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Species Diversity and Geographical Distribution of Sharks along the Eastern Libyan Coast

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Abstract:
The current investigation was conducted to evaluate the species composition and pattern of distribution of sharks along the eastern Libyan coast based on field surveys, literature data, and fishery records conducted from 2018 to 2024. Twenty species belonging to 5 families were reported such as: *Squalus blainville*, *Squalus acanthias*, *Squalus megalops*, *Mustelus mustelus, Galeorhinus galeus*, *Mustelus punctulatus*, *Carcharhinus plumbeus*, *Squatina* and *Carcharodon carcharias.* The year 2023 recorded the maximum number of shark sightings among all the years followed by 2021 then 2020 and least in the year 2024.The main reasons for this are climate change and the high summer temperatures in 2023, as well as intensified illegal fishing, illegal migrant-induced mortality, and excessive local fishing efforts. All these have played a role in attracting more sharks to the shallow coastal waters. Results show nearly 18 endangered species of sharks found along the east Libyan coast, out of nearly 48 species recorded in the Mediterranean Sea. It can be understood from this that ecological importance the Libyan coastline holds as a significant habitat for vulnerable species many of which are listed as Critically Endangered on the IUCN Red List. Some important species reported from this area include: *Squalus acanthias, Carcharhinus plumbeus, Squatina aculeata , Squatina oculata, Squatina squatina*, *Lamna nasus, Carcharodon carcharias* and *Isurus oxyrinchus.*

Keywords: Species diversity, Sharks, Geographical distribution, Eastern Libyan coast , Mediterranean Sea.

Introduction:

Having been on the planet for about 500 million years, long before the dinosaur era, sharks are among the oldest marine animals. They are essential to preserving the equilibrium of marine environments. But over the last 200 years, over 97% of shark families have gone extinct, and overfishing is now posing a growing threat to them (Bradai et al., 2022).
Sharks are top predators in marine communities and perform a key function in ecosystem maintenance by controlling prey populations and by promoting biodiversity (Baranes et al., 2016; Cavanagh and Gibson, 2007). Their preservation promotes the health and recovery of key habitats (e.g., coral reefs, sea grass beds) important for marine species (Ebert, et al 2021). In order to contribute to effective conservation measures, understanding the diversity and spatial distribution of shark species is crucial, especially in areas such as the supplementary materials.
The Libyan coastline, extending over 1,700 kilometers along the Mediterranean basin, represents a key but understudied area within the Eastern Mediterranean for shark research. This coastline, stretching

from the Egyptian border to the Gulf of Sidra, encompasses a mosaic of marine habitats, including shallow coastal zones, deep offshore waters, continental slopes, and estuarine systems. Such ecological heterogeneity provides essential niches for shark species during various life stages—feeding, breeding, and migration (Cavanagh & Gibson, 2007; Soldo et al., 2012). Despite this ecological significance, the shark fauna of Libyan waters remains inadequately documented compared to better-studied regions in the western and central Mediterranean.

Mediterranean waters are home to more than 47 shark and ray species, many of which are threatened by overexploitation, habitat degradation, and climate change impacts (Fowler et al., 2017; Zupančič et al., 2019). Iconic species such as *Carcharodon carcharias* (Great White Shark), *Isurus oxyrinchus* (Shortfin Mako Shark), and *Carcharhinus plumbeus* (Sandbar Shark) have been the focus of research primarily in western Mediterranean zones, with limited data from the Libyan coast (Ebert et al., 2013; Soldo et al., 2012).

About 50 shark species have been recorded in the Mediterranean Sea, 49 of them along the Libyan coast (UNEP, 2005), including roughly 20 species along the eastern Libyan coast.

Habitat utilization Previous studies from the surrounding countries have described a variety of shark assemblages, such as *Isurus paucus* (Longfin Mako), *Carcharhinus limbatus* (Blacktip shark) and Carcharhinus brachyurus (Bronze Whaler shark) (Soldo et al., 2012; Zupančič et al., 2019). Until now, however, these data have not been accompanied by rigorous assessments from within Libya, and there remains a significant knowledge gap concerning which species are present, their seasonal distribution and their ecological role in the region. Moreover, limited important information on human pressures such as disturbance and fishing in Libyan waters.

The International Union for Conservation of Nature (IUCN) established the IUCN SSC Shark Specialist Group (SSG) as part of a conservation initiative to prevent the extinction of angel shark species. The saw back angel shark (*Squatina aculeata*), smooth back angel shark (*Squatina oculata*), and common angel shark (*Squatina squatina*) are the three endangered species of angel sharks that are the focus of this initiative (IUCN, 2008).

One of the marine fish species most in danger of extinction is the shark. Numerous species have been evaluated in the Mediterranean Sea, especially in the eastern part, which is thought to be a suitable habitat for many of them, including the school shark (*Galeorhinus galeus*), the copper shark (*Carcharhinus brachyurus*), and the great white shark (*Carcharodon carcharias*) (FAO, 2012; Rafi & El-Mor, 2015). One of the cartilaginous fish species found in Libyan waters is the school shark (*Galeorhinus galeus*), which has become increasingly common along the country's eastern coast in recent years.

Due to severe overfishing, mainly for its meat, skin, and fins, which are used in a variety of industries, this species is listed as vulnerable and threatened (FAO, 2005; 2012 & IUCN, 2010). This species' longest recorded length is around 200 cm (Compagno, 1984; Al-Honie & Al-Kabeer, 1991; Al-Kabeer, 2006). Between 2017 and 2020, six great white shark sightings were reported off the coast of Libya, underscoring the significance of ongoing scientific monitoring of this species and the necessity of creating practical plans to prevent its extinction.

The IUCN Red List, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the Convention on Biological Diversity are just a few of the regional and international agreements that aim to conserve biodiversity. The international community has acknowledged the serious environmental threats that these species face, which has led to increased efforts to monitor their status (Libyan Marine Sciences Society, 2018).

Through a variety of strategies, such as legislation, scientific research, genetic analysis, and awareness campaigns, local, regional, and international environmental organizations are essential to shark conservation. Through close collaboration between nations and local communities, these organizations aim to achieve marine sustainability and protect endangered species, such as Mediterranean Sea sharks. For instance, Derna's non-governmental organization "Organization of Marine Science and Organisms" contributes significantly to the preservation of the marine environment and the protection of marine life, particularly sharks, along Libya's eastern coast by: Scientific research and environmental monitoring: carrying out fieldwork to investigate biodiversity, gathering precise information on shark distribution and water quality, and assessing the effects of human activity. Raising community awareness and involvement: planning educational initiatives to educate the public about the value of shark conservation and working with nearby fishermen to implement sustainable fishing methods. Protecting marine habitats: Promoting the creation of marine protected areas that offer endangered shark species safe havens while keeping an eye on the condition of coral reefs and other important coastal areas.

This study intends to fill these gaps by offering a thorough evaluation of the geographical distribution and species diversity of sharks along the coast of Eastern Libya. The goals are to: (1) identify shark species using different techniques, fisheries data, and field surveys; (2) map their spatial distribution to identify hotspots for biodiversity; (3) investigate seasonal migration and movement patterns; and (4) assess the effects of human threats on shark populations. The results highlight how urgently better monitoring and conservation measures are needed.

Materials and Methods:

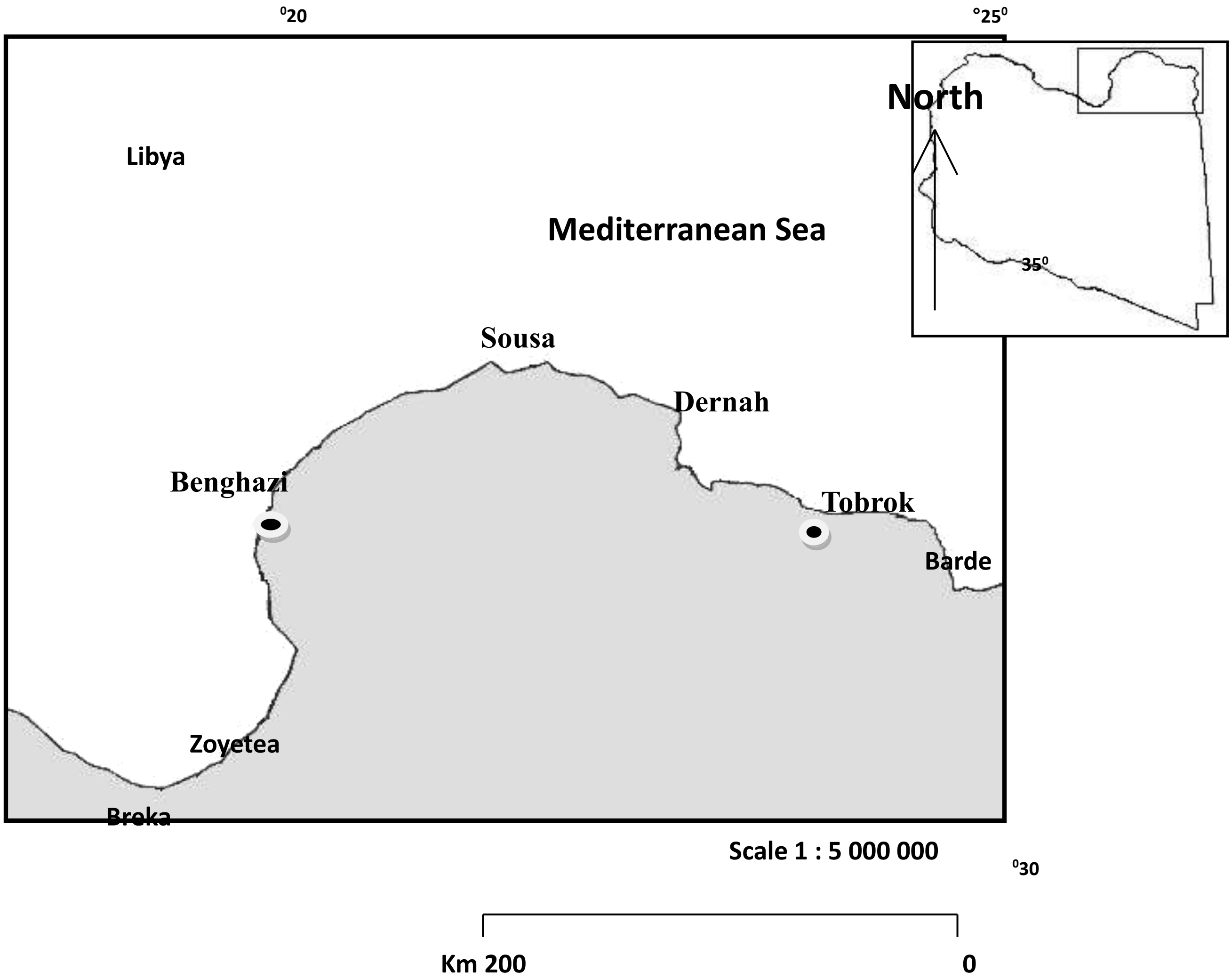
Study Area

The Mediterranean coastline from Benghazi to Tobruk was included in the study, which was carried out along the eastern Libyan coast. This area has a variety of marine habitats, including sea grass beds, rocky shorelines, and sandy bottoms. Three primary sampling zones were established within the area:

Zone I: Benghazi to Derna

Zone II: Derna to Ras al-Hilal

Zone III: Ras al-Hilal to Tobruk (A map 1)



A map (1): showing the study region from Benghazi to Tobruk along the eastern Libyan coast, the Mediterranean Sea.

Sampling Period

To take into consideration possible seasonal variations in shark diversity and distribution, field surveys were carried out over an 84-month period, from January 2018 to December 2024, covering all four seasons.

Sampling Methods

Shark diversity and distribution were evaluated using a mix of fishery-dependent and fishery-independent techniques:

Fishery-Dependent Data: A structured questionnaire survey was used to gather data from about 200 - 260 local fishermen (average number per year) in different locations along the coast of Eastern Libya. The purpose of the survey was to collect both qualitative and quantitative data on the existence of shark species, fishing methods, and perceived shifts in shark populations. Secondary data was gathered from official and institutional sources, such as the National Center for Meteorology, the Organization for Marine Science and Biology (OMSO), the Fishermen's Union, and the Ministry of Marine Resources, in addition to field-based data. A more thorough examination of the diversity of shark species and their geographic distribution in the study area was made possible by the vital environmental and fisheries-related data from these sources.

Fishery-Independent Surveys: Selected locations in each of the three zones were equipped with standardized logline and baited remote underwater video systems (BRUVS). In order to record dial activity patterns, each deployment lasted roughly two hours and was carried out both during the day and at night.

Species Identification

Using morphological traits derived from standard taxonomic keys, sharks were identified down to the species level (e.g., Compagno, 1984). Photographs and tissue samples were obtained as needed for expert confirmation and possible future genetic analysis.

Data Analysis

Species diversity was quantified using standard biodiversity indices including:

Species Richness (S)

Shark occurrences by species and zone were mapped using Geographic Information Systems (GIS) to analyze geographic distribution patterns. To find species richness hotspots and evaluate potential anthropogenic or environmental influences, a spatial analysis was carried out.

Environmental Data

A handheld CTD probe was used at each sampling site to record environmental parameters like depth, salinity, and sea surface temperature. To look into possible ecological drivers, these data were correlated with species distribution.

Results and discussion:

1. **Number of shark sightings:**

Table (1): Shows annual shark sightings across three zones of the Eastern Libyan coast

Shark observed	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Zone I: Benghazi to Derna	5	5	7	10	5	12	4
Zone II: Derna to Ras al-Hilal	2	2	4	8	3	10	3
Zone III: Ras al-Hilal to Tobruk	2	3	4	5	2	8	1

Table (1) documenting a 2018 to 2021 Increase: Sightings increased significantly in all zones during 2018 to 2021, with the largest increases in Zone I and Zone II. This variation suggests that either sharks increased in abundance or with better monitoring.

Each zone had the highest number of sightings recorded during 2023: Zone I: 12, Zone II: 10 and Zone III: 8. This may suggest good environmental opportunities are available, high aggregation populations, and increased observer effort. All zones witnessed a significant decline in sightings in 2024, with only 1 sighting unique to Zone III. Potential Consequences of Storm Daniel (September 2023) Storm Daniel, an extreme Mediterranean cyclone, impacted eastern Libya – and particularly Derna and adjacent coastal areas (Zone I and Zone II) – on September 2023, resulting in: Failure of the Derna dams, ntense flooding that fed large volumes of freshwater, debris and urban runoff into the marine environment and Strong and sudden fluctuations in salinity, turbidity, oxygen levels, and substrate type.

Ecological Considerations for Sharks:

1. Habitat Disturbance Coastal flooding likely disturbed or modified benthic habitat (muddy or rocky bottom) important to species like Mustelus spp., Squatina spp., and Galeus melastomus (Ferretti et al., 2010).
2. Freshwater and sediment influx Meanwhile, drastic declines in salinity and increased turbidity near estuaries have been shown to initiate avoidance behavior in coastal sharks (Whitney et al., 2012).
3. Mortality and emigration Potentially, there was direct mortality occurring due to flood debris or forced displacement driven by habitat suitability, primarily in Zones I and II, which would explain the decline (Heupel et al., 2014).
4. Limited monitoring In post-disaster activities, there appears to be strict limits, or cessation, to field activity that may have included costs associated with reduced frequency of observation (Speed et al., 2010).

The peak in 2023 may reflect both ecological factors (e.g., seasonal aggregation, prey abundance) and human effort (better data collection or surveys). However, the sharp decline in 2024—despite the previous high—is strongly linked to the environmental disturbance caused by Storm Daniel, especially given the proximity of the worst-affected zones (I & II) to the city of Derna.

The data suggest that natural disasters can cause temporary disruption in shark distribution, either by direct habitat alteration or by inducing behavioral shifts such as migration or avoidance

2. **The Diversity of shark species along the Eastern Libyan Coast**:

The classification of shark species documented along the Eastern Libyan coast presented in Table (2) indicates a worrying trend in conservation status. Many species (mainly from the families Squatinidae, Lamnidae, and Triakidae) are listed as Critically Endangered (CR), Endangered (EN), or Vulnerable (VU), by the IUCN Red List (IUCN, 2023), thus highlighting the significant anthropogenic pressures such as overfishing, habitat disturbance, and by catch in commercial fishing, which continue to hinder shark populations globally (Dulvy et al., 2014; Pacoureau et al., 2021). A significant number of species in the Carcharhinidae family, are classified as Data Deficient (DD), as there is not enough biological or population data. Unfortunately, being classified as DD is significantly problematic as many of these species could be threatened, but simply go unnoticed, due to a lack of monitoring (IUCN, 2023). A substantial number of DD species suggests a significant need for targeted fieldwork and region-specific assessments of Libyan marine waters, in order to develop appropriate conservation actions. Furthermore, the presence of multiple threatened shark species in this region, supports the growing literature on the Mediterranean Sea is a hotspot for peril and risk over extinction for sharks & rays (Notarbartolo di Sciara et al., 2016).Consequently, the results from this research provided compelling justification to augment conservation frameworks, enforce harvesting restrictions, and generate public awareness in order to ameliorate declines in abundance these ecologically vital top predators.

Table (2). Classification of different Families Sharks According to the IUCN Red List

Family	**Species**	**Common name**	**Red -list category (ICUN)**
Squalidae	*Squalus blainville* (Risso, 1827)	Long nose spurdog	Data Deficient (DD)
	Squalus acanthias (Linnaeus 1758)	Spiny dogfish shark	Endangered (EN)
	Squalus megalops (MacLeay, 1881).	Short nose spurdog	Data Deficient (DD)
Triakidae	*Mustelus mustelus* (Linnaeus, 1758)	Smooth-hound	Vulnerable (VU)
	Galeorhinus galeus (Linnaeus, 1758)	Tope shark	Vulnerable (VU)
	Mustelus punctulatus (Risso, 1827)	Black spotted smooth-hound	Vulnerable (VU)
Carcharhinidae	*Carcharhinus plumbeus* (Nardo, 1827)	Sandbar shark	Endangered (EN)
	Carcharhinus obscurus (Lesueur, 1818)	Dusky sharks	Data Deficient (DD)
	Prionace glauca (Linnaeus, 1758)	Blue shark	Near Threatened (NT)
	Carcharhinus altimus (Springer, 1950)	Bignose shark	Data Deficient (DD)
	Carcharhinus amblyrhynchos (Bleeker, 1856)	Grey reef shark	Data Deficient (DD)
	Galeus melastomus (Rafinesque, 1810)	Black mouth cat shark	Least Concern (LC)
	Carcharhinus brevipinna (Müller & Henle, 1839)	Spinner shark	Not Applicable (NA)
	Carcharhinus melanopterus (Quoy & Gaimard, 1824)	Black tip reef shark	Data Deficient (DD)
Squatinidae	*Squatina aculeata* (Cuvier, 1829)	Saw back angel shark	Critically Endangered (CR)
	Squatina oculata (Bonaparte, 1840)	Smooth back angels hark	Critically Endangered (CR)
	Squatina squatina (Linnaus, 1758)	Common angel shark	Critically Endangered (CR)
Lamnidae	*Lamna nasus* (Bonnaterre, 1788)	Porbeagle shark	Critically Endangered (CR)
	Carcharodon carcharias (Linnaeus, 1758)	Great white shark	Critically Endangered (CR)
	Isurus oxyrinchus	Short fin mako	Critically Endangered

	(Rafinesque, 1810)		(CR)

3. **Analysis of the Geographical Distribution of Shark Species The study aims to map**

The distribution of shark species at the various sampling stations along the eastern Libyan coast, specifically to see if any of the local environmental factors e.g., depth, substrate type, temperature, and salinity have an effect on the distribution.

Zone I: **Benghazi to Derna**

Table (3): Shark Species Recorded Along the Coast of from Benghazi to Derna and Their Associated Depths, Substrate Types, Temperature (T), and Salinity (S)

Shark species observed	Depth (meters)	Substrate	Temperature T (°C)	Salinity S (‰)
Squalus blainville	5-20	Sandy Bottom	15	36.5
Squalus acanthias	50-80	Sandy Bottom	14	37.5
Squalus megalops	80-150	Sandy Bottom	18	37.5
Mustelus mustelus	80-150	Sandy Bottom	18	37.5
Galeorhinus galeus	Not registered			
Mustelus punctulatus	50-80	Sandy Bottom	18	37.5
Carcharhinus plumbeus	50-80	Muddy Bottom	20	37.5
Carcharhinus obscurus	Not registered			
Prionace glauca	5-20	Muddy Bottom	18	37.5
Carcharhinus altimus	5-20	Rocky Bottom	17	37.5
Carcharhinus amblyrhynchos	Not registered			
Galeus melastomus	50-80	Rocky Bottom	15	36.5
Carcharhinus brevipinna	50-80	Muddy Bottom	14	37.5
Carcharhinus melanopterus	80-150	Muddy Bottom	14	37.5
Squatina aculeata	80-150	Rocky Bottom	13	36.5

Squatina oculata	80-150	Sandy Bottom	13	36.5
Squatina squatina	50-80	Rocky Bottom	13	36.5
Lamna nasus (Bonnaterre,	5-20	Sandy Bottom	17	37.5
Carcharodon carcharias	5-20	Sandy Bottom	17	37.5
Isurus oxyrinchus	5-20	Sandy Bottom	17	37.5

Table (3) presents the various shark species recorded along the Benghazi coastal waters together with their relationships to environmental variables including depth, substrate type, temperature (T), and salinity (S). The ecological diversities shown by this data showed species-specific relationships for certain ecological conditions.

1. Depth Distribution of Shark Species

The data shows that some species utilize shallow waters (5-20 meters), namely *Squalus blainville, Prionace glauca, Carcharodon carcharias,* and I*surus oxyrinchus*. Other species occupied, moderate to deep waters (50-150 meters), namely: *Squalus megalops, Mustelus mustelus*, and *Squatina aculeata*. This pattern corresponds with previous studies that ecological depth had an influence on shark distribution, as depth can limit sharks solicitation of additional aspects of its habit such as pressure, light availability, and/or density of prey availability (Compagno, 2001; Ebert & Stehmann, 2013).

2. Substrate Type

Sandy bottoms were the most frequently recorded habitat, observed in 9 species. Muddy bottoms were associated with 5 species, and rocky substrates with 4 species. *Squatina* species (angel sharks) were commonly associated with rocky and deeper substrates, consistent with their benthic and ambush behavior (Bilecenoglu & Taskavak, 1999). This underscores the importance of habitat availability in maintaining shark biodiversity, particularly for demersal and cryptic species.

3. Temperature

Sea temperatures recorded were seen to range between 13°C and 20°C demonstrating a suitable thermal gradient for the species' physiological tolerances. Deeper-water species (e.g., *Squatina aculeata*) were recorded in the cooler zones, whereas coastal species (e.g., *Carcharhinus plumbeus*) where recorded in the warmer areas. Past studies have shown the temperature has a marked influence on shark distribution, activity, and reproduction (Sims et al., 2003).

4. Salinity

Salinity conditions were relatively constant among sites, between 36.5‰ and 37.5‰, which are normal for Eastern Mediterranean waters (MEDAR Group, 2002), and while no distinguishable trend can be made at a species level based on salinity, its stability was likely beneficial to those species sensitive to chemical variation.

5. Unregistered Species

Species like *Galeorhinus galeus* and *Carcharhinus obscurus* were not seen in the study region, which reflects possible explanations of:

- local rarity or seasonal migration

- inadequate sampling methods,
- demographic pressure or anthropogenic influence.

The absence of these species warrants additional seasonal and spatial assessments to determine whether the species were truly absent or simply not seen at the time.

Zone II: **Derna to Ras al-Hilal**

Table (4): Shark Species Recorded Along the Coast of from Derna to Ras al-Hilal and Their Associated Depths, Substrate Types, Temperature (T), and Salinity (S)

Shark species observed	Depth (meters)	Substrate	Temperature T (°C)	Salinity S (‰)
Squalus blainville	0-150	Muddy Bottom	14	36.5
Squalus acanthias	Not registered			
Squalus megalops	Not registered			
Mustelus mustelus	Not registered			
Galeorhinus galeus	Not registered			
Mustelus punctulatus	50-80	Rocky Bottom	21	37.5
Carcharhinus plumbeus	50-80	Muddy Bottom	21	37.5
Carcharhinus obscurus	Not registered			
Prionace glauca	Not registered			
Carcharhinus altimus	Not registered			
Carcharhinus amblyrhynchos	Not registered			
Galeus melastomus	0-150	Rocky Bottom	21	37.5
Carcharhinus brevipinna	50-80	Muddy Bottom	17	37.5
Carcharhinus melanopterus	Not registered			
Squatina aculeata	0-150	Rocky Bottom	21	37.5
Squatina oculata	Not registered			

Squatina squatina	50-80	Rocky Bottom	20	37.5
Lamna nasus (Bonnaterre,	5-20	Muddy Bottom	17	37.5
Carcharodon carcharias	Not registered			
Isurus oxyrinchus	0-150	Rocky Bottom	21	37.5

In table (4), the ecological distribution of shark species seen along Derna to Ras Al-Halal coast is summarized based on the occurrence in regards to depth, substrate, temperature, and salinity. These data clearly show that both biotic and abiotic factors influence the local shark community structure.

1. Depth Distribution

Sharks were mainly recorded at depths between 50 and 150 m, which implies sharks prefer moderate to deep environments, particularly for benthic and demersal species such as *Squatina aculeata* and *Galeus melastomus*. *Lamna nasus* was the only species detected at shallower depths (5-20 m) which was consistent with this species having far-ranging pelagic behavior (Campana & Joyce, 2004). The absence of *Squalus acanthias* and *Mustelus mustelus*, which are found in coastal zones of the Mediterranean (Ebert & Dando, 2021), could suggest they are absent seasonally, are low in abundance, or have been overfished locally.

2. Substrate Preferences

The substrate composition played a notable role in species distribution: Muddy bottoms were associated with *Squalus blainville*, *Carcharhinus plumbeus*, *C. brevipinna*, and *Lamna nasus*. Rocky bottoms were the habitat of *Mustelus punctulatus*, *Galeus melastomus*, *Squatina squatina*, *Squatina aculeata*, and *Isurus oxyrinchus*. Species such as *Squatina* spp. and *Galeus melastomus* are known to favor hard substrates that provide camouflage and protection, supporting their ambush predation strategies (Compagno, 1984; Serena et al., 2010).

3. Temperature Influence

Over the course of the study, the temperature range was between 14°C to 21°C. This is consistent with rather transitional conditions in the Eastern Mediterranean. With the majority of species recorded in the greater water temperatures (17–21°C), presumably their preferences moved to warmer temperature as warm-water thermophilic species. This was especially evident with *Mustelus punctulatus* and *Squatina aculeata* recorded in waters of 21°C suggesting a distinct preference for late spring–summer thermal conditions. Importantly, temperature is one ecological force influencing shark metabolic rates, reproductive cycles, and migratory pathways; temperature will typically drive sharks seasonal aggregations in coastal warm-water environments (Sims et al. 2003). As noted, temperature gradients changes cause variability in both busy pelagic aggregation and space use exhibited by steep-bodied, low-profile benthic and demersal sharks.

4. Salinity Patterns

Salinities were consistently high (36.5–37.5 ‰), characteristic of the easter Mediterranean Sea, which is one of the saltiest basins in the world. The continuously stable salinity across all habitats recorded supports the notion that salinity will not be a limiting factor for the shark species identified in this study as most Mediterranean sharks are euryhaline and only tolerate small salinity variations (Ben Rais Lasram et al., 2008).

5. Unregistered Species

Several species were not recorded in this sampling area (e.g., *Carcharodon carcharias*, *Prionace glauca*, *Carcharhinus obscurus*), possibly due to:

- Sampling method limitations (e.g., gear type, effort),
- Seasonal migration patterns,
- Local extirpation due to overfishing or habitat degradation.

These absences underscore the need for long-term monitoring programs to determine whether such species are rare or functionally extinct in the area.

Zone III: Ras al-Hilal to Tobruk

Table (5): Shark Species Recorded Along the Coast of from Ras al-Hilal to Tobruk and Their Associated Depths, Substrate Types, Temperature (T), and Salinity (S)

Shark species observed	Depth (meters)	Substrate	Temperature T (°C)	Salinity S (‰)
Squalus blainville	0-150	Muddy Bottom	15	37.5
Squalus acanthias	Not registered			
Squalus megalops	Not registered			
Mustelus mustelus	0-150	Muddy Bottom	20	37.5
Galeorhinus galeus				
Mustelus punctulatus	0-80	Rocky Bottom	21	37.5
Carcharhinus plumbeus	0-80	Muddy Bottom	20	37.5
Carcharhinus obscurus	0-150	Rocky Bottom	14	37.5
Prionace glauca	0-150	Rocky Bottom	17	37.5
Carcharhinus altimus	0-150	Rocky Bottom	19	37.5
Carcharhinus amblyrhynchos	Not registered			
Galeus melastomus	0-150	Rocky Bottom	14	37.5
Carcharhinus brevipinna	0-80	Muddy Bottom	17	37.5
Carcharhinus melanopterus	Not			

	registered			
Squatina aculeata	0-150	Rocky Bottom	19	37.5
Squatina oculata	Not registered			
Squatina squatina	50-80	Rocky Bottom	19	37.5
Lamna nasus (Bonnaterre,	5-20	Muddy Bottom	14	37.5
Carcharodon carcharias	Not registered			
Isurus oxyrinchus	0-150	Rocky Bottom	19	37.5

Table (5) presents various species of sharks of the genera *Squalus, Mustelus, Carcharhinus, Squatina, Galeus* etc. Most species were found at depths from 0 to 150 meters which is considered the continental shelf zone. This is an area of the ocean that can produce adequate environmental conditions for many types of coastal and demersal shark species. Research indicates that environmental factors such as bottom type, temperature, and salinity have a strong effect of the distribution of sharks (Compagno, 2005; Ebert & Stehmann, 2013).

2. Depth and Substrate Correlation with Species Distribution

Muddy Bottom Environments:

Species such as: *Squalus blainvillei*, *Mustelus mustelus*, *Carcharhinus plumbeus*,*Carcharhinus brevipinna* and *Lamna nasus* were recorded in muddy substrates, which are rich in benthic invertebrates, making them ideal feeding grounds for bottom-feeding sharks that prey on crustaceans and mollusks (Ebert et al., 2021).

Rocky Bottom Environments:

Species such as: *Mustelus punctulatus*, *Carcharhinus obscures*, *Prionace glauca*,*Galeus melastomus*, *Isurus oxyrinchus* and *Squatina spp.* were observed in rocky habitats, indicating a preference for environments that offer shelter, camouflage, and access to reef-associated prey (Serena et al., 2020).

3. Temperature and Its Influence on Distribution

Recorded temperatures ranged from 14°C to 21°C, which falls well within the optimal range for species that are adapted from subtropical to temperate waters. Species such as *Carcharhinus obscurus, Galeus melastomus,* and *Lamna nasus*, all occurring at 14°C, demonstrate their tolerance of cooler waters in respect of a deeper or more northern distribution (Compagno, 2001). At the upper end, *Mustelus punctulatus* and *Mustelus mustelus* were recorded at 20–21°C demonstrating a preference for warm, coastal waters (Notarbartolo di Sciara et al., 2007).

4. Salinity and Its Uniformity

The recorded species were all located in waters with stable salinity of 37.5‰, consistent with the Mediterranean Sea. This means that the differences in species distributions were likely not the result of variability in salinity, but rather depth, substrate, and temperature.

5. Unregistered Species

Species such as: *Squalus acanthias*, *Squalus megalops*, *Carcharhinus amblyrhynchos*, *Carcharhinus melanopterus* and *Carcharodon carcharias* are yet to be documented and could lack adequate records due to either their rarity, seasonality, offshore or deep-water preferences, available survey effort, or inadequate sampling gear (Ferretti et al., 2008). For example, *Carcharodon carcharias* are confirmed to occur in the Mediterranean, but are very rarely recorded (Morey et al., 2003).

Conclusion

This study provided a thorough scientific evaluation of shark species composition and distribution along the eastern Libyan coast through field surveys, literature data, and fisheries data. The following results were generated: A total of 20 shark species were recorded in 5 families, including numerous endangered species (*Squalus acanthias, Carcharhinus plumbeus, Squatina spp., Carcharodon carcharias, etc.)*. The year 2023 had the most records of shark sightings, followed by 2021 and 2020, while the year 2024 had the least number of sightings. The most significant factors in the increase in sightings in 2023 included the following: Climate change and elevated sea temperatures during the summer months. Illegal fishing and increasing human pressure in the area due to irregular migration. Certain species of sharks appearing to congregate in shallow coastal waters in response to environmental changes. The study was able to record 18 endangered species of sharks along the eastern Libyan coast from a total of 48 species that are known in the Mediterranean Sea, highlighting the ecological role of the Libyan coast as a natural refuge for rare and threatened species.

Recommendations:

Improve monitoring programs for marine environments and biodiversity with a focus on rare and endangered species of sharks. Improve fishery regulations and local fishing practices to combat over fishing, as well as enhancing control of illegal fishery practices. Generate marine protected areas from the land to the sea, in order to protect important ecological areas along the eastern Libyan coast.

The Role of Local NGOs in Marine Environmental Protection

ocal non-governmental organizations (NGOs) working in the field of marine environmental conservation, such as the Derna Association for Marine Environment Protection, play a vital role in supporting monitoring and conservation efforts along the eastern Libyan coast. These organizations contribute significantly by:

1. Collecting field data on marine biodiversity, including sharks and other species.
2. Raising environmental awareness among coastal communities about the importance of protecting endangered species and combating overfishing and marine pollution.
3. Participating in environmental education programs, collaborating with schools and universities to foster a culture of marine sustainability.
4. Organizing beach cleanup campaigns and monitoring pollution, especially in the aftermath of environmental disasters such as Storm Daniel in 2023.
5. Collaborating with governmental and international bodies to implement sustainable marine resource management and establish marine protected areas.
6. Specific Recommendation:

It is recommended to support and fund local NGOs like the Derna Association by:

- Providing equipment and technical assistance.
- Officially integrating them into national monitoring programs for endangered species.
- Training their members in scientific research methods and species documentation.

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الملخص العربى

1. اجريت هذه الدراسة لتقييم تركيب الأنواع ونمط التوزيع الجغرافي لأسماك القرش على طول الساحل الشرقي الليبي، وذلك استنادًا إلى المسوحات الميدانية، والبيانات المنشورة، وسجلات المصايد خلال الفترة من 2018 إلى 2024. تم توثيق عشرين نوعًا من القروش تنتمي إلى خمس عائلات، ومن بين الأنواع المسجلة: *Squalus blainville*، *Squalus acanthias*، *Squalus megalops*، *Mustelus mustelus*، *Galeorhinus galeus*، *Mustelus punctulatus*، *Carcharhinus plumbeus*، *Squatina spp.* و *Carcharodon carcharias*.

2. سُجل أعلى عدد من مشاهدات القروش في عام 2023 مقارنةً بجميع السنوات الأخرى، تلاه عام 2021 ثم عام 2020، في حين سُجل العدد الأدنى في عام 2024.
تغير المناخ وارتفاع درجات الحرارة خلال فصل الصيف، إلى جانب :وترجع هذه الزيادة في عام 2023 إلى عدة عوامل، أهمها تزايد عمليات الصيد غير القانوني، وارتفاع معدلات النفوق الناتجة عن الهجرة غير الشرعية، والجهود المحلية المفرطة في أنشطة الصيد.
وقد ساهمت هذه العوامل مجتمعةً في جذب أعداد أكبر من القروش نحو المياه الساحلية الضحلة.
3. نوعًا مهددًا بالانقراض من القروش على طول الساحل الشرقي الليبي، من أصل حوالي 48 18أظهرت النتائج وجود ما يقرب من نوعًا تم تسجيلها في البحر الأبيض المتوسط.
ومن هذا يتضح الأهمية البيئية البالغة للساحل الليبي كمأوى طبيعي لأنواع بحرية مهددة، إذ يُعد موئلًا مهمًا لعدد من الأنواع المُدرجة ضمن قائمة الأنواع المهددة بالانقراض بشدة وفقًا للقائمة الحمراء للاتحاد الدولي لحفظ الطبيعة (IUCN).
4. ومن بين الأنواع المهمة المسجلة في المنطقة: *Squalus acanthias* ،*Carcharhinus plumbeus* ،*Squatina aculeata* ، *Squatina oculata* ،*Squatina squatina* ،*Lamna nasus* ،*Carcharodon carcharias* و ،*Isurus oxyrinchus*.
5. الكلمات المفتاحية:
تنوع الأنواع، القروش، التوزيع الجغرافي، الساحل الشرقي الليبي، البحر الأبيض المتوسط.