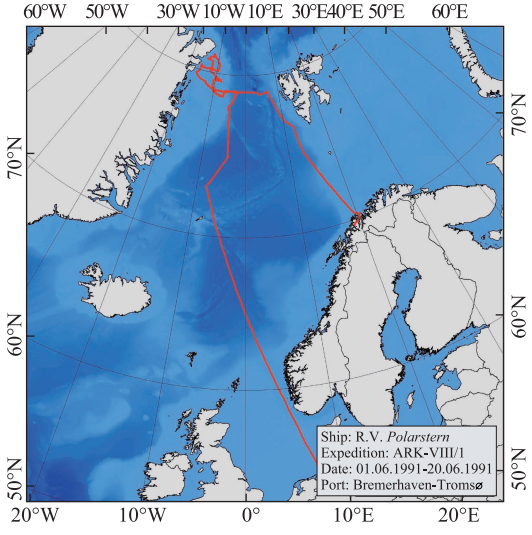
2 Material and methods

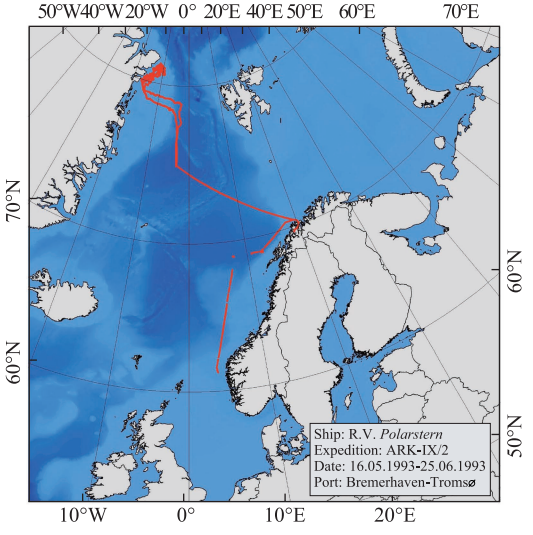
Data were collected during (strip) transect counts from the bridge mainly in the Greenland and Norwegian seas and Fram Strait on 30 expeditions. These summer expeditions basically covered the northern Greenland Sea and Fram Strait, mainly along the 79°N and 75°N transects between Greenland and Spitsbergen; typical examples of *Polarstern* route are shown in Figure 1 in order to display the important

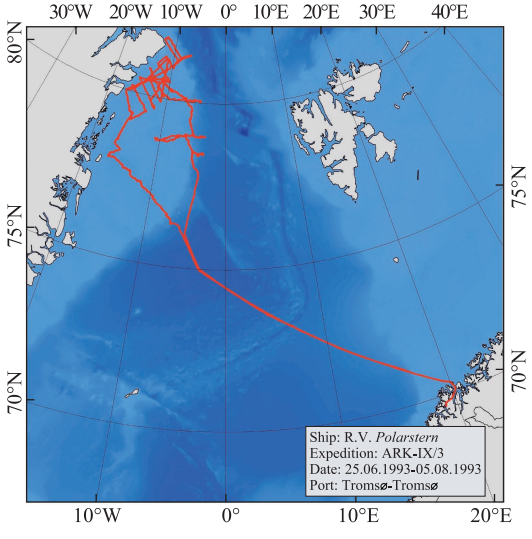
* Corresponding author, E-mail: crjoiris@gmail.com

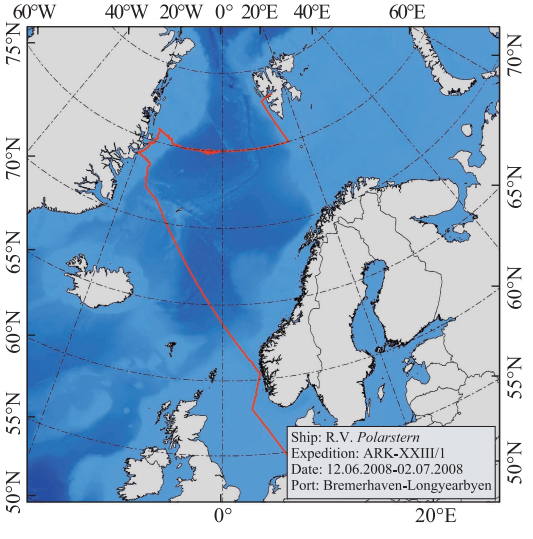

70°W 60°W 40°W 20°W 0° 30°E 50°E 60°E 70°E
70°N
20°W 10°W 0° 10°E 20°E
Ship: R.V. *Polarstern*
Expedition: ARK-V/2
Date: 06.06.1988-05.07.1988
Port: Reykjavik-Tromsø

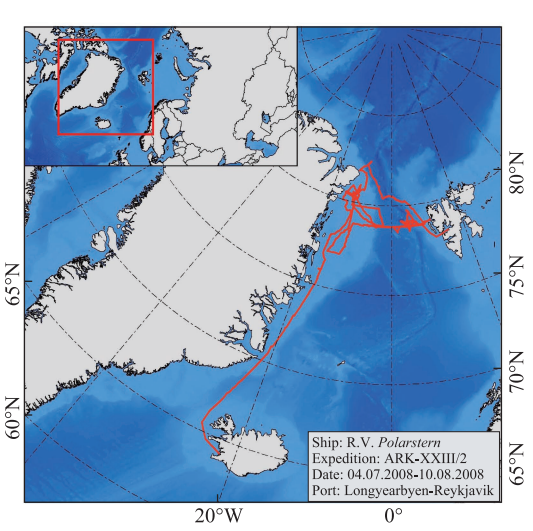

0° 10°E 20°E 30°E 40°E 50°E 60°E
80°N
75°N
70°N
65°N
0° 10°E 20°E 30°E
Ship: R.V. *Polarstern*
Expedition: ARK-VIII/2
Date: 20.06.1991-31.07.1991
Port: Tromsø-Tromsø

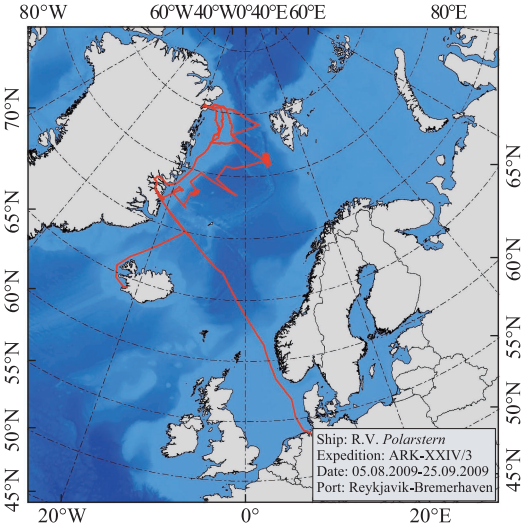

60°W 50°W 30°W 10°W 10°E 30°E 40°E 50°E 60°E
70°N
60°N
50°N
20°W 10°W 0° 10°E 20°E
Ship: R.V. *Polarstern*
Expedition: ARK-VIII/1
Date: 01.06.1991-20.06.1991
Port: Bremerhaven-Tromsø

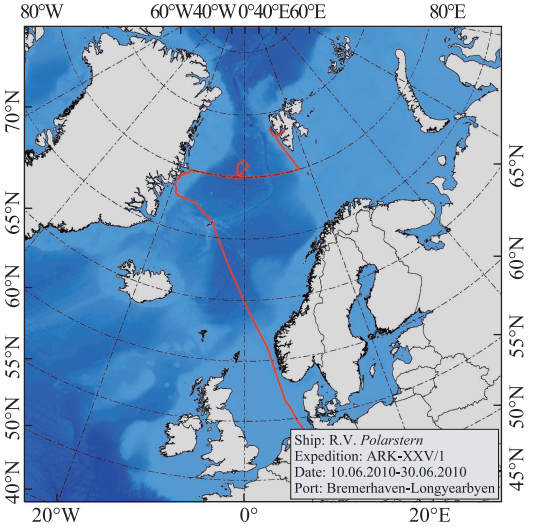

50°W 40°W 20°W 0° 20°E 40°E 50°E 60°E 70°E
70°N
60°N
50°N
10°W 0° 10°E 20°E
Ship: R.V. *Polarstern*
Expedition: ARK-IX/2
Date: 16.05.1993-25.06.1993
Port: Bremerhaven-Tromsø

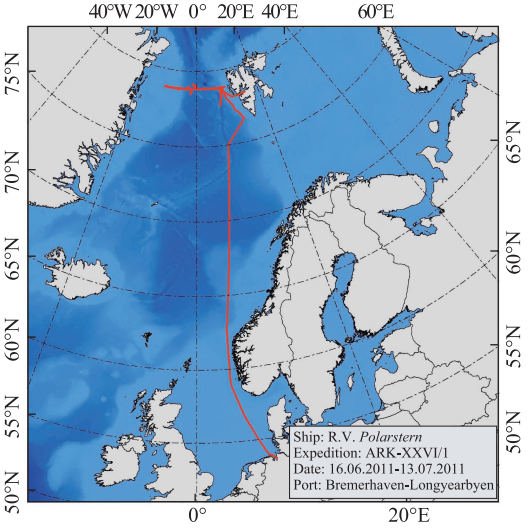

30°W 20°W 10°W 0° 10°E 20°E 30°E 40°E
80°N
75°N
70°N
10°W 0° 10°E 20°E
Ship: R.V. *Polarstern*
Expedition: ARK-IX/3
Date: 25.06.1993-05.08.1993
Port: Tromsø-Tromsø

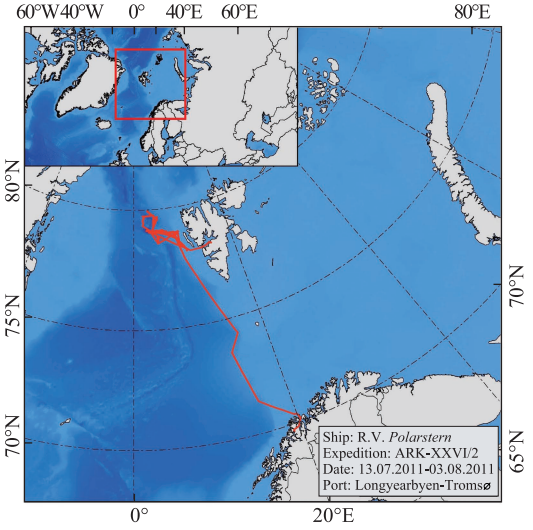

60°W 40°W 20°W 0° 20°E 40°E 60°E
75°N
70°N
65°N
60°N
55°N
50°N
0° 20°E
Ship: R.V. *Polarstern*
Expedition: ARK-XXIII/1
Date: 12.06.2008-02.07.2008
Port: Bremerhaven-Longyearbyen

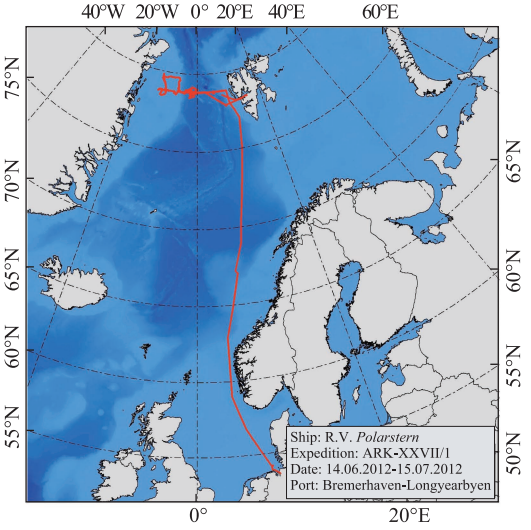

Ship: R.V. Polarstern
Expedition: ARK-XXIII/2
Date: 04.07.2008-10.08.2008
Port: Longyearbyen-Reykjavik


Ship: R.V. Polarstern
Expedition: ARK-XXIV/3
Date: 05.08.2009-25.09.2009
Port: Reykjavik-Bremerhaven


Ship: R.V. Polarstern
Expedition: ARK-XXV/1
Date: 10.06.2010-30.06.2010
Port: Bremerhaven-Longyearbyen


Ship: R.V. Polarstern
Expedition: ARK-XXVI/1
Date: 16.06.2011-13.07.2011
Port: Bremerhaven-Longyearbyen


Ship: R.V. Polarstern
Expedition: ARK-XXVI/2
Date: 13.07.2011-03.08.2011
Port: Longyearbyen-Tromsø


Ship: R.V. Polarstern
Expedition: ARK-XXVII/1
Date: 14.06.2012-15.07.2012
Port: Bremerhaven-Longyearbyen

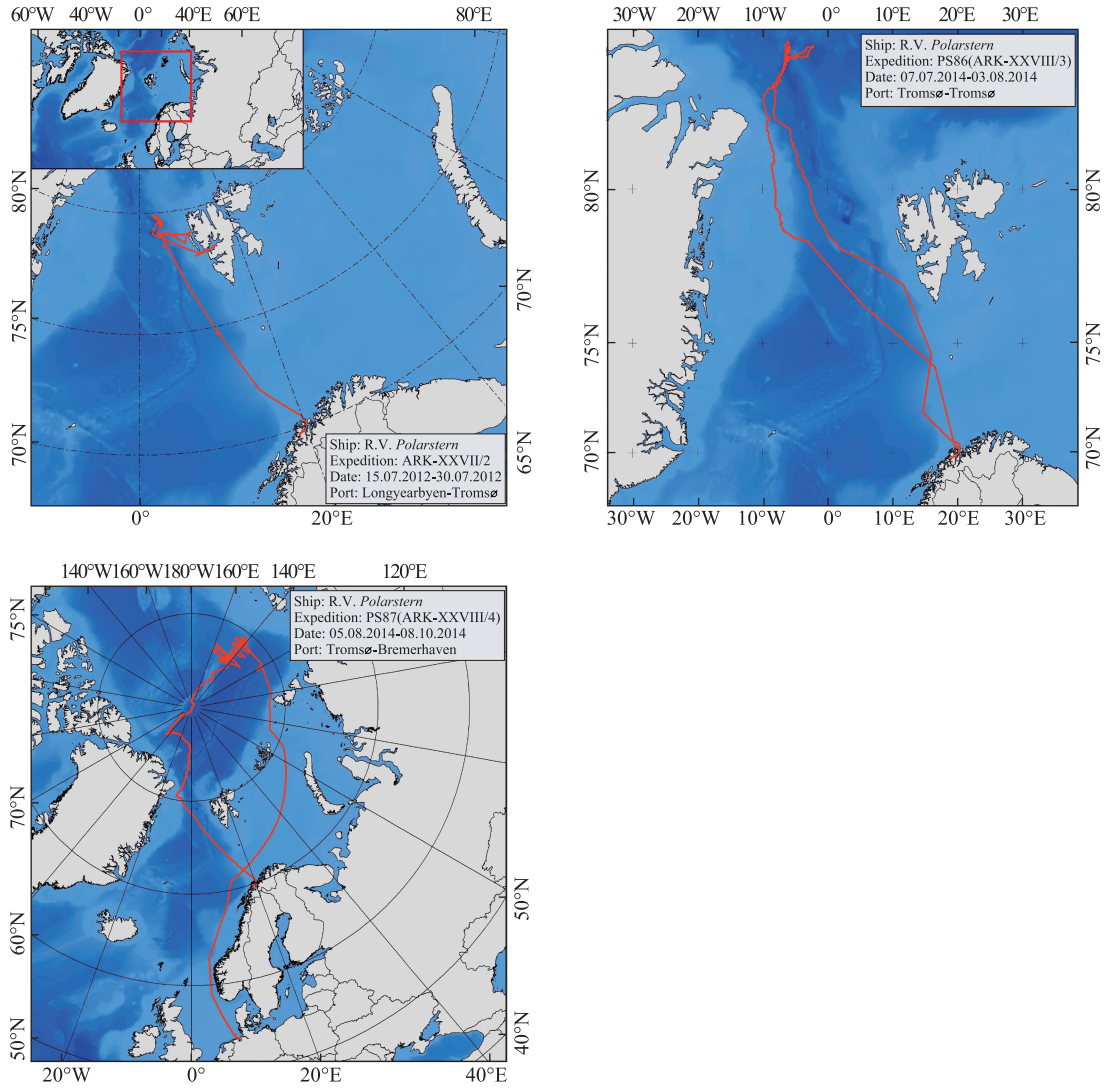


Figure 1 Typical examples of the route of *Polarstern* expeditions in the Greenland Sea and Fram Strait (from: AWI, *Polarstern* Expeditions).

geographical coverage. Each count lasted 30 min, without width limitation; cetaceans were detected with naked eye, observations being confirmed and detailed with 10×50 binoculars; one observer out of three was continuously counting from the bridge during ship's transects, light conditions permitting; the ship's speed was 11 knots in open water. Description and comments about the counting method were published previously[6-8]. Basic uncorrected data are presented in this article as numbers per count; they were all collected by the same team, same methodology and, from 1988 on, same platform. For illustration, photos of the main species are included in Figure 2.

3 Results

Bowhead whale *Balaena mysticetus* used to be very rarely encountered in the Greenland Sea and Fram Strait: during 16 expeditions for a total of 5400 counts from 1979 to 2003 (including the Barents Sea ones) only a single individual was tallied by late Jacques Tahon[10]. This minimal encounter rate seems to correspond to the very low N Atlantic population level, estimated as less than twenty individuals. Drastic increases in encounter rates started from 2005 on – especially from 2007 on: bowheads were encountered in every second expedition with 34 individuals during 14 cruises over 6300 counts, *i.e.* 0.006 individuals per count, mean value. The increase was thus much more than by one order of magnitude. Changes were as important for other species: from zero to 200 humpback whales *Megaptera novaeangliae* (0.04 per count), from zero to 70 bue whales *Balaenoptera musculus* (0.01 per count), from 21 to 670 fin whales *Balaenoptera physalus* (0.11 per count). Minke *Balaenoptera acusrostrata* and sperm whales *Physeter macrocephalus* numbers did not increase at a similar level.

As a consequence, numbers of all large whale species pooled strongly increased as well, by one order of magnitude, from 115 (0.02 per count) before 2005 to 1220 after 2005 (0.20 per count) (Table 1, Figure 3). The Sei whale *Balaenoptera borealis* was not included in this discussion, being observed in very low numbers only – less than ten – even if an increase was detected during last decade.

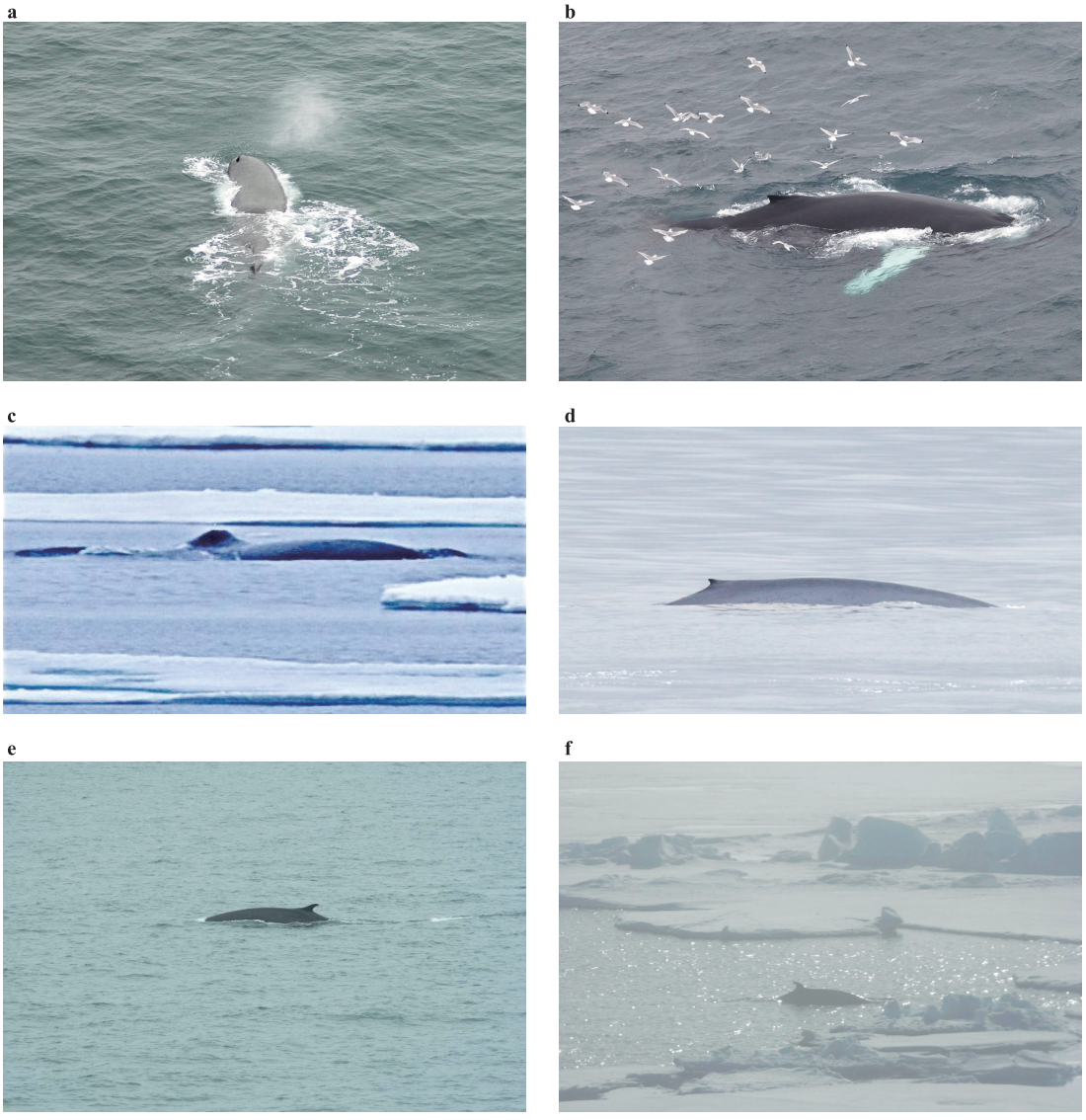


Figure 2 Illustration: **a**, sperm whale *Physeter macrocephalus*; **b**, humpback whale *Megaptera novaeangliae*; **c**, bowhead *Balaena mstucetus*; **d**, blue whale *Balaenoptera musculus*; **e**, fin whale *B. physalus* and **f**, Minke whale *B. acurostrata* in the Greenland Sea and Fram Strait (Photos CR Joiris).

4 Discussion

Older sightings of bowheads used to be very scarce in this area: with a single individual recorded in 1987 and 1990[2, 9], and seven individuals at Franz Josef Land in 1990[10].

In contrast, recent studies of bowhead abundance in the N Atlantic have detected significant numbers: up to 20 individuals were encountered at eight stations in 2006 along a 2000 km long transect[11]. The synthesis of data collected from 1949 to 2009[12-13] showed no clear trend in density but an increase of contacts from 1980 on: this might be due to increasing efforts, e.g. during the *Polarstern* expeditions. During extensive ship- and plane surveys in 2006—2008, 17 bowheads were encountered in 13 observations[14]. Multiple recordings of bowheads' calls and songs in the Fram Strait in 2008[15] provide a confirmation of their presence. Seven bowheads were detected during a 850 km long plane transect in the North East Water (NEW) polynya in 2014, plus five out of effort[16]. Moreover a pod of 80 bowheads was noted in the Fram Strait, West of Spitsbergen in June 2015[17] [or a pod of 40 seen twice?], and individuals were recently observed off the Cornwall coast and Scilly Island, United Kingdom[18]. These observations seem to correspond to the important increase we detected in 2005/2007.

Table 1 Summary of the large cetacean observations in the North Atlantic Ocean, 1979—2012

	Species		sperm whale *Physeter macrocephalus*		humpback whale *Megaptera novaeangliae*		bowhead whale *Balaena mysticetus*		blue whale *Balaenoptera musculus*		fin whale *Balaenoptera physalus*		Minke whale *Balaenoptera acurostrata*		∑ large cetaceans		
Expeditions	Years	*n*	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	Remark
11 cruises	1979-1993	3768	24	0.006	0	0	1	0.0003	0	0	4	0.001	38	0.010	67	0.018	
3 cruises	1991, 1992, 1993	554	0	0	0	0	0	0	0	0	0	0	17	0.031	17	0.031	Barents Sea
EPOS II	1991	377	2	0.005	0	0	0	0	0	0	2	0.01	6	0.016	10	0.027	around Svalbard
ARK XIX/1	2003	730	0	0	0	0	0	0	0	0	15	0.02	7	0.010	22	0.03	
Total a	**1979-2003**	**5429**	**26**	**0.0048**	**0**	0	**1**	**0.0002**	**0**	0	**21**	**0.020**	**68**	**0.013**	**116**	**0.021**	
ARK-XXI/1	2005	1116	10	0.009	11	0.010	0	0	11	0.01	78	0.07	39	0.035	149	0.134	
ARK XXII/1	2007	190	13	0.068	21	0.111	8	0.010	11	0.058	109	0.57	6	0.032	198	1.042	
ARK XXIII/1, 2 & 3	2008	771	2	0.003	149	0.193	8	0.010	4	0.005	16	0.02	31	0.040	205	0.266	
ARK XXIV/1	2009	425	0	0	0	0	7	0.016	2	0.000	23	0.05	7	0.016	39	0.092	
ARK XXIV/3	2009	1076	3	0.003	5	0.005	7	0.007	2	0.000	8	0.01	3	0.003	27	0.025	
ARK XXV/1	2010	440	3	0.007	4	0.009	0	0	4	0.009	32	0.07	9	0.020	52	0.118	
ARK XXV/2	2010	546	8	0.015	12	0.022	0	0	6	0.011	75	0.14	7	0.013	108	0.198	
ARK XXVI/1 & 2	2011	720	6	0.008	11	0.015	4	0.006	17	0.024	246	0.34	31	0.043	315	0.438	
ARK XXVII/1 & 2	2012	732	12	0.016	3	0.004	1*	0	13	0.018	88	0.12	11	0.015	127	0.173	1* from helicopter
PS86 & PS87	2014	419	0	0	0	0	0	0	0	0	30	0.07	0	0	0	0	*partim* 70° to 82°N
Total b	**2005-2012**	**6016**	**57**	**0.009**	**216**	**0.036**	**34**	**0.006**	**70**	**0.012**	**675**	**0.11**	**144**	**0.024**	**1220**	**0.20**	
Total all	**1979-2012**	**11445**	**83**	**0.007**	**216**	**0.019**	**35**	**0.003**	**70**	**0.006**	**696**	**0.06**	**212**	**0.019**	**1336**	**0.12**	

Notes: N = total number recorded; mean per count; *n* = number of 30 min transect counts. Published data from references [8-10, 22-26, 28, 29]

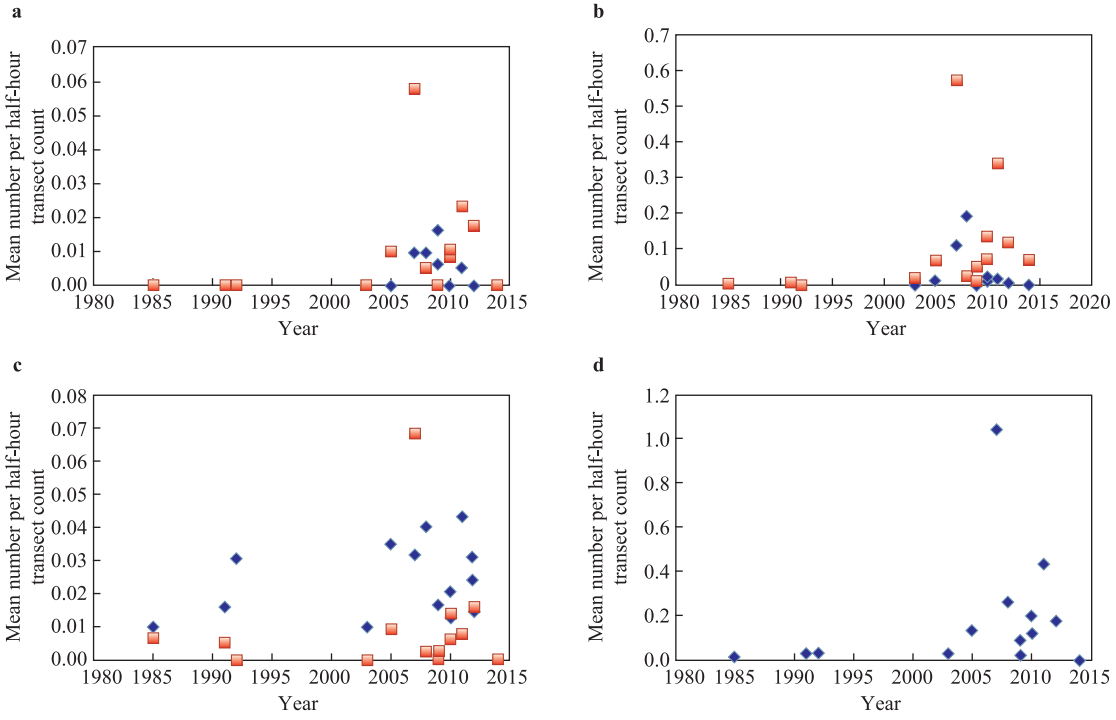


Figure 3 Temporal evolution of large whales in the Greenland Sea and Fram Strait. Mean number per half-hour transect count: **a**, bowhead (diamonds) and blue whale (dots); **b**, humpback (diamonds) and fin whale (dots); **c**, Minke whale (diamonds) and sperm whale (dots); **d**, all large whales pooled; note differences in scale. 1979—1993 pooled under 1985, 1991—1993 (Barents Sea) under 1992.

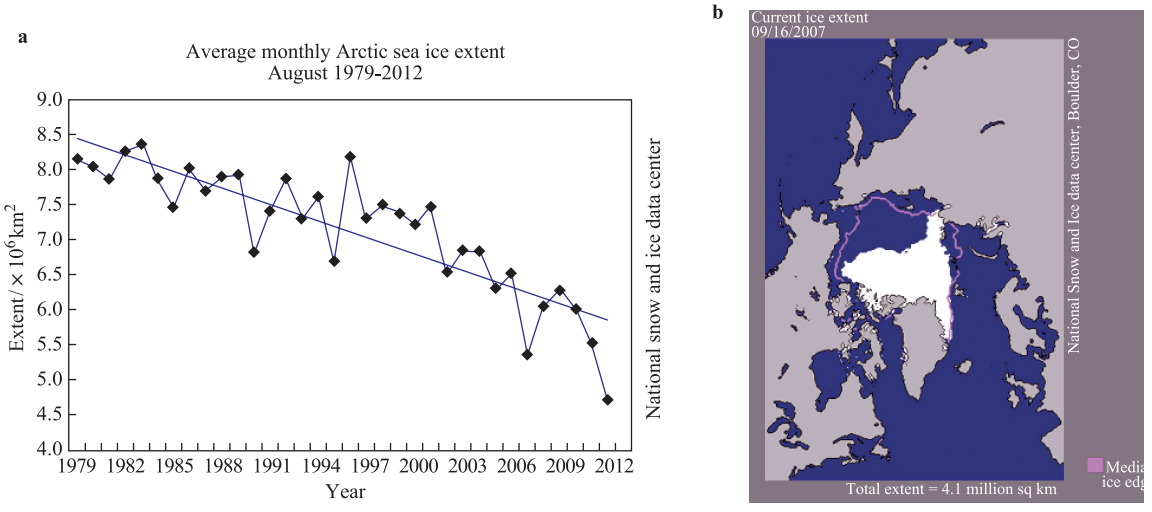


Figure 4 Evolution of summer ice coverage in the Arctic Basin: **a**, August situation for the period 1979—2012; **b**, sea ice extent, 16 September 2007 (National Snow and Ice Data Center, University of Colorado, Boulder, USA).

It has been suggested that a kind of relic population could have survived, hidden and undetected off East Greenland[16]. This however seems highly improbable, since the area was regularly covered by our study (Figure 1).

Considering on the other hand that such a drastic and sudden increase cannot be due to population growth, usually estimated as seven to nine per cent a year[19], the best hypothesis is that the increase can only be due to an inflow from adjacent areas. The proposed interpretation is that very low ice coverage in 2005 and mainly 2007 – at the time the lowest ever recorded – allowed opening of the Northeast and/or Northwest Passages (Figure 4) and that individuals could move from the much more abundant Pacific population to the very low, almost depleted one, in the N Atlantic. The same mechanism might explain the increased bowhead abundance in West Greenland exceeding by far population growth[20]. This possibility was confirmed by the observation in the Northwest Passage of two satellite tagged male bowheads, from West Greenland and Alaska respectively[21].

The fact that other baleen whales (*Mysticeti*):

humpback, blue and fin whales showed a similar and simultaneous increase seems to support the existence of a single mechanism for the different species. Other species showed a much lower increase – if any – by less than a factor two: sperm whale, Minke whale. This might be explained by the limited depletion of these species in the N Atlantic during the whaling era. The consequence of this interpretation is that separate "stocks" merged into one single N Atlantic population: if so, genetic effects should be detected by future DNA research.

Two important aspects are on the one hand the geographical differences in distribution: bowhead and Minke whale at the ice edge, fin whale in the eastern Greenland Sea (at the shelf slope off W Spitsbergen) and humpback in the western Greenland Sea (at the shelf slope in Denmark Strait). And on the other hand the existence of large seasonal aggregations: 145 humpback whales off East Greenland[22], 140 fin whales off West Spitsbergen[9]. Both factors result in an important heterogeneity/patchiness in the data, making density calculations vain as well as statistical analysis.

One can also consider the risks of consanguinity for the pre-2005 close to depleted bowhead N Atlantic population, now avoided by inflow of new N Pacific individuals.

5 Conclusion

The drastic and abrupt increase in abundance of the N Atlantic bowhead and other large baleen whale populations from 2007 on – starting in 2005 already for some species – cannot be interpreted as reflecting the persistence of a hidden "relic" Spitsbergen population, nor to population growth, nor to changes of distribution pattern within the European Arctic. The most reasonable hypothesis consists thus in considering an inflow from the higher Pacific populations following opening of the Northeast and/ or Northwest Passages in 2005 and 2007, at the time the period with lowest ice coverage ever recorded. The access of the Northwest Passage to individuals from West Greenland and Alaska[21] provides an important argument supporting this interpretation.

Acknowledgments I am very grateful to the German Hydrological Institute (DHI), Hamburg, the Murmansk Marine Biology Institue (MMBI), and the Alfred Wegener Institute (AWI), Bremerhaven, for kind invitations on board the German RV (old) *Meteor* during the period 1979-1987, RV *Dalnie Zelentsy* in 1991, 1992 and 1993 in the Barents Sea, and icebreaker RV *Polarstern* during the period 1988-2014 respectively. Observers were CJ and many PolE members during the *Dalnie Zelentsy* and *Polarstern* expeditions. Access to *Polarstern* is denied by coordinator R. Knust from 1 January 2015 on. Two anonymous reviewers and J.-M. Valette helped improving the first version of this manuscript.

References

1 Reeves R R, Leatherwood S. Bowhead whale Balaena mysticetus Linnaeus, 1758//Ridgway S H, Harrison R J. Handbook of marine mammals, Vol 3: the sirenians and baleen whales. London: Acad Press, 1985: 305–344

2 Christensen I, Haug T, Øien N. Review of the biology, exploitation and present abundance of large baleen whales and sperm whales in Norwegian and adjacent waters. IWC Scientific Committee, SC/42/05, 1990: 28

3 Klinowska M. Dolphins, porpoises and whales of the world: the IUCN red data book. Gland, Switserland, Cambridge, UK: IUCN, 1991: 249

4 Moore S E, Reeves R R. Chapter 9: distribution and movement// Burns J J, Montague J J, Cowles C J. The bowhead whale. Special publication number 2, The Society for Marine Mammalogy, Canada. Lawrence, Kansas: Allen Press, Inc., 1993: 313–386

5 Zeh J E, Clark C W, George J C, et al. Chapter 11: current population size and dynamics//Burns J J, Montague J J, Cowles C J. The bowhead whale. Special publication number 2, The Society for Marine Mammalogy, Canada. Lawrence, Kansas: Allen Press, Inc., 1993: 409–510

6 Joiris C R. Possible impact of decreasing Arctic pack ice on the higher trophic levels-seabirds and marine mammals. Adv Environ Res, 2012, 23: 207–221

7 Joiris C R, Falck E. Summer at-sea distribution of little auks Alle alle and harp seals Pagophilus (Phoca) groenlandica in the fram strait and the Greenland Sea: impact of small-scale hydrological events. Polar Biol, 2011, 34(4): 541–548

8 Joiris C R, Falck E, D'Hert D, et al. An important late summer aggregation of fin whales Balaenoptera physalus, little auks Alle alle and Brünnich's guillemots Uria lomvia in the eastern Greenland Sea and Fram Strait: influence of hydrographic structures. Polar Biol, 2014, 37(11): 1645–1657

9 Joiris C R, Tahon J. Distribution of seabirds and cetaceans in the N. E. Atlantic and Arctic oceans. Eur Cetacean Soc. 1987: 28–29

10 Wiig Ø. Seven bowhead whales (Balaena mysticetus L.) observed at Franz Josef Land in 1990. Mar Mamm Sci, 1991, 7(3): 316–319

11 Wiig Ø, Bachmann L, Berge J, et al. Surveys of bowhead whales (Balaena mysticetus) in the Northeast Atlantic in 2006 and 2008. IWC SC/60/BRG32, 2008

12 Gilg O, Born E W. Recent sightings of the bowhead whale (Balaena mysticetus) in Northeast Greenland and the Greenland Sea. Polar Biol, 2005, 28(10): 796–801

13 Wiig Ø, Bachmann L, Øien N, et al. Observations of bowhead whales (Balaena mysticetus) in the Svalbard area 1940-2009. Polar Biol, 2010, 33: 979–984

14 Boertmann D, Merkel F, Durinck J. Bowhead whales in East Greenland, summers 2006-2008. Polar Biol, 2009, 32(12): 1805–1809

15 Stafford K M, Moore S E, Berchok C, et al. Spitsbergen's endangered bowhead whales sing through the polar night. Endang Spec Res, 2012, 18(2): 95–103

16 Boertmann D, Kyhn L A, Witting L, et al. A hidden getaway for bowhead whales in the Greenland Sea. Polar Biol, 2015, 38(8): 1315–1319

17 Oceanwide. Exceptional sighting of 80+ Bowhead Whales. https://oceanwide-expeditions.com/blog/exceptional-sighting-of-80-bowhead-whales, 2015

18 BBC News. Rare arctic bowhead whale seen off Cornwall. http://www.bbc.com/news/uk-england-cornwall-36305054, 2016-05-16

19 Koski W R, Davis R A, Miller G W, et al. Chapter 7: reproduction// Burns J J, Montague J J, Cowles C J. The bowhead whale. Special publication number 2, the society for marine Mammalogy, Canada. Lawrence, Kansas: Allen Press, Inc., 1993: 239–274

20 Heide-Jørgensen M P, Laidre, Borchers D, et al. Increasing abundance of bowhead whales in West Greenland. Biol Lett, 2007, 3(5): 577–580

21 Heide-Jørgensen M P, Laidre K L, Quakenbush L T, et al. The Northwest Passage opens for bowhead whales. Biol Lett, 2012, 8(2): 270–273
22 Joiris C R. A major feeding ground for cetaceans and seabirds in the south-western Greenland Sea. Polar Biol, 2011, 34(10): 1597–1607
23 Joiris C R. At-sea distribution of seabirds and marine mammals around Svalbard, summer 1991. Polar Biol, 1996, 16(6): 423–429
24 Joiris C R. Summer distribution and ecological role of seabirds and marine mammals in the Norwegian and Greenland seas (June 1988). J Mar Syst, 1992, 3(1–2): 73–89
25 Joiris C R. Summer at-sea distribution of seabirds and marine mammals in polar ecosystems: a comparison between the European Arctic seas and the Weddell Sea, Antarctica. J Mar Syst, 2000, 27(1–3): 267–276
26 Joiris C R, Tahon J. Distribution and food intake of seabirds and marine mammals in the Norwegian and Greenland seas (July 1988). Brussels: Royal Acad Overseas Sci, 1992: 113–133
27 Joiris C R, Kampp K, Tahon J, et al. Summer distribution of seabirds in the North-East Water polynya, Greenland. J Mar Syst, 1997, 13(1–4): 51–59
28 Joiris C R, Tahon J, Holsbeek L, et al. Seabirds and marine mammals in the eastern Barents Sea: late summer at-sea distribution and calculated food intake. Polar Biol, 1996, 16(4): 245–256
29 Joiris C R, Boos K, D'Hert D, et al. Low density of top predators (seabirds and marine mammals) in the high Arctic pack ice. Scientifica, 2016, 3:1–14

Documentation

1 Burns J J, Montague J J, Cowles C J. The bowhead whale. Special publication number 2, the society for marine mammalogy. Lawrence, Kansas: Allen Press, Inc., 1993: 787
2 Cousteau J Y, Diolé P. The whale, mighty monarch of the sea. New York: Doubleday & Co, Inc, 1972: 300
3 Martin A R. The illustrated encyclopedia of whales and dolphins. New York: Portland House, 1990: 192
4 Ridgway S H, Harrison R J. Handbook of marine mammals, Vol. 3: the sirenians and baleen whales. New York: Academic Press, 1985: 362
5 Ridgway S H, Harrison R J. Handbook of marine mammals, Vol. 4: river dolphins and the larger toothed hales. New York: Academic Press, 1989: 44234
6 Sale R. A complete guide to Arctic wildlife. Richmond Hill, Ont: Firefly Books, 2006: 464
7 Shirihai H, Jarrett B. Whales, dolphins and seals: a field guide to the marine mammals of the world. London: A & C Black Publishers Ltd, 2006: 384
8 Wilson D E, Mittermeier R A. Handbook of the mammals of the world, Vol. 4. Sea mammals. Barcelona: Lynx Edicions, 2014: 614