How has the community, distribution and diversity of sharks changed since the 1980s in Trinidad?

¿Cómo ha cambiado la comunidad, distribución y diversidad de tiburones desde la década de 1980 en Trinidad?

Comment la communauté, la distribution et la diversité des requins ont-elles changé depuis les années 1980 à Trinidad ?

KELLY KINGON[1], DAVID PORTNOY[2], CHRISTOPHER RAGOBAR[3], TERRYN CONSTANTINE[1], NAVIN KALPOO[4], MARC BEJAI[5], CHRISTOPHER NAKHID[1], JUSTIN ISAACS[6], CHELSEA MANGAROO[1] AND DANIEL NAITRUM[1]

1 University of Trinidad and Tobago, Chaguaramas Campus, 962-968 Western Main Road, Chaguaramas Carenage 110804, Trinidad and Tobago, TT kelly.seaweed@gmail.com, terryngconstantine@gmail.com, chris24.94@hotmail.com, chelsea.mangaroo806@we.utt.edu.tt, daniel.naitram575@we.utt.edu.tt
2 Texas A&M University - Corpus Christi, 6300 Ocean Drive, Corpus Christi, Texas 78412, USA david.portnoy@tamucc.edu
3 St. Joseph's Convent Secondary School, 57-59 Pembroke Street, Port of Spain, Trinidad and Tobago christopher.ragobar@gmail.com
4 Kalpoo's Bird Sanctuary Ibis Tours, Caroni, Trinidad and Tobago kalpoosltd@hotmail.com
5 Fisheries Division, Ministry of Agriculture, Land and Fisheries, #35 Cipriani Boulevard, Newtown, Port of Spain, Trinidad and Tobago mbejai@hotmail.com
6 Trinidad and Tobago Fire Service, Ministry of National Security, Wrightson Road, Port of Spain, Trinidad and Tobago

EXTENDED ABSTRACT

Many shark populations are threatened with extinction, mostly due to targeted fisheries and incidental catches. The extraction rate often exceeds their ability to repopulate because of long gestation periods, few offspring and late maturity. Sharks are diverse and abundant in the waters around Trinidad due to the highly productive, tropical marine ecosystems fuelled by large, rivers such as the Orinoco and Amazon, which provide nutrients that support diverse and abundant assemblage of prey species. However, fishing regulations in Trinidad are outdated (implemented in 1916 with very few amendments since) and as a result, sharks are not as prolific as they once were because of the open access fishery, no quotas or size limits, and minimal enforcement of the few pertinent gear regulations that do exist. Large numbers of juveniles and small species of shark are caught in gillnets, while larger sharks are targeted with longlines. The meat from these sharks is consumed locally, typically in the dish “bake and shark”, while the fins are exported or used by residents in shark fin soup. Data are also limited because the Fisheries Division only collects catch data at broad taxonomic levels, e.g., “sharks” or “hammerheads”. Only one historical, directed shark survey was done in the mid-1980s (Castro 1987), which is what we will compare with our recent surveys.

We performed monthly visits to approximately 16 landing sites and fish markets around Trinidad to document the elasmobranchs landed. We also caught sharks and rays monthly using mostly longline gear, but also using hook and line and gillnets, to identify nursery areas for elasmobranchs around the island. Our preliminary results from fishing surveys completed between August 2021-August 2022, and our landing site surveys from April 2021-September 2022 are discussed here and compared to Castro (1987). At the landing sites, sharks were identified and counted; each animal was measured (pre-caudal length, fork length, total length and head width), weighed, and sexed as well. Data on where and how they were caught were recorded, and tissue samples were taken for genomic analysis. Each shark was assessed for relative age since birth using umbilical scar wounds (Duncan & Holland 2006) and maturity for males by measuring their claspers (Musick & Bonfil 2005) and checking them for calcification. Nearly 2,000 sharks were encountered at the landing sites and fish markets.

For the fishing surveys, we went out with local fishers monthly along each coastline and caught sharks using a short-soak, 100 hook longline, approximately 1 km long, with 2 hooks sizes: 10/0 and 13/0. Hooks were spaced 10m apart and were attached to 3m clipped gangions made of 500lb test monofilament. Data from 53 longline sets were included below. The same data as at the landing sites were recorded for each shark caught and we also implanted pit and dart tags into some of the sharks before their release to track them. One fisher pulled in his gill net while we were out with him a couple times so we have included those data and data from hook and line sampling at six sites as well. Our fishing surveys were done at depths ranging from 6-82m with an average of 28m.

Castro (1987) performed gillnet surveys along each coast of Trinidad between 9m and 37m deep with less sampling

along the north coast, similar to our sampling. He visited fish markets, identified sharks caught and encountered to species, measured, weighed and sexed them, and analysed their stomach contents (Castro 1987). He also took blood for future genetic work and vertebrae for aging (Castro 1987). Unfortunately, most of the data and all the samples are missing. Comparisons were made using the information in the summary report available to us (Castro 1987).

We do not know the amount of effort for the Castro (1987) study, but 19 species of sharks were included in the report for Trinidad. Of these species, most were the same species that we encountered across the 2000+ sharks we observed at landing sites and 160 sharks we caught while fishing. There were a few exceptions as we have yet to see any daggernose, *Isogomphodon oxyrhynchus*, spinner, *Carcharhinus brevipinna,* finetooth, *C. isodon,* or scoophead, *Sphyrna media* sharks in our surveys. Instead, we now have dusky smoothhounds, *Mustelus canis* and potentially Atlantic sharpnose sharks, *Rhizoprionodon terranovae*. The number of species decreased from 19 to 17 and the overall species composition has changed slightly since the 1980s. There were also differences in the regional composition of sharks across decades. Figure 1 shows a map with species breaks (red lines) assigned by Castro (1987) where he noticed different groups of sharks and changes in dominant species. We assigned our catches to these same regions and only included the data from our fishing surveys for the comparisons, because these were the only data with accurate catch locations. Only 13 species of sharks were caught on our longline. The dominant species shifted in most of the regions and the species compositions and richness changed (Table 1). The northeast region was found to be the most productive area for sharks for both time periods. Across regions the dominant species now are mostly *M. higmani* and *R. lalandii*, the two smallest species of coastal shark found in the waters of Trinidad. Castro (1987) reported these two species being dominant bycatch in shrimp trawls in the Gulf of Paria. However, today sharks are very rarely caught in shrimp trawls in the Gulf (MB personal observation).

When comparing the most abundant species caught around all of Trinidad through time, we found a temporal shift in which species were dominant (Table 2). Currently, only one of the top species from the 1980s *C. limbatus*, blacktip is not listed as globally threatened by the IUCN

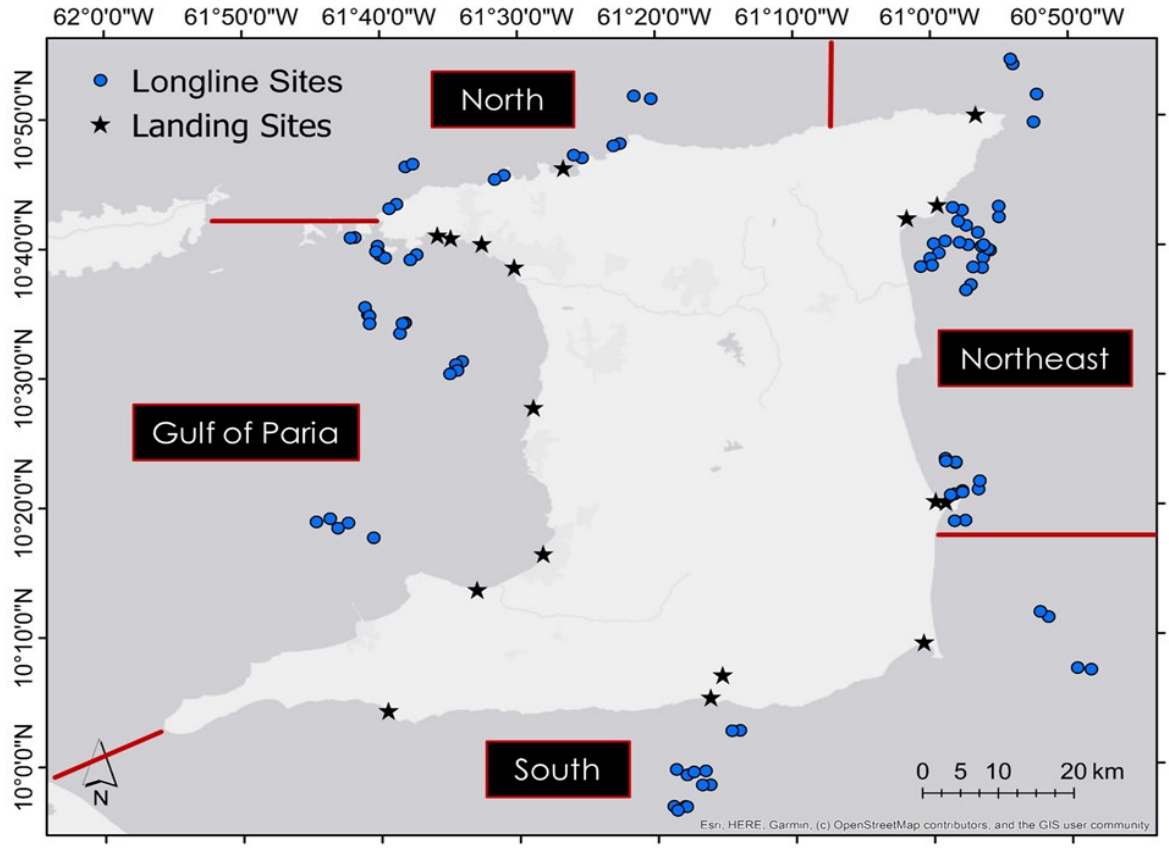

Figure 1. A map of Trinidad showing the regions assigned by Castro (1987) based on different shark species compositions he encountered in each region. The regions are delineated by the red lines and labelled in the black boxes. Our results were assigned to these same regions .

Red List (Table 2, IUCN 2023). Eighty percent of the elasmobranchs caught in our surveys and 90% of the sharks encountered at the landing sites are globally threatened (IUCN 2023). Without the prior effort data for Castro (1987), it is hard to say how drastic the decline in shark catch per unit effort is, but the vast majority of fishers reported decreases in numbers and sizes of sharks that they catch (Kingon et al. *In prep*.).

In conclusion, most of the current shark catch is composed of species threatened with extinction. Some species may already be locally extinct including *S. media, I. oxyrhynchus, C. brevipinna* and *C. isodon* as we haven't seen individuals of any of these species in the last eight years. Over that same time period, *Negaprion brevirostris*, lemon sharks, have also become very rare with only one encountered. The dominant shark species in each region have changed but the overall top five species are close to the same, just in a different order and smaller species (e.g., *R. lalandii*, Brazillian sharpnose and *M. higmani*, smalleye smoothhound) with less susceptible life history strategies are now the more common species. *R. lalandii* reaches maturity at sizes just over 50cm at about two years of age and *M. higmani* matures around 45cm in total length (IUCN 2023). Quick maturation at a smaller size helps to keep these species from being caught in gill nets before they produce offspring, but their low reproductive output of seven pups or fewer per litter (IUCN 2023) still leaves them quite vulnerable to being overfished.

The northeast region of Trinidad still has the largest abundance and species richness of sharks. This is also an

Table 1. The table below depicts the changes in dominant species, species composition and species diversity of sharks by region between the 1980s and early 2020s

Region	Castro (1987)		Our Study (2022)	
	Dominant Species	Other Species Present	Dominant Species	Other Species Present
Northeast	*Sphyrna tudes, Carcharhinus porosus*	*C. limbatus, S. tiburo, Rhizoprionodon porosus, S. mokarran, S. media, Ginglymostoma cirratum, Galeocerdo cuvier*	*S. tudes, R. lalandii, Mustelus higmani, R. porosus*	*G. cirratum, C. porosus, C. limbatus, C. acronotus, M. canis, R. terranovae, S. lewini, S, mokarran*
North	*No dominant species listed*	*R. lalandii, M. higmani, S. lewini, C. porosus*	*M. higmani*	*R. lalandii, R. porosus*
South	*S. tiburo, C. limbatus, S. lewini*	*C. acronotus, C. leucas, I. oxyrhynchus, C. isodon, S. mokarran, G. cirratum, G. cuvier*	*R. lalandii, M. higmani, R. porosus*	*S. lewini*
Gulf of Paria	*R. lalandii, M. higmani*		*No dominant species, too few sharks caught*	*R. lalandii, M. higmani, C. leucas*

Table 2. This table shows the five most abundant species caught in the 1980s compared to our two survey methods. Beside each species name is its current global population status assigned by the IUCN Red List, CR – critically endangered, EN – endangered, VU – vulnerable, NT – near threatened.

Castro (1987)	Our Study (2022)	
	Longline Surveys	**Landing Sites**
1. Smalltail *Carcharhinus porosus* CR	Brazillian sharpnose *R. lalandii* VU	Scalloped hammerhead *S. lewini* CR
2. Golden hammerhead *Sphyrna tudes* CR	Smalleye smoothhound *M. higmani* EN	Brazillian sharpnose *R. lalandii* VU
3. Blacktip *C. limabatus* NT	Golden hammerhead *S. tudes* CR	Smalleye smoothhound *M. higmani* EN
4. Scalloped hammerhead *S. lewini* CR	Caribbean sharpnose *R. porosus* VU	Blacktip *C. limabatus* NT
5. Brazilian sharpnose *Rhizoprionodon lalandii* VU	Scalloped hammerhead *S. lewini* CR	Smalltail *C. porosus* CR

extremely important area for threatened leatherback sea turtles and highlights the need for management measures particularly in this area to protect these species before more disappear locally. Trinidad and Tobago are signatories of several international treaties including CITES, CMS and ICCAT that are supposed to include protections for some species of sharks, yet nothing has been implemented in Trinidad to uphold these obligations. Conserving Trinidad's marine resources requires more attention and funding from the government to develop, implement and enforce management, but also more support for local fishers and a push for community-based management to empower those fishers is needed.

KEYWORDS: elasmobranchs, threatened species, fisheries, Caribbean Sea, community shifts

ACKNOWLEDGEMENTS

Special thanks go to the following people who have helped with data collection or other aspects of the study: Sinead Briggs, Adrian Wilson, Tiffany Ramdoo, Aaron Clarke, Derrelle DuBois, Anna-Marie Steele, Lou Dillon Green, Thea Fermin, Dean Grubbs, Amanda Barker, Karishma Rampersad, Zaheer Mohammed, KenRick James, Daniella Salandy, Brandon Moonsammy, Jennifer Phillips, Wayne Dass, Kelly Moore, Jairam Sinanan, Kempes Miller, Imran Khan and more! Funding for the recent surveys was provided by the Save Our Seas Foundation - SOSF513.

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