# Fish species transshipped at sea (*Saiko* fish) in Ghana with a note on implications for marine conservation

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# Abstract

Increasing global seafood demand over the last couple of decades has resulted in overexploitation of certain fish species by both industrial and small-scale artisanal fishers. This phenomenon has threatened the livelihoods and food security of small-scale fishing communities especially in the West African sub-region. In Ghana, fish transshipment (locally referred to as *saiko*) has been catalogued as one more negative practice that is exacerbating an already dire situation. The goal of this study was to characterise transshipped fish species landed in Ghana on the basis of composition, habitat of origin, maturity and conservation status on the IUCN list of threatened species to enhance understanding of the ecological implications of the practice and inform regulatory enforcement and policy formulation. Using identification manuals, morphometric and gravimetric analyses among others, data on *saiko* fish samples landed at Elmina in the Central Region of Ghana were collected at bi-weekly intervals between November 2016 and June 2017. A total of sixty-eight (68) fish species from 44 families comprising finfish and shellfish of pelagic, demersal, benthopelagic, and reef-associated fishes were identified. The round scad (*Decapterus punctatus*), the mackerel scad (*Caranx rhonchus*), the round sardine (*Sardinella aurita*) and the red pandora (*Pagellus bellottii*) were the numerically dominant species recorded. By habitat classification, 44 species (65%) were demersals while 6 species (9%) were pelagic and 6 species (9%) were reef-associated. Majority of the demersal species were juveniles while composition of juveniles among the pelagic species ranged between 67% - 84%. In addition, 6 (10%) of the recorded species were either vulnerable or near threatened on the IUCN red list of threatened species. It could be deduced from these observations that the recruitment of juveniles into the small pelagic fish stocks may be compromised and possibly lead to the future collapse of such fishery. The practice is also inadvertently a clear threat to the marine ecosystem, and sustainable fish production in Ghana.


# 1. Introduction

Fish is a major source of protein for Africans who consume about 21% of global fish output (FAO, 2016). Regrettably, with the increased demand for seafood globally, the oceans have been intensely overexploited of certain fish species by both industrial and small-scale artisanal fishers. According to the Food and Agriculture Organization of the United Nations (2016), 31% of global fish stocks were overfished or fished unsustainably, as of 2013, while another 58% were “fully fished”. In West Africa, industrial vessels compete with small-scale artisanal boats for same fish species and fishing grounds putting more pressure on fish populations. Consequently, fish stocks have declined, and artisanal fishers are working in increasingly difficult conditions. This threatens the livelihoods and food security of small-scale fishing communities in the region.

In Ghana, the challenges have birthed a new practice of transshipment at-sea; locally referred to as *saiko*. The term *saiko* was originally derived from Japanese industrial trawlers, whose vessels discarded their bycatch which they considered useless and thrown into the sea to create room for storage in exchange

for food items and other valuables. The Japanese words "*saite*" and "*saiko*" were used to distinguish between "bad" and "good" fish respectively. The practice is literally legitimized in Elmina because the *saiko* operators have formed an association and appointed executives. The *saiko* boats are marked to distinguish them from the other artisanal fishing boats, with the operators having operational arrangements with the Ghana Industrial Trawlers Association (GITA).

Transshipment is the act of transferring the catch from one fishing vessel to either another fishing vessel or to a vessel used solely for the carriage of cargo (EJF, 2018). *Saiko* involves the transshipment of frozen by-catch from industrial fishing vessels to small-scale artisanal canoes without supervision, which is prohibited under the fisheries laws of Ghana (Fisheries Act 625, 2002). The Fisheries Regulation 2010 (LI 1968) further outlaws the practice of *saiko.* Though it is deemed illegal, *saiko* has been described as having a 'double-edged sword' effect, being positive and useful in one scenario and negative and destructive in another. While some authors such as Nunoo et al. (2009) earlier suggested that by-catch which was deemed thrash fish (*saiko*) was treasure for fishers, latter workers such as Lazar et al. (2018) have argued that *saiko* is a major contributor to fish stock collapse in the country.

Resource managers and researchers have also argued that *saiko* is problematic from an ecological perspective and violates conservation and sustainable management measures. They contend that, *saiko* is a barrier when trying to determine if the fish has been caught legally. *Saiko* exacerbate the issue of overfishing and threatens effective management of fisheries. Transshipment at-sea has strong links with illegal, unreported and unregulated (IUU) fishing activities and other crimes including money laundering, transport of drugs, and human trafficking.

Industrial trawlers now deliberately target by-catch species, including juveniles, to sell to small-scale fishers. This aggravates overfishing leading to possible extinction of some fish species and stock collapse. According to the FAO (2010) "Bycatch is of concern when it comprises a significant proportion of the capture in a specific fishery, or when, across all fisheries, it comprises a large proportion of the catch in a fishery". Indeed, *saiko* is also putting the industrial fishing vessels in direct competition with majority of the small-scale fishers for catches and if the practice continues, Ghana's long-standing 'seek and capture' traditional fishing vocation may be lost (Atta-Mills et al., 2004), since transshipment is becoming the preferred method for some fishing communities. Illegal, unreported and unregulated fishing is a substantial global problem threatening ecosystems, food security, and livelihoods around the world. To reduce IUU fishing, it is important to address the challenges associated with transshipment.

*Saiko* is a poorly researched issue considering its impact on Ghana's fisheries. Categorizing species composition and diversity from the *saiko* catches will enhance understanding of the ecological implications of the practice and inform regulatory enforcement and policy formulation. To date no systematic, comprehensive and empirical research exist on *saiko* fishery focusing on the diversity of species transshipped, maturity and conservation status of the species harvested. To increase our understanding of the implications of the practice on marine fisheries conservation, we sought to assess fish species composition, habitat categorization, maturity and conservation status of the *saiko* fish

samples which are important determinants of ecosystem productivity and ecological stability. The information is also needed for formulating policy and management decisions. It is anticipated that the results of this study will give a comprehensively informed outlook on IUU fishing practices and inform researchers, policy makers and resource managers on the need to develop policies and management options to safeguard fisheries resources in West Africa and beyond.

# 2. Materials And Methods

### *2.1 Study area*

This study was conducted from February 2016 to June 2018 in Elmina (5°5′0″N 1°21′0″W) (Fig. 1a & b) which is the third largest fish landing site in Ghana (Aheto et al., 2012). Elmina was purposively selected because it contributes about 15% of the country's total fish output (Hen Mpoano, 2015a) and has the highest intensity of *saiko* operations in the country (Hen Mpoano, 2015b).). Being a historic fishing community where fishing dates to the 1400s (Odotei, 1992), the Elmina fish landing harbor provides a very good landing quay for all types of canoes and small semi-industrial boats engaged in traditional fisheries. In 2013, it was estimated that, there were 5890 fishermen and 411 canoes operating in Elmina (Akyeampong et al., 2013).

### *2.2 Data collection*

Samples of frozen fish slabs were randomly collected from *saiko* canoes at the *saiko* landing site within the Elmina fish landing quay every fortnight over a period of six months between November 2016 and June 2017. Samples were not taken in February and March 2017 due to the industrial fishing closed season implementation in the country. A total of 4,713 *saiko* fish specimens were sampled. On each sampling occasion, collected fish were identified and classified using taxonomic manuals on fishes in the coastal waters of Ghana (Kwei and Adu-Ofori, 2005) and in the Gulf of Guinea (Schneider, 1990). The total length (TL) of finfish was measured to the nearest 0.1 cm using a fish measuring board, while carapace length for crabs and mantle length for cephalopods were measured to the nearest 0.1 cm using a Vernier caliper. Total length of finfish was measured from the tip of the snout to the end of the caudal fin, mantle length of cephalopods was measured from the anterior edge of the mantle to the posterior end, while carapace length of crabs was measured from the anterior end to the posterior end of the carapace. The weight of each specimen was recorded to the nearest 0.01 g using a digital balance.

Desktop study was carried out to establish the habitat and niches for each of the species following which the fish were classified into pelagic, demersal, benthic, neritic, benthopelagic, pelagic-neritic, semi-pelagic; bathydemersal and reef associated. Furthermore, the status of each of the species on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species was determined. The maturity size of fish species with a sample size of 100 or more was determined by comparing with other studies.

### *2.3 Data analysis*

Total length of each species was analysed based on their ranges. Percentage composition of fish species by habitat, numerical dominance and status on the IUCN red list were analysed and presented in pie charts. The proportions (%) of juvenile and mature fish in the samples by species were estimated and tabulated.

# 3. Results

### *3.1 Composition of species in the transshipped (saiko) fish samples*

Table 1 provides information on the *saiko* fish samples. A total of sixty-eight (68) fish species from 44 families were identified comprising finfish and shellfish of pelagic (P), semi-pelagic (SP), demersal (D), neritic (N), benthopelagic (BP) and reef associated species (RF) among others. The commonest among these are the round scad *Decapterus punctatus* (Carangidae), the mackerel scad *Caranx rhonchus* (Carangidae), the round sardine *Sardinella aurita* (Clupeidae) and the red pandora *Pagellus bellottii* (Sparidae) which are also very important in Ghana's small-scale fisheries.

**Table 1: Inventory of fish species encountered in the *saiko* fish samples**

| Family | Species | Common Name | No. of specimens | Range TL(cm) | | IUCN Status |
|---|---|---|---|---|---|---|
| | | | | Min | Max | |
| *Finfishes* | | | | | | |
| Acanthuridae | *Acanthurus monronviae* (D) | Monrovia doctorfish | 4 | 34.8 | 38.5 | Least concern |
| Apogonidae | *Apogon* sp. (D) | Cardinalfish | 17 | 6.5 | 11.4 | - |
| Ariommatidae | *Ariomma bondi* (BP) | Silver-rag driftfish | 7 | 15.0 | 17.6 | Least concern |
| Balistidae | *Balistes punctatus* (D) | Blue spotted triggerfish | 2 | 24.1 | 24.6 | Vulnerable |
| Balistidae | *Balistes capriscus* (D) | Grey triggerfish | 4 | 29.0 | 44.0 | Vulnerable |
| Bathysauridae | *Bathysaurus ferox* (BD) | Deep-sea lizardfish | 10 | 10.8 | 21.3 | Least concern |
| Batrachoididae | *Halobactrachus didactylus* (D) | Lusitanian toadfish | 4 | 21.1 | 21.8 | Least concern |
| Bothidae | *Bothus guibei* (D) | Guinean flounder | 233 | 6.0 | 17.6 | Data deficient |
| Bothidae | *Bothus podas* (D) | Wide-eyed flounder | 175 | 9 | 17.6 | Least concern |
| Bothidae | *Monolene helenensis* (D) | Moon flounder | 72 | 6.0 | 24.4 | Data deficient |
| Bothidae | *Monolene mertensi* (D) | Marten's moonflounder | 218 | 5.4 | 22.4 | Least concern |
| Bothidae | *Monolene microstoma* (D) | Smallmouth moonflounder | 10 | 5.8 | 21.3 | Least concern |
| Carangidae | *Chloroscombrus chrysurus* (BP) | Atlantic bumper | 1 | - | 17.0 | Least concern |
| Carangidae | *Decapterus punctatus* (P) | Round scad | 1124 | 6.0 | 29.0 | Least concern |
| Carangidae | *Caranx rhonchus* (P) | False scad/Mackerel scad | 789 | 5.0 | 19.9 | Least concern |
| Carangidae | *Trachurus trecae* (P) | Cunene horse mackerel | 106 | 13 | 18 | Least concern |
| Carcharhinidae | *Carcharhinus altimus* (P) | Bignose shark | 1 | - | 59 | Data deficient |
| Chaetodontidae | *Chaetodon robustus* (D) | Butterfly fish | 3 | 13.1 | 13.3 | Least concern |
| Pomacentridae | *Chromis cadenati* (RA) | Cadenat's chromis | 277 | 3.0 | 17.9 | Least concern |
| Clupeidae | *Sardinella aurita* (P) | Round sardine | 375 | 8.0 | 17.9 | Least concern |
| Cynoglossidae | *Cynoglossus senegalensis* (D) | Senegalese tonguesole | 1 | - | 30.5 | Near Threatened |
| Dactylopteridae | *Dactylopterus volitans* (RA) | Flying gurnard | 97 | 6.1 | 38.9 | Least concern |
| Engraulidae | *Engraulis encrasicolus* (PN) | European anchovy | 85 | 9.7 | 11.5 | Least concern |
| Fistulariidae | *Fistularia tabacaria* (RA) | Blue spotted cornetfish | 3 | 40 | 87 | Least concern |
| Haemulidae | *Brachydeuterus auritus* (SP) | Bigeye grunt | 56 | 9.4 | 21.2 | Near Threatened |

| Family | Species | Common Name | No. of specimens | Range TL(cm) | | IUCN Status |
|---|---|---|---|---|---|---|
| Haemulidae | *Parakuhlia macrophthalmus* (N) | Dara | 1 | - | 12.3 | Data deficient |
| Lutjanidae | *Apsilus fuscus* (D) | African forktail snapper | 4 | 11.5 | 15.3 | Least concern |
| Soleidae | *Microchirus ocellatus* (D) | four-eyed sole | 1 | 14.6 | 19.5 | data deficient |
| Monacanthidae | *Aleuterus heudoloti* (D) | Dotterel filefish | 1 | - | 9.3 | Least concern |
| Monacanthidae | *Aluterus schoepfii* (D) | Orange filefish | 3 | 32.5 | 45 | Least concern |
| Monacanthidae | *Cantherhines pullus* (D) | Oranges potted filefish | 1 | - | 14 | Least concern |
| Monacanthidae | *Stephanolepis hispidus* (D) | Planehead filefish | 13 | 10.0 | 20.1 | Least concern |
| Mullidae | *Pseudupeneus prayensis* (D) | West African goatfish | 18 | 11.9 | 143.2 | Vulnerable |
| Muraenesocidae | *Cynopticus ferox* (D) | Guinean pike | 1 | - | 11.4 | Least concern |
| Ogcocephalidae | *Dibranchus atlanticus* (BD) | Atlantic batfish | 1 | - | 10.5 | Least concern |
| Ophichthidae | *Mystriophis rostellatus* (D) | African spoon-nose eel | 1 | - | 40.1 | Least concern |
| Ophichthidae | *Osphisurus serpens* (D) | Serpent eel | 1 | - | 40.2 | Least concern |
| Priacanthidae | *Priacanthus arenatus* (RA) | Atlantic bigeye | 188 | 6.7 | 27.5 | Least concern |
| Rajidae | *Raja miraletus* (D) | Brown ray | 38 | 15 | 40 | Least concern |
| Scaridae | *Scarus hoefleri*(D) | Guinean parrotfish | 1 | - | 35.6 | Least concern |
| Labridae | *Xyrichtys novacula* (RA) | Pearly razorfish | 8 | 15.6 | 19.4 | Least concern |
| Scombridae | *Scomber colias* (P) | Atlantic chub mackerel | 10 | 14 | 24.2 | Least concern |
| Scorpaenidae | *Scorpaena annobonae* (D) | Annobon scorpionfish | 2 | 13.3 | 15.0 | Data deficient |
| Scorpaenidae | *Scorpaena laevis* (D) | Senegalese rockfish | 2 | 11.3 | 15.6 | Least concern |
| Scorpaenidae | *Scorpaena maderensis* (D) | Madeira rockfish | 1 | 12.4 | 14.6 | Least concern |
| Serranidae | *Rypticus saponaceus* (N) | greater soapfish | 3 | 19.3 | 22 | Least concern |
| Soleidae | *Dagetichthys lusitanicus* (D) | Portuguese sole | 1 | - | 12.3 | Not evaluated |
| Soleidae | *Microchirus* sp. (D) | - | 13 | 13 | 19.5 | - |
| Sparidae | *Boops boops* (D) | Bogue | 21 | 8.9 | 16.2 | Least concern |
| Sparidae | *Dentex angolensis* (D) | Angolan dentex | 4 | 12.3 | 15.5 | Near threatened |
| Sparidae | *Dentex canariensis* (D) | Canary dentex | 11 | 8.6 | 13.0 | Least concern |

| Family | Species | Common Name | No. of specimens | Range TL(cm) | | IUCN Status |
|---|---|---|---|---|---|---|
| Sparidae | *Dentex congoensis* (D) | Congo dentex | 26 | 9.4 | 21.2 | Least concern |
| Sparidae | *Pagellus bellottii* (D) | Red Pandora | 323 | 4.0 | 15.9 | Least concern |
| Sparidae | *Pagrus caeruleostictus* (D) | Blue spotted seabream | 12 | 9.5 | 12.8 | Least concern |
| Synodontidae | *Synodus saurus* (D) | Atlantic lizardfish | 3 | 13.5 | 17.3 | Least concern |
| Tetraodontidae | *Lagocephalus laevigatus* (PN) | Smooth puffer | 50 | 13.5 | 292 | Least concern |
| Synodontidae | *Trachinocephalus myops* (RA) | Bluntnose lizardfish | 118 | 7.7 | 39.4 | Least concern |
| Trachinidae | *Trachinus araneus* (D) | Spotted weaver | 1 | - | 18.5 | Least concern |
| Trachinidae | *Trachinus armatus* (D) | Guinean weaver | 10 | 14.4 | 23.3 | Least concern |
| Triglidae | *Chelidonichthys lastoviza* (D) | Streaked gurnard | 2 | 17.5 | 18.5 | Least concern |
| Triglidae | *Trigla lyra* (BD) | Piper gurnard | 112 | 12.1 | 25.5 | Least concern |
| Uranoscopidae | *Uranoscopus polli* (D) | White-spotted stargazer | 6 | 15.1 | 25.5 | Least concern |
| Zeidae | *Zeus faber* (BP) | John dory | 2 | 34.1 | 34.3 | Data deficient |
| **Shellfishes** | | | | | | |
| Sepiidae | *Sepia hierredda* (B) | Giant African cuttlefish* | 6 | 7.5 | 11.3 | Data deficient |
| Octopodidae | *Callistoctopus macropus* (D) | White-spotted octopus | 1 | - | - | Least concern |
| Loliginidae | *Alloteuthis africana* (D) | African squid* | 15 | 6 | 14.5 | - |
| Portunidae | *Callinectes marginatus* (D) | Marbled swim crab** | 2 | 3.7 | 5.3 | - |
| Scyllaridae | *Scyllarides herklostii* (D) | Red slipper lobster** | 1 | - | 8.2 | - |

*Mantle Length; **Carapace length
Habitat Classification: P - Pelagic; D - Demersal; B - Benthic; N- Neritic; BP - Benthopelagic; PN- Pelagic-neritic; SP- Semi-pelagic; BD- Bathydemersal; RA - Reef associated

In relation to habitats and niches occupied by the fish within the marine environment (Fig. 2), 44 out of the 68 species representing 65% were of demersal origin, 9% were pelagic species while a similar 9% were species associated with reef habitats. The rest were from diverse niches spanning across semi-pelagic, benthic and neritic zones of the ocean.

Numerically, pelagic species were dominant , with the round scad *Decapterus punctatus* (24%), the mackerel scad *Caranx rhonchus* (17%) and the round sardine *Sardinella aurita* (8%) together constituting nearly 50% of the landings (Fig. 3). Demersal fishes such as the sea breams (*Pagellus bellottii, Pagrus caeruleosticus, Dentex angolensis, Dentex canariensis, Dentex congoensis* - Sparidae), the snapper

(*Apsilus fuscus* – Lutjanidae), the sole (*Cynoglossus senegalensis*) and the flounders (*Monolene helensis, Monolene mertensi, Monolene microstoma, Bothus guibei, Bothus podas)* comprised less than 50% of the catch.

Analysis of status of the *saiko* fish on the IUCN Red List of Threatened Species showed that 5% were Near Threatened (NT) while 5% were Vulnerable (VU) (Fig. 4).

### *3.2 Proportions of juvenile and mature fish in the saiko samples*

In general, the common pelagic species namely *Decapterus punctatus*, *Caranx rhonchus, Trachurus trecae* and *Sardinella aurita* which dominated the *saiko* catch were largely immature fish specimens, with the proportion of juveniles ranging from 67% to 100% (Table 2). The sea bream *Pagellus bellottii* and the flounder *Bothus podas* which were common demersal fishes in the sample were entirely juveniles. A considerable proportion (54%) of the bluntnose lizardfish *Trachinocephalus myops* were mature while the rest (46%) were immature.

**Table 2: Proportions of juvenile and mature fish in the *saiko* fish sample**

| | N | Range TL (cm) | Proportion of sample | | Reported maturity length in other studies |
|---|---|---|---|---|---|
| | | | Juvenile | Mature | |
| *Decapterus punctatus* | 1124 | 6.0 - 29.0 | 67% | 32% | 11.0 cm (Fishbase, 2014) |
| *Caranx rhonchus* | 789 | 5.0 - 19.9 | 84% | 16% | 16.0 cm (Sley et al., 2015) |
| *Sardinella aurita* | 375 | 8.0 - 17.9 | 72% | 28% | 16.40 cm (Osei, 2015) |
| *Pagellus bellottii* | 323 | 4.0 - 15.9 | 100% | 0% | 20–21 cm (Asabere-Ameyaw, 2000) |
| *Bothus podas* | 175 | 9.0 - 17.6 | 100% | 0% | 20-21 cm (Abid et al., 2010) |
| *Trachinocephalus myops* | 118 | 7.7 - 39.4 | 46% | 54% | 18 cm (Yang et al., 2013) |
| *Trachurus trecae* | 106 | 13.0 – 18.0 | 100% | 0% | 1. cm (Fishbase, 2014) |

# 4. Discussion

### *4.1 Habitat and numerical composition of transshipped fish species*

The transshipped fish comprised pelagic, semi-pelagic, demersal, neritic, benthopelagic and reef associated species. The occurrence of fish from such a wide range of biotopes primarily suggests that the industrial trawl fishery is non-selective, and this could have a multiplicity of ecological effects on the marine communities and the ecosystem at large (Agardy, 2000). Importantly, the practice of “fishing down the food webs” through indiscriminate fishing of high trophic level bottom fishes together with low trophic level pelagic fishes by the trawlers could have potentially damaging effects on the marine ecosystem (Pauly et al., 1998). As indicated by Pauly et al. (1998) as well as Pauly and Palomares (2005), such patterns of exploitation are unsustainable although pervasive.

Although demersal fish had a diversity of 44 species, pelagic fish with a diversity of 6 species were numerically dominant constituting nearly 50% of the *saiko* landings. While the occurrence of a significant number of demersal species in the catch may not be of concern because these are the targeted species of the trawlers, the landing of large quantities of pelagic fishes raises fundamental issues of gear design, selectivity and illegality of the operations in relation to Ghana's fisheries regulations. This is because the industrial trawl vessels which transship the fish to artisanal canoes are licensed to operate only as bottom trawlers offshore targeting demersal stocks. It is claimed by the fishers that the small pelagics and other fishes traded as *saiko* commodity are bycatch or trash fish, but this has been argued by Nunoo et al. (2009) that the supposedly trash fish has become treasure due to the increasing demand of the commodity, hence, the industrial bottom trawl fleets are now targeting pelagic stocks than ever.

### *4.2 Composition of juveniles in transshipped fish*

Of a more serious concern is the preponderance of juveniles of both pelagic and demersal species in the catches. All specimens of the flounder *Bothus podas*, the sea bream *Pagellus bellottii,* and the horse mackerel *Trachurus trecae* sampled from the catches were immature while over 70% of others such as *Caranx rhonchus* and round sardine *Sardinella aurita* were also juveniles when compared with their reported maturity sizes in literature (e.g. Sley et al., 2015 for *Caranx rhonchus*; Osei, 2015 for *Sardinella aurita*; Asabere-Ameyaw, 2000 for *Pagellus bellottii*, etc. see Table 2). Harvesting significant proportion of juveniles of such important fish as *Sardinella aurita* which forms the back bone of Ghana's marine fishery gravely puts the country's fishery in a jeopardy. Already, Ghana's marine small pelagic fish stocks including *S. aurita* have declined significantly over the last two decades with projections pointing to a possible collapse in the year 2020 (Lazar et al., 2018), and the contribution of the *saiko* operations to this precarious situation cannot be underemphasised as the practice has equally progressed over two decades.

Again, the occurrence of appreciable quantities of immature fish in the catches of the industrial trawlers raises questions of compliance with designated fishing grounds for industrial trawling, prescribed mesh sizes of trawl nets and other regulations. Section 81(3) of Ghana's Fisheries Act 625 (2002) prohibits fishing by trawlers within the Inshore Economic Zone (IEZ - defined by 30-metre isobath or the 6 nautical miles offshore limit); the zone within which spawning and nursery activities of small pelagics occur. Being an exclusively reserved zone for small scale fishers, cases of livelihood conflicts continually ensue between the artisanal fishermen and industrial trawlers within the zone (Ameyaw, 2017). It is therefore difficult to assimilate that juveniles of small pelagics in trawl catches are incidental or by-catch rather than target fish. Granted, that these are by-catch, Section 89 (1) of the Act (2002), as well as Section 31 (1) of the Fisheries Regulation 2010 (L.I. 1968), requires persons who catch juvenile fish as by-catch to release them immediately to their natural environment in a manner that causes them no harm. Therefore, the apparent harvest and sale of juvenile fish in the *saiko* business suggests a deliberate non-compliance with the fisheries laws. It is also conceivable that the trawl fishers do not adhere to using the minimum mesh size of 60 mm prescribed in the Act for industrial trawl nets in the country, questioning sustainability of the practice.

### *4.3 Status of the saiko fish species on the IUCN red list and implications for marine conservation*

Fish transshipment is a major form of IUU in West Africa and therefore of immense international concern (EJF, 2018). Indeed, IUU fishing practices in particular have threatened fisheries conservation efforts around the globe (FAO, 2016). According to IUCN (2019), the issue of IUU is a global concern because it threatens fish stocks, the ocean biodiversity and the incomes of sustainable fisheries. The vulnerable fish species identified in this study are *Balistes punctatus, Balistes capriscus*, and *Pseudupeneus prayensis,* while the near-threatened are *Cynoglossus senegalensis, Brachydeuterus auritus* and *Dentex angolensis.* Though the proportion of near threatened species (5%) and vulnerable (5%) as categorized on the IUCN red list were low, it is important to note that they are the next category to become endangered so efforts should be made to conserve them. The practice is also inimical to marine conservation given the non-selective nature of the trawl fishery which depletes fish stocks. The trawl drags on sea floor and impacts on critical habitats affecting productivity, biodiversity and marine food webs (Hen Mpoano, 2015b).

# 5. Conclusions

Pelagic fish constituted about 50% of total *saiko* fish landed. This imply serious consequences for the sustainability of the artisanal fisheries sector in Ghana. Harvesting of threatened and vulnerable species also raises legitimate concerns about conservation of marine fish stocks in Ghanaian waters. The findings raise a number of issues including gear design and selectivity in the industrial trawl fishery in the face of a near collapse of the small pelagic fishery. The need to recognize that *saiko* harms the marine environment and the consequent commitment by regulators and relevant stakeholders to eliminate the practice in Ghana's waters is therefore imperative.  If unchecked, the socioeconomic implications are equally costly as it borders on the loss of livelihoods and income of about an estimated three million Ghanaians dependent on the fishery.

# 6. Recommendations

Fisheries management planning and enforcement targeted at curbing the *saiko* practice must be based on accurate data and the evaluation of the ecological impacts raised in this research. There is an urgent need for the creation and implementation of a national action plan against *saiko* and other forms of IUU through government inter-ministerial approach. National efforts to eradicate *saiko* should be based on consensus by government, industry and civil society actors. Specifically institutions such as the Attorney General's Department, Fisheries Enforcement Unit (FEU), Fisheries Associations, chief fishermen, traditional authorities and NGOs should play crucial roles. They should be tasked to formulate and implement a coherent but multi-disciplinary national plan of action towards *saiko* and other forms of IUU prevention including a monitoring and evaluation mechanisms. Finally, we recommend a legislative revision of the industrial trawl gear mesh size to above 60 mm at the codend.

# Declarations

### Acknowledgements

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### Ethical statement

This study did not involve experiments on humans and did not use unapproved methods of data collection.

### Author contributions

D.W.A designed research, supervised the work and wrote the manuscript, I.O. analysed the data, wrote the manuscript and revised the manuscript, N.K.A. designed and supervised the work, J.E. acquired data-sets, J.O.O. wrote some sections of the manuscript and reviewed the manuscript.

### Competing interests

The authors declare no competing interests.

### Disclaimer on trademarks

The mention or use of any trademarks in this study does not imply any affiliation with or endorsement of them.

### Data Availability

The datasets generated and used during this study are available from the corresponding authors on reasonable request.

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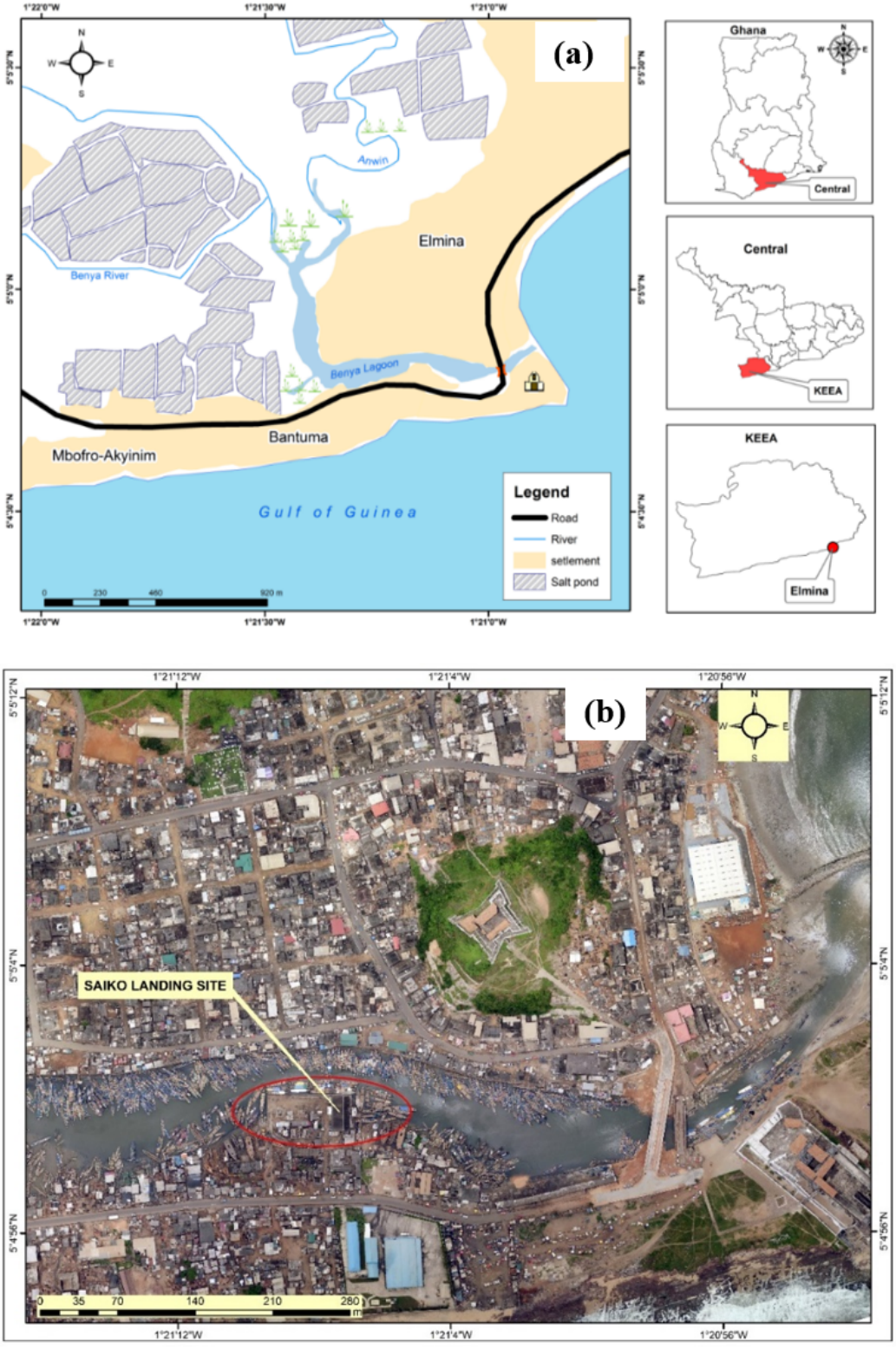
# Figures




## Figure 1

(a) Map of study Area Elmina; (b): Aerial photo of Elmina Landing Site (Source: Centre for Coastal Management, University of Cape Coast, 2016)

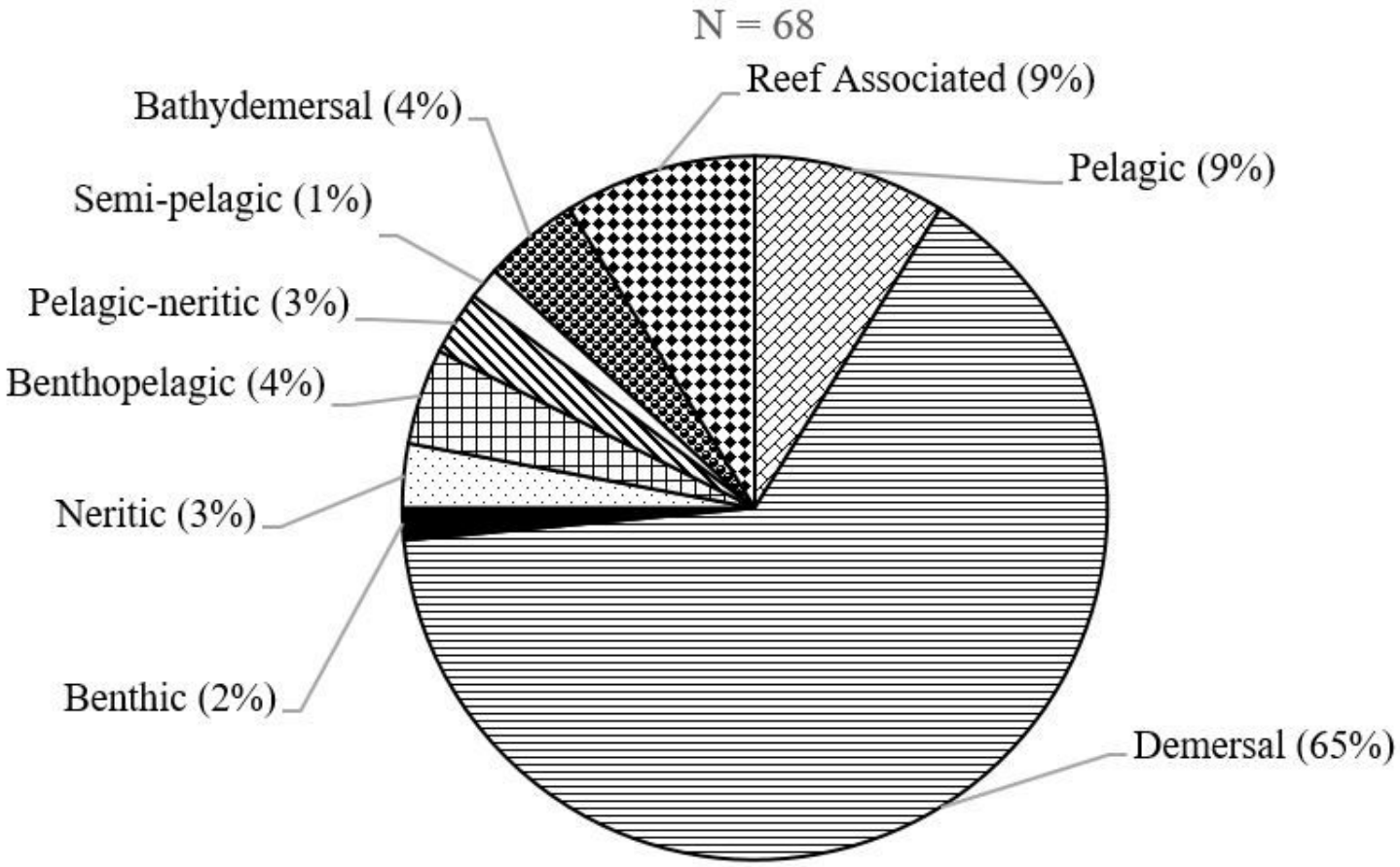
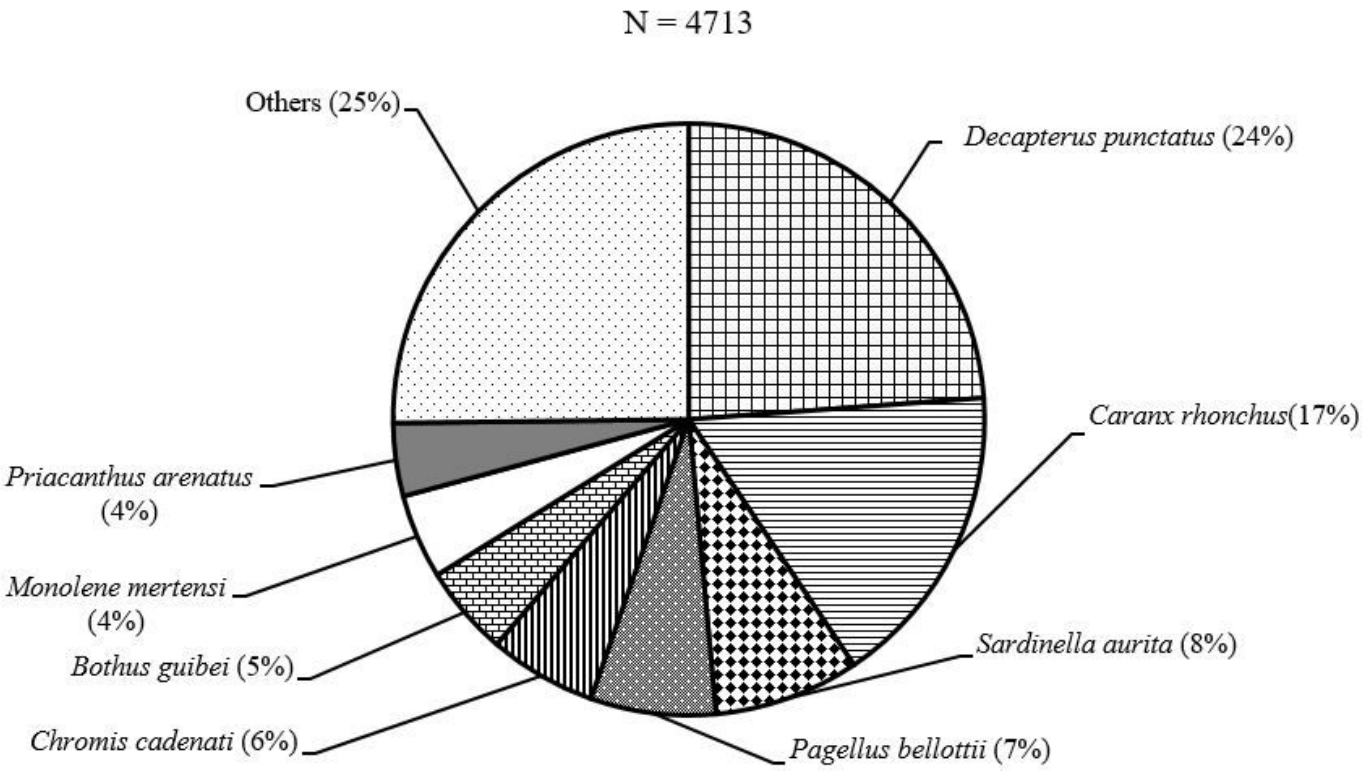


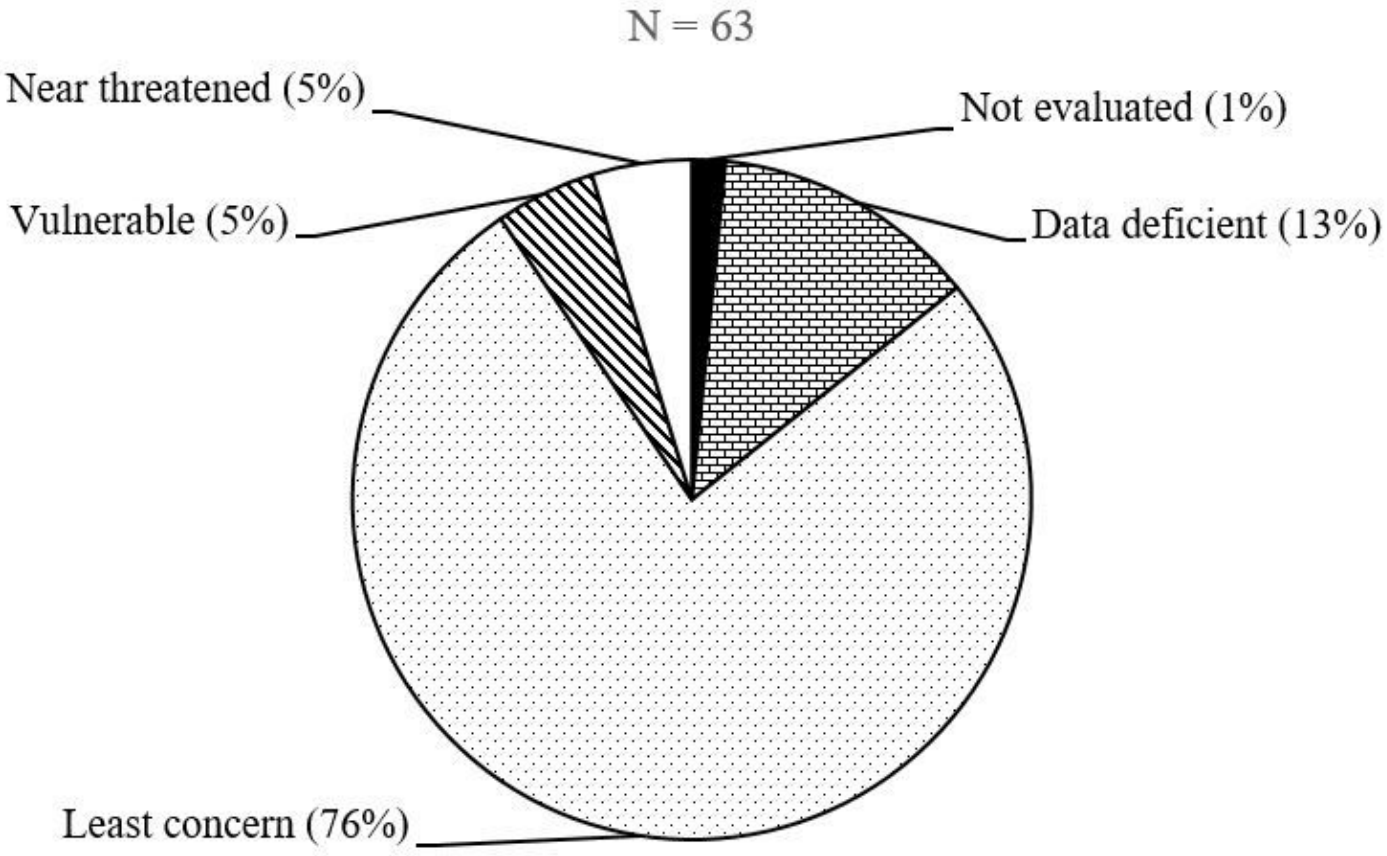

**Figure 2**

Composition of the transshipped fish species by habitats and niches




## Figure 3

Numerical composition of fish species in the saiko catch



## Figure 4

Status of saiko fish species on the IUCN Red List of Threatened Species