New records of the threatened blue shark *Prionace glauca* off Cadaqués coast, Western Mediterranean

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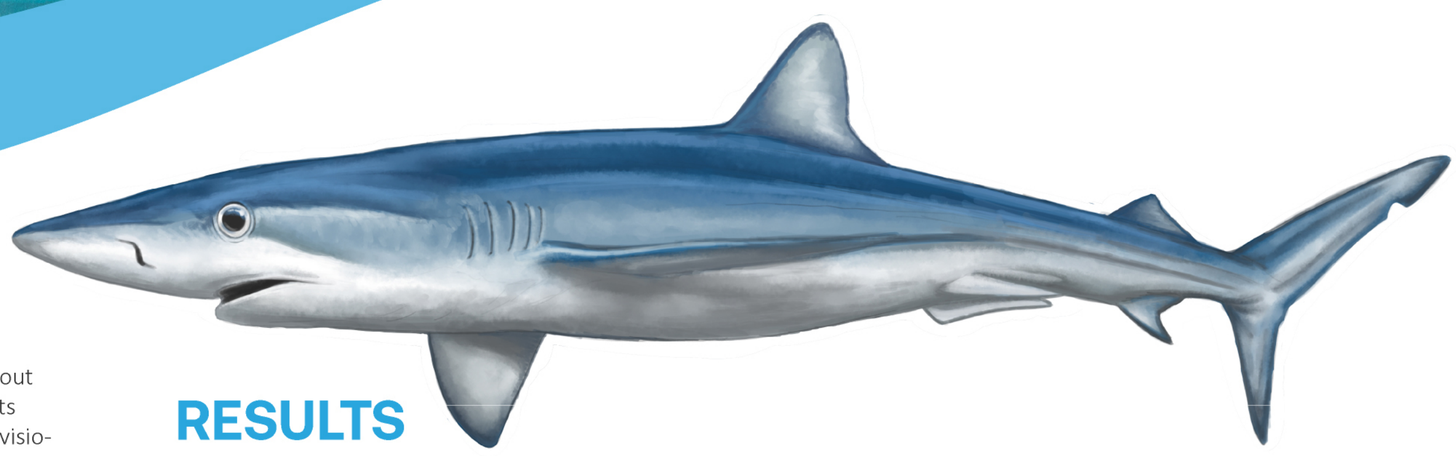

INTRODUCTION

The blue shark *Prionace glauca* is a large, pelagic-oceanic and highly migratory species with a circumglobal temperate to tropical distribution. For the Mediterranean Sea there is concern about this species where it is classified as “critically endangered” (Sims et al. 2016). This study presents new records of blue sharks off Cadaqués coast, Western Mediterranean Sea of Spain, using provisioning methods.

MATERIALS AND METHODS

The observations were carried at the head of Cap de Creus submarine canyon, the most southwestern submarine canyon of the Gulf of Lions (Figure 1). This is considered one of the most productive areas in the Mediterranean. The head of the canyon is located about 5 km north- east from the Cap de Creus promontory and progressively reaches a maximum amplitude of 6 km, with depths ranging from 650 m to 2200 m (Madurell et al. 2012).

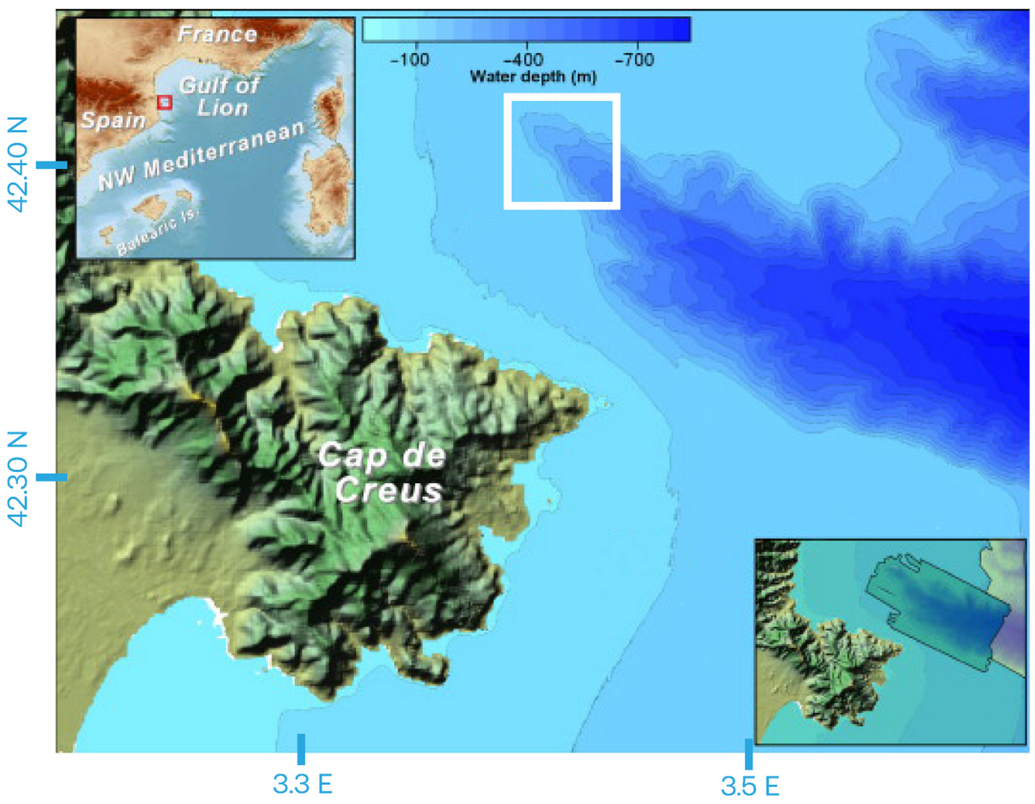

Figure 1: Map of the Cap de Creus area and the Cap de Creus submarine canyon. The white square indicates our study area. Map retrieved from Iacono et al. (2012).

Provisioning methods were used to attract sharks, being chumming the main attraction method. A chum container at 5 m deep and a bait line were also deployed to keep sharks interested around the boat. The chum consisted of a mix of seawater and triturated sardines and it was continuously released overboard for a minimum of 4.5 hours, the chum container, consisting of the same mix, was deployed at the same time. Total shark abundance, sex, and size were recorded along with environmental factors *in situ* like sea surface temperature (SST) and wind speed. A relative abundance index as sighting per unit effort (SPUE) was calculated by dividing the number of registered sharks by the hours of attraction time per month. Sharks total length (TL), was estimated by observers and classified into 5 size classes. Sex determination was also carried out by direct observation, classifying individuals as male, female, and non-determined (ND), for those which identification was not possible. Following Pratt (1979), Nakano & Stevens (2008), and Rigby et al. (2019), individuals with 35-40 cm TL were classified as newborns (Nb.).

RESULTS

From April 7th to September 22nd, a total of 54 surveys and 270 hours and 45 minutes of chumming time were performed. The presence of at least one blue shark was observed on 34 surveys (62.96%) and 64 shark observations were registered in total. SST was on average 21,95 Cº reaching up to 27.01 Cº in August (Table 1). The highest SPUE corresponded to June with 0.492 ind h^{-1} and 0.363 ind h^{-1} in July (Figure 2).

Months	Surveys	Attraction time (hh:mm)	SPUE	Number of sightings	Avg. TL (cm)	Females	Males	ND	Nb.	Avg.Temp (Cº)
April	5	24:47	0.040	1	120.00	/	/	1	/	14,92
May	13	67:30	0.104	7	124,29	2	1	3	/	18,72
June	9	48:46	0.492	24	133,41	/	6	16	2	22,23
July	12	60:34	0.363	22	125,00	4	14	4	/	25,19
August	10	46:12	0.173	8	101,63	2	2	3	1	25,79
September	5	22:50	0.088	2	100,00	1	1	/	/	24,85
Total	54	270:45	0.210	64	117,39	10	24	27	3	21,95

Table 1: *Prionace glauca* calculated sightings per unit effort (SPUE), Average TL, and Sex determination for the Cap de Creus submarine canyon area.

Sharks TL was estimated for 62 individuals, with the average TL as 117.39 cm; both the minimum (35 cm) and the maximum (250 cm) sizes were recorded in June (Table 1). The size classes with the more abundance were the ones ranging from 101 to 150 cm and 51 to 100 cm for both males and females during all months. For the size class from 201 to 250 cm there were only three registers (Figure 3). We recorded 3 blue sharks measuring 35 and 40 cm long (Table 1, Figure 3). Sex of individuals was recorded in 34 of the 64 shark observations and males represented 70% of them, although for 27 observations sex could not be determined (ND).

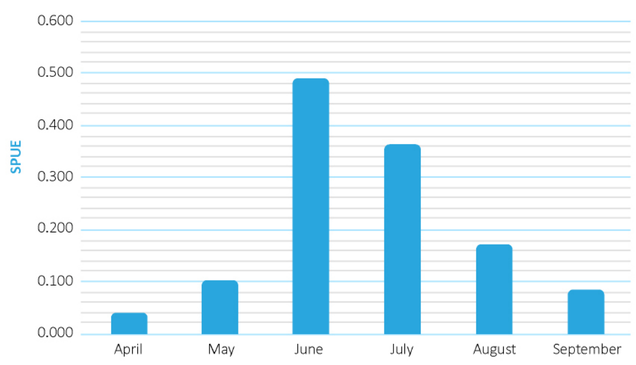

Figure 2: SPUE per month.

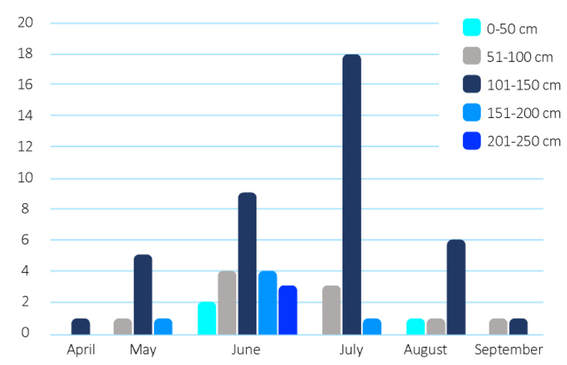

Figure 3: Abundance of *Prionace glauca* per size class per month.

DISCUSSIONS AND CONCLUSIONS

Our results confirm the regular presence of blue sharks in the Cap de Creus submarine canyon from April to September 2022. According to Pratt (1979), Nakano & Stevens (2008), and Rigby et al. (2019), TL for newborns of *Prionace glauca* is recorded between 35-50 cm. The register in this study of three individuals of TL 35 and 40 cm suggests they were born at or near the Cap de Creus submarine canyon area. The dates of their sightings occurred in June and August, matching with Nakano & Stevens (2008) who described blue shark birthing season from April to July. The TL of 81 % of the recorded individuals ranged from 51 to 150 cm. According to previous estimates of the total length at age, blue sharks of 149.5 cm are likely to be 3 years old (Megalofonou et al. 2009). This species reaches sexual maturity at 4-5 years old (Pratt 1979, Skomal & Natanson 2003, Megalofonou et al. 2009). Thus, our sightings show a greater abundance of juvenile blue sharks in the submarine canyon of Cap de Creus. As defined by Vandeperre et al. (2014) nursey areas of blue sharks are characterized by environmental conditions that provide a suitable habitat along the year, supporting rapid juvenile growth without the need to move great distances. Population growth of blue sharks is strongly dependent on the survival of juveniles (0-4 years) (Aires da Silva & Gallucci 2007). As described by Würtz et al. (2011) underwater canyons support increased biological production and are ecological "hotspots" for pelagic life and top pelagic predators, including sharks, for both feeding and breeding. The high presence of juvenile individuals in the Cap de Creus submarine canyon through all surveyed months may suggest this canyon could be a nursery area for blue sharks, although nursey areas present additional attributes and further monitoring is needed to confirm this idea. The high presence of juvenile blue sharks registered in this study suggests the Cap de Creus submarine canyon could be an important area for *Prionace glauca* in the Western Mediterranean.

Figure 4: Picture during our fieldwork of several blue sharks around the chum container.

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Drawings
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