

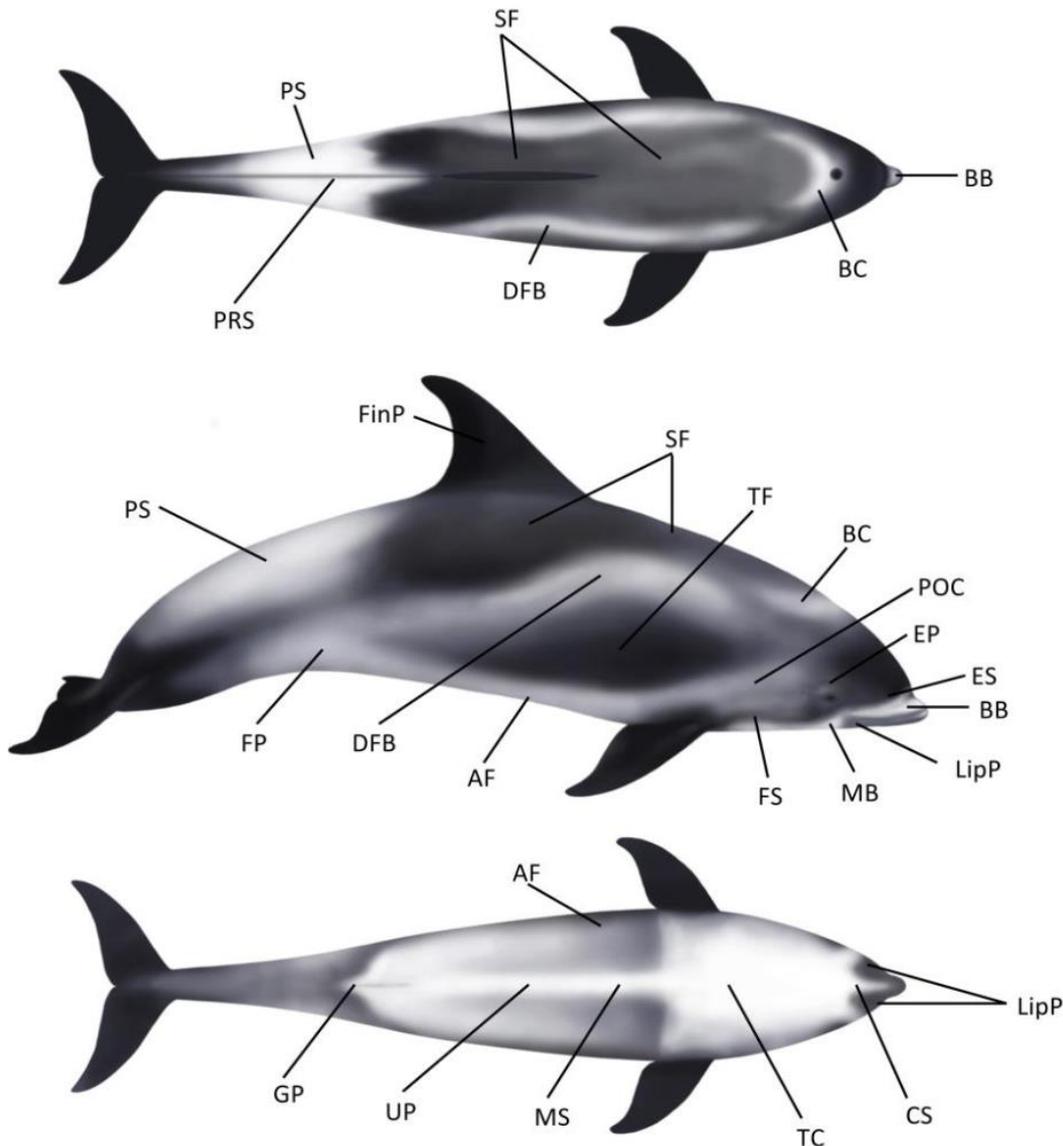
THE WHITE-BEAKED DOLPHIN IN EUROPE: RESEARCH & CONSERVATION



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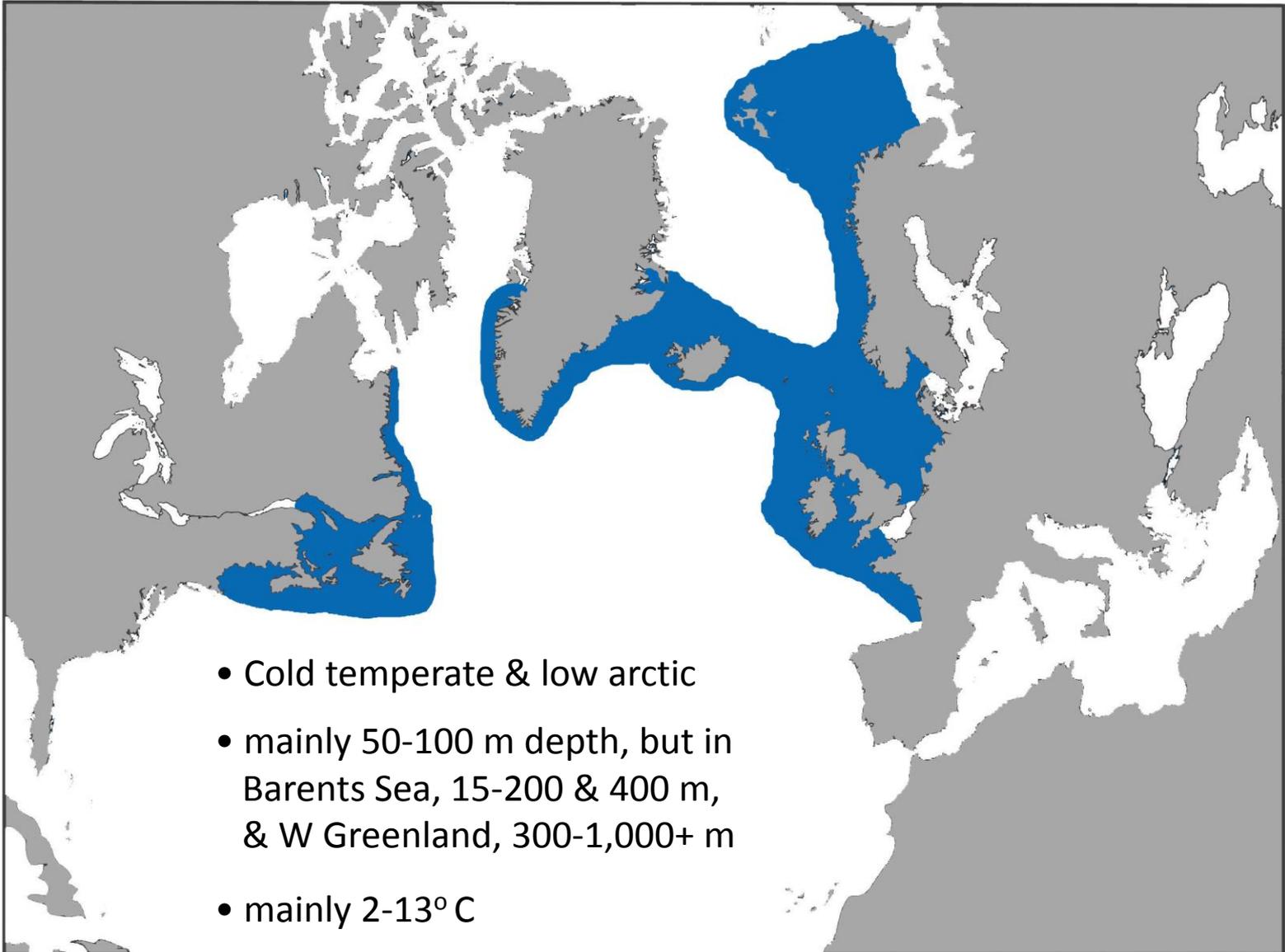
White-beaked Dolphin body coloration patterns



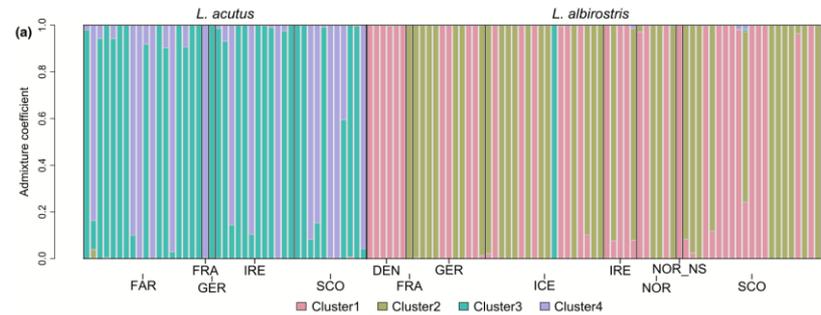
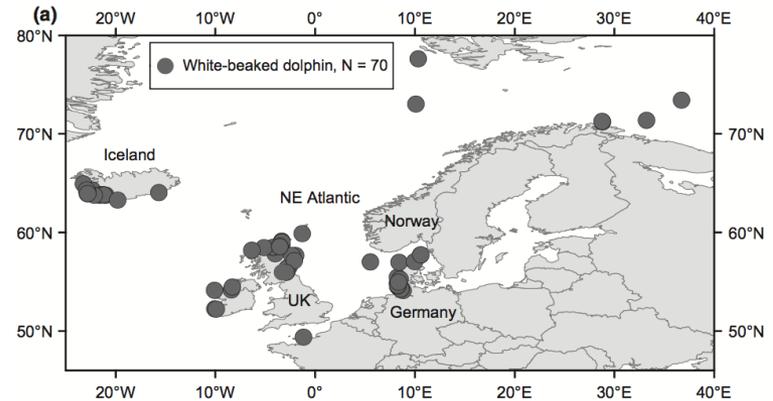
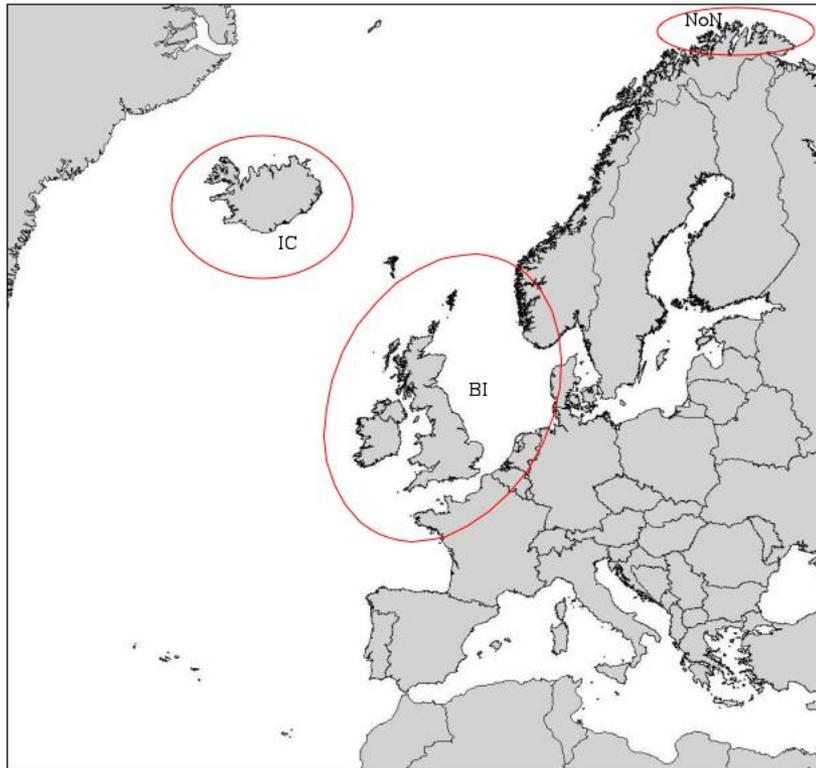
- Juveniles have light grey beaks, and any of the following: speckling, semi-circular head blaze and lateral patch
- Adults have fully-developed blowhole chevron, completely filled-in post-ocular crescent, continuous dorsal flank blaze, peduncular saddle, dark grey abdominal field, beak blaze of dark grey colour with white or pink tip, and flipper stripe as a demarcation line between white throat chevron and grey post-ocular crescent

Source: Bertulli *et al.*, 2016

White-beaked Dolphin distribution in North Atlantic



White-beaked Dolphin population structure



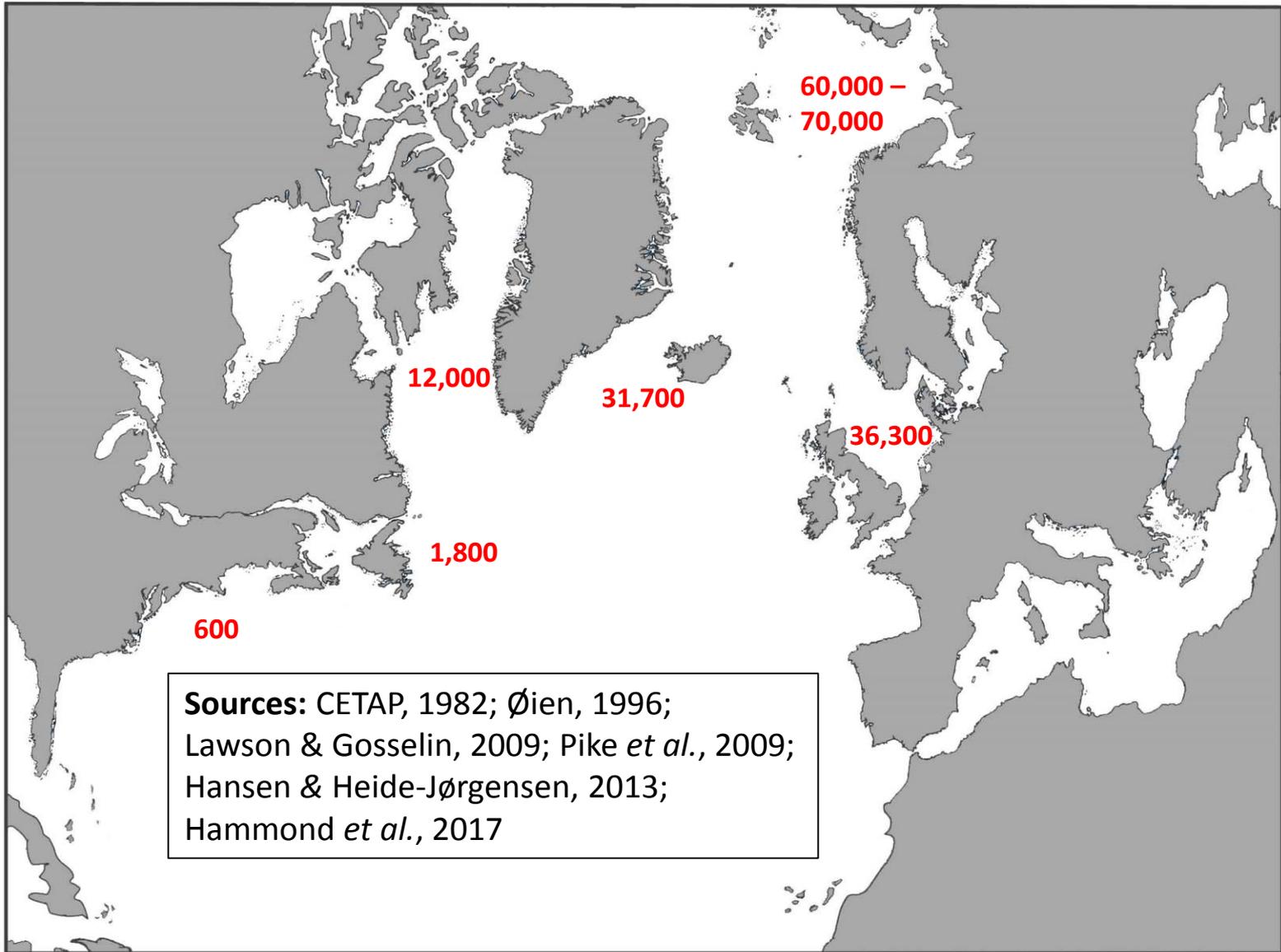
- mtDNA analysis indicated three management units in Europe: British Isles/Netherlands, northern Norway and Iceland, with a separate one in the NW Atlantic
- Moderate haplotype diversity ($h=0.73$) from mt D-loop
- Low nucleotide diversity ($\pi=0.0056$) indicating past bottleneck

Source: Evans & Teilmann, 2009; Banguera-Hinestroza *et al.*, 2010

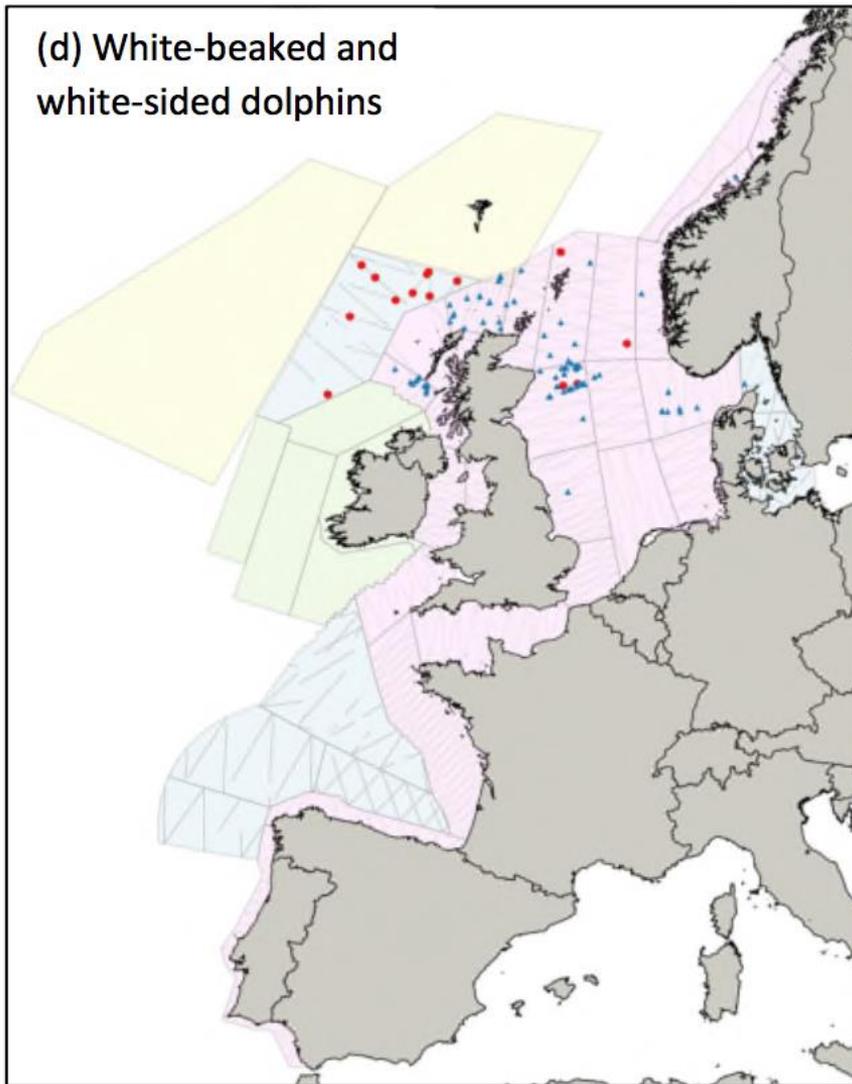
- Some sub-structuring in white-beaked dolphin compared with white-sided dolphin, based on RADSeq of whole genome
- Observed heterozygosity = 0.012
- Low nucleotide diversity ($\pi=0.03$)

Source: Fernandez *et al.*, 2015

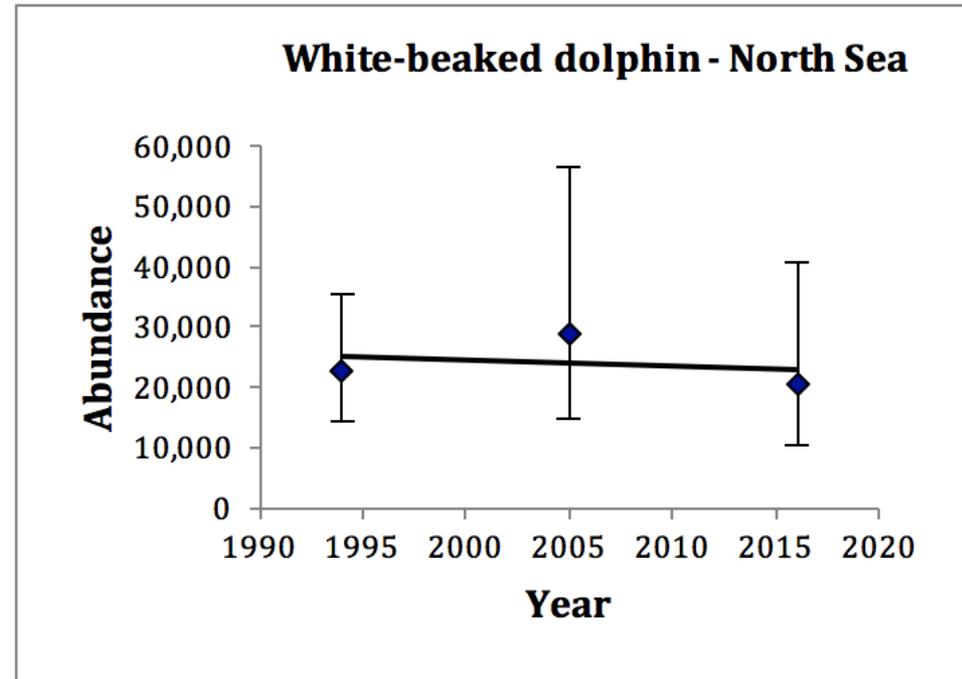
White-beaked Dolphin abundance estimates



White-beaked Dolphin population trends



WBD = blue triangles; AWS = red circles



Total Abundance: July 2016: 36,287
(CV=0.29; 95% CI: 18,694-61,869)

July 2005/07: 37,689 (CV=0.36)

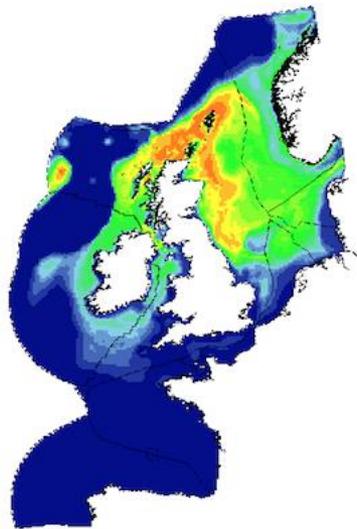
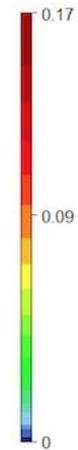
July 1994: 23,716 (CV=0.30)

Estimated Annual rate of change:
-0.5% (95% Cis: -18; 22%), $p=0.82$ (CV=0.36)

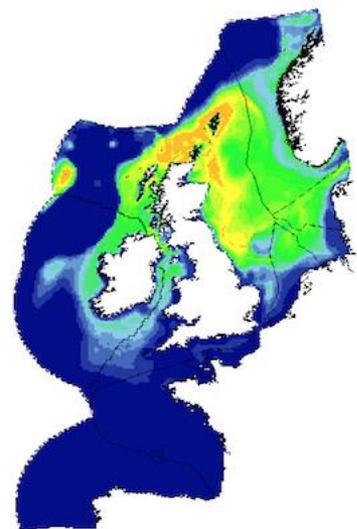
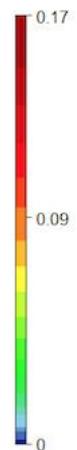
Source: Hammond *et al.* (2017)

White-beaked Dolphin seasonal densities in NW Europe

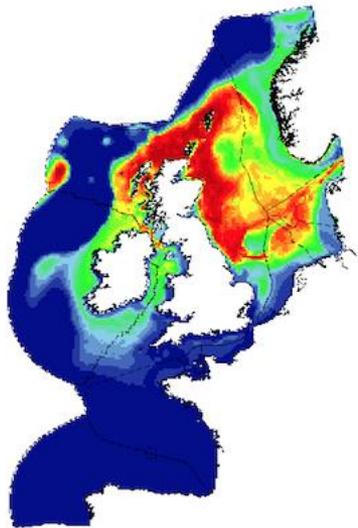
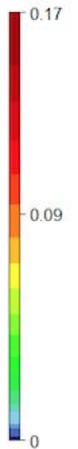
Jan



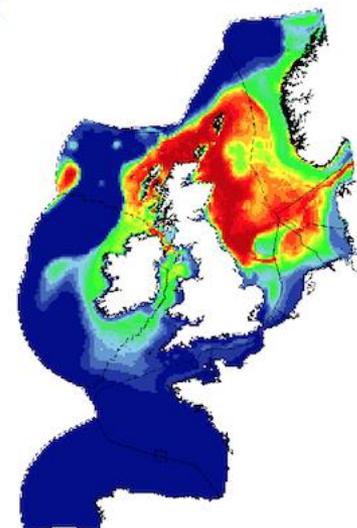
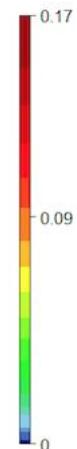
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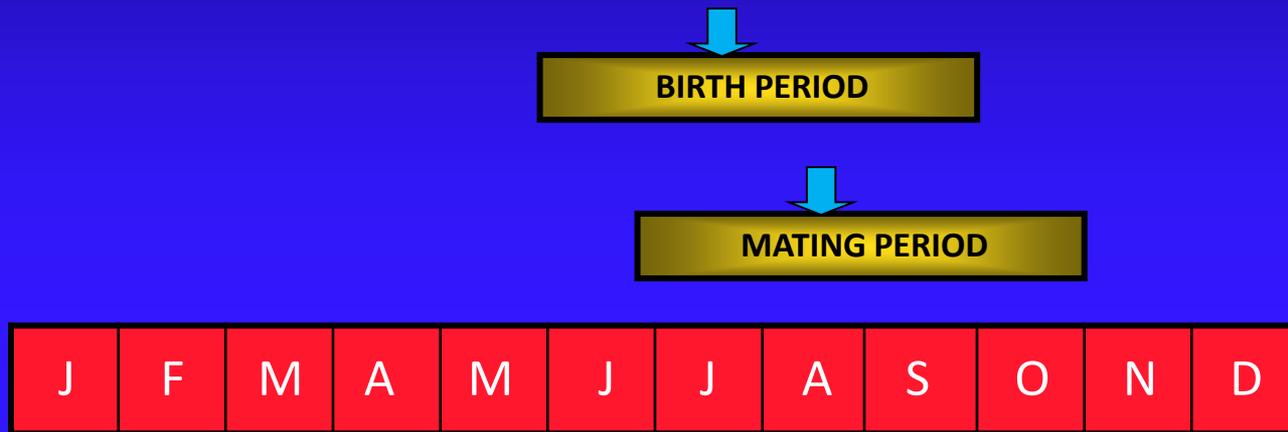


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Source: Evans & Waggitt (unpublished)

ANNUAL CYCLE OF THE WHITE-BEAKED DOLPHIN



Gestation Period: c. 11 months

Lactation Period: ??

Calving Interval: ??

White-beaked Dolphin Life History Parameters

Growth & Reproduction

- Length at birth is 110-120 cm at c. 40 kg weight
- Males become sexually mature at 230-260 cm length and 8-12 years of age
- Females become sexually mature at 230-240 cm length and 6-8 years of age
- Adult males average 273 cm length (range 252-290 cm), up to 354 kg
- Adult females average 251 cm (range 242-265 cm), up to 306 kg



Life Span

- Males at least 32 years
- Females at least 39 years

Sources: Kinze *et al.*, 1997; Evans & Smeenk, 2008; Galatius *et al.*, 2010; Galatius & Kinze, 2016

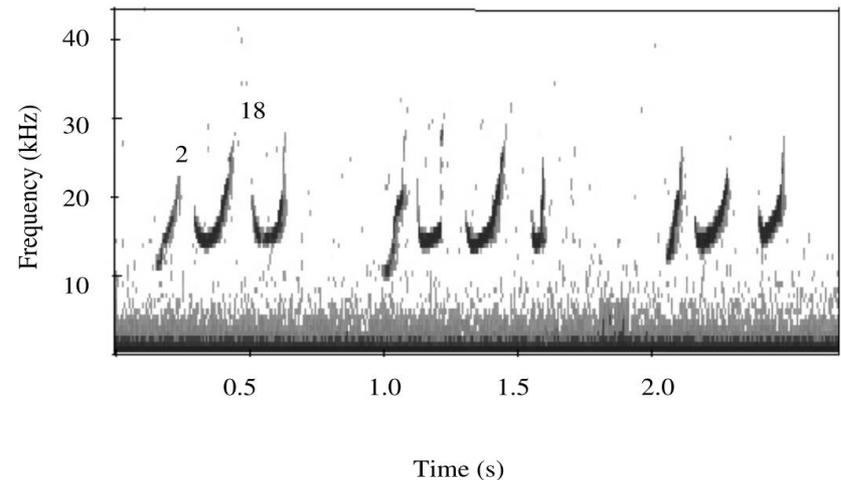
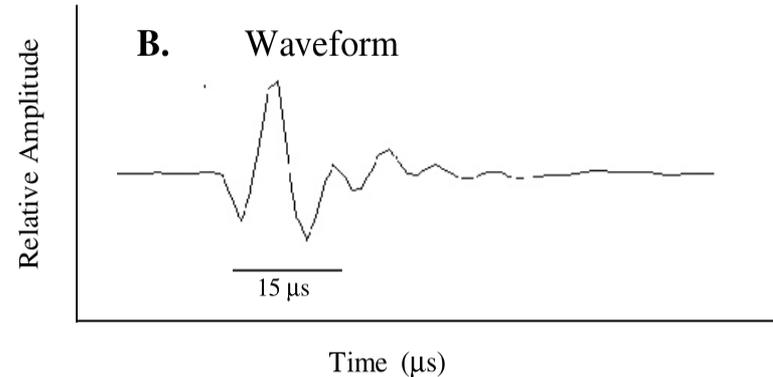
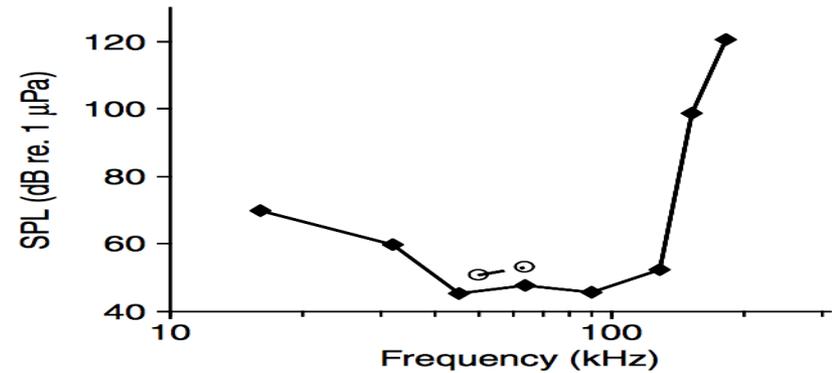
White-beaked Dolphin Group Sizes



Mean (Range) Group Size: 5.1 (1-220) – UK (Evans, 1992; Anderwald, 2002; Evans *et al.*, 2003)
7.9 (1-300) – Faxaflói , SW Iceland (Bertulli, 2015)
10.0 (1-150) – Skjálfandi, N Iceland (Bertulli, 2015)
8.0 (1-150) – Barents Sea (Fall & Skern-Mauritzen, 2014)
8.6 (1-200) – Gulf of St Lawrence (Kingsley & Reeves, 1998)
9.1 (1-20) – Nova Scotia (Simard *et al.*, 2006)
6.3 (1-100) – NASS Survey, Iceland (Pike *et al.*, 2009)

White-beaked Dolphin Acoustics

- Audiogram from two free-living white-beaked dolphins indicate a hearing range of 16-181 kHz with peak sensitivity c. 50-64 kHz (Nachtigall *et al.* 2008)
- Highest hearing sensitivity of any dolphin recorded: 90 dB at 152 kHz and 111 dB at 181 kHz (Nachtigall *et al.*, 2008)
- Very narrow echolocation beam width: 8° at 3 dB & 10° at 10 dB (Rasmussen *et al.*, 2004)
- Echolocation clicks have average peak frequencies c. 115 kHz with a secondary peak c. 250 kHz, and a centre frequency at 82 kHz; click source levels 190-210 dB re 1 μ Pa (Rasmussen & Miller, 2002; Rasmussen *et al.*, 2002)
- Burst pulse signals also made at 719 Hz (range 423-1,103 Hz) with mean peak frequency of 35.3 kHz (Simard *et al.*, 2008)
- Whistles range from 3-35 kHz with few having harmonics; duration 0.03-1.62 s. (Rasmussen & Miller, 2002)

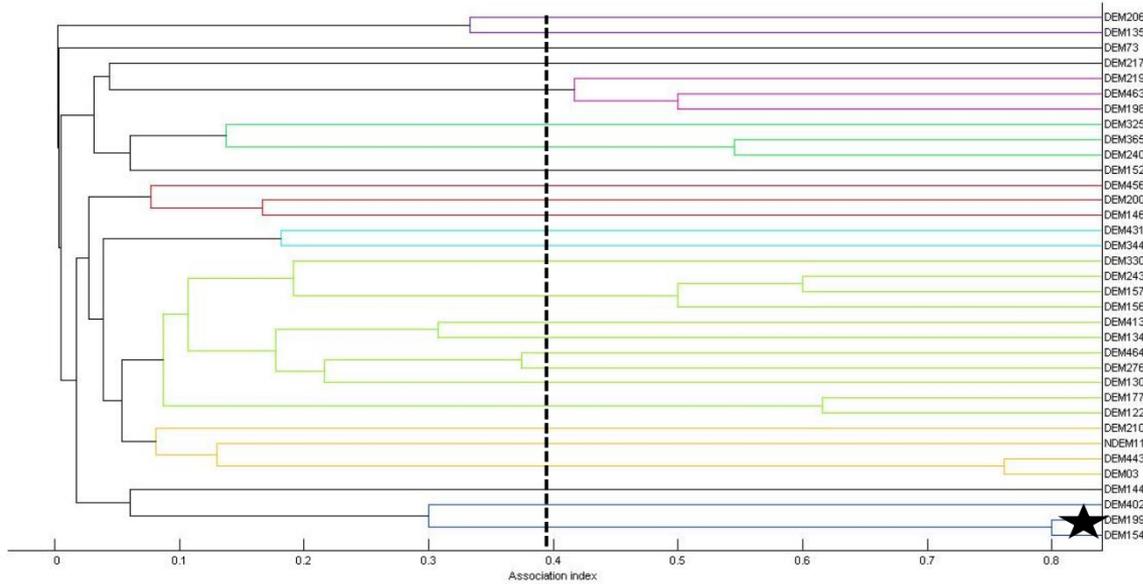


White-beaked Dolphin Behaviour

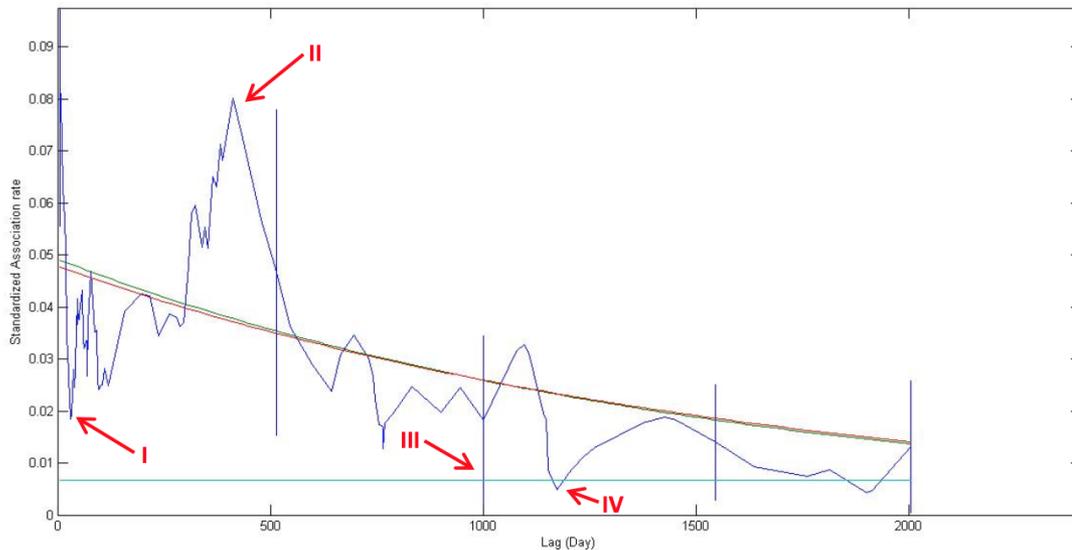
- Frequently bow-ride vessels, breach, and may cooperatively herd pelagic fish (Evans, 1987)
- Swim speeds average 6-12 km/hr, but can attain 30 km/h (Evans & Smeenk, 2008)
- Mean dive depth was 24 m for tagged individual in Iceland, with max. dive depth of 45 m in dives of up to 78 sec (Rasmussen *et al.*, 2013)
- More than 50% of dives apparently to sea floor (Rasmussen *et al.*, 2013)
- Travel great distances: one recognisable individual re-sighted 361 km away in only 6 days (Tetley, 2004); a satellite tagged male ranged over large areas of Iceland between the Westfjords and Faxaflói (Rasmussen *et al.* 2013); and movements recorded between Faxaflói, Breiðafjörður and Skjálfandi (Tetley 2006; Bertulli 2010, Bertulli *et al.* 2015)



White-beaked Dolphin Social Structure



- Highly fluid coefficients of association with few long-term bonds
- Association patterns best described as casual acquaintances



- A fall in lagged association rates suggest that individuals may separate after c. 10 days
- However, some associations last through study period

Source: Bertulli (2015)

Whaling



Over fishing



Entanglement in fishing gear



Ship strikes



Pollution



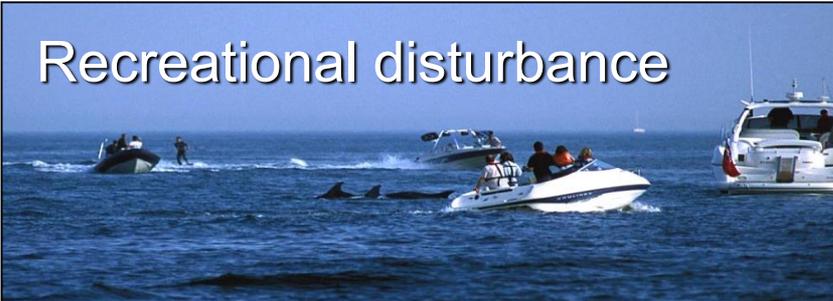
Active sonar



Shipping



Recreational disturbance



Climate



Change

Wind farm construction



White-beaked Dolphin Threat

		Greater North Sea	Celtic Seas	NE Atlantic	
POLLUTION & OTHER CHEMICAL CHANGES	Contaminants	M	M	M	
	Nutrient enrichment	L	L	L	
PHYSICAL LOSS	Habitat loss	L	L	L	
PHYSICAL DAMAGE	Habitat degradation	L	L	L	
OTHER PHYSICAL PRESSURES	Litter (inc. <u>microplastics</u> and discarded fishing gear)	L	L	L	
	Underwater noise changes	Military Sonar	M	M	M
		Seismic surveys	M	M	M
		Pile-driving	M	M	M
		Shipping	M	M	M
	Barrier to species movement (offshore windfarm, wave or tidal device arrays)	L	L	L	
Death or injury by collision	L	L	L		
BIOLOGICAL PRESSURES	Introduction of microbial pathogens	L	L	L	
	Removal of target and non-target species (prey depletion)	M	M	M	
	Removal of non-target species (marine mammal bycatch)	M	M	M	
	Disturbance (e.g. wildlife watching)	L	L	L	
	Deliberate killing + hunting	L	L	L	

Source: Updated from ICES, 2015

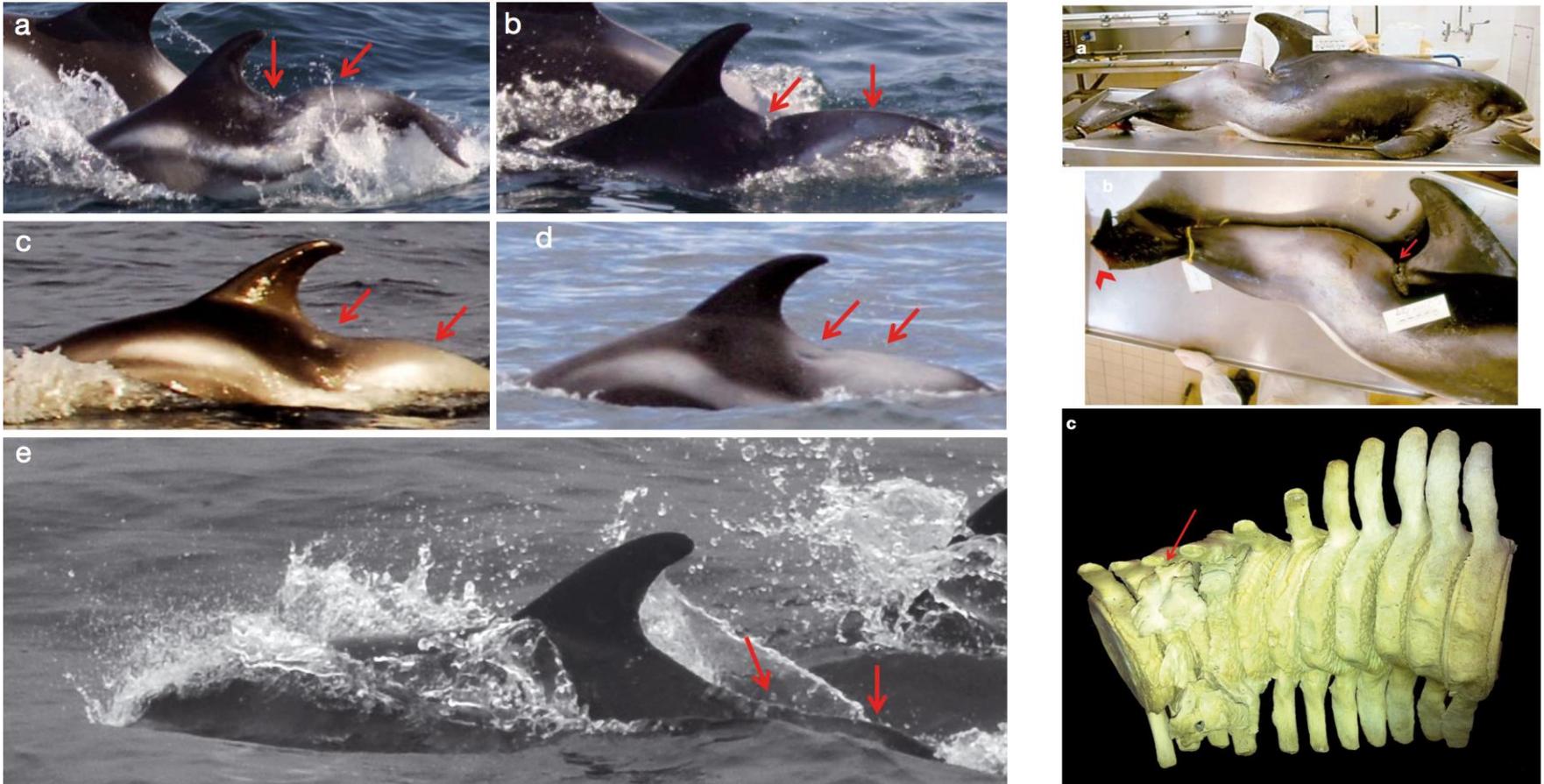
White-beaked Dolphin

Health Status



- Of 89 PME's in the UK from 1990-2011, 29 (33%) were live strandings, 14 (16%) had died of starvation, 9 (10%) of infectious disease, 8 (9%) of by-catch, 7 (8%) of physical trauma of unknown origin, 5 (6%) from dystocia (Deaville, 2013)
- Levels (mg/kg dry weight) of heavy metals from 28 ice entrapped indivs from Newfoundland ranged between 0.01-2.17 lead, 3.5-32.1 copper, 0.2-43.8 cadmium, 0.0-5.8 mercury, **0.0-20.2 selenium**, and 43.5-136.0 zinc; 4.5-88.6 Σ DDT, 20.3-83.8 Σ oxaphenes, **9.6-87.0 for Σ PCBs**, and 3.7-25.0 mg/kg wet wt Σ chlordanes (Muir *et al.*, 1988)
- Levels of **mercury** ranged between 1.3-27 mg/kg wet wt in the UK (Law *et al.*, 1991), and **5.7-220.7** mg.kg dry wt in Germany, and **229** mg/kg dry wt in French Channel (Anderson & Rebsdorff, 1976; Law *et al.*, 1991; Siebert *et al.*, 1999; Das *et al.*, 2003)

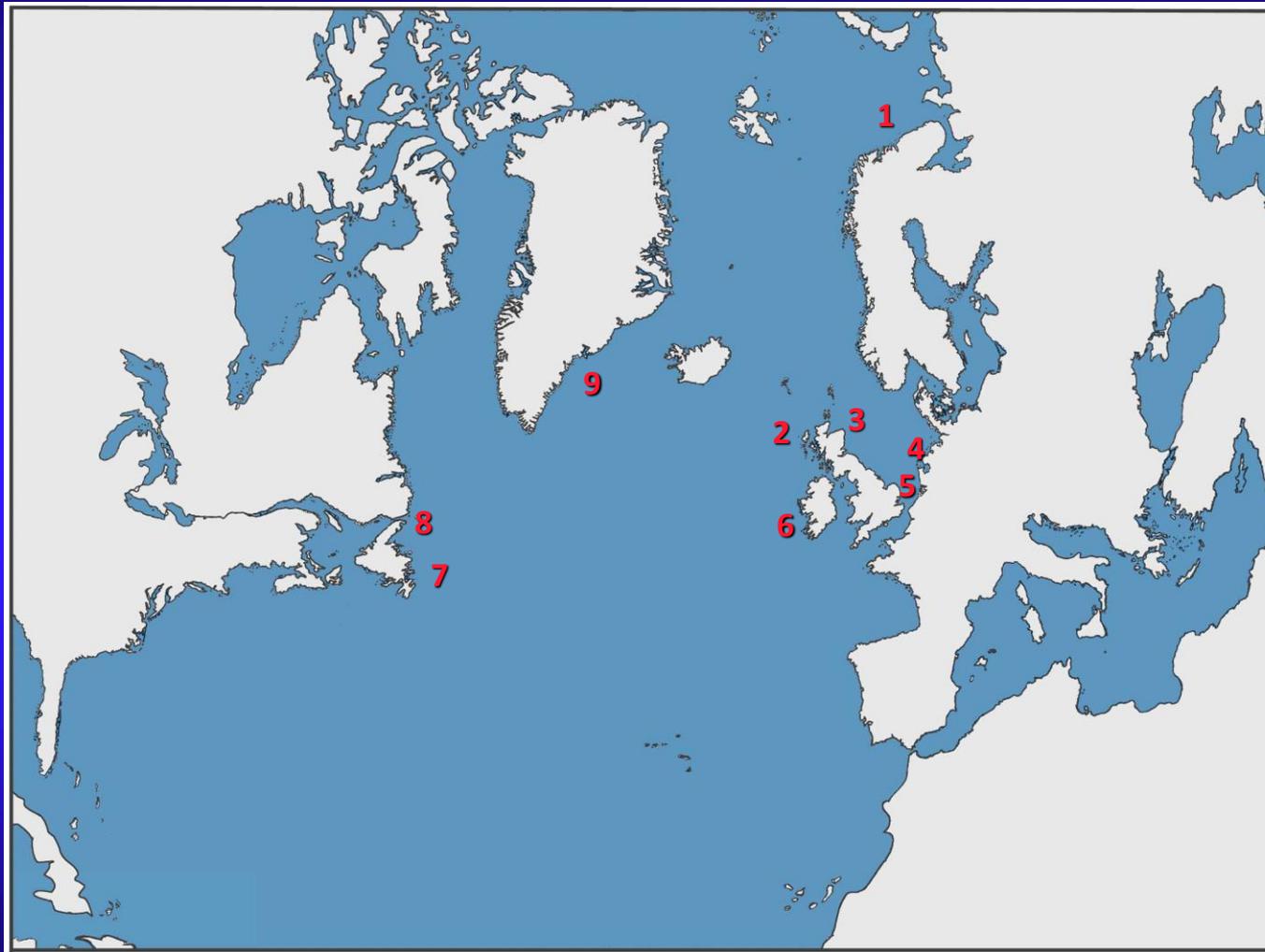
White-beaked Dolphin Vertebral Deformities



- 72% (18 of 25 adults) in the North Sea had vertebral lesions associated with spondylosis deformans; 11 of these had pathologically fused vertebrae; 5/400 adults in Iceland had similar deformities

Sources: Galatius *et al.*, 2009; Bertulli, 2015; Bertulli *et al.*, 2015

Geographic Variation in White-beaked Dolphin Diet



Principal Species

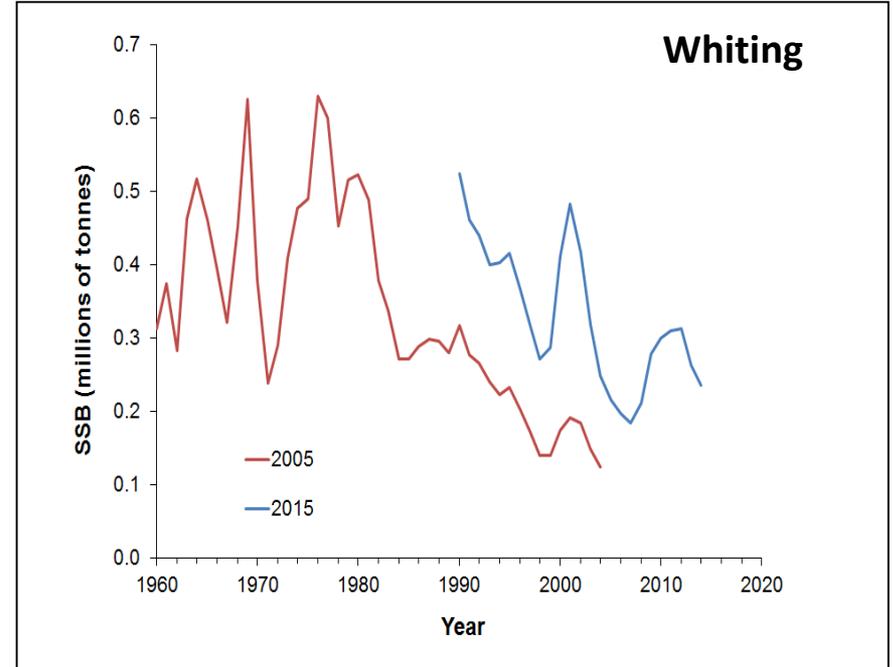
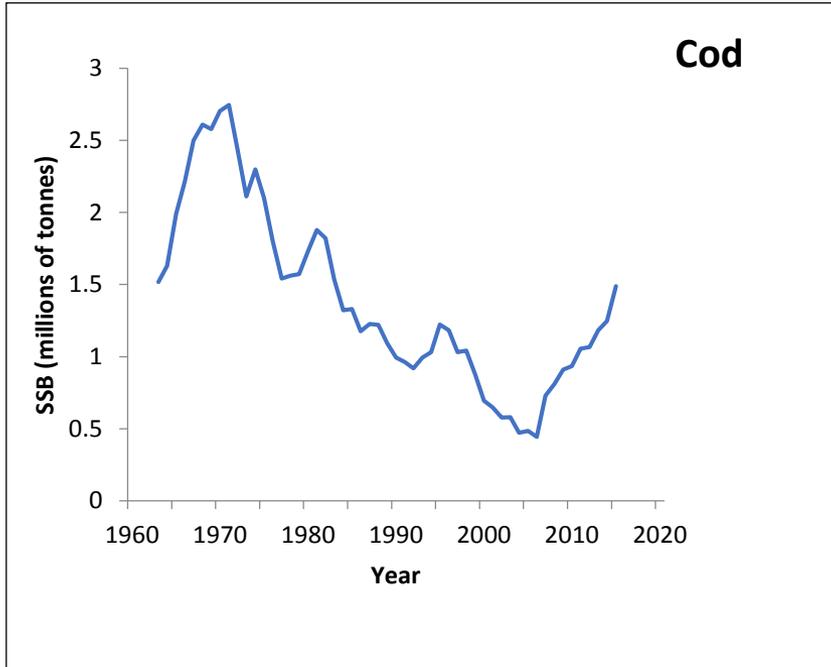
- 1 Blue whiting*, herring*, capelin*
- 2 Herring*, mackerel*
- 3 Haddock, whiting, hake, cod
- 4 Cod, whiting, poor-cod
- 5 Cod, whiting, bib, sandeel, gobies, shrimp, squid
- 6 Scad, gadids
- 7 Cod
- 8 Cod
- 9 Capelin

(Sources: Sergeant & Fisher, 1957; Jonsgard & Christensen, 1968; Evans, 1987; Lick, 1994;

Berrow & Rogan, 1996; Dong *et al.*, 1996; Canning *et al.*, 2008; Skern-Mauritzen *et al.*, 2009; Jansen *et al.*, 2010)

Temporal trends in fish prey species

North Sea Spawning Stock Biomasses



Source: ICES data



*Thanks to Chiara Bertulli, Anders Galatius,
Phil Hammond & Carl Kinze for additional
unpublished information*