# Bycatch Assessment in the Gambian Sole Bottom Gillnet Fishery

**Gambia-Senegal Sustainable Fisheries Project (USAID/BaNafaa)**

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**Cover Photo:** Gambia gillnet fishery

**Photo Credit:** Christopher Parkins, USAID/BaNafaa project/World Wide Fund for Nature-West Africa Marine Program Office (WWF-WAMPO).

## Acknowledgements

There is little doubt that involving stakeholders as partners in developing management plans will assist in the progress towards improved management of the fishery resources. Local fishermen contributed greatly to this study on bycatch and subsequent research. We wish to thank the fishermen of the Gambia who participated in this project. The Gambian Department of Fisheries staff members, Asberr Mendy, Salifu Ceesay and Fatou Joof were key to collecting the information and developing the gillnet bycatch profile. This information dramatically improved the data poor scenario and allowed very specific questions to be formulated and investigated.

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## Introduction

Bycatch (or incidental catch) is commonly described as the unintended capture of species of fish. It will typically be retained for sale or use or discarded back to sea based on regulatory requirements or low value. By law, The Gambian fishermen are not permitted to discard, therefore all catch is landed regardless of its value, size or quantity.

Sole was reported as primarily harvested by the gillnet in the artisanal fishery. Three methods are generally used: circle, bottom stationary and drift. Usually considered to be one of the most selective gear types, the multispecies nature of the fishery complex in the Gambia increases the probability of impact on non-target species. Over the last few years, there has been a change in the gillnet characteristics and fishing methods as fishermen place more of an emphasis on catching high value demersal fish such as catfish, grunts and croakers leading to higher nets and a looser hanging ratio. The selectivity of the gillnet has decreased becoming more of an entanglement net (Gabis, et al., 2011).

During the pre-audit assessment conducted by the MSC in September 2008 for certification of the Gambian sole fishery, the lack of information on retained bycatch and ETP species was identified as a weakness for future management actions. Ninety-two potential non-target species had been identified by the MSC but insufficient data was available on these species to allow for a standardized assessment. 11 species were designated as high risk including catfish species, sharks and guitarfish and the captainfish (Giant African threadfin*, Polydactylus quadrifilis*). The MSC developed a simple risk evaluation of bycatch in the sole fishery using attributes referring to species productivity and susceptibility. Overall it was determined that a medium level of risk of causing serious or irreversible harm as a result of the sole fishery was present. However, more catch specific information would allow for a better understanding, especially if minimum sizes were to be used in management.

Additionally, it was highlighted that a co-management approach would produce a stronger plan for research and management activities. Therefore, a participatory bycatch assessment was developed with support from the BaNafaa project (USAID funded through WWF) in cooperation with the Department of Fisheries and stakeholders. The objective of this study was to document the bycatch with a particular concern for marine turtles and sharks and other vulnerable fish stocks.

## Materials and Methods

The bycatch surveys were carried out in the landings sites of Gunjur, Sanyang, Brufut and Kartong which collectively harvest over 50% of the artisanal fishery sole landings. At each site, a master fisherman was selected. A BaNafaa staff member accompanied the fishermen on the fishing trip and recorded bycatch (species and weight), fishing areas (using GPSMap 60CSx Compass (with an accuracy of < 10 meters)) and gear type. Fish were weighed using a 25 kg and 50 kg Salter scale). Fish were all brought back to the beach where recordings were made just prior to sale of the fish. Encounters with ETP species were also recorded. A minimum of three trips/month were recorded (Table 1). Fish were identified using the guide to the identification of saltwater Senegalese and Gambian Fish (Bellemans et al, 1988). Gear used by each fisherman was as standardized as possible however; mesh sizes and length of net varied by date and site.

Figure 1: Gillnet used to catch sole.

Table 1. Number of sampling trips per month per site

| | **Kartong** | **Sanyang** | **Brufut** | **Gunjur** |
|---|---|---|---|---|
| July 2010 | 3 | 3 | 3 | 3 |
| Aug | 10 | 10 | 10 | 9 |
| Sept | 8 | 9 | 9 | 9 |
| Oct | 8 | 7 | 8 | 9 |
| Nov | 6 | 5 | 7 | 4 |
| Dec | 9 | 6 | 8 | 10 |
| Jan 2011 | 8 | 9 | 8 | 8 |
| Feb | 8 | 8 | 9 | 8 |
| Mar | 10 | 10 | 9 | 9 |
| Apr | 8 | 8 | 8 | 9 |
| May | 9 | 9 | 9 | 8 |
| June | 9 | 8 | 9 | 9 |
| Total | 96 | 92 | 97 | 95 |

## Results

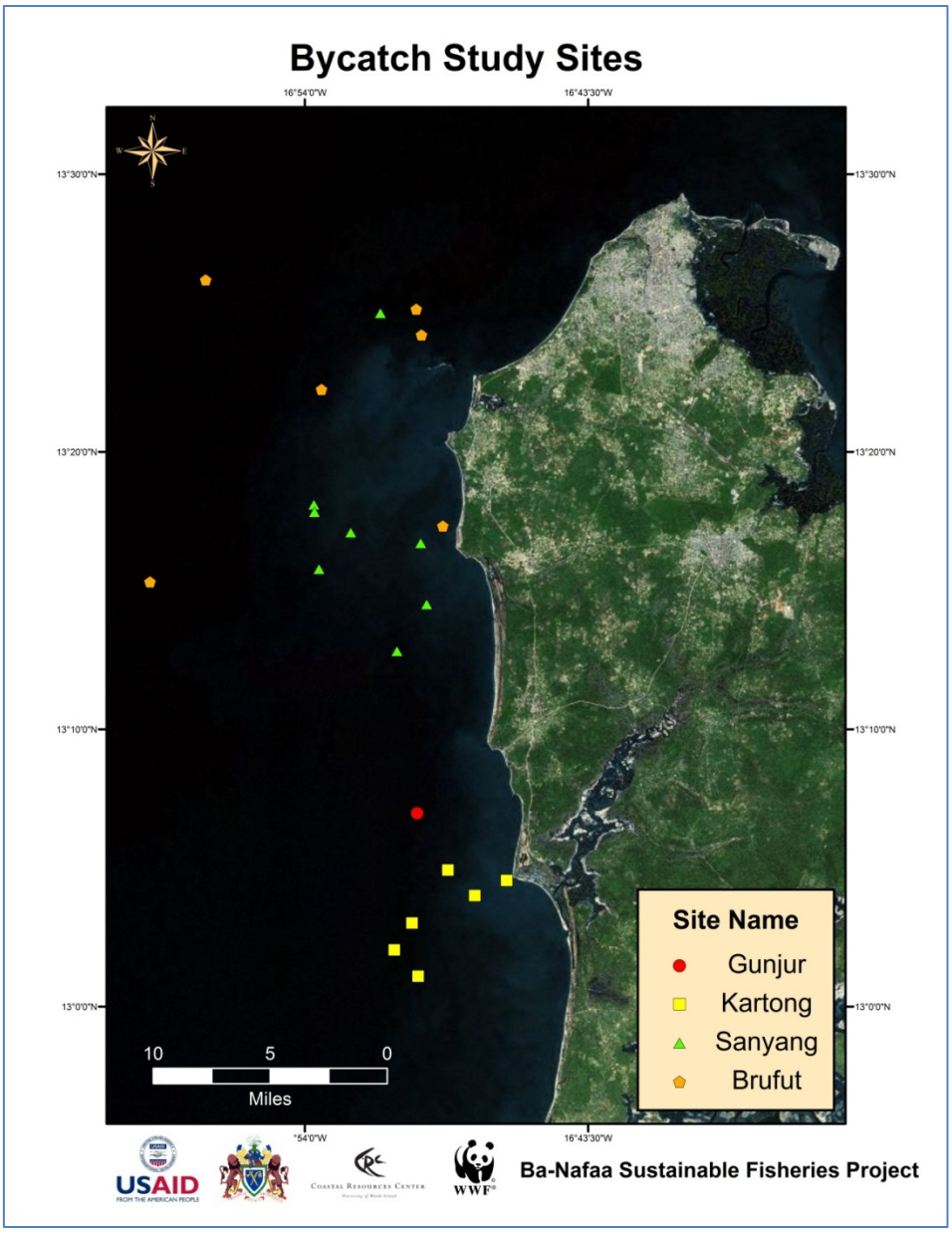


Figure 2: Location of fishing sites for bycatch characterization study.

Table 2. Number of total species collected in gillnet survey by site and month.

| Month | Gunjur | Brufut | Kartong | Sanyang |
|---|---|---|---|---|
| July 2010 | 16 | 21 | 23 | 25 |
| Aug | 24 | 29 | 34 | 27 |
| Sept | 13 | 23 | 25 | 23 |
| Oct | 23 | 28 | 26 | 30 |
| Nov | 26 | 31 | 26 | 26 |
| Dec | 18 | 27 | 30 | 28 |
| Jan 2011 | 19 | 22 | 30 | 33 |
| Feb | 24 | 22 | 30 | 29 |
| Mar | 26 | 23 | 27 | 35 |
| Apr | 19 | 26 | 27 | 26 |
| May | 26 | 30 | 24 | 30 |
| June | 27 | 31 | 24 | 29 |
| Total Species | 46 | 49 | 45 | 55 |

Table 3. Percent catch of *Cymbium* (mean weight in kgs) in bycatch survey by site

| Species | Kartong | Sanyang | Brufut | Gunjur |
|---|---|---|---|---|
| ***Cymbium cymbium*** | 2.6 | 4.3 | 6.1 | 6.0 |
| ***Cymbium pepo*** | 13.6 | 9.4 | 5.1 | 17.2 |
| ***Cymbium glans*** | 7.6 | 6.7 | 0.99 | 5.7 |
| Total | 23.8 | 20.4 | 12.2 | 28.9 |

Figure 3: Cymbium species are the largest bycatch (by weight) of the sole fishery.

Table 4. Percent catch of primary species (not including *Cymbium* species) by site and risk index (as determined by Medley et al., 2008).

| **Name** | **Common Name** | **Kartong** | **Sanyang** | **Brufut** | **Gunjur** | **Risk** |
|---|---|---|---|---|---|---|
| *Cynoglossus senegalensis* | Red sole | 5.0 | 14.4 | 11.4 | 6.7 | target |
| *Synaptura cadenati* | Black sole | 2.1 | 2.5 | 5.5 | 5.6 | target |
| *Arius spp* | catfish | 46.8 | 20.8 | 15.8 | 22.6 | high |
| *Pomadasys jubelini* | Sompat grunt | 6.0 | 9.0 | 11.0 | 15.4 | low |
| *Pseudotolithus typus* | Ladyfish | 6.4 | 4.1 | 8.0 | 13.6 | med |
| *Scomberomorus tritor* | Spanish mackeral | 2.0 | - | - | - | - |
| *Pseudotolithus senegalensis* | Cassava croaker | 2.4 | 12.6 | 8.6 | 2.1 | med |
| *Pseudotolithus brachynathus* | Law croaker | 2.9 | 3.3 | 6.9 | 6.6 | med |
| *Pseudotolithus elongatus* | Bobo croaker | 2.2 | 2.5 | 6.2 | - | med |
| *Plectorhynchus mediterraneous* | Rubberlip grunt | - | - | 3.9 | - | low |
| *Polydactylus quadrifilis* | Giant African threadfin | 2.0 | - | - | 2.6 | high |
| *Sepia elegans* | Elegant cuttlefish | - | - | - | 4.7 | low |
| *Galeoides decadactylus* | Lesser African threadfin | - | 3.8 | 2.8 | - | med |
| *Murax duplex* | Murax | 2.9 | - | - | - | - |
| *Dentax angolensis* | Angolan dentax | - | 2.6 | - | 2.5 | low |
| *Ephippion guttifer* | Prickly puffer | 3.2 | - | 2.8 | - | low |
| *Drepane africana* | African sicklefish | 2.7 | - | 2.5 | - | - |
| *Taeniura grabata* | Round stringray | - | - | 2.0 | - | - |
| *Rhinoptera marginata* | Lusitanian cownose ray | - | - | - | 3.3 | med |
| Total weight of all catch (kg) | | 4103.0 | 5035.3 | 10641.3 | 6648.9 | |

Table 5. Ratio of target to bycatch species by site (by kgs)

| Name | Common Name | Kartong | Sanyang | Brufut | Gunjur |
|---|---|---|---|---|---|
| *Cynoglossus senegalensis* | TARGET | 1 | 1 | 1 | 1 |
| *Synaptura cadenati* | | | | | |
| *Arius spp* | catfish | 6.58 | 1.2 | 0.93 | 1.83 |
| *Pomadasys jubelini* | Sompat grunt | 0.84 | 0.54 | 0.65 | 1.25 |
| *Pseudotolithus typus* | Ladyfish | 0.89 | 0.42 | 0.47 | 1.1 |
| *Scomberomorus tritor* | Spanish mackerel | 0.28 | - | - | - |
| *Pseudotolithus senegalensis* | Cassava croaker | 0.34 | 0.75 | 0.51 | 0.17 |
| *Pseudotolithus brachynathus* | Law croaker | 0.41 | 0.19 | 0.41 | 0.53 |
| *Pseudotolithus elongatus* | Bobo croaker | 0.31 | 0.15 | 0.37 | - |
| *Plectorhynchus mediterraneous* | Rubberlip grunt | - | - | 0.22 | - |
| *Polydactylus quadrifilis* | Giant African threadfin | 0.27 | - | - | 0.21 |
| *Sepia elegans* | Elegant cuttlefish | - | - | - | 0.37 |
| *Galeoides decadactylus* | Lesser African threadfin | - | 0.22 | 0.17 | - |
| *Murax duplex* | Murax | 0.40 | - | - | - |
| *Dentax angolensis* | Angolan dentax | | 0.15 | | 0.21 |
| *Ephippion guttifer* | Prickly puffer | 0.45 | -- | 0.16 | - |
| *Drepane africana* | African sicklefish | 0.37 | - | 0.15 | - |
| *Taeniura grabata* | Round stringray | - | - | 0.11 | - |
| *Rhinoptera marginata* | Lusitanian cownose ray | - | - | - | 0.27 |

Figure 4: Examples of bycatch in the gill net.

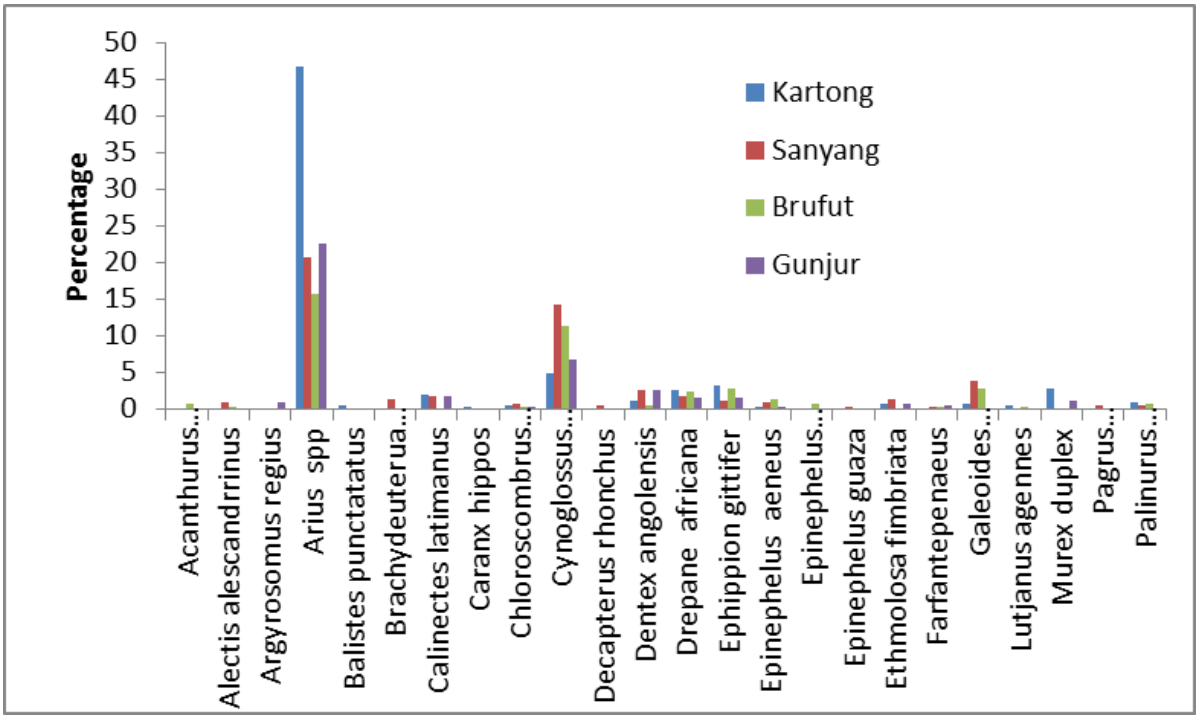


Figure 5: Relative percent catch by species per site (Note different axes on graphs).

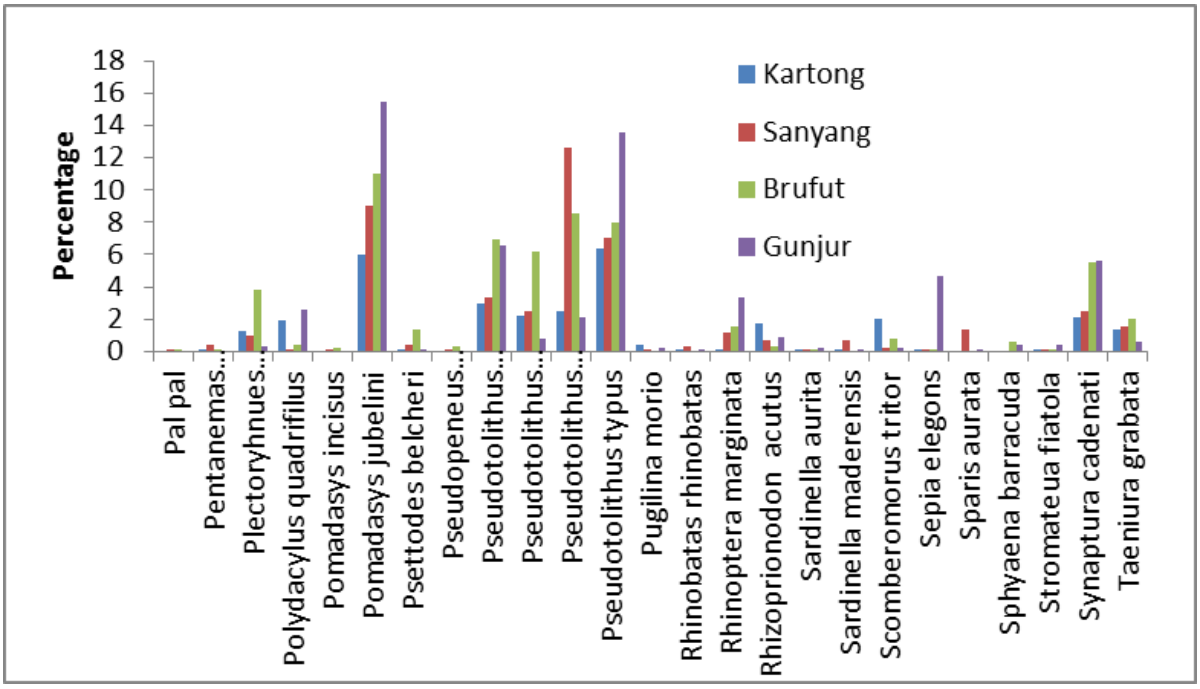


Figure 6: Relative percent catch by species per site (Note different axes on graphs).

## Significance of the Bycatch

### Catfish

There are several species of catfish harvested from the Gambian waters. Recent interviews with local fishermen indicate that up to 8 species are found in saltwater while 6 are identified in estuary/freshwater environment (Table 6). Investigation in the beach landing sites positively identified three species: *Arius latiscutatus* (black kong or rough head sea catfish) *Arius parkii* (white kong) and *Arius heudelot* (Ngunja or smooth head sea catfish)(Figure 9). Since species varied by season it is important to continue to monitor catches to verify fishermen's identification over the whole year.

Figure 7: White kong, Arius parkii and Ngunja, Arius heudeloti.

Table 6. Landings by site (information from local knowledge survey).

| Landing Site | Saltwater Species | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | White Kong | Black Kong | Ngunja | Anka | Jik (Jiko) | Daka | Red Kong | Kunkungo |
| *West Coast Region* | | | | | | | | |
| Kartong | | X | X | | | | | |
| Gunjur | X | X | X | | | | | |
| Sanyang | X | | X | X | | | | |
| Bato-Kunku/ Tujering | X | | X | | | | | |
| Tanji | X | X | X | | | | | |
| Brufut | X | | X | X | | X | | |
| Bakau | X | X | X | | X | | | |
| Old Jeswang | X | X | X | | | | | |
| Banjul | X | | X | | | | X | |
| *North Bank Region* | | | | | | | | |
| Barra | X | X | X | | X | | | |
| Albreida | | X | X | | X | | X | |
| Mbankam | X | X | X | | X | | | |
| Jinak Nigee & Kajata | | X | X | | X | | | |
| *Lower River Region* | | | | | | | | |
| Bintang | X | X | X | | | | | X |
| Tendaba | | | X | | | | | X |

The brackish and freshwater species identified by local fishermen and community members during the local knowledge survey are listed in table 7 below.

Table 7. Brackish and freshwater species of catfish landed in the Gambia (From local knowledge survey).

| Landing Site | Brackish/Fresh water species | | | | | |
|---|---|---|---|---|---|---|
| | Kosoo | Konokono (Ekono) | Nala | Koleer | Yelemoo | Konkiriko |
| *West Coast Region* | | | | | | |
| Kartong | | X | | | | |
| Old Jeswang | X | X | X | | | |
| Banjul | X | X | | | | |
| *North Bank Region* | | | | | | |
| Albreida | X | | | X | | |
| Jinak Nigee & Kajata | X | | | | | |
| *Lower River Region* | | | | | | |
| Bintang | X | | | | X | X |
| Tendaba | X | X | | | | X |

Catfish landings have been high since 2005 (Figure 10). Catfish were landed at all sites for every month in the Gambia (Figure 11). The number of sampling trips differed between months but was fairly uniform between sites for each month. Proportionally, landings of catfish were highest in Kartong in Mar-June; Highest in Brufut in Nov-Jan. The fishermen confirm the availability of catfish all year but note that peak is in the rainy season (April-June) and the "Ngunga" species (*Arius heudeloti*) is found further off shore most of the year except the rainy season. This is the same pattern reported by Conand et al (1995) off the coast of Guinea.

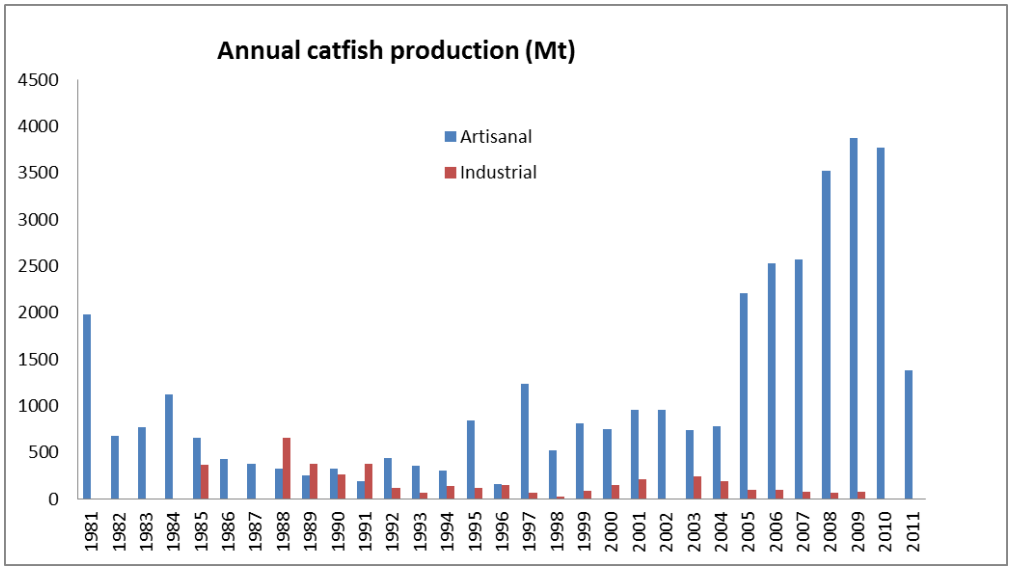


Figure 8: Landings of catfish from the artisanal and industrial fisheries (Data from the Gambian Department of Fisheries). 2011 is not complete.

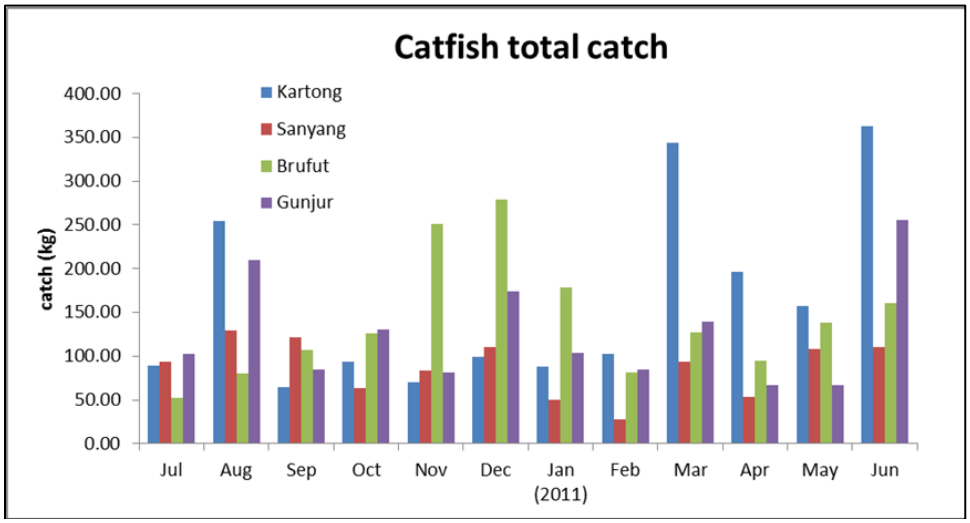


Figure 9: Total catch of catfish by month in each site (Data from bycatch survey).

Note: Number of trips varied per month, but was similar between sites in each month).

There is no data on growth of these species in the Gambia but it is reported in the same species from Guinea (Table 8). Growth is believed to be seasonal with one annulus formed per year (using dorsal spine). No differences were noticed between males and females. The growth function parameters for Guinean catfish are listed in Table 9. In Guinea, there are fish in the landings greater than 80 cm which are assumed to be between 20-30 years old. Their natural mortality is believed to be low. Their morphology with the hard skull and strong protective spines probably protects them from strong predation pressure.

Table 8. Von Bertalanffy growth parameters for Guinean catfish (from Conand et al 1995).

| Species | $L\infty$ (FL, cm) | K | $t_o$ |
|---|---|---|---|
| *A headeloti* | 70.0 | 0.142 | -0.390 |
| *A parkii* | 61.2 | 0.171 | -0.281 |
| *A latiscutatus* | 65.0 | 0.154 | -0.309 |

Table 9. Age-length relationships calculated from growth. Lengths given are fork lengths.

| Age (years) | *Arius headeloti (FL cm)* | *Arius parkii (FL cm)* | *Arius latiscutatus (FL cm)* |
|---|---|---|---|
| 1 | 13 | 12 | 12 |
| 2 | 20 | 20 | 19 |
| 3 | 27 | 26 | 26 |
| 4 | 32 | 32 | 32 |
| 5 | 37 | 36 | 36 |
| 6 | 42 | 40 | 40 |
| 7 | 45 | 44 | 44 |

The $L_{50}$ for maturity is reported as between 27-28 cm for females (Age 3, Fishbase, 2012). Fishermen have observed spawning from May (Kartong and Gunjur) through September (Banjul). They believe the fish spawn inshore near the mouth of the river and bolongs. They produce a small number of eggs (Figure 12) which the males incubate in their mouths for up to 2 months (Fishbase, 2012).

Figure 10: Catfish eggs tend to be relatively large compared to other species and receive parental care.

Fishermen state that migration occurs from the north and the south (Bakau, Old Jeswang, Sanyang and Kartong say from north; Gunjur says north and south; Tanji, Brufut says from south). These differences may account for the differences in relative catch rates reported above and may reflect different stocks or species. Fishermen travel great distance to fish for catfish (up to 74 km). There are several gear types known to catch catfish in the Gambia: hook and line, bottom gillnet, purse seine and longlines. Fishermen state that the gillnet is more effective when catfish are schooling where longlines are better when they are spread out. It is unknown how much the gillnet landings contributes to the total landing volume of catfish in recent years as there was a shift towards longline that occurred in 2008 (Figures 12 and 13).

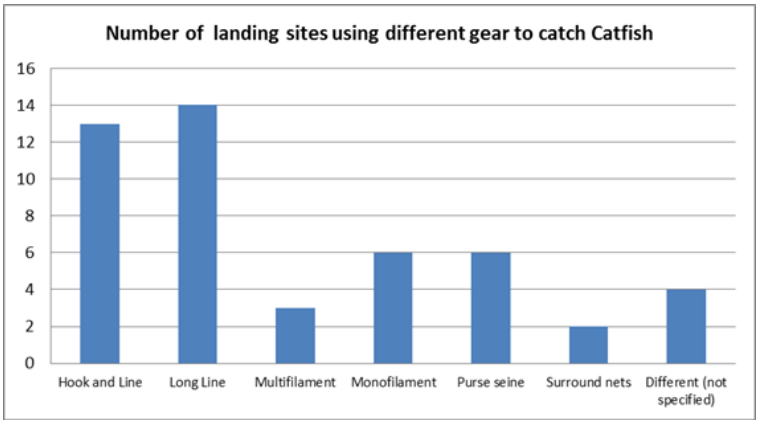


Figure 11: Number of landing sites using different gear types (per local knowledge) for catfish.

Figure 12: Longline used for catfish

The Gambian Department of Fisheries maintains catch records per gear type for rough head sea catfish (*A. latiscutatus*) and smooth mouth catfish (*A. heudelot*) (in kg and percent of total catch). (2009-2012 data not yet available) (Tables 10 a and b).

Table 10. Rough Head Sea Catfish

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Encircling net | 23,580 | 131,886 | 8,660 | | | | |
| Set bottom gillnet | 2,499,599 (98.97) | 2,304,690 (89.9) | 1,681,437 (49.63) | | | | |
| Other gillnet | | | 1,191 | | | | |
| Drift net | | | 5,034 | | | | |
| Stow net | 1,353 | 2,355 | 64,607 | | | | |
| hook/line | 1,070 | 76,891 | 111,420 | | | | |
| longline | | | 161,883 | | | | |
| Other | | 47,339 | 1,355,045 | | | | |
| total | 2,525,603 | 2,563,160 | 3,388,087 | | | | |

Table 11. Smooth Mouth Sea Catfish.

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Encircling net | | | | | | | |
| Set bottom gillnet | | | 132,180 (97.9) | | | | |
| Drift net | | | | | | | |
| Other gillnet | | | 2,392 | | | | |
| Stow net | | | 366 | | | | |
| hook/line | | 3147 (100) | 54 | | | | |
| longline | | | | | | | |
| other | | | | | | | |
| total | Not recorded | 3147 | 134,992 | | | | |

From this database, there has been a noticeable shift from gillnets to hook and line and longlines as the primary gear for the rough head sea catfish between the period from 2006-2008. The local knowledge survey conducted in 2012 verified that this trend has continued.

Figure 13: Women cleaning catfish

Figure 14: Final smoked product

The marine catfish complex is a very important one for local consumption and export product (Njai, 2000). Hot smoked catfish is prepared by the women. Fish is cleaned in fresh water, the eggs are removed. The fish is then soaked in boiling water for 2-5 minutes to coagulate and harden the skin (Figure 14). The skin is then scraped and the fish is cleaned thoroughly and left to drip dry prior to smoking. The fish is arranged on the grill and covered creating a smoking chamber (Figure 15).

After cooling, the product is packed in locally weaved baskets for marketing. 90% of the product is for the local market and 10% is exported (Table 11. Njai, 2000). Shelf life is believed to be 1- 3 days.

| Market | Products | Estimated share | Quantity (kg) | Value (US$ | $/kg |
|---|---|---|---|---|---|
| Urban market | Hot smoked shad | 90 | 13875 | 88325 | 0.6 |
| | Smoked dry shad | 2-5 | 1278 | 281 | 0.22 |
| | Smoked shark | 35 | 30875 | 22318 | 0.82 |
| | Hot smoked catfish | 90 | 33885 | 51844 | 1.53 |
| | Smoked specialty | 10 | 1350 | 2484 | 1.84 |
| Ethnic market (Europe and USA) | Hot smoked shad | 3 | 256 | 486 | 1.90 |
| | Hot smoked catfish | 10 | 6777 | 18501 | 2.73 |
| | Smoked specialty | 88 | 2551 | 20584 | 3.50 |

Table 12. Distribution of different artisanal smoked products according to markets (From Njai, 2000)

The MSC pre-assessment identified catfish species as high risk based on their productivity/susceptibility attributes (Medley et al., 2008). The combination of slow growth, large investment in small number of young, and long life span makes these species very susceptible to overfishing and needs to be closely monitored.

## Giant African Threadfin (Captainfish)

There is little information available about the captainfish catch available from the landing statistics. However, due to the low bycatch rates, it does not appear to be at risk from this fishery.

Figure 15: Captainfish

## Summary

The bycatch assessment of the gillnet fishery has recorded many species of fish captured in this gear type. The target species, sole, is not the predominant catch. In most cases, the largest catch is of *Cymbium* species and catfish (*Arius* spp). Because of the vulnerability and importance of the catfish resource, this multispecies fishery must be considered when evaluating effect on the ecosystem of the sole gillnet fishery. Future recommendations include the development of a multispecies management plan to avoid overharvesting of sole fish and the vulnerable bycatch species such as catfish resources that will include recommendations for gillnet and longline fisheries.

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