ANALYSES ON THE OCCURRENCE OF
PELAGIC SHARKS IN THE EASTERN
ADRIATIC SEA

Madiraca, F. *Davidov, B. †Udovičić, D. ‡

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Abstract: In the presented paper, the authors give detailed analyses on
the occurrence of six pelagic shark species in the Eastern Adriatic Sea. The
collected records include captures and sightings of the given species as well
as results of the expeditions conducted by the Shark Conservation Society
in 2005, 2006, 2009 and 2013. These were accounted to the specific areas
of the Eastern Adriatic (Northeastern Adriatic, Central Eastern Adriatic
and Southeastern Adriatic) and presented through graphs that were created
according to the area and depending on the year or the time period of the
occurrences. In addition, graphs depicting the number of occurrences for the
whole Eastern Adriatic Sea during the years or time periods are given in the
article.

Key words: Occurrence, Pelagic, Sharks, Eastern Adriatic Sea.

1 Introduction

The Adriatic Sea can be viewed as the northernmost gulf of the Medi-
terranean as it reaches 45° 47’ N. It is linked to the Mediterranean with the
Strait of Otranto. The Adriatic is 870 km long and 159.3 km wide. With
islands included, it covers the surface of 138,595 km² which makes for 4.6%
of the Mediterranean [19]. It is considered to be a shallow sea with a mean
depth of 252 m [68]. Depth gradually increases from the northwest to the southeast. In the Central Adriatic the greatest depth is found in the area known as Jabuka Pit (273 m). The greatest depth measured in the Adriatic is in the Southern-Adriatic Pit (1233 m) [67]. The Adriatic is considered a high salinity sea. At the surface the salinity level is on average 38.30 ppm. This is a bit lower than at the surface in the Eastern Mediterranean Sea (39 ppm), but slightly higher than in the Western Mediterranean [4] [5]. In the open sea areas of the Adriatic the salinity drops from south to north. Adriatic Sea is a moderately warm sea.

Adriatic Sea is a moderately warm sea. In its biggest depths the water temperature is always higher than 10 to 12 °C. The surface temperature extremes range from 3 to 29 °C. During the summer a thermocline develops in the open Adriatic at depths between 10 to 30 meters. At that point the surface temperature varies from 22 to 25 °C. With the beginning of winter, because the surface layer temperature is dropping, isotherm occurs. During the winter (December - March), but not in the summer, the average temperature of the entire water column in the North Adriatic Sea (Gulf of Trieste) is about 8 to 10 °C lower than the water column (0 to 300 meter depth) temperature in the South Adriatic [16] which is the reason that North Adriatic exhibits more prominent boreal characteristics. The surface temperature for the whole Adriatic Sea in its coastal area is highest in July and August and lowest in February.

The following geo-political sections of the Adriatic Sea compose the area that is Eastern Adriatic Sea: Italian territorial waters east from and including Caorle, Slovenian territorial waters, Croatian territorial waters, territorial waters of Bosnia and Herzegovina, territorial waters of Montenegro, and territorial waters of the Eastern Adriatic under the governance of Albania.

Pelagic sharks inhabit the pelagic zone of seas and oceans worldwide. They are not associated with the sea bottom as opposed to benthic or bottom-dwelling sharks [8] and are most often the apex predators of the food chains accounted to their environment. Various pelagic shark species are classified into following taxonomical families: Rhincodontidae, Odontaspididae, Pseudocarchariidae, Megachasmidae, Alopiidae, Cetorhinidae, Lamnidae, Car- charhinidae, Somniosidae, Dalatiidae [8]. Unfortunately sharks and their relatives are threatened by overfishing, pollution and habitat destruction.
The number of instigated pelagic shark species in the Adriatic Sea varies depending on the author. Šoljan reported 28 species [64], Jardas 29 [19], Bello 28 [1], Milišić 31 [34], Lipecj et al. cite 28 confirmed and 6 suspected species [27], and Gajić reports 32 species [17]. Even though large pelagic sharks are rarely observed and make less total species percentage in comparison to small demersal sharks their value and importance to the ecosystem is significant.

Main purpose of this article was to collect as much data on the historical occurrences of large pelagic sharks in the Eastern Adriatic Sea, and compare them between the specific areas: Northeastern Adriatic, Central Eastern Adriatic and Southeastern Adriatic (Figure 1). Authors wanted to investigate if there was evidence of decrease or increase in certain species numbers and instigate a possible link of the results with human influence on the given ecosystem.

As Soldo & Jardas [55] state, there have unfortunately only been a few studies conducted on the biology and distribution of pelagic sharks, and while there are some reports, a number of sightings and landings are kept as a secret. Furthermore the abundance of the occurring species and their habitat locations are very much unknown as these are highly migratory animals.

Of the pelagic species reported in the Adriatic Sea, 6 species are analyzed in this article: blue shark, Prionace glauca (Linnaeus, 1758); common thresher shark, Alopias vulpinus (Bonnaterre, 1788); basking shark, Cetorhinus maximus (Gunnerus, 1765); great white shark, Carcharodon carcharias (Linnaeus, 1758); shortfin mako shark, Isurus oxyrinchus Rafinesque, 1810 and porbeagle shark, Lamna nasus (Bonnaterre, 1788).

2 Material and Methods

The data used in this paper was gathered from available published literature concerning the occurrence of the following species in the Eastern Adriatic Sea: basking shark, Cetorhinus maximus (Gunnerus, 1765); great white shark, Carcharodon carcharias (Linnaeus, 1758); shortfin mako shark, Isurus oxyrinchus Rafinesque, 1810 and the porbeagle shark, Lamna nasus (Bonnaterre, 1788). The species used in this article were the ones that authors deemed true pelagic sharks and had 10 or more records attributed to them in the Eastern Adriatic Sea. Additional data was gathered from media reports mainly for the common thresher shark, Alopias vulpinus (Bonnaterre, 1788) and the blue shark, Prionace glauca (Linnaeus, 1758) because there is a lack
of information in the form of published scientific papers on the occurrence of these two species for the Eastern Adriatic Sea. Also for *P. glauca* (Linnaeus, 1758), reports from several Shark Conservation Society expeditions were used as well.

Some records on all the other species researched in the article were only available from the media. The media reports, that had photographs or videos accompanying written evidence were the only ones used, while others were discarded. In addition a report was acknowledged based on the analysis of tooth fragments in the case where a Slovenian diver was attacked by a *C. carcharias* (Linnaeus, 1758) while spearfishing at the island of Vis [23]. The media reports used were collected from the following online portals: 24sata, Bljesak.info, Cafe Del Montenegro, Delo, Dnevnik.hr, Dnevnik NOVE TV,
Dubrovacki vjesnik, Gazeta Panorama Online, Jutarnji list, PodUckun.net, Radio Kotor, Radio Val, RTL Televizija, Slobodna Dalmacija, Vecernji list, Vijesti online and Zadarski List. Only the reports that the authors deemed reliable and contained information on both location and the year of the occurrence were used.

The second step was to categorize the number of the occurrences of *C. maximus* (Gunnerus, 1765), *C. carcharias* (Linnaeus, 1758), *I. oxyrinchus* Rafinesque, 1810 and *L. nasus* (Bonnaterre, 1788) into periods of five years that were set across the year span from 1817 until 2014. For *A. vulpinus* (Bonnaterre, 1788) and *P. glauca* (Linnaeus, 1758) reports were categorized yearly because there was no data available prior the year 2000 for *P. glauca* (Linnaeus, 1758) and prior 2007 for *A. vulpinus* (Bonnaterre, 1788). The reports were accounted to the area where they occurred: Northeastern Adriatic, Central Eastern Adriatic and Southeastern Adriatic. When all the data was categorized, it was presented in the form of graphs and curves that show the year and area dependent records of the said shark species. The categorization and calculation of the data was conducted using Microsoft Office Excel tools.

3 Results and Discussion

Occurrence of six pelagic shark species native [19] in the Eastern Adriatic Sea was researched in this article: blue shark, *Prionace glauca* (Linnaeus, 1758); common thresher shark, *Alopias vulpinus* (Bonnaterre, 1788); basking shark, *Cetorhinus maximus* (Gunnerus, 1765); great white shark, *Carcharodon carcharias* (Linnaeus, 1758); shortfin mako shark, *Isurus oxyrinchus* Rafinesque, 1810 and porbeagle shark, *Lamna nasus* (Bonnaterre, 1788). Classification of the aforementioned species is presented in Figure 2 [36].

3.1 Blue shark, *Prionace glauca* (Linnaeus, 1758)

Blue sharks inhabit depths from 0 to 150 m and are only occasionally seen near the coast. The maximum total length is considered to be 4 m, but they usually grow up to 3 m. Reproduction is viviparous. Females mature at 173-221 cm, males at 182-281 cm. Litter size range is 4-135 pups that are 35-45 cm long, mating occurs during the whole year. Its diet includes fish and cephalopods. Blue sharks are frequent in the Mediterranean and in the Adriatic are thought to be more numerous in the southern parts of the sea [19].
Between the year 2000 and 2014, 54 blue shark, *Prionace glauca* (Linnaeus, 1758) occurrence reports had been made [62] [63] [49] [50] [69] [60] [61] [52] [53] [54] [30] [45] [3] [41] [6] [31] [32] [7] [37] [72] [24]. In the North Adriatic there were 4 reports, in the Central Adriatic 45 reports, and in the South Adriatic 5. As seen in Figure 3 blue sharks occurred mostly in the Central Adriatic. Also it must be noted that in the years 2005 [60], 2006, 2009 and 2013 Shark Conservation Society conducted expeditions in Central Adriatic [52] [53] [54]. Whilst no shark had been encountered during the 2013 expedition the previous ones were successful with a total of 28 sharks reported. During their research in the field they had been actively chumming in effort to attract sharks, while other records used in our study were mostly incidental catches and sightings.

Research conducted in this article showed that in a fairly small time window there had been considerably more blue shark records in comparison to other species described. There are 2 peaks (Figure 4) present, one is accounted to the 2005 expedition and 2006 expedition conducted by the Shark Conservation Society. The other is due to a combined effect from a report
Figure 3: Number of blue shark, *Prionace glauca* (Linnaeus, 1758) reports for the given years in the Northeastern Adriatic (blue), Central Eastern Adriatic (red) and Southeastern Adriatic (green). (Source: Authors)

Figure 4: Number of blue shark, *Prionace glauca* (Linnaeus, 1758) reports in the whole Eastern Adriatic Sea for the given years. (Source: Authors)
of a female blue shark found on the beach with 7 pups [3] and the results of the 2009 Shark Conservation Society research expedition. After that there is a downfall of occurrences and the graph ends with what seems as a slight increase of records starting in 2011.

The utmost issue confronted during the data collection is that because of their abundance blue sharks are often overlooked in scientific research if we count out the expeditions managed by the Shark Conservation Society in the Central Adriatic. Also there is a complete lack of records available to the public concerning the years prior to 2000.

3.2 Common thresher shark, *Alopias vulpinus* (Bonnaterre, 1788)

A large epipelagic shark found from 0 to 350 m. It can grow up to 5.5 m, possibly even 6 m in length. Reproduction is ovoviviparous. Females mature at 4 m and males at 3.5 m in length. Females give birth to 2-4 pups 114-150 cm long. It feeds upon small pelagic fish, cephalopods and pelagic crustaceans [19]. Frequent in the Mediterranean, and thought as such in the Adriatic, especially its north part. The species is also known by utilizing its long tail during hunting [20].

The data concerning the common thresher shark, *Alopias vulpinus* (Bonnaterre, 1788) could only be collected for the period from 2007 to 2014 and there had been a total of 16 reports on the occurrence of the common thresher shark [22] [42] [38] [46] [29] [51] [66] [44] [47] [48] [43] [71] [10] [28]. In the Northeastern Adriatic were 2 reports, 7 from the Central Eastern Adriatic and 7 from the Southeastern Adriatic. A light increase of the occurrence can be seen in Figure 5 and Figure 6 and is attributed to the Southeastern Adriatic.

It seems in Figure 5 that common thresher sharks occurred more in the Central Eastern and Southeastern Adriatic. Considering that Jardas et al. [20] state the species to be more frequent in Northeastern Adriatic than in its other parts and given the low input data on the species in this article it would be best not to make any assumptions on why this is the case. We must point out that there is a complete lack of information concerning the species occurrence reports. No published records on the species could be found so the authors had to rely on media reports. Unfortunately these
Figure 5: Number of common thresher shark, *Alopias vulpinus* (Bonnaterre, 1788) reports for the given years in the Northeastern Adriatic (blue), Central Eastern Adriatic (red) and Southeastern Adriatic (green). (Source: Authors)

Figure 6: Number of common thresher shark, *Alopias vulpinus* (Bonnaterre, 1788) reports in the whole Eastern Adriatic Sea for the given years. (Source: Authors)
reports were scarce and only noted occurrences were dated from the year 2007 and onwards.

In Figure 6 a steep decline of the records can be seen between 2007 and 2008. The years 2008 and 2011 yielded the lowest number of reports with only one specimen landed per year. Considering the 2009-2010 and 2012-2013 it would seem that mostly 2 or 3 sharks are caught during the year. But it must be pointed out that because of the lack of data the authors do not deem the research sample sufficient and advise not to make any assumptions on the general population trend for the species from the gathered results.

As a large and important pelagic predator the common thresher shark deserves much more scientific attention and its abundance, as well as ecology and biology, should be investigated more often. Until the science community gathers more data we are concerned that the conservation management of the species will not have the desirable effect.

3.3 Basking shark, *Cetorhinus maximus* (Gunnerus, 1765)

The basking shark, *Cetorhinus maximus* (Gunnerus, 1765) is the biggest shark native to the Adriatic Sea considering it grows on average up to 10 m, and according to some even up to 12-15 m. Reproduction is ovoviviparous with pups 1.5-1.8 m long. Males reach maturity at 4-5 m, and females at 8, possibly 10 m length. It preys upon plankton, mostly crustaceans [19].

Occurrences have been noted almost every year with a total of 52 reports [26] [55] [56] [25] [59] [15] [70] [73] [18] [21] [35] [33] [65]. The data that was collected for the 1822 to 2013 time period showed that the species is most commonly observed in the North Adriatic with 38 reports in this area, following is the Central Adriatic with 10 and is most rare in the South Adriatic with only 4 reports (Figure 7).

A noticeable increase of the species in the Adriatic Sea has started following the 1991-1996 year span and was in an upwards trend until the 2003-2008 year span. In the following years the occurrences have dropped to only 8 specimens that were observed in the North Adriatic (Figure 8).
Figure 7: Number of basking shark, Cetorhinus maximus (Gunnerus, 1765) reports for the given time periods in the Northeastern Adriatic (blue), Central Eastern Adriatic (red) and Southeastern Adriatic (green). (Source: Authors)

Figure 8: Number of basking shark, C. maximus (Gunnerus, 1765) reports in the whole Eastern Adriatic Sea in the given years. (Source: Authors)
Soldo [59] instigated a link between the abundance of zooplankton and the occurrence of basking sharks. It seems that zooplankton is the main food source (especially the species *Calanus helgolandicus*) for the species and when its abundance increases the sharks come in high numbers to feed. Having in mind that North Adriatic is a highly productive part of the Adriatic Sea and that most basking sharks have been sighted in this particular area we share the assumption that basking shark occurrence does indeed depend on the zooplankton abundance. Could the increase in occurrence in fact be the result of possible higher levels of zooplankton abundance in the years following the 1991-1996 period or some other factor like climate change or specific biological and ecological characteristics of basking sharks, is unknown at the moment.

3.4 Great white shark, *Carcharodon carcharias* (Linnaeus, 1758)

The largest predatory shark grows up to 6.4 and possibly to 8 m in length. It is found along beaches and in the open sea at depths of 0-1300 m. Most often it is located near the sea surface. It is not often found in the Mediterranean and is rare in the Adriatic. Reproduction is ovoviviparous with litter size at about 9 pups that are 60-140 cm long. Individuals mature approximately at 4 m length. In its diet large fish, other sharks, sea turtles, sea mammals, squid and similar prey are often found [19].

The species showed a pleasing consistency of records in the Eastern Adriatic (Figure 9). From the year 1868 to 2011 there had been a total of 81 reports [12] [55] [56] [57] [23] [2] . In the Northeastern Adriatic the number of occurrences is 52, Central Eastern Adriatic 17, and in Southeastern Adriatic 12 (Figure 9).

In the 1910-1915 period no great white sharks were recorded and in the 1916-1921 period there is only one record in the Central Eastern Adriatic. This may partially be due to the fact that World War I started in 1914 and the nation was more occupied with politics and war then fishing at the time. For the 11 long years with only one record starting in 1976, the reason could be the decline of Atlantic bluefin tuna (*Thunnus thynnus*) numbers in the Mediterranean. Although a number of uncertainties exist in the reported data, especially from the Mediterranean region, the best estimates from the most recent 2010 stock assessment indicate that there has been a global decline of between 29% and 51% based on summed spawning stock biomass...
Figure 9: Number of great white shark, *Carcharodon carcharias* (Linnaeus, 1758) reports for the given time periods in the Northeastern Adriatic (blue), Central Eastern Adriatic (red) and Southeastern Adriatic (green). (Source: Authors)

Figure 10: Number of great white shark, *Carcharodon carcharias* (Linnaeus, 1758) reports in the whole Eastern Adriatic Sea for the given years. (Source: Authors)
(SSB) from both the Western and Eastern stocks over the past 21-39 year for the Atlantic bluefin tuna [11]. Soldo [55] stated that the start of intensive tuna fishing in open waters of the Eastern Adriatic, especially during 70's, is in direct relation with the disappearing of great white sharks in these waters.

After the 1967-1972 time period the number of reports for the Northeastern Adriatic dramatically collapsed. In the following years the species was mostly observed in the Central Eastern Adriatic and Southeastern Adriatic while in the Northeastern Adriatic there were only two occurrences. The overall records number had greatly decreased after the 1931-1936 period. The only noticeable highs are accounted to the 1877-1882 and 1931-1936 periods (Figure 10).

During the 143 year time span of occurrences it is evident that the species is fairly constant inhabiting the Central Adriatic. The numbers are higher in the North Adriatic during the late 19th century and the first half of 20th century and it should be noted that in the said period several commercial fisheries of Atlantic bluefin tunas (*Thunnus thynnus*) existed in the same location [12]. One can easily assume that during the tuna fishing the sharks that were also in pursuit of their natural prey could wonder near the fishing nets and find themselves as prey to the fishermen. In addition, high numbers of captures could be attributed to the active hunting of *Lamnidae* shark species, primarily *C. carcharias* (Linnaeus, 1758) endorsed by the Marine Section of the Austrian Ministry of Commerce that started in 1872 and ended in 1905. Landing of a single *C. carcharias* (Linnaeus, 1758) was rewarded with 500 Austro-Hungarian Florins, if above 4 m in length (around US$ 1,000 today) [14].

Even though great white sharks are probably the most often studied species of sharks in the world they are still enveloped with many unknowns concerning their life cycle aspects. This is even more so for the Mediterranean great white sharks because they do not frequent the said waters so often unlike their counterparts in South Africa, Australia and other representative locations for the species in the world.

### 3.5 Shortfin mako shark, *Isurus oxyrinchus* Rafinesque, 1810

Epipelagic, found by the coast and in the open sea, this species ventures into depths of 150 and possibly even 700 m. It is a swift and agile swimmer
that can grow up to 4 m. Reproduction is ovoviviparous with litter size at 4-16 pups. Males mature at 195 cm and females at 280 cm. It feeds on fish, cephalopods, turtles and such. A frequently seen shark in Mediterranean but is rare in the Adriatic [19].

Between the year 1871 and 2014 a total of 47 occurrences of the shortfin mako shark, *Isurus oxyrinchus* Rafinesque, 1810 have been noted [57] [70]. In the North Adriatic the number of occurrences was 20, Central Adriatic 17, and South Adriatic 10 (Figure 11).

The results show that *I. oxyrinchus* Rafinesque, 1810 was fairly common from 1871 to 1900. From there on there had only been 2 specimens landed in the 1931-1936 period, 1 specimen in the 1955-1960, and also only 1 in the 1967-1972 period. The 3 cases occurred only in the Central Adriatic. After a long period of 42 years a specimen was landed in the Southeastern Adriatic.

Results show a significant fall in occurrence numbers (Figure 12). The possible high number of captures at the end of the 19th century and the following decrease can maybe be attributed to the Marine Section of the Austrian Ministry of Commerce interest for the capture of various shark species mentioned in this article. As said before, the hunt was stopped in 1905 but it seems that shortfin mako sharks were too vulnerable to the fisheries pressure at the time, and that their population in the Adriatic Sea had never fully recovered. During this active hunting period the species was mostly observed in the North and Central Adriatic.

### 3.6 Porbeagle shark, *Lamna nasus* (Bonnaterre, 1788)

Rarely seen from the coast, these epipelagic sharks usually frequent depths at 200-700 m. They grow up to 3 but possibly even up to 4 m in length. Reproduction is ovoviviparous with 1-15 pups in each litter. They feed upon pelagic and demersal fish as well as cephalopods and are considered rare in the Mediterranean and even more so in the Adriatic [19].

A total of 14 porbeagle shark, *Lamna nasus* (Bonnaterre, 1788) reports exist from 1893 to 2012 [53] [39] [13] [40]. In the Northeastern Adriatic basin there had been no reports. 11 reports have been noted in the Central Eastern Adriatic basin, and in the Southeastern Adriatic basin 3 (Figure 13).
Figure 11: Number of shortfin mako shark, *Isurus oxyrinchus* Rafinesque, 1810 reports for the given time periods in the Northeastern Adriatic (blue), Central Eastern Adriatic (red) and Southeastern Adriatic (green). (Source: Authors)

Figure 12: Number of shortfin mako shark, *Isurus oxyrinchus* Rafinesque, 1810 reports in the whole Eastern Adriatic Sea in the given years. (Source: Authors)
Figure 13: Number of porbeagle shark, Lamna nasus (Bonnaterre, 1788) reports for the given time periods in the Northeastern Adriatic (blue), Central Eastern Adriatic (red) and Southeastern Adriatic (green). (Source: Authors)

Figure 14: Number of porbeagle shark, L. nasus (Bonnaterre, 1788) reports in the whole Eastern Adriatic Sea in the given time periods. (Source: Authors)
Given that it has mostly been observed in the Central Eastern Adriatic and a few have been recorded in the Southeastern Adriatic it should be noted that a possible nursery area for the species that stretches over a wide area of Central Eastern and Southeastern Adriatic was instigated by Soldo [58]. A slight increase of the species numbers can be seen in Figure 14 starting following the 2003-2008 time period. Until the noted increase, porbeagle sharks showed an almost periodical pattern of occurrences but were still rarely seen. Similar as with the common thresher shark, *A. vulpinus* (Bonnaterre, 1788) the data collected seems to be too deficient to make any strong conclusions on the population trend of the species.

Porbeagle shark, *Lamna nasus* (Bonnaterre, 1788) is thought to be very rare in the Adriatic and even though there had been an increase mentioned this would best be ignored. At the moment it is unknown what is causing this. The upwards trend is pleasing to the eye, but nevertheless the amount of data is unfortunately too low and no greater conclusions can be made at the moment.

### 4 Conclusion

Pelagic sharks inhabit the open waters of seas and oceans worldwide. They are most often the apex predators of the food chains accounted to their environment. Unfortunately they are also threatened with overfishing (as target catch mostly for shark fin soup and sport fishing as well as bycatch) and with the issues of habitat destruction and pollution.

Of the pelagic species reported in the Adriatic Sea, six species were analysed in this article: blue shark, *Prionace glauca* (Linnaeus, 1758); common thresher shark, *Alopias vulpinus* (Bonnaterre, 1788); basking shark, *Cetorhinus maximus* (Gunnerus, 1765); great white shark, *Carcharodon carcharias* (Linnaeus, 1758); shortfin mako shark, *Isurus oxyrinchus* Rafinesque, 1810 and porbeagle shark, *Lamna nasus* (Bonnaterre, 1788).

54 blue shark, *P. glauca* (Linnaeus, 1758) occurrence reports had been made between the year 2000 and 2014. In the Northeastern Adriatic there were 4 reports, in the Central Eastern Adriatic 45 reports, and in the Southeastern Adriatic 5 (Figure 3). It seems that a greater number of blue sharks are caught than the other pelagic shark species but they are still rather underreported so an estimate of a population trend could not be given here (Figure 4).
The data concerning the common thresher shark, *A. vulpinus* (Bonnaterre, 1788) could only be collected for the period from 2007 to 2014 and there had been a total of 16 reports. 2 reports are from the Northeastern Adriatic, 7 from the Central Eastern Adriatic, and 7 in the Southeastern Adriatic (Figure 5). Similar as in the case of the blue sharks this species also seems to be present in the Eastern Adriatic Sea rather frequently but it is also heavily underreported and the data should not be used to extrapolate any strong conclusions.

Regarding the occurrences of the basking shark, *C. maximus* (Gunnerus, 1765) has been noted with a total of 52 reports. The data that was collected from the 1822 to 2013 time period showed that the species is most commonly observed in the Northeastern Adriatic with 38 reports in this area, following is the Central Eastern Adriatic with 10 and is most rare in the Southeastern Adriatic with only 4 reports (Figure 7). It should be noted that there seems to be an uprising of records for the species starting in the early 90’s but a downfall can be seen in the 2003-2008 period (Figure 8).

81 reports on the great white sharks, *C. carcharias* (Linnaeus, 1758) were analysed. The data shows 52 occurrences in the Northeastern Adriatic, 17 in the Central Eastern Adriatic and 12 in Southeastern Adriatic (Figure 9). The reports are dated from 1868 to 2011. The species showed a pleasing consistency of reports but with a downward trend (Figure 10). While being more frequent in the Northeastern Adriatic Sea prior to the 1967-1972 period it almost completely vanished from the area in the following years.

The data regarding the occurrence of the shortfin mako shark, *I. oxyrinchus* Rafinesque, 1810 have been collected 1871 to 2014. In total 47 specimens have been reported, 20 in the Northeastern Adriatic, 17 in the Central Eastern Adriatic and 10 in the Southeastern Adriatic (Figure 11). The species showed a dramatic collapse of reports from what seemed to be a relatively frequent species at the end of the 19\textsuperscript{th} century (Figure 12). The following periods were the longest without any reports on the species: 1898-1932, 1934-1957 and 1972-2014.

A total of 14 porbeagle shark, *L. nasus* (Bonnaterre, 1788) reports exist from 1893 to 2012. In the Northeastern Adriatic there had been no reports. 11 reports have been noted in the Central Eastern Adriatic and in the Southeastern Adriatic basin 3 (Figure 13). Given that it has mostly been observed
in the Central Eastern Adriatic and a few have been recorded in the Southeastern Adriatic it should be noted that a possible nursery area for the species that stretched over a wide area of Central Eastern and Southeastern Adriatic was instigated by Soldo [58]. Unfortunately the data on this species is scarce.

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