Studies on sperm whales (*Physeter macrocephalus*) stranded on the coast of Schleswig-Holstein, Germany, in 2016

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The strandings. Multiple strandings of sperm whales (*Physeter macrocephalus*) have occurred along the coastal North Sea since the medieval times (Smeenk 1997). In January and February 2016, however, the largest sperm whale mortality event to date was reported in the area. A total of 30 sperm whales stranded, of which 13 animals died at the coasts of Schleswig-Holstein, Germany (Figs. 1 and 2). Necropsies were conducted on 12 individuals. Age was determined by counting growth layer groups in the teeth, and further detailed investigations were carried out to gain the maximum information from the animals. Each digestive tract was completely opened and contents were collected and preserved. All whales were immature males. Body lengths ranged between 10.18 m and 12.34 m, and age varied from 10 to 15 years (Table 1).

Fig. 1. (a) Stranded sperm whales at Kaiser-Wilhelmkoog off Dithmarschen (Schleswig-Holstein), (b – i) photographs illustrating transport, field work and dissection of sperm whales at Speicherkoog (Dithmarschen, Schleswig-Holstein), 4-7 February 2016. Copyright of photographs: Brunckhorst/LKN.SH, ITAW, GEOMAR.

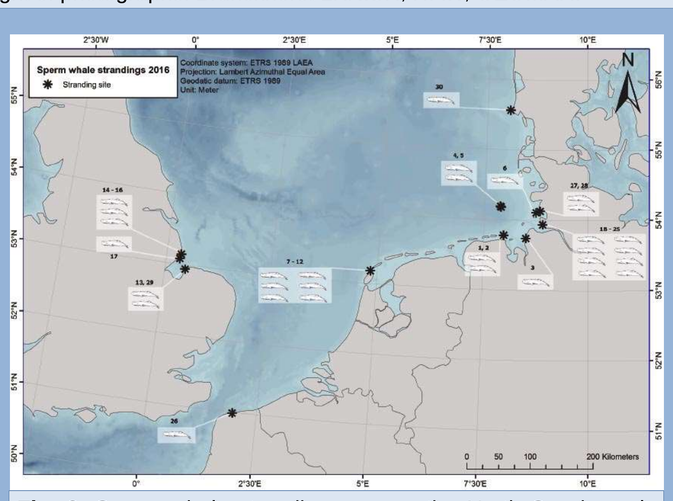

Fig. 2. Sperm whale strandings across the North Sea in early 2016. Asterisks with numbers 4-6; 18-25; 27; 28 indicate strandings in Schleswig-Holstein.

Whale number	Date found	Location found	Mass [t]	Length [m]	Age [years]
1	12.01.2016	Helgoland	n.m.	12.34	13
2	12.01.2016	Helgoland	n.m.	12.00	13
3	13.01.2016	Büsum, Süderpip area	n.m.	10.70	12
4	01.02.2016	Dithmarschen, Kaiser-Wilhelmkoog	n.m.	10.50	12
5	01.02.2016	Dithmarschen, Kaiser-Wilhelmkoog	n.m.	11.40	11
6	01.02.2016	Dithmarschen, Kaiser-Wilhelmkoog	n.m.	11.30	10
7	01.02.2016	Dithmarschen, Kaiser-Wilhelmkoog	15.1	10.18	12
8	01.02.2016	Dithmarschen, Kaiser-Wilhelmkoog	n.m.	10.95	10
9	01.02.2016	Dithmarschen, Kaiser-Wilhelmkoog	n.m.	11.20	15
10	01.02.2016	Dithmarschen, Kaiser-Wilhelmkoog	n.m.	n.m.	11
11	01.02.2016	Dithmarschen, Kaiser-Wilhelmkoog	n.m.	10.80	12
12	03.02.2016	Dithmarschen, Büsum	15.0	11.40	11
13	03.02.2016	Dithmarschen, Büsum	18.0	12.00	15

Table 1. Basic biological data (body mass, body length and age) as well as date and location when and where each sperm whale had been found. N.m. = not measured.

Fig. 3. (a) Collecting parasites, (b) cysts of larval cestods in whale blubber.

Condition, diseases , parasites and debris. Based on blubber thickness and muscle condition the whales were in a good nutritional status. No signs of severe trauma, apparent infections or diseases were found. Metazoan parasites were present on the skin, in the blubber (mainly larval stages of the cestod *Phyllobothrium delphini*; Fig. 3b), stomach, intestine, and on the skin mostly associated with mild lesions. Four whales displayed marine litter in the digestive tract. This included fishing related and general debris such as netting, plastic buckets, and a car part (Unger et al. 2016; Fig. 4).

Fig. 4. Remains of plastic buckets and bags in first stomach compartment.

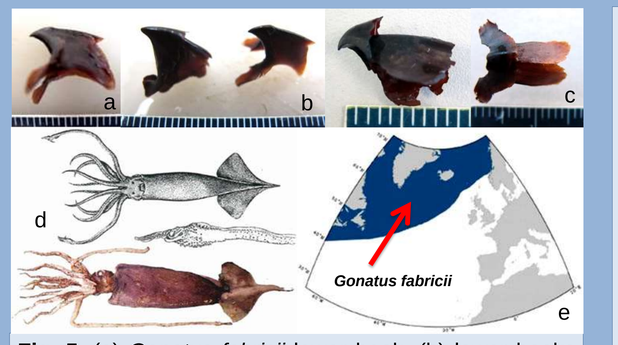

Fig. 5. (a) *Gonatus fabricii* lower beak, (b) lower beaks of *Todarodes sagittatus* and an unknown squid, (c) upper and lower octopod beak, (d) drawing and image of *G. fabricii* (Okutani 2015), (e) distribution of *G. fabricii* in the North Atlantic (Piatkowski et al. 2015).

Prey. Stomach content found consisted of cephalopod beaks and fish remains. It was dominated by an enormous number of beaks (n = 106 566) of the Boreoatlantic armhook squid (*Gonatus fabricii*), a cephalopod living in the northeast Atlantic (Figs. 5 a; d; e). This indicates that the whales were feeding successfully on their preferred prey occurring in the North Atlantic before entering the North Sea. Fish remains (mainly bones and otoliths) were much less abundant than cephalopod beaks. The most important fish prey was monkfish (*Lophius piscatorius*) (Figs. 6 a; f). All fish species that were found in the whales' stomachs are common in the northeast Atlantic, as well as in the North Sea.

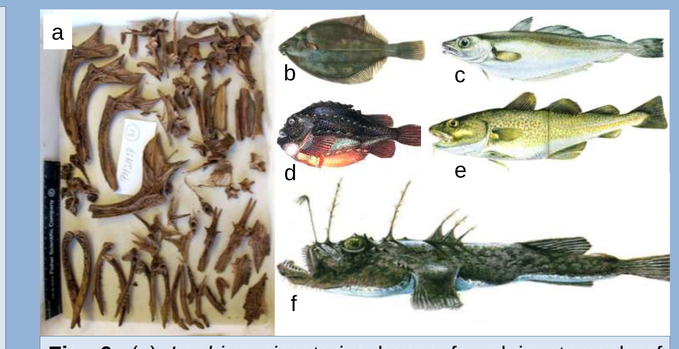

Fig. 6. (a) *Lophius piscatorius* bones found in stomach of whale no. 13 (Table 1), (b) common dab (*Limanda limanda*), (c) whiting (*Merlangius merlangus*), (d) lumpsucker (*Cyclopterus lumpus*), (e) Atlantic cod (*Gadus morhua*), (f) monkfish (*Lophius piscatorius*). Fish images from Muus (1991).

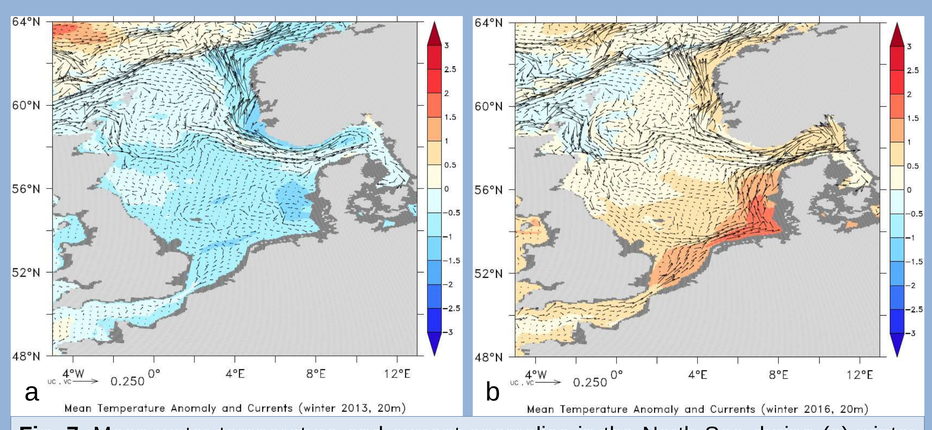

Fig. 7. Mean water temperature and current anomalies in the North Sea during (a) winter 2013 (cold and normal), and (b) winter 2016 (exceptionally warm). A. Biastoch (GEOMAR), pers. comm. Data from Copernicus Marine Environment Monitoring Service (CMEMS).

Why these fatal strandings? It remains unclear why the animals migrated into the North Sea. There are lots of assumptions such as sun storms, noise, too much debris in stomachs, pollution, etc. The most plausible reason could be attributed to climatic conditions within the North Atlantic during early 2016. Water temperature and storm velocities were much above average values (Fig. 7b). This probably caused the young sperm whales to leave their traditional southwesterly migration routes and guided them, and possibly also their major prey, towards the shallow waters of the southern North Sea.

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