First record of scalloped hammerhead shark *Sphyrna lewini* (Carcharhiniformes: Sphyrnidae) in freshwater habitat

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**Abstract**

A scalloped hammerhead shark *Spyraena lewini* (Griffith & Smith, 1834) with c. 40 cm of total length was stranded and photographed on 6 April 2020 in Mahakam river, East Kalimantan province, Indonesia. This unexpected finding is represent a first ever know inland record of *S. lewini* in freshwater habitat.

**Key words:** *Sphyrna lewini*, record, freshwater, Kalimantan, Indonesia.

**Introduction**

The hammerhead sharks (family Sphyrnidae) unmistakable sharks have unique head shape with the eyes located at the tips of laterally expanded blades which resemble an hammer (Last & Stevens 1994). These function as a submarine-like bow plane to improve manouvrability and increase sensory capacity by enhancing stereoscopic vision and ability to triangulate sources of scent and electromagnetic signals (Compagno *et al.* 2005). The hammerhead sharks feed mainly at night, good reason for having well-developed senses other than vision (Moyle & Cech 2004).

Family Sphyrnidae is a small group of sharks containing two genera, with eight or ten described species (Ebert *et al.* 2013; Nelson *et al.* 2016; Gallagher & Klimley 2018). The scalloped hammerhead shark *Spyraena lewini* is one of species of family Sphyrnidae that cosmopolitan in tropical and warm temperate seas (Last & Stevens 1994). The *S. lewini* is a large shark (370-420 cm of total length) with a maximum age of up to 35 years (Ebert *et al.* 2013). However, this species is recently listed as Critically Endangered by IUCN because global population trend estimated median reductions of 76–97%, with the highest probability of >80% reduction over three generation lengths or about 72 years (Rigby *et al.* 2019). As other species of hammerhead sharks, *S. lewini* inhabit marine, primarily continental shelf and occasionally brackish in Atlantic, India and Pacific (Nelson *et al.* 2016; Marie *et al.* 2017); including in Indonesian waters, from Sumatra in the west to the West Papua in the east (Gloerfelt-Tarp & Kailola 1984, Fahmi 2010, Chodrijah & Setyadj 2015; Sentosa *et al.* 2016).
A recent inland record of *S. lewini* on the basis photographic evidence was reported in Mahakam river, East Kalimantan, Indonesia. This finding presented a first ever known worldwide record of *S. lewini* in freshwater habitat.

**Materials and Methods**

A specimen of *S. lewini* (c. 40 cm of total length) was stranded and photographed on 6 April 2020, at Mahakam river, Muara Baroh village, Muara Pahu subdistrict, Kutai Barat district, East Kalimantan province, Indonesia (00°19'25"S, 116°03'46"E) (Fig. 1). This area is inland freshwater habitat located c. 150 km distance from mouth of river. Photos of this shark were shown to us by local people. There is no specific details on measurements, but this small size suggest this species is very early young male juvenile shark, when small claspers are present (Fig. 2). Specimen is unpreserved for a museum collection. It is reported that this specimen requested by staff of local animal conservation NGO in East Kalimantan, but we are unable to track further for checking specific informations. Identification is therefore based on the features that are visible in the photographs. Proportional morphological characters expressed as percentage of total length based on the photographs shown in Table 1.

![Figure 1](image.png) **Figure 1.** Location of known *S. lewini* in Borneo. Yellow circles are *S. lewini* recorded in Bornean waters after Last et al. (2010), and red circle is recent inland record from Mahakam river, East Kalimantan province.
Figure 2. The *S. lewini* which stranded in Mahakam river at Muara Baroh village, Muara Pahu subdistrict, Kutai Barat district, East Kalimantan province (Photo: Yuni Sri Wahyuni).

Figure 3. Another side of *S. lewini* on 6 April 2020 in Mahakam river at Muara Baroh village, Muara Pahu subdistrict, Kutai Barat district, East Kalimantan province (Photo: Yuni Sri Wahyuni).
Results and Discussions

An individual of stranded shark found in Mahakam river has brownish grey dorsally and pale ventrally, head laterally expanded into prominent keels resembling an hammer with maximum width 24-30% of total length; body fusiform and moderately slender; anterior profile of hammer curved anteriorly with median and lateral indentations; first dorsal fin origin about over or slightly behind pectoral fin insertion, first dorsal fin broad and relatively erect, pelvic fin posterior margin nearly straight, no other fin markings (Figs. 2 and 3). These characters are fitted well to the characters of S. lewini (Compagno & Niem 1998; Compagno et al. 2005; Last et al. 2010; Ebert et al. 2013). The S. lewini is very resemble to smooth hammerhead S. zygaena, its closest relative; but S. lewini is distinguished from S. zygaena by a median indentation (scallop) on anterior margin of head (Figs. 2 and 3) (Gilbert 1967). The Carolina hammerhead Sphyrna gilberti in western Atlantic Ocean is a cryptic species of S. lewini, and morphologically can only separate with S. lewini in the number of precaudal vertebrae (Quattro et al. 2013).

The S. lewini is a large endangered shark with a world wide distribution, observed in the open ocean but linked ontogenetically to coastal embayments for parturition and juvenile development (Daly-Engel et al. 2012). Populations from different locations are generally distinct (Compagno et al. 2005; Duncan et al. 2006; Ebert et al. 2013); and two distinct forms have been identified from molecular analysis of Borneo specimens, but these forms have not yet been clearly distinguished (Last et al. 2010). Some aspects of reproductive biology of the S. lewini have been studied (eg. Hazin et al. 2001; Duncan 2006; Bejarano-Alvarez et al. 2010; Salinas-de-León et al. 2017; Marie et al. 2019), but it is still lacking in Indonesia and Borneo (Last et al. 2010; Wahyudin et al. 2019).

The occurence of up to 150 km inland S. lewini of in Mahakam river is unexpected. This record is a first ever known report for S. lewini in freshwater habitat. Sphyrna lewini and other hammerhead sharks are among the most intriguing yet imperiled groups of large sharks globally that understanding of their ecology, diet, life histories and movements was challenged by a lack of studies (Gallagher & Klimley 2018). Nursery populations of S. lewini linked by continuous coastline have high connectivity, but that oceanic dispersal by females is rare (Duncan et al. 2006). This species is a cosmopolitan and seasonal marine migratory species where they can move up to 600 to 1,700 km away (Diemer et al. 2011; Ketchum et al. 2012; Hoyos-Padilla et al. 2014), but there is no information on movement to freshwater habitat.

Specimen of S. lewini found in Mahakam river is a very young individual based on its small size of c. 40 cm of total length. The present of very young S. lewini in Mahakam river indicate this river possibly a nursery area for this species. No information available if S. lewini occur in freshwater or tolerate low salinities (Compagno & Niem 1998; Compagno 2002; Compagno et al. 2005; Last et al. 2010; Ebert et al. 2013; Gallagher & Klimley 2018). In Indonesia, recent records of young sharks entering freshwater habitat

**Table 1.** Proportional morphological characters of S. lewini expressed as percentage of total length based on the photographs. S1 = specimen from Mahakam river, S2 = other specimens on the basis of Quattro et al. (2013).

| Characters                  | S1  | S2 (range) |
|-----------------------------|-----|------------|
| Head length                 | 24  | 20-24      |
| Pre-first dorsal fin        | 28  | 24-28      |
| Pre-second dorsal fin       | 61  | 57-61      |
| Prepectoral length          | 24  | 19-24      |
| Prepelvic length            | 47  | 43-47      |
| Preanal length              | 59  | 59         |
| Snout-vent length           | 48  | 44-48      |
| Interdorsal space           | 20  | 20-25      |
| Second dorsal-caudal space  | 6   | 5-6        |
| Pectoral-pelvic space       | 20  | 15-20      |
have been significantly increase (Iqbal et al. 2019a, b, c). The invasion to freshwater habitats has been known independently many times in sharks and other elasmobranchs evolution (Lucifora et al. 2015). The reasons why affecting the poor penetration of sharks into freshwater habitat are still unclear, however, an important assumption could be the high urea requirement of many proteins in marine sharks (Ballantine & Robinson 2010). More information and further research are needed to confirm the status of S. lewini in freshwater habitat, particularly in Mahakam river and other parts of Bornean waters. Further study in the future should have address if it is an incidental or a regular movements.

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