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INTERNATIONAL WHALING COMMISSION

A novel digitalisation approach and multi-stakeholder involvement for tracking cetacean by-catch and strandings along Ghana's coast

Isaac Okyere[1,2*], Eric Mawuko Atsiatorme[3], Kwadwo Kesse Mireku[1], Elizabeth Agyekumwaa[1,2], Ernest Obeng Chuku[2,4], Patrick Ofori-Danson[6,7], Joseph Sefah Debrah[1], Denis Worlanyo Aheto[1,2], Donkris Mevutah[3] and Wim C. Mullié[5]

[1]Department of Fisheries and Aquatic Sciences, School of Biological Sciences, CANS, University of Cape Coast (UCC), Cape Coast, Ghana

[2]Centre for Coastal Management (Africa Centre of Excellence in Coastal Resilience - ACECoR), UCC, Ghana

[3]Friends of the Nation, Post Office Box MC 11, Takoradi, Western Region, Ghana

[4]Institute for Marine and Antarctic Studies (IMAS), University of Tasmania, Hobart, TAS, Australia

[5]Independent Researcher, Dakar 10700, Senegal

[6]Department of Marine and Fisheries Sciences (MAFS), University of Ghana (UG), P.O. Box LG 99, Legon, Ghana

[7]Conservation and Research of West African Aquatic Mammals (COREWAM), c/o MAFS, UG, Legon, Ghana

***Corresponding author**: *iokyere@ucc.edu.gh*

Abstract

Although there has been an increasing trend in the directed catch of cetaceans (marine bushmeat) in Ghana's EEZ in the face of near collapse fisheries, data on cetacean by-catch has remained scanty for decades and the available data were usually limited in time series continuity and geographical scope. Due to the lack of a national marine mammal monitoring programme, producing data for evidence-based management of cetacean by-catch remains the effort of non-governmental entities and private individuals or groups of scientists who are largely resource-constrained. We explore for the first time in Ghana, the approach of adopting and deploying a model that integrates the deployment of mobile phone and web-based technologies by a multi-stakeholder network to monitor cetacean landings along the entire coast of Ghana. A multi-stakeholder Ghana marine mammal reporting network was established for collecting and providing data on strandings and cetacean landings, after which technologies for using mobile phone and web-based applications and platforms for collecting, transmitting, analysing, visualising and monitoring data in a centralised database was developed. Data from the database was used to engage relevant stakeholders on designing cetacean conservation actions based on trends. Over the twelve-month period (April 2022 to March 2023), the project documented a total of 254 individual cetaceans from 18 species comprising 249 (98%) landings from artisanal fisheries and 5 (2%) strandings from nine sites. Records were dominated by the Clymene dolphin, *Stenella clymene* (21%) and the Pantropical spotted dolphin, *Stenella attenuata* (17%). Monthly landings show a minor a peak in August 2022, and a major peak in January 2023. Estimates of 20.8 cetacean mortalities month^{-1} and 0.8 day^{-1} were imputed, with the peak monthly landings of 1.2 animals day^{-1} in August and 2.7 animals day^{-1} January, and drift gill net being the main fishing gear implied. Comparing catch rates with previous studies suggests a downward trend. Prospects for our newly initiated Ghana marine mammal by-catch and strandings programme as a national programme for cetacean monitoring and conservation, as well as the possibility of our approach serving as a model for replication in similar cetacean related data-deficient countries in Africa are highlighted.

1. Introduction

Although there have been significant efforts towards provision of data on cetacean exploitation in Ghana over the last three decades, the availability of consistent time series data for monitoring long term trends remains a challenge. Since 1998, a number of studies, which included identification of cetaceans have been executed to assess bycatch and directed catch by marine fisheries from major fishing communities in the country (Figure 1). Van Waerebeek and Ofori-Danson (1999) described landings in Apam, Jamestown (Accra), Kpone (near Tema) and Winneba (near Apam). Debrah (2000) added some information from Apam, Kpone, Shama, Dixcove and Axim. Periodic visits between 1998 and 2003 to these sites plus Tema added more information (Van Waerebeek *et al*. 2009), while Debrah *et al*. (2010) added some more data from Axim in 2007 and Dixcove in 2010. The earliest time-series data comes from Dixcove where landings were recorded over a twelve-month period in 2013-2014 (van Waerebeek *et al*. 2014) when 750 individuals were recorded. This was updated by information from September 2018 (van Waerebeek *et al*. 2018). The information, albeit non-continuous and from few fishing ports, showed that bycatch and, in particular directed catch, had increased: in Dixcove it increased from 0.74 animals day^{-1} in 2001-2003 (Debrah *et al.* 2010) to 2.82 animals day^{-1} in 2013-14. The directed catch even led to the use of a new term: Marine Bush Meat (Alfaro & van Waerebeek 2001).
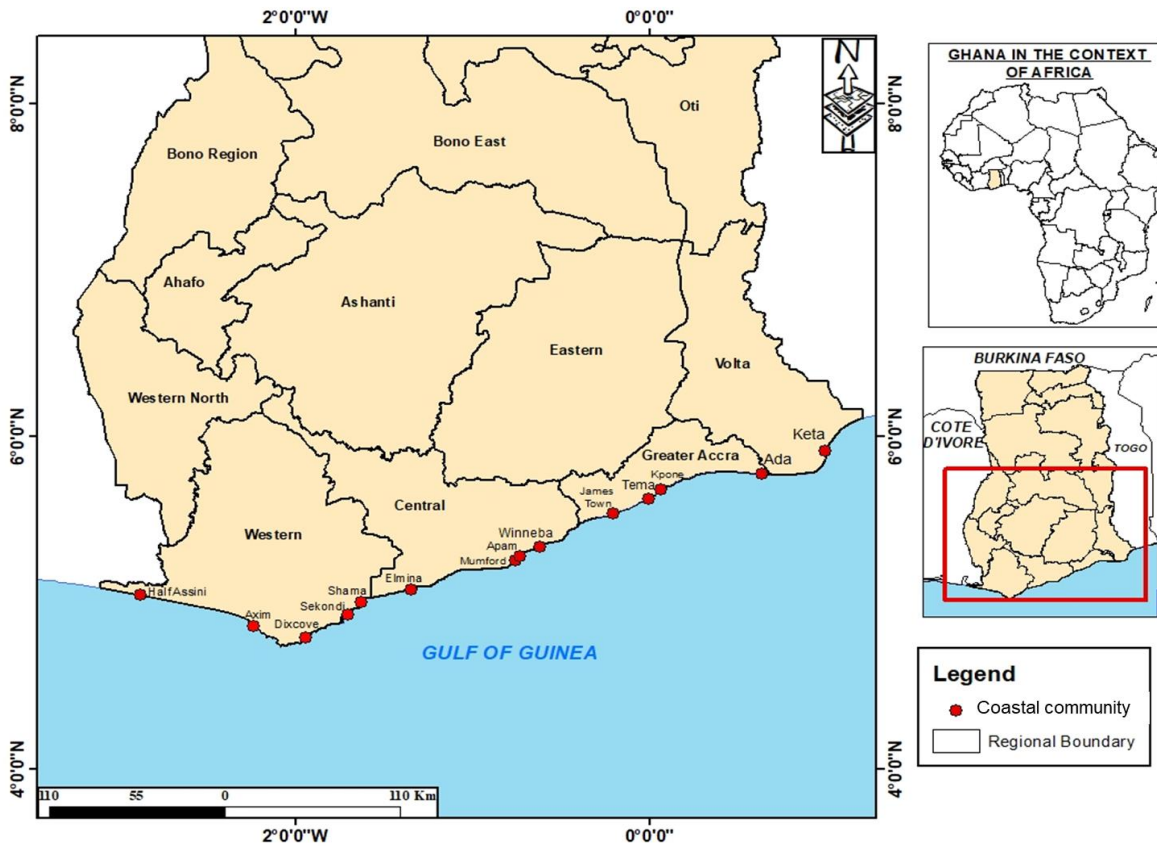

Figure 1: Towns along Ghana's coastline with major fish landing sites where cetacean landings are also reported

Signs of possible reversed trends have been observed in latter studies. Based on landings in Dixcove September 2018, Van Waerebeek *et al.* (2018) showed that trends had regressed to 0.41 animals day[-1]. The authors suggested that poor finfish catches and a shortage of (expensive) fuel seemed to have kept many canoes inactive at the port. In a further update on Dixcove, Ofori-Danson et al. (2019) observed a slightly higher catch of 0.59 animals day[-1], although this remained lower than earlier rates of 2.82 animals day[-1] in 2013-2014. The authors additionally reported the prevalence of common dolphins in landings to have significantly decreased in the period 2000-2018 while Fraser's dolphins and false killer whales increased. In a recent year-long (2019-2020) assessment by the Ghana Wildlife Society across ten major landing sites: Half Assini, Axim, Dixcove, Shama, Apam, Mumford, Elmina, Kpone, Ada and Keta, the study estimated a national average of 1.09 animals month[-1], with a peak of 1.8 animals month[-1] in October 2019 (Ghana Wildlife Society, 2020).

Some indications suggest that a higher percentage of cetacean carcasses than before are not landed but rather are cut-up offshore and used for bait in the shark fishery. Reportedly, baited hooks are deployed in auxiliary longlines set alongside drift gillnets with a shark aggregating purpose (van Waerebeek *et al.* 2018). There are reasons to conclude that this level of bycatch/directed catch in Ghana is not sustainable and concern was raised in particular for the numbers of Clymene dolphins *Stenella clymene* landed. The danger of overexploitation has prompted CMS Parties to list the West African stock of *S. clymene* on CMS Appendix II in accordance with Scientific Council recommendation (CMS/ScC14/-Doc.5). A concerted national effort towards curbing the continuous exploitation of cetaceans in the country is therefore imperative, and the availability of consistent long-term national level data for evidence-based decision-making support is even more dire. Authors of the previous studies indicated that due to time, money and manpower constraints, information on landings of bycaught or deliberately caught cetaceans is still very incomplete as it covers only a limited number of landing sites, whereas the total number of landing sites along Ghana's coast is about 300 (Dovlo *et al.* 2016).

Apparently, due to the lack of a national marine mammal monitoring programme, cetacean-related data collection and monitoring in Ghana have emanated from, and still remain the efforts of non-governmental entities including NGOs (e.g. Ghana Wildlife Society) and private individuals or groups of scientists who are largely resource-constrained. This principally accounts for the limited geographical coverage, lack of consistent long-term data, and unavailability of easy-to-access centralised data system on cetaceans.

To establish a cetacean management programme that addresses the current constraints faced with national coordination, availability, frequency, continuity and geographical coverage of cetacean data (also including strandings), we explore for the first time in Ghana, the approach of adopting and deploying degitalisation and multi-stakeholder involvement in the monitoring and conservation marine mammals. Our approach integrates the deployment of mobile phone and web-based technologies by a multi-stakeholder network to monitor cetacean landings along the entire coast of Ghana in a centralised database, which provides a decision support system for collaborative management. The key objectives were to : (1) establish a multi-stakeholder Ghana marine mammal network for collecting and providing data, (2) develop and use mobile phone and web-based technologies for collecting, transmitting, analysing, visualising and monitoring data in a centralised database, and (3) engage relevant stakeholders on cetacean conservation actions based on data and trends.

2. Methodology

2.1 *Initiation of the Ghana marine mammal by-catch and strandings management programme*

As a first step to achieve the objectives, the Ghana Marine Mammal By-catch and Strandings Management Programme was conceived and initiated by the Friends of Nation (FoN - a socio-environmental non-governmental organisation), and the Centre for Coastal Management as well as the Department of Fisheries and Aquatic Sciences, University of Cape Coast (UCC). The programme was initiated to provide a national scope of multi-stakeholder and multi-sectoral involvement, and importantly serve as the umbrella programme under which all cetacean data related issues in Ghana are coordinated. Within the framework of the programme (Figure 2), FoN and UCC jointly coordinated the establishment and operationalisation of the Ghana Marine Mammal Network. In addition, UCC used its technical expertise to develop and deploy mobile application and web-based data management platforms for collecting and managing cetacean data. The network conducted capacity building and data collection using the mobile phone and web platforms developed, and FoN led in using the data for multi-stakeholder engagement on cetacean conservation actions mainly with the fishers and the Fisheries Commission including the Fisheries Enforcement Unit.
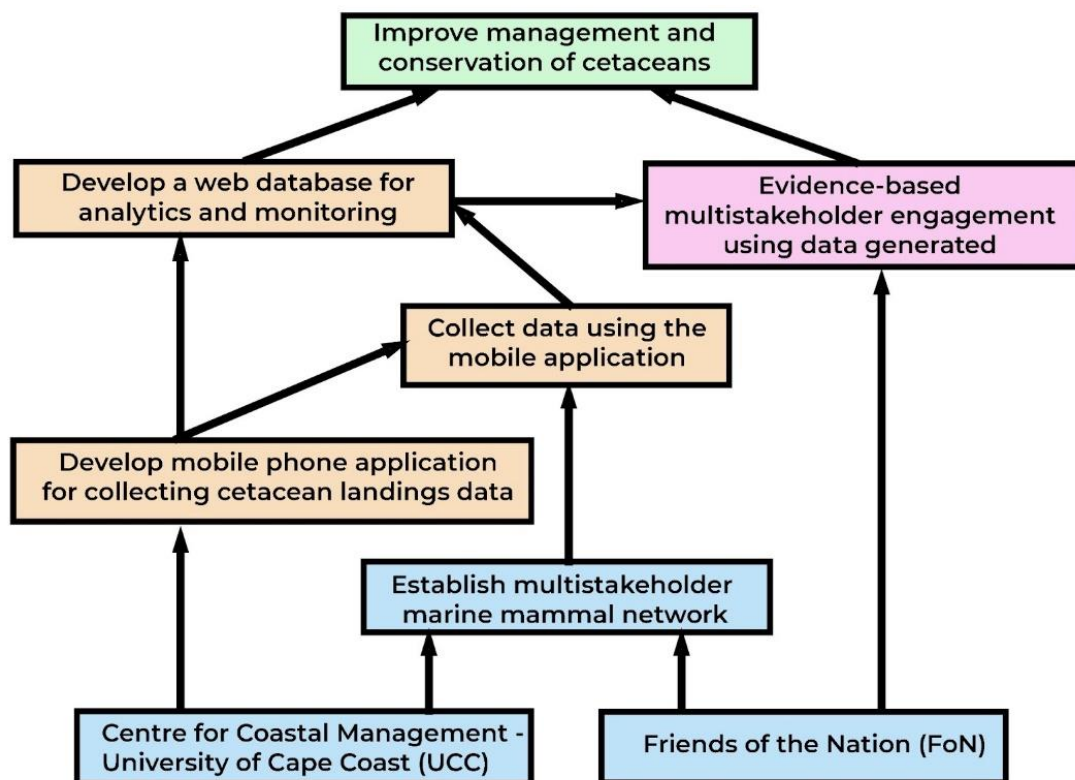

Figure 2: Framework for implementation of the Ghana marine mammal by-catch and strandings management programme

2.2 *Establishing and training the Ghana Marine Mammal Network*

The establishment of the Ghana Marine Mammal Network commenced in 2018 and was finally operationalised in 2022. The network, which was started with four members currently has a membership of thirty-six, drawn from the academia (University of Cape Coast and University of Ghana), state actors (Fisheries Commission and the Ghana Wildlife Division of the Forestry Commission), NGO (Fiends of the Nation), community volunteers, the media and a freelance cetacean expert based in Senegal. The network also incorporates a diversity of skilled expertise, involving fisheries scientists, cetacean biologists, Information Technology (IT) experts, GIS and Remote sensing experts, graduate students and fishermen. This offers the network a pool of experts and resources for implementing its activities. A majority of the members are Field Technical Officers (FTOs) of the Fisheries Commission stationed at the fish landing sites along the coast whose daily schedule involves collecting fisheries data.

Upon establishing the network, trainings were organised to develop and enhance the capacity of members of the network on basic cetacean data collection covering photographic documentation for identification purposes, identification using keys and morphological features, morphometric measurements, sex determination, scoring the state of freshness and decomposition of carcasses in case of strandings, and fishing gear identification and measurements. The trainings were facilitated by the cetacean biologists and fisheries scientists from the University of Ghana, the University of Cape Coast and the freelance cetacean expert based in Senegal, all members of the network.

2.2 *Developing and deploying technologies for data collection and management*

The IT and GIS experts from the Centre for Coastal Management, University of Cape Coast, who are also members of the network, led the development and training on the mobile application and web-based platform for data collection and management. An android-based application named CetaData app was developed and hosted on Google Play Store with in-built ArcGIS functionality for geo-location-based data collection and submission. (https://play.google.com/store/apps/details?id=gh.edu.ucc.dfas.Ceta_Data). The CetaData app operates on android mobile phones and was installed for all network members. In addition, the team developed an online database named CetaData (https://cetadata.ucc.edu.gh/admin/login) for receiving transmitted data from the CetaData app, and storage, processing, analysing and visualising data. Members of the network were trained on the use of the app and the online database.

2.3 *Data collection*

Data collection commenced in April 2022 and remains ongoing. Data are received on the database daily from members of the network through the CetaData app. Data collected include an initial option of whether the report is on stranding, by-catch or live sighting, then date, location, photograph of the animal, species, number of animals, length, sex, gear used and state of the carcass depending on the initial option selected. Each member submitting data is uniquely identifiable through individual accounts created for data submission. Cleaning and validation are conducted by the graduate students and cetacean biologists who provide technical back-stopping

at the back-end of the database before the data are cleared into the analytics and visualisation stages of the database.

2.4 *Engaging community and national stakeholders*

The data were used to develop flyers for awareness raising in the hotspot communities, as well as factsheets and policy briefs for stakeholder engagement on cetacean conservation actions and policy reforms especially the Fisheries Commission authorities and the Fisheries Enforcement Unit at national workshops and other fora.

3. Results

3.1 *Composition of cetacean species in landings*

Over the twelve-month period (April 2022 to March 2023) of data collection by the network, the project documented the landing or stranding of a total of 254 individual cetaceans, representing 18 species. This comprised 249 (98%) landings from artisanal fisheries and 5 (2%) strandings, of which the predominantly caught species were the Clymene dolphin, *Stenella clymene* (21%) and the Pantropical spotted dolphin, *Stenella attenuata* (17%) (Figure 3). Other considerably landed cetaceans were the Common bottlenose dolphin, *Tursiops truncatus* (11%), Rough toothed-dolphin, *Steno bredanensis* (9%), Fraser's dolphin *Lagenodelphis hosei* (8%) and Long-snouted spinner dolphin, *Stenella longirostris* (7%). The rest of the species encountered were the Melon-headed whale, *Peponocephala electra* (6%), Long-beaked common dolphin, *Delphinus caprensis* (5%), False killer whale, *Pseudorca crassidens* (4%), Short-finned pilot whale, *Globicephala macrorhynchus* (4%), Risso's dolphin, *Grampus griseus* (2%), Pygmy killer whale, *Feresa attenuata* (2%), Short-beaked common dolphin, *Delphinus delphis* (1%) and Dwarf sperm whale, *Kogia sima* (1%). One specimen of a suspected Pgymy sperm whale, *Kogia breviceps* was also encountered. The five stranded animals were two individuals of *Globicephala macrorhynchus*, one *Feresa attenuata*, one Humpback whale, *Megaptera novaeangliae* and a suspected Blue whale, *Balaenoptera musculus*.

3.2 *Trends of cetacean landings*

Comparing the landings across the fishing communities (Figure 4), Dixcove recorded the highest landings of 99 animals over the one year period, averaging 9.5 animals month^{-1} and 0.37 animal day^{-1} (using 26 fishing days in a month excluding Tuesdays which are traditional fishing holidays in Ghana). This was followed by Axim with 70 animals per year (6.7 animals month^{-1}and 0.26 animal day^{-1}), 53 per year in Tema (5.1 animals month^{-1} and 0.20 animal day^{-1}), 15 in Shama (1.4 animal month^{-1} and 0.06 animal day^{-1}), 10 in Apam (1.0 animal month^{-1} and 0.04 animal day^{-1}), 3 in Half Assini (0.3 animal month^{-1}, virtually 0 animal day^{-1}) and 2 in Busua (0.2 animal month-1 virtually 0 animal day^{-1}). The records from British Komenda (west of Elmina) and Princess Town (west of Dixcove) were incidences of stranding.
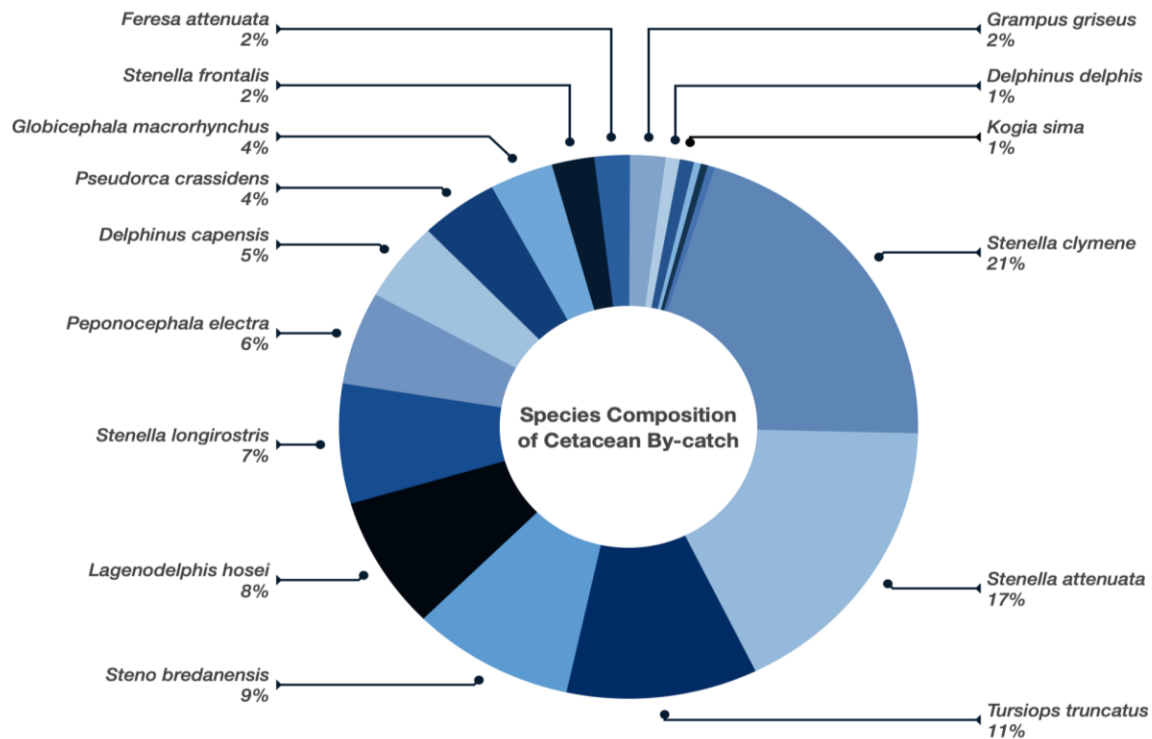
Figure 3: Percentage composition of cetacean species landed in the communities monitored along the coast of Ghana from April 2022 to March 2023
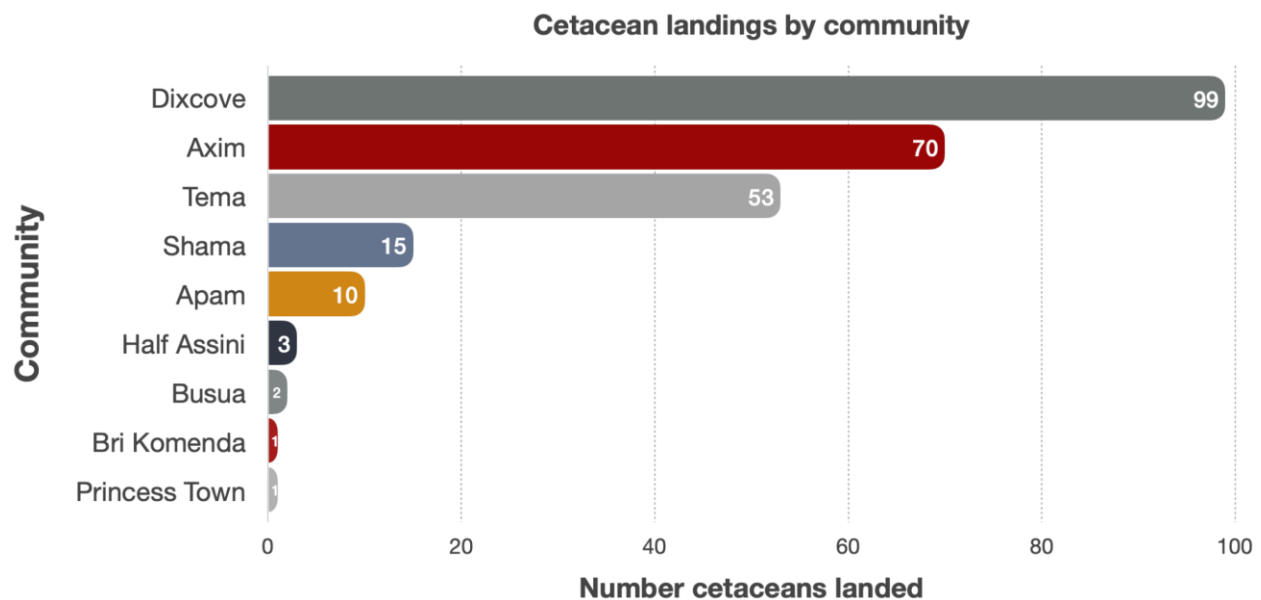

Figure 4: Proportion of cetaceans landed in the communities monitored along the coast of Ghana during the monitoring period (April 2022 - March 2023)

The trend of monthly landings (Figure 5) shows that the highest cetacean catches occurred between July and October 2022 with a peak in August 2022, and between December 2022 and February 2023 with a major peak in January 2023. From the total of 249 landed in the year-long survey, estimates of 20.8 animals month^{-1} and 0.8 day^{-1} can be imputed, with the peak monthly landings of 1.2 animals day^{-1} in August and 2.7 animals day^{-1} January, the highest being exploited in Dixcove.
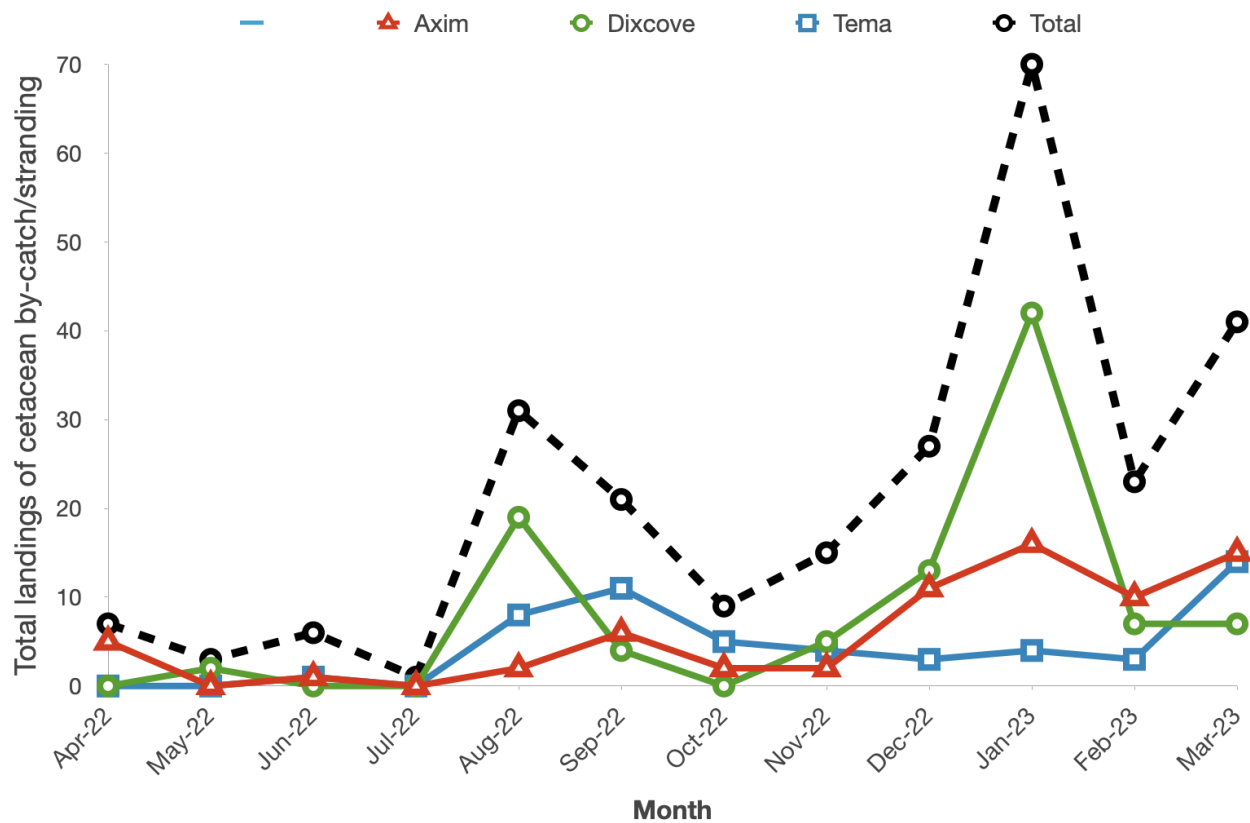

Figure 5: Total monthly landings of marine mammal landings and trends for the top three communities among the sites monitored along the coast of Ghana

3.2 *Sizes of cetaceans landed and fishing gears used in exploitation*

The mean sizes of species landed (including stranded animals) are shown in Figure 6, further analyses are ongoing to compare to adult sizes in literature. The primary fishing gear used in harvesting the cetaceans were drift gill nets (DGN), accounting for over 98% of the catches (Figure 7). The incidence of catching cetaceans using purse seine nets or Ali-Poli-Watsa (APW) were minimally encountered.
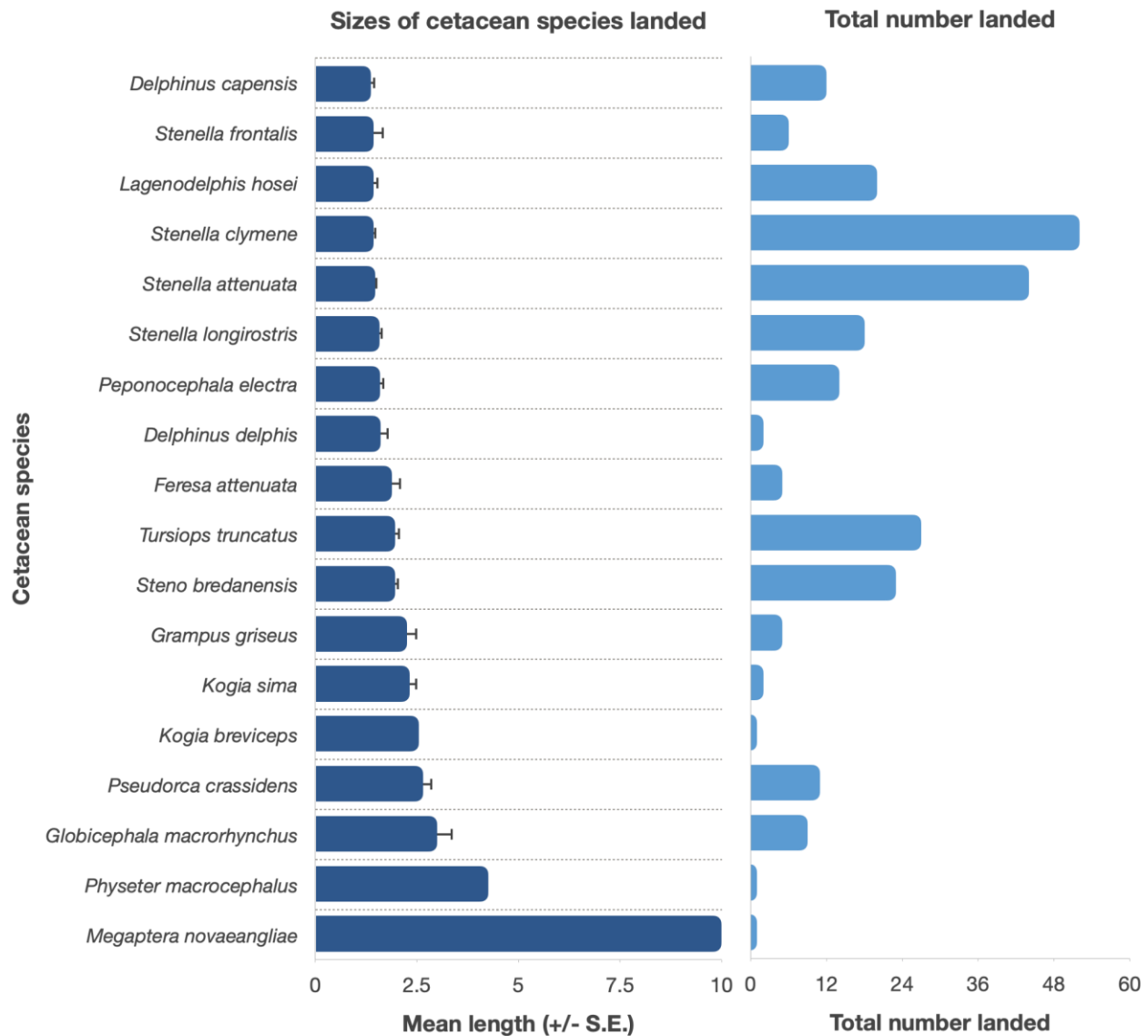

Figure 6: Mean length and total number of landings for each species recorded during the monitoring period (April 2022 - March 2023)
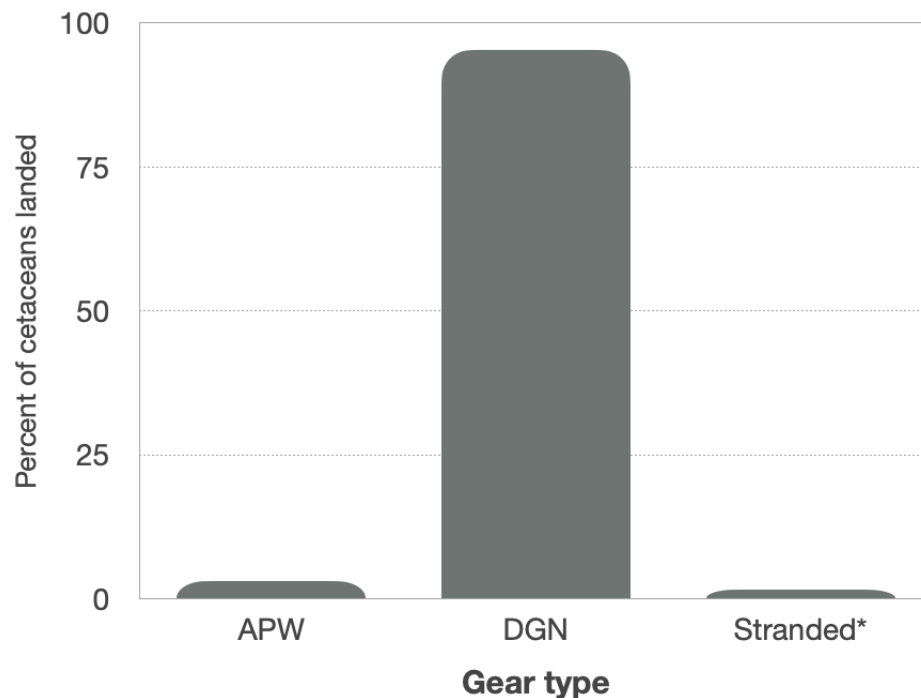
Figure 7: Percent of cetaceans caught per fishing gear and number stranded (DGN- Drift Gill Net;
APW – Ali-Poli-Watsa or purse seine)

4. Discussion

The data received so far from our digitalisation and multi-stakeholder involvement approach provides useful information for discussion on the cetacean population, trends of landings, improving cetacean management efforts, and promoting this novel national cetacean monitoring programme in Ghana. It is important, however, to highlight that the number of cetaceans recorded in this monitoring offers a conservative estimate, as recent law enforcement in the fishing communities has rendered fishers less tolerant to any acts of data collection, with most of them hiding their marine mammal catches.

Earlier studies on cetaceans populations along Ghana's coast reported a numerical preponderance of the Clymene dolphin *S. clymene* over the Pantropical spotted dolphin *S. attenuata*. In the report of Debrah *et al.* (2010) from Axim, Apam and Dixcove, *S. clymene* constituted 24.5% of the landed cetacean fauna, followed by *S. attenuata* (13.2%). Similarly, a year-long monitoring of landings at Dixcove from January 2013 to February 2014 indicated a higher prevalence of *S. clymene* (32.1%) than *S. attenuata* (17.4%) although both remain part of the three commonly landed species (van Waerebeek *et al.*, 2014). A latter assessment in Axim by Ofori-Danson *et al.* (2019) during which a dominance of *S. attenuata* (28.1%) over *S. clymene* (17.5%) was observed, led the authors to suggest a significant decline in *S. clymene* landings over the years with a continuous increase in *S. attenuata* landings. The results of our current monitoring (*S. clymene* = 21% and *S. attenuata* = 17%) however rhymes with the previous observations of *S. clymene* dominance, and also partly consistent with the one year survey by the Ghana Wildlife Society across ten landing sites which reported *S. clymene* (24%) as the most abundant but was followed by *S. longirostris* (20%); *S. attenuata* constituted only 1% of the landings (Ghana Wildlife

Society, 2020). Unravelling the current inconsistencies in data on the trend of the proportion of Clymene and Pantropical spotted dolphins requires a sustained national campaign for consistent long term data over larger number of landing beaches, and offers a call for support in sustaining the national cetacean conservation programme initiated in current effort.

Dixcove, the hotspot for cetacean by-catch in Ghana, recorded 99 animals over the one year period. This number is significantly lower compared to the 743 individuals recorded by van Waerebeek *et al*. (2014) as well as the 209 reported by Ghana Wildlife Society (2020) in surveys conducted at the site over similar duration. The catch rate of 0.37 animal day^{-1} estimated in this study reinforces the signs of reversing trend from the earlier rates of 2.82 animals day^{-1} in 2013-2014 (van Waerebeek *et al.*, 2014) and 0.59 animals day^{-1} in 2018 (Ofori-Danson *et al.*, 2019). This is a possible indication of a general decline in cetacean landings as suggested by Ofori-Danson *et al.* (2019), and conceivably influenced by recent law enforcement campaign on cetacean landings in the country which seem to have deterred fishers from openly landing the animals thereby undermining accurate reporting. Axim appeared to be the site with second highest catch rate of 70 cetaceans per year, a rate higher than the 25 animals reported by Ghana Wildlife Society (2020) from March 2019 to February 2020. The current study importantly posits Tema as a potential third hotspot with 53 animals per year (5.1 animals month^{-1}), but has unfortunately not been highlighted in previous studies for management consideration.

The Ghana Wildlife Society observed only one peak of cetacean landing in September 2019 during their 2019-2020 survey while two peaks were recorded in the current study. The highest catches occurred between July and October 2022 with a minor peak in August 2022, and between December 2022 and February 2023 with a major peak in January 2023. These are notably the periods for upwelling in the Gulf of Guinea (Kämpf and Chapman, 2016); major upwelling peaks in August and minor in January. The reason for recording catches rates in the minor upwelling in January exceeding twice the catch in the major upwelling in August is unclear. Upwelling intensity in Ghanaian waters varies with season and by year, which also dictates fish catch (Okyere, 2021), and could account for this observation. It is difficult comparing the current overall estimates of 20.8 animals month^{-1} and 0.8 day^{-1} as well as the peak rates 1.2 animals day^{-1} in August and 2.7 animals day^{-1} January to the national average of 1.09 animals month^{-1} and 1.8 animals month^{-1} in October 2019 inferred by Ghana Wildlife Society (2020) due to a lack of clarity on how the author estimated the figures. Nevertheless, our estimates provide reference base for future studies.

Drift gill nets mainly used by artisanal canoes targeting tuna, billfishes and sharks, and to a lesser extent purse seines remain the fisheries consequently cited as the principal cause for cetacean bycatch. Van Waerebeek et al. (2018) even mentioned a novel longline technique by combining longlines and DGN for the capture of sharks and cetaceans. The industrial bottom and midwater trawlers are also a source of cetacean bycatch, although not currently covered in our monitoring. For none of these fisheries reliable data on cetacean bycatch exist. DGN fisheries are primarily concentrated in the Western Region with 819 units on a total of 976 for the whole of Ghana (Dovlo *et al.* 2016). Based on the past data collected in Ghana, annual numbers of cetaceans landed in a single site, Dixcove, were *c.* 750 in a 12-month period (van Waerebeek *et al.*, 2014). Based on this and other studies, numbers of bycaught annually in Ghanaian fisheries were expected to be in the thousands, making Ghana one of the countries with the highest cetacean (by)catch in West Africa (Altherr *et al*. 2018). However, the recent studies and current estimates which suggest a downward trend provides the opportunity to intensify research, monitoring, fisher engagement and deterrence through a national action plan to unravel whether the observed decline is attributable to a decrease

in cetacean populations due to unsustainable exploitation, or a case of compliance on the part of fishers occasioned by law enforcement. Unfortunately, the revised Ghana Fisheries Management Plan (2022-2026) barely touches on plans for cetacean by-catch management. The IWC has adopted resolutions highlighting the potential for negative human health impacts caused by consumption of cetacean products (resolutions 1998-11 and 2012-1). An increase in knowledge and better understanding of the aquatic bushmeat issues is needed in order to implement local and international management programmes for the effective monitoring and mitigation of unsustainable and illegal hunting and use of aquatic mammals (Cosentino & Fisher, 2016). This is very critical and overdue as the use of migratory megafauna for aquatic wild meat is reportedly a widespread practice in the tropics and subtropics (Ingram *et al.*, 2022).

Through awareness raising in the three hotspot communities (Dixcove, Axim and Tema) informed by data on trends from the present study, awareness of fishermen and fish processors on the need to avoid exploitation of cetaceans has increased. Importantly, our engagement with the Fisheries Commission of Ghana on the monitoring outcomes, trends of landings, the existence of easy-to-access centralised database, and availability of functional reporting network for broader geographical coverage at a minimal cost, has yield the draft of a tripartite Memorandum of Agreement (MoA) between the Commission, UCC and FoN on data collection, data sharing and joint cetacean by-catch management effort. It is hoped that our approach could offer a model for replication across other cetacean related data-deficient African countries.

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