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Montenegro Dolphin Research Annual Report on

Bottlenose and striped dolphins of Montenegro

An insight into sighting variations, behavioural patterns, photo-identification, core habitats, marine traffic and conservation initiatives

2017-2018

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Marine Mammals Research Association

Foreword

Marine Mammals Research Association - Deniz Memelileri Araştırma Derneği (DMAD) (www.dmad.org.tr) is a dedicated NGO that aims to promote the conservation of marine mammal species and their associated habitats in locations where the baseline knowledge of marine top predators is scarce. DMAD undertakes a combination of activities from academic research to public engagements and social awareness campaigns. From the eastern Mediterranean to the southern Adriatic Sea, each of our study areas aims to address a variety of questions regarding the relative abundance and distribution of cetacean species, species behavioural budgets and the anthropogenic threats each species is faced with. The ultimate goal is to propose mitigation and conservation strategies as a tool to minimise the impacts of marine traffic, tourism, habitat destruction, seismic and fishing practices.

The Adriatic Sea is identified as a marine hotspot within the Mediterranean Sea. Yet, for certain species, including cetaceans, populations have declined by up to 50% in the last 50 years due to anthropogenic pressures. Montenegro itself, has a high level of tourism activities, marine debris and illegal dynamite fishing activities within its waters. Representing one of the most vulnerable deep waters, the territorial waters of Montenegro have recently been targeted by the oil and gas industry for the exploration and exploitation of hydrocarbons. Therefore, constant monitoring is essential to minimise and mitigate the negative consequences at both species and ecosystem level.

In order to address this necessity, Montenegro Dolphin Research, whom have conducted around 400 days of survey effort purely in Montenegrin waters, have run dedicated surveys since 2016 to fill current knowledge gaps and to engage with stakeholders. We have one single goal in mind: to encourage the implementations of Marine Protected Areas with applied conservation strategies for sustainable tourism, fishing practices and mitigated seismic activities within the country and neighbouring waters.

Nevertheless, the dedicated research and conservation effort of Montenegro Dolphin Research is not enough by itself for the effective protection of our marine environment. Protection of our nature can only be sustained when mutually respectful relationships are developed regardless of boundaries or borders. We therefore stress the importance of collaborative research both within and between countries, in order to achieve a common goal: A better future for us, for our oceans and the species within them. We believe this can only be achieved if we all do this, TOGETHER!

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Summary

The Adriatic Sea is home to five cetacean species, classified as at risk by the IUCN. Bottlenose dolphins (*Tursiops truncates*), striped dolphins (*Stenella coeruleoalba*), Risso's dolphins (*Grampus griseus*), Cuvier's beaked whales (*Ziphius cavirostris*) and fin whales (*Balaenoptera physalus*), are all identified as species in which the community has a vested interest and are under strict protection by the Montenegrin Government and by law. Since 2016, our studies, alongside existing data, have demonstrated the presence of resident bottlenose and striped dolphins in Montenegro, in addition to sightings of Cuvier's beaked whales and Risso's dolphins in its offshore waters. The regional status of species, assessments of threats and future conservation efforts can only be determined with dedicated and systematic surveys. Further, the Adriatic Pit, the deepest region of the entire Adriatic, holds the highest levels of biodiversity, whilst also being one of the most vulnerable regions to anthropogenic threats.

The purpose of our survey effort is to expand upon the data we have already acquired within the coastal and offshore waters of Montenegro to cover data deficient species such as Cuvier's beaked whales and Risso's dolphins and to explore the possible presence of common dolphins that were thought to be regionally extinct until recent sightings in the summer of 2018 by the Blue World Institute.

As a result of the necessity for economic growth, Montenegro is rapidly developing its tourism industry and more recently, the country has participated in oil and gas explorations. Yet any human activities that remain unregulated, are likely to form severe threats to marine species and their associated habitats. Therefore, our research and conservation outcomes form one of the most important steps towards effective conservation strategies, which promote not only the protection of nature, but also sustainable economic growth. For this reason, our project continues its dedicated survey effort in 2019, covering both the coastal and the offshore waters of Montenegro. Coupled with the recent addition of our sighting and stranding networks, we hope to aid the relevant authorities in the creation of regulation measures for the benefit of both nature and the economy.

The dedicated survey effort of Montenegro Dolphin Research revealed the annual presence of bottlenose dolphins within coastal waters of Montenegro, with the Boka Kotorsko Bay hosting a high density of dolphin presence independent of season. Even though the sighting proportion for each season is around 36%, there is little significant variation between seasons. The northern region of Montenegro, (mainly the waters of Herceg Novi) is shown to be significantly more likely to have sightings compared to the central and southern waters of Montenegro. Furthermore, our photo identification study identified 72 individuals, with variations in their residency patterns. Additionally, the re-sighting rate of individuals and their site fidelities were very high, underlining the importance of Montenegrin waters for its bottlenose dolphin population. Striped dolphins were also documented sporadically in the offshore waters of Montenegro, which is likely to be the result of isolated survey efforts in offshore waters. The distribution and residency patterns of striped dolphins can only be fully understood with further dedicated survey effort towards offshore waters. The majority of the encountered groups, both for bottlenose dolphins and striped dolphins, were engaged in diving and travelling behaviours, which once again indicates that the area is likely to hold an important migration corridor between the neighbouring waters, as well as its importance as a foraging ground. Further, it is important to highlight that the majority of the sighted bottlenose dolphin groups hold several sub-adults, underlining the importance of Montenegrin and its adjacent waters containing possible nursing

grounds. Socialising and resting behaviours were the least recorded within Montenegro for bottlenose dolphins. Nevertheless, socialising behaviours of striped dolphins were recorded in deep waters.

Lastly, when marine traffic distribution and the presence of dolphins were mapped, the core bottlenose dolphin habitats overlapped with areas of dense marine traffic, resulting in the likelihood that several negative impacts ranging from ship strikes to noise pollution could occur. However, further studies are necessary in order to examine the effect of each threat on the populations. Striped dolphins appeared to have a lower occurrence of interaction with marine traffic. Despite this, their habitat is currently under the pressure of seismic activities related to oil and gas exploration, signifying the necessity for understanding both the short and long term effects of seismic practices in Montenegro.

Montenegro Dolphin Research remains the first, and continues to be, the only annual cetacean monitoring project in Montenegro. By combining dedicated research effort with stakeholder engagement, not only will our understanding of cetacean populations in Montenegrin waters be considerably enhanced, but also our ability to turn this knowledge into a subsequent management plan. By establishing networks and producing influential documentation within the community, the conservation implications will be more effective and longer lasting.

Contents

1. Introduction

1.1. Adriatic Sea and Mediterranean Basin

The Adriatic Sea is a semi-enclosed sea situated in the northernmost region of the Mediterranean Basin (Cushman-Rosin et al., 2001). Separated into three sections; the northern, central and southern Adriatic, the overall basin itself has an asymmetrical bathymetry and vertical water properties which demonstrate homogeneity (Artegiani et al., 1997; Cushman-Rosin et al., 2001). The northern Adriatic spans from the northern most point of the basin to the 100 metre isobath which separates the northern and central Adriatic (Artegiani et al., 1997). The central Adriatic represents a transition zone from the 100 m isobaths to the Pelagosa sill, which separates the Central and Southern Adriatic (Artegiani et al., 1997; Cushman-Rosin et al., 2001). This transition zone has some open sea characteristics, such as seamounts and fractures, containing the Pomo Depressions at a depth of 250 metres (Russo & Artegiani, 1996; Artegiani et al., 1997). The southern Adriatic basin however, is a much deeper sub-basin of the Adriatic, mainly characterised by its greater salinity and deeper waters in comparison with the other sub-basins (Cushman-Rosin et al., 2001). Starting at the Pelagosa sill and ending at the Otranto channel, the maximum depth of the southern sub-basin reaches 1200 metres (Artegiani et al., 1997; Cushman-Rosin et al., 2001), also known as the Southern Adriatic pit (Grbec et al., 1998). Seasonal changes in deep-water production and cyclonic gyres at varying thermohaline gradients in the southern Adriatic, make it an important habitat hosting multiple benthic, pelagic and neritic species (UNEP-MAP-RAC/SPA, 2015).
Given the relatively small area and large variation in bathymetry and salinity across the whole Adriatic, the region offers a wide range of ecosystems, pinpointing it as a biodiversity hotspot within the Mediterranean (Coll et al., 2010; UNEP/MAP, 2012). Within the Mediterranean itself, Cuvier's beaked whale (*Ziphius cavirostris*), Fin whale (*Balaenoptera physalus*), Sperm whale (*Physeter microcephalus*), Common Bottlenose dolphin (*Tursips truncatus*), Striped dolphin (*Stenella coeruleoalba*), Risso's dolphin (*Grampus griseus*), Short-Beaked Common dolphin (*Delphinus delphis*) and Long-Finned Pilot whale (*Globicephala melas*) (Holcer, 1994; Holcer et al., 2002; UNEP-MAP-RAC/SPA, 2014) can be found throughout. Whilst, Killer whale (*Orcinus orca*) are only present in the Strait of Gibraltar, Rough-Toothed dolphins (*Steno bredanensis*) only reside in the Levantine and Harbour Porpoise (*Phocoena phocoena relicta*) only inhabit the Aegean Sea and Black Sea (Birkun & Frantzis, 2008; Notarbartolo di Sciara & Birkun, 2010; UNEP-MAP-RAC/SPA, 2014). Current knowledge on the status of cetacean species in the Mediterranean suggests that species known to be present across the Mediterranean are recorded in different densities to the Adriatic.

1.2. Cetacean Species, Population Statuses and Main Threats

Studies have shown the common bottlenose dolphin to be one of the most common marine mammal species found regularly in the Adriatic (Bearzi et al., 1997). Long term studies in Slovenia (Genov et al., 2008; 2009; Halpin et al., 2009; Genov, 2013), throughout Croatia (Impetuoso et al., 2003; Fortuna et al., 2011; UNEP-MAP-RAC/SPA, 2014; Gaspari et al., 2015; Pleslic et al., 2015; Ribarič, 2018), Italy (Bearzi & Fortuna, 2006; Bearzi et al., 2008; Genov, 2016) and most recently Montenegro (Fortuna et al., 2011; Đurovic et al., 2016; Bas et al., 2018; Affinitio *et al.*, 2018), demonstrate the species to be widely distributed throughout the entire Adriatic. Unfortunately, due to extermination and directed kill campaigns in the 1960's alongside long-term bycatch mortality (Bearzi *et al.*, 2008), the species Mediterranean subpopulation is listed as 'vulnerable' under the International Union for Conservation of Nature (IUCN) Red List criteria (Bearzi et al., 2012). Ongoing threats are thought to be decreasing the Mediterranean sub-population in recent years, which currently stands at less than 10,000 individuals (Bearzi et al., 2008; Gonzalvo et al., 2013), however, the overall population size for the Adriatic itself remains unknown. Commercial fisheries target the same species as bottlenose dolphin prey species, thus increasing both the risk in the number of dolphins being caught as bycatch and increasing prey depletion as a result of overfishing (Bearzi, 2002; Bearzi et al., 2008; Ribaric, 2018). Reduced prey availability is thought to be an explanation as to why bottlenose dolphin densities are reduced in the Adriatic and Ionian Sea's in comparison with the rest of the Mediterranean (Bearzi et al., 2008). Increased boat and acoustic disturbances in recent years have increased the potential for behavioural disruptions and habitat loss. Widely documented interactions between bottlenose dolphins and anthropogenic vessels have resulted in negative impacts on their behaviour and critical habitats (Lusseau, 2003; Lusseau & Higham, 2004; Arcangeli et al., 2008; Christiansen et al., 2010; Gonzalvo et al., 2013; Pennino et al., 2016; Bas et al., 2017), whilst seismic air gun use and marine construction practises are also concerning (Nowacek et al., 2007; Finneran et al., 2015).

Striped dolphins are thought to be the most widely distributed cetacean species in the Mediterranean, found in deep waters both towards the coastline and beyond the continental shelf (Aguilar, 2000; IUCN, 2012; UNEP-MAP-RAC/SPA, 2014; Bas et al., 2018). In the Adriatic, their distribution can predominantly be found across the entire Southern Adriatic sub-basin (Fortuna et al., 2011; UNEP-MAP-RAC/SPA, 2014; Notarbartolo di Scaria, 2016). Although their population size is unknown, under IUCN Red List criteria, the species is listed as 'vulnerable' for the Mediterranean due to the range of threats they are susceptible to and limited conservation actions taking place to protect the species (Aguilar & Gaspari, 2012). Enzootic viruses particularly affect striped dolphins and Morbillivirus endemics in 1990-1992 and 2006-2007, affecting the coastlines of Spain, France and the Italian Ligurian Sea, both saw mass strandings of striped dolphins (Aguilar & Raga, 1993; Garibaldi et al., 2008; Raga et al., 2008; Aguilar & Gaspari, 2012). Reports of striped dolphin entanglement are thought to have devastated the overall Mediterranean population in the early 1990's. The Spanish driftnet fishery in the Alboran Sea reportedly killed 148-170 dolphins per year, whilst in 2001, a report was released stating French driftnet fisheries killed an estimated maximum of 472 striped dolphins per season (Tudela, 2003). In contrast, little knowledge or information on bycatch has been documented on these threats for the Adriatic population.

The abundance of Risso's dolphins is unknown for the Mediterranean, although their sightings are frequent throughout (Frantzis et al., 2003; Azzellino et al., 2008; Notarbartolo di Scaria & Birkun, 2010; Bearzi et al., 2011; Gaspari & Natoli, 2012; UNEP-MAP-RAC/SPA, 2014). With their preference for deep water and steep continental shelf slopes (Azzelino et al., 2008), several sightings during aerial surveys from 2010 and 2013 also confirmed their presence in the southern Adriatic (UNEP-MAP-RAC/SPA, 2015). Basin wide data on their distribution and abundance however is lacking. Data on Risso's dolphins predominantly arises from stranding records along the Italian coastline whilst being absent from Montenegro and Albania (UNEP-MAP-RAC/SPA, 2014) and under IUCN Red List criteria they are listed as 'data deficient' (Gaspari & Natoli, 2012). Although threats to Risso's dolphins in the Adriatic are unidentified, there have been reports of bycatch elsewhere in the Mediterranean (Notarbartolo di Scaria, 1990; Valeiras et al., 2001) and studies in the UK have shown they have high sensitivity to sonar (Jepson et al., 2005).

Cuvier's beaked whales are another data deficient species of the Mediterranean Sea yet scientific reports reveal no difference in distribution between the western and eastern Mediterranean Basin (Notarbartolo di Sciara & Demma 1994; Notarbartolo di Sciara 2002; UNEP-MAP-RAC/SPA, 2014; Canadas & Notarbartolo di Scaria, 2018). Nevertheless, their distribution, abundance and occurrence estimates are scarce in the Adriatic, despite reports stating their presence in the Adriatic Pit (UNEP-MAP-RAC/SPA, 2014; Podesta et al., 2016). Only five sightings were reported during the 2010 and

2013 aerial surveys over the Southern Adriatic basin with both adult and juvenile individuals recorded, suggesting the sub-basin may be a nursery for the species in the Adriatic (UNEP-MAP-RAC/SPA, 2014; 2015). Seismic exploration, naval sonar and other anthropogenic sources of noise are thought to be the main threats to the species (Jepson et al., 2003; Fernandez et al., 2005; Holcer et al., 2007; UNEP-MAP-RAC/SPA, 2014).

Although regular sightings of fin whale in Mediterranean deep waters occur, their permanent presence in the Adriatic is uncertain (Panigada & Notarbartolo di Sciara, 2012). Most recently, fin whale sightings in the Adriatic have been recorded in Croatia, both in 2012 and 2017 (Blue World Institute, 2018a), with a recent stranding event in 2018 (Blue World Institute 2018b). Under IUCN Red List criteria, they are listed as ‘vulnerable’ (Panigada & Notarbartolo di Scaria, 2012) due to threats from anthropogenic noise sources such as increased boat traffic and seismic activity (Notarbartolo di Sciara, 2016) and increased risk of ship strikes from high speed ferries (Panigada & Notarbartolo di Sciara, 2012; Notarbartolo di Sciara, 2016).

Distributed throughout the Mediterranean Sea and once considered the most abundant species, the short-beaked common dolphin is experiencing steep declines in their population (Bearzi *et al.*, 2004; UNEP-MAP-RAC/SPA, 2014). These declines are likely as a result of the combined pressures of human interference and climate change influencing the availability of dolphin prey, making it difficult to distinguish between the two (Bianchi & Morri, 2000; Bearzi et al., 2004). Other factors include overfishing and incidental bycatch in gillnets (Canadas & Hammond, 2008; Notarbartolo di Sciara, 2016). Under IUCN Red List criteria, the species is listed as ‘endangered’ (Bearzi et al., 2004). With the last of the most stable populations residing in the Alboran Sea (Canadas & Hammond, 2008), the Adriatic population is thought to have been locally extinct after aerial surveys between 2001 and 2013 did not yield any sightings (Fortuna et al., 2011; UNEP-MAP-RAC/SPA, 2014). However, in July 2018, a group of 50 short-beaked common dolphins were once again sighted in the Adriatic, just off the coast of Kornati, Croatia. Although this does not mean they are once again residents of the Adriatic, it does suggest that the species has the potential to once again inhabit each of the sub-basins of the Adriatic (Blue World Institute, 2018c).

1.3. Threats in Montenegro

1.3.1. Seismic surveys

The Adriatic Sea is undoubtedly affected by ever-increasing anthropogenic activities (UNEP/MAP, 2012). Cetaceans, being long-lived animals with low reproductive rates and very slow recovery rates, are particularly vulnerable (de Segura et al., 2006). Anthropogenic exploitation of marine ecosystems have led to increased human induced noise (Weilgart, 2007), whereby marine construction, seismic exploration – a threat of particular concern in the waters of Montenegro at present, and marine traffic all contribute. Covering an area of 338km^2, through the use of three supporting vessels, 3D seismic surveys began in waters off the coast of Montenegro in November 2018. The activity was set to last a period of 30 days, with the possibility of extension dependent on weather conditions. Seismic airguns using a depth range of 50–100m below sea level (Energean Oil and Gas, 2018) have been used to search for oil and gas deposits beneath the sea floor and can penetrate hundreds of kilometres below the seabed (Weilgart, 2012). Sound emitted by airguns is likely to be heard from survey vessels at distances up to 4,000km away (Nieukirk et al., 2012). In other areas of the world, historic unregulated seismic activities have had catastrophic impacts on the marine ecosystem as a whole (Gordon et al., 2003; Nowacek et al., 2007; 2015). The effects on marine mammals as keystone species (Sergio *et al.*, 2006), are likely to impact upon other organisms further down trophic webs, with many studies demonstrating predator abundance heavily influences ecosystem structure, functioning and resilience (Paine, 1969; Duffy, 2002; Baum & Worm, 2009).

Marine mammals are extremely vocal animals dependent on acoustics for many aspects of their lives. Intra- and inter-specific social communication, navigation, reproduction and prey detection are all biological aspects and life history traits in which cetaceans rely upon acoustics for, and thus, are sensitive to anthropogenic noise (Weilgart, 2007; Richardson *et al.*, 2013). Observed impacts include widespread and localised avoidance of seismic vessels within the range airguns emit sound (Gordon et al., 2003; Stone, 2006) for periods extending beyond the timeframe in which airgun activity occurred (Castellote et al., 2012). Airgun pulses and increased background noise were found to modify communication processes of cetaceans (Weilgart, 2007; Castellote et al., 2012). A variety of changes in vocalisation has been reported across cetacean species to overcome 'masking' (Weilgart, 2007); shifts in call frequency (Lesage et al., 1999), increased call duration (Foote et al., 2004), lengthened mating calls (Miller et al., 2000) and an increase in whistles (Rendell and Gordon, 1999; Buckstaff, 2004). Conversely, vocalisations have also been known to decrease, or even cease entirely (Weilgart, 2007). These alterations in communication processes could result in decreased foraging activity, group cohesion and reproduction rates while increasing energy expenditure and predation risks (Croll et al., 2002; Weilgart, 2007). Prey species themselves are also affected by seismic activity (Dalen and Knutsen, 1987). Cephalopods have been shown to adopt behaviours associated with being under threat; responding by displaying avoidance strategies alongside behaviours also adopted by bony fishes; moving further down in the water column and swimming in tighter group formations (Fewtrell, 2012; de Soto, 2013). Seismic activity has also been related to cetacean stranding events (Gordon et al., 2002; Engel et al., 2004). In 2000, a beaked whale stranding was likely to be associated with seismic airgun activity in the Galapagos and later, in 2002, an additional beaked whale stranding occurred when the same vessel carried out seismic airgun pulses in the Gulf of California (Gordon et al., 2003). Unusual increases in humpback whale stranding events were also recorded in 2002 in conjunction with seismic activity along the north-eastern coast of Brazil (Engel et al., 2004), however, in all cases, no direct link was found.

1.3.2. Fishing Practises

Fishing practices can both directly and indirectly change marine ecosystem dynamics (Coll et al., 2007), altering complex structures within whole ecosystems (Tudela, 2004). The act of fishing itself, particularly the use of mobile bottom gear, destroys marine benthic habitats and ultimately results in a loss of biodiversity (Coleman & Williams, 2002). According to the data of the Montenegrin Ministry of Agriculture and Rural Development, the Montenegrin fishing fleet is dominated by small fishing vessels that engage in artisanal fishery (91 vessels), whilst the industrial fleet consists of bottom trawlers (20 vessels) and purse seiners (17 vessels) (Montenegro Ministry of Agriculture and Rural Development, 2015). Despite the artisanal fishery having more than twice as many boats as the industrial fishery, the artisanal catch is much lower than that of the pelagic and demersal fisheries. In 2017, the total catch of pelagic fishes was 659 tonnes, the total catch of demersal fishes was 185 tonnes, whilst other species accounted for just 88 tonnes of the reported catch (MONSTAT, 2018). The total annual catch, since the Montenegrin independence, has varied from 690 tonnes up to 933 tonnes per year, with a rising trend since 2015 (FAO, 2018). According to the Regional Activity Centre for Specially Protected Areas, the most significant fishing practice in Montenegro is trawling (RAC/SPA - UNEP/MAP, 2013) which can have widespread negative impacts on benthic communities if it is employed in unregulated and uncontrolled manners. A single trawling pass has been found to reduce the mean abundance of animals by approximately 55% (Collie et al., 2000).

Interactions between cetaceans and commercial fisheries have been documented for centuries and have been reported to be increasing in frequency and intensity (Read et al., 2006). Cetaceans can be heavily impacted by fishing practices due to lower prey availability, habitat loss or degradation, injury or mortality due to retaliation and bycatch from the fishing industry (Bearzi, 2002). Unintentional disturbances by fishing operations are also related to modifications in behaviour (Bearzi, 2002). Both short term changes in behaviour, such as a decrease in inter-animal distance, changes in direction and an increase in swimming speed (Nowacek et al., 2007) and long-term changes including dispersion and emigration have been observed, all of which can have an effect on the energy storages of individuals (Bearzi, 2002).

Although this number should be considered as an underestimation, a reported 82,000 vessels are thought to make up various Mediterranean fishing fleets, of which 80% are small scale vessels (Fisheries - European Commission, 2018). Reported catch from all fishing vessels is approximately 800,000 tonnes per year in the Mediterranean, with a higher concentration in the eastern Mediterranean and Adriatic Sea (Fisheries - European Commission, 2018). Overexploitation of marine fisheries is believed to be an issue for almost all commercial fisheries worldwide (Watson, 2013). Early research into the Mediterranean fish stocks show that 78% were fully exploited (Sherman, 2010) and the exploitation rate is gradually increasing and selectively deteriorating, leading to a decrease in fish stocks (Vasilakopoulos et al., 2014). Historical reconstruction of Croatian and Montenegrin fisheries catches from 1950-2010, show that illegal, unreported and unregulated catches represent approximately 34% of the reported catches in this period, and as much as 300% of the reported catches in the artisanal fisheries (Keskin et al., 2014). The study additionally estimates that officially reported fisheries statistics for Montenegro may have accounted for less than half of actual total catches in this period (Keskin et al., 2014).

In pelagic waters, the major cause of fishing-related mortality for many cetacean species is entanglement (Notarbartolo di Sciara and Gordon, 1997). Indeed, bycatch is often the main cause of human-related mortality in many cetacean species and in some areas of the world it has brought about the close extinction of cetacean species or populations (International Whaling Commission, 1994; Grose et al., 1994; Read, 1996). Reports have even suggested that cetaceans caught in trawl nets are fully aware of the nets initially, yet they proceed to take advantage of these fishing practices as a feeding strategy (Bearzi, 2002). In areas of the Mediterranean, cetaceans have been regularly observed following trawlers (Fortuna et al., 1996; Bearzi & Notarbartolo di Sciara, 1997; Holcer, 2012) and dolphin bycatch has been associated with pelagic pair trawlers (Fortuna et al., 2010). Despite the benefits of associating with fishing vessels, opportunistic feeding behaviour is likely the cause of most cetacean bycatch by trawl nets (Overholtz & Waring, 1991; Read, 1996).

Further, historical associations between dolphins and fishing practices led to direct killings of dolphins, where bounties were often given and supported by several governmental bodies (Smith, 1995). Historically in the northern Adriatic Sea, dolphins were viewed as pests, resulting in the systematic killings of thousands of bottlenose and short-beaked common dolphins, particularly in the former Yugoslavian Republic (Bearzi et al., 2004). Though the last record of a bounty for the culling of a dolphin was in 1960, fishermen in the eastern Adriatic were historically found to carry guns, frequently shooting dolphins (Bearzi et al., 2004) due to the legalities of being able to kill dolphins in the region up until 1995 (Bearzi et al., 2008).

1.3.3. Tourism

Mediterranean countries are one of the leading tourism regions, accounting for approximately 50% of international tourism arrivals worldwide (Šimundić & Kuliš, 2016). Montenegro has a high number of cruise ships navigating its waters, with foreign cruise ships amounting to 480 in 2016, an increase of 16.8% from 2015 (Cimbaljevic & Muratovic, 2018). Touristic vessel intensity, such as cruise ships and ferries, particularly increase during summer months (Pennino et al., 2017) which can lead to increases in underwater noise and pollution.

Impacts of marine vessel interactions can lead to short-term changes in behaviours (Christiansen *et al*, 2010; Pennino *et al*, 2016; 2017) which in turn are likely to lead to long-term changes in behaviour, habitat displacement and declines in reproductive success (Lusseau, 2003, 2004; Lusseau & Higham, 2004; Christiansen *et al*, 2010; Christiansen & Lusseau, 2014; Bas *et al*, 2017; Pennino *et al*, 2017).

1.3.4. Marine traffic

The Mediterranean Sea is an area of high marine traffic intensity (Pennino et al., 2017) with approximately 220,000 vessels travelling its waters daily (Panigada *et al.*, 2006; Pennino et al., 2017). Rapid development of the shipping industry and marine vessel traffic has resulted with an increase in cetacean ship strikes (Carrillo & Ritter, 2010) with large whales and small cetaceans, such as dolphins and beaked whales, being particularly vulnerable (Van Waerebeek et al., 2007). Ship strikes are a common occurrence in the Mediterranean, however there have been no reports of collisions between cetaceans and large vessels in the Adriatic (Panigada et al., 2006; Carić & Mackelworth, 2014). Disturbance to small cetaceans from shipping and boating activity has been documented however, particularly during the summer, resulting in seasonal displacement of cetacean populations (Rako et al., 2013). Further negative consequences of marine traffic can be classified either under short or long term. Whilst long term consequences include ship strikes and permanent area avoidance, short term consequences of marine traffic presence include behavioural alterations and temporary area avoidance (see bottom of section 1.3.3. Tourism).

1.5. Conservation Actions

Anthropogenic influences on natural ecosystems are continuously increasing (Wikelski & Cooke, 2006) and with the state of the world's oceans rapidly deteriorating, marine species are constantly under threat from changing environmental dynamics (Jackson et al. 2001). Dedicated scientific research is the first step in addressing these issues by establishing the ecosystem processes taking place in ever changing natural and anthropogenic environments, however on its own this is not enough to mitigate such problems. Engagement of the public plays a key role in conservation and historically, terrestrial ecosystems have received the most attention in terms of conservation, however it is becoming increasingly evident that conservation measures are also urgently required for the oceans (Myers et al. 1997, Casey & Myers 1998). Raising public awareness about marine life and the threats they face is imperative if they are to be effectively protected. Even small actions, such as beach cleaning, sharing information with locals and having presentations in public schools can help people of all ages understand how important it is that we all take a part in the conservation of nature.

2. Methodology

2.1. 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. The survey area covered the coastline and offshore waters of Montenegro (Figure 1).

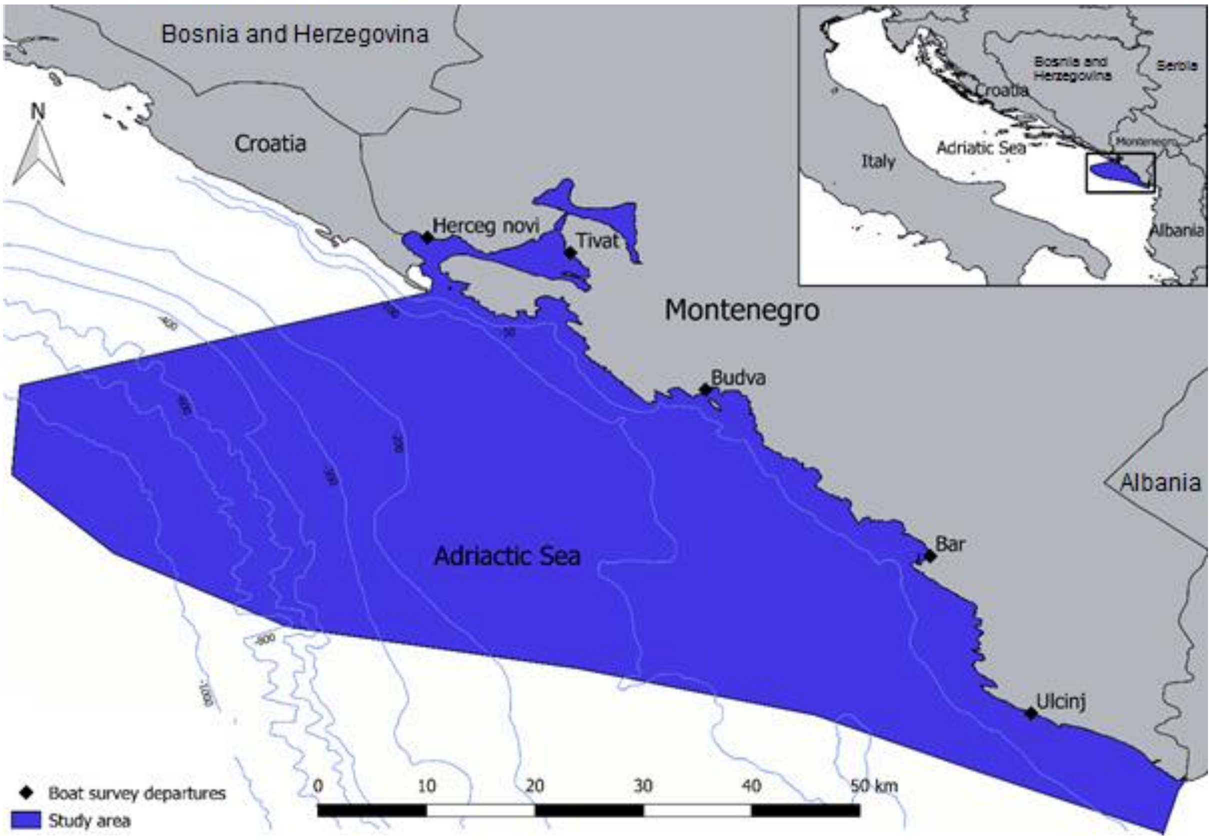

Figure 1 - The map of survey area. The polygons have been created using the track lines of our boat surveys in order to represent the true coverage (from Volwater et al., in preparation).

2.2. Survey platforms

2.2.1. Land surveys

Five land survey stations were selected along the Montenegrin coastline in order to cover the coastal waters of Montenegro (Table 1). Each land survey station was selected to optimise the observable field of view in order to increase the encounter possibilities of the cetaceans. Land based observations enable researchers to observe the natural behaviour of the focal group, without the possible impact of the nearby research vessel disturbing the focal group. Two sets of land surveys were conducted; morning surveys (beginning with sunrise) and afternoon surveys (ending with sunset). Each survey was undertaken for a minimum duration of three hours.

Table 1. The coordinates and altitudes of land stations

Station	Latitude	Longitude	Altitude (m)
Ulcinj	41°55’18”	19°12’43”	33
Utjeha	42°03’01”	19°07’52”	78
Bar	42°07’11”	19°04’19”	23
Budva	42°12’31”	18°55’54”	108
Herceg Novi	42°27’11”	18°32’25”	84

To determine the geographic position of dolphins and marine vessels, a theodolite (SOKKIA DT5A) was operated and the vertical and horizontal angles of target objects were recorded. In order 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. The observation height and geographic position of the theodolite were saved by the software for each of the stations. Using the Pythagoras software, the paths and velocity of focal dolphin groups and vessels were determined. Species and marine vessel types were defined in Pythagoras in advance as well as the associated focal behaviour of the target species.

Environmental conditions such as cloud cover, Beaufort sea state, glare, wind speed, wind direction, air and sea surface temperature and tide height were recorded every 60 minutes or whenever the conditions changed considerably. 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. The ‘daybreak’ was recorded by dividing the time between sunrise and sunset into 4 equal time periods (early morning, morning, afternoon, and evening). Environmental conditions were also inputted into the Pythagoras software.

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

2.2.2. Boat surveys

Boat surveys were carried out using a number of different routes to maximise the coverage of the Montenegrin coastline.

1. Bar to Utjeha
2. Budva to Kotor
3. Boka Kotorska Bay
4. Offshore surveys

An attempt was made for boat surveys to be undertaken each week but due to weather conditions and logistical restrictions, this was not always possible. Data collection took place between sunrise and sunset (06:00 and 21:00), covering 3 to 7 hours per day, depending on sea conditions. Surveys took place only in calm seas with a Beaufort Sea State between 0-3 and good visibility (>1 nautical mile).

The speed of the boat was kept relatively constant, aiming for an average of 4 knots. Surveys have been carried out either with 6 metre fishing boats equipped with outboard engines, 12 metre speed boats equipped with outboard engines or a 17 metre sailing boat equipped with an inboard engine. Using a GNSS (Global Navigational Satellite System) tracking device, the geographic position of the observation boat was recorded every two minutes. This was recorded into the software Logger 2010 (Marine Conservation Research, 2019) in order to create a boat track line. The date and time, track line type, number and initials of port and starboard observers, the initials of helmsperson and data logger and environmental data (sea state, wave height, swell height, weather type, cloud cover, visibility, wind speed and direction, glare and intensity and angle and sail angle) were also recorded in the Logger 2010 software. When cetaceans were observed, 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 the focal cetacean group as slowly as possible to get accurate data and photographs whilst causing as little disturbance as possible. The group was approached from the side or rear and the research vessel remained idle whenever possible. The focal group was followed maintaining a minimum distance of 50 m and a maximum distance of 400 m. If the dolphins approached closer, the research vessel speed was reduced gradually and sudden changes in direction and speed were also avoided. 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 a minimum of five researchers; one researcher was stationed at the bow of the boat, scanning a 180° field of vision with binoculars, two researchers were stationed on either side of the centre of the boat, scanning their respective sides and behind the boat with binoculars, one researcher was responsible for the GPS tracker and logger system and one researcher was responsible for inputting data on the datasheets. Researchers rotated hourly to avoid fatigue. Upon a dolphin sighting, the researcher stationed at the bow of the boat was responsible for taking photographs of the focal group. All sightings and effort data as well as environmental and survey conditions were recorded on data sheets and entered into a database at the end of each week.

Focal group datasheets were used both during land and boat surveys and information on the cetacean species observed, observation time, observation number, the distance and angle of the species from the observation boat, species group size, their behaviour and the surrounding marine vessels was recorded.

2.3. Behaviour Sampling

Focal groups were defined as aggregations of dolphins, observed in a clearly visible constellation (less than 100 metres apart from the next closest dolphin with a chain rule). The method of instantaneous focal group scan sampling was chosen to collect behavioural data. With scan sampling the behaviour of all individuals in a focal group were recorded at a predetermined time interval of 5 minutes. These behaviours were documented for both behavioural states and behavioural events; behavioural states endure for an appreciable time, whereas behavioural events are instantaneous (Shane, 1990; Bearzi et al., 1999).

At the start of each sampling unit (every five minutes), the time, the minimum and maximum group size, the number of sub-adults were recorded. At the start and end of the first minute of each sampling unit, the most frequent group type, swim style and behavioural state of the group was recorded. Individual behavioural events were recorded for the entirety of the first minute. Behavioural states and events are explained in more detail in Table 2 and Table 3. The number, type and distance of marine vessels from the focal group was also recorded.

Table 2. The predetermined behavioural states and their abbreviations used in the study

Behavioural states	Description
(TR) Travelling	Movement of the group with constant speed and direction. The group has to travel at least 150 m in 1 minute (approximate speed of 4 knots).
(TR-DV) Travel-Diving	Dolphins swim underwater for a long time moving in a consistent direction, often appear far from where they were last seen.
(DV) Diving	Characterised by steep dives, dolphins stay within a ~100 m radius, moving in varied directions. This behaviour often relates to foraging and can also be linked to vertical avoidance of human presence.
(SU-FE) Surface-feeding	Movement is extremely varied with lots of splashes in the same area. High activity on the surface. There are likely to be birds and fish present.
(SOC) Socialising	Active on the surface with observed physical contact between dolphins.
(RE) Resting	Dolphins travel very slowly in a coordinated manner, staying close to one another. Dive intervals are short and group activity is very low. The group travels less than 50 m in 1 minute
(MI) Milling	Non-directional movements. Even though the group moves, the group cohesion doesn't change considerably.
(BOW) Bow-riding	Dolphins 'surf' alongside the bow of a boat, using the upwelling caused by the boat to allow them to travel using very little energy.
(FOL) Following a trawler	Dolphins evidently pursue a trawler, often holding a fixed direction and speed during this time period.

Table 3. The predetermined behavioural events and their abbreviations used in the study

Behavioural Events	Definition
Tail slap (TS)	Individual slaps its tail on the water surface
Spy hop (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
Full leap (FL)	Individual leaps its complete body above the water surface
Fluke up (FU)	Individual protrudes its fluke above water surface

2.4. Marine Vessel Sampling

The number and type of marine vessels, along with their distance to the cetaceans were collected, including that of the research vessel during boat surveys, to investigate the effect of vessels on the focal group behaviour. Marine vessels were categorised into twelve groups: MB (motor boat), LB (luxury boat), JS (jet ski), PED (peddler or kayak), PB (passenger boat), FV (fishing vessel), RV (research vessel), SB (sailing boat), FE (ferry), CS (cargo ship), CR (cruise ship), and UND (undetermined). Marine vessel activity is defined as FI (fishing), SP (speeding), TO (tourism), TR (trawling), CR (cruising), IDL (idle), NA (not applicable), UND (undetermined).

The marine vessel presence within the interaction zone was noted according to its type. The interaction zone was defined as any vessel present within a 400 m radius from the focal group. Therefore, if there was a vessel within a 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 and the activity of the nearest marine vessel to the focal group as well as 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 in swimming direction 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 did not display any apparent response towards the vessels).

2.5. Photo Identification

Focal group and individual photographs were taken during the boat surveys using various models of DSLR cameras, with 70-300m, 150-600m and 70-200mm f/2.8 APO lenses. To maximise the number of high-quality images, the photographer took multiple photographs of each individual dolphin, from both sides of the dorsal fin wherever possible.

Photo-identification was carried out using Discovery Software, whereby the photographs were stored, cropped, matched, added to the catalogue and subsequently graded 1 to 3 for image quality following criteria published by Ingram (2000):

- Photo Grade 1 – Well-lit and focused shots taken perpendicular to the dorsal fin at close range
- Photo Grade 2 – More distant, less well-lit, or slightly angled shots of dorsal fins
- Photo Grade 3 – Poorly lit or out of focus shots taken at acute angles to the dorsal fin.

Once graded, only those photos of grade 1 and 2 were cropped and sorted. Where possible, photos from both the left and right side of the dolphin, that best represented each individual, were used in the matching stage. Pre-determined categories and descriptors were used upon adding the photos to the catalogue in order to filter the individuals. Photos added to the catalogue were either matched to an existing individual or, if there was no match, a new individual was created and assigned a unique identification number. The most obvious feature of the dorsal fin was determined and the appropriate category was subsequently assigned upon matching. Two to three additional features were also identified using the descriptors.

Further, whilst adding the photos to the catalogue each photo was graded 1-3 for distinctiveness of the fin following criteria published by Ingram (2000):

- Severity Grade 1 – Marks consisting of significant fin damage or deep scarring considered permanent
- Severity Grade 2 – Marks consisting of deep tooth rakes and lesions with only minor cuts present
- Severity Grade 3 – Marks consisting of superficial rakes and lesions.

In addition to image quality and fin distinctiveness, each fin added to the catalogue was documented as either ‘left’, ‘right’ or ‘fluke’. Information about the individual, if known, was also noted such as the sex, maturity and if there was a calf present. Sighting data was also added such as the date and time of the sighting along with the geographical coordinates. Once all individuals identified from a survey were added to the catalogue, additional information for the entire focal group was added to the Discovery database, such information included survey effort and sightings data such as; environmental conditions, geographical coordinates and behaviour. Finally, each match was independently verified by a second judge to avoid an error.

2.6. Acoustic data

Between 22nd May 2018 and 15th August 2018, 16 boat surveys were conducted, in which eight of them involved the collection of acoustic data. These were collected in conjunction with behavioural sampling of bottlenose dolphins (see Section 2.3 - Behaviour Sampling). Acoustic data was collected using an omnidirectional Mono Hydrophone "TASCAM DR 100 mkiii Linear PCM Recorder" with a frequency range of 96 KHz and a sampling rate of 48 KHz.

2.7. Data Analyses

Descriptive statistics are provided to summarise our cetacean sighting history. Later, to understand the effect of year, season, section and their interaction on dolphin sightings, generalized log-linear analysis were fitted to the data with a Poisson distribution. The survey effort is considered as an offset with a log (10) transformation.

The dependence of behaviour on the geographic, environmental variable and group structure were also analysed for the time period between September 2016 and October 2017 by Affinito et al. (2018). The variation on behaviour were analysed through considering its dependence on depth, time of day, distance from shore and season through a series of Chi-square tests (Affinito et al., 2018). Later the significant environmental variables and group size were modelled through using multinomial distributions to understand their effect on the behavioural variations and the best fitting models were found through their AIC and BIC values (Affinito et al., 2018).

Further, the distribution of sighted species and marine traffic was mapped for 2016, 2017 and 2018 using ArcGIS9.3. Marine traffic data overlaid onto the map was collected during land surveys only. The Kernel Density function was applied to create a raster map of bottlenose dolphins, striped dolphins and marine traffic within a circular neighbourhood for each raster grid cell of 200 m, with a radius of 2000 m. Group size was embedded in the density analysis for each target to avoid underestimation of dolphin distribution. These data sets were processed using the Mask Extraction tool. Percent Volume Contour was used core zones for dolphins could be visualised and only 70 % of contours were used to map areas defined as important.

For the acoustic data Raven Pro software from Cornell University was used to analyse the recordings. Due to limitations in hydrophone range, acoustic recordings collected when the focal group was sighted more than 500 m away from the research vessel were excluded from the analysis (van der Pouw Kraan, 2019). Further, to form a conservative approach, recordings which contained high levels of background noise were excluded from the analysis. Similarly, recordings where the behavioural sampling was non-descript or in situations where it was not implicitly clear which the predominant behaviour of the focal group was were also removed from the analysis. (van der Pouw Kraan, 2019). Acoustic recordings were split into 30 second time-frames during spectrogram analysis, allowing for clear characteristic identification of cetacean whistle, burst pulse and clicks rates. Signature frequencies and durations of each parameter associated with particular behaviours enabled comparisons to be made between the acoustic recordings, behavioural states and differentiation within each encounter (van der Pouw Kraan, 2019).

Note: The effects of tourism and trawlers on the behavioural transitions are currently being investigated through Markov Chain analysis and the results will be published soon. Further, the seasonal distribution of bottlenose dolphins and their seasonal variation on the behaviour will be published soon. Lastly, the movement pattern of individual bottlenose dolphins is under our scope of research and will be published within 2019.

3. Results

3.1. Survey Effort and Sightings

In total, 396 surveys (1443:30 hours) were carried out between 15th September 2016 and 6th December 2018. Of these, 51 days (146:29 hours) in 2016, 192 days (698:12 hours) in 2017 and 153 days (598:48 hours) in 2018 were spent on systematically designed surveys (Table 4). The dominant survey type between and within the years were land surveys, however a minimum of two boat surveys per month were carried out to collect photo-identification data.

Table 4. Survey type and survey effort between 2016 and 2018. Numbers in brackets represent dolphin group sightings.

Year	Boat Surveys	Land Surveys	Total Survey Effort
2016	*8 (5)*	*43 (20)*	*51 (25)*
2017	*31 (20)*	*161 (51)*	*192 (71)*
2018	*36 (23)*	*117 (34)*	*153 (57)*
Total	*75 (48)*	*321 (105)*	*396 (153)*

During the surveys, two species of cetaceans were sighted within the Montenegrin coastal and offshore waters: bottlenose dolphin (*Tursiops truncatus*) and striped dolphin (*Stenella coeruleoalba*). Additionally, one possible Mediterranean monk seal (*Monachus monachus*) sighting was recorded in Ulcinj in June 2016. Sighting success for delphinidae was highest in 2016 (49%), whereas it was 37% for 2017 and 2018. However, it is important to note that 2016 surveys covered only four months whereas the survey effort was year-long for both 2017 and 2018 (Table 4).

Bottlenose dolphins were the most commonly sighted species by far, whilst striped dolphins were recorded on 15 occasions, eight of which were in 2016, six in 2017 and a single sighting in 2018. Bottlenose dolphin group size varied from 2 to 11 individuals with an average of 3.6±2 individuals. Striped dolphins were encountered in bigger groups ranging from 4 to 40 individuals with an average of 19±11 individuals.

3.2. Variations in the sightings of Bottlenose Dolphins

The dependence of sightings between seasons, sections and years were analysed. According to the results, section holds the lowest AIC of 58.8 thus considered to be the best explanatory variable on the sightings of bottlenose dolphins. The next best explanatory model was the null model of 59.6. The North section had a significantly higher sighting possibility than south or middle sections, with 49% sighting possibility ($Z=2.1$, $SE=0.24$, $p=0.02$) (Snead et al., in preparation).

3.3. Re-sightings of bottlenose dolphins

From 18th October 2016 to 21st September 2018, a total of 72 individuals were identified in Montenegrin waters, of which approximately 61% were re-sighted (either within the same year or across years). Between 2016 and 2017, re-sightings were recorded for approximately 6% of identified individuals, this increased to around 40% between 2017 and 2018. Additionally, individuals sighted multiple times within a year, yet not across years, were calculated at approximately 17%. Regarding the site fidelity of individuals, 74% of re-sighted individuals were consistently sighted in a similar area

(<25 km), the remaining individuals were sighted along the entire coastline, with a maximum re-sighting distance of 75 km.

3.4. Behaviour of Delphinidae

Behaviour of focal groups were recorded in 1419 sampling intervals with 5 min sampling sessions, of which only 95 sampling intervals belonged to the striped dolphins. When the dominant behaviour of bottlenose dolphins for each year was investigated, travelling, followed by diving, formed more than 50% of the observed behavioural budgets for 2016 and 2017. However, diving followed by travelling was the dominant behaviour for 2018 (Table 5). The least observed behaviour was resting for 2016, milling, socialising and surface feeding for 2017 and milling and resting for 2018. Bow-riding was also rarely observed in each year. (Table 5).

Table 5. Number of behavioural recordings of bottlenose dolphins in each year (BOW=Bow-riding; DV=Diving; MI=Milling; RE=Resting; SOC=Socialising; SU-FE=Surface feeding; TR=Travelling; TR-DV=Travel diving; FOL=Trawler Following; UND=Undetermined) (Trawler Following behaviour (FOL) wasn't recorded by the researchers in 2016).

Bottlenose dolphins											
Year	**BOW**	**DV**	**MI**	**RE**	**SOC**	**SU-FE**	**TR**	**TR-DV**	**FOL**	**UND**	**TOTAL**
2016	0	45	3	3	19	17	51	23	0	5	166
2017	2	164	13	53	22	23	192	129	10	12	620
2018	2	211	4	8	33	37	127	55	52	9	538
Total	4	410	20	64	74	77	370	207	62	26	1324

More than 50% of the behavioural observations of striped dolphins in 2016 were diving, followed by travelling activities. In 2017, in addition to diving and travelling, there were high encounters of socialising behaviour. Lastly, 2018 data was limited to a single sighting of striped dolphins and the dominant behaviour was surface-feeding during the observation (Table 6). The least observed behaviour was milling and resting for each year (Table 6).

Table 6. Number of behavioural recordings of striped dolphins in each year (BOW=Bow-riding; DV=Diving; MI=Milling; RE=Resting; SOC=Socialising; SU-FE=Surface feeding; TR=Travelling; TR-DV=Travel diving)

Striped dolphins									
Year	**BOW**	**DV**	**MI**	**RE**	**SOC**	**SU-FE**	**TR**	**TR-DV**	**TOTAL**
2016	0	13	1	0	6	6	11	10	47
2017	2	10	2	3	9	2	6	9	43
2018	0	1	0	0	0	3	1	0	5
Total	2	24	3	3	15	11	18	19	95

3.5. Species Distribution

The density distribution of bottlenose dolphins and striped dolphins was mapped for each year (Figures 2, 3). Bottlenose dolphins showed a distribution throughout the coastal regions instead of a localised presence, except for the sightings in 2016. The reason behind the lack of sightings in 2016 was due to survey effort being localised to the south of Montenegro. Therefore, it is important to bear in mind that dolphins are likely to have been present in the central and north sections of Montenegro for the year 2016 as well. 2017 sightings however did show a wider distribution throughout the coastline than 2018, despite a similar survey effort for both years. Interestingly, the dolphin density was the highest in the waters of Herceg Novi in 2018 whilst the Ulcinj and Utjeha region held highest densities in 2017. Therefore, when the entire study duration is considered, the waters of Herceg-Novi, Bar, Utjeha and Ulcinj host important habitats for bottlenose dolphin populations (Figure 2). Lastly, the core zones of bottlenose dolphins are limited to regions within the 150 m depth contour with a maximum distance of 6 km from the nearest coast. Therefore, the coastal preferences of bottlenose dolphins coincide with their distribution elsewhere in the Mediterranean.

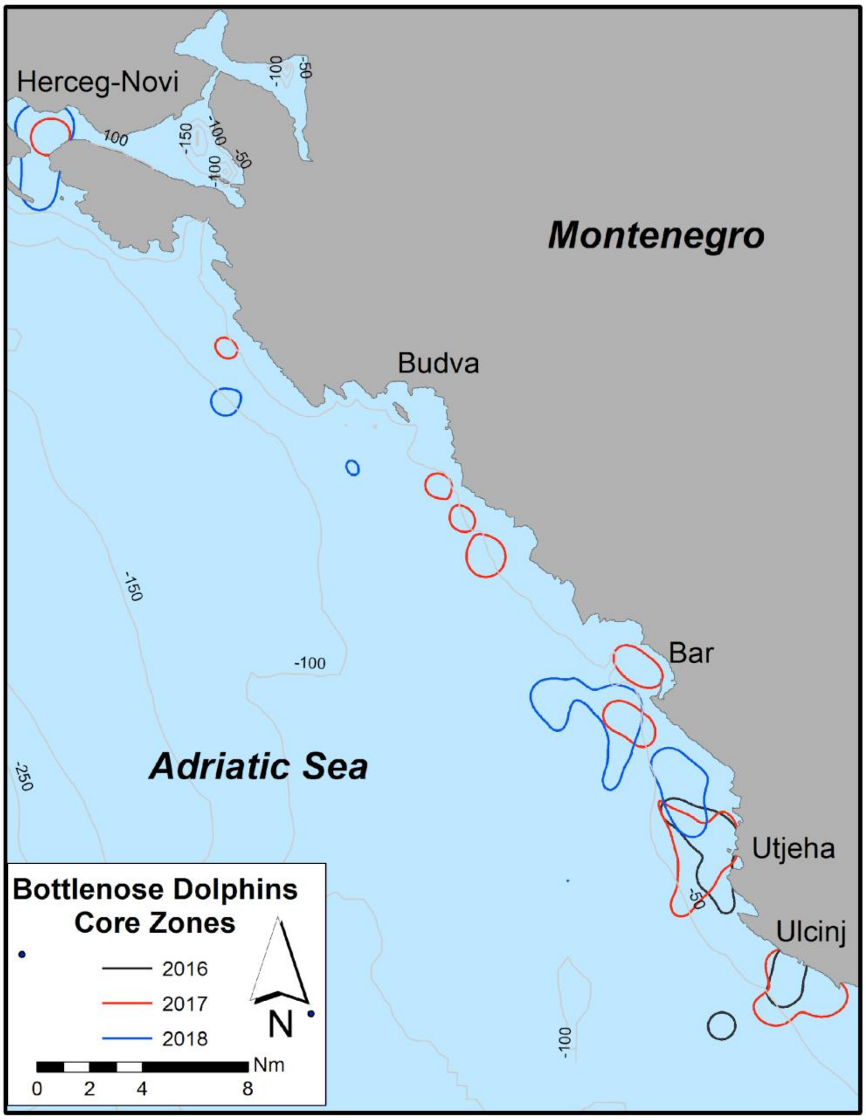

Figure 2 - Core zones of bottlenose dolphins in 2016, 2017 and 2018 within Montenegro.

The core zones of striped dolphins are localised between the years (Figure 3). The concentrated distribution is likely to be the result of the variation in survey effort. 2016 sightings were concentrated in the coastal zones of Ulcinj with a depth preference below 50 m with a maximum distance of 1 km from the nearest coast. The 2017 sightings were between 150 m and 300 m depth zones with a maximum distance of 28 km from the nearest coast. Lastly, 2018 sightings were formed from single coordinates thus the data was not enough to produce density maps. However, the encounters took place at 650 m and 800 m depths with a distance of 45 km from the nearest coastline. Striped dolphins prefer deeper waters mainly above 500 m depths and while the current study confirms their offshore presence, coastal presence is also important to note. (Figure 3)

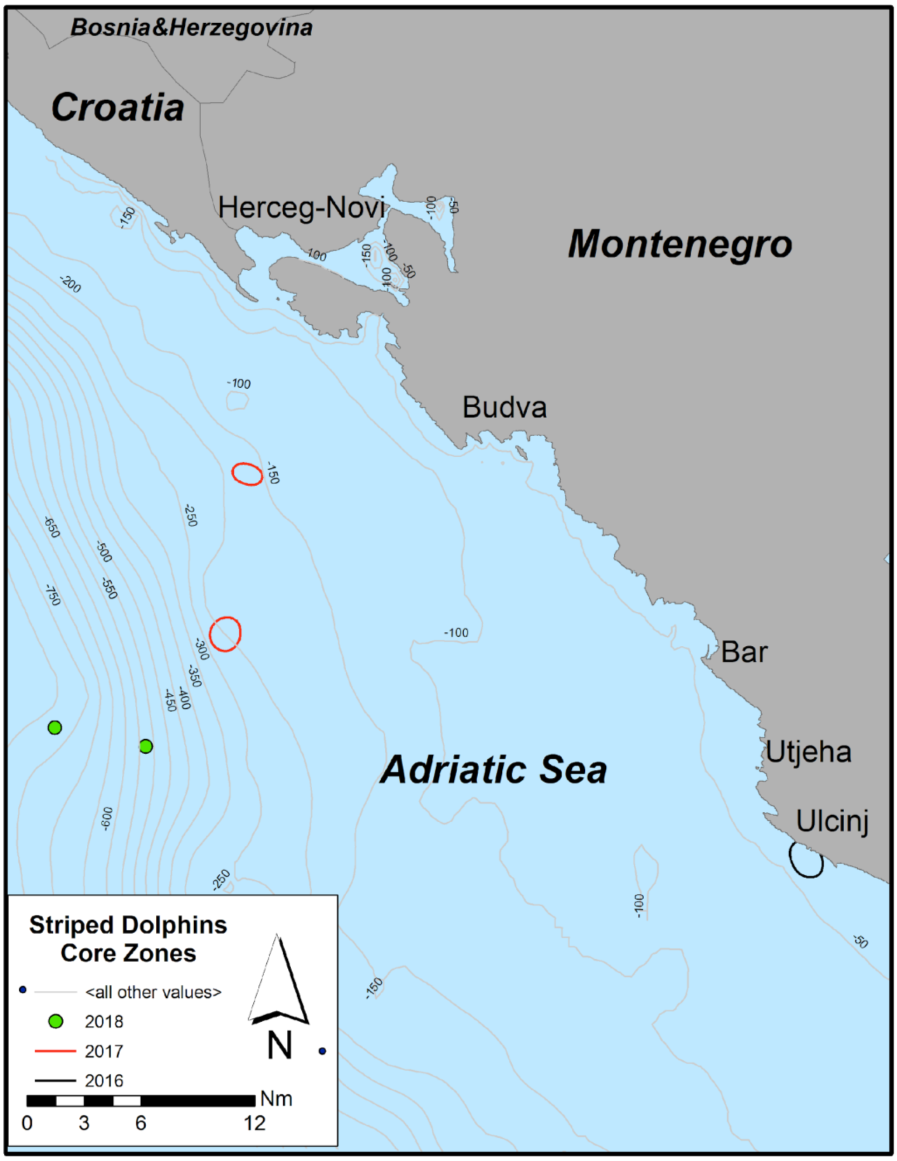

Figure 3 - Core zones of striped dolphins in 2016, 2017 within Montenegro. Green points represent the single sightings of striped dolphins in 2018.

3.6. Marine Traffic Distribution and Overlap with Dolphin Habitats

Regarding the marine traffic data collected during land surveys, the densest areas highly overlap with the bottlenose dolphin distribution with high preferences for coastal waters, and marine vessels appear to have somewhat less of an impact on the striped dolphin populations due to their apparent preference for offshore waters (Figure 5). The marine traffic density shows considerable concentrations in waters close to more densely populated urban areas. Yet, the lack of density in certain locations (such as in Kotor or Tivat) does not demonstrate an absence of marine traffic from these areas. The presented map only displays the traffic around the survey stations (that was in view from the theodolite), yet still forms an important insight into the possible impact of marine traffic on dolphin populations in Montenegro (Figure 4).

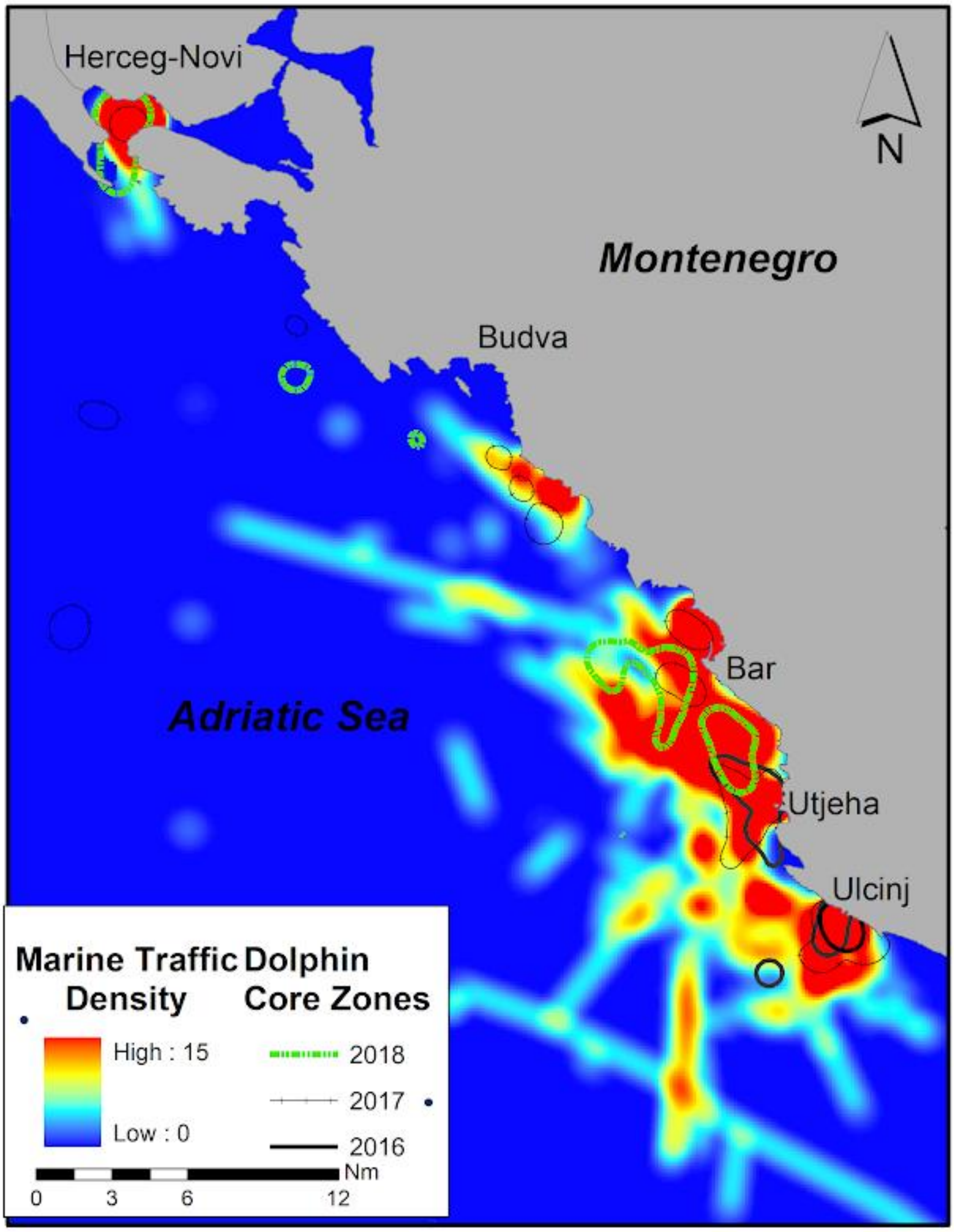

Figure 4 - Density distribution of marine traffic and dolphin sightings in relation to the survey site and survey year

3.7. Acoustic data

3.7.1. Encounters

A total of three encounters (10th July, 11th July and 15th August 2018) with bottlenose dolphins during coastal survey efforts yielded 124 minutes of acoustic data which was recorded in conjunction with behavioural sampling techniques. Each encounter varied in group size (1 - 8) and produced recordings of sufficient quality to proceed to the analysis stage. Additionally, a single encounter during an overnight offshore boat survey (2nd and 3rd August 2018), whereby striped dolphins and bottlenose dolphins were sighted simultaneously, yielded a total of 284 minutes of acoustic recordings. However, limited behavioural data could be collected due to the encounter occurring at night.

3.7.2. Behaviours

Four behavioural states were observed across the encounters with the bottlenose dolphins; 'travelling, socialising, diving and resting', however, 'resting' was excluded from analysis due to the small time-frame in which it was visually observed (van der Pouw Kraan, 2019).
In the limited time the striped dolphins were able to be visually observed, the behaviour most commonly observed was 'surface feeding'.

3.7.3. Vocalisations

Analysis suggested that during socialising, bottlenose dolphins use significantly more clicks, bursts and whistles with shorter click trains. Denser, longer bursts were most commonly associated with diving behaviours (van der Pouw Kraan, 2019). It was revealed that bottlenose dolphins were least vocal whilst travelling, with bursts of lower density and duration than any other observed behavioural states (van der Pouw Kraan, 2019). In addition, click and whistle rate characteristics were significantly different across the three encounters (van der Pouw Kraan, 2019).

3.8. Public Outreach Efforts

From October 2017 to November 2018, various conservation efforts ranging from beach cleaning campaigns to public and scientific outreach workshops have been performed. Ten beach cleaning activities were undertaken in this time. In the period of November 2017 to April 2018, we had six beach cleaning campaigns in Ulcinj and Bar. In April, a beach cleaning event organised in collaboration with Stray Aid Montenegro was used to promote the protection of our oceans and raise awareness on the issue of stray animals in Montenegro. Between June and September 2018, three beach cleaning events integrated public outreach campaigns. Each event promoted the scientific and conservation actions undertaken by Montenegro Dolphin Research. The event in June was used as a pilot study for mapping the distribution and concentration of marine and shoreline pollution along tourist beaches. A week-long beach cleaning event in August, coupled with public outreach demonstrations along the marina and promenade in Bar, visually demonstrated pollution deposition on shorelines. The demonstration involved an information stand (figure 5) and signage displaying the amount of waste collected per hour. This was reinforced through the distribution of posters and leaflets, sharing information on the threats to dolphins in Montenegrin waters and the importance of their conservation. The last of the shoreline public outreach campaigns used a life-sized dolphin (figure 6) made of different types of waste commonly found on coastlines, emphasising ways in which marine pollution is able to damage aquatic life.

Figure 5 - MDR's stand in the middle of Bar, Montenegro. The purpose was to raise awareness of the amount of rubbish being left of Montenegrin beaches.

Figure 6 - Interns beach cleaning with a life-sized dolphin made from waste items left on the beach

3.9. Conferences and workshops attended

A total of seven conferences and workshops were either organised or attended by researchers from the Montenegro Dolphin Research team in conjunction with DMAD during 2018.

From 3rd – 6th February 2018, MDR with the partnership of the National History Association of Montenegro and Marine Mammals Research Association hosted the 27th Rufford Small Grant (RSG) conference in Montenegro, aiming to develop transboundary conservation networks from mountains to deep seas. The RSG Montenegro conference helped build networks between researchers conducting terrestrial research and those conducting marine ecosystem research. Sharing experiences in research and conservation and the problem that each researcher had encountered during their projects helped bridge the gap between governmental and non-governmental bodies, strengthening relationships for conservation implications and standardising data collection protocols for transboundary research. This enabled capacity building and the sharing of information to be incorporated in online platforms.

In light of conservation implications for standardising protocols for transboundary research, two members of the MDR team attended the Ionian Dolphin Conservation 'Marine Biology Camp' from 19th – 23rd March 2018. The purpose of the research camp was to teach students and members of the

public interested in cetaceans the science behind marine mammal observations and what procedures were taken upon encounters. The purpose for the attendance of MDR members was to assess the protocols followed by the organisation in order to collect data, making comparisons with our own to see whether transboundary collaborations were possible for the combination between two databases.
Marine Mammals Research Association in collaboration with Dokuz Eylül University conducted an acoustic workshop under the "Giant Guardians of the Deep Sea" Project, supported by WWF-Turkey. The workshop took place between 1st – 2nd June 2018 at Dokuz Eylül University, Izmir, Turkey. Volunteers of MDR attended the workshop and took valuable knowledge from the workshop surrounding acoustic research which could help transform the research currently undertaken in Montenegro.
A second RGS Conference was attended from 2nd – 4th August 2018, held in Kazbegi, Georgia. The conference was again aimed at researchers sharing their experiences to make new connections for transboundary collaborations. The objectives were taken upon board by our scientific director Dr. Aylin Akkaya Bas in order to begin new collaborative research for wildlife conservation between the countries within the Caucasus region and the eastern Mediterranean.
In order to demonstrate the innovative forward thinking methodologies being developed at MDR to maximise data collection, an abstract and subsequent presentation was submitted and accepted by the International Workshop for the Metrology of the Sea. The workshop was held at the University of Bari, Italy from 8th – 10th October 2018. The workshop was held with the intention to bring together innovative ideas, ground breaking research and diversity in Marine Sciences, ranging from topics in Engineering to Oceanography. One of DMAD’s Senior Research Associates, Jack Clarkson attended the workshop to present the paper 'Social Media for Social Species: A case study on the behavioural transitions of bottlenose dolphins (Tursiops truncatus) in the presence of tourism, Montenegro, South Adriatic' along with co-authors Lucy Abbiss and Dr. Aylin Akkaya Bas – a paper which was aimed at drawing something positive and useful from a daunting topic with many negative opinions surrounding it. The preliminary study proposed the assessment and extraction of posts featuring cetaceans from social media which may be useful for photo-identification. In the knowledge that regulations, guidelines and mitigation strategies can often be ignored or take years to be implemented without sufficient data, the proficient use of social media by not only tourists, but the general public, could provide a new platform for data collection alongside standardised methods. The current study is ongoing.
Marine Mammals Research Association and MDR were also represented at the 12th Meeting of the Scientific Committee of ACCOBAMS (the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area) in Monaco from 5th – 8th November 2018, chaired by Simone Panigada. This four-day event saw the meeting of organisations and experts from around the ACCOBAMS region who come together to present ongoing and completed projects and make recommendations for the next steps for ACCOBAMS and the countries involved in the agreement. During 2018’s meeting, the committee discussed a multitude of items including cetacean population estimates, ship strikes, seismic surveys and the very successful ACCOBAMS Survey Initiative. One of DMAD's Senior Research Associates, Tim Awbery, attended the conference as well as contributing to two small working groups on bycatch and anthropogenic noise. Tim was able to share ideas and experiences with experts from around the Mediterranean and found the conference to be a highly productive event and commented on the dedication and professionalism of the Scientific Committee. We hope to be involved with ACCOBAMS more and more in future years.
MDR’s scientific director Dr. Aylin Akkaya Baş and colleague Dr. Mehmet Akif Erdoğan conducted a workshop at Marmara University on the importance and use of photo-identification and GIS. ACCOBAMS alongside the WWF-Turkey project, Giant Guardians of the Deep Sea, hosted the event

between 14th – 15th November 2018. In the program, Baş and Erdoğan provided practical training for both students and expert participants. Focussing in the field of ethology, 25 participants attended the workshops on DISCOVERY for photo-identification and ArcGIS programs used for geographical information systems, mapping study areas and distribution and density models.

4. Discussion

It is of great importance to gather the necessary baseline information of at risk species in order to facilitate effective conservation strategies for the protection of species and the habitats that they rely on (Forcada et al., 2004). With regards to these measures, Montenegro Dolphin Research was formed in order to set important milestones contributing to the delineation of important habitats for both bottlenose dolphins and striped dolphins within Montenegrin waters. The wider context of the project's work aims to disseminate information on species sightings, photo identification, encounter rates, residency patterns, site fidelities, key behaviours and the behavioural modifications in relation to marine traffic. Previous information on the distribution of bottlenose and striped dolphins are scare in the southern Adriatic Sea (Bearzi et al., 2004; 2008; 2009; Genov et al., 2008; 2009; Rako et al., 2009; Affinito et al., 2018; Bas et al., 2018), an area that has been pinpointed as a cetacean hotspot (Bearzi et al., 2012; Aguilar & Gaspari, 2012). There is considerably more research effort directed towards bottlenose dolphins within the northern and central Adriatic Sea (e.g. Shane et al., 1986; Bearzi et al., 1997, 1998, 1999, 2004, 2008; Fortuna, 2007; Genov et al., 2008; Pompe-Gotal et al., 2009; Bilandžić et al., 2012; Rako et al., 2013; Gaspari et al., 2015; Bas et al., 2018), striped dolphins are almost data deficient in the Adriatic Sea with the exception of certain studies (e.g. Marsili et al., 1997; Bearzi et al., 2004; Pompe-Gotal et al., 2009; Fortuna et al., 2011; Bilandžić et al., 2012). This is of particular importance since the habitats are currently experiencing rapid changes associated with increased tourism and seismic practices.

4.1. Variations in the Sightings of Bottlenose Dolphins

Photo-identification of bottlenose dolphins revealed the presence of 72 individuals in the coastal waters off Montenegro, of which 61% were re-sighted. The highest re-sighting rates were recorded between 2017 and 2018. The considerably high re-sighting rates underline the importance of Montenegrin waters on the lifecycle of bottlenose dolphins. Additionally, 2018 yielded an increase of 31% from 2017 in the number of new individuals identified, thus re-sighting analysis for these newly identified individuals is not possible with no comparison data. Thereby the figure of 39% for individuals never re-sighted is likely to be an overestimation. However, if this figure is indeed representative, results suggest that while certain individuals show some type of site fidelity to Montenegro, certain individuals are indeed visitors or transient, using Montenegro as a corridor for movement (Bas et al., 2018).

As with the current study in Montenegro, the majority of studies documenting the sighting variation of bottlenose dolphins in the Adriatic report high levels of site fidelity, yet their movement patterns and home ranges remain poorly understood (Genov et al., 2016). Evidence of long-distance movements by bottlenose dolphins in the Adriatic are lacking, despite reports of a re-sighting distance as high as 130 km in the Northern Adriatic within a one week period (Genov et al., 2016). This suggests bottlenose dolphins throughout the entire Adriatic could be capable of travelling significant distances in short periods of time. Our current study reported a maximum re-sighting distance of 75 km across a 10 month period on a multi-year basis. Upon comparing geographical locations for each individual per re-sighting in our study, results yielded relatively constant sighting locations for each individual. A value of 74% regarding the proportion of individuals re-sighted in the same area (<25 km) gives suggestions for strong site fidelity. In order to confirm these suggestions, further transboundary collaborations

with other organisations is essential if we are to truly understand the long or short-distance movement patterns of bottlenose dolphins.
One of the limitations to our current photo-identification results is that despite multiple photographs being taken on surveys to maximise the number of high quality images, occasionally not all individuals are able to be photographed, therefore low re-sightings of certain individuals may merely be due to not being re-photographed, as opposed to their being absent, this could also explain why some individuals were sighted in 2016 yet not re-sighted until 2018. In addition, images collected on surveys often contained a high proportion of individuals that could not be identified due to lack of distinguishable features, hence they could neither be added to the catalogue nor matched. Higher re-sighting, and indeed new sightings, between 2017 and 2018 are likely explained by the higher survey effort across those two years, since 2016 only saw a survey effort of four months, thus highlighting the importance of conducting long-term study in this area before drawing conclusions on the residency patterns of bottlenose dolphins.

Note: Analysis into variation in sightings between the northern, central and southern sections of Montenegro is currently under way and the full results will be published shortly.

4.2. Dolphin and Marine Traffic Distribution

Our study revealed several areas that represent important habitats for bottlenose and striped dolphins. However, in order to reduce negative impacts upon these species, it is important to begin to understand the spatial overlap between the distribution of both vulnerable species habitats and the parameters which may contribute to stress upon individuals and their environment. In this case, the core zone habitat overlap of dolphin species with marine traffic distribution.

The distribution pattern of bottlenose dolphins and striped dolphins are in line with previous studies from the Mediterranean Sea. Bottlenose dolphins were mainly found to be distributed along the coast during the current study as well as in previous studies (Notarbartolo di Sciara et al. 1993; Marini et al. 2015; Bas et al. 2017), whereas striped dolphins were found in deeper offshore waters, again supporting other findings in the Mediterranean (e.g. Notarbartolo Sciara et al. 1993; Bearzi et al. 2004; Boisseau et al. 2010; UNEP-MAP-RAC/SPA, 2014), with unusual coastal sightings during the current study.

Results identified all five coastal study sites as hotspots for high intensities of marine traffic, partially overlapping the core zone habitats of the two study species. The highest degree of marine traffic intensity was confined to coastal waters, whilst offshore areas demonstrated reduced intensity. Habitat choice of the two species is the most likely contributor to the degree of overlap between marine traffic and dolphin core zone habitats. A predominantly coastal distribution for both bottlenose dolphin and marine traffic results in anthropogenic pressures overlapping dolphin core zone habitats, particularly in Bar, Utjeha and Herceg Novi. In Bar and Herceg Novi in particular, this is critical as they are not only annual dolphin habitats with regular sightings, but also important ports used by ships crossing between the western and eastern Adriatic. Such persistent pressures and long term high levels of spatial overlap between dolphin core zone habitats and marine traffic distribution has led to a great degree of interaction between the two both within Montenegro and across the world. Thus, both the short and long term effects of marine traffic on bottlenose dolphins have been widely researched (Lusseau, 2003; Lusseau & Higham, 2004; Christiansen et al., 2010; Papale et al., 2011; Bas et al., 2015; Pennino et al., 2016; 2017;Marley et al., 2017).

Whilst almost all of the core zones displayed for bottlenose dolphins with a coastal distribution demonstrate high degrees of overlap with marine traffic, striped dolphins appeared to show a much lower degree of spatial overlap with marine traffic. Despite this, striped dolphin habitats, which tend to be deeper, steeper and in offshore waters (Aguilar, 2000; UNEP-MAP-RAC/SPA, 2014; Bas et al., 2018) are clearly not exempt from imbricating with marine vessels. Previous research in the western Mediterranean Sea has demonstrated striped dolphins to have the highest degree of overlap with marine traffic distribution, although this was because they were the most frequently observed species during the study and were often seen approaching vessels (Pennino et al., 2017). However, previous results from offshore areas in the Mediterranean, like those found off the coast of Montenegro which have characteristics commonly associated with striped dolphin core zone habitats, showed lower degrees of spatial overlap with marine traffic (Campana et al., 2015). There is likely to be significantly more overlap than presented here as land surveys have limited ability to monitor marine vessels in areas that have the potential to be core striped dolphin habitats due to the distance from the shore. This, along with low numbers of sightings in comparison with bottlenose dolphins has led to greater apparent disparity between the two.

Additionally, favourable habitats of striped dolphins are currently being explored by seismic vessels for the potential oil and gas that could be exploited in these areas. Therefore, dedicated survey efforts in deeper Montenegrin waters are more important than ever to understand the possible impacts of the seismic activities and thus to propose the effective conservation tools moving forward.

4.3. Acoustic Data

Our study is one of the first to have collected acoustic recordings of cetaceans within Montenegrin waters, however its implementation remains within the preliminary stages due to a shortage of funding. Therefore, our results must be reviewed with caution. Bottlenose dolphins are known for being vocally complex and often have individually distinct vocalisations (King et al., 2013). Our findings suggest that the acoustics of bottlenose dolphins are likely to vary according to behaviour (van der Pouw Kraan, 2019), which can be confirmed by previous studies (Mann et al., 2000; Janik, 2009; Marley et al., 2017). The current study revealed that bottlenose dolphins in Montenegro were found to use significantly more clicks, bursts and whistles during socialising and were found to be less vocal during travelling (Mann et al., 2000; Janik, 2009; Marley et al., 2017; van der Pouw Kraan, 2019). This is the first time acoustic data has been collected and compared with behavioural data in the coastal waters of Montenegro for bottlenose dolphins and indeed thought to be the first time acoustic data has been collected for striped dolphins in the area. Visually, we were able to confirm the offshore encounter consisted of both bottlenose and striped dolphins, however further analysis of the acoustic recordings has yet to be conducted to confirm acoustics were collected for both species. Additionally, due to the short time frame of our acoustic monitoring effort within the project, conclusions drawn from only three encounters with bottlenose dolphins cannot be applied at population level. Thus, further research needs to be conducted both in the coastal and offshore waters of Montenegro in order to gain a better understanding of the relationship between vocalisation and behaviour.

4.4. Public, National and International Outreach.

Before MDR began its research efforts in September 2016, Montenegro lacked year-round data on the cetaceans inhabiting its territorial waters. It is important to note that previous survey efforts have taken place but these were for limited time periods and these never covered the full year.

With the exception of the fishing community who spend many hours out at sea, and members of the public involved in the tourism industry, many people whom have approached us during our land survey efforts say they do not know that there are marine mammals in Montenegrin waters. Our public outreach efforts such as beach cleaning campaigns and demonstrations, have attempted to reach these local citizens, to disseminate information regarding the cetaceans of Montenegro, raising awareness on the environment before them and the role that they can play in the future conservation efforts of Montenegro. Educational outreach programmes held in schools encourage and engage younger members of the public to consider a future in the environmental sector, providing an understanding as to how cetaceans, as top predators (Sergio et al., 2006), are important for the marine ecosystem.

Nationally and internationally, each scientific publication emphasises the importance of research towards conservation measures, intelligent designs and online data sharing platforms. The attendance of the RGS conferences, Research Camps and Workshops which display work conducted by members of DMAD, bring a new way of looking at these aspects. Attendance at such events allows for a wider understanding of the perspective of diverse researchers through their work in relatively unexplored areas within their field. At the end of each conference and workshop attended, new relationships, methodologies from other areas of research and ultimately, perspectives within science and conservation are built between researchers. This allows for the potential of transboundary research which will give rise to several future projects which can be implemented towards Species Monitoring Action Plans and other reports to be presented to governmental bodies.

4.5. Proposals following our research

Following the results found by Montenegro Dolphin Research revealing that both bottlenose and striped dolphins show uneven distribution patterns, but strong site fidelities within Montenegro, we propose that the entrance of Boka Kotorsko Bay is an important bottlenose dolphin habitat and should be protected. The absence of MPAs within Montenegro forms an important barrier against the protection of the top predators of the Adriatic, which are under the rapidly increasing pressures of human activities ranging from maritime transport to tourism and seismic practices, all having an irreversible effect unless managed correctly. In light of the current seismic explorations along the Montenegrin coastline, in particular the offshore water of Bar, further extensive and long-term research considering all oceanographic aspects needs to be conducted in order to disseminate information and to delineate whether the area can be safeguarded as an MPA (or SPAMI/SSSI). This work would not only recognise the area as a critical location for various species, but also implement stricter regulations on the work conducted by marine constructors and seismic vessels.

5. Conclusion

Montenegro Dolphin Research has continued its year-round dedicated survey effort and now better understands the relative abundance, distribution and encounter rates of dolphin species in Montenegrin waters. We have also further developed our public outreach programmes and attended more conferences, building relationships both locally, nationally and internationally. The impact of various human threats identified in the previous annual report (habitat degradation, marine debris, overfishing, bycatch, marine traffic and boat strikes and noise pollution) with the additional threat of increased seismic activity for the exploration and exploitation of natural resources must be investigated at a species level to understand the magnitude of its effect. Therefore, it is imperative that we continue our dedicated survey effort to look at how these threats are impacting Montenegrin species. Our ultimate goal is for our research to eventually lead to the creation of a protected area for marine mammals in Montenegro. However, research alone is not enough and in order to effectively protect marine mammals we need to continue our outreach and awareness programmes to educate and unite the public. Furthermore, we will continue to work with and develop new relationships with organisations both within Montenegro and internationally. **The future of marine biodiversity depends on transboundary collaborations between all stakeholders and Montenegro Dolphin Research will work with all parties and lead the way to make this dream a reality!**

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