

Agenda Item 3

Special Species Session: White-beaked
dolphin

Introduction and Conservation Status

Document Inf.3.1.b

**White-beaked dolphin review (2016)
- *Lagenorhynchus albirostris*
(Cetacea: Delphinidae)**

Action Requested

- Take note

Submitted by

Secretariat



**NOTE:
DELEGATES ARE KINDLY REMINDED
TO BRING THEIR OWN COPIES OF DOCUMENTS TO THE MEETING**

Secretariat's Note

The Rules of Procedure adopted at the 19th Meeting of the ASCOBANS Advisory Committee remain in force until and unless an amendment is called for and adopted.



Lagenorhynchus albirostris (Cetacea: Delphinidae)

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Abstract: *Lagenorhynchus albirostris* (Gray, 1846a) is a delphinid commonly called the white-beaked dolphin. A robustly built dolphin with black, white, and gray coloration, it has a whitish beak, a prominent dorsal fin, and a white saddle behind the fin. Endemic to the temperate and subarctic North Atlantic, it is associated with continental shelf habitats. The conservation status of *L. albirostris* is poorly known. *L. albirostris* is currently listed as “Least Concern” by the International Union for Conservation of Nature and Natural Resources and it is listed on Appendix II of the Convention on International Trade in Endangered Species of Flora and Fauna.

Key words: cetacean, continental shelf, dolphin, North Atlantic, subarctic waters, temperate waters, white-beaked dolphin

Synonymy completed 1 August 2015

DOI:10.1093/mspecies/sew003

Version of Record, first published online August 05, 2016, with fixed content and layout in compliance with Art. 8.1.3.2 ICZN.

Nomenclatural statement.—A life science identifier (LSID) number was obtained for this publication: LSID: urn:lsid:zoobank.org:pub:88910570-34C1-4EB7-8427-7ADE88A44449

Lagenorhynchus albirostris J. E. Gray, 1846a

White-beaked Dolphin

Delphinus Tursio Brightwell, 1846:21, plate 1. Not *Delphinus tursio* Fabricius, 1780.

Lagenorhynchus albirostris: J. E. Gray, 1846a:84. No type locality specified, but stated as “North Sea, coast of Norfolk” by Gray (1846b:35); restricted by Gray (1850) to Great Yarmouth. First use of current name combination.

Delphinus albirostris: J. E. Gray, 1846b:35, plate 10. Incorrect reference to *Lagenorhynchus albirostris* (Gray, 1846a)

Delphinus pseudotursio Reichenbach, 1846:plate 24, figure 76. New name based on Brightwell’s (1846) description (see “Nomenclatural Notes”).

Delphinus Ibsenii Eschricht, 1846:297. Type locality: “Agger Tange,” West coast of Jutland, Denmark.

Delphinus (Lagenorhynchus) albirostris: van Beneden, 1860:28. Name combination.

CONTEXT AND CONTENT. Order Cetacea, suborder Odontoceti, family Delphinidae. Subfamily assignment remains unsettled. Traditionally, the genus *Lagenorhynchus* comprised 6 short-snouted delphinid species. Molecular research, however, has found this grouping to be polyphyletic, that is, comprising at least 2 unrelated lineages: (1) the Pacific and Southern ocean members (*L. obliquidens*, and *L. obscurus*, *L. australis*, and *L. cruciger*, respectively), assigned to the subfamily

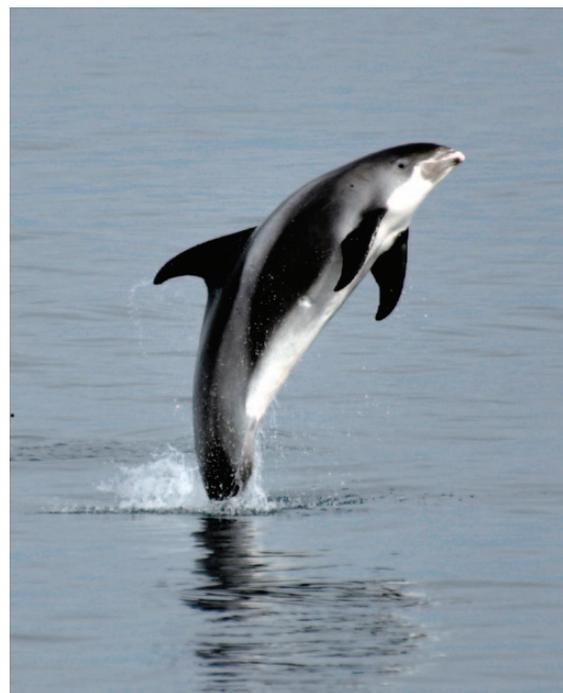


Fig. 1.—An adult *Lagenorhynchus albirostris* from Faxaflói Bay, Iceland, N64°7'47" W22°7'53", lateral view. This individual does not display the typical white beak of the species, but has a partly gray lower beak, which is common in adults. Used with permission of the photographer O. Graillet, Faxaflói Cetacean Research.

Lissodelphininae; and (2) the 2 North Atlantic members of the genus (*L. albirostris* and *L./Leucopleurus acutus*—Cipriano 1997; LeDuc et al. 1999; Harlin-Cognato and Honeycutt 2006; McGowen et al. 2009; McGowen 2011; Banguera-Hinestroza et al. 2014). Molecular studies addressing the relationship between the latter 2 species have provided conflicting results (LeDuc et al. 1999; Harlin-Cognato and Honeycutt 2006; Banguera-Hinestroza et al. 2014). All studies agree that the taxa have basal positions in the Delphinidae phylogeny, but they either represent separate lineages (subfamilies) within the dolphin family (Delphinidae) or they are indeed sister species and form their own subfamily Lagenorhynchinae (Banguera-Hinestroza et al. 2014). In the latter case, the time of their divergence has been estimated as far back as 11.49 million years ago, which may merit assignment to separate genera (Banguera-Hinestroza et al. 2014).

NOMENCLATURE NOTES. Brightwell's (1846) description of a dolphin from Great Yarmouth that he assigned to *Delphinus Tursio* of Fabricius (1780) was promptly corrected by Gray (1846a) in what is considered the formal description of the white-beaked dolphin. In this and his later paper (1846b), Gray applies *Lagenorhynchus* as the generic name, although in his 2nd account (Gray 1846b), he incorrectly credited himself for applying the name *Delphinus albirostris* in the 1st account (Gray 1846a). Later, the binomen *Delphinus albirostris* was used by Gray and many others.

The work of Reichenbach (1846) does not include a description of the new species in the text but contains on plate XXIV, as number 76, a mirrored version of Brightwell's (1846) original figure with a caption reading: *Delphinus pseudotursio* Rchb. *D. Tursio* Th. Brightwell. *An. Mag. Hist.* 1846. Hereby Reichenbach, independently from Gray (1846a, 1846b) recognized Brightwell's dolphin as a new species. The new species name chosen by Reichenbach, clearly is based on Brightwell's specimen and therefore available, but since no exact date of publication could be established it falls into junior synonymy.

Wagner (1846) provided a short Latin description of the species and in the accompanying plate volume (Wagner 1847), a mirrored version of the original Brightwell (1846) drawing. He considered *Lagenorhynchus* a subgeneric name introduced by Gray and consequently named it *D [elphinus]. albirostris*. Generic and subgeneric names were often used interchangeably. van Beneden (1860) for the 1st time gave the scientific name in full: *Delphinus (Lagenorhynchus) albirostris*, but later, he used both *Delphinus albirostris* and *Lagenorhynchus albirostris*.

Eschricht (1846) gave a short description of the skeleton of a new dolphin species he intended to describe under the name *Delphinus Ibsenii*, but he never published an extended description. Gray (1850) and Claudius (1853) put *Delphinus Ibsenii* into the synonymy of *Lagenorhynchus albirostris*. Kinze (2009) established that Gray's specific name (*albirostris*) antedates Eschricht's and therefore is to be considered the senior synonym.

Delphinus tursio was still in use for specimens of white-beaked dolphins until at least 1861 (Sundevall 1861). Several

European museums hold specimens of the white-beaked dolphin originating from waters around Greenland and collected before the formal description in 1846, these were originally assigned to *Delphinus delphis*.

The name, *Lagenorhynchus*, is composed of the Latin word *lagena*, meaning bottle or flask, and the Greek word *rhynchus*, meaning snout. The specific name, *albirostris* (Latin: white-beaked), refers to the common, but not universal, white beak. Additional common names for *L. albirostris* include the following: hvidnæse (Danish); witsnuitdolfijn (Dutch); kjarthvitur springari (Faroese); dauphin avec bec blanc (French); Weißschnauzendelfin (German); ardluarsuk (Greenlandic); Blettahnýðir or Hnýðingur (Icelandic); deilf na ngoba bána (Irish); kvitnos (Norwegian); delfin bialosy (Polish); belomordyi del'fin (Russian); delfin de hocicio blanco (Spanish); vitnosdelfin (Swedish). It is commonly referred to as "springer" or "jumper," especially in parts of Canada, the Faroes, and Norway. These latter names are also used to refer to the Atlantic white-sided dolphin.

DIAGNOSIS

Lagenorhynchus albirostris is most likely to be confused with the Atlantic white-sided dolphin, *L. acutus*, from which it differs by the white or gray beak, a light gray-to-white saddle behind the dorsal fin, and the lack of a yellow field on the posterior flank. Skulls of *L. albirostris* can be distinguished from those of other North Atlantic delphinids by a toothrow with more than 20 teeth and by the shorter (< 240 mm) and wider (> 125 mm) rostrum. Skeletons of *L. albirostris* differ from those of other cetaceans by the high vertebral count, 88–93. Only right whale dolphins (*Lissodelphis*—up to 90 vertebrae) and Dall's porpoise (*Phocoenoides dalli*—up to 98 vertebrae), both absent in the North Atlantic, reach this range.

GENERAL CHARACTERS

Lagenorhynchus albirostris is robust compared to most other delphinids, with a comparatively short, thick beak protruding 5–8 cm from the offset of the melon. The tall, falcate dorsal fin is located around mid-length. Coloration is complex and changes during ontogeny, this has been described and broken into components by Bertulli et al. (2016). As the vernacular name implies, white-beaked dolphins have a white or whitish beak, which in many, particularly adult individuals, is darkened to an ashy gray (Bertulli et al. 2016). The color of the beak often continues backward a few cm posterior to the base of the melon. The dorsum, flanks, and the remainder of the melon are dark gray, whereas the dorsal fin, flippers, and fluke are generally dark gray except for a white or light gray saddle behind the dorsal fin and the occurrence of light patches on the anterior leading edges of fin and flippers in adults. A light patch surrounds the eye, with a darker section immediately around the

eye. The dark gray areas of the dorsum and flanks are overlaid by a lighter gray blaze starting near the anal region and extending dorso-anteriorly along the peduncle and flank to the level of the flippers. Another light gray area on the anterior (thoracic) flank lies between the flipper and the flank patch. The belly is entirely light gray-to-white with a narrow white medial band from the flippers to the genital slit (Figs. 1 and 2). This general pattern varies among ontogenetic stages, individuals, and possibly geographic areas (Harmer 1927; Mercer 1973; Camphuysen 1991; Ree 1994; Bertulli et al. 2016). The longest known specimen is a 310 cm male from the British Isles (Fraser 1974), but few specimens reach 300 cm in total length (Guldberg and Nansen 1894; Harmer 1927; Galatius et al. 2013a). Adult males are larger than females (Dong et al. 1996) due to an extended period of growth (Galatius et al. 2013a). In a sample from the North Sea, adult females were 242–265 cm with a mean length of 251 cm and males were 252–290 cm with a mean of 273 cm (Galatius et al. 2013a).

Ranges of selected body measurements (cm; by C. C. Kinze) from adult females and males, respectively, stranded in the eastern North Sea were: dorsal fin height, 22–38 ($n = 19$) and 26–40 ($n = 15$); anterior flipper length, 32–48 ($n = 21$) and 36–52 ($n = 19$); fluke span, 42–70 ($n = 18$) and 52–83 ($n = 17$); and snout to center of genital aperture, 90–120 ($n = 15$) and 75–90 ($n = 16$).

The observation of a pregnant female only 174 cm long suggests that *L. albirostris* may reach adulthood at smaller sizes in the western North Atlantic (Dong et al. 1996). Few weights have been reported, the largest known male weighed 354 kg (van Utrecht 1981) and the largest female 306 kg (Reeves et al. 1999).



Fig. 2.—Lateral, dorsal, and ventral views of representative coloration pattern of adult *Lagenorhynchus albirostris* based on photos of 437 individuals taken around Iceland (Bertulli et al. 2016). Used with permission of the illustrator U. Gorter, Natural History Illustration.

Means and ranges (mm; by A. Galatius) of selected cranial measurements of adult females and males, respectively, from the eastern North Sea were: condylobasal length, 444 (415–452; $n = 16$), 451 (435–464; $n = 12$); rostral length, 219 (206–227; $n = 17$), 220 (212–226; $n = 12$); rostral width at base, 139 (130–145; $n = 16$), 143 (132–153; $n = 12$); width at antorbital processes, 228 (216–241; $n = 16$), 234 (222–246; $n = 12$); zygomatic width, 243 (233–257; $n = 16$), 253 (240–266; $n = 12$); right mandible length, 369 (350–385; $n = 17$), 376 (354–391; $n = 15$); length of right upper toothrow, 192 (182–202; $n = 16$), 194 (188–202; $n = 12$). The skull has large, deep temporal fossae and robust antorbital, postorbital, and zygomatic processes (Fig. 3).

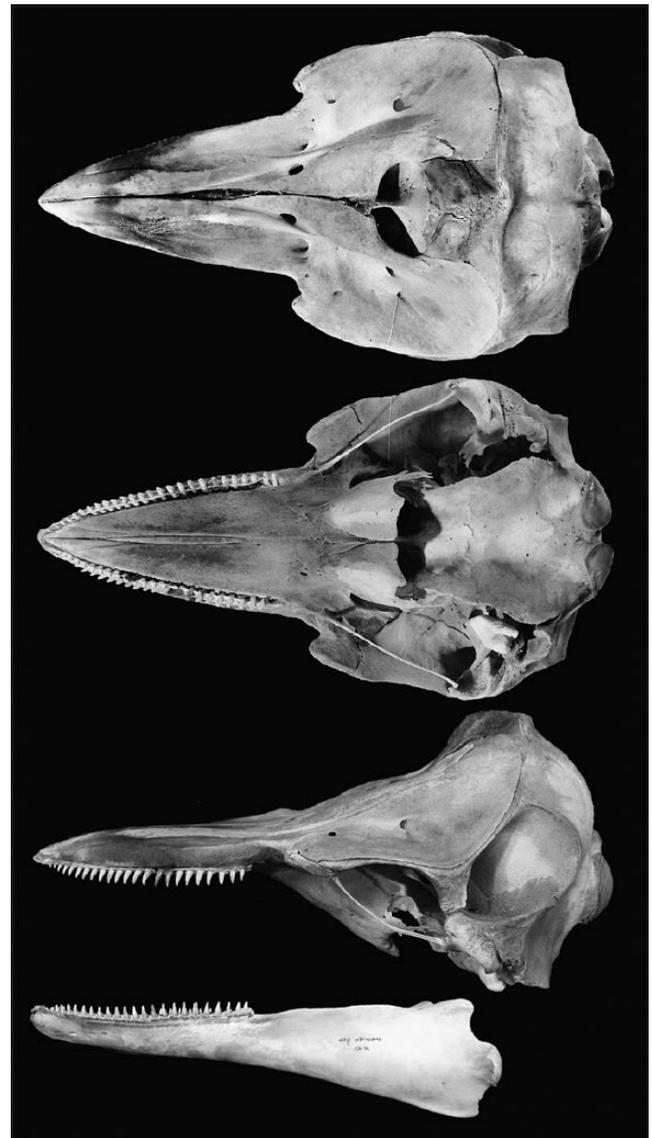


Fig. 3.—Dorsal, ventral, and lateral views of skull and lateral view of mandible of an adult *Lagenorhynchus albirostris* of unknown sex (CN94; Natural History Museum of Denmark, University of Copenhagen) collected in Esbjerg, Denmark. Condylobasal length is 429 mm. Photos by A. Galatius and G. Brovad, with permission.

DISTRIBUTION

Lagenorhynchus albirostris is endemic to the cooler temperate and subarctic North Atlantic (Reeves et al. 1999; Fig. 4). Four principal centers with higher density have been identified (Kinze 2009): (1) The Labrador Shelf and southwestern Greenland; (2) around Iceland; (3) around the northern part of the British Isles and the North Sea; (4) the shelf along the Norwegian coast, including the Barents Sea. In (1), the species has been recorded from western Greenland in the North (71°) to Cape Cod, Massachusetts (Alling and Whitehead 1987; Kingsley and Reeves 1998; Waring et al. 2008; Lawson and Gosselin 2009; Hansen and Heide-Jørgensen 2013). Apart from 2 recent sightings near the southeastern coast of Baffin Island, the species is unknown in this area (Reinhart et al. 2014). In (2), *L. albirostris* is the most common dolphin (Vikingsson and Ólafsdóttir 2004; Pike et al. 2009). This area may also extend to southeastern Greenland, where it is also the most common dolphin (Jonsgård and Christensen 1968). In (3), the highest sighting rates are from the Outer Hebrides and in the western North Sea, but its distribution also extends into the central North Sea to the Danish coast, around Ireland and even some sightings in the English Channel (Northridge et al. 1995, 1997; Hammond et al. 2002; Reid et al. 2003; Hammond et al. 2013). In (4), distribution of *L. albirostris* extends throughout the western Barents Sea except for the northernmost parts (Øien 1996; Fall and Skern-Mauritzen 2014).

FOSSIL RECORD

There is no fossil record of the taxon. Subfossil remains from the greater North Sea and Baltic Sea area document its presence in European waters since the last glacial period (Aaris-Sørensen et al. 2010). Degerbøl (1936) reported subfossils from the medieval Norse West Settlement in Greenland.

FORM AND FUNCTION

The dental formula of *Lagenorhynchus albirostris* is 25–28 homodont teeth in each jaw, but the 3 anteriormost teeth often do not protrude from the gums (van Bree and Nijssen 1964). Vertebral formula is 7 C, 15–16 T, 23–24L, 43–45 Ca, total 88–92 vertebrae (Lütken 1888; True 1889) or 7 C, 14 T, 27L, 45 Ca, total 93 (Tomilin 1967). This is the highest count of vertebrae in a delphinid. The vertebrae have short, wide centra and long spinal and transverse processes. Such vertebral morphology is an adaptation to fast, dynamic swimming at the expense of flexibility (Buchholz 2001). We have observed that the first 2 cervical vertebrae are always fused, but often all 7 are fused. The phalangeal formula is I2, II6, III4, IV1, V0 (Tomilin 1967). In most specimens, the right humerus is longer and more robust than the left, indicating lateralized behavior, something that has been recorded in several cetacean species (Galatius 2006).

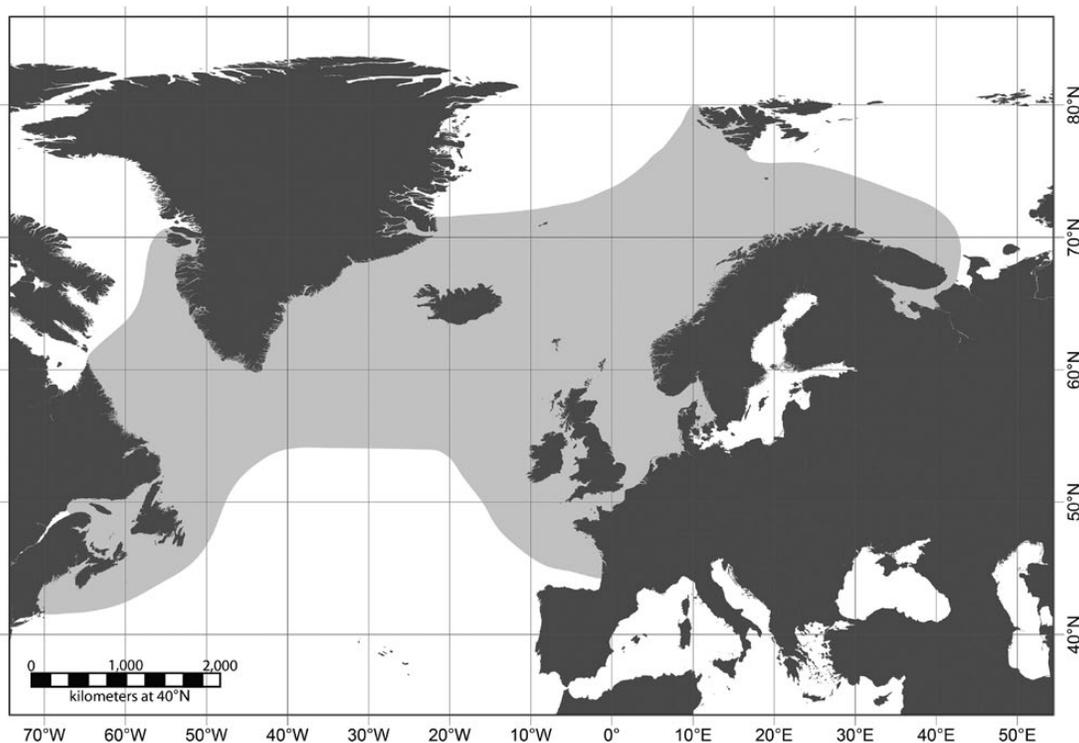


Fig. 4.—Geographic distribution of *Lagenorhynchus albirostris* according to Øien (1996); Reid et al. (2003); Waring et al. (2008); Lawson and Gosselin (2009); Pike et al. (2009); Hammond et al. (2013); Hansen and Heide-Jørgensen (2013); Fall and Skern-Mauritzen (2014). Recent data on distribution off East Greenland are not available, but Jonsgård and Christensen (1968) report the species as the most common dolphin off southeastern Greenland.

The 2–4 vibrissae on each upper lip in fetuses and neonates (Turner 1889; Japha 1912) disappear during development as in other Odontoceti and adults have none. The integumentary blubber is 18–31 mm thick, except for the fins and flukes in which a countercurrent heat exchange system operates to conserve heat (Scholander and Schevill 1955). The organ systems of *L. albirostris* exhibit a typical delphinid organization (muscular system—Murie (1873); nervous system: spinal cord—Cunningham (1877), brain—Weber (1887); sensory system—Fraser (1952); lungs—Cleland (1884) and Weber (1887); digestive system: stomach—Clark (1876), Cleland (1884), Weber (1887), and Turner (1889), small and large intestine—van Beneden (1860) and Cleland (1884); circulatory system: blood vessels—Slijper (1936), heart—Smet et al. (1985) and van Nie (1985, 1986); female reproductive system—van Beneden (1860) and Meek (1918); functional anatomy of mammary slits—Gylling (1912)).

In animals from the North Sea ($n = 10$), the lungs weighed 1,100–2,000 g (left) and 1,300–2,200 g (right). Heart masses were 800–1,900 g, liver masses 1,800–3,400 g, and kidneys weighed 300–600 g each. Adrenals are tiny: 2–8 g (Reeves et al. 1999; and measured by C. C. Kinze).

ONTOGENY AND REPRODUCTION

Ontogeny.—Some highly specialized information is known only from single fetal specimens of *Lagenorhynchus albirostris* (larynx—Thompson 1890; retina—ten Doesschate 1918). Length at birth is estimated at 110–120 cm (Tomilin 1967; Collet and Duguy 1981), but the age and length at weaning are not known. Growth has only been thoroughly investigated in a North Sea sample of 64 females and 52 males (Galatius et al. 2013a). During the first 3 years, young of both sexes grew to about 210 cm, after which growth rate slowed somewhat. Females reached 95% of asymptotic length by about 5.2 years but males continued growing 5 more years, resulting in sexual size dimorphism. Females become sexually mature at 6–10 years and 230–240 cm in length. Males become sexually mature about 2 years later than females and are typically 230–260 cm in length. Adult size of the cranium is achieved at about 6 years of age in the North Sea population ($n = 81$), whereas sutures of the skull are not fully developed until about 9 years of age (Galatius 2010).

Reproduction.—Paired testes mass in 16 adults from the North Sea showed annual fluctuations from about 700 g during the winter to near 2,100 g during the boreal summer, suggesting that mating occurs in the latter period (Galatius et al. 2013a). Around the United Kingdom, strandings of calves below 130 cm in length are reported almost exclusively between June and September, supporting that parturition occurs during this time (Fraser 1974; Canning et al. 2008). Gestation is believed to last about 11 months (Reeves et al. 1999), litter size is 1 as in other Cetacea. Only 3 of 22 sexually mature females were lactating and only 1 was pregnant in the North Sea sample of Galatius et al. (2013a). This observation indicates either a

significant resting period between parturitions or segregation of reproductively active females from others.

ECOLOGY

Population characteristics.—Skull morphometric evidence suggesting segregation between the eastern and western North Atlantic populations of *Lagenorhynchus albirostris* (Mikkelsen and Lund 1994) was confirmed by a molecular study (Banguera-Hinestroza et al. 2010), which also found segregation between dolphins from the United Kingdom and North Sea and those from northern Norway. The latter study did not include samples from Iceland or Greenland; thus, population structure throughout the range of the species remains unresolved. Using > 50,000 single nucleotide polymorphisms, Fernandez et al. (2016) detected 2 genetic clusters among 70 *L. albirostris* sampled throughout the eastern North Atlantic.

Aerial surveys conducted from 1978 to 1982 for the shelf waters from Cape Hatteras to Nova Scotia yielded a population abundance estimate of 573 ($CV: 0.69$ —Cetacean and Turtle Assessment Program 1982). Aerial surveys in the 1980s off eastern Newfoundland and the Labrador coast yielded an estimate of 5,500 *L. albirostris* (no CV —Alling and Whitehead 1987). An abundance of 3,486 individuals (95% $CI: 2,001$ – $4,971$) was estimated from a shipboard survey of a small segment of the Labrador shelf in 1982 (Alling and Whitehead 1987). Aerial surveys in 1995 and 1996 in the Gulf of St. Lawrence yielded estimates of 2,640 ($SE: 2,080$) and 2,380 ($SE: 2,540$), respectively (Kingsley and Reeves 1998), and a 2007 aerial survey of the Canadian shelf from north Labrador to the United States border gave a preliminary estimate of 1842 ($CV: 0.22$ —Lawson and Gosselin 2009). A coast-to-90 km aerial survey of the shelf of West Greenland up to 71°N yielded an estimate of 11,984 ($CV: 0.19$) *L. albirostris* in 2007 (Hansen and Heide-Jørgensen 2013). Aerial surveys in Icelandic waters in 2001 yielded a point estimate of 31,653 (95% $CI: 17,679$ – $56,672$ —Pike et al. 2009). This estimate also included other dolphin species, although the overwhelming majority of the sightings were *L. albirostris*. In the greater North Sea, shipboard surveys in 1994 yielded an estimate of 7,856 individuals ($CV: 0.30$ —Hammond et al. 2002). A 2005 estimate for this area was 16,536 ($CV: 0.30$ —Hammond et al. 2013). The latter survey covered an area to the west that was not covered in 1994 and showed high density in 2005. The design of this survey was criticized for being inappropriate for the patchy distribution of *L. albirostris* (MacLeod 2014). In their response, Hammond et al. (2014) maintained that the design was appropriate for large-scale abundance estimates, but not for understanding fine-scale distribution and abundance. This discussion probably is relevant for all the abundance studies cited here. Estimates of numbers of small Delphinidae, of which the dominant species was *L. albirostris*, for Norwegian waters, including the southern North Sea, waters south and west of Svalbard and the southern Barents Sea are 132,000 ($CV: 0.23$) in 1988 and 91,000 ($CV: 0.59$) in 1995 (Øien 1996). In brief, *L.*

albirostris seemingly is abundant in the temperate and subarctic shelf habitats of the North Atlantic Ocean and in many localities is the most common dolphin.

Stranding data indicate a segregation of the sexes in the eastern North Atlantic. For example, along the eastern coast of the North Sea, a pronounced bias toward stranded females is reported (Jansen et al. 2010). A similar but less pronounced tendency is found around the British Isles (Canning et al. 2008). It is also likely that reproductively active females are segregated from others because only 4 of 22 sexually mature females in the sample of Galatius et al. (2013a) from Denmark, Germany, and the Netherlands were pregnant or lactating. Around the British Isles, the majority of the stranded calves are reported from Scotland (Canning et al. 2008), suggestive that most births occur in northern waters in this population.

Space use.—*Lagenorhynchus albirostris* is found primarily in shelf waters (Kinze et al. 1997; Northridge et al. 1997). Around Scotland, *L. albirostris* mainly occurs in waters less than 200 m deep (Weir et al. 2001; MacLeod et al. 2007). By contrast, it is reported from deeper waters off the West Greenland shelf, with large groups associated with depths from 300 to 1,000 m and smaller groups in even deeper waters (Hansen and Heide-Jørgensen 2013). Sightings and strandings of *L. albirostris* in northwest Scotland decline in number as water temperatures rise (MacLeod et al. 2005), and distribution around the United Kingdom is restricted to more northerly, cooler areas, especially during the summer (Canning et al. 2008). Thus, distributions of *L. albirostris* vary seasonally. For example, sightings in the coastal waters off Aberdeenshire, Scotland, were recorded only in the June–August periods of 1999–2001 (Weir et al. 2007).

Diet.—Although associated with schools of herring (*Clupea harengus*) and mackerel (*Scomber scombrus*—Harmer 1927; Fraser 1946; Evans 1980; Evans 1987), analyses of stomach contents indicate that *Lagenorhynchus albirostris* relies heavily on gadoid fishes. In a Dutch sample, gadoids constituted 98% of prey items by weight (Jansen et al. 2010), with the most important species being cod (*Gadus morhua*; 56%) and whiting (*Merlangius merlangus*; 38%). In a sample from the British Isles, haddock (*Melanogrammus aeglefinus*, 43% by weight) and whiting (24%) were most important (Canning et al. 2008). In another eastern Atlantic study, Lick (1994) found a predominance of whiting, cod, and poor cod (*Trisopterus minutus*). In the western Atlantic, stomachs from 20 animals from Newfoundland contained only cod (Dong et al. 1996) as did 2 specimens from other Canadian waters (Sergeant and Fisher 1957). In the North Sea, Irish Sea, and French Channel coast, $\delta^{15}\text{N}$ values show *L. albirostris* to be among species in the highest trophic positions (Das et al. 2003a, 2003b). In the Barents Sea, *L. albirostris* is associated with schools of blue whiting (*Micromesistius poutassou*—Fall and Skern-Mauritzen 2014), but not of capelin (*Mallotus villosus*).

Diseases and parasites.—Staphylococci were implicated in the deaths of 3 of 5 *Lagenorhynchus albirostris* rescued from ice entrapment in Newfoundland; the others died from infections

of *Erysipelothrix rhusiopathiae* bacteria and unidentified Gram-negative bacteria (Buck and Spotte 1986). Two mortalities of wild dolphins were due to *Morbillivirus* (Osterhaus et al. 1995; Wohlsein et al. 2007), but, because 2 stranded and rescued animals infected with Dolphin *Morbillivirus* lived for up to 6 months before dying from other causes, this strain does not seem to be highly virulent to *L. albirostris* (van Elk et al. 2014). A rhabdo-like virus was also isolated from a stranded specimen (Osterhaus et al. 1993). *L. albirostris* seems to be particularly susceptible to vertebral lesions associated with spondylosis deformans; 15 of 29 of the North Sea adults of Kompanje (1995) were affected and 18 of 25 adults in the North Sea sample of Galatius et al. (2009) were afflicted, of which 11 had pathologically fused vertebrae. The youngest afflicted specimens were 12 years old. Of more than 400 identified free-ranging individuals around Iceland, 5 *L. albirostris* had conspicuous vertebral malformations, another 3 stranded individuals with the same condition were reported from the eastern North Atlantic (Bertulli et al. 2015). The most common parasite is the nematode *Anisakis simplex*, found in the 1st and 2nd stomachs (Krabbe 1878) where severe infestations can cause stomach ulcers. The tapeworm *Plicobotrium globicephalae* occurs in the intestines and another nematode, *Halocercus lagenorhynchi*, in the lungs (Raga 1994). In a study of skin disorders of free-ranging *L. albirostris* from Iceland (2004–2009), tattoo-like epidermal marks were found in 6 of 90 dolphins and cutaneous bumps in one individual (Bertulli et al. 2012).

With its role as a top predator of carnivorous fishes, it is not surprising that some populations of *L. albirostris* have high concentrations of heavy metals and organochlorine compounds in their tissues. In a sample of 27 *L. albirostris* killed by ice entrapment in Newfoundland in 1982, Muir et al. (1988) quantified heavy metal concentrations (mg/kg dry weight in kidney, liver, and muscle tissue). Lead ranged between 0.01–2.17; copper, 3.50–32.1; cadmium, 0.20–43.8; mercury, 0.0–5.82; selenium, 0.0–20.2; and zinc, 43.5–136, of which selenium levels may be cause for concern (Dietz et al. 1998). Two individuals of *L. albirostris*, one stranded in the United Kingdom in 1989 (Law et al. 1991) and one in Denmark in 1972 (Andersen and Rebsdorff 1976), showed levels comparable to those found in the United Kingdom for copper, but levels of zinc and cadmium were lower and those of mercury were higher (1.3–19.0 mg/kg wet weight). One dolphin from West Kirby, Scotland, had 27 mg/kg wet weight mercury in the liver (Law et al. 1991). A white-beaked dolphin from the French Channel coast (collected between 1998 and 2001) had liver concentrations in mg/kg dry weight of mercury (229), copper (27), cadmium (0.4), and zinc (96—Das et al. 2003a). In the same study, 3 dolphins from Ireland (1989–1993) had mg/kg dry weight values 14–34 (Cu), 0.2–0.3 (Cd), and 81–121 (Zn). Three *L. albirostris* from the German North Sea coast (1991–1993) had median mercury concentrations in the liver of 5.7–220.7 mg/kg dry weight (Siebert et al. 1999). The greater part of this range is above thresholds for toxicity (Dietz et al. 2013). Compared to other studies from the early 1990s, lead levels in the kidneys of coastal dolphins in Newfoundland

(Muir et al. 1988) were 40 times higher than those of harbor porpoises (*Phocoena phocoena*) from the Bay of Fundy, Nova Scotia (Gaskin 1982), but one-half of that of harbor porpoises from the North and Baltic Seas (Andersen and Rebsdorff 1976; Harms et al. 1978) and dolphins from the western Mediterranean (Viale 1978). In the ice-entrapped sample from Newfoundland (Muir et al. 1988), the mg/kg wet weight concentrations of the dominant organochlorines in the blubber were 4.5–88.6 for Σ DDT, 20.3–83.8 for Σ toxaphenes, 9.62–87.0 for Σ PCBs, and 3.72–25.0 for Σ chlordanes. Among these, the range for Σ PCBs goes well beyond the level for marked reproductive impairment in ringed seals at 41 mg/kg lipid weight (Helle et al. 1976). The organochlorine concentrations were generally several times higher than those in long-finned pilot whales (*Globicephala melas*) from the same area (Muir et al. 1988). Perfluorooctane sulfonate (PFOS) in concentrations of 14–443 ng/g wet weight was found in liver tissues of 6 *L. albirostris* stranded in Belgium, France, and the Netherlands in 1995–2000 (van de Vijver et al. 2003) compared to a critical body residue of 655 ng/g wet weight for carcinogenicity (Dietz et al. 2015). Among 7 specimens stranded in Denmark from the same period, the predominant perfluorinated chemicals were PFOS (126–540 ng/g wet weight) and perfluorooctanesulfonamide (PFOSA; 4–283 ng/g wet weight). The total concentrations of perfluorinated chemicals were below known levels for toxic effects and similar to those in harbor seals (*Phoca vitulina*) and harbor porpoises from the same area, but PFOSA concentrations were higher than in the other species, indicating different species-specific capabilities for metabolism of the substances (Galatius et al. 2013b).

Interspecific interactions.—*Lagenorhynchus albirostris* is known to associate with feeding baleen whales such as fin whales (*Balaenoptera physalus*) off the coast of Greenland (Jonsgård and Christensen 1968) and humpback whales (*Megaptera novaeangliae*) off the coast of Canada (Sears and Williamson 1982). It sometimes mixes with several species of delphinids; common dolphins (*Delphinus delphis*) off Norway and in the Irish Sea (Haug et al. 1981; Jones 1984), long-finned pilot whales in Canada (Sears and Williamson 1982), bottlenose dolphins (*Tursiops truncatus*) off Ireland (Evans 1980), Risso's dolphin (*Grampus griseus*) off Scotland (Jeevooonarin et al. 1999), and *L. acutus* in the North Sea (Haase 1987; de Boer 1989). *L. albirostris* and *L. acutus* partition habitat in Scotland; the latter species replaces the former as water depths increases (MacLeod et al. 2007). When sea surface temperatures exceed 13–14°C, common dolphins replace *L. albirostris* in shelf habitats of the United Kingdom and Ireland, (MacLeod et al. 2008). A fine-scale study in the Minch Strait (Scotland) detected a degree of habitat segregation or niche partitioning between these 2 species, with *L. albirostris* foraging subsurface and farther from shore than common dolphins, which tended to forage more at the surface (Weir et al. 2009).

Even top predators sometimes are prey themselves. Rake marks, probably tooth marks from killer whales (*Orcinus orca*), were found on 3 of 90 *L. albirostris* in waters near Iceland (Bertulli et al. 2012). Killer whales hunting *L. albirostris* have

been observed in Pentland Firth, Scotland (British Broadcasting Corporation 2012). In their review of killer whale interactions with other marine mammals, Jefferson et al. (1991) recorded no predatory events on *L. albirostris* and 6 nonpredatory interactions of killer whales and *L. albirostris* without specifying locations or other details. In the southern North Sea, 2 harbor porpoise calves were found stranded with scars suspected to originate from *L. albirostris* teeth (Haelters and Everaarts 2011).

Lagenorhynchus albirostris has also been reported in association with seabirds such as thick-billed murres (*Uria lomvia*) in the Barents Sea (Mehlum et al. 1998) and northern gannet (*Sula bassana*) off northwestern Scotland and the Shetland Islands (Evans 1982; Skov et al. 1995). Gannets and murres possibly take advantage of fish herded by the dolphins (Evans 1982; Mehlum et al. 1998).

BEHAVIOR

Lagenorhynchus albirostris, like other delphinids, shows tendencies to form social groups. Most reports are of average group sizes of less than 10 animals (United States and Canada—Cetacean and Turtle Assessment Program 1982; Alling and Whitehead 1987; Kingsley and Reeves 1998; Greenland—Hansen and Heide-Jørgensen 2013; Iceland—Pike et al. 2009; North Sea and United Kingdom—Evans 1992; Kinze et al. 1997; Reid et al. 2003; Weir et al. 2009; Norway—Øien 1996; Barents Sea—Fall and Skern-Mauritzen 2014). Large social groups from Iceland have up to 100 individuals (Pike et al. 2009) and even larger groups are known from the Barents Sea (Fall and Skern-Mauritzen 2014). Off West Greenland, large groups used depths of 300–1,000 m and smaller groups tended to use deeper waters (> 1,000 m—Hansen and Heide-Jørgensen 2013).

Studies of acoustics and hearing in free-ranging *L. albirostris* off Iceland have estimated the 3 and 10 dB beamwidths of the echolocation signals to be 8° and 10°, respectively, significantly narrower than in the bottlenose dolphin (Rasmussen et al. 2004). The echolocation clicks of *L. albirostris* off Iceland have average peak frequencies around 115 kHz with a secondary peak around 250 kHz, and a center frequency at around 82 kHz (Rasmussen and Miller 2002; Rasmussen et al. 2002). Click source level (the effective level of sound intensity) varies from about 190–210 dB re. 1 μ Pa, increasing with the distance to the target (Rasmussen et al. 2002; Atem et al. 2009). The maximum source level recorded is about 219 dB re. 1 μ Pa peak-to-peak (Rasmussen et al. 2002). When socializing, whistles vary in frequency up to 35 kHz (Rasmussen and Miller 2002). Whistles can potentially be used for communication at distances up to 10.5 km (Rasmussen et al. 2006). Hearing studies in 2 captured and restrained dolphins from western Iceland (Nachtigall et al. 2008) revealed highest sensitivities between 45 and 128 kHz. In one dolphin, detection threshold at 152 kHz was at 100 dB and at 181 kHz at 121 dB, indicating that *L. albirostris* has more sensitive high-frequency hearing than any known dolphin. The capability for temporal resolution of sound, when tested in one of

the caught dolphins (Mooney et al. 2009), revealed the dolphin could follow rhythmic clicks up to a rate of about 1,125–1,250 Hz, a similar capability to other odontocetes. Mean pulse rate for supposed communication burst-pulse signals was at 719 Hz (range 423–1,103), with a mean peak frequency of 35.3 kHz (Simard et al. 2008).

Lagenorhynchus albirostris sometimes approaches vessels and rides their bow waves (Jonsgård 1962; de Boer 1989; Evans 1991) and frequently leaps out of the water, often vertically (Sears and Williamson 1982; Katona et al. 1983; Baptist 1987). Although it usually travels at 6–12 km/h, speeds of 30 km/h are known from the North Sea area (Evans and Smeenk 2008). A juvenile male from Faxaflói Bay in western Iceland (Rasmussen et al. 2013) dove to 45 m (mean dive depth: 24 m) in dives up to 78 s (mean: 28 s). More than one-half of the feeding activity seemed to occur at the sea floor.

GENETICS

Moderate variation of mitochondrial as well as nuclear markers in a sample of *Lagenorhynchus albirostris* from the United States and Canada, the United Kingdom, the Netherlands, and northern Norway (Banguera-Hinestroza et al. 2010) indicate a population contraction, possibly during the last glacial epoch. Fernandez et al. (2016) mapped 52,981 nuclear single nucleotide polymorphisms in *L. albirostris* and *L. acutus*. Studies of the mitochondrial genome (Xiong et al. 2009; Vilstrup et al. 2011), mitochondrial and nuclear markers (Harlin-Cognato and Honeycutt 2006; Banguera-Hinestroza et al. 2014), and mitochondrial sequences (Cipriano 1997; LeDuc et al. 1999) show that *L. albirostris* is not related to its putative Pacific and Southern ocean relatives formerly included in the *Lagenorhynchus* genus. It may be the sole extant representative of a long-lasting independent taxon, which is possibly the sister taxon of the remaining Delphinidae, although the studies opening this possibility (Xiong et al. 2009; Vilstrup et al. 2011) did not include *L. acutus* in their study. One study (LeDuc et al. 1999) did not find a close affinity between *L. acutus* and *L. albirostris*, but Harlin-Cognato and Honeycutt (2006) and Banguera-Hinestroza et al. (2014) supported monophyly of the 2 species.

CONSERVATION

Although population size of *Lagenorhynchus albirostris* has been assessed in all centers of distribution, few of the surveys are recent. Also, the results of these surveys come with the caveat related to most abundance assessments of cetacean species: large statistical uncertainties of the estimates. Furthermore, repeated surveys to assess trends in abundance are few. The molecular studies of population structure have not covered the entire range of the species (Banguera-Hinestroza et al. 2010; Fernandez et al. 2016) and the available abundance data refer to areas rather than well-defined populations. *L. albirostris* is listed on Appendix II of

the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Culik 2011; Convention on International Trade in Endangered Species of Wild Flora and Fauna 2014). *L. albirostris* is also listed as “Least Concern” under the International Union for Conservation of Nature and Natural Resources Red List of Threatened Species (Hammond et al. 2012). A decrease has been observed in the rates of sightings and strandings of *L. albirostris* concurrent with increased presence of common dolphins off northwestern Scotland as water temperatures have risen (MacLeod et al. 2005). This has led to concern that as water temperatures rise *L. albirostris* may be displaced by warmer water species in much of its current distribution (MacLeod et al. 2005; Canning et al. 2008; MacLeod et al. 2008). Particularly in northwestern Europe, the area of suitable shelf waters may be dramatically reduced (MacLeod et al. 2005).

Reported concentrations of heavy metals and organic pollutants in *L. albirostris* have been similar to or greater than those found in other cetacean species from the same areas (Andersen and Rebsdorff 1976; Muir et al. 1988; Siebert et al. 1999; van de Vijver et al. 2003; Galatius et al. 2013b). The effects of these concentrations are unknown. However, in the sample of Muir et al. (1988), organochlorine concentrations were well beyond the concentrations associated with reproductive failure in pinnipeds (Helle et al. 1976; Reijnders 1980).

Lagenorhynchus albirostris has been hunted in Canada (Sergeant and Fisher 1957), Iceland (Mitchell 1975), and Norway (Jonsgård 1962). Alling and Whitehead (1987) estimated that 366 *L. albirostris* were taken annually in directed catches along the Labrador coast based on interviews with fishermen in 1982 and *L. albirostris* is still hunted opportunistically in Canada (Lien et al. 2001). Hunting is also done in Greenland, where the reported combined catches of *L. albirostris* and *L. acutus* were 261 and 233 in 2010 and 2011, respectively (Piniarneq 2014). In the Faroe Islands, drive catches for long-finned pilot whales have been conducted for centuries. Among other species, *L. albirostris* is occasionally taken in such drive catches, either in mixed schools with long-finned pilot whales or in single-species groups (Bloch 1996). The reported combined numbers of hunted *L. albirostris* and *L. acutus* in the years 1709–1995 in the Faroes were 5,148 individuals, most of which were *L. acutus* (Bloch 1996). Six dolphins ice-entrapped in Newfoundland were taken to an aquarium in Connecticut, where the last of them died after 101 days (Buck and Spotte 1986). At least 3 specimens were captured off Iceland for live display in Hafnarfjörður Marine Zoo in 1977 (Andrésson 1978). In the North Sea area and the United Kingdom, live-stranded individuals of *L. albirostris* were taken into captivity and in at least 2 instances later released after rehabilitation (Klinowska and Brown 1986; Kastelein et al. 1995; Smeenk 1995; van Elk et al. 2014; Ceta-Base 2015).

Bycatches in pelagic trawls and gillnets are reported throughout the range of *L. albirostris* (Lien 1989; Northridge 1991; Dong et al. 1996; Couperus 1997) but consistently under-reported (Lien et al. 2001). However, because no quantitative assessments of bycatch rate have been made, the impact on

populations remains unknown. Scars or wounds suspected to have resulted from entanglement in fishing gear or marine debris were detected in 15 of 90 photo-identified *L. albirostris* off Iceland (Bertulli et al. 2012), indicating that sublethal conflicts with fisheries also occur.

Like other odontocetes, *L. albirostris* use sound to communicate and echolocate; thus, noise from man-made sources may interfere with behavior and potentially cause physical injury (Southall et al. 2007; Tougaard et al. 2015). Detrimental man-made sound may include explosions, seismic airguns, pile driving, vessels, aircraft, drilling, wind turbines, and active sonars (Southall et al. 2007). Because *L. albirostris* has hearing characteristics similar to those of other dolphins (Nachtigall et al. 2008), it is expected to show similar sensitivities to noise. Like other small odontocetes, *L. albirostris* is behaviorally sensitive to air-gun emissions used for seismic surveys (Stone and Tasker 2006).

Mortality from multiple ice entrapments is known in the northeast Atlantic (Sergeant and Fisher 1957; Muir et al. 1988; Dong et al. 1996) and entrapment is a regular occurrence in Newfoundland, where 21 entrapments of about 350 dolphins were reported from 1979 to 1990, with a known mortality rate of 55% (Lien et al. 2001).

ACKNOWLEDGMENTS

We thank U. Gorter for use of his artwork and G. Brovad and O. Graillot for providing photographs for this account. S. Sveegaard assisted in the creation of the distribution map. The comments of an anonymous reviewer helped improve this account.

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Associate Editor was ROBERT K. ROSE. SERGIO SOLARI reviewed the synonymy. Editor was MEREDITH J. HAMILTON.