Final Report 2018

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This report is made from the data which collection is co-financed by Public institution “Nature Park Telašćica” and Public institution “Kornati National Park”. The aim of the research was to collect data on the biology and ecology of the bottlenose dolphins (*Tursiops truncatus*) and the purpose of the report is to present the research effort and data collected in 2019. Researchers who participated in this project are Nikolina Rako Gospic, Tihana Vučur Blazinić, Grgur Pleslić, Marinela Cukrov Car and Marko Radulović. Research within Adriatic Dolphin Project was conducted under the research permit from Ministry of Environmental and Nature Protection, KLASA: UP/I-612-07/18-48/152, URBROJ: 517-05-1-1-18-9.

TELAŠĆICA
Park prirode
Nature Park

KORNATI
Nacionalni park • National Park

Introduction

The common Bottlenose dolphin (*Tursiops truncatus*) is a cosmopolitan species that inhabits coastal and open sea areas of the moderate and tropical belt. Its robust body, curved dorsal fin, as well as the absence of a defined body pattern with a pale ventral area and a darker upper body is characteristic of this species. Adult size ranges from 2 to 3.8m. Length and weight may vary depending on geographical positioning (Wells and Scott (2002)). In the Adriatic, bottlenose dolphins can reach approximately 3m in length and can weight up to 200 kg. The analysis of abrasion of teeth layers reveal that these species can reach up to 50 years old, however male lifespan is typically shorter than in females (40 to 45 years old) (Wells and Scott (2002)). As for the rest of marine mammals, the sound is of high importance for bottlenose dolphins. They produce “whistles” in order to communicate, and “clicks” for echolocation, helping them navigate, search for food, and detect potential dangers (Wells and Scott (2002)). This species is not only active during the day, but also at night. Diurnal activities of bottlenose dolphins involve traveling, scavenging, feeding, socializing, and resting (Wells and Scott (2002)). Duration of the particular behavior depends on various factors such as age, habitat, time of the day, or mating season (Wells and Scott (2002)). Globally, Bottlenose dolphins are affected by a series of threats such as habitat loss, overfishing, bycatch, diseases caused by pollution, maritime traffic disturbances and underwater noise (Wells and Scott (2002)).

The bottlenose dolphin (*Tursiops truncatus*) is protected under the Nature Protection Act (NN 162/03) and is included in the second Annex of the EU Habitats Directive. The species is listed as “endangered” (EN) in Croatia (D. Holcer (2006)). Based on aerial surveys performed in 2010 and 2013, it is estimated that there are around 5700 bottlenose dolphins (CI = 4300-7600) inhabiting the entire Adriatic area (C. M. Fortuna et al. (2018)). It is estimated that the Northern Adriatic is a significant area for bottlenose dolphins with an estimate of 2600 individuals (CI = 2200-2900), while the middle Adriatic is estimated to hold approximately 1100 individuals (CI = 800-1500) (C. M. Fortuna et al. (2018)). Data on the status of local communities in Croatia exist only in the Kvarner area, Northern Dalmatia and in the waters of the island of Vis. However, in other areas, research has only recently been carried out occasionally and opportunistically; therefore, there is no systematic knowledge of the population and conservation status of bottlenose dolphins in the Adriatic. In the Kvarner area, more precisely in the Cres-Lošinj aquatorium, the resident population of bottlenose dolphins has been studied continuously since 1987. Presently, about 200 individuals are living in this area throughout the year (Pleslić et al. (2015)), while more than 1000 individuals have been recorded in the reference database. Individual dolphins mostly form smaller groups made up of males and females, mostly for activities related to scavenging and feeding. Although food availability is reduced in the area, this allows each individual to have the same probability of finding food (Bearzi, Politi, and Sciara (1999)). Through years of research, it has been established that this resident community has a high degree of site fidelity, including males being territorial and residing in a smaller area compared to females (Rako-Gospić et al. (2017)). Rako et al. (2013) found that the dolphins in the Cres-Lošinj waters preferred different areas during peak tourist season. During the summer months, a higher rate of sightings were recorded in areas far away from the mainland, correlating to lower levels of underwater noise. Specifically, at this time of year, the number of vessels in the aquatorium had increased by 400%, which subsequently increased noise levels at sea. It can be assumed that this is the result of the animal population decline recorded from 1995-2003. Bottlenose dolphins do not have a natural predator in the Adriatic, and human activities in the form of maritime traffic and tourism are one of the main threats to this species in the Kvarner area (Nimak et al. (2007); C. M. Fortuna (2007)). Nimak et al. (2007) consider that the presence of vessels affects the behavioral budget of the bottlenose dolphins and that in the presence of the vessels, dolphins spend less time in activities related to feeding and rest, and spend more time traveling. Furthermore, negative dolphin reactions have been reported in the presence of other vessels, mainly tourists. This has prompted the Blue World Institute to further educate the local community and visitors on animal welfare standards that should be considered during human/dolphin interactions. Following these standards is voluntary, but is still contributing to the positive changes in public awareness. It is essential in understanding the importance of preserving bottlenose dolphin populations in the area and across the globe. The Blue World Institute, through its activities, continuously monitors bottlenose dolphin populations in order to determine its abundance. It controls the impact of human activity on biodiversity and provides the scientific background to the competent authorities to establish protection measures within Natura2000 sites.

Methods

Research area

The Blue World Institute for Marine Research and Conservation conducted research in 2018 in northern and central Adriatic, including the Cres-Lošinj archipelago, Telaščica Nature Park, and Kornati National Park (Figure 1).

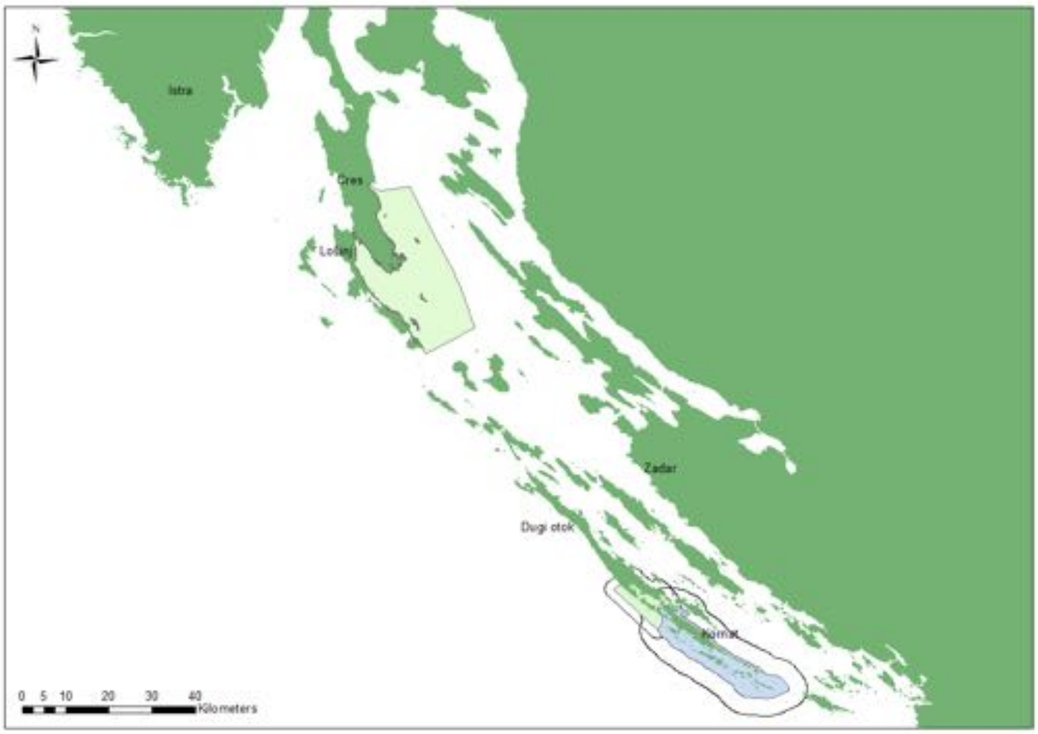

Figure 1: Study area

Data collection and analysis

The research effort

Fieldwork at sea was conducted using a 5.75 m (Novamarine RH585) inflatable boat with the four-stroke engine (Honda Vtec 100hp) at sea conditions less than four, according to the Beaufort scale and during good visibility. Research effort was determined *ad libitum* according to the weather conditions. The average search speed was 14 knots. At least two experienced researchers were always on board, continually inspecting the horizon in a standing position, covering the 180° range in the direction of the movement of the vessel.

Information on the presence of fishing vessels within the study area and the locations of other interesting marine species had been recorded as well. NaviLog application was used to collect the navigation data on the Samsung SM-T550 tablet, developed specifically for the needs of the Blue World Institute (Figure 2).

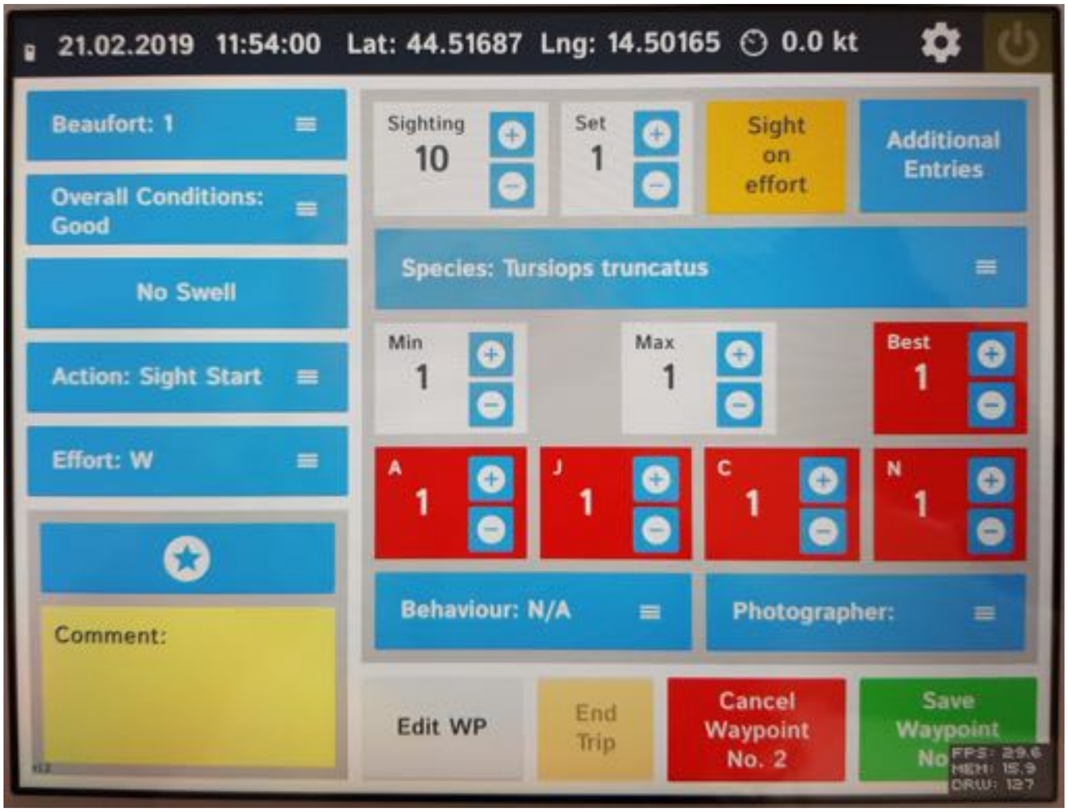

Figure 2: Android application Navilog

For the survey, an array of data were recorded: date, time, coordinates of navigation, sea state changes, the weather conditions, the current research activity, the locations of the sightings of dolphin species, group size, age categories within the group, and behaviour within the groups. All the navigation data was transferred to the navigation database using the GIS ESRI ArcMap 10.2 and RStudio to calculate the research effort and obtaining an outline of its spatial distribution (Team (2016), Bivand and Lewin-Koh (2013), C. Brunsdon, Chen, and Brunsdon (2015), South (2011), Bivand and Rundel (2015), McDonald (2016)).

Encounter rate

For the purpose of this survey, data collection included date, time, navigation coordinates, sea state changes, weather conditions, current research activities, information of the research vessel tracks during sightings, number and age of individuals present in a group and behaviour. Research effort was determined *ad libitum* depending on the weather conditions at sea and trying to ensure a balanced distribution of research effort in the survey area. For this purpose ESRI ArcMap 10.2 and R 3.3.2 computer packages (Team (2016)) were used. The encounter rate is calculated as the total number of encounters of a group of bottlenose dolphins divided by the total number of kilometers driven in the study area (ER1 = n encounters / n kilometers) (C. M. Fortuna (2007)). A graphical chart of encounter rates in different sections of the study area was made using a polygon grid with a cell size 1x1 km, where the total number of dolphin sightings is divided by the total number of kilometers within in each grid cell (ER2) using only the cells in which the total research effort was equal to or greater than 1,414 km (corresponding to the diagonal of the cell of size 1x1 km) (Rako et al. (2013); Bearzi et al. (2005)). The land area was removed from the grid, and proportional surface area of the sea was calculated within each cell for greater accuracy of results. Subsequently, the encounter rate was recalculated as previously obtained encounter rate while divided by the share of the sea within each cell. Encounter rate analysis (ER2) was calculated using ESRI ArcMap 10.2.

Photo-identification

The research procedure involves photo-identification, which represents a non-invasive technique for the identification of individuals in the population. Photo-identification of the observed bottlenose dolphins is based on comparing the unique notches, scratches and scars on their dorsal fin and the side and rear of the dorsal part of the body (B. Wilson, Hammond, and Thompson (1999); Wiirsig and Jefferson (1990))(Figure 3). The edge of the dorsal fin is often and easily damaged during the interactions between individuals and the pattern of such injuries makes every single dorsal fin unique. By systematically taking pictures of dorsal fins, the observed individuals are being identified, and photos are compiled in a reference catalogue consisting of an array of dorsal fins belonging to dolphins living in a particular area. Based on the created catalogue, the population size, social structure, relations between individuals and the rate of reproduction can be determined.

Figure 3: Photo-identification of individuals in the population

Although dorsal fins of young dolphins usually have no marks, they are individually identified by swimming in pairs with their mothers, given that they swim most of the time in their vicinity. Multi-Annual monitoring of animals with their offspring and changes of their fins allows the identification and monitoring of the calves separation from the mother. In each dolphin observation, the monitoring protocol “focal group follow” was used to trace the movement and behavioural patterns of the individual, as well as the use of photo-identification to define the focal group observed (Mann (1999)). A group is defined as all animals in apparent connection to each other, moving in the same direction and generally (though not always) behaving similarly (Shane (1990)).). In case of changes in the composition and the size of the sampled group (dolphins leaving or joining the group) the sighting was divided into sets (Bearzi, Notarbartolo-DI-Sciara, and Politi (1997)). In a photo-identification analysis, each set was analysed separately to determine changes in the monitored group and its dynamics (Bearzi, Notarbartolo-DI-Sciara, and Politi (1997)). Bilježenjem promjena u sastavu promatrane skupine kroz setove omogućeno je praćenje dinamike unutar skupina.

Furthermore, an evaluation of the quality of dorsal fin marks was carried out and classified into one of four categories (highly marked, fairly marked, poorly marked and unmarked) (Figure 4).

- **Heavily Marked** (HM) - Well-worn fins with lots of nicks or notches that often change the general shape of the fin (e.g. tip of the fin missing), white coloration due to numerous scars. Positive identification possible even from poor-quality photos, extremely low chance of misidentification. (Figure 4)

- **Fairly Marked** (FM) - Several nicks and notches of various sizes present on the fin. Positive identification possible on fair-quality and high-quality photos.
- **Poorly Marked** (PM) - One or few small nicks on the trailing edge present, no severe scars or injuries. Positive identification possible only on high-quality photos.
- **Unmarked** (UM) - The fin bears no marks at all, usually seen on young individuals. Positive identification made when young individual was seen in pair with identified mother throughout several occasions.

Figure 4: Example of a bottlenose dolphin with a "highly marked" dorsal fin

This categorization is necessary in order to avoid possible errors and discrepancies in the application of methods for estimating population size when using only fairly (FM) and highly (HM) marked individuals of the total number of identified individuals that include poorly marked (PM) and unmarked (UM) individuals. In the analysis of the size and composition of the group, the data and information on the identification of all individuals, including poorly marked and non-marked animals were used. In addition, regardless of quality, all photos were stored for their possible subsequent identification. Photo-identification technique was applied using a Canon EOS 7D digital camera with Canon lens EF 70-200mm f / 2.8 L IS USM. During the sightings with each group of bottlenose dolphins, the goal was to make high-quality photos of the dorsal fin of every dolphin in the group from both sides. The quality of the pictures depended on the weather conditions and/or the absence of light and on the size and composition of the group and the behaviour of the group and/or individual animals.

Starosne kategorije

The age of individuals present in a group was determined according to four basic categories (tablica 1 i slika 5):

Table 1: Age classes

Age class	Abreviation	Definition
Adult	A	a dark grey individual, generally of length about 2.8 - 3.0 m, with scars on the body
Juvenile	J	a light grey usually poorly scarred and rarely nicked individual 2/3 the length of an adult, always in the same group as its mother but not necessarily always swimming together; Regardless of any difference that was noted in the field, in this thesis categories Calf and Juvenile were treated together
Calf	C	a light grey individual 1/2 the length of an adult, with often visible foetal stripes, always swimming close to its mother in a typical position just behind her dorsal fin
Newborn	N	a dark grey or brown individual 1/3 the length of an adult, with visible foetal stripes, uncoordinatedly swimming always beside an adult, presumably its mother

Figure 5: Examples of the different age classes

Behaviour

Data on group behaviour were collected at 5-minute intervals, and the category of behaviour observed in more than half of the individuals was recorded. Behaviour category is determined by the behaviour of more than half individuals in the observed group and are defined as in Bearzi, Politi, and Sciara (1999); Lusseau et al. (2006); Wise et al. (2007) and López (2006):

- **Socialise** (S) - Most group members in almost constant physical contact with one another; oriented towards one another; no forward movement; display of surface behaviour (jumps, leaps, rolling, tail slaps, etc.).
- **Social Travel** (ST) – Moving steadily in one direction, while socializing intermittently; tight groups often in physical contact (leaps, rolling, etc)
- **Dive** (D) - Pattern characterized by cycles of single long dives, lasting up to several minutes; Dives are spaced by clusters of a relative regular number of ventilations. Last of series of ventilation often a Fluke up or tail stock submergence, suggesting a vertical dive. Submergence and surfacing usually within the same area; dolphins diving often synchronous
- **Dive-Travel** (DT) – A pattern that is consistent of both travel and dive. Dolphins keep same general direction under water as during surfacing. Usually, but not always, single long dives accompanied by a pattern of clustered ventilations. Respiration patterns can be highly variable and poorly consistent in comparison to "Dive" behaviour. Groups or sub-groups often synchronous.
- **Travel** (T) - Consistent directional movement of dolphins, with regular surfacing typically every 10 - 60 seconds.
- **Active Trawler Follow** (ATF) – Following wake of operating trawler, at about 150 - 300m stern. Regular single long dives for several minutes. Dives are broken up by a pattern of regular ventilations.
- **Passive Trawler Follow** (PTF) – Consistent directional movement of dolphins, with regular surfacing typically every 10 - 60 seconds, at about 150 - 300 m stern.
- **Surface Feeding** (SF) – Obvious feeding activities performed near the water surface (chasing of prey, belly up, leaps, jumps, etc.): prey visible near surface; sometimes birds congregating in the area.
- **Mill** (M) - Moving in varying directions in one location, pretending to dive, but showing no surface behaviours and no apparent physical contact between individuals; usually staying close to the surface, floating, etc.
- **Mixed Behaviour** (MB) - No clear prevalence of one of the listed behaviours; different behaviours performed inconsistently by different individuals or subgroups. It is possible to specify the combination of behavioural categories, for example: D+SF, or AFT+PFT+M, etc.
- **Active Purse seine Follow** (APSF) - unregular diving behaviour around the purse seiner. The length of the dive varies, while the distance from the boat itself is several to 100 meters.
- **Fish Farm Feeding** (FFF) - diving around cages where fish is farmed, the dive length varies about 1-5 min, followed by a shorter period of surfacing.

Behavior data collected using the Navilog application was analyzed in R software(Team (2016)).

Vessel impact on dolphin behaviour

Dolphin behaviour data in the presence of vessels were collected from the research boat, regardless of the presence of other vessels. Behaviours observed in more than 50% of individuals present in the group were recorded every 3 minutes for a minimum of 20 minutes. The categories of behaviour are the same as those described in the previous chapter. In addition to behaviour in 3-minute repeats, the following information was recorded: the position of the vessel, the size of the dolphin group and the age composition of the group, the presence and number of other vessels within 500 m of the dolphin group and their distance from the group itself. A control was considered only when the research boat was present within 500 m of a dolphin group, as the vessel is operated in a manner that minimally affects dolphins and their behaviour. Impact situation, i.e., the situation in which the influence on dolphin behaviour may exist, was considered when other vessels were present within 500 m of the group. The data was processed in the RStudio computer package using a Markovchain package (Spedicato (2017)). Transition in behaviour was recorded when the dolphins had changed their behaviour during the same observation, and the probability of behavioural transition was accounted for in both situations (only when a research boat was present (control) and when other vessels were present (impact)).

The cumulative (overall) behavioural budget was based on the calculation of the proportion of time that dolphins spend performing a particular behaviour in a given situation: only when a research boat was present to investigate (control) and when other vessels were present (impact). In this way, information about the impact of vessels, as well as their cumulative behaviour, and how and when it differed between the control and the impact could be obtained. Simulations were also performed for different levels of dolphin exposure to vessels during the day (during daylight), ranging from 0 to 100%, in order to predict at which levels the behaviour of the individual significantly changes in the presence of vessels compared to the control.

Trawler following

Bottlenose dolphins often swim behind bottom trawlers, feeding opportunistically. To determine the frequency of this behaviour in the study area during trawler observation, the research vessel stops at about 200 meters behind the stern of the trawler to observe the surroundings of the ship for at least five minutes. If dolphins happened to find themselves behind the trawler, photo-identification technique was applied. The behaviour of the group was determined to detect whether the trawler was actively or passively followed (see section

Categories of behaviour). By identifying each dolphin, it is also possible to determine whether there is a specific specialization of each animal to follow bottom trawlers or if this applies as general behaviour shown by the whole population in the study area.

Figure 6: Bottlenose dolphins following a trawler

Other species

Common dolphins

During 2018, data at the location and behaviour of the species of common dolphins were collected using Navilog application. The common dolphin (*Delphinus delphis*) inhabit open and coastal waters of the tropical and temperate Atlantic and Pacific (Wells and Scott (2002)). This species has been recorded in the Mediterranean, including the Adriatic Sea (Bearzi et al. (2003)). Until the 1970s, it was one of the most represented species, but since then, its abundance has declined sharply, leading to the complete disappearance of this species from large parts of the previously mentioned area (Bearzi et al. (2003)). Common dolphins were considered “pests” and the primary reason for the reduction of fish stock in the sea, which is why extermination projects had been organized and executed in both the Mediterranean and Adriatic (Bearzi et al. (2003)). Because of this, in combination with environmental changes and overfishing, this species has completely disappeared from the Adriatic Sea. In the last three decades, sightings of common dolphins were extremely rare. They were last observed in the area of Cres and Lošinj in 1997, while the most recent sighting was recorded in 2016 in the central Adriatic. Although occasional sightings have been reported, common dolphins are considered to be a regionally extinct species because there is no resident breeding population. Depending on the habitat, this species feeds on different prey species. Most fish are smaller, like herring, anchovies, sardines, and cephalopods (Bearzi et al. (2003)). They live in large groups of up to several hundred to thousands of individuals. Such groups are formed from smaller groups of 20 to 30 closely related individuals (Wells and Scott (2002)).

Sea turtles

While exploring the study area, the locations of loggerhead sea turtle (*Caretta caretta*) sightings were recorded using Navilog application. The Adriatic Sea is recognized as an essential habitat for juvenile and adult individuals of this species, which nest on the beaches of Greece, Cyprus, and Turkey. It is estimated that about 27,000 (CI = 24,000-31,000) individuals reside in the Adriatic, while the northern Adriatic is recognized as a critical neritic area for this species (C. M. Fortuna et al. (2018)). Aerial surveys in the central Adriatic did not record a large number of loggerhead turtles. It is estimated that only about 1900 (CI = 1,600-2,200) individuals are currently residing in the area (C. M. Fortuna et al. (2018)).

Dead individuals

In the case of the discovery of cetacean carcasses or sea turtle, data was collected from the animal with the location and date, the length and sex, and the general condition of the carcass. According to the Protocol of the Croatian Environment Agency, the competent institutions were informed of the animals examined.

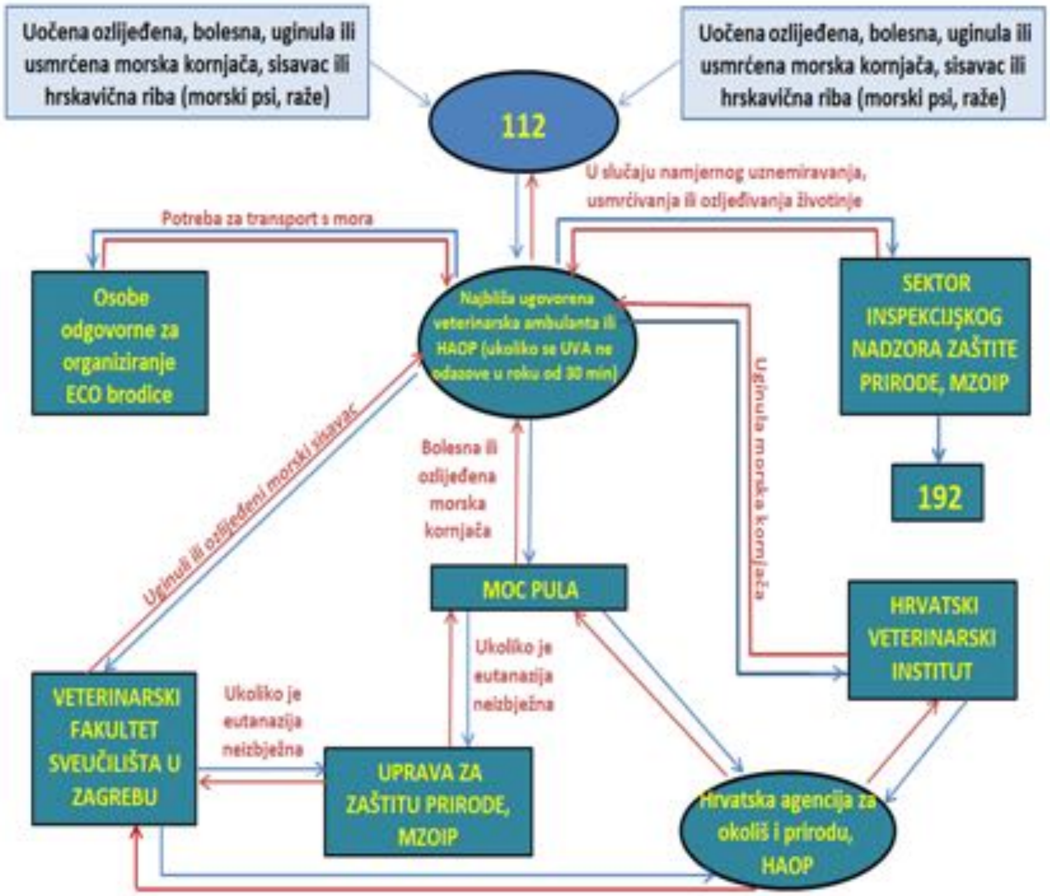

Figure 7: Protocol of the Croatian Environment Agency

Results

Research effort

During 2018 the analysis of navigation data shows that the research vessel covered the area from middle part of the island Cres to south part of National park Kornati. In total 94 fieldtrips were made during which researchers spent 512 hours on the sea and covered the overall distance of 9813,61 km. Distance covered in search for dolphins was 5904,76 km during 238 hours (Figure 8).

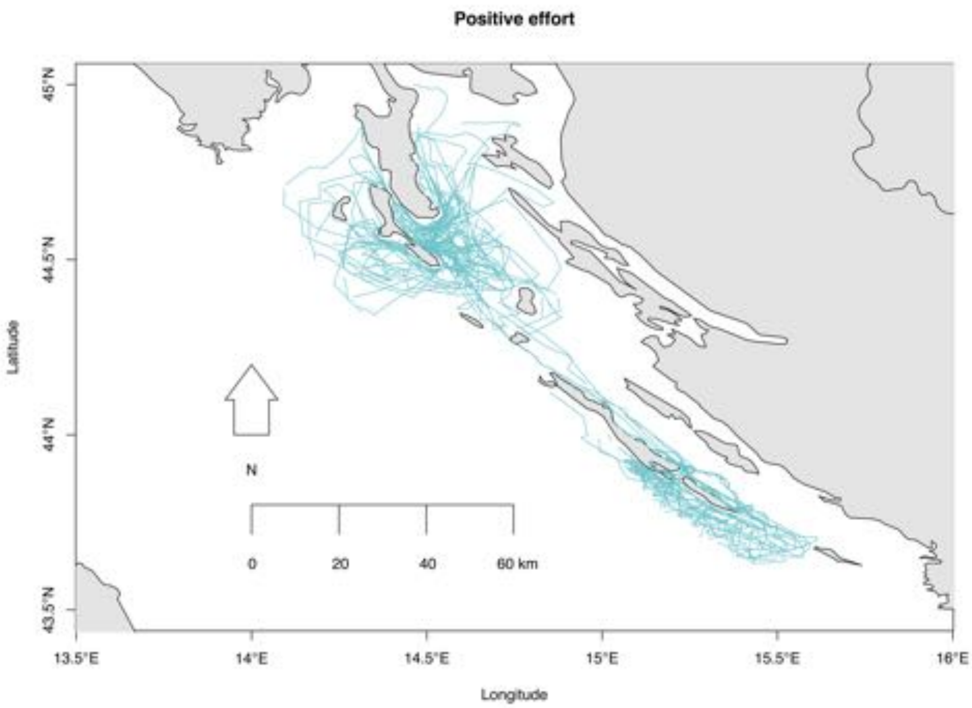

Figure 8: Research effort

Encounters

Bottlenose dolphins were encountered 167 times (Figure 9), while short-beaked common dolphins only once (Figure 21). Encounter rate was calculated in two ways. First way (ER1)-calculated as the ratio of the total number of sightings and total distance covered in positive search effort with a rate of 0.02. Second way (ER2)-was calculated using a polygon mesh size of 1x1 km with a rate of 0,018 (Figure 10). For the winter period, ER1 was 0.012, while ER2 was 0,015. For the summer period ER1 was 0,02 and ER2 was 0,026.

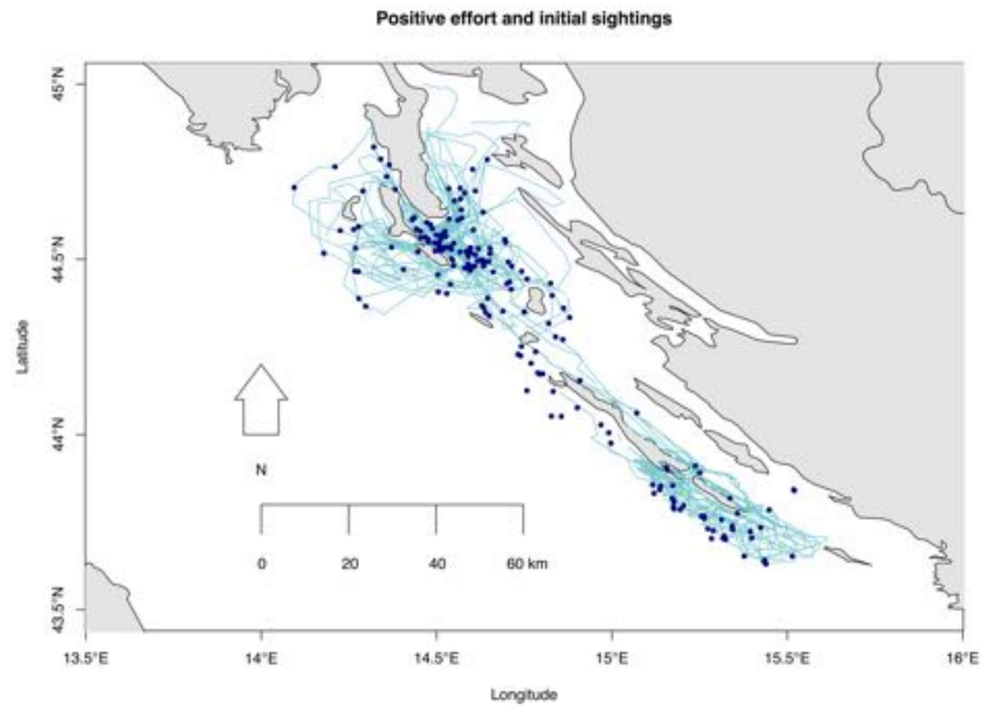

Figure 9: Bottlenose dolphin encounters

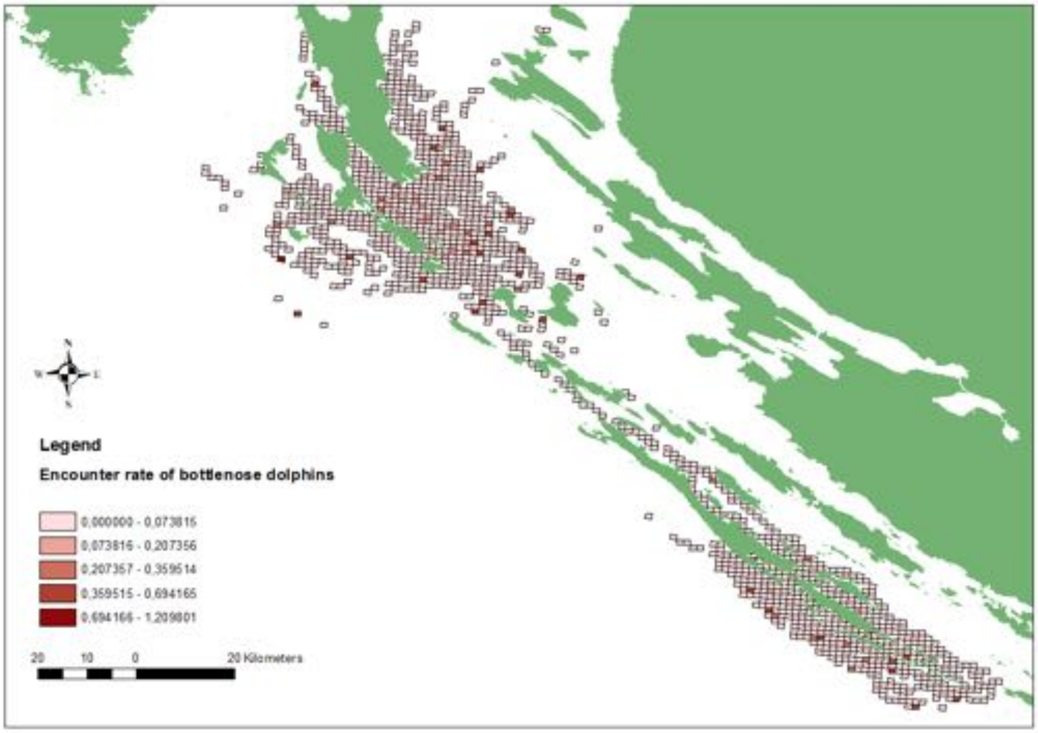

Figure 10: Encounter rate [ER2]

Time spent with the dolphins was 238 hours and distance covered was 677 km. Group size varied from 1 to 37 individuals, and the average group size consisted of 7 individuals. Between summer and winter months, no significant difference in the size of the group was found (Table 2 and 3).

Table 2: Anova Model: Groupsize vs. Season

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Season	1	0.10	0.09804	0.355	0.552
Residuals	121	33.38	0.27588		

Table 3: Difference between summer and winter

Season	Winter	Summer
Research effort[km]	2612.48	3699.22
Encounters	67	101
Encounter rate	0.015	0.026
Groupsize	6.8	7
Initial behaviour	ATF,PTF,D,DT,S,ST,T,APSF	ATF,D,DT,FFF,MB,S,SF,ST,T

Photo-Identification

Based on data collection, a total of 722 bottlenose dolphins have been identified, of which 258 were individuals that have been identified for the first time. The majority of dolphins have been encountered only once, while two individuals have been encountered during the monitoring period for 17 times (Figure 11). Analysis of age categories shows that 575 individuals were adults, 26 juveniles, 95 calves and 26 new-borns (Figure 12).

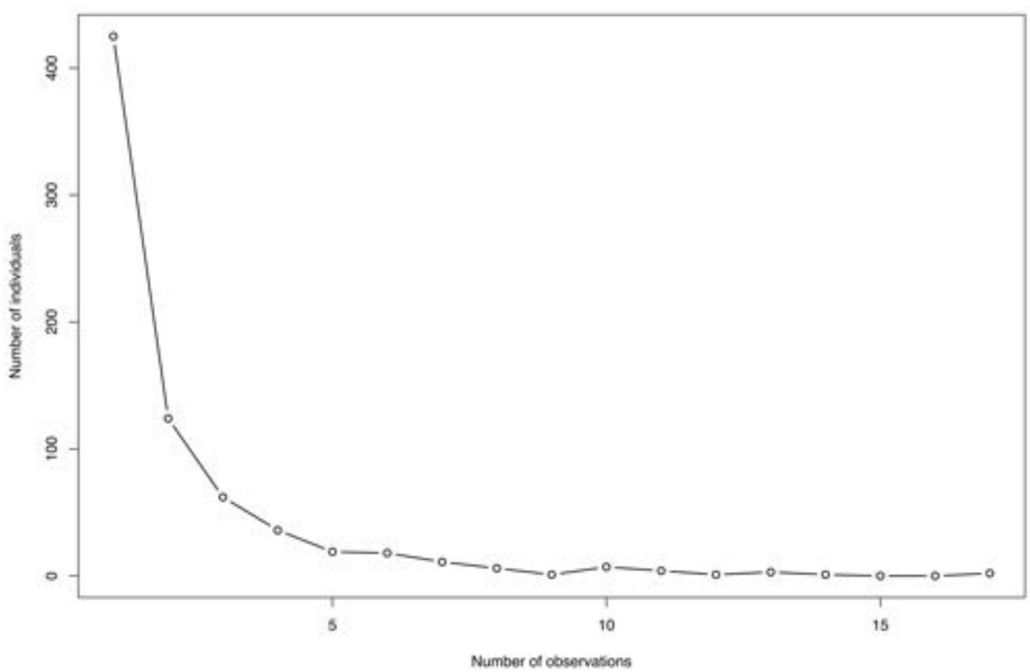

Figure 11: Frequency of occurance of Bottlenose dolphins

Considering the islands of Cres, Lošinj, Dugi otok and Kornat as a geographical barrier between dolphins that are observed along the east and west coasts of these islands, 6% of total number of individuals were observed on both sides of the island (eastern and western).

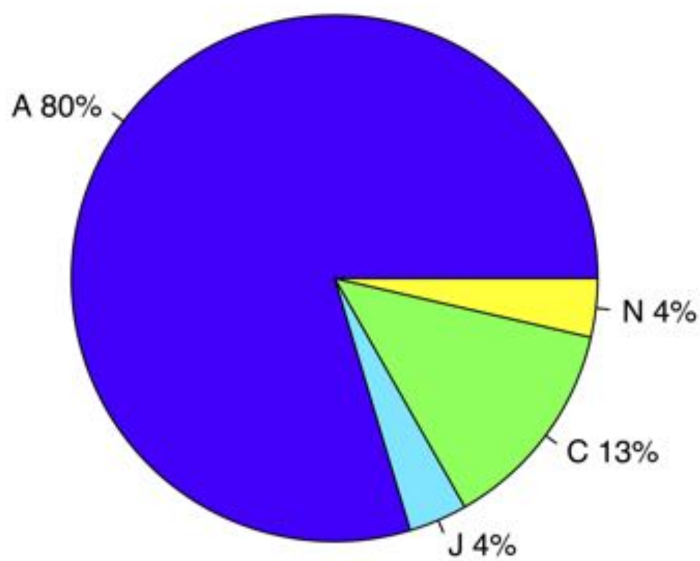

Figure 12: Age class categories observed in 2018

Behaviour

When dolphins were observed, group behaviour was recorded every 5 minutes. The predominant behaviour category defined, based on the overall data collected at the beginning of each dolphin encounter, was dive (D), dive–travel (DT) and „active“ trawler follow (ATF). It was observed that during the winter months initial behaviour “active“ trawler follow was 39% higher than during the summer months, while diving increases by 64% and travel by 60% during the summer months. Partial time spent for dolphins in a specific category of behaviour is expressed in relation to the total time spent with dolphins as shown in Figure 13.

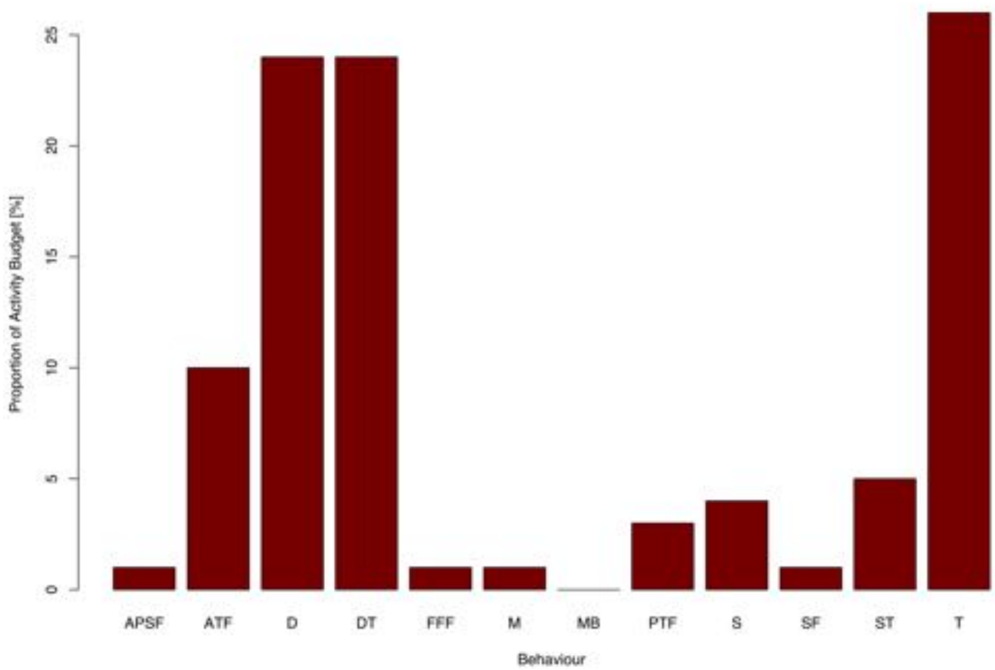

Figure 13: Proportion of activity budget

By analysing the connection of a group size with initial behaviour, it can be observed that in larger groups, mixed behaviour (MB) was recorded followed by travel (T) and social travel (ST), more detailed view of Figure 14.

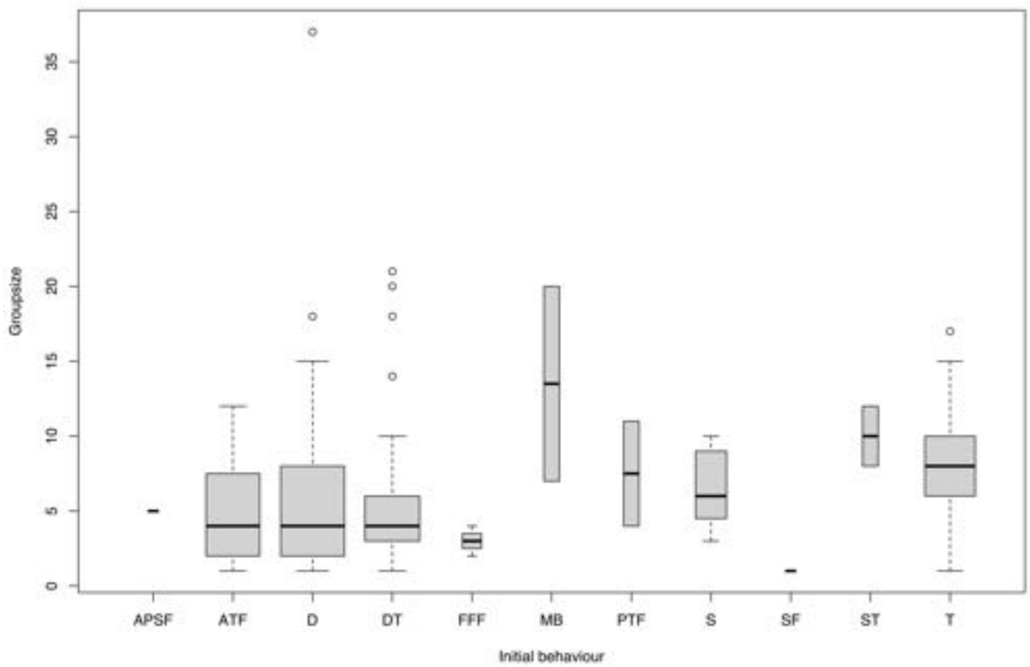

Figure 14: Groupsize vs. Initial behaviour

Behaviour observed during the observation of 6% of individuals from the east and west side of the islands of Cres, Lošinj and Dugi otok is shown in Figure 14.

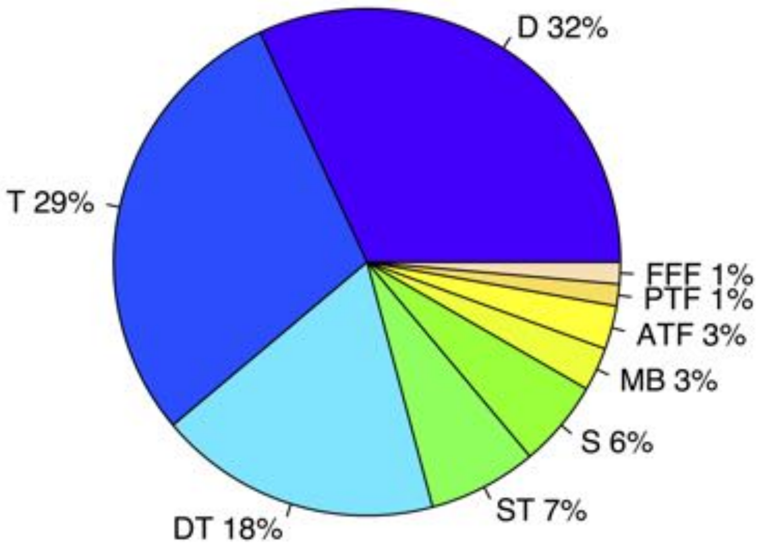

Figure 15: Behaviour observed during the observation of 6 percent of individuals

During 2018 data on the potential effects of marine vessel presence on behaviour of bottlenose dolphins were collected. Cumulative behavioural budget shows that when only the research boat (control) was present, dolphins spent most of the time traveling and dive-traveling, while in the presence of other boats (impact) dolphins spent most of their time following travel and dive behaviour (Figure 16).

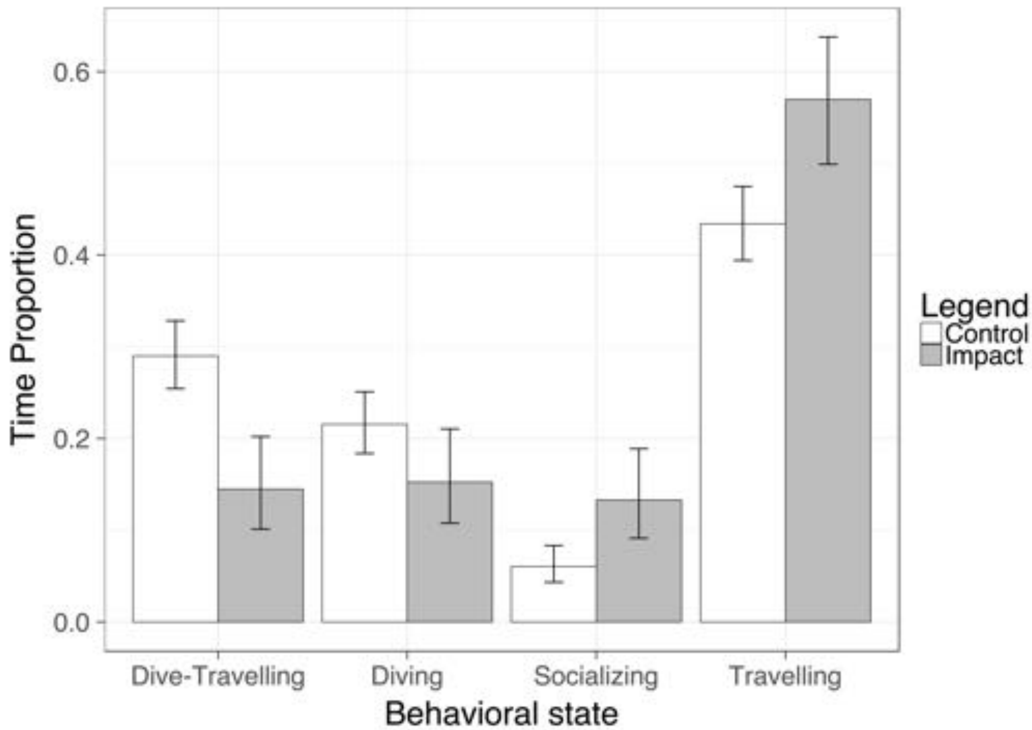

Figure 16: Cumulative behavioural budget

Predicting the impact of vessel presence exposure on the behaviour of different dolphin groups indicate that when dolphins are exposed to vessels 20% of the time during the day (during daylight),the presence of vessels will not significantly affect their behaviour ie dolphins will not change their behaviour due to the presence of the vessel. However, if this percentage rises to 38% and higher, significant changes occur in behaviour (Figure 17).

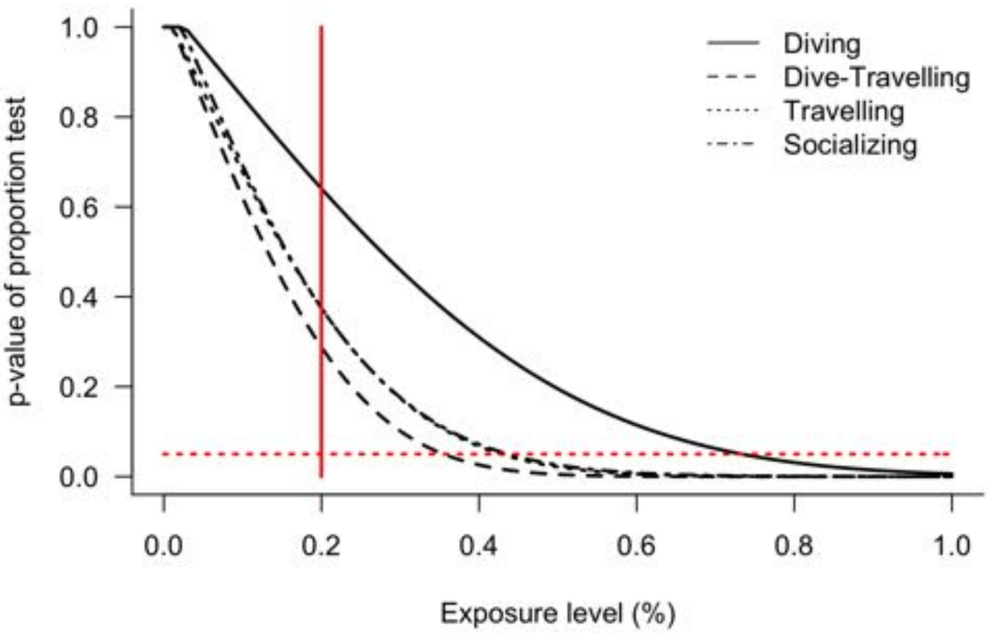

Figure 17: Predicting the impact of vessel presence exposure on the behaviour of different dolphin groups

When behavioural transition probabilities were compared in the presence of the research boat (control) versus the transition recorded in presence of other vessels (impact), dolphins stayed in the same behaviour as a result, when only the research boat was present, while the likelihood that dive-travel changes to just travel behaviour, increased to 29% when other vessels were present (Figure 18).

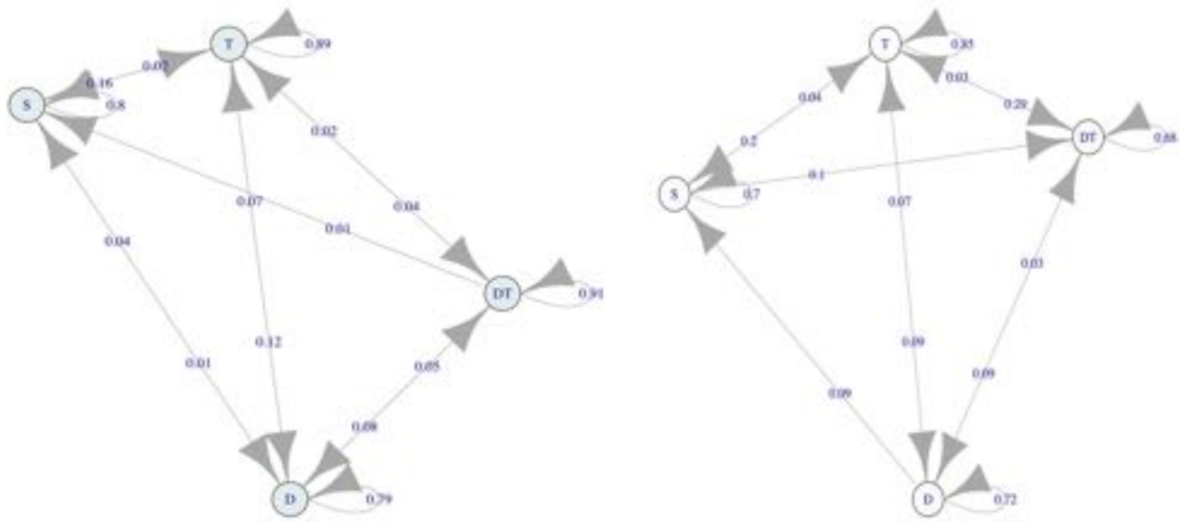

Figure 18: Behavioural transition probabilities in control and impact situation

Observations behind bottom-trawlers

During the monitoring period, 79 trawling boats were recorded and on 23 occasions, bottlenose dolphins were observed while feeding behind the recorded trawlers (Figure 19). Since the trawler following is one of the most dominant behaviour, opportunistic feeding is important for obtaining food in the study area.

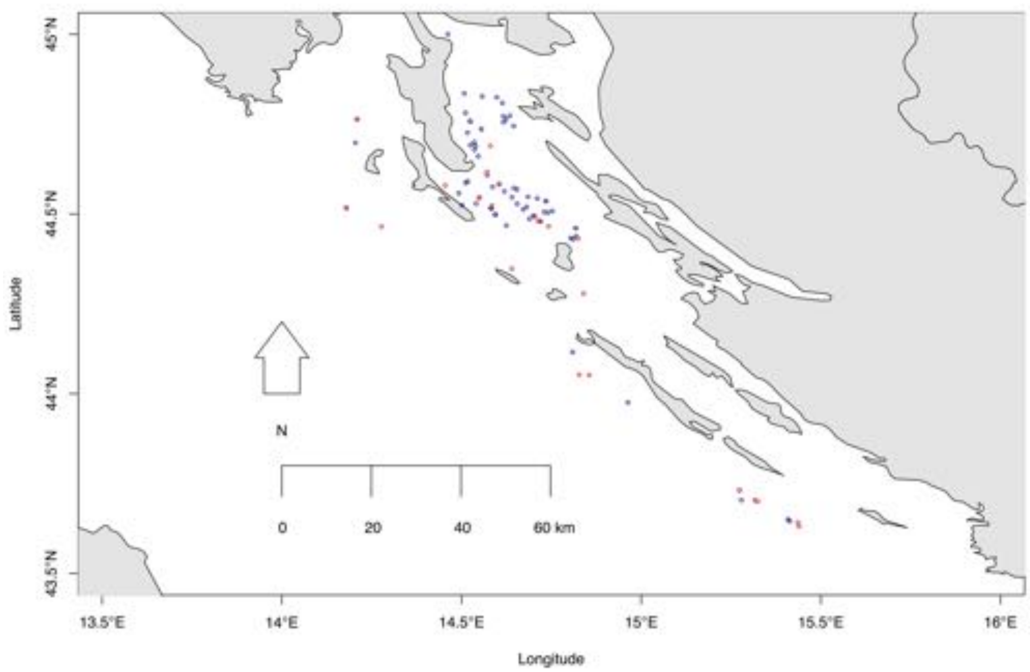

Figure 19: Observations of bottom-trawlers (red- with dolphins following, blue- without dolphins following)

Short-beaked common dolphin

Based on analysis of the pictures 46 individuals were identified, from which 24 were adults and 4 calves. By comparing pictures from previous observations of this species (2015 and 2016) in the middle Adriatic area, it was found that 19% of individuals were recorded in previous years (Figure 21).

Figure 20: Common dolphin

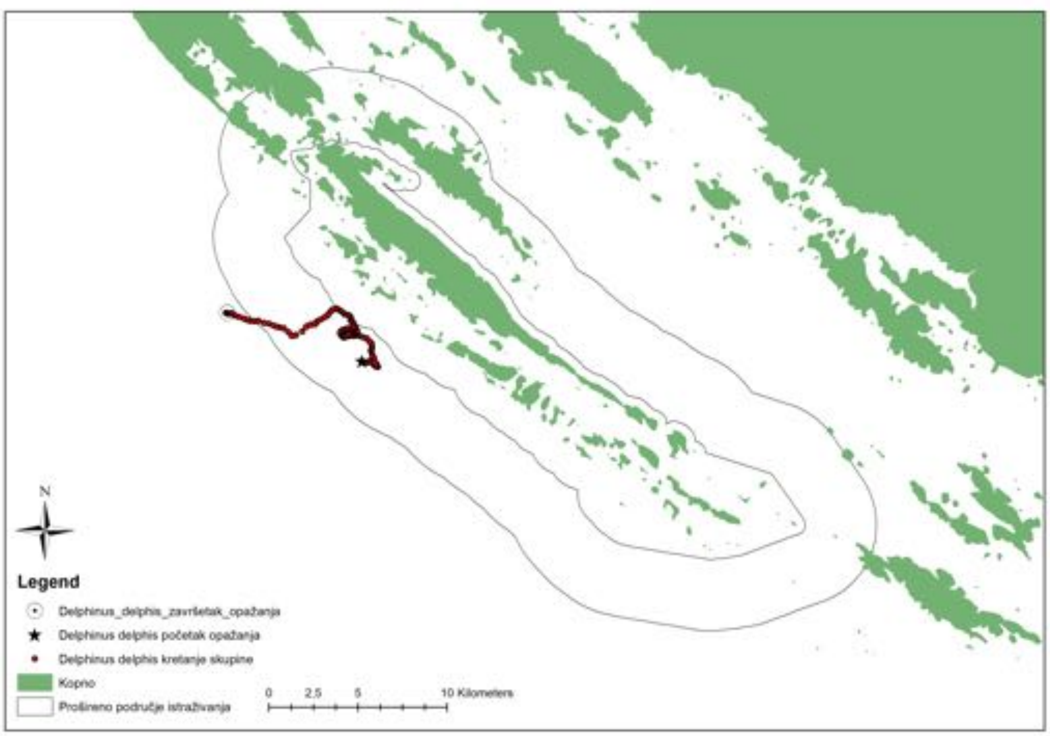

Figure 21: Encounter of Common dolphins

Sea turtles

During the research, 58 Loggerhead turtles were recorded. Sightings locations can be found on Figure 22. Most of the individuals were observed along the western side of the island of Lošinj, Dugi otok and Kornat. In 2018, a total of 27 individuals were reported dead and 3 alive, of which 2 were loggerhead turtles and 1 green turtle.

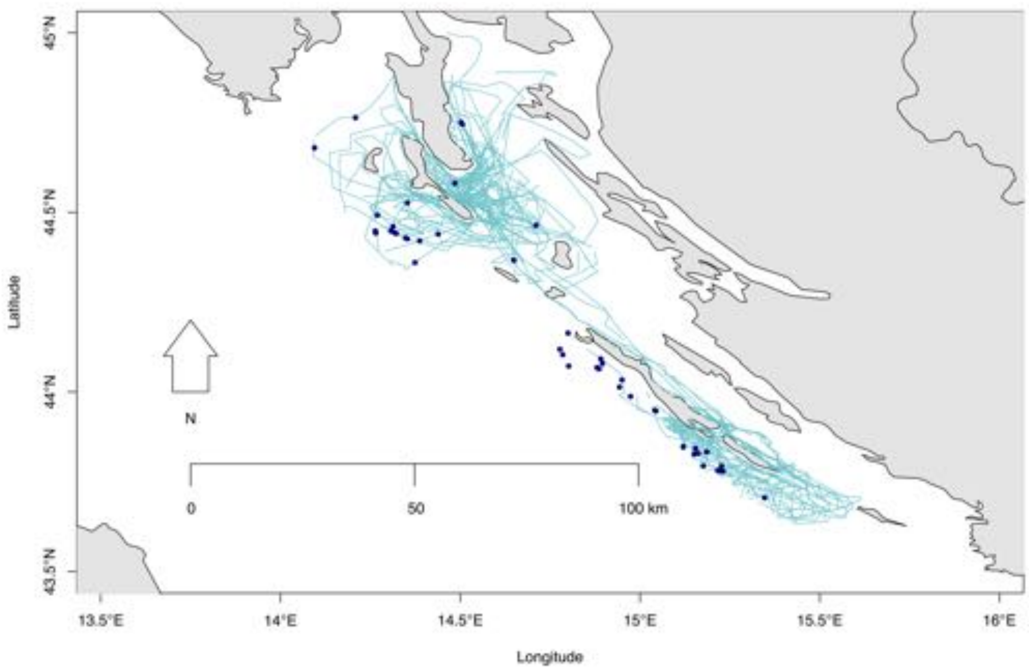

Figure 22: Encounter of Loggerhead turtles

Dead dolphins

During 2018 the Blue World Institute received four reports of dead dolphins. On the 6th of January, researchers were informed about a dead dolphin by the point Kurile on the island of Lošinj. Researchers confirmed that the dolphin was in a highly decomposed state. The individual was a 2.35 m long juvenile male dolphin with no visible injuries that would suggest a violent death. An employee of Kamp Poljan reported the second case on the 15th of February 2018. Researchers found out that the individual was a 1.8 m long female striped dolphin. The body was in good condition without visible injuries and was transported to the Veterinary Faculty in Zagreb, where its necropsy was performed. The third case was reported on the 16th of October. The dolphin carcass was found at point Kalifrant on the island of Rab. Upon arrival, the researchers determined that it was a 1.4 m long young dolphin. Because the carcass was in a highly decomposed state, it was not possible to determine the gender with certainty. They were no visible injuries that would indicate the cause of death. The fourth case was reported after 15 days, on the 31th of October 2018 on the island of Krk in town Krk. The carcass of bottlenose dolphin, about 1 m long, was found stranded on the beach. Due to bad weather conditions, the researchers couldn't reach it. Authorities were informed of all strandings.

Conclusion

During 2018, 94 fieldtrips were conducted; a total distance of over 9800 km was passed, and more than 500 hours were spent at sea. On this occasion, 168 dolphin groups were observed, and over 36 900 photographs were collected. In addition to photographs for the photo-identification method, data on the impact of vessels on dolphin behaviour during 74 sightings were collected and analyzed. The observation rates of ER1 and ER2 dolphins were calculated through two different methods, and the results obtained corresponded to the upper limit of the range of observation rates recorded during recent years (0.008-0.024) (C. M. Fortuna (2007); Rako et al. (2013)). Regarding the winter and summer terrain searches, it was recognized that the observation rate (ER1 and ER2) was lower in winter than in summer. Similar variations between summer and winter were noted by Rako et al. (2013). The average size of the group for 2018 was about 7 individuals, which is within the range recorded in previous years in this area (Pleslić et al. (2015)), and according to the description of this species, typically, the number of individuals in the groups ranges from 2-15 individuals (Wells and Scott (2002)). Although there were more observations with more individuals in the summer months, the mean of the group size was uniform during summer and winter. Preliminary photo analysis identified 722 individuals, of which 35% were recorded for the first time. This percentage includes new-borns and newly identified individuals photographed in the extended area of research, along the west coast of Dugi otok and the Kornati aquatorium. Bottlenose dolphins in the Cres-Lošinj area show habitat fidelity and a relatively low rate of emigration (C. M. Fortuna (2007); Genov et al. (2008); Pleslić et al. (2015); Gaspari et al. (2015); Rako-Gospić et al. (2017)). The analysis of the groups of bottlenose dolphins observed along the eastern and western sides of the islands of Cres, Lošinj and Dugi otok, revealed a low percentage of individuals whose area of movement includes the western and eastern parts of the islands. In the observations of these individuals, the most common activity was feeding or scavenging.

During 2018, the most common initial behaviour was diving, dive-traveling, and active trawler following. When the groups were larger, the number of observations in which the socializing were recorded increased. This finding is in line with previous studies of dolphin behaviour in this area (Bearzi, Politi, and Sciara (1999)). In the winter months, dolphins spend more time following the trawlers, while in the summer months behaviours like dive, travel, and dive-travel are more frequent. In recent years, there has been a significant difference in the distribution of bottlenose dolphins between summer and winter months (Rako et al. (2013); Rako-Gospić et al. (2017)). Due to increased nautical tourism, during the summer, dolphins tend to migrate offshore and can often be seen in areas with fewer vessels (Rako et al. (2013)). For that reason, data on the vessel's impact on the dolphin behaviour were collected during 2018. The results revealed that vessel exposure to dolphins should be limited to no more than 38% in a day (during daylight hours) as the presence of a vessel directly affects dolphin behaviour. The results of the data analysis concerning the state when only a research vessel (control) and when other vessels are present as well (impact), indicate that the dolphins are more likely to continue their control behaviour during a “control” situation. We have already stated in the previous article that during the summer months, diving-travel and diving behaviour are the most commonly observed in the case of bottlenose dolphins. These two behaviours are related to feeding and scavenging. Given the tendency of dolphins to change their behaviour from dive-travel to travel in the presence of a vessels, it is very likely that the dolphins stop feeding and start traveling to move away from the vessel, i.e., the source of the disturbance. This leads to reduced food intake but also loss of energy, which in the long term can have negative consequences on the population. Consideration should be given to the fact that data on the impact of vessels on dolphin behaviour were collected during 74 sightings, 38 of those being in the presence of other vessels, meaning these results should be taken as preliminary results and more data needs to be collected in the upcoming years for more accurate and precise measurements. Furthermore, a research vessel may also have an impact on dolphin behaviour and consideration should be given to collecting data from the mainland in order to obtain data that is more accurate.

During the research of the western shore of the Kornati archipelago, a group of 46 common dolphins (*Delphinus delphis*) were observed. This species is thought to be regionally extinct in the Adriatic Sea; however, in 2015 and 2016, observations of this species have been reported in the middle Adriatic area. By comparing the fins with the ones recorded in 2016, it was determined that 19% of individuals were re-sighted. Therefore, it is essential to continue the research and make additional research efforts to determine the frequency of occurrence of this species in the area and eventual re-sighting of the same individuals.

In 2018, more than 50 sightings of the loggerhead sea turtle species were recorded, mainly along the western coast of the island of Cres and Lošinj and Dugi otok. The Adriatic Sea is an important habitat for juvenile individuals of this species (C. M. Fortuna et al. (2018)). Green turtles were occasionally observed in the Adriatic during the summer as well. Although not abundant and so far only observed in the southern part of the Adriatic (Štrbenac (2015)), only one specimen of green turtle species was recorded in the Karian Sea this year.

In addition to living specimens, in 2018 we received several reports of dead dolphins, loggerhead turtles of one report of a dead striped dolphin. The dolphins had no apparent external injuries that would point to a possible cause of death. Although the Faculty of Veterinary Medicine in Zagreb have performed the necropsy, the cause of death remains unknown. In the case of dead individuals of the loggerhead sea turtles, most were in the extreme degree of decay. In one turtle carcass, a cut was seen on the carapace that could indicate that the individual died from injuries sustained by the propeller of the motor vessel.

Other

Education of students and researchers

The Blue World Institute student internship program was attended by 10 students from Brazil, the Netherlands, Germany, Portugal, Slovenia and Croatia. The students had the opportunity to learn about marine mammal research methods, data collection and analysis, what is important when examining dead individuals, and how to present scientific papers and results to the general public. The master thesis of the student Lisa Granziol from the University of Padua, entitled "Variability of signature whistles of bottlenose dolphins (* Tursiops truncatus *) of Lošinj archipelago", was successfully defended, and Brigita Šimunac from the University of Primorska is preparing her thesis on"The effects of vessel presence as a trigger for behavior changes of bottlenose dolphins (* Tursiops truncatus *) in the Cres-Lošinj archipelago."

Eco-volunteers

Throughout the summer of 2018, 30 eco-volunteers from the United Kingdom, Germany, USA, Spain, France, Israel, Sweden and Serbia joined the Blue World Institute. Through their work, they have helped to collect data on the behavior and movement of bottlenose dolphins and to sort and prepare databases for the analysis. During their stay, they were educated about the work and projects of the Blue World Institute and how to collect data using different scientific methods.

International presentations and published papers

Nikolina Rako Gospić, PhD, and Marko Radulović, M.Sc., participated in oral presentations at the 13th Croatian Biological Congress, September 19-23, 2018 in Poreč:

Rako-Gospić, N., Radulović, M., Vučur, T., Pleslić, G., Holcer, D. and Mackelworth, P., (2018). Factor associated variations in the home range of a resident Adriatic common bottlenose dolphin population. Marine Pollution Bulletin. In: 13th Croatian Biological Congress (eds. by Kružić P, Mihalić KC, Gottstein S, Pavoković D & Kučinić M), pp.89-90. Croatian Biological Society, Poreč, Croatia.

N. Rako-Gospić, G. La Manna, M. Picciulin (2018). Variability in common bottlenose dolphin (*Tursiops truncatus*) whistles in relation to opportunistic feeding strategies in sardinian and Northern Adriatic waters. In13th Croatian Biological Congress (eds. by Kružić P, Mihalić KC, Gottstein S, Pavoković D & Kučinić M), pp.93-94. Croatian Biological Society, Poreč, Croatia.

Ph.D. Peter Mackelworth, M.Sc. Jelena Basta and Dr.sc. Draško Holcer, held a workshop in the 6th Mediterranean Conference on Marine Turtles in Poreč, October 16-19, 2018. The theme of the workshop was “Whose biodiversity, whose value? Engaging with stakeholders to understand their perceptions”.

Blue World Institute of Marine Research and Conservation cohosted the International School of Marine Conservation Science. Conservation programme director dr.sc. Peter Mackelworth, Director of Science Program Ph.D. Nikolina Rako Gospić and researchers Tihana Vučur Blazinić,M.Sc Marko Radulović,M.Sc held lectures and workshops.

During 2018, six papers were published in reputable scientific journals and books:

Fortuna, C. M., Cañadas, A., Holcer, D., Brecciaroli, B., Donovan, G. P., Lazar, B., ... & Mackelworth, P. C. (2018). Coherence of the European Union marine Natura 2000 network for wide-ranging charismatic species: a Mediterranean case study. Frontiers in Marine Science, 5, 356.

Fraschetti, S., Pipitone, C., Mazaris, A. D., Rilov, G., Badalamenti, F., Bevilacqua, S., ... & Daunys, D. (2018). Light and shade in marine conservation across European and Contiguous Seas. Frontiers in Marine Science, 5, 420.

Giakoumi, S., McGowan, J., Mills, M., Beger, M., Bustamante, R., Charles, A., ... & Guidetti, P. (2018). Revisiting “success” and “failure” of marine protected areas: a conservation scientist perspective. Frontiers in Marine Science, 5, 223.

Gissi, E., McGowan, J., Venier, C., Carlo, D. D., Musco, F., Menegon, S., ... & Possingham, H. (2018). Addressing transboundary conservation challenges through marine spatial prioritization. Conservation Biology, 32(5), 1107-1117.

Mannocci, L., Roberts, J. J., Halpin, P. N., Authier, M., Boisseau, O., Bradai, M. N., ... & Fortuna, C. M. (2018). Assessing cetacean surveys throughout the Mediterranean Sea: a gap analysis in environmental space. Scientific reports, 8(1), 3126.

Rako-Gospić, N., & Picciulin, M. (2019). Underwater Noise: Sources and Effects on Marine Life. In World Seas: an Environmental Evaluation (pp. 367-389). Academic Press.

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