BLUE WORLD INSTITUTE OF MARINE RESEARCH AND CONSERVATION

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FINAL REPORT

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ADRIATIC DOLPHIN PROJECT - LOŠINJ

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INTRODUCTION

The east coast of Cres and Lošinj islands is an important habitat for the resident population of bottlenose dolphins (*Tursiops truncatus*) in the northern Adriatic Sea (Fortuna, 2006; Mackelworth *et al.*, 2003). Scientific studies of bottlenose dolphins have been conducted since 1987. The Adriatic Dolphin Project (ADP) is a fundamental scientific research project at the Blue World Institute for Marine Research and Conservation in Veli Lošinj.

Long-term studies have shown that the Cres-Lošinj archipelago (Kvarnerić, Northern Adriatic) is an important area for reproduction and foraging of these sea mammals in the Adriatic Sea. The coastal area of Cres and Lošinj islands is exposed to strong anthropogenic pressure. Specifically, the Cres-Lošinj archipelago represents a famous tourist destination, and in the last ten years, Lošinj tourism has increased by 12.5% (according to the data from the Tourist Board of Mali Lošinj). During summer months, the boat traffic in these waters rises by around 400% (Karpouzli, 1996). A significant drop in the number of bottlenose dolphins of about 39% was recorded in the period from 1995 to 2003 (Fortuna, 2006). This decrease in the number of bottlenose dolphins was the main reason for the establishment of a marine protected area for dolphins in the Cres-Lošinj archipelago and the basis for its inclusion in the ecological network Natura 2000 sites under the Habitats Directive.
Dolphins, as top predators are indicators of a healthy marine environment. A decline in their numbers is a clear sign of the vulnerability of this community, which reflects the degradation of their natural habitat due to human activity.

During 2017, the Blue World Institute conducted a monitoring of the Cres-Lošinj archipelago and a part of northern Adriatic Sea that includes Istrian coast, Vinodol-Velebit Channel and Vir Sea. The aim was to determine the state of the local bottlenose dolphin populations as well as the type and intensity of anthropological impact on the biodiversity of this area. The purpose of this study is also to provide a scientific basis, which would help authorities in establishing management measures for Natura 2000 sites.

METHODS

THE RESEARCH EFFORT

Field work at the sea was conducted using a 5.75 m long inflatable boat (Novamarine RH585) driven by a four-stroke engine (Honda Vtec 90 hp), with sea conditions lower than 3 according to Beaufort scale. Collected data was date, time, navigation coordinates, changes in the sea state and weather conditions, current research activities, the presence of fishing vessels and information of the research vessel tracks during dolphin sighting. Research effort was determined ad libitum depending on the weather conditions at the sea and trying to ensure a balanced distribution of research effort in the survey area. The average search speed was 15 kts, to be in accordance with an average dolphin diving time and observation possibilities. Since this is a relatively shallow area (depth does not exceed 100 m), dolphins usually dive for 3 to 5 minutes, so search speed of 15 kts provides a good overview of the area, reducing the chance that a particular group has passed by without being observed at the surface.
All data on the navigation were transferred to the navigation database and used to calculate the time spent in the research area in search for dolphins, the time spent with groups of dolphins, and to calculate and display the research effort with the use of GIS ArcView 10.3 software and Excel Geofunc add-in.

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 (Wilson *et al*., 1999; Würsig & Jefferson 1990; Würsig & Würsig 1979). 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, which consists of dorsal fins of 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.

Although dorsal fins of young dolphins usually or often 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 sometimes makes it possible to identify and monitor the calves after separation from the mother.

In each dolphin observation, we used the monitoring protocol "focal group follow" (Mann, 1999). We trace the movement, behaviour and use photo-identification of the "focal group". A group is all animals in apparent connection with 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 *et al.* 1997). In a photo-identification analysis each set was analysed separately to determine changes in the monitored group and the dynamics of groups (Bearzi *et al.* 1997).

Also, 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).

• Highly 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.

• 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.

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. Also, regardless of quality, all photos are 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.

The age of individuals present in a group was determined according to four basic categories (Figure 1):

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.

A J C N Figure 1 – Age classes

DOLPHIN SPATIAL DISTRIBUTION

Spatial distribution monitoring of bottlenose dolphins within the research area is based on the navigation data collection using the GPS device (Garmin 76 Cx) and NaviLog app (installed on the Samsun Galaxy TabA device) developed for the purpose of research by the Blue World Institute. Data collection included the use of photo identification techniques together with the size of the group data and their age classes (number of adults, calves, newborns). These data are based on observations recorded under positive research effort (active field search while good research conditions: sea state up to 3 according to Beaufort scale, good visibility). Data analysis was made using the GIS Arc View 10.3 computing package.

When observing dolphins, the behaviour of the group was determined before approaching with a research vessel. Behaviour category is determined by the behaviour of more than half individuals in the observed group and are defined as in Bearzi *et al.* (1999) and Lusseau (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 (MIX) - 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.

Figure 2 – A group of dolphins

MONITORING OF BOTTOM-TRAWLERS

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. In the case dolphins were behind the trawler, photo-identification technique was applied. The behaviour of the group was determined to see 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 is general behaviour shown by the whole population of the study area.

Figure 3 – Fishing vessels followed by the dolphins

RESULTS

The analysis of navigation data shows that the research vessel covered an overall distance of 3778,31 NM in this year. Distance covered in search (good search conditions, sea state <3 according to the Beaufort scale) was 2520,89 NM (Figure 4). Researchers spent 192 hours on the sea, in search for dolphins. Time spent with the dolphins was 113 hours.

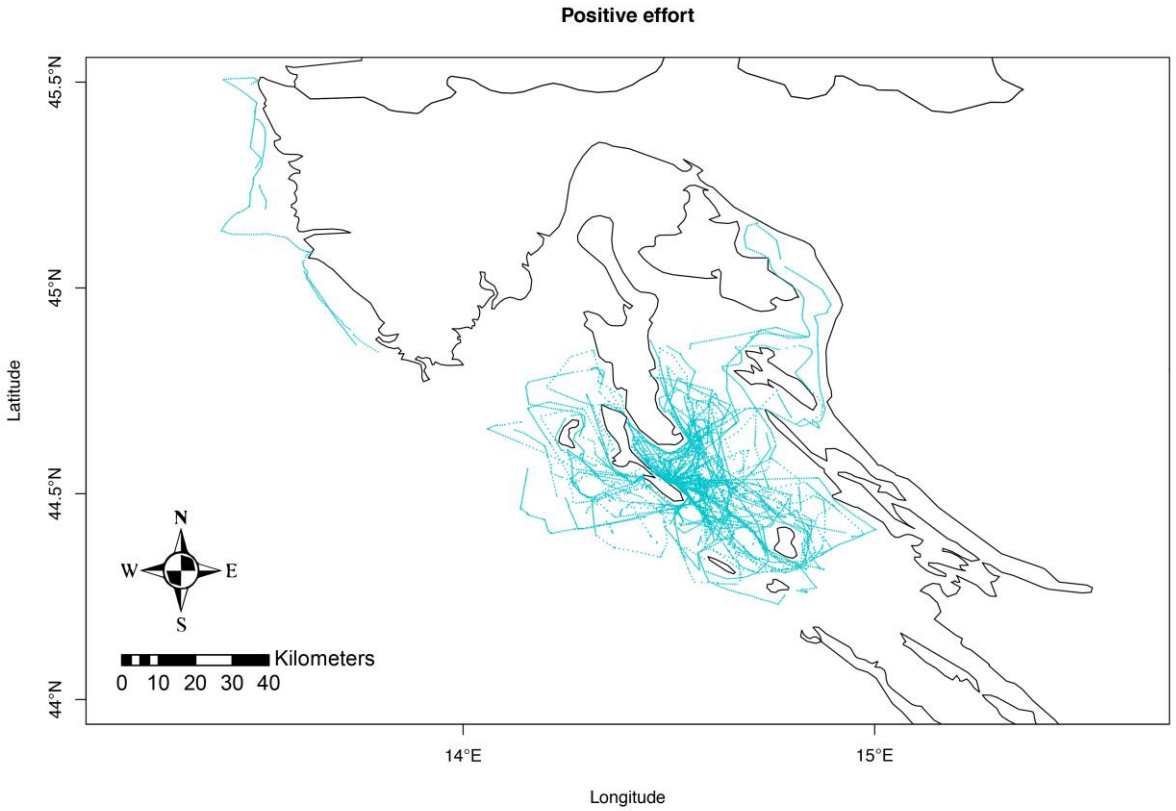

Figure 4 – Study area with tracks indicating positive search effort

Locations of 146 bottlenose dolphin encounters are presented in Figure 5. Based on collected data, a total of 619 bottlenose dolphins have been identified, of which 497 were adults, 24 juveniles, 74 calves and 24 newborns (Figure 6.). The average group size consisted of nine individuals. Photo–identification of the individuals was done using the referent Blue World Institute photo–ID catalogue. In total, 198 individuals have been identified for the first time. Most dolphin groups were mixed, composed of both males and females with calves. In 20 observations only one individual was present.

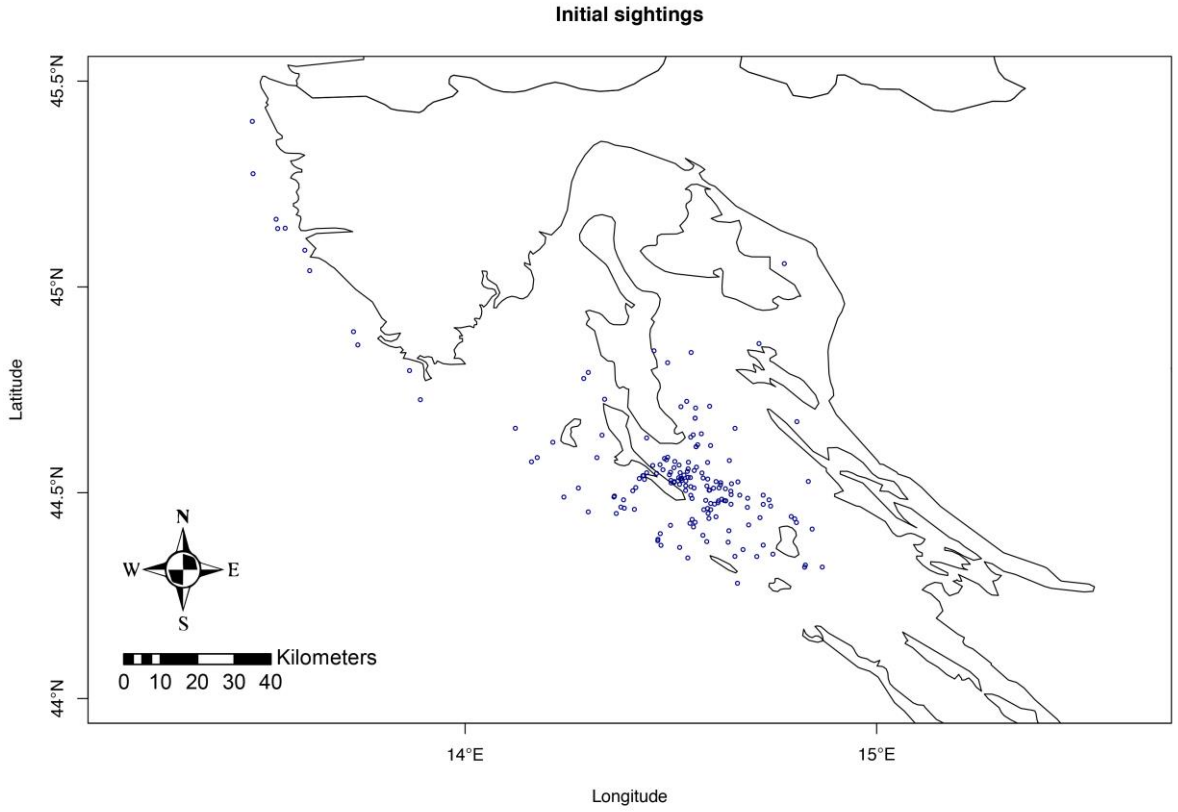

Figure 5 - Study area and sighting locations of bottlenose dolphins (*Tursiops truncatus*), (N= 146) in 2017

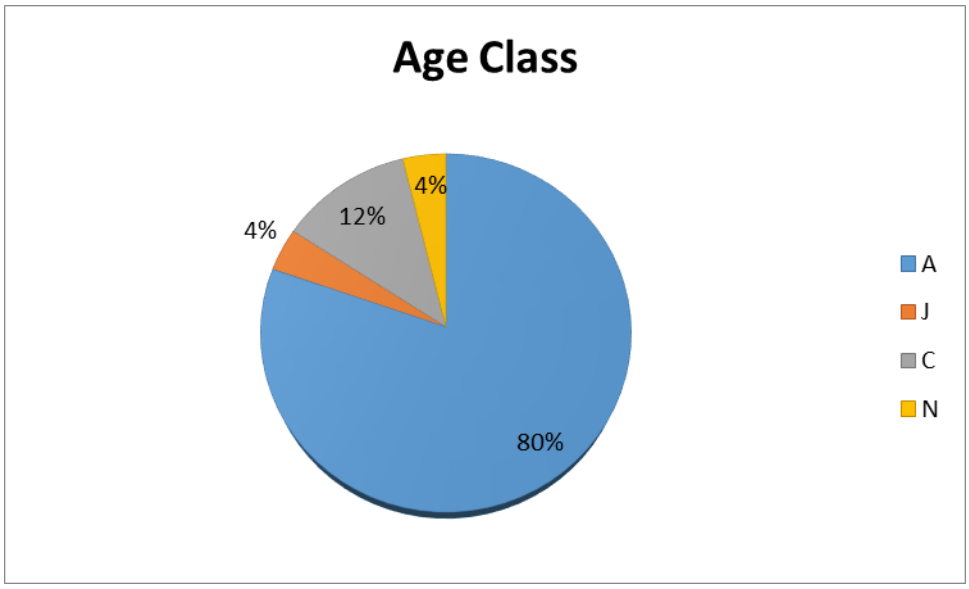

Figure 6 – Age class categories observed for 2017

The frequency of re-occurrence of dolphins during the encounters is shown in Figure 7. The majority of dolphins (356 individuals in total) has been encountered only once, while one dolphin have been encountered during the monitoring period for 15 times.

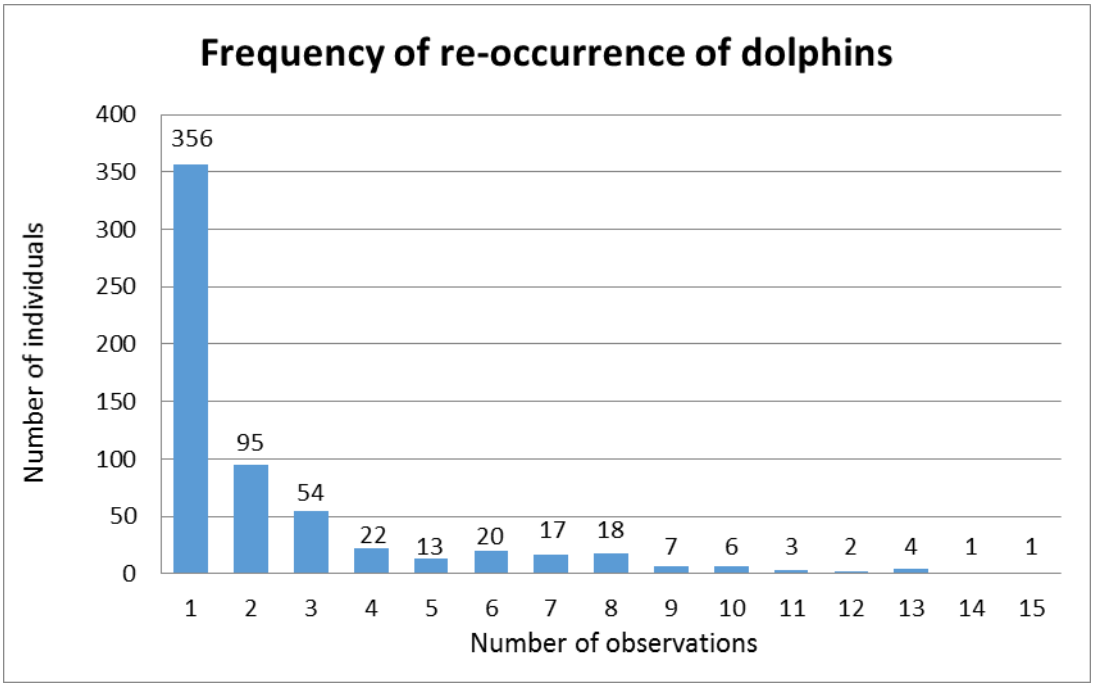

Figure 7 – Frequency of re-occurrence of dolphins

The predominant behaviour category defined based on the overall data collected at the beginning of each dolphin encounter was dive (D) and then dive–travel (DT). The number of all initial behavioural categories recorded during the monitoring is presented in Figure 8.

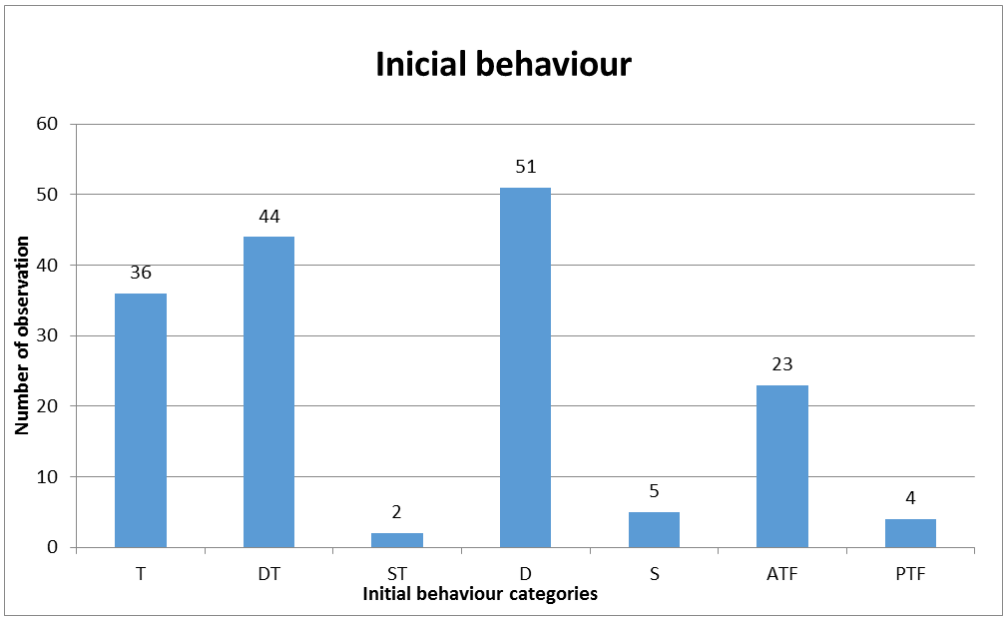

Figure 8 – Prevalence of different initial behaviour categories of monitored groups

During the monitoring period, 79 trawling boats were recorded and checked for the dolphin presence. Dolphin groups were observed on 23 occasions while feeding behind the recorded trawlers (Figure 9).

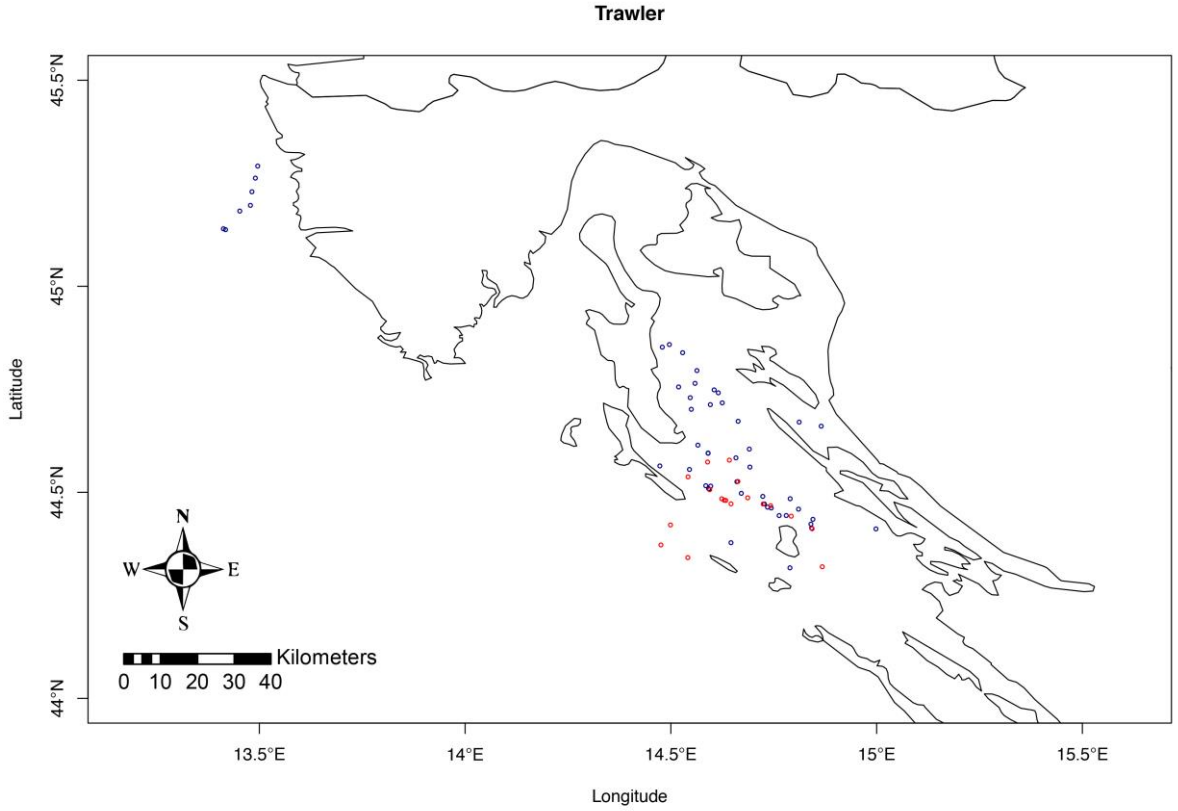

Figure 9 – Trawling boat positions recorded in 2017 (red-dolphins observed behind the trawler; blue- no dolphins behind the trawler)

Twenty live loggerhead turtles (*Caretta caretta*) were also recorded within the study area during the monitoring. During the year, two injured turtles were taken care of in the rehabilitation centre for sea turtles (July 24, 2017 and December 22, 2017).

During 2017 the Blue World Institute has received nine reports of dead dolphins. On 21st of February researchers were informed about a stranded dolphin in Starigrad, Paklenca. The following report was received on 22nd of April, about a dead dolphin that was stranded in bay Gajac on Pag. Blue World Institute was informed about 5 strandings during August, on the island of Murvenjak on August 4, on 7th of August at the Pakoštane, after 8 days, 16th of August a stranded dolphin was found on the island of Hvar, on 24th at Karinsko more and the last stranded dolphin in August was found on the island of Silba on 28th. On 3rd of September a dead dolphin was stranded on the island of Vir and the last report was received in November 1st near Pula.

Besides reported strandings, the Blue World Institute documented 4 strandings in Kvarnerić area. The first one was on 16th of February, when a dead dolphin was reported in the bay of Čikat, island of Lošinj. It was missing its tail. The case was reported also to the police. The Veterinary faculty in Zagreb conducted necropsy and the results showed that the dolphin died from suffocating and the tail was cut after it died. Probably it was entangled in a net. The second dolphin was found dead on 27th of March, stranded on the beach in camp Poljana on the island of Lošinj. It was an adult dolphin in highly decomposed state with no visible injuries. The dolphin was sent to the Veterinary faculty in Zagreb for necropsy. No cause of death was determined. The third dolphin was inspected 23rd of Jun on the island of Silba. It was a newborn male dolphin which was sent on Veterinary faculty in Zagreb, but the cause of death was not found. Next day, 24th of Jun, another stranding was documented by the Blue World Institute. A young dolphin was floating between the islands of Cres and Trstenik. It had a wound next to the dorsal fin. The carcass was sent to the Veterinary faculty in Zagreb. Even though it was in an advanced stage of decomposition, the veterinarian concluded that the wound was not the cause of death, which remains unknown.

CONCLUSIONS AND RECOMMENDATIONS

In the period from January 1 to December 31, 2017 the ADP research station in Veli Lošinj, has been monitoring populations of bottlenose dolphins and anthropogenic activities in the marine environment of Primorsko - goranska county, Istrian county and a part of Zadar county (northern Adriatic Sea). During the monitoring, a total distance of 3778,31 NM was traversed, bottlenose dolphins (Tursiops truncatus) were seen 146 times and the locations of trawling activities were recorded.

Given the long-term residency of the observed individuals and regular observations of females with calves, the results of the monitoring presented here and a comparison with the results of previous Blue World Institute research indicate that the Cres-Lošinj (HR0000161) Natura 2000 site is of great significance for bottlenose dolphins, especially for sensitive groups composed of mothers with newborns. The most significant anthropogenic factors affecting the conservation status of the local bottlenose populations are fisheries and tourism. Regarding fisheries, dolphins often feed behind the fishing trawlers. This feeding strategy makes it easier for dolphins to catch their prey, but also points to the deficiency of prey. Data from 2004 to 2017, show that dolphins followed 30% of trawlers in the area. Additionally, 14% of dolphin behaviour in 2017 were the active feeding behind the trawlers.

Interactions with tourist vessels are numerous, but deliberate harassment has not been observed during the monitoring. Nonetheless, a negative impact on the dolphin community is possible since, even without intentional disturbance, cumulative negative effects of boat engine noise and vessel presence occur. Therefore, it is recommended to continue the monitoring program, including the study of underwater noise on the occurrence and distribution of dolphins, as well as public awareness campaigns.

OTHER

EDUCATION OF STUDENTS AND RESEARCHERS

Eleven students from Italy, Germany, Portugal, Croatia and the United States participated in the Blue World Institute internship program. Students were involved in the fieldwork and data analysis. Thereby they have gathered experience in data collection, use of equipment and research procedure. Besides the acquired research skills, students also participated in educational programs. Lisa Granziol has prepared her thesis in collaboration with the University of Padua and the Blue World Institute.

ECO-VOLUNTEERS

Eco-volunteers participated in the Adriatic Dolphin Project from May 1 to September 22. The project was joined by 43 eco-volunteers from Europe (Germany, Austria, Belgium, United Kingdom, France, Netherlands, Hungary, Switzerland), South Korea, Kazakhstan, Malaysia, Canada and USA. They were introduced to the Blue World Institute research and activities and trained to help during sampling procedures on the boat and data analysis. Their presence was of great significance for research during the season.

INTERNATIONAL PRESENTATION

In March, conservation director Ph.D. Peter Mackelworth participated in workshop for MPA governance Marcon action held in Sopot, Poland.

In April, conservation director Ph.D. Peter Mackelworth participated in workshop on Transboundary Conservation, which was held in Zagreb, Croatia.

In April and May, president of the Association Ph.D. Draško Holcer participated on World Sea Turtles congress as a part of LIFE Euroturtles project. The congress was held in Las Vegas, USA.

In May, researcher Ms.c. was giving a colloquium at the University of Hamburg, Institute of Hydrobiology and Fisheries Science, with specific focus on distribution and abundance of marine mammals in the Adriatic Sea.

In September, senior technician for Turtle Rescue Center, MS.c. Mateja Zekan, participated on the LIFE Euroturtle project meeting, which was held on Larnaca, Cyprus.

In October, educational director Jelena Basta, prof., and education centre manager Andrea Borić participated in Act for Litter workshop, held in Barcelona, Spain. President of the Association Ph.D. Draško Holcer and director of conservation, Ph.D. Peter Mackelworth participated in NATURA 2000 meeting organized in Zadar, Croatia. Also they attended Marcon meeting within Horizon 2020 project, which was held in Lisbon, Portugal.

In November, President of the Association Ph.D. Draško Holcer, director of the scientific program Ph.D. Nikolina Rako – Gospić, and director of conservation, Ph.D. Peter Mackelworth participated in the workshop on mitigating the impact of underwater noise on marine biodiversity, with specific focus on seismic surveys in the southeastern European waters in the Mediterranean Sea held in Split, Croatia.

On the same month director of conservation, Ph.D. Peter Mackelworth, educational director Jelena Basta, prof., and education centre manager Andrea Borić participated on the Act for Litter workshop within MedPAN meeting. The workshop was held in Izola, Slovenia.

PUBLISHED PAPERS

During 2017, four papers were published in reputable scientific journals and books:

Katsanevakis, S., Mackelworth, P., Coll, M., Fraschetti, S., Mačić, V., Giakoumi, S., Jones, P., Levin, N., Albano, P., Badalamenti, F., Brennan, R., Claudet, J., Culibrk, D., D'Anna, G., Deidun, A., Evagelopoulos, A., García-Charton, J., Goldsborough, D., Holcer, D., Jimenez, C., Kark, S., Sørensen, T., Lazar, B., Martin, G., Mazaris, A., Micheli, F., Milner-Gulland, E-J., Pipitone, C., Portman, M., Pranovi, F., Rilov, G., Smith, R., Stelzenmüller, V., Vogiatzakis, I. & Winters, G. (2017). Advancing marine conservation in European and contiguous seas with the MarCons Action. Research Ideas and Outcomes 3: e11884.

La Manna G., Rako Gospić N., Manghi M., Picciulin M. and Sara' G. (2017). Assessing geographical variation on whistle acoustic structure of three Mediterranean populations of common bottlenose dolphin (Tursiops truncatus). Behaviour 154(5): 583-607.

Rako-Gospić, N., Radulović, M., Vučur, T., Pleslić, G., Holcer, D., and Mackelworth, P. (2017). Factor associated variations in the home range of a resident Adriatic common bottlenose dolphin popula!on. Marine Pollution Bullettin, https://doi.org/10.1016/ j.marpolbul.2017.07.040

Stelzenmüller, V., Coll, M., Mazaris, A., Giakoumi, S., Katsanevakis, S., Portman, M., Degen, R., Mackelworth, P., Gimpel, A., Albano, P., Almpanidou, V., Claudet, J., Essl, F., Evagelopoulos, T., Heymans, J., Genov, T., Kark, S., Micheli, F., Pennino, M., Rilov, G., Rumes, B., Steenbeek, J., Ojaveer, H. (2017). A risk-based approach to cumulative effect assessments for marine management. Science of the Total Environment.