Vol. 50: 133–150, 2023
https://doi.org/10.3354/esr01222

ENDANGERED SPECIES RESEARCH
Endang Species Res

Published March 23

Impacts of trophy collection and commercial fisheries on sawfishes in Queensland, Australia

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ABSTRACT: Globally, populations of sawfishes (Batoidea: Pristidae) have declined due to directed fishing and bycatch. Before international trade protection, sawfish rostra were often collected as trophies, and sawfish fins could fetch some of the highest prices in the shark fin trade. Australia is now considered a global stronghold for 4 out of 5 species. The present study analyses data of 723 sawfish rostra from all 4 Australian species that were caught in Queensland over the last 100 years. The majority of rostra (92.2%) originated from gillnet captures. Morphometric data from rostra were used to calculate sawfish total lengths and ages at mortality using published ratios. Rostra were split into the mass retention subgroup (n = 569), which originated from ≤5 active commercial inshore gillnet fishers with known large geographic origin regions and decades of origin, and the small-scale retention subgroup (n = 154), for which individual years and locations are known. Across all regions of Queensland, species composition changed significantly before and after the year 2000. After 2000, *Anoxypristis cuspidata* became the dominant species on the east coast. Large adult *Pristis zijsron* were present across Queensland before 2000 and numbers declined after this. The commercial gillnet industry likely impacts all life history stages of sawfishes. Since 2002, it has become compulsory for Queensland's commercial fishers to report interactions with sawfishes in SOCI (Species of Conservation Interest) logbooks. Comparison of rostra from gillnet captures with logbook data indicates that underreporting is higher than previously assumed.

KEY WORDS: Sawfish rostra · Endangered species · Fisheries · Net fishing · Trophy collection

1. INTRODUCTION

Globally, populations of sawfish (Batoidea: Pristidae) have declined dramatically in recent decades (Dulvy et al. 2014, Department of the Environment 2015). As a result, all 5 species of sawfish are listed as Endangered or Critically Endangered on the IUCN Red List of Threatened Species (IUCN 2021). Historically, sawfishes occupied tropical and subtropical waters worldwide in at least 92 countries and territories (Harrison & Dulvy 2014). As of 2014, sawfishes remain in only 44 countries and territories, with the southeastern USA and northern Australia considered the last strongholds for 1 and 4 species, respectively (Harrison & Dulvy 2014). In 2007, sawfishes were listed on the Convention on International Trade in Endangered Species (CITES, www.cites.org) Appendices I and II, restricting their international trade, and in 2013, all species were moved to Appendix I. Before trade protection, sawfish rostra were commonly retained as trophies, and their fins could fetch some of the highest prices in the globalized shark fin trade (Dulvy et al. 2014). Sawfishes thus constituted a profitable bycatch of fisheries that target teleost fishes (Stevens et al. 2005).

Sawfishes occupy shallow, coastal waters, including rivers and estuaries (Peverell 2005). The rostrum, or 'saw', is a protrusion of the chondrocranium that

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bears lateral teeth and it is used to detect and hunt small fish and invertebrates (Wueringer et al. 2011a,b, 2012). Similar to other chondrichthyan species, sawfishes mature late in life and have low fecundity. Green sawfish *Pristis zijsron* are estimated to sexually mature at approximately 9 yr old, corresponding to 380 cm total length (TL) in females (Peverell, 2005), while dwarf sawfish *P. clavata* and freshwater sawfish *P. pristis* mature at 8 yr (260 cm TL) and 8–10 yr old (300 cm TL), respectively (Thorburn et al. 2007, Peverell 2008). The narrow sawfish *Anoxypristis cuspidata* matures the fastest at 2–3 yr old, corresponding with 200 cm TL in males and 230 cm in females, respectively (Peverell 2005, Harrison & Dulvy 2014). Narrow sawfish are likely the most abundant species of sawfish due to their higher fecundity (Last et al. 2016). Sawfishes are born at around 56–80 cm TL, depending on species. Their biological characteristics and coastal/inshore habitats make sawfishes highly sensitive to fishing pressures. All species frequently encounter commercial gillnets (Dulvy et al. 2016), which are a key threat to their populations (Simpfendorfer 2000). Sawfishes living in heavily fished areas may not reach sexual maturity (Harrison & Dulvy 2014), limiting the ability of populations to recover once depleted (Thorburn et al. 2007).

Of the 5 species of sawfish, 4 occur in northern Australia (3 species of *Pristis* and *A. cuspidata*). In Australia, sawfishes were protected federally under the Environment and Biodiversity Conservation (EPBC) Act of 1999, with the last species listed in 2009. Since 2008, the Queensland Fisheries Act 1994 prohibits the retention of sawfishes in Queensland's commercial fisheries and possession of sawfish body parts without a permit. Currently, Fisheries Queensland (QDAF) officers can issue an on-the-spot fine of AUD 575 (Fisheries Infringement Notice for taking/possession of regulated fish, 4 penalty units; QDAF Fisheries Manager pers. comm.), and if the matter goes to court, the maximum penalty for possessing or taking regulated fish in Queensland is AUD 143750 (QDAF Fisheries Manager pers. comm).

All 4 species of sawfish occur in the Gulf of Carpentaria (Peverell, 2008) and at least 3 species (*P. pristis, P. zijsron,* and *A. cuspidata*) are known to occur on the east coast of Queensland. Their distributions within the Great Barrier Reef Marine Park are not well understood (Harrison & Dulvy 2014, Department of the Environment 2015, Wueringer 2017, Hudgins et al. 2020). *P. pristis* is likely still present in waters north of Cairns (Last et al. 2016, Jacobsen et al. 2021). The Great Barrier Reef Marine Park Authority estimates populations of green sawfish *P. zijsron* to be just biologically viable (Great Barrier Reef Marine Park Authority 2012). In New South Wales, *P. zijsron* are presumed extirpated (Harrison & Dulvy 2014). On the east coast of Queensland, the holotype of *P. clavata* Garman, 1906 is the only known historic occurrence of this species, and it is uncertain whether it is extant (Grant et al. 2022).

Queensland's major commercial net fisheries are split into the Gulf of Carpentaria Inshore Fin Fish Fishery (GoCIFFF) and the East Coast Inshore Fin Fish Fishery (ECIFFF) (Fisheries [Commercial Fisheries] Regulation 2019). Both the ECIFFF and GoCIFFF fisheries interact with sawfishes (Salini et al. 2006, Peverell 2008, Jacobsen et al. 2019b, 2021). The ECIFFF extends across all tidal waters along Queensland's east coast, and its commercial sector harvests approximately 100 species of teleost using net and line gear. Only master fishers, in possession of a primary commercial fisher licence, fishing boat licence, and endorsement for a fishery via fishery symbols, can participate in the fishery. No new primary commercial fishing licenses are issued for net fisheries in Queensland and new entrants to the fishery must obtain existing licenses and fishery symbols to participate in a fishery (Fisheries [Commercial Fisheries] Regulation 2019). In the ECIFFF, the number of active netting licences and effort days fished has been declining since 2011 and 2012, respectively (Jacobsen et al. 2019a). The GoCIFFF operates all tidal waters from the tip of Cape York to the Northern Territory border (Jacobsen et al. 2019c). The commercial fishery operates net and line gears, with net fisheries primarily targeting barramundi, mackerel, threadfin salmon, and sharks. The GoCIFFF is quite similar to the ECIFFF, but with a simpler licensing system, fewer licenses, and smaller annual catch and effort (Jacobsen et al. 2019c). The GoCIFFF also has fewer spatial closures than the ECIFFF (Jacobsen et al. 2019c). The recreational use of gillnets was banned in Queensland in 1970 (Fisheries Declaration 2019).

Bycatch mitigation measures in both the ECIFFF and GoCIFFF include restrictions on the net type, length, mesh size, and rules surrounding net attendance. In addition, 3 net-free zones were implemented in 2015 (Cairns, Mackay, and Rockhampton; see Fig. 1 in Wueringer 2017), prohibiting commercial gillnetting but allowing recreational cast and bait netting (Fisheries Declaration 2019). Since 2002, it is compulsory for commercial fishers in the ECIFFF and GoCIFFF to report any interactions with sawfishes through Species of Conservation Interest (SOCI) logbooks, which as of September 2021 are referred to as Threatened Endangered and Protected (TEP) logbooks. SOCI logbook data indicate that over half of the reported sawfish interactions are with *A. cuspidata* (Jacobsen et al. 2019b), but currently no independent data verification program exists. Due to biological and capture data deficiencies, low fecundity, and ease of entanglement, all 4 species of sawfish were assigned the highest risk score in the productivity and susceptibility analysis (PSA) as part of the ecological risk assessment done for the ECIFFF (Jacobsen et al. 2021).

In order to better understand Australian sawfish distributions, Sharks And Rays Australia (SARA) commenced a citizen science campaign in 2017, asking members of the general public to submit sightings of sawfishes or rostra, both historical and recent (see submission site at www.cytags.com). This study aims to increase our understanding of historical and recent sawfish populations in Queensland, Australia, through analysis of trophy rostra.

2. MATERIALS AND METHODS

This study focuses on sawfish rostra from Queensland. Data was collected on n = 824 sawfish rostra, of which n = 101 originated from outside Queensland or did not have any confirmed locality data and which were not further considered here. The remaining rostra (n = 723) had known location data within Queensland. Some rostra were located in pubs, roadhouses, and private collections, while others were donated directly to SARA. Some rostra and their associated data were donated to SARA after confiscation by Queensland authorities. The majority of rostra in this study are now owned by SARA (n = 634), while some are still owned by members of the general public (n = 178), and some were destroyed (n = 12). Each rostrum owned by SARA is tagged with a 'QDAF Seizure' tag and used for education and outreach.

All rostra were photographed, specific characteristics (e.g. damage, missing teeth) were noted, and tissue samples were collected for a separate study. Measurements to the nearest mm (Fig. 1) were taken according to Faria (2007) and Whitty et al. (2014). Species were identified following Whitty et al. (2014). For all rostra, associated data such as capture location, donation date, date of sawfish mortality, and capture gear type were recorded, if available. All rostra morphology data were compiled and analysed using Microsoft Excel v16.69, R version 4.2.1 (R Core Team 2022), and RStudio v 2022.02.3 (www.rstudio.com). All values are presented as mean ± SD.

2.1. Size and age

Analyses on sawfish size used complete rostra (n = 667) only. Of these, n = 663 had a known capture date, and n = 662 had a known capture location. For *Pristis* spp., completeness was determined by the presence of a flare of the rostral base, indicating the transition to the head. In *Pristis* spp., teeth extend almost to the flare, as evidenced by an SRL (standard rostrum length, from the tip of the rostrum to the most basal tooth) to TRL (total rostrum length, tip to base) ratio between 0.91 and 0.95 (Whitty et al. 2014). Thus, n = 45 *Pristis* spp. rostra were excluded (see Table 1). In *Anoxypristis cuspidata* teeth do not span the entirety of their rostra (Fig. 1). Rostra were considered complete if they ended at a distance greater than twice the length of the most proximal tooth gap (Fig. 1). N = 11 *A. cuspidata* rostra were excluded.

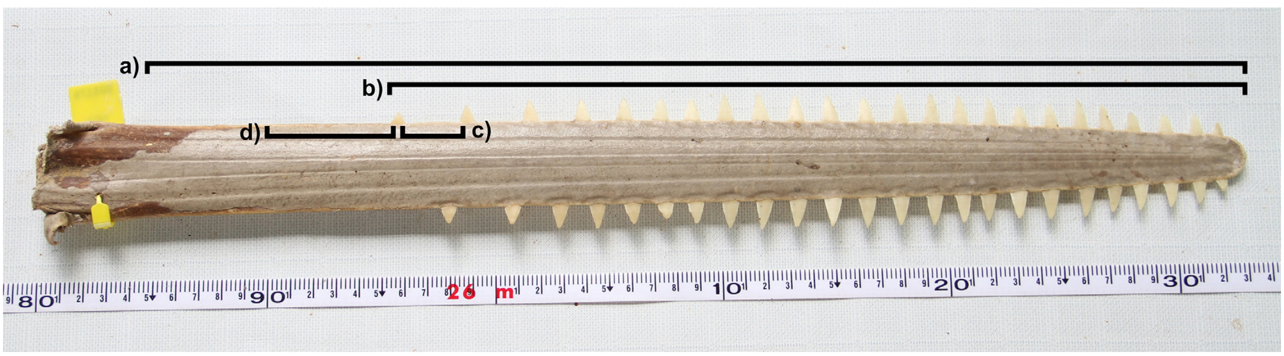

Fig. 1. A complete rostrum of *Anoxypristis cuspidata*. Total rostrum length (TRL) is measured from the tip to the basal flare (a). Standard rostrum length (SRL) is measured from the tip to the most proximal tooth (b). A rostrum was considered incomplete if (d) < (2 × c), with (c) being the length of the proximal-most tooth gap

Sawfish total length (TL) was calculated via ratios of SRL to TL from Whitty et al. (2014) (Table 1). Alternate published length relationships from Whitty et al. (2014), Peverell (2008), Thorburn et al. (2007), Faria (2007), and Morgan et al. (2011) risk skew towards the age class each was modelled after, and power and quadratic models over- or underestimate TL of sub-adult and adult specimens (V. N. Biskis unpubl. data). The resulting TLs were further used to calculate approximate ages using the modified von Bertalanffy growth function presented by Peverell (2008) (Table 1). For some rostra, the corresponding TL of the sawfish was known.

Table 1. Published growth and morphometric relationship equations used in assessing total length (TL) (after Whitty et al. 2014) and age (after Peverell 2008) for 4 species of sawfish. Rostra (n = 723) used in the present study are presented as values of complete rostra (total n = 667), with values of incomplete rostra in brackets (total n = 56). SRL: standard rostrum length

Species	Linear approximation	Bertalanffy growth
Anoxypristis cuspidata n = 552 (11)	TL = SRL/0.2	$\text{Age} = \frac{-\ln\left(1-\frac{\text{TL}}{4090}\right)}{0.31} - 0.47$
Pristis clavata n = 37 (6)	TL = SRL/0.19	$\text{Age} = \frac{-\ln\left(1-\frac{\text{TL}}{5080}\right)}{0.08} - 2.09$
P. pristis n = 28 (17)	TL = SRL/0.23	$\text{Age} = \frac{-\ln\left(1-\frac{\text{TL}}{6380}\right)}{0.08} - 1.55$
P. zijsron n = 50 (22)	TL = SRL/0.24	$\text{Age} = \frac{-\ln\left(1-\frac{\text{TL}}{5400}\right)}{0.12} - 1.12$

In the present study, the following age class definitions are used, based on calculated TL in the context of published biological data for each species: YOY sawfish are young-of-the-year, referring to newborns to 1 yr of age, juvenile sawfish are older than YOY but younger than subadult and adult sawfish. Subadult sawfish are animals that could be sexually mature if male but would be sexually immature if female. Adult sawfish are animals that were longer than length of maturity for both sexes. These definitions are used, as sex was not determined from rostral DNA and overlap in rostral tooth counts between sexes and populations limits morphological determination (see Whitty et al. 2014 for a review).

2.2. Spatial and temporal analysis of rostra origins

For each sawfish rostrum, a GPS mark was generated in QGIS 3.24.2 (QGIS Development Team 2022). When the exact GPS location of a capture was unknown, a general location was derived through proximity to a shore, river mouth, or township. A radius of uncertainty to the nearest km was assigned to each location point using the measure feature. When the capture area was a bay, inlet, or river, the midpoint at the mouth of the feature was assigned the GPS location. If multiple locations could be chosen within a large geographic feature (e.g. Albatross Bay), and uncertainty was greater than 10 km, a boundary of the feature was downloaded from the Queensland Spatial Catalogue (https://qldspatial.information.qld.gov.au/). N = 7 rostra are known to have originated from within Queensland, but lack the spatial resolution to estimate a GPS location within 250 km. These rostra were not included in maps, but their sizes and capture years were used in statistical analyses. Rostra of the mass retention subgroup were treated differently (see Section 2.3).

The spatial distribution of sawfish rostra was analysed according to the decade and method of capture, and calculated TL and maturity state of the animal. Rostra origins were also separated into 6 regions within Queensland, defined after Queensland Fisheries zone and watershed boundaries (see Fig. 5): Southeast Queensland (SEQ, New South Wales border to Baffle Creek), Central East Coast (CEC, Baffle Creek to the northern border of Townsville), Northeast Queensland (NEQ, east coast north of Townsville), the Gulf of Carpentaria (GOC, Northern Territories border to including the Mitchell River), Western Cape York (WCY, north of the Mitchell River to the tip of Cape York), and Torres Strait (TS, all Queensland waters north of the tip of Cape York). For complete rostra of Queensland origin, total length, age, and age class were analysed for each region, with rostra from unknown locations removed from this particular analysis (n = 662). Total lengths and ages of sawfishes from both eastern and western Queensland were compared for *P. zijsron* and *A. cuspidata* by Welch's *t*-tests (*t*-test assuming unequal variances), but not for *P. pristis* and *P. clavata* due to low sample sizes for eastern Queensland.

Rostra in the present study belonged to Queensland sawfish mortalities between 1920 and 2020. Of the n = 723 rostra with spatial data, capture decades are known for n = 702, and within those, capture year of n = 64 rostra are known. N = 14 rostra could be attributed to captures before the year 2000 and are only used in analysis of species composition throughout time, and n = 7 rostra did not have known capture dates. For some analyses, rostra were split into collection categories before and after the year 2000. The year 2000 was chosen; around this time, Queensland Fisheries started working with gillnet fishers in the GoCIFFF to collect biological data for sawfishes (Peverell 2005), running an observer program, and handling workshops for 8 yr (Peverell 2008).

2.3. Analysis of rostra subgroups

For further analyses, the n = 723 rostra with associated capture dates and locations were split into 2 subgroups, based on the quality of associated data. Of the 'small-scale retention subgroup' of n = 154 rostra, capture dates and locations were known for n = 147 rostra. While this subgroup contained incidences where multiple rostra could be attributed to an active commercial fisher, each rostrum was attributed a mortality year and location. Geographic distributions of sawfishes in the small-scale retention subgroup were plotted separately for before and after the year 2000. For this analysis, n = 97 rostra that were complete were used. Welch's *t*-tests were used to compare TL and ages for all species pooled, and for *A. cuspidata* and *P. pristis* separately before and after the year 2000, but not for *P. clavata* and *P. zijsron* due to low sample sizes.

The remaining n = 569 rostra are collectively referred to as the 'mass retention subgroup'. They originated from donation events directly related to ≤5 active commercial inshore gillnet fishers. These rostra were taken by the fishers over several years or decades, and a large geographic area, without specific GPS marks associated with each rostrum. For rostra in this group, years of activity, date of donation, net fishery zone, and any known boundary of fishing area were recorded. Commercial fishing net zones and catch data were obtained from Queensland Spatial (https://qldspatial.information.qld.gov.au) and Qfish (https://qfish.fisheries.qld.gov.au) to generate grids of fishing effort within the Queensland net fishery. Overlay of fishing effort zones, with boundaries known for each commercial fisher, resulted in individual effort polygons. Within each polygon, points were randomly assigned via the 'Random Points in Polygons' tool in QGIS, resulting in a heatmap visualizing density of all mortalities of the mass retention subgroup. In addition, each mortality was randomly assigned a capture year within the fisher's years of fishing activity. Resulting distributions were only used to construct a density time graph.

2.4. Comparison of SOCI data with rostra from gillnet captures

In order to assess compulsory self-reporting of sawfish interactions by commercial fishers, data of sawfish mortalities from gillnet captures from the presented data set were compared with known sawfish bycatch interaction data from SOCI logbooks. In 2017, the first author (B. E. Wueringer) requested SOCI logbook data (2003–2017) for sawfishes in Queensland under the Freedom of Information Act. SOCI logbook data (2006 onwards) are also freely available through the Queensland Government online data portal (https://www.data.qld.gov.au/dataset/total-number-of-species-of-conservation-interest-interactions-with-released-conditions). These logbook data were compared with data presented in Jacobsen et al. (2021), which allowed separating sawfish interactions in gillnet fisheries in the GoCIFFF from those in the ECIFFF.

3. RESULTS

The data set contained n = 824 sawfish rostra belonging to all 4 species of Australian sawfish: *Anoxypristis cuspidata* (75.6%, n = 621), *Pristis clavata* (6.1%, n = 50), *P. pristis* (6.7%, n = 55), *P. zijsron* (11.9%, n = 98). Data associated with n = 723 rostra from Queensland, with known location data, were analysed: *A. cuspidata* (77.9%, n = 563), *P. zijsron* (10.0%, n = 72), *P. pristis* (6.2%, n = 45), *P. clavata* (6.0%, n = 43). Rostra in the present study belonged to sawfish mortalities between 1920 and 2020 (Figs. 2 & 3). Rostra of *A. cuspidata* and *P. clavata* originated mainly after 2000, with a mean ± SD mortality year of 2001 ± 6.6 and 2008 ± 10.9 respectively, while rostra of *P. zijsron* and *P. pristis* were older, corresponding to mean mortality years of 1998 ± 24.3 and 1982 ± 21.4, respectively (Fig. 3).

3.1. Size and age

The smallest and youngest rostra belonged to *A. cuspidata* and *P. clavata*, estimated to be YOY sawfish 0.1 yr old and −0.04 yr old at time of mortality, respectively. The minimum estimated TL in both species was around 760 mm (Table 2, Fig. 4). In contrast, rostra of *P. zijsron* belonged to the oldest and largest

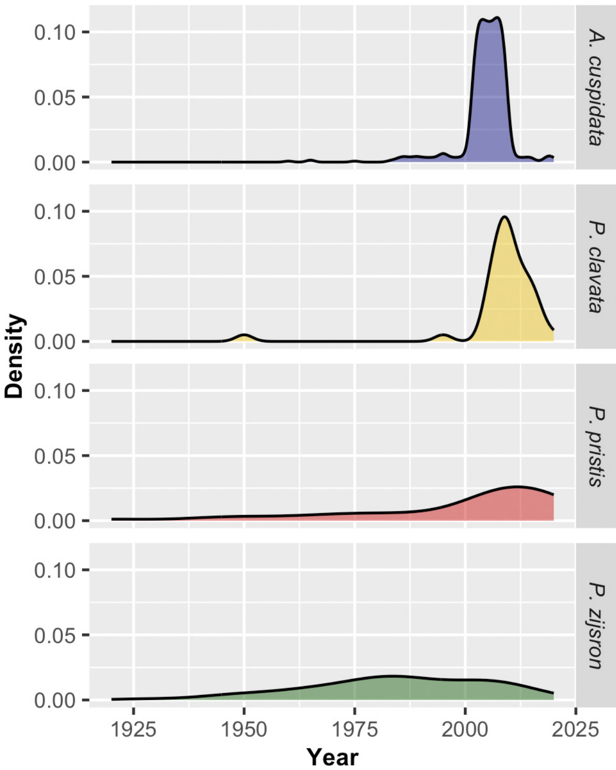

Fig. 2. Density of n = 702 sawfish rostra (complete and incomplete) analysed as a function of capture year, according to each species. Rostra without a known capture decade were excluded from this graph (n = 21)

fish, with one adult specimen of *P. zijsron* estimated to be 58.6 yr old at 6041.7 mm TL. Adult *P. pristis* were the second-largest and oldest sawfish in this study, with the largest specimen 20.5 yr old at 5282.6 mm TL. A paired *t*-test identified no statistical difference between known TLs and estimated TLs after Whitty et al. (2014), for each species (*A. cuspidata*: paired *t*-test, df = 7, p = 0.70; *P. clavata*: paired *t*-test, df = 3, p = 0.32; *P. pristis*: paired *t*-test, df = 9, p = 0.43; *P. zijsron*: paired *t*-test, df = 3, p = 0.41).

With species pooled, mean TLs and ages at mortality for sawfishes decreased significantly after the year 2000 (Fig. 3) (all species TL: Pearson's r = –0.90, df = 11, p = 7.50×10^{-5}; age: Pearson's r = –0.76, df = 11, p = 4.3×10^{-3}). When species were analysed separately before and after the year 2000, both *P. pristis* and *P. zijsron* showed significant downward trends in total length (*P. pristis* TL: Pearson's r = –0.96, df = 7, p = 2.1×10^{-4}; *P. zijsron* TL: Pearson's r = –0.82, df = 11, p = 2.0×10^{-3}), but decreases in age were only significant in *P. pristis* (*P. pristis* age: Pearson's r = –0.95, df = 7, p = 3.3×10^{-4}; *P. zijsron* age: Pearson's r = –0.58, df = 9, p = 0.08). *Anoxypristis cuspidata* and *P. clavata* showed non-significant increases in total lengths after the year 2000 (*A. cuspidata* TL: Pearson's r = 0.22, df = 9, p = 0.57; *P. clavata* TL: Pearson's r = 0.78, df = 4, p = 0.12) and age (*A. cuspidata* age: Pearson's r = 0.34, df = 9, p = 0.37; *P. clavata* age: Pearson's r = 0.78, df = 4, p = 0.12).

3.2. Rostra composition by region

Complete rostra, which allowed assessing the stage of maturity, with known capture dates and locations (n = 662), were analysed by region. In SEQ, sawfish numbers were low (n = 6), and only *P. zijsron* and *A. cuspidata* were present, with 100% of *P. zijsron* (n = 4) being adults. In the CEC, all 4 species were present (n = 534), with 41.0% YOY sawfishes and 35.2% adults. Within the CEC, 41.9% of rostra belonged to *A. cuspidata* YOY, while 35.7% were adults. For *P. zijsron* in the CEC, 71.4% of the rostra were from juveniles. One *P. pristis* was an adult, and one *P. clavata* was a juvenile. On the NEC, *A. cuspidata, P. zijsron* and *P. clavata* were present (n = 15), with 40.0% juveniles and 40% adults. The majority of *P. zijsron* in the NEC were juveniles (71.4%), while the majority of *A. cuspidata* were adults (57.1%). One *P. clavata* was a juvenile. All rostra from TS belonged to *A. cuspidata* (n = 2), with 1 adult and 1 subadult sawfish present. Within WCY, n = 34 rostra belonged to all 4 species, with 44.1% juveniles and 41.2% adults. Within WCY, 84.6% of *P. pristis* were juveniles, while 72.7% of *A. cuspidata* were adults. In the GOC, n = 71 rostra belonged to all 4 species, with 60.6% juvenile sawfishes. In this region, all *P. clavata* (n = 32) were juveniles.

When fishing boundaries were combined into eastern (CEC, NEC, and SEQ) and western Queensland (GOC and WCY), the oldest and largest *A. cuspidata*, *P. clavata,* and *P. pristis*, and the youngest *P. zijsron* were caught in eastern Queensland. The oldest and largest *P. zijsron* and the youngest *A. cuspidata*, *P. clavata*, and *P. pristis* were caught in western Queensland (Table 3). Total lengths and ages of *P. zijsron* differed significantly between eastern and western Queensland (*t*-tests assuming unequal variances, total length: df = 47, p = 4.3×10^{-4}; age: df = 19, p = 0.04). For *A. cuspidata*, no significant differences in TL (*t*-test assuming unequal variances, df = 20, p = 0.56) and age (*t*-test assuming unequal variances, df = 21, p = 0.62) were found between specimens from eastern and western Queensland.

Visual analysis (Fig. 5) of all rostra with known origins and, independent of their sizes (n = 711), split by

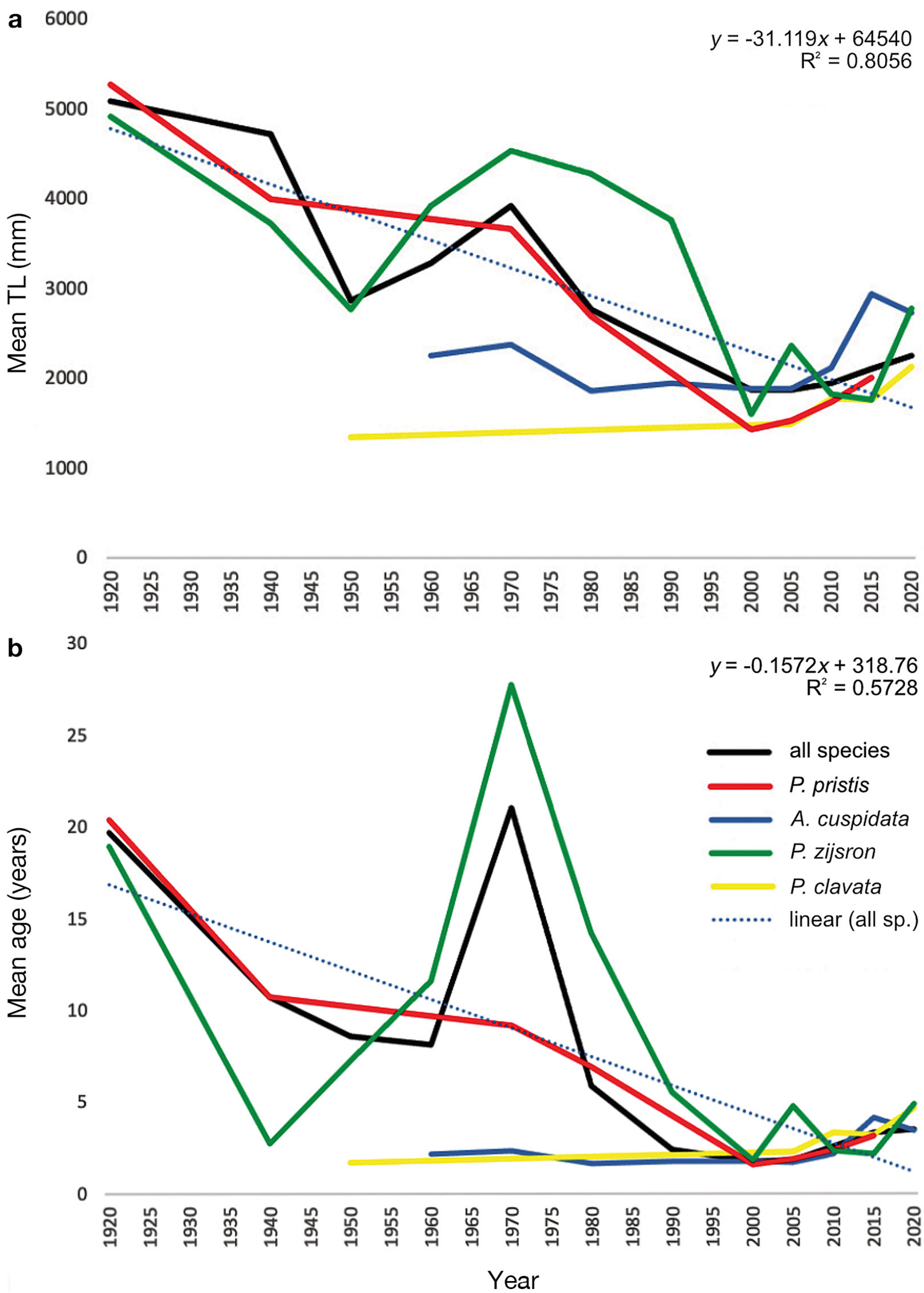

Fig. 3. (a) Mean total lengths and (b) mean ages for rostra belonging to 4 species of sawfish by decade. Equations and R^2 values are for the trendlines through all species. Data from complete rostra of Queensland origin (n = 667). *P.: Pristis*; *A.: Anoxypristis*

Table 2. Total lengths and ages by species of sawfish present as complete rostra. Values were calculated from complete rostra and are presented as mean ± SD, with minimum and maximum values in brackets

Species	Total length (mm)	Age (yr)
Anoxypristis cuspidata (n = 552)	1915.4 ± 686.3 (760–3385)	1.8 ± 1.3 (0.1–6.2)
Pristis clavata (n = 37)	1664.7 ± 331.6 (768.4–2336.8)	2.9 ± 1.2 (−0.04–5.6)
P. pristis (n = 28)	2317.9 ± 1185.7 (934.8–5282.6)	4.9 ± 5.0 (0.4–20.5)
P. zijsron (n = 50)	3612.4 ± 1655.3 (837.5–6041.7)	11.6 ± 13.4 (0.3–58.6)

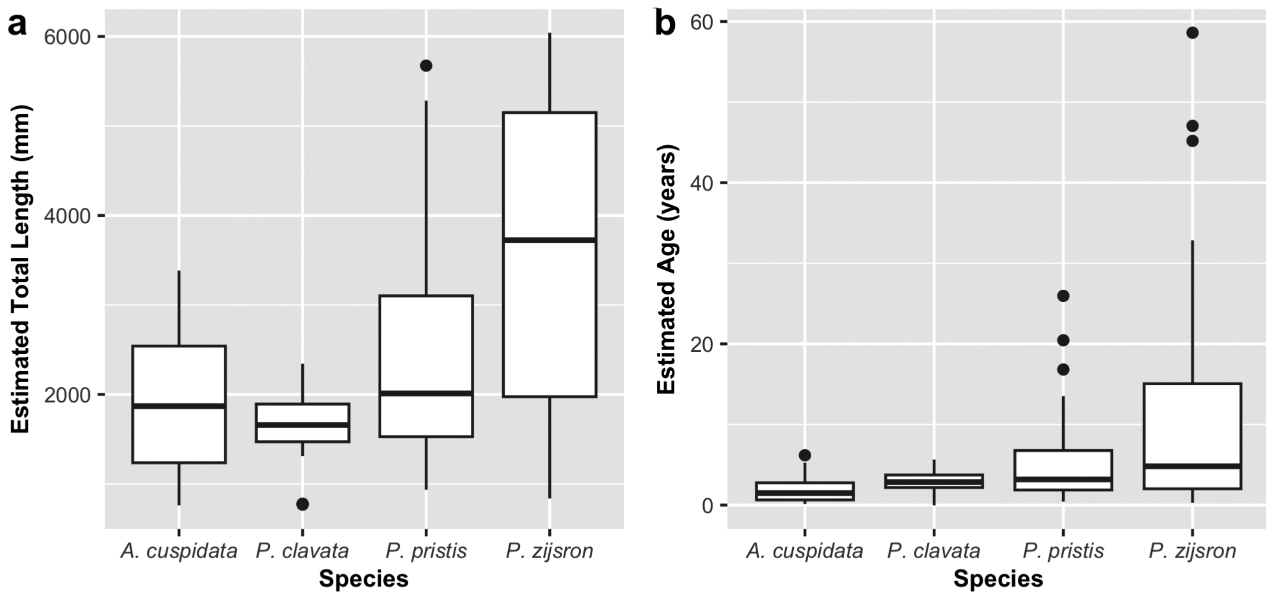

Fig. 4. Estimated (a) total lengths (mm) and (b) ages (yr) for n = 667 sawfish calculated from rostra, by species. Medians are presented as horizontal lines, boxes represent quartiles, and dots represent outliers. *P.: Pristis*; *A.*: *Anoxypristis*

location and pre- versus post-year 2000 collection dates indicates that species compositions changed from the earlier years. Before the year 2000, all locations were dominated by the presence of *P. zijsron*, while after the year 2000, species compositions were dominated by different species in each location. The largest stronghold of *P. pristis* now appears to be in WCY , and after 2000, *P. pristis* and *P. clavata* seem to have disappeared off the east coast of Queensland.

Table 3. Total lengths (mm) and ages (yr) calculated from n = 662 sawfish rostra belonging to 4 species for eastern and western Queensland (QLD) and Torres Strait. Values are presented as mean ± SD, with minimum and maximum values in brackets

Species	East QLD	West QLD	Torres Strait
Age (yr)			
Anoxypristis cuspidata	1.8 ± 1.3 (0.3–6.2)	1.9 ± 1.1 (0.1–3.9)	2.23 ± 0.2 (2.07–2.39)
Pristis clavata	3.7 ± 2.7 (1.8–5.6)	2.9 ± 1.1 (−0.04–4.7)	N/A
P. pristis	20.5	4.2 ± 4.2 (0.4–16.8)	N/A
P. zijsron	7.3 ± 7.7 (0.28–26.7)	17.5 ± 17.8 (1.3–58.6)	N/A
Total length (mm)			
A. cuspidata	1909.5 ± 684.7 (886.0–3385.0)	2007.5 ± 723.1 (760.0–2940.5)	2295.0 ± 113.1 (2215.0–2375.0)
P. clavata	1842.1 ± 699.7 (1347.4–2336.8)	1654.6 ± 316.4 (768.4–2131.6)	N/A
P. pristis	5282.6	2179.9 ± 1063.6 (934.8–4913.0)	N/A
P. zijsron	2803.2 ± 1443.5 (837.5–5208.3)	4392.9 ± 1489.3 (1375.0–6041.7)	N/A

3.3. Capture methods

The effect of capture methods (gillnets, trawl, crab pots, and unknown) on sawfish age class was identified for complete rostra of Queensland origin (n = 667, Fig. 6). Most sawfishes (92.2%) were caught by gillnet, while 1.1% were caught by trawler, 0.2% by crab pot, and 6.6% had unknown capture methods. For all sawfish species pooled, most YOY sawfishes (36.9%) were caught by gillnet, while 71.4% adults were caught by trawlers (Table 4). When the effect of capture method on age class was analysed separately for each species, the majority of *P. clavata*, *P. pristis*, and *P. zijsron* were juvenile or YOY when caught by gillnet. However, 46.9% of all *P. zijsron* caught by gillnet were sexually mature (Table 4). Trawlers mainly caught adult *A. cuspidata*, *P. clavata*, and *P. zijsron*, and subadult *P. pristis*.

3.4. Small-scale retention subgroup

Within this subgroup, with all species pooled, both TL (*t*-test assuming unequal variances: df = 64, p = 7.06×10^{-10}) and age (*t*-test assuming unequal variances: df = 42, p = 7.27×10^{-5}) of sawfishes differed significantly pre- and post-year 2000. Mean TL and age did not differ significantly for *A. cuspidata* pre- and post-year 2000 (*t*-test assuming unequal variances, TL: df = 33, p = 0.74; age: df = 33, p = 0.98). Before the year 2000, *A. cuspidata* had a mean TL of 2104.0 ± 563.6 mm and a mean age of 2.2 ± 1.0 yr (n = 13). After the year 2000, *A. cuspidata* had a mean TL of 2026.0 ± 844.3 mm and an age of 2.7 ± 1.6 yr (n = 23).

Only one *P. clavata* was present before the year 2000, with a TL of 1347.4 mm and age of 1.76 yr. After the year 2000, *P. clavata* had a mean TL of 1389.5 ± 627.7 mm and a mean age of 2.1 ± 2.2 yr (n = 5). *P. pristis* were significantly younger and smaller after the year 2000 (*t*-test assuming unequal variances, TL: df = 5, p = 0.03; Age: df = 5, p = 0.03). Before the year 2000, *P. pristis* had a mean TL of 3668.8 ± 1474.2 mm and age of 10.6 ± 6.5 yr (n = 6), and after the year 2000, *P. pristis* had a mean TL of 1746.4 ± 379.4 mm and age of 2.5 ± 1.0 (n = 19). Before the year 2000, *P. zijsron* had a mean TL of 4349.7 ± 1314.8 mm (n = 28) and age of 17.6 ± 15.6 yr (n = 22), while after 2000 their mean TL was 1719.8 ± 381.5 mm and age of 2.1 ± 0.9 yr (n = 2).

Visual plotting of the rostra in the small-scale retention subgroup (Fig. 7) showed a marked change in species compositions pre- and post-year 2000. *P. zijsron* have not only gotten smaller, but have also more or less disappeared across Queensland. On the contrary, *A. cuspidata* dominated in all locations after the year 2000. Post-year 2000, *P. pristis* disappeared from the east coast of Queensland. Collection methods of rostra in the small-scale retention subgroup are known for n = 94 rostra, with n = 82 caught via gillnet, n = 11 via trawl, and n = 1 in a crab pot.

3.5. Mass retention subgroup

All rostra in this subgroup (n = 569) originated from ≤5 commercial gillnet fishers. The vast majority of rostra belonged to *A. cuspidata* (n = 518), with 3 *Pristis* spp. present as well. Within the mass retention subgroup, of n = 63 rostra which all originated from one commercial fisher, at least 36 rostra (= 57%, Fig. 8) were cut deep enough into the head that the sawfish would have been unlikely to have survived the amputation, due to their braincase being fully exposed (Morgan et al. 2016). A heatmap of fishing pressure constructed from the rostra of the mass retention subgroup shows the impact to be in a relatively narrow area within established commercial fisheries, limited to 2 principal regions (Fig. 9): the CEC and the GOC. These areas comprise 3 fishing zones (N2, N3, N4) within the GoCIFFF and ECIFFF.

3.6. SOCI comparisons

The comparison of SOCI logbook sawfish interaction data from 2008–2009, which contains data from all net fisheries across the GoCIFFF, with published N3 inshore net fishery of GoCIFFF observer records from the same time span (Zeller & Lawson 2015) shows that sawfish captures as reported by observers are more than 4 times higher than those reported in SOCI logbooks (Fig. 10). This is even though observers were likely only present on a few selected vessels of the N3 component of the GoCIFFF.

A comparison of sawfish interactions reported by set net fishers in their SOCI logbooks over the years (Fig. 11a,b) with rostra captured in gillnets between 2003–2019 (Fig. 11c,d) indicates that SOCI logbook data highly underestimates interactions of fishers with sawfishes. As the number of active fishing licences and SOCI data are quite variable over the years, the extent of underreporting is difficult to quantify. In both the ECIFFF and the GoCIFFF, the number of reported sawfish has increased in recent years (Fig. 12). Sawfish species composition reported in SOCI logbook data over the years is more diverse in the GoCIFFF than in the ECIFFF. In the ECIFFF, both SOCI logbook data and rostra are dominated by *A. cuspidata*, with juvenile and subadult *P. zijsron* also present. In the GoCIFFF, SOCI logbook data show interactions with all 4 species of sawfish, while rostra in the mass retention subgroup are dominated by juvenile *P. zijsron* and *P. clavata*.

4. DISCUSSION

4.1. Size and age estimates at time of mortality

This study aims to increase our understanding of historical and current sawfish populations in Queensland, Australia, through analysis of trophy rostra. Size estimates of sawfishes were derived from rostra lengths via the equation by Whitty et al. (2014). Comparison with known total lengths, where available, found no significant statistical differences, confirming Whitty et al. (2014)'s equation to be a reliable estimate. Corresponding ages were estimated after Peverell (2008), but as actual ages of sawfishes were unknown, estimate accuracy could not be confirmed.

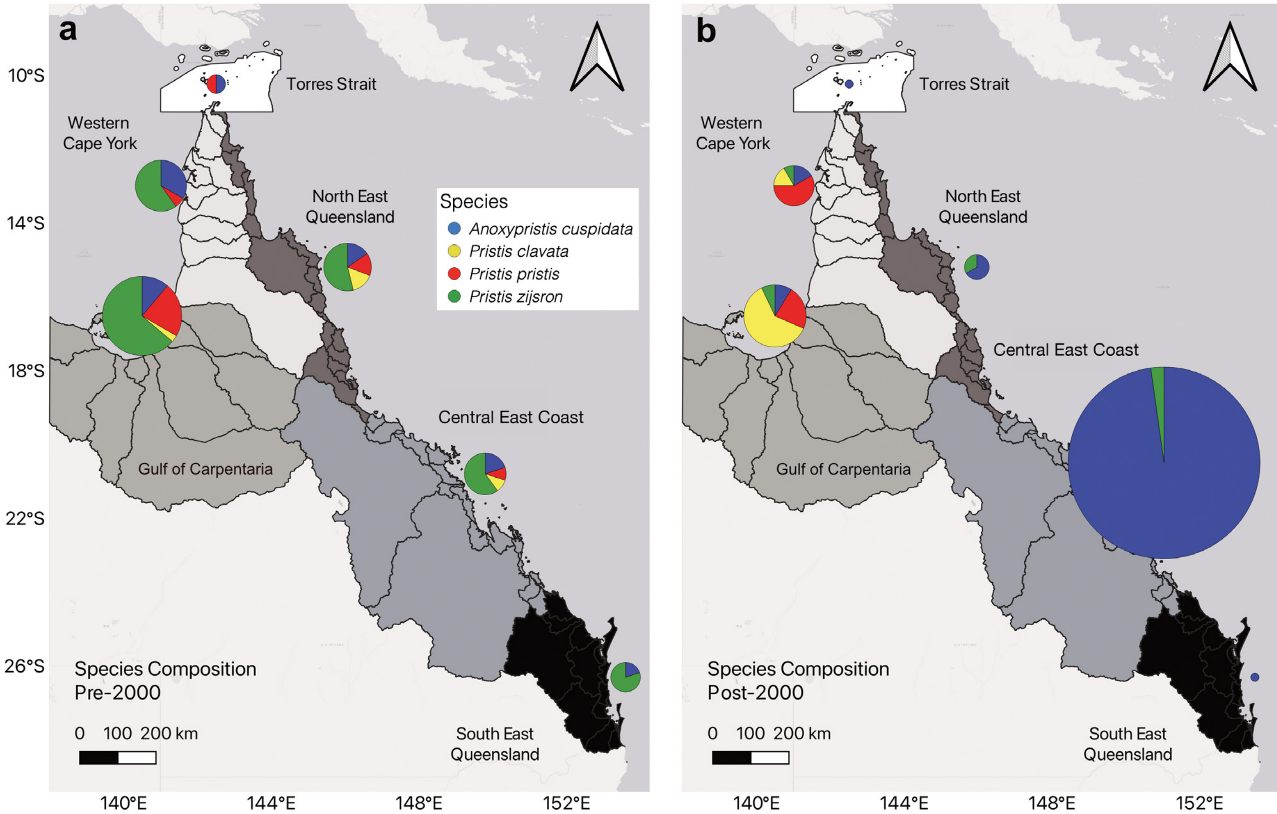

Fig. 5. Species composition of n = 711 rostra of known date and origin, separated across 6 zones in Queensland. These are separated as being collected (a) prior to 2000 (n = 103) or (b) between 2000 and present (n = 608). The size of the pie corresponds to the number of rostra. Due to the high number of rostra received by a small number of fishers, all pies were log transformed, so the remaining locations were visible

The youngest sawfish in this study was a *Pristis clavata*, with an estimated age of −0.04. Negative age estimations occur when outside of currently accepted growth curves and may imply that *P. clavata* could be born at smaller sizes than those presumed to date, of 650–810 mm (Peverell 2008, Last & Stevens 2009). The oldest estimated age was 58.6 yr for a *P. zijsron*. However, a few rostra (n = 8) of *P. zijsron* lay outside the bounds of the currently established growth equation, indicating that the study included *P. zijsron* older than 58.6 yr. This suggests that *P. zijsron* gets older than the previously reported maximum age of 53 yr (Peverell 2008). The oldest *P. pristis* in this study was estimated to be 20.5 yr old and considerably younger than the oldest maximum age of 80 yr estimated for this species (Peverell 2008). Total length and ages of narrow sawfish *Anoxypristis cuspidata* did not differ significantly between pre-year 2000 and post-year 2000 cohorts.

The present study includes 3 historic records of *P. clavata* from the east coast of Australia, with the southern-most record being a rostrum from the 1950s from the Fitzroy River/Port Alma region in CEC. The species was historically present on the east coast, with the species holotype from the Townsville region (Garman 1906) the only known record. Our records were not removed from the dataset, as the donors insisted that the animals were caught locally by their relatives, who had never fished with nets anywhere else in Australia. It is unclear if *P. clavata* is extant on the east coast of Queensland (Grant et al. 2022).

4.2. Small-scale retention subgroup

Rostra in the small-scale retention subgroup mainly originated from private individuals. Species compositions pre- and post-year 2000 are significantly different. Rostra from *P. clavata*, *P. pristis*, and *P. zijsron* were more common in eastern Queensland pre-2000 than in recent years (Fig. 6). After 2000, *A. cuspidata* appeared to be the dominant pristid on Queensland's east coast, confirming that this species' higher fecundity (Last et al. 2016) renders it more resilient to fishing pressure. Analysis of TL, age, and species compositions before and after 2000 uncovered interesting

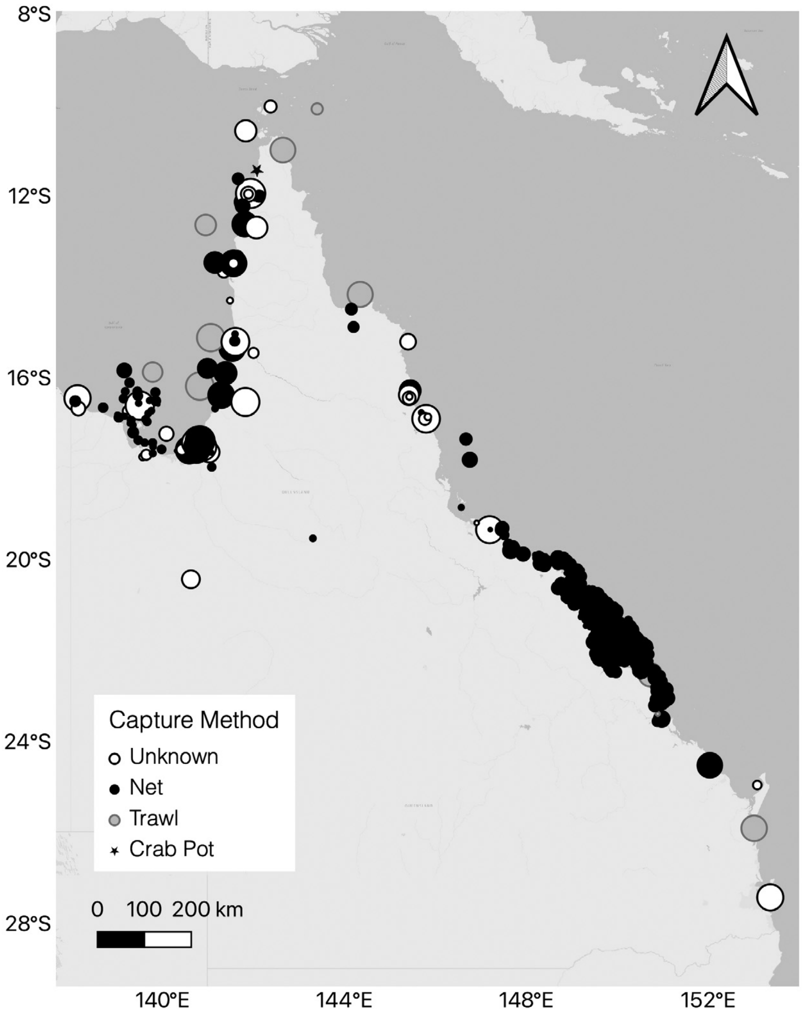

Fig. 6. Sawfish captures in Queensland (n = 667) with ○, ● and ● indicating different fishing methods. Size of the circle represents size of the animal. Note that crab pot is represented by a single capture, shown as ★ at the tip of Cape York

trends. With species pooled, both TL and age differed significantly before and after 2000, with older and larger sawfishes caught before 2000, and post-2000 populations being younger and smaller. Both *P. pristis* and *P. zijsron* caught before 2000 were, on average, older and larger than after the year 2000, and this was confirmed by Welch's *t*-tests for *P. pristis.* However, a bias for retaining large, noteworthy rostra, and private individuals caring more about large, old trophy rostra than small ones cannot be excluded. This is evidenced by the fact that even though possession of sawfish body parts is illegal in Queensland, people are reluctant to donate large rostra. Of the 55 rostra belonging to sexually mature green sawfish in this study, only 5 were donated willingly. It appears likely that these older and larger sawfishes are increasingly rare and therefore, efficient protection measures are vital.

4.3. Impact of commercial fishers — mass retention subgroup

The present study presents an impact estimate for commercial fishers on sawfish populations based on the mass retention subgroup, which included sawfish originating from ≤5 commercial gillnet fishers, who all, at the time of donation/confiscation, were still active in the gillnet industry. This group included n = 518 *A. cuspidata*, n = 33 *P. clavata*, n = 2 *P. pristis*, and n = 16 *P. zijsron*, which were retained over a maximum merged time between 1986 and 2018.

While the majority of fishers indicated to have retained rostra before protections of sawfishes were implemented in Queensland in 2009, the authors consider it unlikely that active fishers would hold on to large quantities of rostra for up to 12 yr after protection without adding rostra of deceased animals to the collection. One fisher indicated that when offered AUD 50 per rostrum for their collection of more than n = 400 rostra, they did not sell as they thought the value to be higher. The same fisher also indicated that before sawfishes were protected in 2009, they were readily retained. 'Wet' fins (as opposed to dried fins) were sold for AUD 150 per kg, and the meat of sawfish trunks was sold for AUD 2.50 per kg. The average set of fins (2 dorsal fins and one caudal fin with the tail removed) of a narrow sawfish (*A. cuspidata*) used to fetch AUD 450 for the fisher.

The impact of some fishers on local sawfish populations is likely underestimated. Rostra were confiscated from one fisher when they were selling them at a local market 7 yr after sawfishes were protected (Slezak 2016). It is unknown how many rostra the fisher had sold. Given that large sawfish rostra are valuable and rare trophies or collector's items, it is reasonable to assume that larger rostra may already have been sold. The fisher likely had an additional, unquantifiable impact on adult *A. cuspidata* and *P. zijsron*, which were not present in their data set. Other fishers only donated smaller rostra of *P. zijsron* and *P. clavata* to the present study. Effects and impacts of rostra collection do likely differ by species

Table 4. Percentages of sawfish per age class (young-of-the-year [YOY], juvenile, subadult, adult) captured via different fishing methods for all species and each species. Data includes n = 667 complete rostra of Queensland origin

Fishing gear	% YOY	% Juvenile	% Subadult	% Adult
All species combined				
Gillnet (n = 615)	36.9	21.1	8.1	33.8
Trawler (n = 7)	14.3	0	14.3	71.4
Crab Pot (n = 1)	0	100	0	0
Unknown (n = 44)	9.1	27.3	9.1	54.6
Anoxypristis cuspidata				
Gillnet (n = 530)	41.9	12.6	9.3	36.3
Trawler (n = 1)	0	0	100	0
Unknown (n = 21)	19	9.5	14.3	57.1
Pristis clavata				
Gillnet (n = 34)	5.9	94.1	0	0
Unknown (n = 3)	0	100	0	0
P. pristis				
Gillnet (n = 19)	15.8	78.9	0	5.3
Trawler (n = 1)	0	0	0	100
Unknown (n = 8)	0	37.5	12.5	50
P. zijsron				
Gillnet (n = 32)	3.1	50	0	46.9
Trawler (n = 5)	20	0	0	80
Crab Pot (n = 1)	0	100	0	0
Unknown (n = 12)	0	33.3	0	66.7

and are likely higher on species that grow larger and mature later, such as *P. zijsron,* compared to smaller species such as *A. cuspidata* or *P. clavata*.

The geographic impact by fishers in the mass retention subgroup on sawfish populations is reported as the geographic coverage of their fishing grounds. However, sawfishes were likely encountered in specific hotspots within fishing grounds. Integrated fisheries management that allows gillnetting but protects sawfishes will likely only be successful if key geographic areas or habitats are closed to gillnetting, and fishers are confident to release sawfishes in good condition safely. However, key habitats are difficult to define for sawfishes as biological data is scarce.

4.4. Effect of capture method on species/age class — gillnetting as a key threatening process for sawfishes

Ninety-two percent of sawfishes in the present study had been caught by gillnet. These data indicate that, both historically and recently, targeted and incidental captures in gillnets represent a key threatening process for all species of sawfish in Queensland. Globally, gillnet captures have also been identified as a key threat to sawfishes (Simpfendorfer 2000, Stobutzki et al. 2002). Trawlers also have a notable impact, as the majority (80%) of rostra originating from trawlers belonged to adult sawfishes, some estimated to have been over 60 yr old at mortality. The impact of these captures may be mitigated to a certain extent, but that requires fishers to be trained in and willing to implement quick release methods that minimize harm to sawfishes, people, or fishing gear (Wueringer 2017). An analysis of the incidental captures of sawfishes in the unbaited gillnets set by the Queensland Shark Control Program supports this idea, reporting that the majority of sawfishes captured between 1962–2016 were reported to be alive upon the encounter with the contractors (Wueringer 2017). These data indicate that sawfishes survive the initial gillnet capture, likely because batoids can ventilate their gills through active buccal pumping (Ellis et al. 2017). However, it is essential to note that post-release mortality and potential adverse effects on fecundity due to gillnet captures have never been assessed in sawfishes.

4.5. SOCI comparison with gillnet mortalities

In Queensland, all 4 species of sawfish were listed as no-take species in the Fisheries Act 1994 in 2009. Since 2002, it is compulsory for Queensland's commercial fishers to report any interaction with a sawfish in their SOCI logbooks, as per requirement of ecological guidelines of the EPBC Act 1999. The comparison between SOCI data for GoCIFFF with observer data from the N3 component, both for 2008–2009, clearly indicates that fishers are under-reporting their interactions with sawfishes (Fig. 10), even though this reporting is required by law. Zeller & Lawson (2015) do not specify how many observers were present on how many vessels of the N3 net fishery of the GoCIFFF, but it is reasonable to assume that observer coverage was not 100%, either on a geographic or time scale. The increase in reported sawfish interactions in SOCI data in recent years indicates an increased willingness to report, but it remains questionable if these data could ever be used to estimate regional sawfish abundances across Queensland. Observer data from 2008–2009 indicated that the majority of sawfishes were released alive (Zeller & Lawson 2015).

The sawfish species composition reported in SOCI data over the years is more diverse in the GoCIFFF than in the ECIFFF (Fig. 12). Interestingly, especially

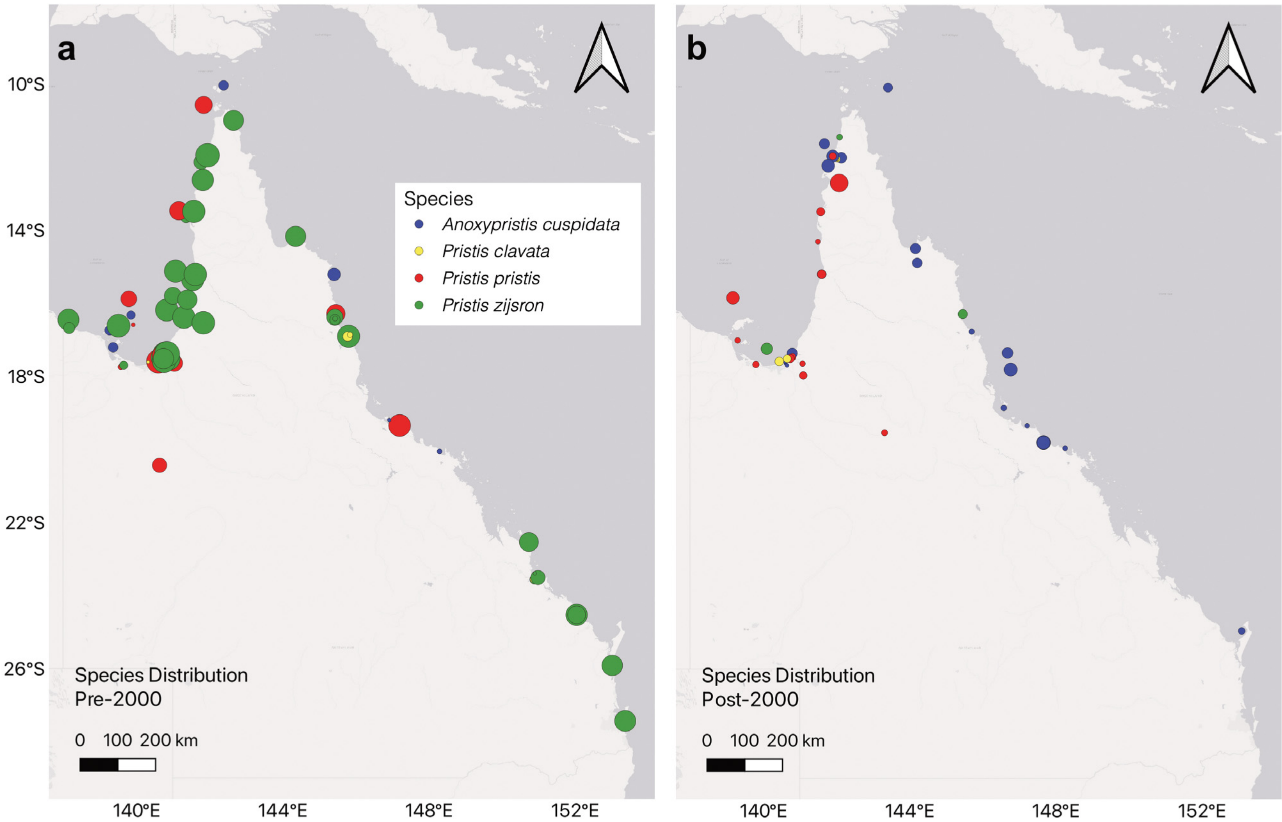

Fig. 7. Current and historic size and distribution for small-scale retention subgroup rostra of known date and relative location (n = 145) caught (a) pre-2000 and (b) post-2000. Skew towards species composition dominated by n ≤ 5 fishers of mass retention subgroup is removed. The size of the circle corresponds to the size of the estimated total length of the sawfish. Location precision varies within the dataset but falls within the size of the circle and does not affect accuracy of species distribution

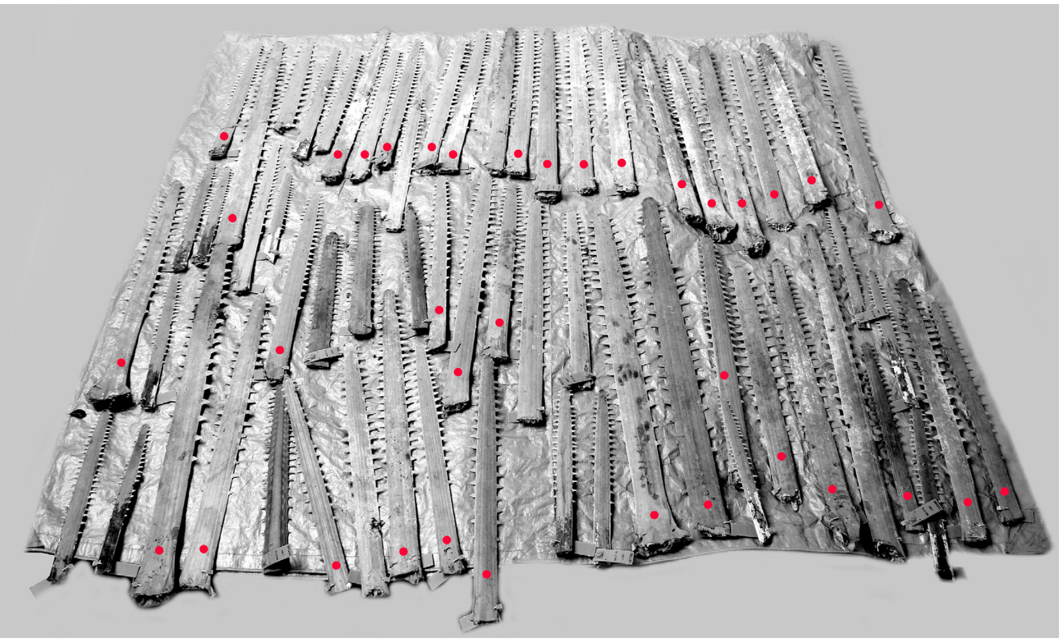

Fig. 8. Of a subset of n = 63 sawfish rostra, at least n = 36 rostra (marked with red dots) had been cut so deep into the head that it would have been fatal to the sawfish

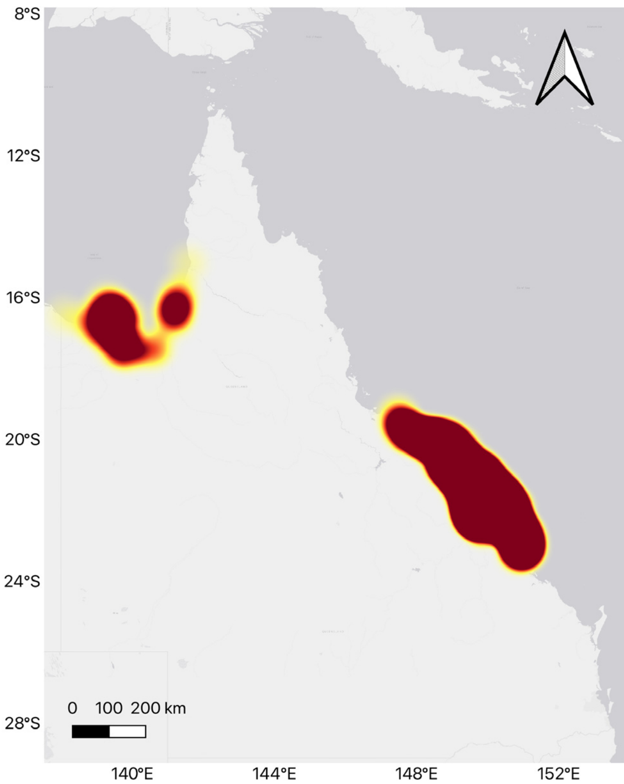

Fig. 9. Heat map indicating distribution of rostra in the mass retention subgroup. All rostra were donated by or confiscated from ≤5 commercial inshore set-net fishers. Density is indicated on a red (high) to yellow (low) gradient

in recent years, SOCI data from both ECIFFF and GoCIFFF report interactions with all 4 species of sawfish, including a relatively high number of interactions with *P. pristis* in the ECIFFF in 2018. However, it is unknown how well trained fishers are at distinguishing sawfish species. To direct sawfish conservation efforts across the state, it is imperative to identify where rare species such as *P. pristis* on the east coast of Queensland are still present according to SOCI data, so that research efforts can be concentrated in these geographic areas. Species composition is also more diverse in rostra composition before the year 2000 (Fig. 5a) compared with after the year 2000 (Fig. 5b). These data likely indicate that the impacts of trophy hunting and commercial net fishing are decreasing species diversity for sawfishes along the east coast of Queensland, with a shift towards *A. cuspidata*, the species with the highest fecundity of all 4 sawfish species and the earliest to reach sexual maturity (at 2–3 yr) (Peverell 2005).

In the GoCIFFF, sawfish interactions reported in SOCI logbooks in the set net category fall under the N3 inshore fishery (90 licences in 2003, 85 in 2020), the offshore N9 fishery (5 licences in 2003–2012 when the fishery ceased operation), the offshore N12 fishery (commenced in 2013, 3 licences since), and the offshore N13 fishery (1 licence since 2013) (Queensland Gulf of Carpentaria Inshore Fin Fish Fishery 2019). In the ECIFFF, sawfish interactions reported in SOCI logbooks in the set net category fall under the inshore N2 fishery (94 licences in 2019), and the offshore N4 fishery (4 licences in 2019, 3 licences since 2021 plus 2 held by the World Wide Fund) (www.fishnet.fisheries.qld.gov.au). Thus, up to 193 gillnet licences in Queensland contributed to the SOCI logbook sawfish interaction data compared with our mass retention subgroup, which only contains partial data of ≤5 commercial gillnet licence holders. It is unknown how many of the active commercial gillnet fishers have contributed to SOCI logbook data over the years, but comparison of SOCI data from all gillnet fisheries with rostra from ≤5 commercial gillnet license holders indicates that most fishers likely do not report their sawfish interactions accurately.

4.6. Possession of rostra and fines issued

Currently, QDAF officers can issue an on-the-spot fine of AUD 575, with the maximum penalty for possession/taking of regulated fish being AUD 143 750 (QDAF Fisheries Manager pers. comm.). Given that individual sawfish rostra in Australia can sell for prices as high as AUD 3416 (*P. zijsron*, 2020 auction in NSW, SARA Submission No. 0696, unpubl.), with most rostra selling for a few hundred AUD (for example: *P. pristis*, 2019, AUD 200 SARA Submission No. 0590; *P. zijsron*, 2020, AUD 325, SARA Submission No. 0722; *P. pristis, P. zijsron, A. cuspidata*, 2020, AUD 750 each, SARA Submission No. 0309; all unpubl.), the on-the-spot fine and fines issued to fishers appear low in comparison to the value of trophy rostra.

In Queensland, sawfish rostra are owned by (1) members of the general public (individual, old rostra); (2) museums, pubs, and roadhouses, (often privately owned collections of up to 10 locally acquired, historic rostra); and (3) commercial gillnetters. Conversations by 2 authors (B. E. Wueringer, V. N. Biskis) with fishers across Queensland indicate that they stopped removing rostra from sawfishes when they were protected, but some did not know that possession of rostra required a permit. One fisher of the mass retention subgroup donated more than 400 sawfish rostra to SARA, which appears to be the largest haul globally. This, together with the fact that

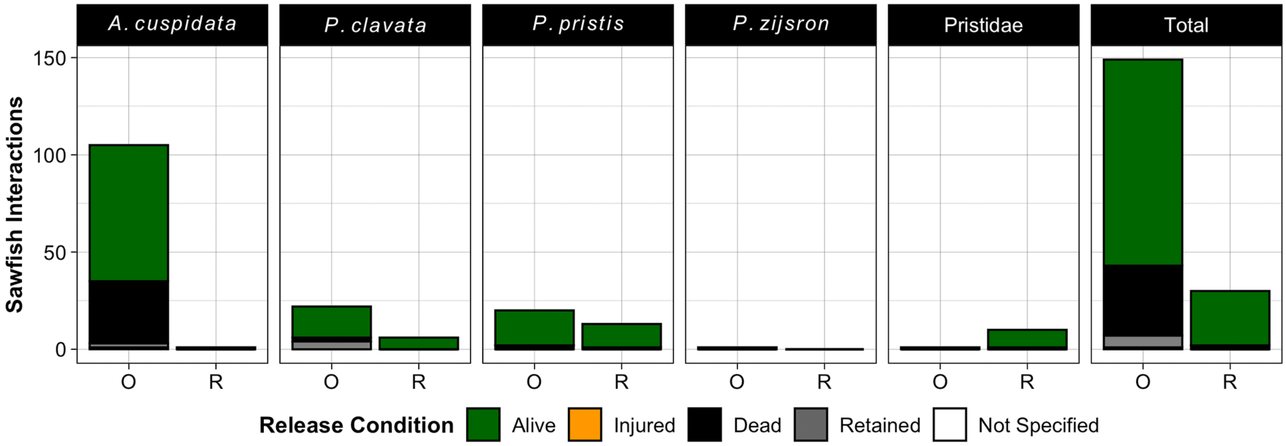

Fig. 10. Comparison of Species of Conservation Interest (SOCI) data of 2008–2009, which contains data (R) from all net fisheries across the Gulf of Carpentaria Inshore Fin Fish Fishery (GoCIFFF) with observer (O) records from the same time span (N3 inshore net fishery of GoCIFFF only), as reported by Zeller & Lawson (2015). *P.*: *Pristis*; *A.*: *Anoxypristis*

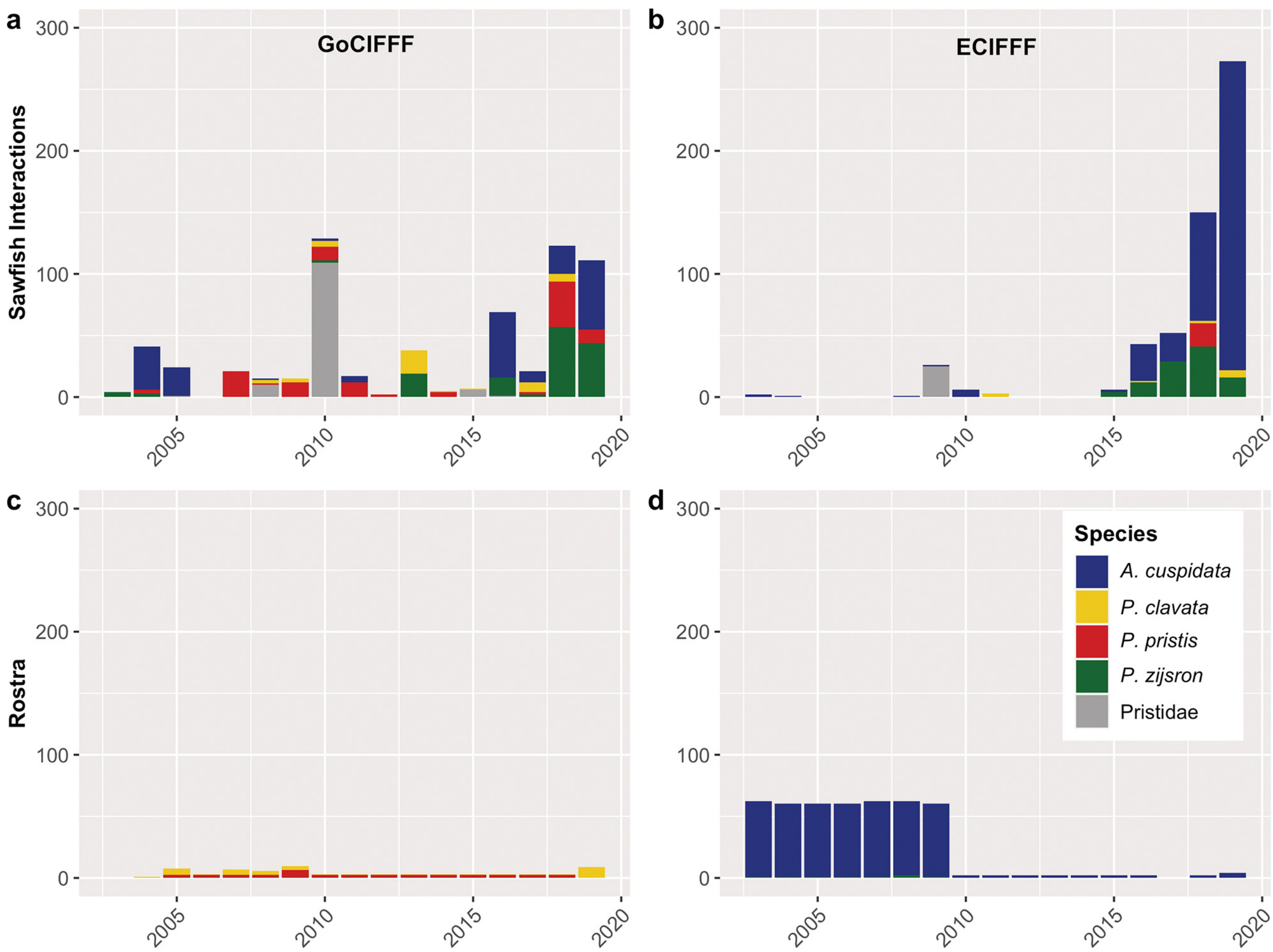

Fig. 11. Sawfish interactions as reported by set-net fishers in the (a) Gulf of Carpentaria Inshore Fin Fish Fishery (GoCIFFF) and (b) East Coast Inshore Fin Fish Fishery (ECIFFF) in their compulsory Species of Conservation Interest (SOCI) logbooks, between 2003 and 2019, in comparison with gillnet rostra mortalities present in the (c) GoCIFFF and (d) ECIFFF. Data of rostra were spread out over the years that they were taken as indicated by fishers

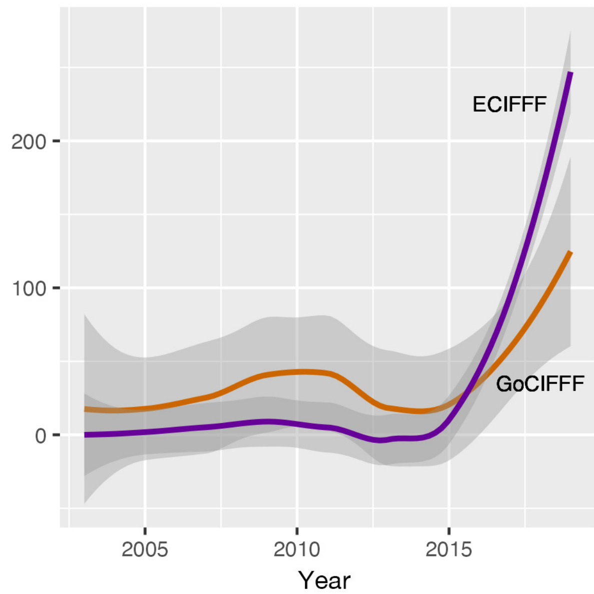

Fig. 12. Sawfish interactions in 2003–2019 as reported by set-net fishers in the East Coast Inshore Fin Fish Fishery (ECIFFF) and Gulf of Carpentaria Inshore Fin Fish Fishery (GoCIFFF) in their compulsory Species of Conservation Interest (SOCI) logbooks. Data is presented as a Loess function, shaded areas represent 95% confidence interval. Purple line: ECIFFF; orange line: GoCIFFF

SARA received multiple donations of rostra directly linked to active commercial gillnet fishers, indicates that the issue of removing rostra from sawfish could be ongoing. This is underpinned by multiple personal communications to B. E. Wueringer and V. N. Biskis by members of the general public, who were told by commercial fishers that sawfish rostra grow back after amputation, even though they do not (Morgan et al. 2016).

4.7. Conservation implications

This study shows that sawfish rostra can be used to derive biological parameters of sawfishes. Rostra, along with catch data, can also be used to understand the historical and current population distributions for sawfishes. Extensive fishing activity within important habitats is likely to have significant implications for the local recovery of sawfishes (Harrison & Dulvy 2014). As *Pristis* spp. are slow-growing, reaching sexual maturity at around 9 yr of age for some species (Last & Stevens 2009, Peverell 2005), population recovery for Queensland's *Pristis* spp. will likely take decades. This also means that sawfish population recovery may take several decades before the threat of extinction has disappeared (Simpfendorfer 2000). Within the CEC, 518 out of the 534 rostra belonged to *A. cuspidata.* Percentages of occurrence of YOY (41.9%) and adult (35.7%) *A. cuspidata* were comparable, with fewer juveniles (12.9%) and subadults (9.5%). This implies that all life history stages of this species are susceptible to being caught in inshore gillnet fisheries. As this species reaches sexual maturity at a younger age than other sawfishes, at around 2–3 yr old, *A. cuspidata* is likely more resilient to fishing pressures than *Pristis* spp. (Peverell 2005, Harrison & Dulvy 2014, Dulvy et al. 2016). However, *A. cuspidata* has the highest post-release mortality of any sawfish species and is thus not immune to being caught as bycatch (Harrison & Dulvy 2014, Dulvy et al. 2016).

Successful conservation of endangered species includes maintaining genetic diversity across populations. Sawfishes are known to display reproductive philopatry with fine-scale ranges, and some species have male-biased dispersal (Phillips et al. 2011, Feutry et al. 2015, Green et al. 2018, Feutry et al. 2021, Smith et al. 2021). Moreover, the 3 *Pristis* species have experienced population bottlenecks in the Gulf of Carpentaria (Phillips et al. 2017). Genetic data on east coast *Pristis* spp. are lacking, as the animals have become extremely rare. It is vital that the protection of remnant populations in Queensland is successful.

Management of interactions of protected species with fisheries depends on accurate reporting in fishery logbooks, as fisheries managers have to account for total and acceptable levels of fishing mortalities (Emery et al. 2019). The issue of underreporting protected species interactions in logbooks is widespread, but it can be combated with electronic monitoring (Emery et al. 2019). It is of vital importance for sawfishes that changes in Queensland's Sustainable Fisheries Strategy are implemented quickly and include independently validated electronic monitoring of protected species interactions, closure of key habitats, and a training module on how to successfully release protected species safely. With the recent re-assessment of the IUCN Redlist statuses of all 3 Australian *Pristis* spp. indicating globally Critically Endangered statuses (Espinoza at al. 2022, Grant et al. 2022, Harry et al. 2022), Australia and Queensland have a responsibility to manage the last global stronghold of these species accordingly.

Acknowledgements. Sawfish rostra were donated by the Department of Agriculture and Fisheries and members of the general public to Sharks And Rays Australia (General Fisheries Permit No. 200015, and No. 256550). Rostra data were taken by B.E.W., V.N.B., and SARA volunteers (Patrick Burke, Julia Constance, Annmarie Fearing, Emmaline Hardy, Russell Hosp, Constanza Ordones, Emily Robson) and interns (Lisa Stevenson, Ben Mooney, Maddison Jones). Manuscript drafts written and data analyses by all authors, maps created by V.N.B., plots created by V.N.B. and G.A.P.. This study is part of a larger project on the biology and conservation of sawfishes in Queensland. It is funded by the Save Our Seas Foundation (grant Nos. 309, 278, 457), a Small Grant from the Shark Conservation Fund, funding from the Sea World Research and Rescue Foundation, and funding from the Queensland Government (Citizen Science grant from the Office of the Chief Scientist, and an Engaging Science grant). The authors and SARA would like to thank the many officers from Queensland Fisheries (Department of Agriculture and Fisheries), as well as many members of the general public, for donating sawfish rostra. We also thank the 3 anonymous reviewers for their time and expertise.

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Editorial responsibility: Richard Reina, Clayton, Victoria, Australia
Reviewed by: J. Seitz and 1 anonymous referee

Submitted: June 14, 2022
Accepted: December 13, 2022
Proofs received from author(s): March 5, 2023