

Stenella coeruleoalba (Meyen, 1833)

English: Striped dolphin, blue-white dolphin

German: Blauweißer Delphin

Spanish: Delfín listado

French: Dauphin bleu et blanc, dauphin rayé

Family Delphinidae

1. Description

The species name "coeruleoalba" refers to the pattern of blue/dark-gray and white stripes and blazes along the lateral and dorsal sides of the body. The dorsal cape is muted blue or blueish-grey, usually invaded by a white to light grey spinal blaze. The sides are darker than the belly. Striped dolphins have a long beak, well demarcated from the melon and falcate dorsal fin. In the field, they are most likely confused with common dolphins (*Delphinus delphis*) and other similar-sized species but can be distinguished by their robust body and coloration. The largest recorded specimen was 2.56 m long and the maximum weight recorded was 156 kg. Mean body length in the western Pacific is 2.4 m for males and 2.2 m for females (Archer, 2009).

Striped dolphins show only moderate geographical variation in skeletal morphometrics and little if any geographical variation in pigmentation pattern. However, several authors found slight but significant differences in body size between local populations in the eastern North Atlantic, the northwestern Mediterranean, and the southwestern Mediterranean (Rice, 1998). MtDNA and microsatellite differentiation suggests that NE-Atlantic striped dolphins form a separate population from the Mediterranean population (Garcia-Martinez et al. 1999; Bourret et al. 2007).

2. Distribution

<http://www.iucnredlist.org/apps/redlist/details/20731/0/rangemap>

Distribution of S. coeruleoalba (Hammond et al. 2008; © IUCN): warm temperate, subtropical, and tropical waters around the world.

The striped dolphin is distributed world-wide in tropical and temperate waters. It ranges north in the Atlantic to Newfoundland, northern Scotland, and Denmark; in the Mediterranean Sea; and in the Pacific to the Sea of Japan, Hokkaido, about 40°N across the western and central Pacific, and British Columbia (Canada). The southern limit of its range is in Argentina, Cape Province of South Africa, Southern Australia, New Zealand, and Peru (Archer and Perrin, 1999; Hammond et al. 2008).

Although Perrin et al (1994) stated that it is not a common inhabitant of cold boreal waters as previously claimed, there are coldwater records, e.g. from Greenland and the Faroe Islands, and Syvertsen et al. (1999) and Isaksen and Syvertsen (2002) reported sightings/strandings from the Norwegian and Swedish coasts. Vagrants have even been recorded from Komandorskiye Ostrova (Rice, 1998).

3. Population size

Würsig et al. (1998) assessed cetacean responses to survey ships and aircraft and found that *S. coeruleoalba* moved to avoid the ships in 33% of sightings. This indicates that density estimates for this species may tend to be biased downwards.

In the western Atlantic Ocean, the most recent estimate of abundance for striped dolphins in oceanic waters of the Northern Gulf of Mexico (US EEZ) pooled from 2003 to 2004, is 3,325 animals (CV=0.48) (Mullin 2007). This value is not statistically different from the 1996-2001 estimate of 6,505 (Warring et al. 2009).

In the eastern Atlantic Ocean, the Bay of Biscay population size was estimated at 74,000 animals in 1993 (Goujon, 1996) and more recently at 56 500 (95% CI 29 100-90 400) in 2002 (Certain et al. 2008).

In the central Mediterranean, striped dolphins were the most abundant species (43.5%) observed during surveys (Perrin et al. 1994, Reyes, 1991 and refs. therein). In the waters of the central Spanish Mediterranean coast, 2001 – 2003 estimates yield a mean abundance of 15,778 dolphins (95% CI = 10,940-22,756). This density is comparable to that obtained in the International Ligurian Sea Cetacean Sanctuary (Gomez et al. 2006). In the southern Tyrrhenian Sea around the Aeolian archipelago the 2003 estimate was 4,030 individuals (CV=0.30) (Fortuna et al. 2007).

In the Pacific Ocean, the preliminary 2003 estimate of abundance for the 2001-2005 striped dolphins is 1,470,854 (CV=0.15) animals (Gerrodette et al. 2005). Geometric mean abundance estimate for California, Oregon and Washington waters based on the 2001 and 2005 ship surveys is 17,925 (CV=0.37) striped dolphins (Forney 2007).

A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 10,385 (CV=0.48) striped dolphins (Barlow 2003). This is currently the best available abundance estimate for this stock.

In the western North Pacific, most recent estimates are dated (Hammond et al. 2008) and stem from the 1980's: 570,000 (CV = 0,19) striped dolphins occurred there (Miyashita, 1993). Two areas of concentration were identified, comprising about 52,682 animals (CV = 95%) between 20° and 30°N and around 497,725 (CV = 18%) animals between 30° and 40°N. Relatively few striped dolphins (about 19,631; CV = 70%) were present in the nearshore waters off Japan. However, there is clear evidence that there has been a decline since the 1950's as a result of stock depletion by over-hunting (Kasuya 1999). They are uncommon in the Sea of Japan, East China Sea and Ryukyuan waters (Reyes, 1991).

There is very little data from other areas of distributional range: Ballance and Pitman (1998) found that *S. coeruleoalba* was the second-most abundant species sighted in the western tropical Indian Ocean (14% of all cetaceans, compared to 33% for the eastern tropical Pacific and 10% for the Gulf of Mexico). Striped dolphins are also reported from the coast of Angola (Weir, 2007).

4. Biology and Behaviour

Habitat: Striped dolphins are pelagic animals. In the Pacific waters off Japan, they are found in three geographical aggregations in the summer, between 20 and 42 °N. Occurrence is seasonal in the northern part of the range (Toshio 1999). In the eastern Pacific, they prefer

areas with large seasonal changes in surface temperature and thermocline depth and with seasonal upwelling (Reyes, 1991).

In western North Atlantic waters, striped dolphins seem to be confined to the Gulf Stream or the waters off the continental slope (Davis et al. 1998). Along the Mid-Atlantic Ridge from Iceland to the Azores they inhabit warmer (12-22 °C) and more-saline (34.8-36.7 psu) waters in the south (Doksaeter et al. 2008). In the eastern North Atlantic, as well as off South Africa they are found in deep water (greater than 1,000m) past the continental slope (Perrin et al. 1994 and refs. therein). In the Strait of Gibraltar and in the Mediterranean they prefer waters of 600 m or more depth (Hashmi, 1990; Reyes, 1991; Bourreau and Gannier, 2003).

Schooling: Schools are of varying size and composition. Of 45 schools examined from off the coast of Japan, most (86%) contained fewer than 500 individuals. The mean school size was 101 animals. Schools moving south with the retreating front of the Kuroshio Current are larger than those moving north earlier in the year. Schools in the eastern North Atlantic more commonly have 10–30 individuals and rarely reach the hundreds. In the western Pacific, three major types of schools are recognised: juvenile, adult and mixed, the latter being divided into breeding and non-breeding schools. Juvenile schools may migrate closer to the coast than adult and mixed schools. Calves remain in adult schools until 1 or 2 years after weaning and then leave to join juvenile schools (Perrin et al. 1994 and refs. therein).

Food: Feeding depth may extend to below 200m and down to 700m (Archer, 2009); 75–80% of the prey in the Japanese and South African material had organs of luminescence. Individual fish in the stomachs of the animals captured off Japan ranged in length from 60 to 300mm (Perrin et al. 1994 and refs. therein; Santos et al. 2001a, 2001b). Myctophid fish predominate in specimens from Japan and South Africa whereas in dolphins stranded on the Mediterranean coasts of France, Spain, and Italy, cephalopods dominate in the stomach contents. Blanco et al. (1995) found that the cephalopods *Albraliopsis pfefferi*, *Onychoteuthis banksii*, *Todarodes sagittatus* and *Brachioteuthis riisei* were dominant in stomach samples from the western Mediterranean. In the eastern Mediterranean Sea off the Turkish coast, the cephalopod *Abralia veranyi* was the most common prey (51.2% of all the beaks found in this species), followed by *Onychoteuthis banksii* and *Heteroteuthis dispar*. The stomachs also contained remains of fish and shrimp (Öztürk et al. 2007).

In the oceanic waters of the Northeast Atlantic, the diet was found to be primarily composed of fish (39% by mass) and cephalopods (56%) and less of crustaceans (5%). The most significant fish family identified was the lanternfish (24%). The oceanic squid *Teuthowenia megalops* and *Histioteuthis* spp. were the most significant. The pelagic shrimp *Sergastes arcticus* and *Pasiphaea multidentata* were the most prevalent crustaceans. Prey sizes ranging from 30 to 170 mm accounted for 80% of the prey items, while 80% of the reconstituted biomass consisted of prey measuring between 60 and 270 mm. Prey composition and size-range differed slightly with sex and age or body size of the dolphins. The state of digestion of food remains suggested that predation took place at dusk or during the early hours of the night (Ringelstein et al. 2006). In the Bay of Biscay striped dolphins are able to shift from vertically migrating meso-pelagic prey to neritic or coastal prey types (Spitz et al. 2006). The diet of striped dolphins also varies according to food availability both in terms of quantity and composition, reflecting changes in the relative abundance of fish species (Spiz et al. 2003).

5. Migration

While in some regions (e.g. portions of the US east coast) striped dolphins are encountered in all seasons, they elsewhere appear to be associated with the fronts of warm oceanic currents that move seasonally and produce sporadic warm-water intrusions and meanders. In Japanese waters, the species is associated with the northern boundary of the warm Kuroshio Current, which extends up to 46°N in the summer and retreats to 33°N in the winter. It appears earlier in the season than *S. attenuata*, consistent with the hypothesis that the latter is the more tropical (Perrin et al. 1994 and refs. therein). Striped dolphins approach the coast in September and October and move southward along the coast, apparently dispersing into the East China Sea for the winter. In April they return along roughly the same route, but farther offshore. Eventually they leave the coast to summer in the pelagic North Pacific. Segregation by age is observed (Reyes, 1991).

Seasonal movements may also occur in the Mediterranean. The dolphins move towards the northern part of the basin as the sea surface temperatures in the southern part increase. Between the French mainland and Corsica, data obtained 2001 – 2004 show that relative abundance peaks in May and September, while a consistent minimum is obtained from December to April (Laran and Drouot-Dulau, 2007). Sighting data also suggest seasonal movements of this species in the eastern tropical Pacific (Perrin et al. 1994; Reyes, 1991 and refs. therein).

In the Ligurian Sea of the French Riviera, there are also diurnal offshore-inshore movements. Night acoustic results show the presence and intense feeding activity of striped dolphins close to the shelf break. Day distribution shows a marked preference for the open sea (Gannier, 1999).

6. Threats

Direct catch: The largest direct catches have been taken in Japanese waters, in drive and hand-harpoon fisheries at several locations. The catches were voluntarily reduced beginning in 1981 and have since varied between 358 (in 1987) and 4,883 (1981), averaging 2,830 during the period 1981-89. Between 1989 and 1993, the average annual catch was 1,028.

Kasuya (1999) reported that Japanese multispecies dolphin fisheries now receive an annual quota of 725. Ten years later, striped dolphins continue to be caught in Japan. In the Wakayama prefecture, 86 were landed by hand-harpoon and 384 by driving fisheries in 2007. The quota for 2007/2008 was set at 685 dolphins (Iwasaki, 2008). Fragmented information on morphology, life history, pollutant levels and genetics suggests that the striped dolphins taken by Japanese fisheries are from more than one population, with varying proportions among fisheries and perhaps over time (Kasuya, 1999).

Striped dolphins are also taken in the drive fishery at Malaita in the Solomon Islands and in the harpoon fishery for small cetaceans at St Vincent. Other such small indigenous fisheries may exist elsewhere. Small numbers were taken by French and Spanish fishermen for human consumption in the Mediterranean (Perrin et al. 1994 and refs. therein; Jefferson et al. 1993).

In the Northeast Atlantic, striped and common dolphins were harpooned to supply food for consumption on board or to scare them away from tuna trolling lines. It is difficult to ascertain the number of dolphins taken in this way, but it has been estimated in the thousands (Reyes, 1991).

Incidental catch: Incidental catches are known to occur in gillnets in the north-eastern Indian Ocean, in tuna purse seines in the eastern tropical Pacific, in fisheries in the northeastern Atlantic, in drift nets, purse seines and other gear in the Mediterranean, in various gear off the coast of Japan, and in drift gillnets in the North Pacific, and probably occur in similar fisheries in tropical and warm-temperate waters around the world. Although rare, striped dolphins have also been caught in shark nets in Natal and South Africa (Perrin et al. 1994 and refs. therein).

Recently, the Inter-American Tropical Tuna Commission estimated that 6 striped dolphins were caught as by-catch in the 2007 purse-seine tuna fishery (IATTC, 2009). There has been no reported fishing-related mortality during 1998-2006 in the US waters of the Northern Gulf of Mexico or off the northeast U.S. coast (Warring et al. 2009). Similarly, no striped dolphins were observed killed in the most recent five-year period in eastern Pacific US waters (Carretta et al. 2009).

Elsewhere, the news are less good. Despite a UN moratorium on the use of drift-nets in the high seas and a ban in the Mediterranean by all European Union countries, some fisheries continue to operate illegally. In 2002 and 2003 line-transect surveys conducted in the southern Tyrrhenian Sea around the Aeolian archipelago estimated the striped dolphin by-catch as 36 by-caught animals over a period of only 12 days. These results are a cause for concern (Fortuna et al. 2007). According to international official sources, Morocco harbors the bulk of this fleet in the Mediterranean. Between 2002 and 2003 the driftnet fleet targeting swordfish (*Xiphias gladius*) based in Al Hoceima (Alboran Sea) consisted of at least 177 units with estimated average net length ranging from 6.5 to 7.1 km. This fleet causes estimated by-catch mortality of 3,110-4,184 common and striped dolphins per year, and annual take rates exceed 10% of their population sizes in the Alboran Sea (Tudela et al. 2005).

Antoine et al. (2001) estimated that by-catches in the tuna drift-net fishery in the Northeast Atlantic were to 90% composed of *Delphinus delphis* and *S. coeruleoalba*. Mean catch rate by trip in the years 1992–1993 were 4.7 striped dolphins per km of net and per day. Such rates are similar to those estimated in other driftnet fisheries. Goujon (1996) estimated the annual additional mortality linked to the driftnets in the Bay of Biscay albacore tuna fishery to 1.8% for the striped dolphin (this estimate must be increased by 30% in order to take into account the whole European albacore tuna driftnet fishery). The extrapolated decadal scale data from Irish and other driftnet fleets operating in this area suggest that during the period 1990-2000, a minimum of 12,635 (10,009-15,261) striped dolphins were killed as by-catch (Rogan and Mackey, 2007). Unfortunately, acoustic deterrents developed for harbour porpoise (*Phocoena phocoena*) show no effect on striped dolphins (Kastelein et al. 2006).

In the Southwest Atlantic, off Brazil, by-catch of *S. coeruleoalba* was also noted (Zerbini and Kotas, 1998).

Pollution: Contaminants have been studied more intensively in this species than in any other cetacean. A long series of papers has reported the levels, accumulation rates, distribution, relationships and transfer dynamics of organochlorine compounds and heavy metals in striped dolphins taken in the Japanese drive fishery or washed ashore as by-catch in the Mediterranean.

In Japanese samples, increasing trends of PBDEs and HBCDs were observed, suggesting a growing pollution in Japan and surrounding countries in recent years (Isobe et al., 2009).

In European waters, decreasing lead concentrations in tissues reflect the decrease in the production of alkyl lead and the increasing use of unleaded gasoline (Caurant et al., 2006). Similarly, concentrations of PCBs, DDT and its metabolites have slowly decreased, although the decline in PCB has been steeper than that of DDT, suggesting that the offshore marine environment has not been exposed to significant releases of these contaminants in recent years (Aguilar and Borell, 2005; Wafo et al., 2005). However, the detected levels reflect the ubiquity and environmental persistence of these compounds.

Other studies revealed high levels of mercury in striped dolphins from the Ligurian, Adriatic, and Tyrrhenian Seas (Cardellicchio, 2000). Monaci et al. (1998) found that mercury levels were higher in tissues from animals stranded on the Italian coasts and in skin biopsies obtained in the Tyrrhenian and Ligurian Seas than in the respective Spanish samples. This is probably related to Hg pollution from the natural weathering of cinnabar ores in central Italy. Geographical differences in trace-element accumulation patterns may also reflect the existence of two different populations of *S. coeruleoalba* in the western Mediterranean.

According to Aguilar (2000) tissue levels of organochlorine compounds, some heavy metals and selenium are high in Mediterranean samples and exceed threshold levels above which detrimental effects commonly appear in mammals. However, apart from the indication that these levels may have acted as triggering factors in the 1990-1992 epizootic by depressing the immune system of diseased individuals and potential lesions in the ovaries, no information on pollutant-related effects is available.

Noise pollution: Observations undertaken during seismic surveys employing airguns in UK and adjacent waters show a clear effect on several dolphin species. Small odontocetes showed the strongest lateral spatial avoidance (extending at least as far as the limit of visual observation) in response to active airguns (Stone and Tasker, 2006). In 2005, there was a series of stranding events throughout Taiwan, involving several species including striped dolphins, which was linked to navy exercises using sonar (Wang and Yang, 2006).

Overfishing: The European anchovy is the most heavily exploited pelagic resource in the Mediterranean, where some other stocks of pelagic fish are already over-exploited. Since striped dolphins are reported to eat anchovies and sardines in the area, this could eventually become either a source of conflict with the commercial fisheries or a potential threat for dolphin populations (Reyes, 1991). The 1990-1992 epizootic devastated the whole Mediterranean population; over one thousand corpses were examined in the western Mediterranean alone, but the toll was probably much higher. The causative agent of the die-off was a morbillivirus, but the effect of some pollutants and decreased food availability were suggested as triggering factors. Depletion of fish and cephalopod resources is widespread in the Mediterranean and, given that the diet of striped dolphins includes commercial species, this undoubtedly has a potential for limiting population numbers (Aguilar, 2000).

7. Remarks

Range states (Hammond et al., 2008) :

Algeria; American Samoa; Anguilla; Antigua and Barbuda; Aruba; Australia; Bahamas; Bangladesh; Barbados; Belize; Benin; Bermuda; Brazil; British Indian Ocean Territory; Brunei Darussalam; Cambodia; Cameroon; Canada; Cape Verde; Cayman Islands; China; Cocos (Keeling) Islands; Colombia; Comoros; Congo; Congo, The Democratic Republic of the; Cook Islands; Costa Rica; Côte d'Ivoire; Cuba; Cyprus; Denmark; Djibouti; Dominica; Dominican Republic; Ecuador; El Salvador; Equatorial Guinea; Ethiopia; Fiji; France; French

Guiana; French Polynesia; Gabon; Gambia; Germany; Gibraltar; Greece; Greenland; Grenada; Guadeloupe; Guam; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; Hong Kong; India; Indonesia; Iran, Islamic Republic of; Ireland; Israel; Italy; Jamaica; Japan; Kenya; Kiribati; Kuwait; Liberia; Madagascar; Malaysia; Maldives; Marshall Islands; Martinique; Mauritania; Mexico; Micronesia, Federated States of; Monaco; Morocco; Mozambique; Myanmar; Namibia; Netherlands; Netherlands Antilles; New Caledonia; New Zealand; Nicaragua; Nigeria; Niue; Northern Mariana Islands; Oman; Pakistan; Palau; Panama; Papua New Guinea; Peru; Philippines; Pitcairn; Portugal; Puerto Rico; Qatar; Saint Helena; Saint Kitts and Nevis; Saint Lucia; Saint Pierre and Miquelon; Saint Vincent and the Grenadines; Samoa; Sao Tomé and Príncipe; Senegal; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Spain; Sri Lanka; Suriname; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; Turks and Caicos Islands; United Arab Emirates; United Kingdom; USA; Uruguay; Venezuela; Viet Nam; Virgin Islands, British; Virgin Islands, U.S.; Wallis and Futuna; Western Sahara; Yemen

S. coeruleoalba is categorised as "Least Concern" by the IUCN (Hammond et al. 2008). The species is listed in Appendix II of CITES. The eastern tropical Pacific population and the Mediterranean populations are included in Appendix II of CMS. However, observations off the coast off Japan also indicate migratory behaviour in these waters. Range states concerned in these waters are Japan, North and South Korea, the Peoples Republic of China and Taiwan (see Perrin et al. 1996 in Appendix 2). Therefore, it is recommended that the West Pacific Stock also be included in Appendix II of CMS.

To date, striped dolphins have faced relatively few threats compared with other small cetacean species, although very little is known about the species in some areas. However, some discrete populations are affected either by both direct and indirect catches or by habitat encroachment. In particular the direct catches off the Pacific coast of Japan are a matter of concern, as was expressed by the International Whaling Commission. The levels of contamination in the Mediterranean Sea, coupled with the increasing incidental catches in the driftnet fishery and reduced prey availability represent the major threats for this and other cetacean species in the area.

8. Sources

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