



NOTE

New inland records of the bull shark *Carcharhinus leucas* from Sumatra, Indonesia

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ABSTRACT. Six new records of the bull shark *Carcharhinus leucas* from five different river basins of Sumatra, Indonesia, were reported as a result of captures by artisanal and recreational fishers, including records from rivers of northern and western Sumatra for the first time. These findings may highlight the importance of Sumatran river basins for the reproduction of this threatened species in Indonesian waters. Inland records of *C. leucas* in Southeast Asia and in particular Indonesia are scarce but important for nature conservation purposes and sustainable future fishery management.

Key words: Biogeography, Carcharhinidae, elasmobranchs, freshwaters, conservation, data-poor area.

Nuevos registros continentales del tiburón toro *Carcharhinus leucas* de Sumatra, Indonesia

RESUMEN. Se reportaron por primera vez seis nuevos registros del tiburón toro *Carcharhinus leucas* en cinco cuencas fluviales diferentes de Sumatra, Indonesia, como resultado de las capturas de pescadores artesanales y deportivos, incluidos registros de ríos del norte y oeste de Sumatra. Estos hallazgos resaltan la importancia de las cuencas de los ríos de Sumatra para la reproducción de esta especie amenazada en aguas de Indonesia. Los registros continentales de *C. leucas* en el Sudeste Asiático y, en particular, en Indonesia, son escasos pero importantes para la conservación de la naturaleza y la gestión pesquera sostenible en el futuro.



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Palabras clave: Biogeografía, Carcharhinidae, elasmobranchios, agua dulce, conservación, área con datos escasos.

The Indonesian Archipelago can be considered as a data-poor area, as there is currently no systematic study on the status of its shark populations (Jaiteh et al. 2017). Although the Malay Archipelago has been identified as a hotspot of elasmobranch biodiversity, containing about 30% of the more than one thousand shark and ray species in the world (Last and Stevens 2009), this region remains poorly investigated and a major blind spot for conservation. This lack of knowledge can be understood as a lack of concerted research effort on both marine and non-marine elasmobranchs in Indonesia, due to financial limited research support and logistical difficulties in conducting research in remote, hard-to-access, and politically unstable areas rather than a lack of interest on this topic.

Several shark species utilize specific inshore locations (coastal embayments, estuaries, river mouths) as nursery areas, but only a few elasmobranchs are euryhaline, able to transition between marine and freshwater environments for prolonged periods (Thorson 1972; Pillans et al. 2009). *Carcharhinus leucas* (Valenciennes, 1839), the bull shark, is a circumglobal, euryhaline apex predator widespread in the coastal areas of the tropical, subtropical, and warm-temperate regions of all ocean basins (Compagno 1984; Last and Stevens 2009; Ebert et al. 2021; Gausmann 2021). This species relies on low salinity habitats for reproduction and in the early stages of its life cycle (Thorson 1976). Rivers and river mouths can be considered as important nursery grounds for neonate, young-of-the-year, and juvenile bull sharks, as they provide low-mortality habitats and large amounts of suitable food items (Heupel and Simpfendorfer 2011; Matich and Heithaus 2015; Pillans et al. 2020). *Carcharhinus leucas* has been reported historically from major streams of the world thousands of kilometers inland (Gausmann 2021). Thus, the bull shark is currently known as one of the few shark species that penetrates freshwater for extended periods due to its osmoregulatory competencies (Pillans et al. 2005). Grant et al. (2019) reviewed the use of non-marine habitats by elasmobranchs and produced a classification of elasmobranchs using freshwater based on the importance of freshwater habitats on the life history of each species. According to these authors, only 4 shark species, 3 *Glyphis* spp. and *C. leucas*, can be considered truly euryhaline. In the Indo-Pacific region, bull sharks are born at 60 to 75 cm total length (TL), both males and females reaching maturity at ~ 10-20 years and 180 to 230 cm TL and reaching a maximum recorded size of 400 cm TL (Wintner et al. 2002; Last and Stevens 2009; McCord and Lamberth 2009). *Carcharhinus leucas* is assessed as Vulnerable (VU) on a global scale in the IUCN Red List (Rigby et al. 2021).

Carcharhinus leucas is currently recognized from Sumatra in available distribution maps (Ebert et al. 2021; Gausmann 2021; Rigby et al. 2021). Only few verified inland records of juveniles and subadults from Sumatran freshwater environments had been previously reported (Batang Hari River Basin: Tan and Lim 1998; Musi River: Iqbal et al. 2019). *Carcharhinus leucas* is known from both marine and freshwater Indonesian habitats (Gausmann 2021), but there are gaps in the distribution due to a lack of verified records for many parts of Indonesia. Some of the freshwater records of *C. leucas* from Indonesia are quite old (Boeseman 1964) and require verification. In summary, distributional information on *C. leucas* in Indonesia and Southeast Asia is scarce (Kottelat 2013; Hasan et al. 2021), and better information is needed on specific localities for better management and conservation planning for this species. The present study aims to report hints on new potential nursery areas of *C. leucas* for conservation purposes, to fill in gaps in the distribution of this species in Indonesia, and to outline the benefits of both artisanal and recreational fisheries data to scientific studies.

Herein, catch data on *C. leucas* from Sumatra Island, Indonesia, a data-poor area of Southeast Asia, are summarized (Table 1). Moreover, distributional data of immature bull sharks from Sumatra are provided from alternative and inexpensive existing sources (Figures 1 and 2). The second author of the present work started a call targeting Sumatran fishermen to report catches of *C. leucas* from riverine habitats for scientific investigation and to gain distributional data for this species from a remote region of Indonesia. A systematic survey of entire towns or regions was not conducted. However, six juvenile to subadult specimens of *C. leucas* were landed and photographed by artisanal and recreational fishers in the period between 2013 and 2019, from five river basins on Sumatra Island. These sites were located between ~ 4 and ~ 195 km inland from the mouths of these rivers. Distances of catch sites to the sea were

Table 1. Inland records of *Carcharhinus leucas* in Sumatran river basins in the period 2013–2019. Numbers refer to locations in Figure 1.

No	Date of catch	River Basin	Water temperature (°C)	Province	Name of village or town	Coordinates	Distance from sea/river mouth (km)	Used fishing gear	Estimated size (cm) –total length)	Life history phase and sex
1	08.03.2013	Buluh	29-32	Sumatera Barat (West Sumatra)	Padang	0° 49' 54.4" S, 100° 18' 52.7" E	~ 4	Small hook (< 7/0)	~ 70	Juvenile female
2	07.05.2016	Asahan	29-31	Sumatera Utara (North Sumatra)	Pulau Raja	2° 42' 20.3" N, 99° 37' 17.6" E	~ 80	Casting net	~ 130	Subadult, female
3	21.06.2017	Babalan	29-30	Sumatera Utara (North Sumatra)	Pangkalanbrandan	4° 01' 47" N, 98° 15' 14.0" E	~ 11	Medium hook (> 7/0)	~ 75	Juvenile
4	29.09.2017	Musi	30-32	Sumatera Selatan (South Sumatra)	Teluk Kijing	2° 58' 58.1" S, 104° 07' 47.1" E	~ 195	Small hook (< 7/0)	~ 70	Juvenile, male
5	26.08.2019	Asahan	28-31	Sumatera Utara (North Sumatra)	Tanjung Balai	2° 58' 14.7" N, 99° 47' 33.9" E	~ 16	Medium hook (> 7/0)	~ 120	Subadult, female
6	08.09.2019	Indragiri	30-32	Riau (East Sumatra)	Tembilahan	0° 18' 11.7" S, 103° 14' 32.2" E	~ 44	Gill net	~ 70	Juvenile

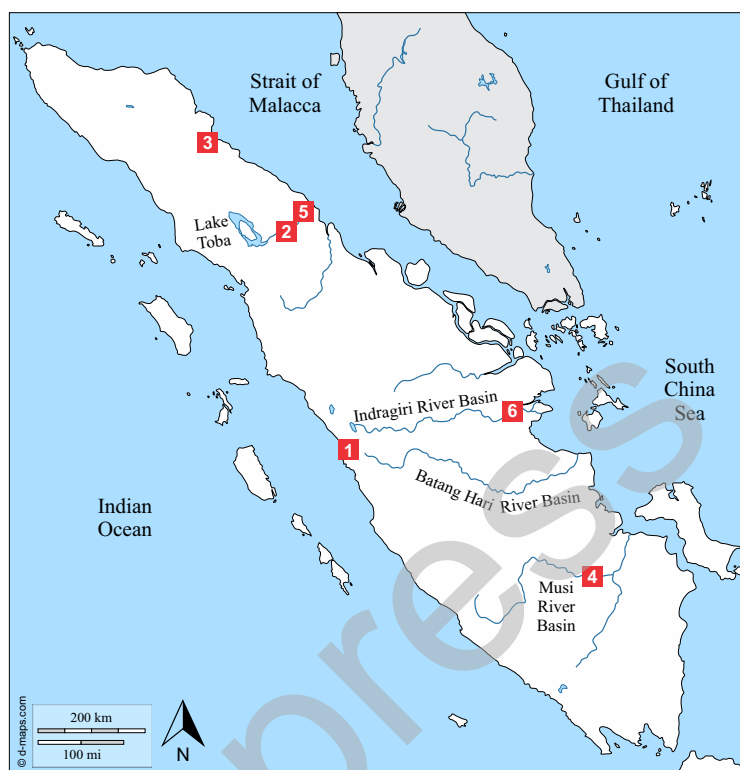


Figure 1. Known records of *Carcharhinus leucas* in river basins of Sumatra from 2013 to 2019. Numbers refer to Table 1.

measured by using a Geographical Information System (GIS), although a small inaccuracy remains. Some of these catches were incidental, as *C. leucas* is not a target species for local small-scale fisheries. Photos of the sharks were voluntarily shared with the authors by the fishers and villagers, who consented to their use in this publication. The sizes of the reported sharks were estimated by the authors from the received photographic material.

While the Asahan, Babalan, Musi, and Indragiri rivers drain into the Strait of Malacca and the South China Sea, the Buluh River drains into the Indian Ocean (Figure 1). Due to the remote location of the catch sites, the only measured water parameter was temperature, which was obtained from nearby measuring stations. The five rivers can be characterized as typical, low- to medium-impacted lowland rivers of the wet tropics, with

peak discharges during the rainy monsoon season (November to March) and a period of low flow when rainfall decreases. Due to larger settlements along the larger Musi and Indragiri rivers, these are more polluted than the more pristine Asahan, Buluh, and Babalan rivers. Catch sites with short distance to the sea (Table 1, records 1, 3, and 5) are presumably tidal-influenced but nevertheless low salinity habitats.

Specimens recovered by fishers were in acceptable condition, allowing for their identification using visible features (blunt snout, small eyes, lack of an interdorsal ridge, and typical first to second dorsal fin ratio) cross-referenced with information in the literature (Garrick 1982; Compagno 1984; Ebert et al. 2013). Similar looking carcharhinids, such as members of the Genus *Glyphis* and *Lamiopsis* were excluded by their relatively large size of the second dorsal fin in



Figure 2. Selection of photographs of bull shark specimens caught by local fishers in Sumatra. A) Subadult female of *Carcharhinus* from the Asahan River, North Sumatra (Table 1: record 2). B) Juvenile of *C. leucas* from the Babalan River, North Sumatra (Table 1: record 3). C) Local fisher holding a subadult female *C. leucas* from the Asahan River, North Sumatra (Table 1: record 5). D) Underside of *C. leucas* specimen in D. E) Juvenile male *C. leucas* from the Musi River, South Sumatra (Table 1: record 4). F) Recreational fisherman holding juvenile *C. leucas* was captured in the Indragiri River, Riau, East Sumatra (Table 1: record 6).

comparison to the first dorsal fin. The similar *C. amboinensis* was also excluded by the ratio of the first to the second dorsal fins that were used to separate *C. leucas* ($< 3.1:1$) from *C. amboinensis* ($> 3.1:1$). Estimated sizes suggest that specimens recorded herein were juveniles (~ 70 - 75 cm TL) and subadults (~ 120 - 130 cm TL). Sex was determined by the presence/absence of claspers. No specimens were preserved. Some of the captured

specimens were later on sold on the local markets and some were directly consumed, with no specimens released again.

Sites recorded herein (Figure 1; Table 1) include the Musi River Basin ($n = 1$), from where *C. leucas* had been previously reported by Iqbal et al. (2019), whereas records from the Asahan ($n = 2$), Buluh ($n = 1$), Babalang ($n = 1$) and Indragiri ($n = 1$) rivers are putative new records.

Moreover, the present records of *C. leucas* from North Sumatra (Asahan River) and West Sumatra (Buluh River) represent first records for these regions. Reported specimens were representative of different life history stages of *C. leucas* from juveniles to subadults, with juveniles dominating (Figure 2). The farthest freshwater penetration was that in the Musi River, the largest of the five rivers (~ 750 km length), at approximately 195 km from the sea (Figure 1; Table 1).

Reports by fishers to scientists can be a valuable toolkit for the identification of crucial habitats for sharks in data-poor regions. The use for scientific purposes of animals caught by artisanal and commercial fishers can be an effective tool for the analysis of fish distributions, including those of elasmobranchs (Giaretta et al. 2021). The confirmed presence of *C. leucas* in the Musi River indicates that juvenile and subadult bull sharks utilize this river as a freshwater habitat, presumably as a nursery area. This was already suggested by previous records of *C. leucas* from the Musi River, therefore fulfilling the repeated use criterion for nursery areas as outlined by Heupel et al. (2007). The present data suggests that numerous river basins on Sumatra may be utilized as nursery areas by immature bull sharks.

Present records from four rivers (Buluh, Asahan, Babalan, Indragiri), in addition to the Musi and Batang Hari rivers, increase the number of known Sumatran river basins with occurrences of *C. leucas* to six. Moreover, our data show that the rivers of Sumatra likely represent an important habitat in the life-history of this species in the area, and that they therefore require management alongside the coastal areas of Indonesia. Catch dates indicate that these Sumatran rivers are utilized by immature *C. leucas* at least between March and September (Table 1). Our results suggest that additional river basins of Sumatra and Indonesia may also function as nursery areas for bull sharks, so future records of *C. leucas* from Indonesian and adjacent river basins in Southeast Asia can be expected.

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