Montenegro Dolphin Project Annual Report on

Bottlenose dolphins and Striped dolphins: Species distribution, behavioural patterns, encounter rates, residency patterns and hotspots in Montenegro, South Adriatic

2016-2017

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Marine Mammals Research Association *in partner with* **Natural History Association of Montenegro**

Foreword

Marine Mammal Research Association, a non-profit organisation based in Turkey, aims to monitor marine mammal populations in the coastal waters of the Eastern Mediterranean Sea and Adriatic Sea. The Montenegro Dolphin Project was established in September 2016, in partnership with the Natural History Association of Montenegro, becoming the first long term research study on cetacean populations in Montenegrin waters. The project received an important contribution from the Rufford Small Grant Foundation. Our purpose, together with Natural History Association of Montenegro, is to identify the population status, distribution patterns and main threats to cetaceans in order to fill in scientific knowledge gaps and help implement effective conservations actions, while also promoting awareness of nature conservation initiatives.

When it comes to the protection of wildlife, nothing is as essential and effective as a joint effort. From the mountains to the deep seas, human impact on animal survival has dramatically increased and is now more substantial than ever before. The Adriatic Sea and its nature are no exception. Transboundary collaborations represent the only successful tool for implementing sustainable and effective conservation strategies, particularly for those species whose persistence relies on migration and, thus, the absence of boundaries. For this specific reason, any requests to access the data presented here for research and conservation purposes are welcomed and should be made in writing to the Montenegro Dolphin Project, email: info@dmad.org.tr and/or drustvoprirodnjakacg@gmail.com.

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SUMMARY

Summary

The Montenegro Dolphin Project ran the first dedicated annual survey effort within the coastal and offshore waters of Montenegro between 2016 and 2017, with plans to keep the survey effort going until 2020. The results presented here contribute to fill the gaps in knowledge and provide baseline information on the cetaceans of Montenegro. We urge management authorities to implement necessary in-field conservation measures for the protection of cetaceans that must lead to the protection of the whole marine ecosystem. During the current study, regular sightings of bottlenose dolphins and striped dolphins were recorded throughout the year. The encounter rate of bottlenose dolphins was estimated at 4 groups (9 individuals) per 100 km^2 for the entire country. Additionally, photo identification study of bottlenose dolphins revealed multi-year sightings of individuals with varying degrees of residency patterns, ranging from transient to regular individuals. Several individuals were noted to travel from the southern to the northern edge of Montenegro, and vice versa, with a maximum re-sighting distance of 80 km. Sub-adult presence in the groups was also frequently recorded. Furthermore, Montenegro's southern and northern waters, revealed high incidence of key behaviours: foraging, socialising and resting. While the coastal waters of Montenegro hold important habitats both for bottlenose and striped dolphins, offshore waters need to be monitored more frequently for the delineation of likely important cetacean habitat. It is important to note that the effect of tourism and marine traffic both on the dolphin sightings and behaviour was reported, yet no significant pressure effect was found here. Nevertheless, human pressure on the marine ecosystem should not be ignored. Currently there are over 100 gas and oil extraction platforms in the whole basin, with many more on the way, especially around the Southern Basin. Additionally, coastal tourism has become one of the most significant sources of income in the last decades. Moreover, pressure from unregulated fishery activities and maritime transportation, both on local and international scales, has increased over the same timescale. According to the Convention for Biological Diversity, Montenegro lies in the Ecologically or Biologically Significant Areas (EBSA). Yet, Montenegro holds no Marine Protected Areas in its waters and proposed SPAMI sites (Specially Protected Areas of Mediterranean Importance) doesn't cover the territorial waters of Montenegro. The majority of Adriatic countries have legislative frameworks to regulate anthropogenic activities with potential impact on cetaceans, including Montenegro. The gap in baseline data, in addition to public ignorance towards nature conservation, forms one of the strongest obstacles to effective and sustainable conservation measures. The results of the current study aim to build a solid foundation for marine conservation in Montenegro via the of bridging research and public education, while emphasising the strong need for collaboration between research institutes both on the local and international scale.

Content

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Introduction

CETACEA

Marine wildlife research and awareness activities, particularly in regards to cetaceans, have increased significantly in recent years (Jefferson et al, 1993). They have harnessed aquatic ecosystems from the poles to the equator and through a range of habitats from freshwater river systems, estuaries and intertidal zones, to the deep ocean (Hocking et al., 2017; Parsons, 2013). Cetaceans are large scale consumers and do so at almost every trophic level, feeding on a range of other organisms from large marine mammals to plankton (Parsons et al., 2013). Thus, they play a prominent role in engineering their ecosystems through activities such as, acting as nutrient distributors and as 'biotubators'- influencing invertebrate community structures (Hocking et al., 2017).

Currently there are over 88 cetacean species recognized (Society For Marine Mammalogy, 2016), divided in to two suborders: the *Odontocetes* and *Mysticetes* (The Marine Mammal Center, 2017; Parsons et al., 2013). Mysticetes, also called Baleen whales, are the largest of all the marine mammal families, contained within it is the largest and heaviest animal species globally, the blue whale (*Balaenoptera musculus*), belonging to the Rorqual family (Balaenopteridae) (Jefferson et al., 1993; Goldbogen et al., 2011). They are classified in 4 families (Jefferson et al., 1993) and count 14 distinct species (Society For Marine Mammalogy, 2016). The name *Mysticeti* means 'moustached whale', referring to the hundreds of baleen plates descending from their upper jaw which they have instead of teeth. They have two blowholes and their body size is generally larger than 6 meters (Carwardine, 2002). When foraging, *Mysticetes* dive to various depths for different periods of time. The gray whale (*Eschrichtius robustus*) dives in depths ranging from less than 10-80 m with an average duration of 3-4 minutes when foraging (Würsig et al.,1986), while the blue whale can dive up to 200 m deep (Croll et al.,2001). Moreover, these marine mammals are also known to be the longest lived animals, with the oldest, a bowhead whale (*Balaena mysticetus*) aged 211 that was killed by whalers in Alaska. This was a premature death and therefore this whale could have gone onto live longer (Parsons et al., 2013).

Odontocetes describe toothed whales and comprise over 70 distinct species with 9 classified families (IWC, 2016). Most cetacean species can be listed within this large taxonomic group as it contains all dolphin and porpoise species. These cetaceans are generally small to medium-sized (Jefferson et al., 1993), except for species such as the sperm whale (*Physeter microcephalus*), which is the largest member of the toothed whales and can reach lengths of up to 18 m (Reid et al., 2003; Parsons at al., 2013). Conversely, the smallest member of this group is the most endangered cetacean species on earth, the Vaquita (*Phocoena sinus*), a species of porpoise measuring only 1.5m (Parsons et al., 2013). A very distinguishing feature of odontocetes is the presence of teeth, even if in some species, the teeth are not visible as they are buried in the gum or jawbone like in some female beaked whale species (Carwardine, 2002; Jefferson et al., 1993) and moreover, this suborder only possesses a single blowhole (Carwardine, 2002). When foraging, odontocetes are capable of deeper and longer dives than Mysticetes. Sperm whales can hold their breath for over 2 hours and dive to depths of 1200 m or more (Watkins et al.,1993). Although beaked whales (*Ziphiidae*) are the least known of all cetaceans, the deepest dives recorded are of the Cuvier's beaked whale (*Ziphius cavirostris*), reaching almost 3000 m (Schorr et al., 2014). The largest and most diverse family within the *Odontocetes* is the *Delphinidae* with 36 currently recognized species (IUCN, 2017), which includes inter alia 6 toothed whales (Carwardine, 2002).

MEDITERRANEAN SEA

The Mediterranean Sea is the largest semi enclosed European Sea, almost completely landlocked by the coasts of Europe, Africa and Asia. 22 countries occupy the Mediterranean coast with a total population size of about 480 million people. One third of this is concentrated along its coastline of 46,000 km (NOAA, 2009). It has an average depth of 1,460 meters (deepest point 5,267m) and occupies an area of approximately 2,500,000 km^2 (excluding the Black Sea) (Coll et al., 2012).

Narrow straits and gulfs are connecting the Mediterranean Sea with the Atlantic Ocean, the Black and Red Sea (Coffey, 2001). In the West, the Strait of Gibraltar between Morocco and Spain enables the exchange of water between the Atlantic and Mediterranean waters. The channel extends over a width of about 13 km at its narrowest point (Salah & Boxer, 2010) and reaches an average depth of 365 m (Walle et al., 1993). In the Northeast, the Dardanelles connect the Mediterranean Sea with the Sea of Marmara which in turn is connected to the Black Sea. Lastly, the Suez Canal links the Mediterranean Sea with the Red Sea (Amblàs et al., 2004)

Geographic sub-areas
The Mediterranean can be separated into several main and sub-divisions (Figure 1). The strait of Sicily is a submarine ridge 365 meters deep (Salah & Boxer, 2010) dividing the Mediterranean Sea into a western (0.85 million km^2) and eastern (1.65 million km^2) basin (Coll et al., 2010). The western part is connected to the Atlantic Ocean by the Strait of Gibraltar, the most western point of the Mediterranean Sea. Entering from the Atlantic, the first sub-region to the Mediterranean is the Alboran Sea, bordered by the coasts of Morocco and Spain, followed by the Baleric Sea, in which the Baleric Islands are located in the centre. South of the Baleric Sea, the Algerian and Tunisian waters can be found. On the southern coast of France, the Gulf of Lions links the Northern Baleric Sea with the French mainland and east of here, are the islands Corsica and Sardinia. The Ligurian Sea connects Northern Corsica and the Italian mainland and in addition, along the western Italian peninsula, bordered by Corsica, Sardinia and Sicily the Tyrrhenian Sea is located (Coll et al., 2010).

Crossing the Strait of Sicily eastwards, the Eastern basin begins. The deepest Mediterranean point of 5.267 m can be found in the Ionian Sea, arching from the Strait of Sicily in the west, over the Strait of Otranto in the north and to the Levantine Sea in the east (Amblàs et al., 2004). The Adriatic Sea is bordered by the coasts of Italy, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro and Albania, and is located North of the Ionian Sea, connected by the Strait of Ortranto. A submarine ridge between Crete and Libya's shore sets the border between the Ionian and Levantine Sea in which Cyprus is located to the south of the Turkish mainland. Lastly, north of the Levantine Sea the adjacent Aegean Sea can be found where multiple islands of the Grecian archipelago are located; Crete represents the division between these two Mediterranean sub-regions (Coll et al., 2010; Salah & Boxer, 2010).

Figure 1 The Mediterranean Sea with depth contours and submarine features (Encyclopædia Britannica, Inc., 2016).

Nutrients, temperature & salinity

The basic geologic conditions play a prominent role in the general environmental features. Both the eastern and western basins exhibit characteristic differences determined by strong environmental conditions (Zenetos et al., 2002). The Mediterranean Sea is oligotrophic, where the water is generally poor in nutrients but rich in oxygen with an eastward increase; therefore, the eastern basin is more oligotrophic than the west. Also, the annual sea surface temperature varies strongly seasonally, increasing from west to east. In the western basin, average surface temperatures, recorded in the Strait of Gibraltar, vary from 15°C in winter to 21°C in summer; however they range from 16°C in winter to 26°C in summer in the Eastern Levantine Sea. Moreover, surface salinities show an eastward increase; from a measured 36.2 % in the Strait of Gibraltar to 39 % in the Levantine Sea. In deeper layers, in depth zones of 200 to 1.000 m, salinities (38.2 % in the west to 38.9 % in the east) and temperatures (13.5°C in the west to 14.9°C in the east) show a smaller range compared to the surface measurements in summer (Zenetos et al., 2002).

Circulation & currents

The gradients of salinity and temperature affect the thermohaline circulation system in the Mediterranean basin. A driving contributor of this is the inflow of Atlantic water through the Strait of Gibraltar (UNEP/MAP, 2012). The pressure created causes Atlantic water to flow from the Strait of Gibraltar across the Mediterranean Sea along the northern African coast. This water is cool, and low in salinity, but increases in temperature as it flows east. This current is a main and constant part of the system determining the Mediterranean circulation. When the water, transported in the current, reaches the eastern half, it increases in salinity and therefore sinks in the Levantine Sea from where it circulates towards the west and exits the Mediterranean through the Strait of Gibraltar into the Atlantic (Coll et al., 2010; Salah & Boxer, 2010).

Biodiversity

The level of biodiversity in the Mediterranean Sea is regarded as very high; it is estimated that approximately 17.000 marine species occupy the Mediterranean as their home (ODEMM, 2011; UNEP/MAP, 2012). This region is one of the planet's biodiversity hot spots considering its richness of flora and fauna. The millions of years of evolution and geology and the unique climate and hydrology of the Mediterranean Sea were pointed out as being the main reasons for the high level of biodiversity (Bianchi & Morri, 2000). The proportion of endemic species (20 to 30%) is relatively high compared to the other world's marine environments (UNEP/MAP, 2012). Additionally, the connections to the Atlantic Ocean and Red Sea affects the Mediterranean's biodiversity with more than 50% of the marine species originally native to the Atlantic and approximately 17% from the Red Sea (UNEP/MAP/RAC/SPA , 2010; UNEP/MAP, 2012).

An array of marine mammal fauna, with a total of twenty-eight species, are known to occur or have occurred in the area (Nortabartolo di Sciara, 2016); however, today 12 species are recognised, including a single seal species (the Mediterranean monk seal, *Monachus monachus*) and 11 cetacean species; bottlenose dolphin (*Tursiops truncatus*), striped dolphin (*Stenella coeruleoalba*), short-beaked common dolphin (*Delphinus delphis*), long-finned pilot whale (*Globicephala melas*), Risso's dolphin (*Grampus griseus*), Cuvier's beaked whale (*Ziphius cavirostris*), sperm whale (*Physeter macrocephalus*), killer whale (*Orcinus orca*), rough-toothed dolphin (Steno bredanensis), fin whale (*Balaenoptera physalus*) and minke whale (*Balaenoptera acutorostrata*)(Bianchi & Morri, 2000; Coll *et al*., 2010; IUCN, 2012; UNEP/MAP, 2012; Notarbartolo di Sciara, 2016). In regard to the cetacean presence, it was assumed that the western Mediterranean Basin showed a higher cetacean abundance than the eastern part (Coll et al., 2010), however recent studies pointed out that this could be linked to the lack of survey effort in the eastern basin than the actual cetacean distribution (Bearzi et al., 2008; Baş et al., 2016).

The Adriatic Sea

The Balkan and Italian mainland border the Adriatic Sea, the most northern arm of the Mediterranean Sea. The Strait of Otranto is the connection between the semi-enclosed Adriatic Sea and the Ionian Sea in the Eastern Mediterranean. This elongated basin reaches a length of 783 km and an average width of 170 km, stretching over a total surface area of 138,595 km^2 (Blake & Topalović, 1996). Bordered by Italy, Croatia, Slovenia, Bosnia-Herzegovina, Montenegro and Albania, the Adriatic coastline extends over 7.373 m (7.912 m including the coastlines of any islands). The semi-enclosed sea can be divided into three general geographic areas: The Northern, Central and Southern Adriatic (Blake & Topalović, 1996; Gacic et al., 2001).

Division & depths of the Adriatic

The three major regions differ in characteristics (UNEP/MAP RAC/SPA, 2015). The Adriatic has an average depth of 252 m and shows a gradient of increasing depth towards the south. Hence, the northern part is very shallow and does not exceed a depth of 100 m, whereas it reaches a maximum depth of 1,233 m in the south (Blake & Topalović, 1996). In the Central Adriatic, a maximum depth of 280 m can be found in the Jabuka Pit (Blake & Topalović, 1996; Grbec et al., 1998). This intricate subsidence, located between the Italian and Croatian coasts, is characteristic for the Central Adriatic region and embodies an important and highly productive region for fish life (Silva et al., 2014). Further southwards, the Palagruža (Pelagosa) Sill separates the central Adriatic from the southern (Cushman-Rosin et al., 2001). The sea reaches its maximum depth of 1,233 m in the South Adriatic Pit (Grbec et al., 1998) (Figure 2).

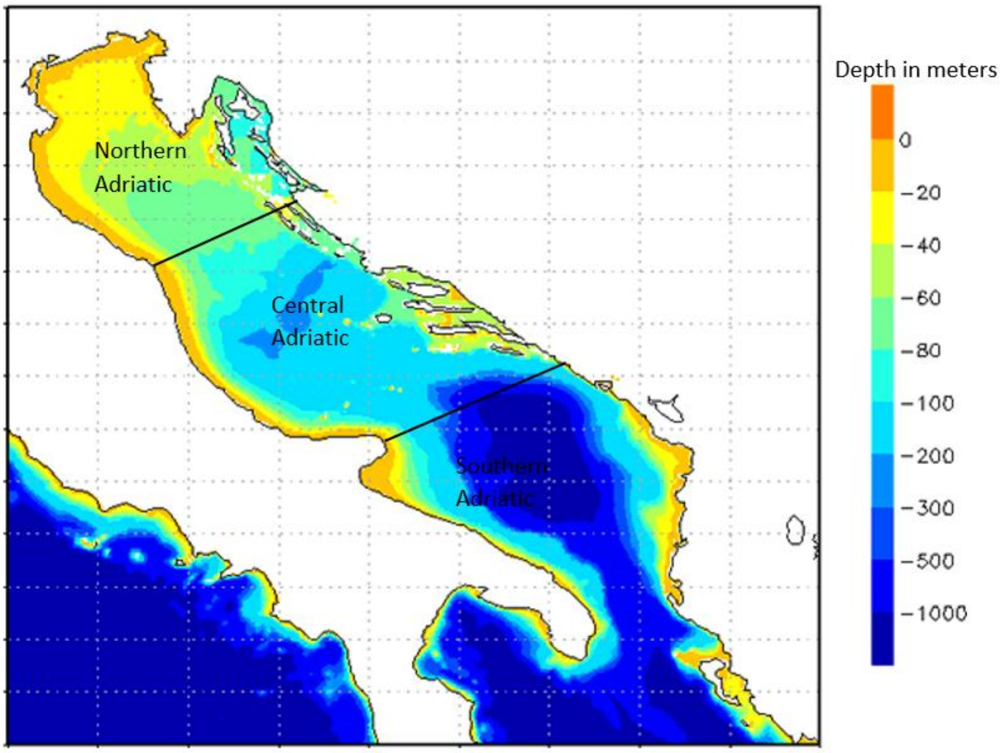

Figure 2 Bottom topography and division of the Adriatic Sea (Oceanlab, 2017; Meteorological and Hydrological Service, 2017).

Circulation, current, tides and salinities

The Adriatic water circulation is determined by two main coastal currents; the Western and Eastern Adriatic Currents, in addition to three gyres situated in the north, above the central and southern region of the Adriatic. These movements generate a counter clockwise circulation with three closed cells in the southern, central and northern areas which are affected by and border the gyres (Artegiani *et al.*, 1997; Cushman-Rosin *et al.*, 2001). Additionally, the Adriatic Sea exchanges its entire volume of water into the Mediterranean through the Strait of Otranto every three to four years. This period is considered to be relatively very short when considering the collective interplay of the riverine input and submarine groundwater discharge (Franic, 2005). Lastly, tidal levels and salinities are closely linked to the geographic regions and decrease and increase with cardinal directions: The Northern area is characterized by higher tide levels of 50 cm and a salinity of 38%, the southern tidal levels ranges around 15 and 20 cm and has slightly higher salinities from 38-39 % (Blake & Topalović, 1996).

Seasonal influence

The Adriatic ocean shows substantial seasonal characteristics: cold water sinks down to the deeper zones in winter, high precipitation and river runoff takes place in autumn and spring, and the surface water warms up significantly in summer (Artegiani et al., 1997; Cushman-Rosin et al., 2001). Likewise, mean temperatures at the surface vary throughout the seasons from about 10°C in February to approximately 23°C in August, and even up to 27°C in shallow bays (Blake & Topalović, 1996). Deep water temperatures fluctuate between 11°C and 14°C (Salah & Boxer, 2010). The open sea is usually warmer than the coastal waters in the east. In general, the Adriatic waters are regarded as “temperate warm” and have a “relatively high” salinity (Cushman-Rosin et al., 2001).

Biodiversity

Adriatic Sea is pinpointed as a biodiversity hot spot, with 49% of the Mediterranean species inhabiting its waters (Coll et al., 2010; UNEP/MAP, 2012). The relatively small area offers multiple variations of ecosystems. Its isolated and semi-enclosed location is probably responsible for its relatively high number of endemic species and level of biodiversity (Coll et al., 2010). That being said, the population sizes of the species found is relatively low (Por & Dimentman, 2006). Studies found 300 species of algae, 40 species of sponges, 150 species of crustaceans, 340 species of molluscs, and almost 400 species of fish, with 3 species of marine turtles and several marine mammal species in the Adriatic waters (Regner et al., 2003). The majority of these species have been recorded in the areas up to a depth of 200 m (littoral zone) and some in the transition zone to the bathyal zone (Regner et al., 2003). Many of these species inhabiting the Adriatic, including Montenegro, are considered as endangered, threatened, or vulnerable and hence, have to be protected more adequately by the countries bordering the Adriatic Sea (Markovic, 2008; Coll et al., 2010).

Montenegro

Montenegro is located on the east coast of the Southern Adriatic Sea, with a coastline of 293 km (UNDP, 2008). The country occupies a surface area of approximately 13,812 km^2 and is bordered by Bosnia-Herzegovina, Serbia, Albania and Croatia. 19% of the total Montenegrin population inhabits coastal regions (Šćepanović et al., 2013). This coastline is characterised by multiple rocky cliffs and beaches, which cover 73 km of the total coastline (UNEP/MAP, RAC/SPA & IUCN-Med, 2014). There are 13 islands, four of which are situated along the southern coast and nine in the Boka Kotorska Bay in the north (Šćepanović et al., 2013). The semi-enclosed Boka Kotorska Bay extends over 107 km and contains an area of water approximately 87 km^2. The intricate shape consisting four coves and specific environmental characteristics make the Boka Kotorska Bay a unique area with ecologic conditions that differ from the rest of the Adriatic coast (UNEP/MAP, RAC/SPA & IUCN-Med, 2014; Đurovic et al., 2016). The River Bojana joins the sea in the most southern area of Montenegro's coast and supplies the Southern Adriatic with fresh water (UNEP/MAP, RAC/SPA & IUCN-Med, 2014).

Montenegro's maritime zone extends to approximately 12 nautical miles out from land, over a total area of an estimated 2,500 km^2 (UNDP, 2008). Varying widths of the continental shelf along the Montenegrin coast have been recorded from near 9.5 nautical miles at the entrance of the Boka Kotorska Bay in the North to some 34 nautical miles at the estuary of the Bojana river in the South (UNEP/MAP, RAC/SPA & IUCN-Med, 2014). The shelf has a maximum depth of around 200 m (CAU; ELARD; ITI, 2014; UNEP/MAP, RAC/SPA & IUCN-Med, 2014) and it is estimated that it covers approximately 43,5% of the entire offshore region (ITI, 2014).

Currents, circulation, temperature and salinity

The circulation and currents of Southern Adriatic Sea are determined seasonal influences, the great depth of the Southern Adriatic Pit and water exchange through the Strait of Otranto. A cyclonic gyre is seasonally present over South Adriatic Pit. This cyclonic surface circulation is determined by topographic features and separates the southern from the central Adriatic (Orlic et al., 1992; Russo & Artegiani, 1996). Near some areas on the eastern coast, upwellings are mainly influenced and caused by the offshore Bora-winds. Furthermore, the general circulation shows influences of the fresh water inflow, delivered by the rivers off the eastern coast (Orlic et al., 1992). The currents off the Montenegrin coast are moving relatively parallel to the shore in a north-westerly direction and exhibit a slow flow (Markovic, 2008; CAU; ELARD; ITI, 2014). However, the intensity of the currents vary in regards to season, depth and climatic conditions; in winter the currents are stronger than in summer (CAU; ELARD; ITI, 2014). Additionally, Montenegrin waters are not characterised by strong tides (Markovic, 2008), with an average daily amplitude of 23 cm and monthly mean amplitude of 64 cm (CAU; ELARD; ITI, 2014). The mean water temperature ranges from 14.28 °C in winter, 15.12°C to 16.17°C in autumn and rises to 27°C in summer in the Southern Adriatic. The average salinity recorded was 38% which is below the Mediterranean average at 39% (Markovic, 2008; CAU; ELARD; ITI, 2014).

Biodiversity

Montenegro has a range of diverse habitats and a high level of species diversity to which a number of rare and endemic species belong (Markovic, 2008). Despite the relatively poor amount of studies of species inhabiting Montenegrin waters, and the Adriatic as a whole, it has been documented that planktonic algae and seaweeds pose as the prominent types of vegetation within this region (Buskovic & Kapa, 2010).

Milestone Conventions

The Mediterranean marine environment, including the Adriatic Sea, is in urgent need for improved conservation actions in order to protect its biodiversity, habitats and threatened species. There are several measures already taken:

The United Nations Environment Programme (UNEP) (1975) was the first Regional Seas Programme, namely the Mediterranean Action Plan (MAP) in which sixteen Mediterranean countries took part in as well as the European Community. The MAP was set up to offer assistance to Mediterranean countries in establishing national environmental policies through addressing coastal zone planning and management, biodiversity conservation and sustainable development.

The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) also plays a crucial role, which took effect in 1978. All 21 participating countries agreed to protect and improve the Mediterranean's coastal and marine environments principally through: control, prevention and reduction of pollution, sustainable management of natural resources, protection of cultural and natural heritage. The influential framework of the Barcelona Convention provides seven protocols which complete the legal framework of the MAP by targeting specific issues of Mediterranean conservation (UNEP/MAP, 2012). All participating member states approved the Ecosystem Approach which ensures that the policy and measures of the Convention are in line with the EU policies such as: the EU Marine Strategy Framework Directive; the Water Framework Directive; the Habitats and Birds Directives; the Urban Waste Water Treatment Directive, and the Bathing Water Directive (EEA, 2015). Also, the Ecosystem Approach supports the Mediterranean Action Plan (MAP) in its former established framework (UNEP/MAP, 2012).

The Convention for Biological Diversity (CBD) (Rio, 1992) aims to sustainably use components of, and conserve, biological diversity (CBD, 2017) CBD together with Barcelona Convention assessed the Adriatic Sea as an **Ecologically or Biologically Significant Area (EBSA)**.

The Convention on Migratory Species (CMS) (Bonn, 1979) represents conservation measures for migratory species, which is crucial for the Mediterranean Sea. As a result of CMS, two significant conservation agreements were created (Parsons *et al*., 2013). Firstly, the 1991 'Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas' (ASCOBANS), which was later extended in 2008 to also include the North East Atlantic and Irish Seas (CMS, 2017). Secondly the more relatable, the 'Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area' (ACCOBAMS) was introduced in 1996 (CMS, 2017; Parsons *et al*., 2013). ACCOBAMS was enforced in 2001 with the aim of assisting scientists with their conservation based research while developing projects like evaluating critical habitats, by-catch rates and disturbance sources (WDC, 2017; Parsons *et al*., 2013).

The Habitats (92/43) and Birds Directive (79/409) play a fundamental role in the development of the **Natura 2000 Network**. This network of terrestrial and marine environments concentrates on the formation of protected areas and their sustainable management (UNEP/MAP RAC/SPA, 2015). By determining, maintaining and protecting these areas, states aim to avoid disturbing protected species. Also, the member states are instructed for the development of a firm protection system of certain plant and animal species (Coffey, 2001). Natura 2000 distinguishes two areas of protection; Sites of Community Importance (SCIs) under the Habitats Directive (92/43/EC), and Special Protection Areas (SPAs) under the Birds Directive (2009/147/EC). When SCIs are formally chosen by each of the concerned country's governments, these areas become assessed as Special Areas of Conservation (SACs) by the State Member (UNEP/MAP RAC/SPA, 2015).

The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979) plays an important role in conserving the Adriatic;the Convention determined the EMERALD Network, which is an extension of the Natura 2000 Network with similar principals for the East-Adriatic countries which –don't belong to the EU. Other international conservation arrangements like the International Adriatic-Cross borders IPA, ADRIAPAN, ADRIPAN are established for non-EU countries to achieve their set goals (UNEP/MAP RAC/SPA, 2015).

It should be taken into account that not all countries of the Adriatic and Ionian Seas belong to the European Union (EU). Greece, Italy, Slovenia, and Croatia are EU Member States, whereas Montenegro is a candidate country and Albania and Bosnia-Herzegovina are only potential candidate countries.

Marine Protected Areas

Creating 'Marine Protected Areas' (MPAs) is a solution to protect the Mediterranean's biota and ecosystem services (ODEMM, 2011), and is unquestionably the most fundamental management and governance tool for biodiversity in the basin (UNEP, 2010). Fortunately over recent decades MPAs have become popular as management technique to conserve endangered marine fauna and their habitats, including marine mammals (di Scaria et al., 2008). They aid conservation efforts to focus at a global scale that is further palpable for the general public. These reserves are therefore able to manage human activities more sustainably through zoning while protecting the local environment and endorsing public awareness and education (Canadas & Hammond, 2008).

Roughly 800 marine and coastal MPAs covering 9910 km^2 (discounting the Pelagos Sanctuary were generated as of 2011 (ODEMM, 2011) amounting to only 0.4% of the total sea surface (UNEP, 2010) of the Mediterranean Sea. More recently, MedPAN and RAC/SPA directed an assessment on the status of MPAs and Other Effective area-based Conservation Measures (OECMs) in the Mediterranean (MEDPAN, 2017). Their findings conclude that there is progress being made, underlining that there are now 1231 MPAs and OECMs covering 179798 km2 (7.14%) of the Mediterranean Sea surface (MEDPAN, 2017). Furthermore there are over 100 sites being considered to become protection zones (MEDPAN, 2017).

These conservation areas are not distributed evenly throughout the sub-regions and habitats which means that a host of habitats and species are not being represented (UNEP, 2010; MEDPLAN, 2017) with over 72.77% of protected surface found in the Western Mediterranean basin (MEDPAN, 2017). Moreover 65.05% of MPAs have a maritime surface under 50 km^2 (77.17% of all MPAs and OECMs (MEDPAN, 2017) which is a relatively small size when taking into consideration the potential range of any given marine mammal. It is also hard to determine the boundaries of these areas and additionally anthropogenic effects such as noise can easily transmit into the regions even if the source did not originate there. Lastly, policing these factors is extremely difficult due to the staffing and monetary implications for each member coupled with proving any illegalities. For example, it is very difficult to prove that an animal was killed deliberately (Parsons et al., 2013).

Limitations in Conservation Legislation

There are more examples of conservation legislations and conventions than what has been described before and indeed in theory it may appear that there is a lot being done to protect the Mediterranean's fauna. However, it is one thing to bring countries together to combat conservation by designating laws and treaties but another thing entirely too appropriately enforce it. For example, China has some of the best environmental laws in the world however its ecosystem is one of the most degraded due to a lack in law enforcement (Parsons et al., 2013). This is arguably due to a lack of funding for enforcement agencies and in addition, many international treaties are non-binding and unfortunately there is regularly no repercussions if member countries to not conform to conditions, even if they are considered obligatory (Parsons et al., 2013). The science behind the need for conservation is often disregarded by politicians and managers as decisions to mitigate harmful sources may be unpopular to people within the industrial and social sectors (Parsons et al., 2013). Ultimately policy makers want to be voted for or re-elected therefore few have been brave enough to address long term conservation issues (Parsons et al., 2013).

DOLPHINS IN HUMAN SOCIETY

HISTORY OF DOLPHINS

Throughout human history, dolphins have played an important role in human culture. The first images of dolphins appeared as early as 1500 BC (Awesome Ocean, 2017). The Minoan, a seafaring culture in the Mediterranean, incorporated dolphins in their art work. Even though there are very little written records, many gods like Poseidon and Delphi are accompanied by dolphins in images and sculptures. A myth about Poseidon explains that the star constellation "dolphin" was put in the sky by him because dolphin messengers brought him a nymph he loved and later married. Furthermore, the Greek God Dionysus shaped the dolphin into a human rescuer at sea. He transformed a pack of pirates who attacked him at sea into a pod of dolphins doomed to save human lives (Awesome Ocean, 2017). The image of the helpful dolphin continued and various ethnic groups have similar tales to tell. Dolphins were known to bring people safely ashore and guide ships through shallow areas; a ship accompanied by dolphins was sure to arrive safely. It was also told that harming a dolphin would bring bad luck for the person and his generation (Awesome Ocean, 2017).

Whaling and Dolphin Hunting

Unfortunately, there is a well-known tradition of whaling and dolphin hunting. In some countries, it is still practised today either for their traditional culture or under the cover of so called scientific research (National Geographic Society, 2011). Some of the first cultures to hunt whales were the Norwegians and the Japanese, which are still pursuing that practice. In the 1700s the practice of whaling was undertaken by America. In the mid-1800s modern technology made the hunt more efficient by providing gun-loaded harpoon guns. Soon after, whales were no longer found in coastal areas and the hunting areas were expanded towards the poles. Most of the lamps were fuelled with whale oil made from blubber.
Since 1946, several countries joined the International Whaling Commission (IWC) which regulates the overhunting of whales, establishes whaling-free sanctuaries and provides data to estimate present populations (National Geographic Society, 2011). However, IWC regulations do not apply to small cetaceans such as dolphins which were less likely to be hunted for meat and cannot produce sufficient amounts of whale oil. Dolphins were sold in local markets, used as bait or even as fillers in tuna cans and other mixed fish products. In some regions like the Adriatic Sea, dolphins were killed to reduce the competition with fishermen (Whale Facts, 2017). They were treated as pest species (Bearzi et al., 2008). Fortunately the Mediterranean does not have a tradition of whaling (Fossi et al., 1992) with only two recorded whaling expeditions thought to have occurred, which lead to the removal of around 237 sperm whales (*Physeter microcephalus*) between 1862 and 1899 (Rendell & Frantzis, 2016). However more recently, immediately after World War II, the same species were reported to have been hunted with explosives around the Straits of Messina (Rendell & Frantzis, 2016).

Fortunately over the last few decades, whaling is seen as a global controversy (Nishi, 2010) meaning that today, cetaceans in this basin are largely safe from direct and illegal whaling activities. Nevertheless, even though dolphins are protected by law, occasional direct killings are still happening today (Notarbartolo di Scara et al., 2001).

Live capture

Removing a live individual from the wild is arguably equivalent to killing it because it is no longer available to maintain the wild population (Reeves et al., 2010). Dolphins were brought into captivity for live display, so called animal assisted therapy, or for research purposes (Bearzi et al., 2008). The former has established over recent years and has become a source of high economic gain (Brownell & Reeves, 2008). Even though live capture is prohibited in the Mediterranean it still happens occasionally if a permit is granted (Bearzi et al., 2008).

In order to be allowed to publicly display marine mammals, zoos are obliged to offer an education and conservation program, be open for the public on a regular basis and be licensed and registered by the country's responsible association (NOAA FISHERIES, 2013; EAZA, 2017). The former is being implemented through dolphin shows and interaction programs such as, 'swim-with-the dolphin' experiences. Zoo owners assume that it increases knowledge, attitude and behavioural intentions of the public in the short term basis. The public does not see what happens behind the scenes. Most of the participants to these shows are not aware that animals suffer from various diseases and depression in captive environments. It's also known that most visitors do not change toward a more conservative outlook after their visit (Benbow, 2004). Thus, zoos fail to deliver the conservation consequences they promise to deliver (Jiang & Lück, 2006). Furthermore, most of the visitors felt that the living conditions are not adequate for certain species. Additionally, the ethics behind keeping animals in captivity and disrupting their families and life cycles is unquestionably morally wrong, and lastly, knowledge and the awareness of environmental issues were higher in non-visitors (Jiang et al., 2008).

Ecotourism: Whale/Dolphin watching

Since the 1970's, the public's awareness and sensitivity towards the subjects surrounding environmental issues has risen. Nowadays, people favour ecotourism where they can support wildlife and at the same time enjoy a wildlife based experience, instead of visiting zoos (Amante-Helweg, 1996). Whale watching is one of the most popular wildlife watching activities, considering the extraordinary scale and growth rate of this business. More than 87 countries participate in this international wildlife phenomenon (Hoyt, 2000). as of 1998, 9 million whale watchers were already documented. The fastest growth rate (13.6%) was in the mid to late 1990's (Hoyt, 2000). From 2001 to 2008 the participant number augmented again from 9 to 13 million with revenues from 1 to 2.1 billion US dollars ($) per year (Cunningham et al., 2011).

Whale watching and whaling are two contrary activities which aim for different target groups. However, both practices exist simultaneously and sometimes even in the same country. Hence, in an era of rethinking, can whaling and whale watching co-exist? Examples of this include Japan and Iceland and the number of implementers increases in both practices. However, whaling is highly subsidized by the government or the private sectors. Whale watching is not only a sustainable and economically rewarding industry, it is also widely accepted by the tourism industry due to the humanizing perception of cetaceans; whereas the ethics of hunting whales are questioned (Cunningham et al., 2011). Justified by its popularity, whale watching can have a positive impact on the environment and target species. Many issues associated with whale watching have not been investigated fully or at all to identify the threshold towards detrimental impacts to populations. Moreover, the needs of all stakeholders within whale watching activities must be considered. These include the need for the species' and environmental protection, the industry and the tourists' desires. Furthermore, much like zoological institutions, whale watching should live to its potential to assure education and conservation. In addition, guidelines for boat operators should be established and reinforced to minimalize species disturbance (Cunningham et al., 2011). The pressure for tourist boat operators to deliver a promised unforgettable experience can result in inconsiderate attempts to engage these sometimes shy animals, should be limited to prevent any harm to them animals (Valentine & Birtles, 2004).

Montenegro: Dolphin Joca in Kotor

Not reluctant towards humans at all was a well-known solitary male bottlenose dolphin in the Boka Kotorska Bay. The main tourist attraction, named Joca by the population stayed at the bay from 1987 to 1992/93. Joca was granted special protection and became the first marine mammal protected by law in Montenegro. Marine mammals became protected in 2009 after Montenegro gained its independence in 2006 and ratified the ACCOBAMS (Agreement on the Conservation of Cetaceans in the Black Mediterranean Sea and Contiguous Atlantic Area). After Joca has disappeared, the Animal Protection Society Fifi established 1997, deploy themselves to protect the environment. Their eco-patrol, which name giver is our popular dolphin, actively protects other species, besides marine mammals, such as stray dogs and sea turtles (Đurovic et al., 2016).

In conclusion, human cultures and traditions are inspired by our surroundings. They influence our mindset and actions. To understand what shaped the present it is necessary to understand the past. However, the important things are often forgotten. Ashley Montagu summarizes this as follows:

"The history of the dolphin […] – a virtually complete loss of knowledge, at least in most segments of the culture, of what was formerly well understood by generations of men. Not in entire forgetfulness in some regions of the world, but certainly in a sleep and a forgetting in the most sophisticated centres of the western world", Ashely Montagu, 1962 (William Andrews Clark Memorial Library, 1962).

CETACEAN SPECIES IN MONTENEGRO

Data collection in regards to cetaceans in this region started in the late 1980s (Notarbartolo di Sciara et al., 1993). Since then, ten species have been recorded in the basin: Recorded species include: bottlenose dolphin (*Tursiops truncatus*); striped dolphin (*Stenella coeruleoalba*); Risso's dolphin (*Grampus griseus*); Cuvier's beaked whale (*Ziphius cavirostris*); fin whale (*Balaenoptera physalus*); sperm whale (*Physeter macrocephalus*), and the short-beaked common dolphin (*Delphinus delphis*) (IUCN, 2012). Additionally, the long-finned pilot whale (*Globicephala melas*) (Holcer, 1994), false killer whale (*Pseudorca crassidens*) and humpback whale (*Megaptera novaeangliae*) have been recorded occasionally (Holcer et al., 2002).

The bottlenose dolphin is globally the most studied cetacean species and is distributed worldwide within the tropical and temperate zones of coastal and oceanic regions (Leatherwood & Reeves, 1990; Connor et al., 2000; Bearzi et al., 2008). This being said, there is still a substantial information gap, particularly in regards to its occurrence, residency and movement patterns within the Mediterranean region. It is found along many parts of the Mediterranean Sea and is present regularly in the Adriatic basin (Notarbartolo di Sciara et al., 1993; Reeves & Notarbartolo di Sciara, 2006; Fortuna et al., 2011; IUCN, 2012). While long-term research and monitoring of this species started in the 1980s in the Mediterranean Sea (Bearzi & Nortarbartolo di Sciara, 1995; Bearzi et al., 2008), it was not researched until 2012 in Montenegro (Đurovic et al., 2016). Furthermore, additional data was collected through aerial surveys in 2010, where the regular occurrence of the bottlenose dolphins throughout the Adriatic Sea was confirmed (Bearzi & Nortarbartolo di Sciara, 1995; Fortuna et al., 2011). The population size of the Mediterranean bottlenose dolphin population has been estimated to be less than 10.000 (Bearzi et al., 2012) thus listed as "vulnerable" under IUCN criterion A2cde and is considered to have declined by least 50 % over the last 50 years in the Adriatic Sea (IUCN, 2012). This species is on the List of protected plants and animals of Montenegro ("Official Gazette of RM", No. 76/06). Past killings by the fishing industry and lack of food due to habitat degradation and overfishing are thought to be the culprits to this decline. Other core factors include bycatch in fishing gear and chemical pollution leading to toxin accumulation in their bodies (IUCN, 2012).

The striped dolphin is a widely-distributed oceanic species. It can be found in open waters beyond the continental shelf as well as deeper coastal regions (IUCN, 2012). The global estimated population size is over 2 million individuals without any major global decline and is thus categorised as 'least concern' (Hammond et al., 2008). IUCN have deemed the Mediterranean's population as 'Threatened' based on criterion A2bcde (Aguilar & Gaspari, 2012). This is predominately because local chemical pollution levels and bycatch in driftnets are just some sources that threaten the species (di Sciara, 2016). The IUCN (2017) report that there is no estimate for this species in the eastern basin however this species is known to be abundant in the southern Adriatic (di Scaria, 2016). Furthermore, between 1990-1992 a massive die-off of the Mediterranean subpopulation occurred, involving many 1000s of deaths caused by an infection which declined its population size rapidly (Aguilar & Gaspari, 2012). It is suspected that over the last three generations (ca. 60 years) the population underwent a depletion of more than 30%. This species is on the List of protected plants and animals of Montenegro ("Official Gazette of RM", No. 76/06).

Risso's dolphin is considered to be a regular inhabitant throughout the entire Mediterranean basin, although no reliable recordings for most waters of the southern Mediterranean exist (Bearzi et al., 2011). This species prefers areas with greater depths, which was confirmed by several sightings during aerial surveys from 2010 and 2013 within the South Adriatic slope area (UNEP-MAP-RAC/SPA, Holcer et al., 2015). This species is globally classified as 'least concern' (Taylor et al., 2012), the Mediterranean subpopulation however is listed as 'data deficient', as no large-scale surveys have been conducted so far (Gaspari & Natoli, 2012). This species is on the List of protected plants and animals of Montenegro ("Official Gazette of RM", No. 76/06).

The Cuvier's beaked whale is a widely-distributed species in offshore waters of all oceans and is the only beaked whale species which regularly occurs throughout the Mediterranean Sea (Holcer et al., 2003). Data from the Adriatic Sea in regards to this species is scarce however Podesta et al., 2016, reported that they can be regularly found in the Adriatic. Although global abundance has not been estimated, there are likely to be over 100.000 individuals and according to IUCN the species is listed as 'least concern' (Taylor et al., 2008). It is alleged that the Mediterranean population of this species is in the low thousands (di Sciara, 2016), however the abundance is distinguished as being impossible to asses due to the lack of data surrounding it, therefore the IUCN Red Data List has listed this population as being "Data Deficient" (Baş et al., 2016; IUCN 2017). Interestingly, there is a proposal currently being assessed to change its Mediterranean status to "Vulnerable" due to the various mass stranding events that have occurred in the last 50 years (Podesta et al., 2016). This species is known to be particularly susceptible to anthropogenic noise from military and seismic exploration sonar, and industrial sources; however, other threats include bycatch in driftnets and marine litter ingestion (di Sciara, 2016; IUCN, 2012). In recent decades, several researchers have reported mass strandings of beaked whale species which have been related to naval activities (Podesta et al., 2006). Regretfully, there is a deficiency of physiology, behaviour, distribution and habitat use data for this species, leading to difficulties in mitigating any disruptive bearings (Podesta et al., 2006).

Fin whales are regularly sighted in the deep waters of Mediterranean Sea, generally between 400-2500m deep (Notarbartolo di Sciara et al., 2003). A rough estimation on the global population size was reported as 53,000 individuals around the year 2000 and this species has a global Red List category of 'endangered' under the IUCN criterion A1d (Reilly et al., 2013). In 2012, the IUCN claimed that their population is close to 5,000 adults and more recently, a paper by di Scaria (2016) reported that there are two populations thought to reside within the region: One being a possibly declining population in the low thousands, inhabiting the areas from the Balearic Islands to the Ionian and southern Adriatic seas; the other population is made up of seasonal visitors granted access from the North Atlantic Ocean through the Strait of Gibraltar (di Sciara, 2016; di Sciara et al., 2016).The main threats to this species are boat strikes (particularly from high speed ferries), noise disturbance from seismic surveys, chemical pollution affecting their reproduction and immune systems (DDT, an organochlorine insecticide accumulates in their tissues), and unregulated whale watching (di Sciara, 2016; IUCN 2012). This species is on the List of protected plants and animals of Montenegro ("Official Gazette of RM", No. 76/06).

Sperm whales predominantly feed on cephalopods (Roberts, 2003) with a distribution throughout the Mediterranean over sloped and deep waters diving for sometimes over an hour to depths of over 1000m, although its average dives consist of being 20-50mins at depths of 300-

600m (IUCN, 2012). They are highly distinguishable due to their size, being the largest 'toothed' whale species, and their prominent squared head (IUCN, 2012). Once commonly seen throughout the region in groups of up to 30 individuals, they are now a rare sight which isn't surprising considering the frequent stranding reports (IUCN, 2012). The current worldwide estimate for the species is 360,000, reduced from over 1 million by whaling activities (Rendell & Fratzis, 2016), however the Mediterranean's population of *P. microcephalus* is not well documented (di Sciara, 2016; Carpinelli et al., 2014). There is an absence of data sets in regards to population size, feeding habits and ecology (Roberts, 2003) however they are thought to be genetically diverse and separate from the Atlantic's, numbering in the low-mid hundreds and with evidence of it declining (di Sciara, 2016). Consequently the IUCN Red List has categorised the subpopulation as being 'Endangered' even though its global status is 'Vulnerable' (IUCN, 2012). Based on aerial surveys, this species is not considered resident but has a seasonal presence throughout the Adriatic (Fortuna et al., 2011).

Allthough no reliable records of the **short-beaked common dolphin** in the Southern Adriatic Sea exist, it was once considered to occur regularly in the Adriatic cetacean fauna (Faber et al., 2004). Their global population size is estimated to be 4 million animals thus is categorised as 'least concern' according to the IUCN (Hammond et al., 2008). However, the size of the Mediterranean subpopulation has declined in the past 30-45 years by more than 50% and nowadays data is TOO deficient to make an accurate estimation (IUCN, 2012). The foundation behind the mass decline is imprecise and the "subject of scientific controversy and political indifference" (Bearzi et al., 2003, p1); however culprits include culling before the 1970s; recent food depletion from overfishing and incidental bycatch in fishing apparatus such as gillnets (di Sciara, 2016; Canadas & Hammond, 2008). Other threats include habitat degradation, noise pollution, climate change and water pollution accumulating in their tissues including PCBs and heavy metals (IUCN, 2012; Bearzi et al., 2003). These threats have triggered the IUCN Red Data List to categorize *D. delphis* as 'Endangered' as of 2003 (IUCN, 2012). This species is on the List of protected plants and animals of Montenegro ("Official Gazette of RM", No. 76/06).

THREATS

One of the most severe global environmental problems, not only for the marine environment but for all the word biomass, is the current loss of biological diversity. Unregulated heavy anthropogenic activities have accelerated in speed and intensity in recent decades and are raising the species extinction rates faster than ever (Myers et al., 2000; Ceballos & Ehrlich, 2002 A rapid decline in the conditions of marine ecosystems are consequences of habitat degradation, chemical and noise pollution, marine debris, over fishing, climate change and the introduction of invasive species (Worm et al., 2005; 2006). Threat levels are higher among marine mammals (Schipper, et al., 2008) and many species, locally, regionally or globally, are now extinct (Dulvy et al., 2003). Cetaceans are particularly at risk from human activity as they are long lived with a low reproduction rate (Parsons et al., 2013; de Segura et al., 2006), therefore further population declines will ensue if the overall mortality rates from damaging activities continue (Zanardo et al., 2016). Since 2001 the conservation status of marine mammals has deteriorated and more species have been listed as 'vulnerable' and even 'endangered' in the IUCN Red List (Culik, 2011; IUCN, 2017). According to the IUCN, the main sources causing this concerning decline in marine top predators include and not limited to, intentional killing, habitat degradation, over fishing, by catch, pollution, climate change and marine traffic (IUCN, 2012). If we take into account the major economic activities in the Mediterranean region, (agriculture, fishing, tourism and marine transport) it is clear to see that these economic activities leave a lasting footprint in all aspects of the fragile Mediterranean environment, (UNEP/MAP-Plan Bleu, 2009). All of the mentioned impacts are estimated to increase in the future unless effective conservation measures are taken (Coll et al., 2010). However public awareness and concern on major anthropogenic threats on cetacean populations and their habitats have increased, and in turn, has led to an increase research and conservation actions in marine wildlife, in recent years (Jefferson et al., 1993; MCU Wellington, 2006).

Habitat degradation & chemical pollution

Unregulated urban and touristic developments have led to significant habitat degradation and loss, which has also led to the destabilisation and erosion of the shorelines. Industrial activities have also increased in line with the urbanisation activities, resulting in high levels of eutrophication, chemical contamination of sediments and biota, and marine litter (UNEP/MAP-Plan Bleu, 2009; UNEP/MAP, 2012). The United Nations Environment Program (UNEP), stated that there is an estimated 650 million tons of sewage, 129.000 tons of mineral oil, 60.000 tons of mercury, 3.800 tons of lead and 36.000 tons of phosphates are dumped into the Mediterranean annually (UNEP, 2017). This does not take into account the incidental oil spills which have detrimental local impacts. Cetaceans are especially inclined to be negatively affected by these forms as they reside at a high trophic level and consequently heavy metals and organohalogens found further down the food chain in small concentrations will bio-accumulate and bio-magnify (Fossi et al., 2000; Parson et al., 2013). These contaminants can accumulate in their tissues and therefore cause detrimental effects to their reproduction and immune systems and even death (IUCN, 2012; Parsons et al., 2013).

Overfishing

Many fish species currently cannot sustain the rate at which humans are fishing them. In recent decades, major fish stocks have crashed while human demand for seafood has risen; therefore a great concern has risen around the competition for food between humans and marine mammals (Piroddi *et al*., 2010). Overfishing in the Mediterranean is well documented (Piroddi et al., 2010) as fishing throughout the basin has overexploited a variety of fish stocks (Zenetos et al., 2002). 95% of fish stocks are being overexploited within the Mediterranean (EC, 2014).Over-fishing is leading to changes in the food web, community structure, ecological processes and services and diversity of marine species, of which many are classified as endangered (Malak *et al*., 2011; UNEP/MAP, 2012). In turn, the populations of the animals which depend on the same declining fish stocks will also decrease (Culik 2011; IUCN, 2012). The European Commission claim that scientists recommend that numerous measures must be taken immediately (Marine Affairs and Fisheries, 2017) as the area has lost 41% of its marine mammals and 34% of the total fish population in the last 50 years (PHYS, 2017)

Bycatch

In addition to the depletion of prey density, marine mammals get often entangled in fishing gear. Thousands upon thousands of cetaceans are annually snared by drift and gill nets (Leonzio et al., 1992). Broken beaks, torn fin or tail fluke, external net wounds, and agonic lung froth are some of the main signs of by-catch in cetaceans (PELAGIS, 2017).

Abandoned, lost or discarded fishing gear is an extensive and persistent type of marine litter with copious negative effects on the marine and coastal environments as well as human welfare (UNEP, 2015). They can bring threats to marine habitats and fauna through entanglement and digestion, to human safety when considering divers and boat crews, and lastly to property in the case of propellers (UNEP, 2015). Fishermen typically do not want to lose their fishing gear as they will ultimately need to replace it, however it is not uncommon for gear to be deliberately thrown away in order to avoid the costs and effort of sustainably discarding it. It is a problem which as accrued global concern, especially in the Mediterranean, however there is a severe lack of data (UNEP, 2015).

Marine traffic and boat strikes

Shipping is of great economic, social, and political attention and prominence in the Mediterranean, amounting to a total of 15% of global shipping activity and acting a 'major transit route' between non-Mediterranean ports (ODEMM, 2011). In an attempt by the European Council to reduce road traffic and congestion of heavy goods vehicles, they have implemented the 'Motorway of the Sea' model. Although this will enhance social and economic growth in the region, it will support the development of the shipping sector, generating new businesses such as shipbuilding and cargo transport; ultimately leading to environmental disruption (ODEMM, 2011). Vessel-cetacean impacts have been reported repeatedly throughout the Mediterranean region, having a particular strain on mysticeti species (Bas et al., 2017b). For example, Panigada et al. (2006) conducted a study on fin whale (*Balaenoptera physalus*) carcasses in the region from 1972-2001 finding that out of 287 corpses, 16% were definitely killed by boats.

Noise pollution

Sound is transmitted far more proficiently through water than light, therefore it is no surprise that marine mammals use sound as their principal method of communication interspecifically and are dependent on sound in almost all areas of their lives (Richardson et al., 2013; Weilgart, 2007). There is a great concern surrounding the adverse effects human induced sound in the marine environment is having on marine mammals, also known as noise pollution (Simmonds *et* *al*., 2014; Merchant *et al*., 2013), especially as human use of the sea is increasing thus increasing human induced noise (Weilgart, 2007). The predominant anthropogenic sources are noise generated by ships, seismic surveys and sonar systems (ASCOBANS, 2007). It can lead to detrimental effects on populations through decreased foraging productivity, higher energy demands, diminished group cohesion, increased predation, and reduced reproduction (Weilgart, 2007).

Climate change and invasive species

The Mediterranean Sea is considered as being very responsive to climate change and is considered as a hot spot for climate change predictions (Giorgi, 2006; EEA, 2015). Because of its relatively small surface area, shallow waters, enclosed nature, and high human costal density, the Mediterranean is particularly susceptible to pH and temperature fluctuations. The Mediterranean itself has increased by approximately 1°C in temperature since 1980, moreover salinity is also rising due to reduced rainfall, rising evaporation and damming in primary rivers (IUCN, 2013). Ocean acidification is a prominent threat to cetaceans worldwide and unfortunately, cetacean species with in the Mediterranean will be unable to migrate away from these conditions unless they are able to leave the basin entirely (Simmonds et al., 2012). Other evidences of climate change in the Mediterranean include more frequent extreme climatic events and related disease outbreaks, shifting faunas and the spread of invasive species (Lejeusne et al., 2009). In short, it disrupts the ecosystems throughout the Mediterranean having a particular effect on lower trophic levels which has a knock-on effect up the food web to cetaceans (Lejeusne et al., 2009; Simmonds et al., 2012). Experts project major changes in the Mediterranean environment in the 21th century because of it. The rise in air temperature also causes substantial decreases in rainfall in Southern Europe, increasing precipitation in Northern Europe, increasing number and severity of drought periods, and rising sea levels are the major predicted consequences.. Moreover, biodiversity, water resources and the soil of the Mediterranean region will also be strongly affected as well (Miran, 2009). The introduction of alien species in the Mediterranean area is mainly caused by humans either with or without intention. These species are also known as ‘invasive species’ and are another major threat on biodiversity, suppressing endemic species and even affecting public health and economies (McKinney et al., 2009).

The main threats in the Adriatic

The Adriatic Sea is unquestionably affected from the steady increase in anthropogenic impacts (UNEP/MAP, 2012). In fact, the Adriatic has been identified as one of the Mediterranean’s sub regions with the highest anthropogenic consequences (Coll *et al*., 2012). The Adriatic marine ecosystems are mainly threatened by habitat degradation, pollution from land-based sources, exploitation of marine resources, illegal fishing, maritime activities such as shipping and climate change (Coll et al., 2012; Micheli et al., 2013). These impacts are identifiable throughout the Adriatic, from offshore to coastal areas and from pelagic to benthic biomes. Ongoing uncontrolled coastal development, and industrial and agricultural activities release sewage into the sea. This causes marine pollution and contamination in several ways, such as through the release of heavy metals and other chemicals. Furthermore, maritime transport is considered to increased with the marine litter rates, as well as air, water and noise pollution and the introduction of invasive species (Kljaković-Gašpić et al., 2006; Carić, 2010).

PREVIOUS RESEARCH

Mediterranean Sea

Modern cetacean field studies began from the late 1980's and have been continued until today in the Mediterranean Sea (Bearzi et al., 2008). However, most studies have been carried out in the northern parts of the western basin than the eastern Mediterranean Basin (Bearzi et al., 2008). Research topics varied over time. While distribution, population structure, ecology and behaviour were the primary subject, nowadays the emphasis lies on threats and human induced impacts from the past and the present (such as fisheries, culling pollution and marine traffic). The primary aim of the researches is presently, conservation management and the establishment of population trends (Bearzi et al., 2008).

Adriatic Sea

Bottlenose dolphin populations in the Adriatic Sea have been the subject of studies since the late 1980's (Bearzi et al., 2008) and the long-term studies started in the Northern Adriatic beginning from 1987, 2002 and 2005 (Genov et al., 2009; Rako et al., 2012). Majority of the research came from Northern Adriatic which includes Slovenia and parts of Italian and Croatian waters (Genov et al., 2009). The least is known about southern part belonging to the coastline of Montenegro, Albania and Italy. The following paragraphs summarize the outcomes of researches conducted in the Adriatic. Furthermore, an extra paragraph is dedicated to research based in Montenegrin waters (the studies are in chronological order).

Since 1987, Croatia started its series of bottlenose dolphin studies with a socio-economic study on biology, ecology and behavioural states in the Kvarneric around the islands Losinj and Cres, Northern Adriatic. Between 1987 and 1994, 106 individual bottlenose dolphins were identified in the Kvarneric region, with most of them showing year-round high site fidelity. The study also questioned the high variability among group size while recording those small groups consisted of adults while large groups hold calves. It is assumed that this high variability in group size might be linked to environmental changes and limited and/or inconstant availability of prey (Bearzi et al., 1997). During the same time frame (September 1987 to September 1994) in the southern part of the Kvarneric archipelago, a study on feeding techniques of free ranging dolphins was also investigated. The study found out that feeding techniques changed by season and prey availability (Bearzi et al., 1999).

The following study, conducted from 1988-2007, aimed to complete existing knowledge gaps in cetacean distribution in the Northern Adriatic to confirm the presence or absence on certain species for the purpose of cetacean conservation. The study identified 97 bottlenose dolphins (Bearzi et al., 2009).

From 1990 to 1991, 82 resident and transient individuals were identified through photo identification and focal group behavioural sampling in Croatian waters. The dominant behavioural states were feeding and foraging related which leads to the conclusion that the area is an important feeding site. Also, the group size varied per time of day (Bearzi et al., 2006).

Another study carried out from 1990 to 1999 focused the first time on the heavy metal concentration of beached bottlenose and striped dolphins along the Croatian coast. The research aims to indicate the extent of contamination in the Adriatic. A total of 49 samples (17 muscle, 16 liver and 16 kidney) was collected from stranded specimens. The total mercury levels were high in each tissue whereas the highest concentrations were found in liver tissues of adult dolphins. The cause, however, is ascribed to natural and anthropogenic sources (Pompe-Gotal et al., 2009). Later, a genetic study was conducted from 1994 to 2003 in Croatia to identify the genetic diversity and the existence of a bottlenose dolphins in the past, and the extend of the genetic diversity to the amount that sub populations of bottlenose dolphins could be identified through microsatellites. It appeared that the genetic diversity was rather high (Galov et al., 2011).

Data collected from 1995-2003 in Kvarneric, assessed the impact of former killing and habitat on bottlenose dolphins and short-beaked common dolphins. According to its results, contrary to the bottlenose dolphins, the short-beaked common dolphins are rare in the Northern Adriatic. In addition, the bottlenose dolphin population suffers from a decline in number which outcome is influenced on conservation actions (Fortuna C. M., 2006). In 1996, a striped dolphin was sighted in Kvarneric and the same study highlighted that common bottlenose dolphins were the only species consistently observed in the Northern Adriatic (Bearzi et al., 1998).

In 1998, a study was conducted population count, seasonal distribution and density of bottlenose dolphins in Croatia. The population size was estimated to 218 individuals throughout the Croatian waters, with no other marine mammal observation (Gomeric et al., 2002).

Between 2000 and 2002, a research was carried out to give an insight on the environmental condition along the Eastern Adriatic coast. An indication for the environmental condition can be given by analysing the toxic concentrations in tissue, muscle kidney and liver in top predators such as bottlenose dolphins, striped dolphins and Risso’s dolphins. This particular study found out that Risso's dolphin had the highest toxic concentrations (Bildanzic et al., 2012).

Between 2001 and 2005, a study performed the first density estimates of bottlenose dolphins in the North-eastern Adriatic Sea of the coast of Italy. Furthermore, behavioural observations were recorded from the North-western Adriatic Sea Gas platforms which are situated 8 to 30km offshore in the Ravanna gas field. The results showed that dolphin density was actually high within that 750 m range around the platforms (UNEP-MAP-RACISPA, 2014).

Between 2001 and 2005, a study was conducted between Croatia and Slovenia to identify the home range and population structure of the bottlenose dolphins. The photo-ID catalogues were examined for possible matches and overlaps. Preliminary results showed that these two populations seem not to exchange many individuals (Genov et al., 2009).

Between 2002 and 2008, the first attempt to provide data on the ecology of bottlenose dolphins in Slovenian and adjacent waters was carried out and its result served as a baseline for conservation effort. Through boat and land based survey, 101 individuals were identified, with 75% re-sighted later. The group size ranged from 1-43 and calves were present in 53.3% of the groups. A yearly mark-recapture density of 0.069 dolphins/km^2 was measured (Genov et al., 2008).

Between 2003 and 2006, the environmental factors that influence the habitat use of bottlenose dolphins were investigated in the North-western portion of the Adriatic off the coast of Italy. The research combined hydrological and physiological variables with dolphin related data. It turned out that habitat use is influenced by oxygen saturation, water temperature, gradient of density anomaly, turbidity, distance to nearest coast and bottom depth. The major changes in hydrological variables are primarily caused by seasonal changes (Bearzi et al., 2008).

Between 2005 and 2008, the well-studied population of the Cres-Losinj archipelago was assessed by long-term noise monitoring. The acoustic analysis identified the area around three marine petrol station and tourist beach camps as the noisiest spots in the area (Rako et al., 2012).

In 2006, researchers realised the decline on the bottlenose dolphin population in the Kvarneric region between 1995 and 2003, thus the archipelago was declared as the Cres-Losinj Special Marine Reserve (CLSMR). However, the protection status lasted only 3 years. Nevertheless, the Kvarneric population has increased either through shift in habitat use or an increase in population size (Pleslic et al., 2013).

Between 2006 and 2009, the type and amount of bycatch was analysed in the Northern and Central Adriatic part of the Italian territorial waters. The study found out that even though many fish species that suffer from overfishing such as piked dogfish (*Squalus acabthias*) and smooth-hounds (*Mustelus mustelus*), the amount of incidentally caught dolphins and turtles is not significant to estimate a reliable impact on the populations (Fortuna et al., 2010).

Between 2007 and December 2009, the study pointed out that high tourist vessel density cause a decline on the bottlenose dolphin population in the Cres-Losinj archipelago, where there were the least dolphins abundance in summer but the highest tourist boat traffic (Rako et al., 2013).

In 2007, the cetacean encounter rate study was carried out for the first time in the Southern Adriatic. The study ran from 2003-2007 in the Mediterranean, however, the Southern Adriatic hasn't been assessed until October 2007. This particular study confirmed the presence of bottlenose dolphins and striped dolphins in the region (Boisseau et al., 2010).

In 2014, movement patterns of bottlenose dolphins were in the focus of research and pointed out that even though bottlenose dolphins in the Northern Adriatic show a high site fidelity one individual was documented to pass over 130 km within a few days. It was sighted in Slovenia and later in Italy. Though conclusion cannot be drawn from one incident, it demonstrates the capabilities these animals have when it comes to movement patterns (Genov et al., 2016).

Montenegro

Unfortunately, up until to the current project, dolphins in Montenegrin waters were widely unstudied. Between 2003 and 2004 during a water bird surveys, bottlenose dolphins were opportunistically sighted during summer, 10 km upstream in the lower Bojana/Buna River. The study assumed that dolphins use this narrow riverine system due to lack of obstacles, embankments and low level of human disturbances (Sackl et al., 2007).

Between 2013 and 2014, first strategic cetacean research was conducted in the Montenegrin Boka Kotorska Bay, with a continuous recording of dolphin presence. The knowledge was used to implement a detailed conservation plan for cetaceans and enforce their protection. A total of 8 individual bottlenose dolphins were identified through photo-ID during the research effort in Boka Kotorska Bay (Đurovic et al., 2016). However, later the same study reported 72 catalogued individuals in the Montenegrin waters (Fortuna et al., 2015).

A recent article published in 2016, confirms the presence of bottlenose, striped dolphins and other cetaceans such as the Cuvier's beaked whale and the Risso's dolphin and occasional sightings of fin whales in the Boka Kotorska Bay (UNEP-MAP-RAC/SPA, 2014). However, only bottlenose dolphins were pinpointed as regular visitors of Montenegro (Đurovic et al., 2016).

PROJECT GOAL

This project builds on integrating scientific research with community engagement for sustainable and effective conservation strategies on marine environment in the South Adriatic Sea. The focus is on cetaceans, because of their vital role on the balance of the marine ecosystem, as top predators. All of the cetacean species found in Montenegro are either classified as “Threatened” or “Data Deficient”, therefore conservation and management measures are of enormous importance not only on these species but also on the ecosystem that they support. Up until this project there have been no systematic annual scientific surveys carried out in Montenegrin waters, despite the consistent and expanding human threats. Montenegro is already a partner country of ACCOBAMS, and thus it holds the goal of healthy marine ecosystems through cetacean conservation. The lack of knowledge on cetacean populations here is, indeed, one of the strongest barriers against effective marine conservation effort in Montenegro.

For this purpose, the project was designed to carry out standardised annual surveys. Surveys were conducted both from the land and by boat, covering the entire coastline of Montenegro. These surveys provide regional level data about distribution, population statuses, abundance, residency patterns and human impacts, specifically touching on the effect of marine traffic. Besides the scientific scope of the project, another objective is to engage and inform stakeholders, from fishermen to students, and encourage them to carry out citizen science activities by organising community activities. This particular report aims to delineate the outcomes of our annual survey effort to initiate the first steps towards efficient conservation measurements and to raise awareness in the community about the cetacean species inhabiting the coast of Montenegro.

Methodology

SURVEY AREA

The entire coastline of Montenegro, between Ada Bojana and Herceg Novi has been surveyed using a combination of fixed land stations and boat based surveys. Survey area covered the coastline and territorial waters in Montenegro (Figure 3)

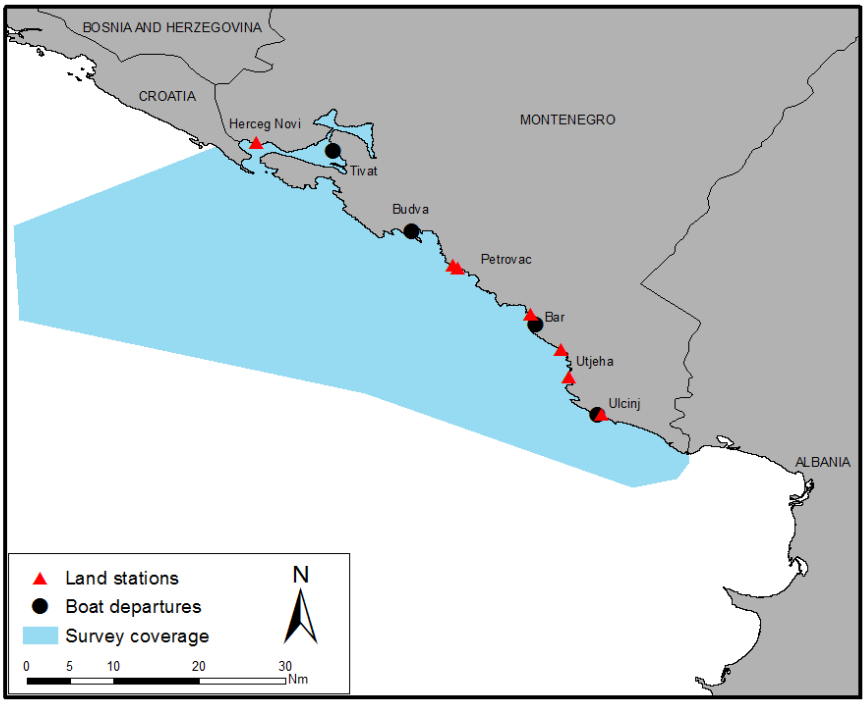

Figure 3. The map of survey area (showed in light blue polygon). The polygon has been created according to our line and boat surveys to represent the true coverage.

Survey platforms

Land surveys

5 survey stations were selected to represent the Southern Adriatic Sea along the Montenegrin coastline (Table 1). Each survey station was selected with an optimal vantage point to study the animals as good as possible. Land based observations enable researchers to observe the natural behaviour of the focal group, without the possible impact of research vessels nearby. Two sets of land surveys were conducted; morning surveys (beginning with sunrise) and afternoon surveys (ending with sunset). Each survey occupied a minimum duration of three hours.

Table 1 The coordinates and altitudes of land stations

Station	Longitude	Latitude	Altitude (m)
Ulcinj	19°12'37.8" E	41°55'28.7" N	92
Utjeha	19°08'45.8" E	41°59'46.1" N	8
Bar	19°04'18.7" E	42°07'10.7" N	18
Petrovac	18°55'17.4" E	42°12'54.2" N	148
Herceg Novi	18°32'24.8" E	42°27'10.9" N	84

To determine geographic positions, a theodolite (SOKKIA DT5A) was operated and vertical and horizontal angles of target objects were recorded. To transfer the theodolite readings into geographic positions the tracking software Pythagoras (version 1.2) was used, based on the predetermined reference point and azimuth. Observation height and geographic position of the theodolite were saved by the software for multiple stations. Through the Pythagoras software, the paths and velocity of focal dolphin groups and vessels was determined. Species and marine vessel types were defined in Pythagoras in advance with the associated focal behaviour for the target species. Also, the environmental data of cloud cover, Beaufort Sea State, glare and tide height are included as environmental conditions to the software. Covariates, such as environmental conditions were recorded every 60 minutes or whenever the conditions changed. Cloud cover and glare were estimated in percentages in steps of 20 (0, 20, 40, 60, 80, 100). The sea state was noted according to 12 integers of the Beaufort scale. Additionally, a tide table was used to estimate the tide height during the survey effort. Moreover, the 'daybreak' was recorded by dividing the time between sunrise and sunset into 4 equal time periods (early morning, morning, afternoon, and evening).

At least four researchers were present during the land surveys; one researcher was responsible for the theodolite operation, another one for entering the theodolite data in a computer in the Pythagoras software and at least two researchers were engaged with the scanning of the sea surface with binoculars. In case of a sighting, the behavioural data of the focal animals was determined ideally by the person using the theodolite. The other person with binoculars was responsible for entering the behavioural data on the data sheet. All members of the observation team rotated their responsibilities hourly.

Boat surveys

Boat surveys have been carried out by following five different routes for the purpose of covering the entire Montenegrin coastline. 1. Bar to Utjeha, 2. Ulcinj to Utjeha, 3. Ulcinj to Ada Bojana, 4. Budva to Kotor and 5. Kotor Bay. Each route was tried to be followed at least once per month and data collection took place between sunrise and sunset (6:00 and 21:00), covering 3 to 7 hours per day, depending on the sea conditions. Surveys took place only in calm seas with Beaufort Sea State between 0-3 and good visibility (>1nmile). The speed of the boat was relatively constant with an average of 3 knots. Surveys have been carried either with 6-meter outboard engine fishing boats, 12-meter outboard speed boats or 17 m sailing boat under inboard engine.
Using a GPS (Global Positioning System), the geographic position of the observation boat was recorded every 3 seconds. In case of cetacean presence, the angle and the distance of the focal group from the boat was determined, to calculate the true coordinates of the cetacean group. The boat approached to the sighted cetacean group with an idle speed to get an accurate data and photographs on the focal cetacean group. As such, focal cetacean group was approached from the side or rear of with an idle speed whenever possible. The focal group was followed from a minimum distance of 50 m to a maximum of 400 m and if the dolphins approach closer, our vessel speed was reduced gradually. The research boat avoided showing sudden changes on its direction and speed. Any changes in the behaviour of the focal group due to the presence of the research boat were also recorded in order to measure our impact.

The survey team consisted of minimum 5 researchers; one researcher scan with the naked eye until 500 m distance from the boat, two researchers use binoculars scanning onward from 500 m, two photographers stationed on the bow-side of the boat. Researchers rotate hourly (starboard, centre, port) to avoid fatigue. While starboard and port researchers were responsible from actual sightings, the researcher in the centre was only responsible from data recording. All sightings and effort data as well as environmental and survey conditions was recorded on the printed data sheets and entered into a database at the end of a survey day. Focal group datasheets contain information on cetacean species observed, observation time, observation number, the distance and angle of the species from the observation boat, species cluster size, their behaviour, their impacted behaviour. Environmental datasheets were composed of cloud cover, Beaufort scale or glare percentage on the sea surface. While focal group was recorded every 5 minutes after the initial sighting, environmental data collected in hourly bases.

BEHAVIOUR SAMPLING

Focal groups were defined as any aggregation of dolphins, observed in a clearly visible constellation (less than 100 meter apart from each other), with similar behavioural activities. The method of focal group scan sampling was chosen to collect behavioural data. With scan sampling the behaviour of all individuals in a focal group are recorded at a predetermined time interval of 5 minutes. Those behaviours can be regarded as states or events; behavioural states endure for an appreciable time, whereas behavioural events are instantaneous. Both, events and states were documented. Per each sampling unit (every 5 minutes), the present behavioural states and events and the number of individuals engaged with these behaviours were noted. In addition, the dominant behavioural state, with which the majority of individuals was engaged, was recorded as well. Behavioural states and events were explained in detail in
Table and Table.

Table 2. Ethogram of all predetermined behavioural states and their abbreviations used in the study

Behavioural States	Definition
Travel (TR)	Individuals move with a constant speed in a certain direction with diving interval between 3 and 5 seconds. They move at least 200 m in 1 minute.
Diving (DV)	Dive periods can range from 30 seconds to several minutes. Individuals show no obvious movement and resurface at almost the same location. They move less than 200 m in 1 minute.
Travel Diving (TR-DV)	Individuals move to a certain direction but dive for appreciable time (<1min) and reappear at a distance. They move at least 200 m in 1 minute.
Surface Feeding (SU-FE)	Individuals show active, rapid directional changes. The presence of birds and a lot of splashes is likely.
Socialising (SOC)	Individuals show various interactive behaviours and create body contact with each other. Events like synchronized full leaps or tail slaps are likely.
Resting (RE)	Individuals are drifting in a slow swimming speed near the water surface with steady and synchronous movements. Dive intervals are short. They move less than 100 m in 1 minute
Milling (MI)	The group shows a non-directional movement and varies in its bearing but stays constant in its cohesion.
Bow-Riding (BOW)	Individuals swim in front of a boat.

Interacting with boat (IN)	Individuals swim along the sides or behind a boat.

Table 3. Ethogram of all predetermined behavioural events and their abbreviations used in the study

Behavioural Events	Definition
Tail slap (TS)	Individual slaps its fluke on the water surface
Spy hoop (SH)	Individual raises its head shortly above the surface
Breaching (BR)	Individual leaps out of the water and lets its body slap the surface.
Belly up (BU)	Individual turns upside down with the belly up.
Full leap (FL)	Individual leaps its complete body above the water surface.
Fluke up (FU)	Individual protrudes its fluke above water surface.

Besides the behavioural states and events, their swim style and the group type was also recorded. The swim style of the focal group represented the spatial structure and formation of the group (Table 4). The group type described how the group is formatted based on the distance between the individuals in a group. Group type was categorized as either "alone" when there was one single individual, "tight" when the group was close together with a distance to each other below 5 m, "far" for a spread group with a distance to each other above 5m or "mixed" when some individuals were close to each other and others far apart.

Table 4 Ethogram of all predetermined swim styles and their abbreviations used in the study

Swim Style	Definition
Alone (AL)	One single individual is present.
Line (LI)	Individuals swim in a line head to tail. The line can be straight or offset.
Circular Dives (CD)	Individuals create a circular formation by appearing in turns at the surface after each other.
Clustered (CL)	Individuals are clustered with no directional movements.
Spread (SP)	The group is spread out, individuals do not swim close to each other.
Front (FR)	Individuals swim in a line side by side.
Team (TE)	The group split up in smaller independent groups ("teams").
Kettle (KE)	Often appears while group feeds at the surface. Many splashes can be seen, water seems boiling like a kettle.
Varied (VA)	The group shows a variation of different swim styles.

Moreover, for each sampling unit (every 5 minutes) the exact time, species, group number and group size were recorded, as well as the surrounding marine vessels and their estimated distance to the focal group. To distinguish between different focal groups during one survey, each group was numbered. When an observed group was out of sight for a timeframe of more than 20 minutes, the next sighting was considered as a new group. In case of a group splitting into to subgroups, the group number of the subgroups were documented as the previous group number added with "a" or "b".

MARINE VESSEL SAMPLING

The number, type and distance of present marine vessels to the cetaceans, including the research vessel, were collected to investigate the effect of vessels to the focal group behaviour. Marine vessels were categorised into 10 different groups: FB (fishing boat), FV (fishing vessel), HSB (high-speed boat), RB (research boat), SB (sailing boat), FE (ferry) HSFE (high-speed ferry), CS (cargo ship), CR (cruise ship) and JET (jet-ski).

The marine vessel presence within the interaction zone was noted according to its type. The interaction zone is defined as any vessel presence within the 400 m radius from the dolphin group. Therefore, if there was a vessel within the 400 m radius, marine vessel presence was recorded as "Present" and if there were no vessels within the 400 m radius, it was recorded as "Absent". Additionally, the distance of nearest marine vessels to the focal group as well as the density of vessels within the radius of 100 meters, 400 meters, 1000 meters and more than 1000 meters from the focal group was recorded. The changes on the swimming directions of the dolphins in relation to the marine vessels, including the research vessel, was categorised as either positive, when the dolphin swam towards the vessel, negative, when the dolphin swam away, or neutral, when the dolphin behaviour does not display any apparent response towards the vessels.

PHOTO IDENTIFICATION

Photographs of dorsal fins, flukes or the whole body of present dolphins have been taken during the boat surveys. Photographs have been taken using various DSLR cameras with 70-300mm and 150-600mm lenses. In an attempt to photograph all individuals in the group, numerous photographs of both sides have been tried to be obtained with care taken to avoid bias toward distinctive individuals. A blank picture has taken between focal groups so that photos of individuals could later be assigned to their respective focal groups.

Photographs have been post processed in three stages; storage, cataloguing and matching by using Discovery Software. During storage, photographs were cropped around the fin and the body for each individual. Later they were stored according to quality rating: (i) Good quality (Dorsal fin is focused, perpendicular to the camera and the entire fin is in the frame); (ii) Medium quality (Dorsal fin is focused with a satisfactory angle and the entire fin is in the frame); (iii) Bad quality (Dorsal fin is out of focus and/or the entire fin is not in the frame); (iv) No info (Photograph doesn't hold any photo-identification value). The cataloguing stage included only Good and Medium quality photographs. Individuals were catalogued according to markings (nicks and scars) on the dorsal fin, fin shape, and body deformities (Würsig and Würsig 1977; Würsig and Jefferson 1990). Later, each individual was classified into one of three categories of distinctiveness; Bad, Medium, or Good. "Bad" individuals had no identifiable features/marks, "Medium" individuals had small markings or nicks that would be difficult to re-identify, and "Good" individuals had at least one permanent, clear and identifiable nick. Thus, picture distinctiveness did not refer to image sharpness but rather to the presence or absence of recognisable features on each individual. The final stage, matching, only included individuals from the "Good" distinctive category. However, if any medium distinctive individual featured several small nicks and scars in the same frame, they were also included in the matching. To avoid mis-identification, calves and individuals without distinctive markings were not included in analysis. Furthermore, to avoid overestimation of the results on residency pattern and site fidelity, the individuals re-sighted in the same day were only recorded once and re-sightings were excluded from the analysis.

DATA ANALYSIS

Descriptive statistic together with quantitative statistic has been used to analyse the data between 15.09.2016 and 03.10.2017. Striped dolphins were discarded from the quantitative statistics due to their small sample size, preventing to reach accurate conclusions at this stage.

Sightings

To understand the effect of seasons, sections and survey type on dolphin sightings, a Poisson regression was fitted to the data. However, due to the over dispersion of the data, negative binomial with log link was the selected model type. While the count data of dolphins was used as the response variable, seasons (spring, summer, autumn, winter), sections (south, centre and north) and survey types (land and boat surveys) were used as explanatory variables, and the survey effort in days was selected as an offset. Furthermore, we looked at the effect of specific land stations as well as specific boat routes on sighting rates in order to identify a potential bias in our dataset through running binomial regression models. During the analysis, two sighted species were considered together.

Lastly, the effects of general weather/sea state condition on sighting probabilities were investigated through performing binomial logistic regression and the sighting data was converted to a binary variable (0=no sighting, 1=sighting). General weather/sea state conditions were selected as Beaufort, glare, cloud cover, season, month and daybreak. Such models were run with various combinations of explanatory variables in order to identify which were most impactful on sighting probability.

Encounter rates of bottlenose dolphins

The data for encounter rate analysis was gathered during the boat surveys between September 2016 and August 2017. Encounter rate was calculated both from groups and individuals per 100 km for the Montenegro coastline. The study area was divided into the grid cells of 2km*2km. The encounter rates per km were calculated using the formula below;

$$encounter\ rate = \frac{n}{L}$$

where *n* represents the number of sightings and *L* the survey effort in km per grid. Cells in which the survey track line resulted in less than the hypotenuse of the cell (2,8284 km) were disregarded for the analysis. Furthermore, to account for cells that do not entirely consist of water, each grid cell was weighted accordingly by multiplying the encounter rate by the proportion of water it contained. The weighted estimators were then implemented for each step and each cell.

Changes on the group size of bottlenose dolphins

The effect of varies parameters on the variation of group size (number of individuals in a group) were tested through mixed effect generalised log-linear model. The investigated parameters were season, survey location, time of the day, group cohesion (group type and swim style), marine vessels presence and distance to marine vessels. Prior to the analyses, the models are corrected for the survey type due to its significant effect on the sighting probabilities. The best-fitting model was selected based on its Akaike information criterion (AIC) by step-wise elimination of non-significant variables from a completely saturated model. The best model was identified once the difference between it and the next closest AIC value was 2 or less.

Variation on the behavioural patterns

The effect of group size, group cohesion, season and anthropogenic factors on the behavioural patterns of dolphins was investigated through running mixed effect log-linear Poisson regression models, with a correction on the effect of survey type. The best explanatory model was selected based on lowest AIC score. While group cohesion defined as group type and swimming style, anthropogenic factors were selected as marine vessel presence within the interaction zone, distance to the nearest vessel and sum of vessels within 400m. Later, variables found to significantly explain behaviour changes were selected to run multinomial regression and identify which behaviours were most affected. To increase the sample size of our dependent variable, in this case behaviour categories, the investigated behaviours were travelling, diving, socialising-resting-milling and surface-feeding. Travelling behaviour included both travelling and travel diving. Socialising, resting and milling behaviour were pooled under one category due to its small sample size, bow riding and interaction with boats were discarded from the analysis.

Residency patterns and site fidelities of bottlenose dolphins

Residency pattern analyses were carried out to investigate whether and during which time period identified individuals use the study area. The monthly residency rate (the number of months an individual was sighted divided by the total number of months surveyed), seasonal residency rate (the number of seasons an individual was sighted divided by the total number of seasons surveyed) and the overall residency rate (the number of re-sightings divided by the number of survey days between the first and the last sighting of that individual) were calculated following Zanardo et al., 2016. Additionally, an overall site fidelity index was also calculated with an index of 1 indicates that the individual was captured on each survey day during the study whereas an index of 0 suggests that the dolphin was never re-sighted again.

An agglomerative hierarchical cluster analysis was performed via XLSTAT in order to distinguish groups or 'clusters' of individuals with a similar degree of monthly residency, seasonal residency and site fidelity indices (Zanardo et al., 2016). Agglomerative hierarchical clustering is a bottom-up clustering method that starts with each observation as an individual cluster, the clusters are then combined based on similarity until all clusters have been combined into one (Zanardo et al., 2016). Squared euclidean distance for the dissimilarity measure and Ward's method as the clustering algorithm was chosen. Automatic truncation was selected for the dissimilarity threshold, and results were displayed as a dendrogram. To check the validity of the dendrogram, the cophenetic correlation coefficient (CCC) was calculated using StatistiXL V 2. When CCC is close to 1, the dendrogram more accurately represents how the clustering solution reflects the data structure (Zanardo et al., 2016).

Body conditions and stranding records

Body conditions of photographed individuals were noted to estimate the health of the target population. Body conditions were categorised as satisfactory weight, underweight and injured. Additionally, the records of stranding were collected from the media releases to have a rough estimate on the yearly stranding number.

Dolphin density maps and important dolphin habitats

The survey area was delineated in consideration with the maximum sighting range of land stations and boat routes. ArcGIS version 10.3.1 was used to create a GIS environment that projected the dolphin coordinates collected both from the land and boat surveys. Uploaded point data transformed to the line shape file, to create the track line of each dolphin group and later used as an input feature for kernel density tool. During the kernel density analysis, each track line was weighted with its group size. Group size was defined as an average of the cumulative minimum and maximum group size observed at 5-minute intervals for the sampling duration for each group. Mask extraction extrapolated the dolphin densities according to the survey area with a given output cell size of 300, and a radius of 3000. Lastly, percent volume contour has been used to visualize the core zones for dolphins, which proceed with the buffer zones for important dolphin habitat delineations.

Results

Surveys were carried out over the course of 212 days (710 hours) between 15.09.2016 and 03.10.2017, of which 180 days (537 hours) were from land and 32 days (173 hours) from boat. The survey effort for each season was similarly distributed, whereas it was unequal between the sections of Montenegro, with the south section having the highest survey effort throughout the year (Table 5). Out of the three sections of coastline defined to survey the Montenegrin waters, 70% of surveys were carried out in the South, 19% in the centre and 11% in the North.

Overall, bottlenose dolphins were encountered on 74 days and striped dolphins were encountered on 12 days (Table 5). A focal group behavioural follow of bottlenose dolphins ranged from one sampling unit (5 minutes) to 29 sampling unit (145 min), while it was three (15 minutes) to 14 sampling units (70 minutes) for striped dolphins. The average group follow for both species was six units (30 minutes). Group size of bottlenose dolphins varied from 1 to 12 individuals with a mean of 4 dolphins. The median group size was of 3 and half of the observation lied between 2 to 5 individuals per group. Whereas striped dolphins showed a variation ranging from 1 to 25 individuals with a mean of 8 and median of 5 individuals in a group and half of the observation lied between 3 to 13 individuals in a group.

Table 5 . Number of survey effort, sightings and groups for each species per season and section in Montenegro (TT=Bottlenose dolphins, SC=Striped dolphins; TR=Travelling, DV=Diving, SOC=Socialising, RE=Resting; NA=Not applicable)

Season	Section	Survey effort in days (hours)	Number of sightings		Number of groups		Dominant Behaviour	
			TT	SC	TT	SC	TT	SC
Autumn	South	42 (115:31)	17	6	32	7	TR,DV	TR,DV
	Middle	10 (27:10)	1	0	3	0	DV,SOC,RE,TR	NA
	North	6 (34:31)	3	0	3	0	TR	NA
Winter	South	35 (99:49)	15	2	24	2	TR	TR
	Middle	7 (17:27)	2	0	7	0	TR,DV	NA
	North	2 (13:00)	1	0	1	0	TR	NA
Spring	South	33 (108:32)	9	1	10	1	TR	TR,DV
	Middle	10 (31:36)	3	0	8	0	TR	NA
	North	6 (38:35)	2	0	7	0	TR	NA
Summer	South	39 (107:56)	14	0	15	0	TR	NA
	Middle	12 (42:24)	4	0	5	0	TR,DV	NA
	North	10 (74:04)	3	3	5	6	TR	TR
Overall		212 (710:35)	74	12	85	16	TR	TR,DV

Sightings

The probability of dolphins sightings were significantly affected by the survey type ($\chi 2 = 9.081$, df = 1, p = 0.003), whereas section and season were found to have no significance on dolphin sightings. Despite the much greater amount of land surveys, sighting probabilities were found to be greater from the boat, with dolphins seen about 67% of the time against only 34% for land based surveys. On average, 1.5 dolphin groups were sighted per boat survey against only 0.5 per land survey.

Despite the uneven spatial sampling pattern, no section (coastal region) revealed an increased sighting probability when compared to the others ($p>0.05$). Yet, the middle section holds the highest recording of sightings among the other sections by 1.4 groups per survey, even though the variation wasn't significant. Within boat-based observations, surveys covering the totality of the coastline instead of any specific subset were more likely to result in a sighting (sd=0.60, z=3.05, $p<0.01$).

No statistically significant effect of seasonality on sighting rates was found. Nevertheless, a clear trend towards increased sightings in winter and spring was observed, with an average sighting per survey of 1.2 groups. No effect of month on sighting probability was found. Lastly, when general environmental conditions were analysed Beaufort explained the variation in sighting probability best (AIC=266) (Figure 4). Sighting rate strongly decreased as Beaufort value increased (sd=0.14, z=-3.87, $p<0.001$).

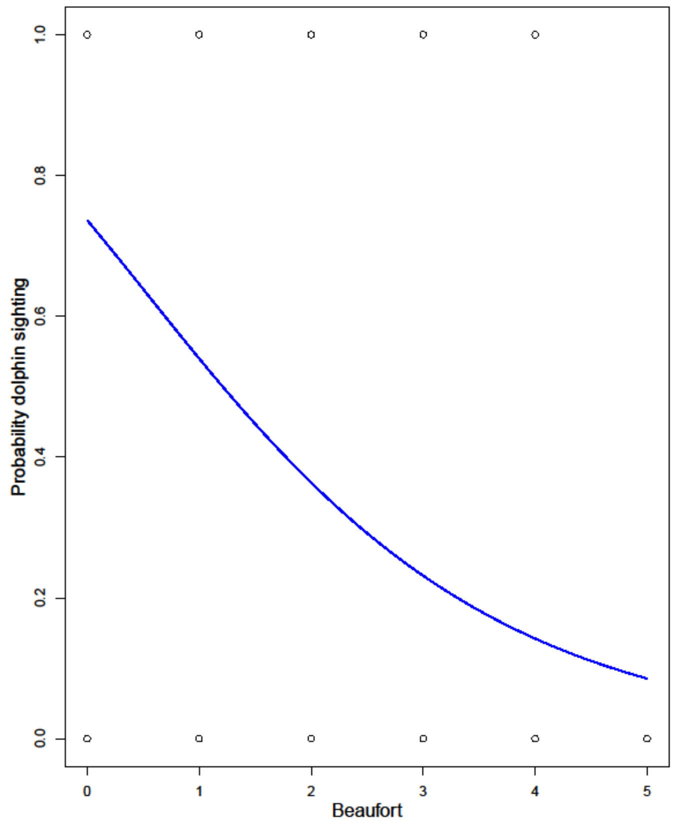

Figure 4. The effect of Beaufort on the probability of dolphin sighting

Encounter rates

To analyse the encounter rate with a correction of the bias on the boat survey effort, 282 grid cells were created in the survey area and only 100 grid cells were used during the analysis. The overall encounter rate was estimated on average 3,5 groups and 9,2 individuals per 100km in Montenegro.

Changes on group size

Variation in dolphin group size was best explained by a model taking season, time of the day, swim style and distance to the nearest marine vessel into account (AIC=2019). When the main effects were considered, season had a significant effect on group size with the lowest group size recorded in spring months with an average of 2 individuals in a group (sd=6.75e-2, z=-2.78, p<0.01), whereas, the highest group size on average was 3 in summer. Additionally, swim style was found to be highly correlated with group size (sd=1.26e-1, z=7.34, p<0.001), with an increase during kettle, team and varied styles (Figure 5). Distance to the nearest marine vessel alone had no significant effect on the variation in group size.

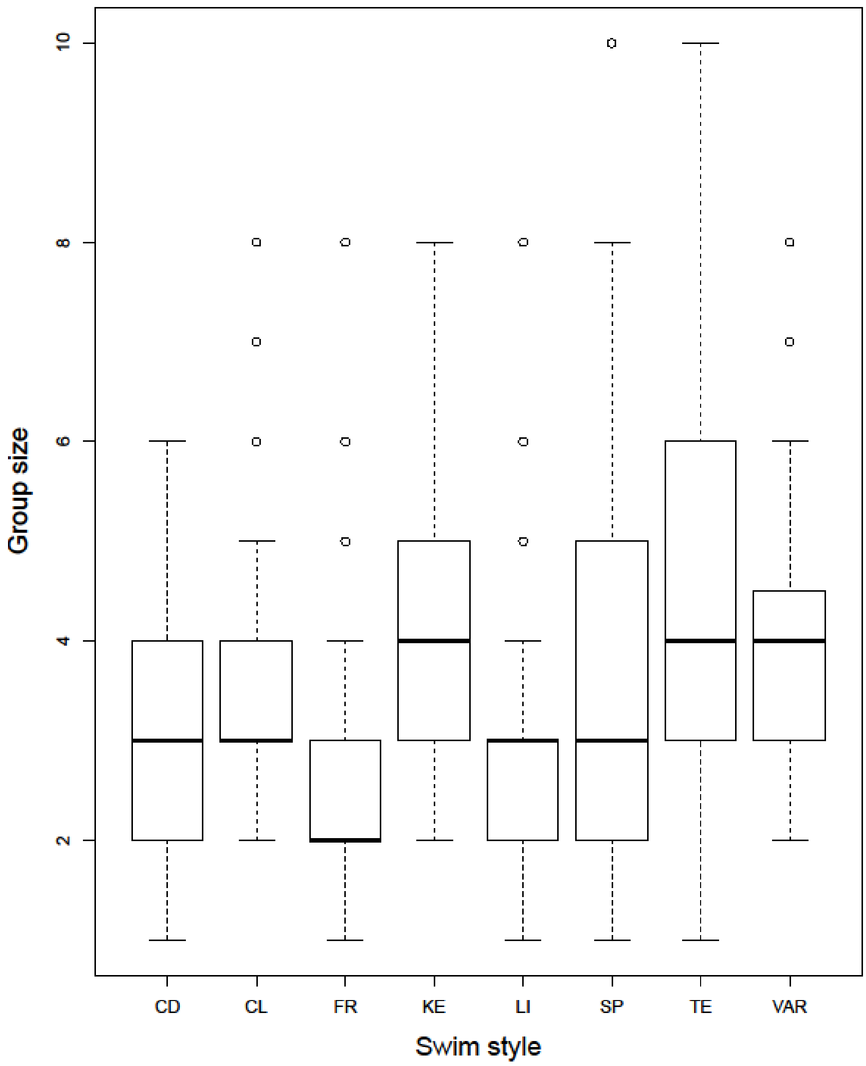

Figure 5. The variation on group size under different swim styles (CD=Circular Dive, CL=Cluster, FR=Front, KE=Kettle, LI=Line, Sp=Spread, TE=Team, VAR=Varied)

Variation on the behavioural patterns of bottlenose dolphins

According to the results of mixed effect log-linear Poisson regression models, behavioural variations were best explained by the interaction model of swim style, group size, season, vessel presence and distance to the nearest vessel. When only the main effects were considered, behavioural patterns varied significantly under group size ($sd=2.15e-2$, $z=-2.00$, $p<0.05$), season ($sd=1.08e-1$, $z=-2.31$, $p<0.05$) and swim style ($sd=2.01e-1$, $z=2.84$, $p<0.01$). However vessel related factors alone showed no significant effect on the behaviour.

Multinomial regression analysis of group size revealed a significant increase in the proportion of both socialising and resting ($z=6.82e-6$, $p<0.05$) and surface feeding behaviour ($z=2.62e-13$, $p<0.001$) as groups get bigger and a significant decrease on the group size during diving ($z=0.07$, $p=0.05$). Nonetheless, travelling behaviour showed to be unrelated to group size (Figure 6).

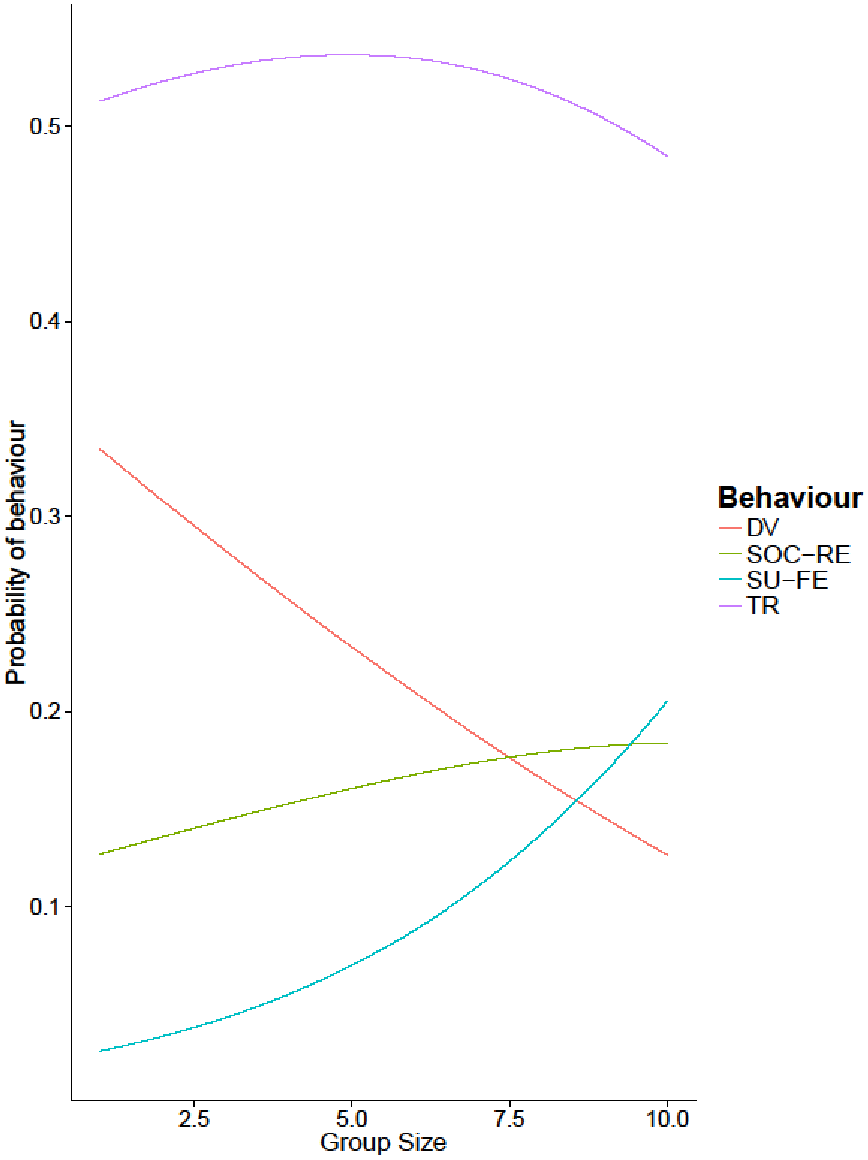

Figure 6. The relationship between group size and behaviours

Only socialising and resting behaviour were significantly affected by season, with an increasing probability of behaviour in autumn and winter ($z=3.05e-5$, $p<0.01$). The occurrence of diving, travelling and surface feeding between the seasons failed to show any significance ($p>0.1$). It is also important to note that despite the non-significant changes on their occurrence with season, travelling behaviour showed the highest recordings in spring and summer, contrary to surface feeding behaviour, with its highest recordings in autumn and winter months (Figure 7).

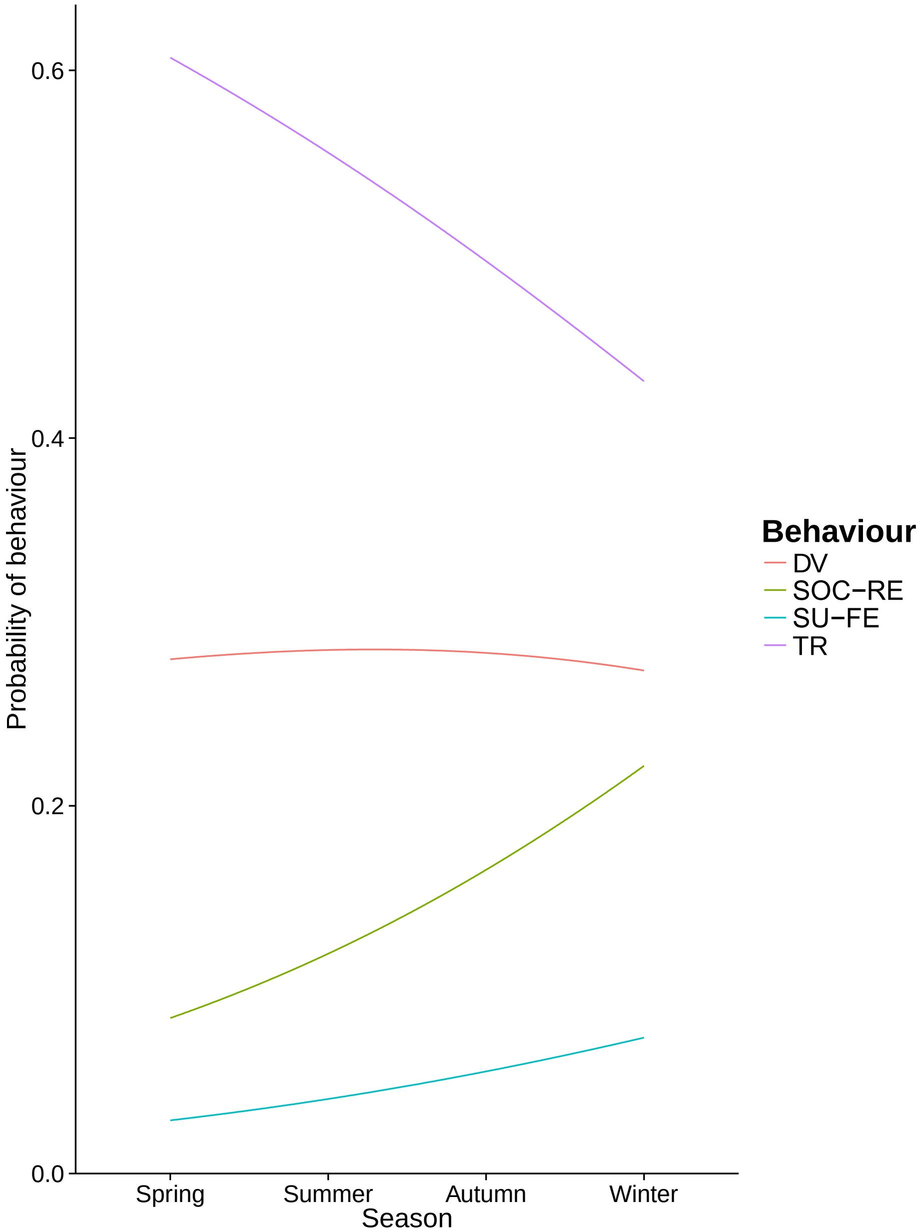

Figure 7. The relationship between behaviour and season

In addition, behaviour was significantly associated with swim style (sd=2.01e-1, z=2.84, $p<0.01$) (Figure 8). Diving was highly associated with the circular dives and spread swimming styles., Socialising and resting behaviours were generally recorded during the clustered style. Surface feeding behaviour was mainly recorded when the swimming style was kettle. Lastly, during travelling, their swimming formation was recorded as line, the majority of the time.

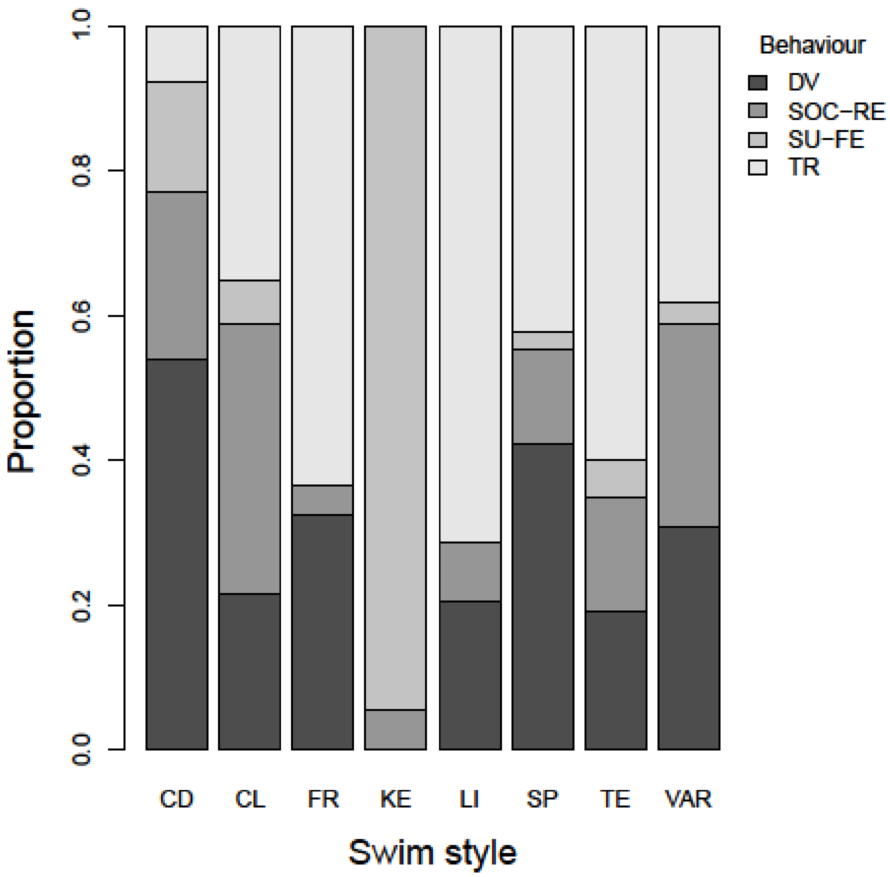

Figure 8. Changes on swim style related to the behavioural activities

Residency patterns and site fidelities of bottlenose dolphins

Overall, 50 individuals were catalogued in Montenegro, of which 15 individuals were re-sighted at least twice. The re-sighting of the individuals varied from 19 to 401 days. Regarding the re-sighting locations, seven and four individuals were re-sighted only on the south and north section respectively. Yet, four individuals were re-sighted in all sections from north to south, with a maximum re-sighting distance of approx. 80 km.

The monthly residency ranged between 0.07 and 0.29 with a mean of 0.10±0.05. On the other hand, the seasonal residency of bottlenose dolphins ranged from 0.20 to 0.60 with a mean of 0.25±0.10. The site fidelity index ranged from 0 to 0.3, with a mean of 0.06±0.10. Considering all the above results, hierarchical cluster analysis suggests that three main group of residency patterns were present in Montenegro (Table 6, Figure 9). Group 1 was composed of 6 individuals and hold high residency indices but comparably low site fidelity, thus classified as regular. Group 2 had 35 individuals with the lowest residency rates and site fidelity indexes. Group 2 individuals were only sighted once or multiple times in the same day with no follow up sightings in following days or months, thus classified as transient individuals. Whereas, Group 3 holds 9 individuals with the highest site fidelity and considerably high seasonal residency thus they have classified as frequent visitors.

Table 6. The mean seasonal and monthly residency indices and site fidelities of bottlenose dolphins according to the groupings of agglomerative hierarchical cluster analysis.

Group	Seasonal Residency	Monthly Residency	Site Fidelity
1	0.433	0.167	0.091
2	0.200	0.071	0.000
3	0.333	0.159	0.247

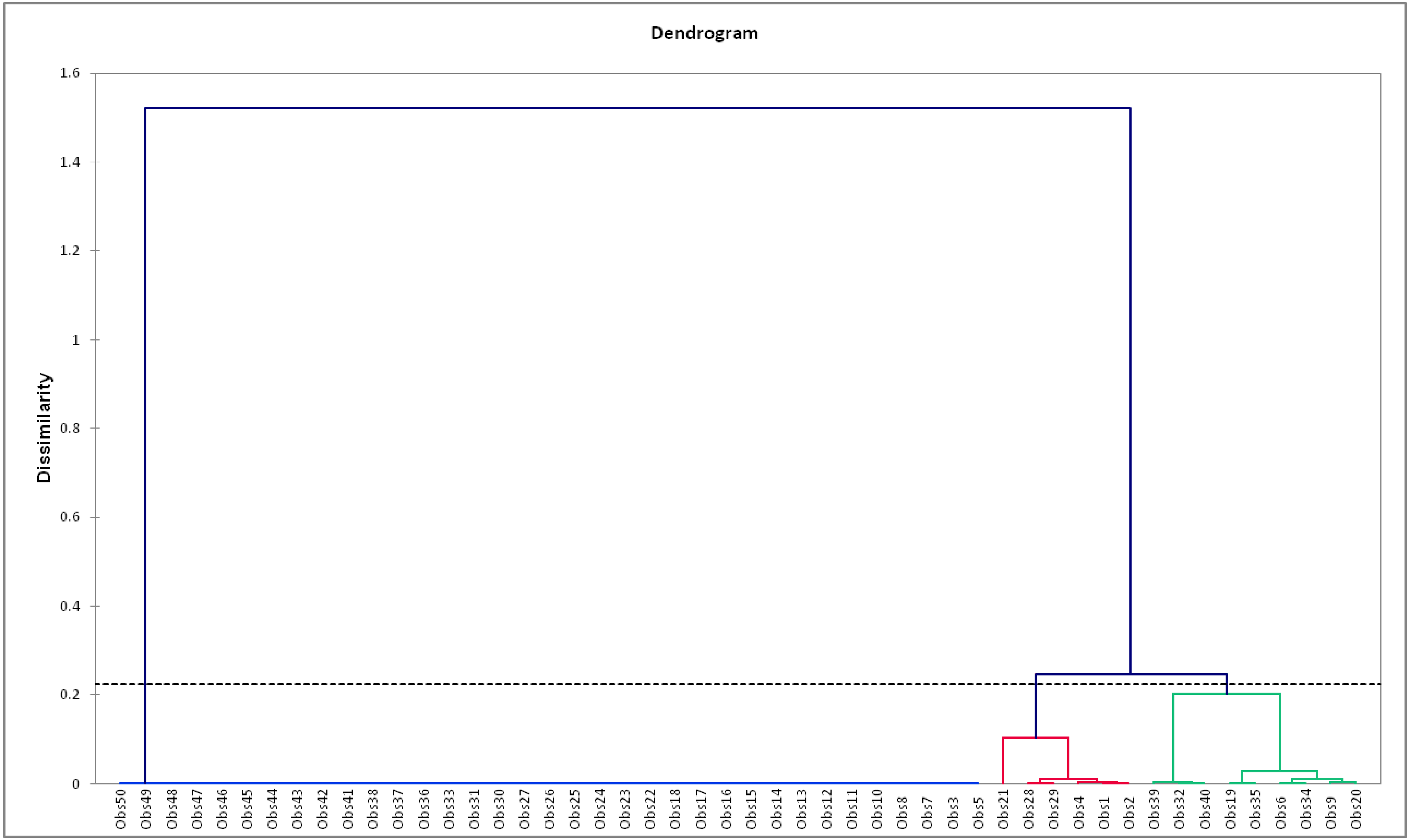

Figure 9. The dendrogram of the agglomerative hierarchical clustering analysis (Obs=Individual).

Body conditions and stranding records

According to the photographed individuals of bottlenose dolphins, the individuals showed no obvious marks of starvation signs. However one individual recorded with an abnormal tissue development on the right side of its body (Picture 1). Regarding to the direct consequences of human interactions, one individual dolphin recorded with a plastic bag around its blowhole (Picture 2). Another individual, called Tangled, suffered from an entangled rope around its tail and fractured his tail either during or after the entanglement (Picture 3). Tangled were photographed in six different dates by our research team in Kotor Bay in summer 2017 and also its presence were reported by the locals. During each encounters, Tangled were spotted alone and close to the human settlements, ports and boats.

Picture 1. Bottlenose dolphin with an abnormality.

Picture 2. A dolphin entangled with a plastic bag

RESULTS

Picture 3. "Tangled" with an entangled rope on the fractioned tail.

Additionally, to our knowledge, between 1999 and 2001, three dead dolphins were stranded in Kotor bay, Bigova and Herceg Novi, Montenegro. The post-mortem examination determined the cause of death was from firearms and dynamite fishing, respectively. In 2008, another dolphin washed ashore in the beach of Igalo. It was probably killed deliberately since the fins were cut off and assumingly kept as a trophy. Another dead dolphin, stranded in 2013 near Tivat, was thought to have drowned in fishing gear (Đurovic et al., 2016). Two more strandings were recorded in 2017, with one of them recorded as striped dolphin on the 10th of April in Budva. The cause of death was assumed to be related to dynamite fishing (Picture 4). Latter, a highly decomposed dolphin carcass found drifting in the sea on the 12th of October in Budva (Picture 5).

Picture 4. Stranding of a striped dolphin

Picture 5. Dolphin carcass

Dolphin density maps

According to the results of our study, south section of Montenegro (Ulcinj and Utjeha) has the highest density recordings of bottlenose dolphins. Additionally, north section of Montenegro, specifically the entrance of Boka Kotorska Bay also holds important density of bottlenose dolphins in its waters (Figure 10a). It is important to highlight that south section also holds the highest survey effort (Table 5), which is the likely reason of high sighting rate. Bottlenose dolphin presence is confined mainly to coastal areas, with a range of up to 80 m depth and their maximum distance to the nearest coast was recorded as 8 km. Regarding the striped dolphins, their highest density recorded 30 km of the coast (Figure 10b). However, their high coastal presence was also recorded in the south and north section of Montenegro, mainly in the coastal waters of Herceg Novi and Ulcinj. Their depth preference ranged from 10 m depth waters up to 450 m depths. However, it is important to consider that the hotspots highlighted by this map are representative of our sampling locations and the nature of the surveys, with south section notably surveyed more than the rest of the sections.

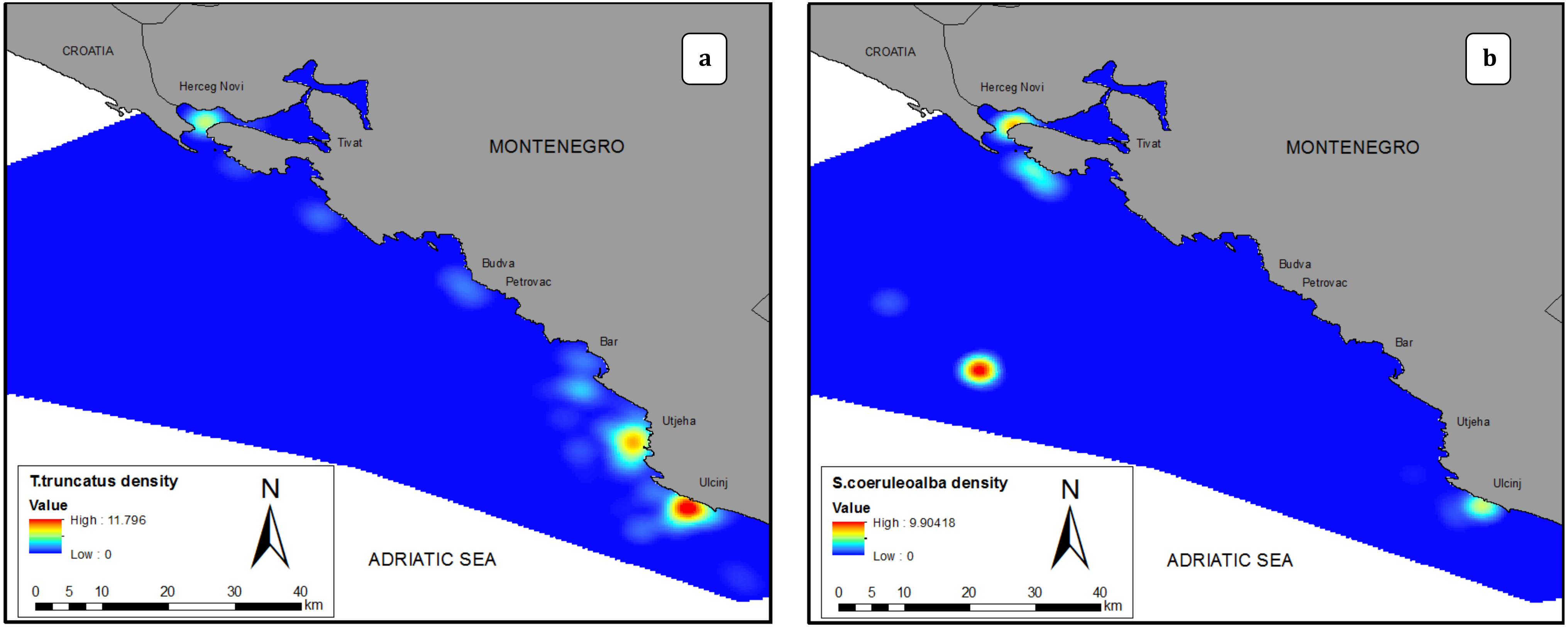

Figure 10. Density distribution of (a) bottlenose dolphins (b) striped dolphins in the survey area.

Discussion

The current study followed a standardised scientific research approach with a similar monthly survey effort between September 2016 and October 2017, with over 200 survey days spent within the coastal and territorial waters of Montenegro. The data gathered forms the first results of an annual survey effort in Montenegro and aims to fill the baseline knowledge gaps for much needed effective conservation and management strategies that are highlighted in each report (Đurovic 2009; Fortuna et al., 2015). This particular report provides results on species sighting proportions, encounter rates, important cetacean habitats (hotspots), behavioural patterns, group cohesion, residency patterns, site fidelity, general body condition and stranding events of dolphins in Montenegro.

However, before moving on to the study results, a number of limitations in the methodology should be highlighted to carefully review all the results presented and to assess the potential of this study in the long term. Firstly, the survey coverage wasn't equal throughout Montenegrin territorial waters, with a concentrated effort in the south of Montenegro, between Bar and Ulcinj. Therefore species distribution maps should be read with caution as the range of delineated important habitats is likely to be wider than what is mapped in this study. Secondly, there were days when dolphins were present but their coordinates could not be recorded through theodolite which is likely to cause an underestimation on their density maps. Lastly, there were also days when dolphins were sighted but photo-identification images could not be collected or had high proportion of unmarked individuals that did not allow neither categorising the image nor matching. This challenged our residency pattern analysis and may increase the chance of false positive or negative errors. Nevertheless, this study is the first implemented year round study with a substantial survey effort (more than half a year), which is likely to decrease the power of the possible biases on the conclusions. Keeping in mind the importance of multiyear continuous survey effort with a similar methodology on the result accuracy, the current study will continue until 2020, with equal survey coverage from the north to the south of Montenegro for an accurate distribution mapping and abundance analysis.

Sightings

The current study shows that sighting proportion of bottlenose dolphins were steady throughout the seasons, with a slight increase during autumn and winter months in Montenegro. Previous year-round projects in the northern and central Adriatic Sea highlighted that bottlenose dolphins are permanent residents and do not seem to show different seasonal distribution patterns in these portions of the basin (Genov et al., 2008; Pleslic et al., 2013; Fortuna et al., 2015; Genov et al., 2016; Rako-Gospic et al., 2017). Current results confirm that Montenegro waters also show a similar pattern with regular year round presence of bottlenose dolphins, rather than seasonal area usage. Moreover, their current sightings were concentrated in the coastal waters and no recordings were made below 100 m depth, which also coincides with the previous studies from the Mediterranean Sea (Bearzi et al., 2008b; Genov et al., 2008; Notarbartolo di Sciara 2016). Despite sporadic sightings, striped dolphins were observed in every season, with a depth zone ranging from 10 m shallow waters up to 450 m depth. Đurovic (2009) reported a high sighting rate of striped dolphins from the Montenegrin offshore waters during the NETCET study-Network for the Conservation of Cetaceans and Sea Turtles in the Adriatic. NETCET study was conducted only in summer 2013, therefore the results were likely representing their summer presence, related to the survey duration. Nevertheless, striped dolphins are considered one of the most abundant species in the Mediterranean Sea, specifically in the offshore waters (IUCN, 2012), contrary to their recordings in the Adriatic Sea (Bearzi and Nortabartolo di Sciara, 1998; Rako et al., 2009). However it is important to point out that there are more frequent reports of striped dolphins in the Adriatic Sea in the last two decades, despite the low research effort on the offshore waters (Rako et al., 2009). Therefore, future survey effort should be directed to the offshore waters with inter-regional collaborations between the neighbouring countries to understand the distribution range of striped dolphins.

Distribution

The southern coastal waters of Ulcinj and Utjeha, and northern waters of the Boka Kotorska Bay, revealed a high species presence. The delineated high density areas (Figure 10a) were also highlighted with the highest encounter rates of bottlenose dolphins during the NETCET study conducted in Montenegro in 2013 (Fortuna et al., 2015). Striped dolphins, on the other hand, were recorded in both offshore and coastal waters with a concentrated distribution on the offshore waters of Bigova. Interestingly, their current distribution showed a notable overlap with the previous study conducted by NETCET as well (Figure 10b) (Fortuna et al., 2015).

Encounter rates

The current study estimated the encounter rate of bottlenose dolphins at four groups (nine individuals) per 100 km for the whole Montenegrin waters. Previous encounter rate analysis revealed it between 1-10 groups per 100 km for Ulcinj, Utjeha (south section) and Boka Kotorska Bay (north section), with the highest individual number of 101-302 per 100 km in the south section. Interestingly, it was only between 1 to 20 individuals per 100 km on the entrance of Boka Kotorska Bay (Fortuna et al., 2015). This variation on the encounter rate estimation between the current and former studies, could originate from the survey method, analysis and/or survey duration. Firstly, the current study reported the overall encounter rate for Montenegro while the previous study investigated the subject per site. Secondly, the current study was conducted with a similar monthly survey effort for a whole year, the previous study was conducted for three weeks in summer and the difference in estimate could just be a reflection of the monthly changes in area usage or the variation in survey methodology and its analysis. However, future studies, following consistent methodology and analysis, are needed to get an accurate estimate of the actual encounter rates.

Group size

On average bottlenose dolphins formed groups of 4 individuals. Interestingly, there was also a high sighting rate of lonely individuals of bottlenose dolphins during the study, which formed over 20% of the total recordings. While the reported mean group size of bottlenose dolphins matched previous NETCET project results (Fortuna et al., 2015), it was slightly lower compared to neighbouring countries, where the average group size was reported to lie between 5 and 8 individuals (Bearzi et al., 1997; Genov et al., 2008). With respect to striped dolphins, the current study estimated a mean group size of 8 individuals. This number is considerably lower than previous recordings (Fortuna et al., 2015). Even though their occasional sightings revealed a single to few individuals (Bearzi et al., 1998; Francese et al., 2007; Rako et al., 2009), a previous NETCET study reported a mean group size of 21 individuals in 2013 (Fortuna et al., 2015), whilst it was reported at 12.5 in 2010 for the whole Adriatic (Fortuna et al., 2011). Therefore there is a visible fluctuation in reported group size of striped dolphins between the years, yet the results should be considered with caution as the current study focused only on Montenegrin waters, whereas the previous mentioned studies targeted the whole Adriatic. Fortuna et al., (2011) also highlighted that despite the low sighting rates of striped dolphins in the north part of the Adriatic; they appeared to be common in the south Adriatic (Fortuna et al., 2011).

The current study also investigated several parameters that can explain the variation in the group size of bottlenose dolphins and found out that the aggregation of individuals in a group depends on several parameters together: season, time of day, group cohesion and the presence of vessels. These results may explain the large variability in recorded group size estimates. Group formation is a complexity and fluid process affected by many factors, from the social state of the group itself to the environmental and anthropogenic conditions of the area.

Behaviour

Travelling and diving were the most recorded behavioural activities of bottlenose dolphins, whereas surface-feeding behaviour was rarely recorded. Travelling behaviour can be linked to actual spatial movements but may also be defined as travelling for prey. Indeed, in several situations dolphins did not move considerably from the original spotted area, despite the recorded behaviour being travelling. On the other hand, diving behaviour is most likely to be related to the foraging activity of bottlenose dolphins. Previous study on the diurnal behaviour of bottlenose dolphins also highlighted that the majority of the behavioural budget was made of long dives, with rare recordings of near-surface foraging behaviour in the northeastern Adriatic Sea (Fortuna et al., 2015). These results do indeed overlap with the current findings.

Season

Travelling and diving were the most recorded behaviours in each season, with no considerable changes between the seasons, socialising and resting behaviour notably increased in autumn and winter. Additionally, surface-feeding showed a slight increase in autumn and winter. The dominance of travelling and diving over other behaviours indicated that Montenegro serves both as a foraging ground and migration route year-round. It is also important to highlight that travelling behaviour is also likely to be related to "travelling in search of food", rather than undertaking long distance movements.

Group size and Group formation (Swim style)

While diving behaviour showed negative correlation with group size, the probability of surface feeding, socialising and resting behaviours increased with increasing group size. Our results, support the theory that group size is balanced by the benefits and costs of aggregation numbers (Heithaus & Dill, 2002). The increased group size during surface feeding is likely related to a foraging strategy reliant on group hunts to increase the chance of prey capture. Conversely, the decreased group size during diving could be linked to increased chances of locating prey sources where the food distribution is known to be patchy. This hypothesis is supported by the group formation preferentially adopted during diving: spread. This variation in group size during diving and surface-feeding, two behaviours closely linked to prey capture, is expected to be advantageous for the group by providing more opportunities to capture food. Additionally, due to their highly social nature, bottlenose dolphins are indeed expected to display an increase in group size during socialising behaviours. Lastly, increased group size during resting is likely due to increased protection from predators via higher alertness levels. Both during socialising and resting, dolphins were dominantly recorded in clustered group formation, with close proximity to each other. In conclusion, group formation is closely linked to the behaviour that the group is engaging and an external impact on the group formation is likely to affect the group behaviour.

Marine vessel presence

Even though vessels had an impact on behaviour in the interaction model, they failed to show significance alone. Yet, it is important to note that travelling behaviour showed a clear pattern of decrease and foraging behaviour showed an increase with increasing distance to the nearest vessel. Moreover, socialising and resting behaviours were recorded notably less often as the amount of vessels within 100 m radius of dolphins increased. Additionally, even though bottlenose dolphins tend to avoid marine traffic, they have been recorded following trawlers on several occasions in the current study. Bottlenose dolphins regularly feed on demersal and pelagic species that are also targeted by the trawlers (Fortuna et al., 2015). This behavioural conditioning towards trawlers has been documented in previous studies from Adriatic Sea (Genov et al., 2008; 2009). This conditioned behaviour has given rise to new foraging strategies, such as begging, depredation and scavenging. Despite the immediate benefit of foraging in the vicinity of trawlers, it comes with severe costs ranging from injuries to death (La Manna et al., 2013).

Residency patterns and site fidelity

Photo-identification analysis revealed the presence of 50 individual bottlenose dolphins within Montenegro's waters between 2016 and 2017. Of these, 15 individuals were re-sighted. Interestingly, while some individuals were recorded localised in certain areas, four individuals were recorded both on the southern and northern waters, with a maximum re-sighting distance of 80 km. Thus, bottlenose dolphins not only prefer particular areas in Montenegro but also use the whole coastline. In an addition note, Genov et al., (2016), reported the maximum distance of re-sighting from the original location as 130 km in the Northern Adriatic.

High numbers of transient dolphins with single sightings were recorded during the current study. This can be linked to their movement range, with Montenegro potentially forming a corridor for movement. However, the current study is too young to make strong conclusions as the observed high numbers could simply be the result of a relatively short study period. Alternatively, the individuals could have been present but were never re-photographed, as there were days when dolphins were sighted but photo-identification images of all individuals was not collected. Nevertheless, there were recordings of regular and frequent visitor dolphins on a multi-yearly bases. These regular individuals are likely part of a bigger population. To estimate the actual individual numbers and to understand if the re-sighting range is larger than the borders of Montenegro, inter-collaborated research effort in photo identification between the neighbouring countries is of paramount importance.

Conclusion

The current study undertook the first year round, dedicated survey effort in Montenegro, to understand and review the cetacean populations of its waters for the sole purpose of contributing the development of meaningful conservation efforts in the face of rapidly increasing human pressure. Baseline knowledge on species distribution, encounter rates, behavioural variations, residency patterns, general body condition and marine traffic presence was gathered from the coastal and offshore waters of Montenegro between 2016 and 2017 to delineate important dolphin habitats. During this particular study, bottlenose and striped dolphins were regularly sighted throughout seasons within the Montenegrin waters, with varying degrees of area preference. Despite the slightly lower encounter rate of bottlenose dolphins when compared to neighbouring countries, this habitat reveals notable re-sighting numbers between and within years, as well as high presence of foraging, socialising and resting behaviours. Specifically, the coastal waters of Montenegro appear to hold several hotspots for bottlenose dolphins. Nonetheless, it is highly likely that offshore waters also hold important cetacean habitats, in particular for striped dolphins. To understand the importance of offshore waters for species distribution, this study will extend its survey coverage in 2018.

The high preference of the coastal waters by both cetaceans and humans results in strong conflicts of area use, with negative consequences to the dolphin species and their environment (Micheli et al., 2013; Merchant et al., 2014). Coastal tourism forms a significant source of income relative to the Gross Domestic Product (GDP) of Montenegro (Fortuna et al., 2015). Additionally, the presence of nautical tourism and the resulting maritime traffic considerably increased in the last ten years in the Adriatic but Montenegro holds moderate importance on the maritime tourism intensity compared to the other Adriatic countries (Fortuna et al., 2015). All the aforementioned tourism activities show a sharp increase in the summer and spring seasons in Montenegro. Interestingly, the same seasons hold the lowest cetacean sightings, although it was not found to be statistically significant. The seasonal variation in sighting number could be related to prey availability, favourable environmental conditions and/or increased tourism activities. While we are unable to evaluate the single most important reason for the seasonality in sighting rates, the negative consequences of unregulated and uncontrolled tourism activities on dolphin population are well documented (Bryant et al., 1984; Barr and Slooten, 1999; Bejder and Samuels, 2003; Constantine et al., 2003; Lusseau, 2004; Christiansen et al., 2010). Therefore, a focused study on the potential interaction between dolphins and touristic activities is crucial to understanding the effect of tourism and to develop effective conservation measures before anthropogenic pressure causes a significant variation in sightings between seasons (Lusseau et al., 2005; Bejder et al., 2006; Bas et al., 2015).

Additionally, overfishing, dynamite fishing, by-catch, direct takes, hydrocarbon exploration and marine pollution are the main areas of concern affecting the dolphin populations of Montenegro (Fortuna et al., 2015). It is worrying to note that the direct consequences of the above threats have also been documented during this study. Montenegro is bound to protect the cetacean populations in its waters by national (O. Gazzete 62/13) and international legislation, conventions and agreements (Bern, Barcelona, CMS, CBD, ACCOBAMS and several EU legislations). Montenegro became a partner country of ACCOBAMS in 2008 for cetacean conservation. Yet, no management actions or Marine Protected Areas exist to this day. This is partly due to the paucity of available data in the area. Identifying critical habitats for cetaceans, in particular those holding unique functions such as foraging and resting, is the first step towards Marine Protected Area implementation and management (Hoyt 2005).

Accordingly, the current study recommends several key points be addressed for effective, accurate and sustainable marine conservation efforts, using cetacean as flagship species:

- Dedicated projects with standardised data collection protocols and joint collaborations between research institutes within and amongst countries has to be implemented foremost. Even though the need for collaboration has been highlighted in several publications, the isolation of researchers and institutes on the subject has not abated. The effective conservation of highly mobile species like cetaceans can only be possible with projects that go beyond the boundaries of countries or the sense of ownership.

-The increase occurrence of key behaviours, such as foraging and resting, as well as the notable increase on the sighting rates in autumn and winter should urge management authorities to put a particular emphasis on the coastal zones of Ulcinj, Utjeha and Boka Kotorska Bay.

-Knowing that tourism is of critical importance to the economy of Montenegro, management authorities should promote eco-tourism activities which will protect not only the income level but also cetaceans and their environment.

-Even though dynamite fishing is illegal in Montenegro it still occurs frequently. Therefore, management authorities should increase patrolling along the coastline to prevent severe irreversible damage to the marine ecosystem as a whole.

-The general public of Montenegro and its local and international tourists displayed high interest in marine protection during the awareness campaigns that this project undertook. Yet it is apparent that majority of people who were interviewed, were not aware that Montenegro holds cetacean species in its waters. Therefore, public awareness campaigns on the marine environment and its protection should increase, targeting both the local populations and tourists, since the general public has a stronger hand in nature conservation than any legislations ever will.

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