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Sawfishes in Papua New Guinea: a preliminary investigation into their status and level of exploitation

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ABSTRACT: The status of sawfishes (family Pristidae), and indeed most sharks and rays, in Papua New Guinea (PNG) is largely unknown due to the paucity of detailed catch and observational records available, both historic and contemporary. This paper provides the first comprehensive review of the published and unpublished literature on sawfish records in PNG. It also collates information for all sawfish specimens in the holdings of museum and fisheries collections, dating back to the late 1800s. Opportunistic sampling during a shark and ray biodiversity project in PNG has resulted in contemporary records for all 4 sawfish species known to occur in the region (i.e. *Anoxypristis cuspidata*, *Pristis clavata*, *P. pristis* and *P. zijsron*) and identification of suitable habitat for the species across PNG. A review of the literature shows that declines in sawfish populations have occurred in a number of locations. Detailed surveys of the key areas highlighted in this study are urgently required to assess the current status of sawfish in PNG. This information is crucial for developing a global strategy for sawfish conservation and fisheries management, given the apparent persistence of all 4 Indo-Pacific species in PNG.

KEY WORDS: Pristidae · Sawfish · Fisheries · Research needs

INTRODUCTION

Papua New Guinea (PNG) lies within the megadiverse region of the Indo-West Pacific known as the Coral Triangle. Elasmobranchs (sharks and rays) are key biota contributing to biodiversity in the Coral Triangle, but our understanding of the fauna of PNG is still in its infancy. Most of our knowledge of sharks and rays in PNG comes from historical records from small-scale biodiversity surveys and expedition reports (e.g. Herre 1936, Roberts 1978, Allen & Coates 1990) and there is no detailed biodiversity information. It is thus difficult to assess the current status of the sharks and rays present in PNG, and how they are impacted by various anthropogenic activities such as mining, pollution and fishing.

An example of the paucity of information available for sharks and rays in PNG was the recent 'rediscovery' of 2 species of river sharks (*Glyphis* spp.) in the Western Province of PNG (White et al. 2015). These species, which are listed as Endangered and Critically Endangered on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2016), had not been recorded from PNG since the 1960s and 1970s. However, during a short field survey to Daru and Katatai in PNG in October 2014, both species were confirmed in the catches of local gillnet fishers, with the fishers report-

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ing that they are regularly caught in low numbers throughout the year at those locations (White et al. 2015). That finding highlighted that the 'rediscovery' reflected a lack of information available for sharks in PNG, rather than the outcome of a directed study to find an elusive and rare species.

During recent surveys of the Western Province in 2014, which aimed to broadly survey sharks and rays, another key finding from the fisheries catches were records of sawfishes. Sawfish are considered the most threatened family of elasmobranchs, with all species listed as Critically Endangered or Endangered on the IUCN Red List (Dulvy et al. 2014, IUCN 2016). It has been suggested by Dulvy et al. (2016) that sawfish are now extinct in at least 20 countries, with the dwarf sawfish *Pristis clavata* considered Possibly Extinct in PNG. The status of sawfish in PNG is largely unknown, both in a historical and contemporary sense, due to the paucity of detailed information on shark and ray catches and observations in PNG. New Guinea has, however, been suggested as possibly being a regionally significant area for sawfishes, and the need to determine local status has been previously highlighted (Kyne & Simpfendorfer 2014).

The area surveyed in Western Province near the mouth of the Fly River is prime sawfish habitat, consisting of mangrove-lined shores with numerous freshwater outflows and high turbidity (Last & Stevens 2009). However, it was surprising to find records of all 4 sawfish species known to occur in this region from the fisheries catches in only a 1 wk survey. The 4 species known to occur in the Australasian region, and more widely the Indo-Pacific, are narrow sawfish *Anoxypristis cuspidata*, dwarf sawfish *Pristis clavata*, largetooth sawfish *P. pristis*, and green sawfish *P. zijsron* (Last & Stevens 2009).

This paper provides a comprehensive review of published and unpublished literature on sawfish records in PNG and holdings in museum and fisheries collections. It also provides data on opportunistic records of sawfish obtained as part of a 4 yr project investigating shark and ray fisheries and biodiversity in PNG.

MATERIALS AND METHODS

Literature records

A comprehensive literature review was undertaken, based on unpublished reports and surveys, to find as many records of sawfish in PNG waters as possible. All literature that included a reference to sawfish in PNG are summarised in Table 1. Note that in most cases, the identity of the species could not be accurately determined based on the information available. Identification of species in particular regions is only as accurate as the literature available to researchers.

In PNG, the main faunal guide available to researchers in the 1960s through the 1980s was Munro's (1967) 'Fishes of New Guinea'. In this book, 2 species of sawfish are listed: *Pristiopsis microdon* and *P. leichhardti*, both of which are synonyms of *Pristis pristis*. Thus, the 3 other sawfish species were not represented in this guide. As a result, subsequent literature typically only makes reference to these 2 species, with most literature sources (that provide a species name) only listing *P. microdon*. A number of literature sources simply list the common name of 'sawfish' or 'sawshark', which are all considered to refer to pristids since no species of sawsharks (family Pristiophoridae) occur in PNG waters. As a result, it is not possible to accurately determine which sawfish species were represented in most of the literature sources. Filewood (1973) provided the first comprehensive key to the sharks and rays occurring in PNG, but this was never published. This key included 3 sawfish species, *Platypristis cuspidatus* (= *Anoxypristis cuspidata*), *Pristis zijaron* (= *Pristis zijsron*) and *P. microdon* (= *P. pristis*).

In addition to literature records, attempts were made to contact authors of publications with brief mention of sawfish records, along with those who visit areas of likely sawfish occurrence, e.g. fishing lodges.

Specimen records

Some literature sources also relate to specimens collected and deposited in museum collections, e.g. Herre (1936), Roberts (1978) and Allen et al. (1992). These records are particularly important in that the species involved can be confirmed. A comprehensive list of all sawfish specimens collected from PNG waters and deposited in the various museum collections around the world was established, and is summarised in Table 2. Where possible, images and measurements were obtained from the specimens (whole or rostrum) to verify their identity. A few records could be accurately linked to a specific literature source. One of the museum collections, the Kanudi Fisheries Research Station (KFRS), deserves a specific mention due to its complicated history. It is estimated that more than 80% of the shark and ray specimens housed in the original collection in Kanudi

Table 1. Literature, electronic resource and personal communication records of sawfish from Papua New Guinea. Arranged in chronological order with personal communication records at bottom. Location contains a map reference number (where possible) which refers to localities in Fig. 1. TL: total length; (–) not measured. When species could not be determined, a question mark is used. USNM: United States National Museum

Source	Location [map reference]	Notes	Size (TL; mm)	Species
Herre (1936)	Korogu, Sepik River [45]	*Pristis perotteti* common in Sepik, very well known, many rostra seen (CAS SU 41013 and 41014)	–	*Pristis pristis*
Munro (1958)	Korogu, Sepik River [45]	*Pristis microdon* based on Herre (1936) records	–	*P. pristis*
Munro (1964)	Northern and southern New Guinea	Only 2 sawfish treated in guide: *Pristiopsis leichhardti* (southern) and *P. microdon* (northern)	–	*P. pristis*
Hinton (1967)	Kapogere, Kemp Welch River [38]	Gillnet catch (8 Sep 1967): 1 *P. microdon* caught in clear water	967	?
Munro (1967)	Laloki River [35] and other southern rivers	*P. leichhardti*	–	*P. pristis*
	Sepik River [44–46]	*P. microdon*	–	*P. pristis*
Glucksman (1969)	Baboa mission, Lake Murray [8 or 9]	Gillnet catch (28 Nov 1969): a *Pristlepis microdon* caught	–	*P. pristis*
Aufenanger (1970)	Sepik River [44–46]	'Occasionally even huge saw fishes and sharks swim up and down this great watercourse'	–	?
Rapson & McIntosh (1971)	Iokea to Orokolo Bay, Gulf of Papua [31]	Sawfish recorded in prawn trawl surveys in Feb 1963	–	?
Dept of Agriculture, Stock and Fisheries (1972)	New Bosnean Camp, Ramu River [43]	Gillnet catch (18 Aug 1972): 1 sawfish	1400	?
	Asau village, Ramu River [42]	Gillnet catch (19 Aug 1972): 1 sawfish	550	?
	Jubin village, Ramu River [42]	Gillnet catch (21–22 Aug 1972): 3 sawfish	550 and 2200	?
	Akurea village, Ramu River [42]	Gillnet catch (23 Aug 1972): 1 sawfish	800	?
	Bangapela village, Ramu River [41]	Gillnet catch (28 Aug 1972): 1 sawfish	1425	?
	Bulna or Borewa village, Ramu River [41]	Gillnet catch (31 Aug 1972): 9 sawfish	1200–1400	?
Anonymous (1973)	Mouth of Morehead River [20]	Gillnet catches (12–14 Mar 1973): 1 *P. microdon* and many *P. clavata*	–	*P. pristis*, *P. clavata*
	Mouth of Bensbach River [18]	Gillnet catches (12–14 Mar 1973): 11 *Pristis clavata* caught	–	*P. clavata*
Filewood (1973)	Papua New Guinea	*Platypristis cuspidatus* common		*Anoxypristis cuspidata*
		Pristis zijaron rare		*Pristis zijsron*
		Pristis microdon present		*P. pristis*
Berra et al. (1975)	Laloki River [35]	Gillnet catches (29 May to 11 Jun 1970): 5 *P. microdon* caught	830–1635	*P. pristis*
Haines (1977)	Purari River and delta [25–28]	*P. microdon* present	–	?
Roberts (1978)	Middle Fly River [2, 4–5, 8, 11–12]	*P. microdon* common in Middle Fly (USNM 217001 and 217002); likely reproduces in Middle Fly due to presence of neonate	809 and 916	?
Haines (1978/1979)	Purari delta [25–28]	See Haines & Stevens (1983)	–	?
Haines (1979)	Purari River and delta [25–28]	*P. microdon* common (5–10 catch^{-1}) in coastal areas [28], rarer in upstream waters [25, 26]	500–3540 (n = 50)	?
	Kikori River [23, 24]	*P. microdon* common (1–4 catch^{-1}) in coastal areas and side branches of river		?
Haines & Stevens (1983)	Purari–Kikori delta area [24, 27–30]	Survey of fishing villages Feb 1976: grouped category with sharks	–	?
Chapau & Opnai (1983)	Western Gulf of Papua [22]	Taiwanese drift gillnet surveys (Oct, Dec 1976 and Jan 1977): *Pristiopsis microdon* 2.8% of catch by number, 30% by weight; 57 ind. in Dec and 189 in Jan	–	?
		Commercial data in 1981 and 1982: *P. microdon* 5% of catch by weight	–	?
Coates (1983a)	Sepik River upstream to at least Ambunti [44]	Not caught but no doubt occurs in river channels with rostra seen in many villages		*P. pristis*
Coates (1983b)	Magendo and Imbuando, Sepik River [46]	Villagers sometimes catch in bottom gillnets in shallow waters	–	?
Frielink (1983)	Delta of the Gulf Province [23–30]	One of top 11 species groups in fisheries catches	–	?

(Continued on next page)

Table 1 (continued)

Source	Location [map reference]	Notes	Size (TL; mm)	Species
Coates (1987)	Sepik River [44–46]	*P. microdon* is rare and likely breeds in the upper river	–	*P. pristis*
Osborne (1987)	Papua New Guinea	*P. microdon* widespread in all rivers	–	*P. pristis*
Allen & Coates (1990)	Sepik River [44–46]	Not caught but local fishers possessed dried rostra	–	*P. pristis*
Smith & Hortle (1991)	Fly River	*P. microdon* recorded in Fly	–	*P. pristis*
Taniuchi et al. (1991), Taniuchi & Shimizu (1991), Mizue & Hara (1991), Ishihara et al. (1991), Watabe (1991), Tanaka (1991)	Magendo 1–3 and Angoram, Sepik River [46]	Gillnet catches (3–8 Sep 1989) *P. microdon:* 8 males and 4 females caught (salinity 0–2)	778–870 (M) 794–869 (F)	*P. pristis*
	Jagita, Bobowa and Miwa in Lake Murray [8–9]	Gillnet catches (17–23 Sept 1989) *P. microdon:* 12 males and 11 females caught (salinity 0–1)	925–2473 (M) 970–1279 (F)	*P. pristis*
	Oriomo River Estuary [21]	Gillnet catches (24–25 Sep 1989): 1 male *P. microdon* and 1 male *A. cuspidata* caught (salinity 20–25)	3611 (*P. microdon*) 1182 (*A. cuspidata*)	*P. pristis, A. cuspidata*
Allen et al. (1992)	Bunapas, Ramu River [43]	Not caught but rostra recorded (e.g. CAS 63666)	–	*P. pristis*
Coates (1993)	Sepik and Ramu Rivers [40–46]	*P. microdon* present in both rivers	–	*P. pristis*
Smith & Bakowa (1994)	Floodplains of Upper and Middle Fly River [1–7]	*P. microdon* caught	–	*P. pristis*
Burton (1995)	Mipan village, Middle Fly [3]	*P. microdon* previously caught but listed by villagers as absent from area due to overfishing	–	*P. pristis*
	Wanga–Wanga, Middle Fly [7]	One sawfish caught at Obo in 1994, none seen recently	–	?
Hyslop (1996)	Lower Angabanga River [32–33]	*P. microdon* recorded from seine net catches in lower, non-tidal reaches	–	?
Powell & Powell (1999)	Mariropa River, Bougainville [58]	*P. microdon* recorded at 2 lower reach locations between 1975 and 1988	1000–1200	*P. pristis*
Swales et al. (1999)	Fly and Strickland River [5–7, 10]	*P. microdon* recorded in gillnet catches and in one rotenone site	–	*P. pristis*
Jenkins (2000)	Lake Lalili, West New Britain [50]	Potentially unharvested populations of *P. microdon* found	–	*P. pristis*
Swales et al. (2000)	Fly River [1, 5, 7, 14–16]	*P. microdon* caught in gillnets	–	*P. pristis*
Hitchcock (2002)	Middle Bensbach River [19]	One *P. microdon* caught in gillnet	–	*P. pristis*
Swales (2002)	Upper and Middle Fly River	*P. microdon* becoming less frequent in catches in main channel sites	–	*P. pristis*
Hitchcock (2004)	Middle Bensbach River [19]	*P. microdon* caught by local fishers (see Hitchcock 2002) and fins traded with Indonesian merchants at Sota	–	*P. pristis*
Storey et al. (2009)	Middle Fly River	Once common in Middle Fly but not seen upstream of Everill Junction [7] for past 15 yr; still common downstream and in Strickland River	–	*P. pristis*
Loop (2015)	Wakunai, Bougainville [56]	A large sawfish caught in net by fishers in a canoe in June 2015	>4000	*P. pristis*
Personal communications				
Garrick Hitchcock, Arafura Consulting, Aug 2016	Balamuk village, Bensbach River [19]	Two sawfish caught in gillnet (16 Oct 1997)	–	*P. pristis*
	Wando village, Bensbach River [19]	Sawfish rostra kept as decorative items in many houses in area	–	*P. pristis*
Garry Barmby, Angling Adventures, Aug 2016	Lake Murray [8–9], Bensbach [20] Rivers	No sawfish observed in at least the last 4 yr [18–19] and Morehead	–	–
Kevin Atana, NFA provincial officer, Buka, Oct 2016	Nissan Atoll [55]	Large sawfish observed on atoll whilst free diving (~10 yr prior)	–	?
Riccard Reimann, Baia Sportfishing, Jul 2016	Mouths of Via, Pandi and Toriu Rivers, West New Britain [51–52]	Observed near mouths of rivers between May and Nov leading up to New Moon and just before whitebait enter rivers	~3000–3658 (10–12 ft)	?
Ray Moore (retired), Jul 2016	Daru region [21] and surrounds Lake Murray [8–9]	In 1970–1980: *P. microdon* most common, One *P. microdon* caught in 1972 Bensbach River to Gulf; *P. zijsron* rare, only in coastal waters; *Anoxypristis cuspidata* only in coastal waters	– ~5000 (16 ft 5 in)	*P. pristis*, *P. pristis* *P. zijsron*, *A. cuspidata*

were lost or destroyed between 1998 and 2002. The remains of the collection is now housed at the University of Papua New Guinea in Waigani, Port Moresby. A large number of sawfish specimens were among those lost or destroyed (see footnote in Table 2).

Recent records

Records of sawfish from fisheries catches were collated from data obtained during an intensive project on sharks and rays in PNG which commenced in 2014. The PNG National Fisheries Authority (NFA) deployed observers on 7 separate prawn trawl trips in the Gulf of Papua between June 2014 and September 2015. Observers recorded all sharks and rays caught during trawl activities and obtained basic data such as species, size, sex and, where possible, maturity stage. Additionally, coastal fisheries catches were examined during a series of artisanal fisheries survey trips, with sawfish recorded during surveys of Daru and Katatai (October 2014; map reference 21 in Fig. 1), Bougainville (October 2015) and Milne Bay (March 2016).

Dried fins were examined at the local fish buyers during artisanal surveys (see also White et al. 2015)

Table 2. Sawfish from Papua New Guinea in various museum collections around the world. Museum abbreviations follow the international standard codes (see Fricke & Eschmeyer 2016). Numbers in square brackets are references to locations in Fig. 1. Sizes are given in total length (TL) or standard length (SL); TRL: total rostral length; ?: unknown whether this was a whole specimen or only rostrum; –: no data available

Registration or field no.	n	Part	Date	Locality [map reference]	TRL (mm)	Size (mm)	Sex
Anoxypristis cuspidata							
FUMT–P10855	1	Whole	24 Sep 1989	Oriomo River Estuary [21]	–	TL: 1182	M
KFRS E028[a]	1	?	Oct 1963	Hall Sound [34]	–	–	–
KFRS E142[a]	1	?	Jun 1964	Yule Island [34]	–	–	–
KFRS E166[a]	3	?	Aug 1965	S of Ramu River mouth [43]	–	–	–
KFRS E191[a]	5	?	Dec 1965	Darapap area [47]	–	–	–
KFRS E238[a]	1	?		N of Yule Island [34]	–	–	–
KFRS E375[a]	1	?	29 Mar 1969	Yule Island [34]	–	–	–
KFRS E394[a]	1	?	20 Dec 1969	Panaroa River [28]	–	–	–
KFRS E404[a]	1	?	7 Apr 1970	Bootless Bay [37]	–	–	–
KFRS E427[a]	2	?		Daru [21]	–	–	–
KFRS unreg	1	Whole	–	Nigoherm Islands [48]	–	TL: 570	F
10/2000 (in Faria et al. 2013)	1	Rostrum	Oct 2000 or earlier	Gulf of Papua	–	–	–
Pristis clavata							
KFRS E205[a]	1	?	Feb 1966	Alele River mouth [30]	–	–	F
KFRS E221[a]	1	?	14 Feb 1966	Alele River [30]	–	–	–
KFRS E224[a]	3	?	13 Mar 1966	Port Romilly [27]	–	–	2F, 1M
KFRS E236[a]	1	?	12–13 Mar 1966	Port Romilly [27]	–	–	–
KFRS E237[a]	1	?	22 Mar 1966	N of Yule Island [34]	–	–	–
KFRS E372[a]	1	?	Mar 1966	Alele River [30]	–	–	–
KFRS E428	1	Rostrum	–	Daru [21]	178	TL: ~890	–
Pristis pristis							
AMS I 30207–001[a]	1	?	Aug 1988	Magendo, Sepik River [46]	–	TL: 784	–
AMS IB. 2854	1	Rostrum	6 Aug 1952	Laloki River, near Bomana [35]	–	SL: 735	–
CAS 63666	2	Rostra	18 Oct 1987	Bunapas, Ramu River [43]	–	–	–
CAS SU 41013	1	Rostrum	23 May 1929	Korogu village, Sepik River [45]	–	–	–
CAS SU 41014	1	Rostrum	23 May 1929	Korogu village, Sepik River [45]	–	–	–
FUMT–P10851	1	Whole	3 Sep 1989	Magendo 3, Sepik River [46]	–	TL: 801	M
FUMT–P10854	1	Whole	17 Sep 1989	Miwa, Lake Murray [9]	–	TL: 970	F
KFRS E024	1	Rostrum	Oct 1963	Hall Sound [34]	1270	TL: ~5292	–
KFRS E025[a]	1	?	Oct 1963	Hall Sound [34]	–	–	–
KFRS E026A	1	Rostrum	27 Jun 1964	Vanapa River [35]	194	TL: ~808	–
KFRS E026B	1	Rostrum	27 Jun 1964	Vanapa River [35]	203	TL: ~846	–
KFRS E027A	1	Rostrum	Aug 1964	Laloki River [35]	225	TL: ~938	–
KFRS E027B[a]	1	?	Aug 1964	Laloki River [35]	–	–	–
KFRS E032A	1	Rostrum	Jun 1964	Yule Island [34]	242	TL: ~1008	–

(Continued on next page)

Table 2 (continued)

Registration or field no.	No.	Part	Date	Locality [map reference]	TRL (mm)	Size (mm)	Sex
KFRS E032B	1	Rostrum	Jun 1964	Yule Island [34]	263	TL: ~1096	–
KFRS E092[a]	4	?	Dec 1962	Orangerie Bay [39]	–	–	–
KFRS E256[a]	1	?	–	Warangoi River [54]	–	–	M
KFRS E278	1	Rostrum	–	?	242	TL: ~1008	–
KFRS E380[a]	1	Embryo	Nov 1969	Kairuku [34]	–	–	–
KFRS E418[a]	1	?	19 Dec 1970	Aiome, Ramu River [40]	–	–	–
KFRS E429A	1	Rostrum	–	Oriomo River [21]	292	TL: ~1217	–
KFRS E429B	1	Rostrum	–	Oriomo River [21]	237	TL: ~988	–
KFRS unreg PNG232	1	Whole	21 Oct 2007	Sapuka, Fly River [13]	–	TL: 870	M
QM I 3686	1	Rostrum	–	?	–	–	–
QM I 3687	1	Rostrum	–	?	–	–	–
USNM 217001	1	Whole	27 Nov 1975	Wam River, swampy lagoons of the Middle Fly [6]	–	TL: 809	F
USNM 217002	1	Whole	6 Dec 1975	Side channel of Strickland 4 km downstream from Massy Bakers Junction [11]	–	TL: 916	M
ZMB 14507	1	Rostrum + parts	1896 or 1899	Ramu River [40–43]	225	TL: ~938	–
ZMB 32538	1	Rostrum	Early 1900s	Bismarck Archipelago	1030	TL: ~4292	–
ZMB 33545	1	Whole	Aug 1913	'Tschessbandai', west of Korogu, Middle Sepik [45]	–	TL: ~700	F
ZMB 33553	1	Rostrum	–	New Guinea	273	TL: ~1138	–
3/1998 (in Faria et al. 2013)	1	Rostrum	Mar 1998 or earlier	Gulf of Papua	–	–	–
12/1999 (in Faria et al. 2013)	3	Rostra	Dec 1999 or earlier	Sepik River [44–46]			
Unregistered (in Seeadler Hotel)	1	Rostrum	–	Seeadler Harbour, Manus [49] (genetic sample # 180758)	790	TL: ~3292	–
Unregistered (in Rabaul Hotel)	1	Rostrum	–	Rabaul Hotel, Rabaul [53]	~1200	TL: ~5000	–
Pristis zijsron							
CAS SU 40592	1	Rostrum	May 1929	Sepik River [44–46]	409	TL: ~1515	–
KFRS E049[a]	1	?	May 1965	Yule Island [34]			
KFRS E378	1	Rostrum	May–Jul 1968	Balimo area [17]	285	TL: ~1056	–
KFRS E411[a]	1	?	8 May 1970	Bootless Bay [37]			
KFRS unreg (200781)	1	Rostrum	–	Probably either KFRS E049 or E411 above	880	TL: ~3259	–

[a]Specimens are considered lost

and from the larger fish buyers in Port Moresby. Key standard morphological measurements of first dorsal (length, height, anterior margin) and caudal (dorsal margin) fins were taken. Tissue samples were taken from all dried fins and DNA barcoding was employed to determine the species involved. DNA barcoding using the *COI* gene follows the methodology provided in White et al. (2015). Since sawfish dorsal fins are similar in size and shape, any dorsal fins that were found to be sawfish needed to be matched into pairs and with a caudal fin (if present) to avoid duplication of numbers in the dried fin batches. For sawfish fins, morphometric measurements were used to estimate total length of the individual by using data obtained from museum specimens in the CSIRO Australian National Fish Collection and measurements in Wallace (1967) and Faria et al. (2013). The proportions used to calculate these lengths are provided in Table 3. For dorsal fins, length was considered the most accurate measurement, with dorsal fin height in particular producing much larger estimated sizes, especially for *A. cuspidata*. When only dried sawfish rostra were observed, the total rostral length (TRL) of each rostrum was taken and the total length (TL) estimated using the TRL/TL morphometric data presented in Whitty et al. (2014).

All recent sawfish records are summarised in Table 4.

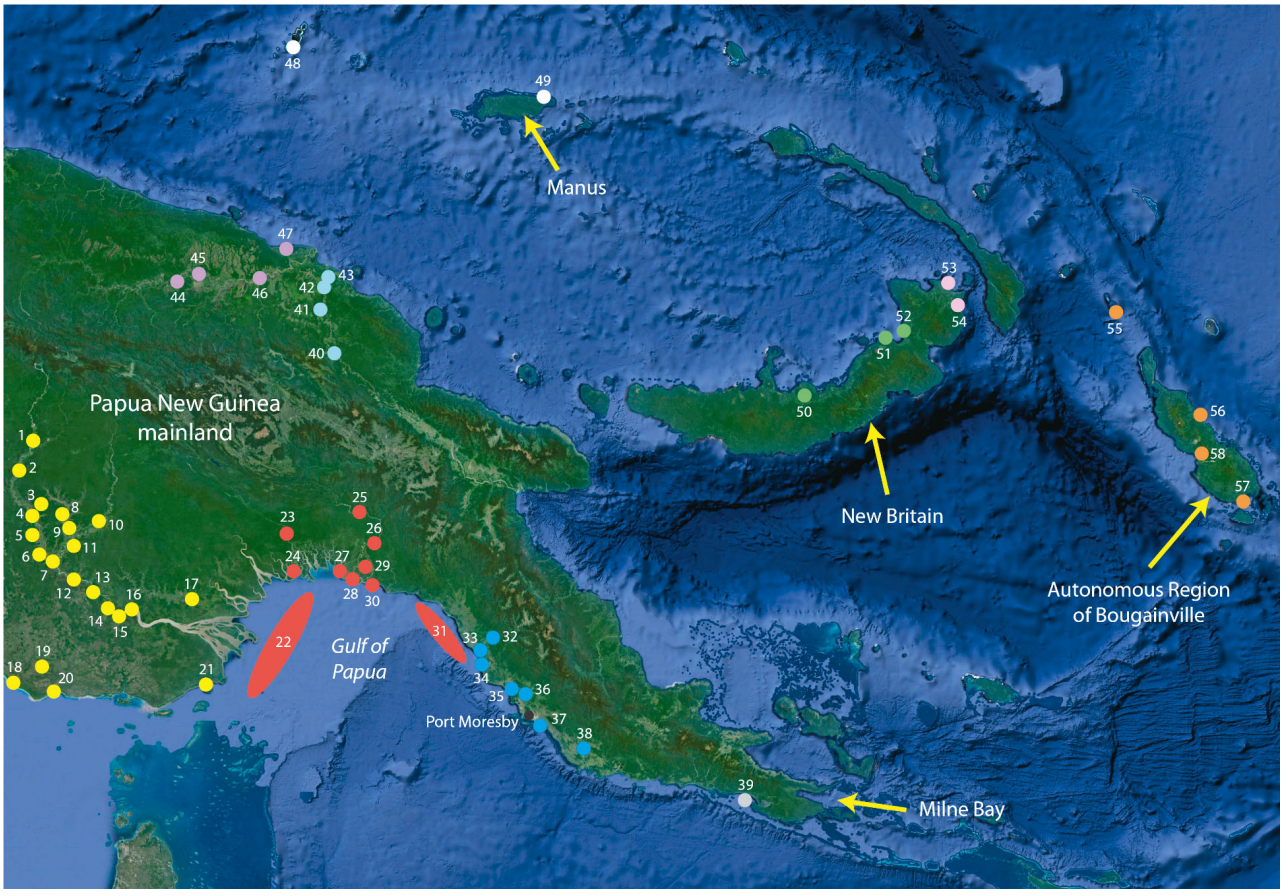

Fig. 1. Locations where sawfish have been recorded in Papua New Guinea. Each numbered reference point corresponds to the map reference in Tables 1, 2 & 4. Provinces (colour of points): Western (yellow; 1–21), Gulf (red; 22–31), Central (blue; 32–38), Milne Bay (grey; 39), Madang (cyan; 40–43), East Sepik (purple; 44–47), Manus (white; 48–49), West New Britain (green; 50–52), East New Britain (pink; 53–54) and the Autonomous Region of Bougainville (orange; 55–58). Base image © NASA, TerraMetrics, Google Earth

RESULTS

Historical records

Table 1 summarises all literature records sourced during this study, including both published and unpublished papers, reports and trip summaries. The first published records of sawfish in PNG were from Herre (1936), who recorded *Pristis perotteti* (= *P. pristis*) from the Sepik River in May 1929 during the Crane Pacific Expedition. Two *P. pristis* and 1 *P. zijsron* rostra were collected by Herre and were deposited in the Californian Academy of Sciences ichthyological collection (see Table 2). Interestingly, only the 2 *P. pristis* jaws were mentioned in Herre (1936) as having been collected from Koragu (= Ko-

Table 3. Number of sawfish specimens used (n) and mean (±SE) proportions of first dorsal fin length (D1L), first dorsal fin height (D1H), first dorsal fin anterior margin (D1A) and dorsal caudal margin (DCM) to total length (TL) for the 4 sawfish species

	D1L/TL		D1H/TL		D1A/TL		DCM/TL	
	n	Mean (±SE)	n	Mean (±SE)	n	Mean (±SE)	n	Mean (±SE)
Anoxypristis cuspidata	1	0.09	1	0.08	1	0.10	1	0.13
Pristis clavata	4	0.10 (±0.000)	5	0.06 (±0.002)	5	0.09 (±0.001)	5	0.14 (±0.001)
Pristis pristis	3	0.10 (±0.002)	13	0.07 (±0.001)	9	0.10 (±0.003)	10	0.16 (±0.003)
Pristis zijsron	1	0.08	–	–	1	0.07	1	0.13

Table 4. Records of sawfish in Papua New Guinea collected as part of an ongoing shark and ray fisheries project. Estimated total length (TL) from caudal and dorsal fins based on proportions in Table 3, where fins were genetically identified. Numbers in square brackets are references to locations in Fig. 1. TRL: total rostral length. GoP: Gulf of Papua

Registration or field no.	Notes	Date	Locality [map reference]	Depth (m)	TRL (mm)	TL (mm)	Sex
Anoxypristis cuspidata							
KFRS unreg. 100616	Whole, prawn trawl	27 Aug 2015	GoP: 8°18′39″S, 146°11′27″E [31]	12–14	–	1330	F
Not retained: 220334	Dried rostrum, gillnet	2014	Katatai village: 9°1′15.1″S, 143°20′30.6″E [21]	<5	780	~3000	–
Not retained: 220344	Dried rostrum, gillnet	Aug 2014	Oriomo River Estuary: 9°2′14.7″S, 143°11′10.6″E [21]	<5	870	~3360	–
Not retained: 100706	Whole, prawn trawl	18 Sep 2015	GoP: 8°8′48″S, 146°1′41″E [31]	11–13	–	1420	F
Not retained: 110053	Whole, prawn trawl	9 Dec 2014	GoP: 8°8′58″S, 144°27′2″E [22]	19–20	–	1020	F
Not retained: 110116	Whole, prawn trawl	14 Dec 2014	GoP: 8°2′8″S, 144°38′33″E [22]	22	–	2150	F
Not retained: 010500	Whole, prawn trawl	27 Aug 2015	GoP: 8°20′14.5″S, 146°12′31.7″E [31]	12–14	–	1280	M
Not retained: 010531	Whole, prawn trawl	29 Aug 2015	GoP: 8°15′19.5″S, 146°7′4.6″E [31]	14–16	–	1880	M
Not retained: 010779	Whole, prawn trawl	4 Sep 2015	GoP: 8°2′36.3″S, 145°43′39.9″E [31]	14–16	–	1280	M
Not retained: 010788	Whole, prawn trawl	7 Sep 2015	GoP: 8°1′12.7″S, 145°43′16″E [31]	12–14	–	1460	M
Not retained: 010843	Whole, prawn trawl	19 Sep 2015	GoP: 8°5′51.2″S, 145°55′11.2″E [31]	9–10	–	1450	F
Not retained: 100029	Whole, prawn trawl	14 Jun 2014	GoP: 8°8′19.2″S, 145°57′4.2″E [31]	14–18	–	–	–
Not retained: 100030	Whole, prawn trawl	14 Jun 2014	GoP: 8°8′19.2″S, 145°57′4.2″E [31]	14–18	–	–	–
Not retained	Dried rostrum, gillnet	2014	Dahuni village, Mullins Harbour [39]	–	730	~2960	–
Not retained: 210324	Dried rostrum, gillnet	2014	Yule Island [34]	–	770	~2810	–
Not retained: 250152, 250153	Dried dorsal fins	Jan to Mar 2016	Milne Bay Province (probably outer islands)	–	–	~3040–3300	–
Not retained (n = 14)	Dried caudal fins	Mid 2015	Unknown, probably GoP	–	–	~820–1120	–
Not retained (n = 5)	Dried caudal fins	Mid 2015	Unknown, probably GoP	–	–	~1200–1420	–
Not retained: 180650	Dried caudal fin	Mid 2015	Unknown, probably GoP	–	–	~1940	–
Not retained: 180603	Dried dorsal fin	Mid 2015	Unknown, probably GoP	–	–	~3050	–
Not retained: 220380, 220402, 220414	Dried caudal and 2 dorsal fins	Sep or Oct 2014	Daru to Katatai area [21]	–	–	~1570	–
Not retained: 220378	Dried caudal fin	Sep or Oct 2014	Daru to Katatai area [21]	–	–	~2090	–
Not retained: 220377, 220363	Dried caudal and 1 dorsal fin	Sep or Oct 2014	Daru to Katatai area [21]	–	–	~2160	–
Not retained: 220419	Dried caudal fin and 2 dorsal fins	Sep or Oct 2014	Daru to Katatai area [21]	–	–	~4100	–
Not retained: 210304	Dried caudal fin	2014	Unknown, probably GoP	–	–	~4480	–
Not retained: 210306	Dried caudal fin	2014	Unknown, probably GoP	–	–	~1040	–
Not retained: 210307	Dried caudal fin	2014	Unknown, probably GoP	–	–	~1340	–
Not retained: 210309	Dried caudal fin	2014	Unknown, probably GoP	–	–	~1630	–
Not retained: 210311	Dried caudal fin	2014	Unknown, probably GoP	–	–	~2090	–
Not retained: 210314, 210308	Dried caudal and 1 dorsal fin	2014	Unknown, probably GoP	–	–	~2390	–
Not retained: 210512	Dried caudal fin	2015	Unknown, probably GoP	–	–	~970	–
Not retained: 210525, 210527	Dried dorsal fins	2015	Unknown, probably GoP	–	–	~1840	–
Not retained: 210520	Dried dorsal fin	2015	Unknown, probably GoP	–	–	~2820–3120	–

(Continued on next page)

Table 4 (continued)

Registration or field no.	Notes	Date	Locality [map reference]	Depth (m)	TRL (mm)	TL (mm)	Sex
Pristis clavata							
Not retained: 210383	Dried caudal fin	Sep or Oct 2014	Daru to Katatai area [21]	–	–	~1730	–
Not retained: 210302	Dried caudal fin	2014	Unknown, probably GoP	–	–	~3030	–
Pristis pristis							
Unreg. 200629	Dried rostrum, gillnet	Caught in 2015	Buin [57]: stored in fisheries office in Buka	–	720	~3000	–
Not retained: 100036	Whole, prawn trawl	15 Jun 2014	GoP: 8°5'9"S, 145°40'22.2"E [31]	16–23	–	3490	M
Not retained: 220343	Dried rostrum, gillnet	Sep or Oct 2014	Oriomo River Estuary: 9°2'14.7"S, 143°11'10.6"E [21]	<5	610	~2640	–
Not retained: 220382	Dried rostrum, gillnet	Sep or Oct 2014	Daru to Katatai area [21]	–	760	~3170	–
Pristis zijsron							
Not retained: 210303	Dried caudal fin	2014	Unknown, probably GoP	–	–	~4730	–
Not retained: 180627	Dried caudal fin	2015	Unknown, probably GoP	–	–	~4850	–
Not retained: 210508	Dried caudal fin	2015	Unknown, probably GoP	–	–	~4930	–
Not retained: 210528	Dried caudal fin	2015	Unknown, probably GoP	–	–	~4930	–
Not retained: 180623	Dried caudal fin	2015	Unknown, probably GoP	–	–	~5240	–
Not retained: 210507	Dried caudal fin	2015	Unknown, probably GoP	–	–	~6420	–
Not retained: 180601, 180631	Dried dorsal fins	2015	Unknown, probably GoP	–	–	~3900	–
Not retained: 220360, 220391	Dried dorsal fins	2014	Daru to Katatai area [21]	–	–	~2270	–

rogu), 346 km from the sea. Given that *P. zijsron* is normally found in coastal waters and not far into rivers (Stevens et al. 2005), the *P. zijsron* rostrum (CAS SU 40592) was possibly collected or acquired near the mouth of the Sepik River. Alternatively, it could have been collected from near Madang and Sek, the only other 2 PNG localities sampled during this expedition; however, Sepik River is hand written on the rostrum itself.

The first detailed list of the fishes of New Guinea (Munro 1958) included *Pristis microdon* based on the Korogu record of Herre (1936). Munro (1964) listed 2 species of sawfish, *Pristiopsis leichhardti* and *Pristiopsis microdon*, which occurred in southern and northern New Guinea, respectively. The comprehensive guide to fishes in Munro (1967) included treatments for these 2 species, both of which are now synonomised with *Pristis pristis*. The treatments for both species refer to the anteriorly placed first dorsal fin (relative to the pelvic fins) which confirms they both refer to *P. pristis*. The separation of the 2 'species' was originally based on the free rear tip of the second dorsal fin reaching the caudal fin in *P. leichhardti* or well separated in *P. microdon* (see Munro 1967). It is possible this observation was an artefact of comparing different size classes (with damaged free rear tips in some specimens) or intraspecific variation.

Many of the literature sources examined include records of *P. microdon* in the catches (e.g. Hinton 1967, Glucksman 1969, Haines 1979, Chapau & Opnai 1983), but the identity of the species cannot be confirmed in most cases. In other sources, the catches included only reference to sawfish without specific species being mentioned (e.g. Rapson & McIntosh 1971, Anonymous 1972, Burton 1995).

Filewood (1973) produced the first detailed key to the elasmobranchs of PNG, but unfortunately this was never published and thus only used by those who had access to the few copies available. The key included the first mention of the species *Platypristis cuspidatus* (= *A. cuspidata*) and *Pristis zijaron* (= *P. zijsron*), as well as *P. microdon* (= *P. pristis*) but did not include *P. clavata*. Confidence can be placed on the identity of *P. zijsron* in Filewood (1973) as the key difference provided is the unequal spacing of the rostral teeth (i.e. wider spacing at the base and closer together at the tip), which is the key character for this species. The records of *P. cuspidatus* and *P. microdon* can also be confirmed from the information provided, i.e. origin of first dorsal opposite or behind pelvic origin versus well before. However, there is an error in one character difference in the key, with the lack of a distinct ventral caudal lobe attributed to *P. cuspidatus*.

Depth of Agriculture, Stock and Fisheries (1973) was the first survey report to record more than one species of sawfish, with both *P. microdon* and *P. clavata* caught during gillnet surveys at the mouth of the Morehead River in Western Province. In this survey report, only a single *P. microdon* was recorded, but *P. clavata* was abundant at this location and at the mouth of the Bensbach River. Although *P. clavata* was reported to be abundant, it is not possible to confirm the identifications of these records. As these records could also refer to *A. cuspidata* or *P. zijsron*, this identification must be treated with caution.

It is important to note that in a number of studies, sawfish were recorded as being abundant in the catches or common according to villagers in the areas visited. For example, Haines (1979) found that sawfish were common in the Purari-Kikori delta region with between 5 and 10 ind. per catch in coastal areas of the Purari and 1 to 4 ind. per catch in coastal areas and side branches of the Kikori. Likewise, Roberts (1978) reported that *P. microdon* (= *P. pristis*) was common in the Middle Fly River.

Fisheries catches

The largest catch records of sawfish in the available literature are from the trial fishery surveys, which used Taiwanese drift gillnets in the Gulf of Papua in October and December 1976 and January 1977 (Chapau & Opnai 1983). During these trial surveys, *Pristiopsis microdon* (= *P. pristis*) accounted for 30.1% by weight and 2.7% by number of the total catch. In December 1976, 57 ind. were recorded with a combined weight of 4500 kg, and in January 1977, 189 ind. were recorded with a combined weight of 12 382 kg. These equate to an average weight per individual of 69 kg. The majority of the sawfish were caught in the shallower sets (7 to 15 m depth) near the mouth of the Fly River. The gillnets used in these surveys were 3440 m long and 14 m deep with 15.2 cm mesh (Chapau & Opnai 1983), thus touching the bottom at these depths. The identity of the species of sawfish involved is not possible to determine and likely consisted of multiple species in the total catch.

Subsequent commercial fishing commenced in mid-1980 with 5 Taiwanese drift gillnet fishing vessels operating through 1981, dropping to 2 vessels in 1982. The nets used by the commercial vessels were 9000 m long, 12 m deep with 17.8 cm mesh and were suspended 5 to 6 m below the surface (Chapau & Opnai 1983). The 1981 and 1982 commercial data showed total catches of 810 and 405 t, respectively, with *Pristiopsis* spp. comprising 5% of the catch by weight. This corresponds to about 60.7 t of sawfish caught during this period, which equates to ~880 ind. based on the average weight of 69 kg from the 1976/1977 survey data. No other data is available after this period, but drift gillnetting came under increasing scrutiny in the South Pacific in 1989 (Stewart 1990) and ceased in 1993 (Anas et al. 2000).

Sawfish are currently recorded in the bycatch of the prawn trawlers operating in the Gulf of Papua (see e.g. Table 4). Surveys to assess the viability of establishing prawn trawling in PNG commenced in the mid-1950s (Rapson 1955) and surveys in the mid-1960s showed there were commercial quantities of prawns in the Gulf of Papua. Rapson & McIntosh (1971) reported sawfish present in prawn trawls between Iokea and Orokolo Bay during surveys conducted in February 1963. The commercial Gulf of Papua fishery commenced in 1969 (Evans et al. 1995), and from 1990 to 2011 the number of vessels operating in this fishery ranged from 1 to 18 (mean: 9.8) (Liviko 2012). No previous detailed surveys have been undertaken on the prawn trawl bycatch, but sawfish are likely to be regularly caught in this fishery. In the current study, observer data was collected from 7 prawn trawl fishing trips in the Gulf of Papua between June 2014 and September 2015, representing 403 trawl shots and 1273 h of trawling. Observers recorded 1 *P. pristis* of 3490 mm TL and 11 *A. cuspidata* ranging from 1020 to 2150 mm TL (Table 4).

Coastal artisanal fisheries also catch sawfish. In the Middle Bensbach River, sawfish are caught by the Wartha people. The flesh is eaten locally and fins are sold to Indonesian merchants at Sota in West Papua (Hitchcock 2002). Customary cross-border trade is allowed under a treaty between PNG and Indonesia as long as traded goods are not prohibited in either country (Hitchcock 2002). However, according to Government Regulation of the Republic of Indonesia (Number 7) 'Concerning the Conservation of Plant and Animal Species' (www.profauna.net/id/regulasi/pp-7-1999-tentang-pengawetan-jenis-tumbuhan-dan-satwa), all species of the genus *Pristis* have been protected in Indonesia since 1999. Sawfish have also been reported to have been caught by villagers in the Sepik River (e.g. Coates 1983b), Ramu River (e.g. Allen & Coates 1990), the Purari-Kikori delta (e.g. Haines & Stevens 1983) and Bougainville (Loop 2015). During surveys of fishing villages in Daru and Katatai (Western Province) conducted in late 2014, all 4 species of sawfish were observed from gillnet catches (see Table 4). Examination of dried fins from

fish buyers in Port Moresby found that sawfish fins were commonly present (see Table 4; based on genetic identifications), but catch details were not available and thus the records could have been from either trawl or coastal artisanal fisheries. Most recently, dorsal fins from a single *A. cuspidata* of ~3 m TL were recorded from a batch of dried fins examined in Alotau, Milne Bay Province (Table 4). These fins come into Alotau from across the Milne Bay Province so no precise location data could be obtained.

In total, 56 *A. cuspidata* were recorded in the current study, ranging in length from ~970 to ~4480 mm TL (Table 4). Two *P. clavata* were recorded with estimated lengths of ~1730 and ~3030 mm TL. Four *P. pristis* were recorded with lengths between ~2640 and 3490 mm TL and 10 *P. zijsron* were recorded with estimated lengths between ~2270 and ~6420 mm TL (Table 4). The largest individuals recorded for *A. cuspidata* and *P. zijsron* were based on dried fins, and the proportions used to estimate their total lengths (Table 3) were based on a single juvenile individual for each species. Thus, ontogenetic differences have not been taken into account and the estimates could be over- or underestimates.

Sawfish in collections

Specimens of sawfish collected from PNG deposited in the various biological collections around the world are compiled in Table 2. The oldest collected sawfish specimen from PNG is ZMB 14507; this record consists of the rostrum and cranium (jaw attached), stomach, and gills and scapulocoracoid of a ~938 mm TL *P. pristis*. The collector was Dr. Carl Adolf Georg Lauterbach, a famous botanist who led several expeditions to German New Guinea (northern PNG). He visited the Ramu River in both 1896 and 1899 (van Steenis Kruseman 1959), which is likely when this specimen was collected.

The majority of the KFRS sawfish specimens (i.e. 35 out of 48 presumed rostra) are no longer present in this collection and must be considered lost. They are still included in Table 2 as they represent important geographical and temporal records. Although the identification of the lost specimens cannot be confirmed, much of the collection was either collected or examined by W. Filewood in the 1960s and 1970s and thus identifications can be considered relatively accurate. Excluding the lost specimens, a total of 3 *A. cuspidata*, 1 *P. clavata*, 32 *P. pristis* and 3 *P. zijsron* were recorded in collections (Table 2). A number of the specimens were collected from locations where sawfish had not been previously recorded, e.g. Nigoherm Islands (Manus Province), Warangoi River (East New Britain), Aiome (Ramu River), Seeadler Harbour (Manus Island) and Balimo (Fly River delta).

DISCUSSION

Cultural significance

Sawfish hold cultural significance in various parts of PNG. Villagers along the Sepik River are said to believe that sawfish spirits 'will punish people who break fishing taboos by unleashing destructive rainstorms' (McDavitt 1996). Some Iatmul clans in the Middle Sepik River use sawfish rostra as a totem and decorated rostra form part of dance costumes. One such example of a decorated rostrum, deposited in Museum Victoria in Australia (Item X 32276), is a painted *Pristis pristis* rostrum collected from the Middle Sepik River in 1920 (Fig. 2). Another example is a

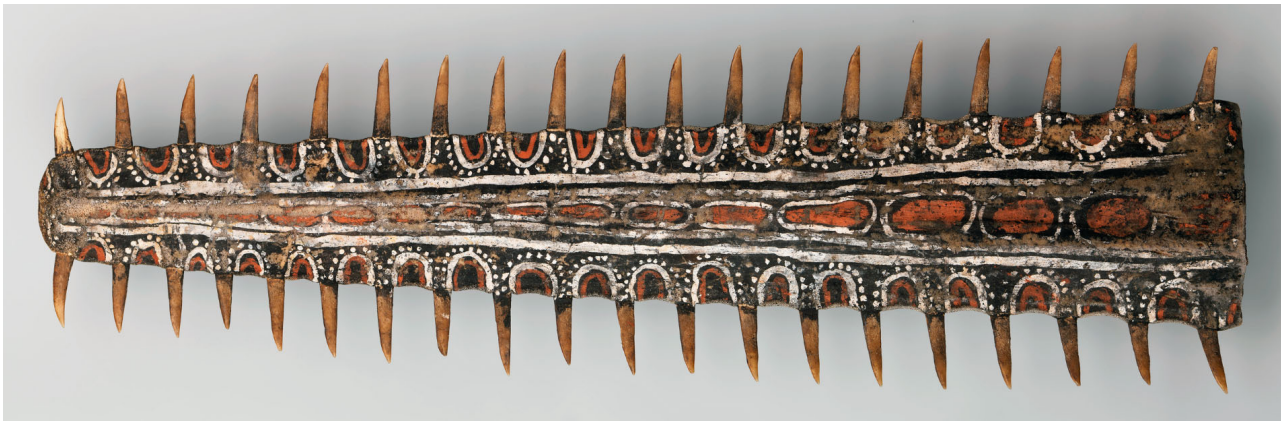

Fig. 2. Painted sawfish rostrum; part of a mask costume. Iatmul, Middle Sepik, Papua New Guinea. Acquired between 1915 and 1920. Australian War Museum Collection, on loan. Source Museum Victoria (X32276). Photograph by Jon Augier

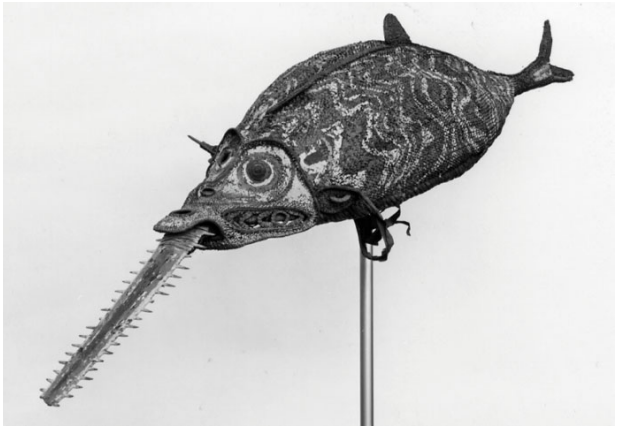

Fig. 3. Decorated rostrum which has been incorporated into a dance mask, deposited in the Ethnologisches Museum der Staatlichen Museen zu Berlin (Tanzmaske - Ident. Nr. VI 48057). Photo: Ethnologisches Museum Staatliche Museen zu Berlin

decorated rostrum which has been incorporated into a dance mask, housed at the Ethnologisches Museum der Staatlichen Museen zu Berlin (Tanzmaske – Ident. Nr. VI 48057) (Fig. 3). Sawfish are depicted on carvings in some locations, particularly in the Sepik River where sawfish heads are sometimes carved on shields (e.g. www.art-pacific.com/artifacts/nuguinea/shields/shieldso.htm) and masks (e.g. www.art-pacific.com/artifacts/nuguinea/sepikriv/sepiklow/sepiklow.htm). Sawfish rostra have also been used as weapons in PNG (McDavitt 1996). There are several records of swords made out of sawfish rostra where the base is cut down to form a handle (see Fig. 162 in Cowper 1906). Two similar such swords are also in the McGregor collection of the University of Aberdeen's Human Culture Collection (registration ABDUA 57939).

Evidence of declines in sawfish populations in PNG

The first indication of declines in sawfish in PNG was documented in Burton (1995), during an interview with the Mipan villagers in the Middle Fly River in March 1994. The interviewees stated that sawfish (local name 'katoga') are now absent from the area, which they attributed to overfishing, possibly from cross-border fishers. Swales (2002) reported that *P. pristis* is less frequently caught in main channel sites of the Upper and Middle Fly River. Storey et al. (2009) reported that although *P. pristis* was once common in the Middle Fly, it has not been seen upstream of Everill Junction for at least 15 yr. In contrast, it was still common downstream of Everill Junction and also in the Strickland River. Everill Junction is a major point of dilution for the mining run-off coming from the Ok Tedi mine site (see below), thus it is possible that sawfish are avoiding the areas upstream in the Middle Fly (Storey et al. 2009). However, increased gillnetting in the Middle Fly by local villagers and possibly Indonesian refugees is likely a major reason for these declines.

The Ok Tedi mine is one of the largest copper mines in the world and commenced operations in 1984. Due to the high rainfall in the area of operation, it is not possible to construct tailings dams; thus tailings and waste rock are discharged into the local waterways which feed into the Fly River system (Swales et al. 2000). This has led to increased riverbed aggradation resulting in the loss of habitat for fish. This, combined with elevated levels of dissolved and particulate copper from mining activities, has possibly affected sawfish in the Upper and Middle Fly River. Increase aggradation of the riverbed of up to 3 m in the Middle Fly River has likely also affected the prey items of *P. pristis*, including freshwater prawns *Macrobrachium* spp. (Storey et al. 2000).

In Lake Murray, Taniuchi et al. (1991) caught 23 *P. pristis* over a week-long period in 1989, but the species has not been seen in that area for at least the last 4 yr (G. Barmby pers. comm.). In the Sepik River, Herre (1936) reported sawfish as being common, but despite rostra seen in many villages, Coates (1983a) did not record sawfish in their survey catches and Coates (1987) considered sawfish rare in the Sepik River. However, it is not possible to determine whether there has been a decline in the Sepik River given the lack of substantiated data. Both of these river systems lack an estuary in contrast to the southern PNG rivers, thus limiting critical habitat for sawfish. One of the authors of this paper (R. R. Mana) observed many rostra, some over 1 m in length, at Marienburg (a Catholic mission close to Imbuando village) in the 1970s, but they have rarely been seen there since the 1980s.

The historical data presented in this study are thus important for highlighting the pre-mining range of sawfish in the Fly and other systems in PNG.

Size information

Last & Stevens (2009) reported that *A. cuspidata* attains lengths of 3500 mm TL, with records of 6000 mm TL doubtful. Two specimens were recorded in this study with estimated lengths exceeding 4000 mm TL (~4100 and ~4480 mm TL). Likewise,

Last & Stevens (2009) stated that *P. zijsron* can attain lengths of at least 5300 mm TL, but was reported to have reached at least 7300 mm TL. Thus, the record of a ~6420 mm TL individual in this study represents one of the largest specimens recorded for this species. *Pristis clavata* was reported to attain lengths of 3100 mm TL (Last & Stevens 2009), close to the ~3030 mm TL individual recorded in this study. Although these estimates must be treated with caution (as they are based on fin measurements), it is interesting to note that for 3 of the 4 species of sawfish, very large individuals close to the maximum known sizes are still present in PNG waters.

Positive news for sawfish in PNG

Although there appear to have been documented declines of sawfish in some parts of PNG, it is not all bad news. The huge delta regions in the Gulf of Papua, e.g. Purari-Kikori and Fly, provide an expansive area of suitable habitat for sawfish in combination with a relatively low human population, and thus low overall fishing pressure. The recording of all 4 species of sawfish in artisanal catches during a week-long survey to Daru and Katatai (Western Province) in October 2014 provides evidence that the species are still common in that area, despite this being more heavily fished than much of the Gulf of Papua inshore region. Recent surveys also highlighted that *P. clavata* is still present, even though it had been considered possibly extinct from PNG (Dulvy et al. 2016). While that species once had a wide range in the Indo-West Pacific (Dulvy et al. 2016), the PNG observations in fact represent the only recent records of the species outside of Australia.

Jenkins (2000) reported possibly unharvested populations of *P. pristis* in Lake Lalili in West New Britain. They could also be distributed widely throughout the rivers of West New Britain. Sport fishers from the Baia Lodge in West New Britain reported seeing sawfish near river mouths leading up to the new moon between May and November, just before baitfish enter the rivers (R. Reimann pers. comm.). The southern coast of New Britain is poorly surveyed and could also represent an important area for sawfish.

Northern Australia is considered to be the last stronghold for the 4 species of sawfish that occur in the Indo-Pacific (Phillips et al. 2011, Dulvy et al. 2016). A detailed investigation into the current status of sawfish in PNG is urgently required to determine whether PNG may also be a stronghold for one or more sawfish species, not only regionally, but globally.

CONCLUSIONS

The information compiled and produced in this study provides a strong baseline from which more detailed studies of the status of sawfish in PNG can be undertaken. This study highlighted a number of critical areas for sawfish in PNG, in particular the Purari-Kikori delta system, Fly and Strickland Rivers (including Lake Murray), Western Province coastal areas (Katatai to mouth of Bensbach), Sepik and Ramu Rivers, Bougainville and West New Britain. These critical areas need to be thoroughly surveyed to determine the abundance and exploitation of sawfish in those areas. Obtaining detailed information on the cultural and socioeconomic value of sawfish to local communities is also paramount. Furthermore, improving the capacity for PNG researchers to develop and maintain a focused research effort on sawfishes will be crucial. Realising these aims will benefit the implementation of a global strategy for sawfish conservation (Harrison & Dulvy 2014).

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