

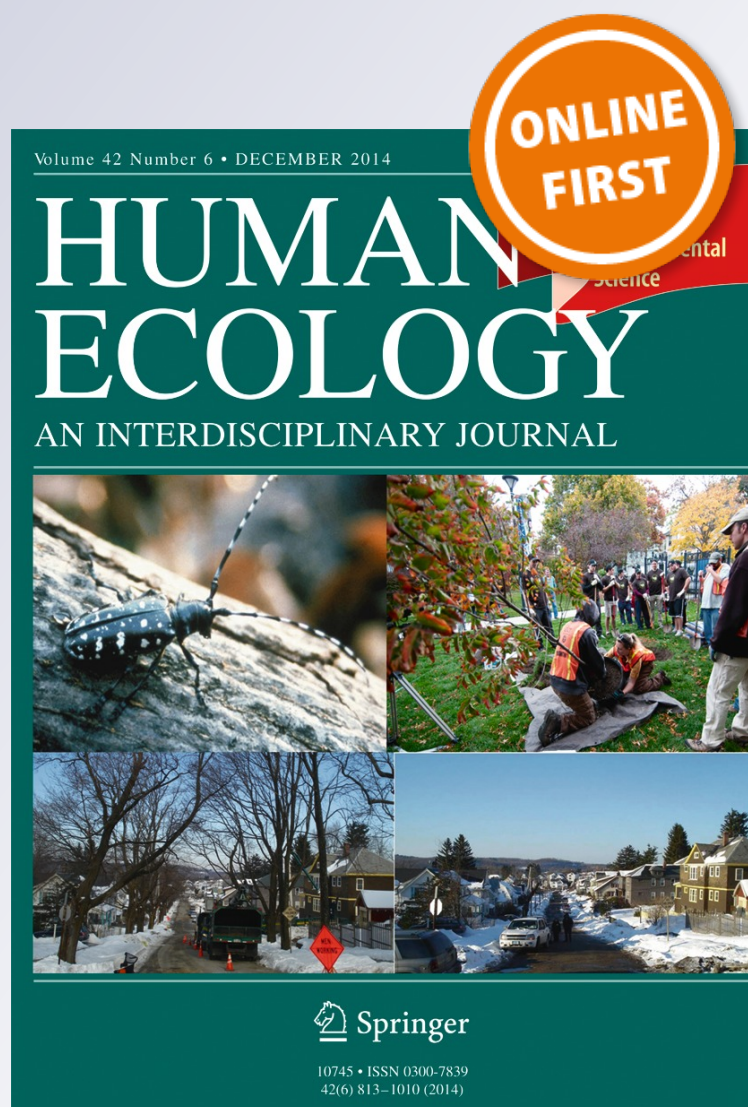
Food, Pharmacy, Friend? Bycatch, Direct Take and Consumption of Dolphins in West Africa

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Food, Pharmacy, Friend? Bycatch, Direct Take and Consumption of Dolphins in West Africa

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Abstract The extent to which bycatch in artisanal fisheries impacts cetacean populations in West Africa is poorly understood. Between 2007 and 2012, 474 interviews were carried out in The Gambia, Senegal and Guinea-Bissau to collect local fishers' knowledge on rates of bycatch, local uses for bycaught animals and any cultural significance attached to cetaceans. At least a quarter of respondents in each country stated that they had accidentally caught a dolphin at least once, and greater proportions of interviewees stated that other fishers sometimes caught dolphins. Bycaught animals were usually distributed amongst the community as food, but the meat and oil of dolphins were also used to treat various ailments. There did not appear to be a sizeable market for the sale of dolphin meat. The continued depletion of fish stocks in this region may place more pressure on coastal communities to rely on cetaceans as a food source.

Keywords Senegal · Gambia · Guinea-Bissau · Marine bushmeat · Local fishers' knowledge

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Introduction

The accidental capture of animals in fishing gear deployed with the intention of catching something else (Reeves *et al.* 2013), often referred to as bycatch, is one of the primary causes of human-related mortality in cetaceans (Lewison *et al.* 2004) and poses a considerable threat to some species and populations, particularly of small cetaceans (Read *et al.* 2006). Recent research has highlighted that not only industrial fishing activities but also artisanal fisheries can have considerable impacts on cetacean populations through bycatch (e.g., Jaramillo-Legorreta *et al.* 2007; Mangel *et al.* 2010). Artisanal fishers may account for over 95 % of the world's fishers (Pauly 2006), and over 70 % of fish production in West Africa comes from artisanal fisheries (Binet *et al.* 2012). An understanding of the extent and nature of bycatch by this sector is thus essential to the conservation of cetaceans in West African waters (Moore *et al.* 2010). However, data on bycatch and discard rates for marine mammals are generally less well-known and more speculative, particularly for fisheries in developing counties (Alverson *et al.* 1994).

There is a paucity of information relating to the abundance, distribution and conservation status of cetaceans in West African waters, and the proportion of published global bycatch research focusing on this region is lower than all other FAO statistical regions except the Antarctic (Soykan *et al.* 2008). In addition, whilst data on cetacean bycatch are available for many industrial fleets they are rarely available for small-scale fisheries (Kelleher 2005; Moore 2007). However, cetaceans are known to be bycaught by artisanal fishers at least occasionally in West Africa (e.g., Van Waerebeek *et al.* 2004; Bamy *et al.* 2010; Collins *et al.* 2010; Uwagbae and Van Waerebeek 2010) and the consumption of 'marine bushmeat'—marine animals such as manatees and cetaceans—is thought to be a growing issue in some regions (Costello and Baker 2011; Robards and Reeves 2011).

Lewison and Moore (2012) estimated that tens of thousands of turtles and dolphins may be caught incidentally and retained by artisanal fishers in Nigeria. In particular, the Atlantic humpback dolphin (*Sousa teuszii*), a species endemic to West African waters and found in mangrove and coastal areas where many artisanal fisheries are focused, has recently been a topic of some concern due to evidence that stocks are subject to incidental capture throughout much of the species' range (Weir *et al.* 2011). Bycatch of this species is of particular concern, given its classification as 'Vulnerable' by the IUCN (2013) and an unknown but likely low total population size (Van Waerebeek and Perrin 2007).

Together the coastlines of Senegal, The Gambia and Guinea-Bissau amount to over 5000 km (UNEP 2007). The Senegambian shelf supports a seasonally-active upwelling (Samb and Mendy 2004) and the Guinea Current Large Marine Ecosystem, one of the world's five most productive marine areas, extends southwards from the Bijagos Archipelago (Guinea-Bissau). Both coastal and offshore environments in this region provide important habitats for numerous species of migratory birds, dolphins, sharks, cetaceans and marine turtles, and sustain the livelihoods of many coastal communities (Chukwuone *et al.* 2009). However, fish biomass in the northwest Africa region, including the waters off The Gambia, Senegal and Guinea-Bissau, declined by a factor of 13 between 1960 and 2001 (Christensen *et al.* 2004). International fishing activities in West African waters exert considerable pressure on fisheries resources and do not promote sustainable use (Kaczynski and Fluharty 2002; Ramos and Grémillet 2013; Lundy 2014). In addition, fishing pressure has further intensified in recent years due to increased human migration to the coasts (Diop and Dossa 2011). Burgeoning coastal communities and dwindling fish stocks force fishers to exploit new areas, new species, or use different methods and gears, all of which can impact upon cetacean populations.

It is well established that local ecological knowledge (LEK) and traditional ecological knowledge (TEK) can contribute significantly to ecological studies (e.g., Berkes *et al.* 2000; Drew 2005; Wilson *et al.* 2006). TEK has been defined as 'a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment' (Berkes *et al.* 2000). LEK is similar to TEK in that it is linked to place, such as specific fishing grounds, and is acquired through observation and experience, over a single lifetime or over many generations. However, whilst TEK requires that the population be indigenous and incorporates a multi-generational or even an ancient accumulation of knowledge, an individual can accumulate LEK through interacting with one or more local environments over the course of his or her lifetime (Gilchrist *et al.* 2005). In this

study, the term local fishers' knowledge (hereafter LFK) is used to refer to knowledge of cultural and societal traditions relating to the use and management of marine resources, as well as ecological knowledge (such as spatial and temporal distribution and abundance of various marine species), business and economic aspects of fishing. Using interview surveys to collect LEK can be an effective means of covering large study areas and collecting information on species and habitat distributions (e.g., Gagnon and Berteaux 2009; Teixeira *et al.* 2013), general population trends (e.g., Tregenza 1992; Turvey *et al.* 2010; Maynou *et al.* 2011; Leeney and Poncelet 2013), local patterns of habitat use (e.g., Dulvy and Polunin 2004) and human-wildlife interactions such as bycatch, hunting, and co-operative fishing (e.g., Aragones *et al.* 1997; Moore *et al.* 2010; Zappes *et al.* 2011). Despite the limitations inherent in social survey data (Gilchrist *et al.* 2005; Silver and Campbell 2005), such methods are particularly appropriate where few or no baseline data exist, particularly in remote and understudied regions (Drew 2005) where resources are limited and where the logistics of scientific surveys can be complicated (Aragones *et al.* 1997; Moore *et al.* 2010).

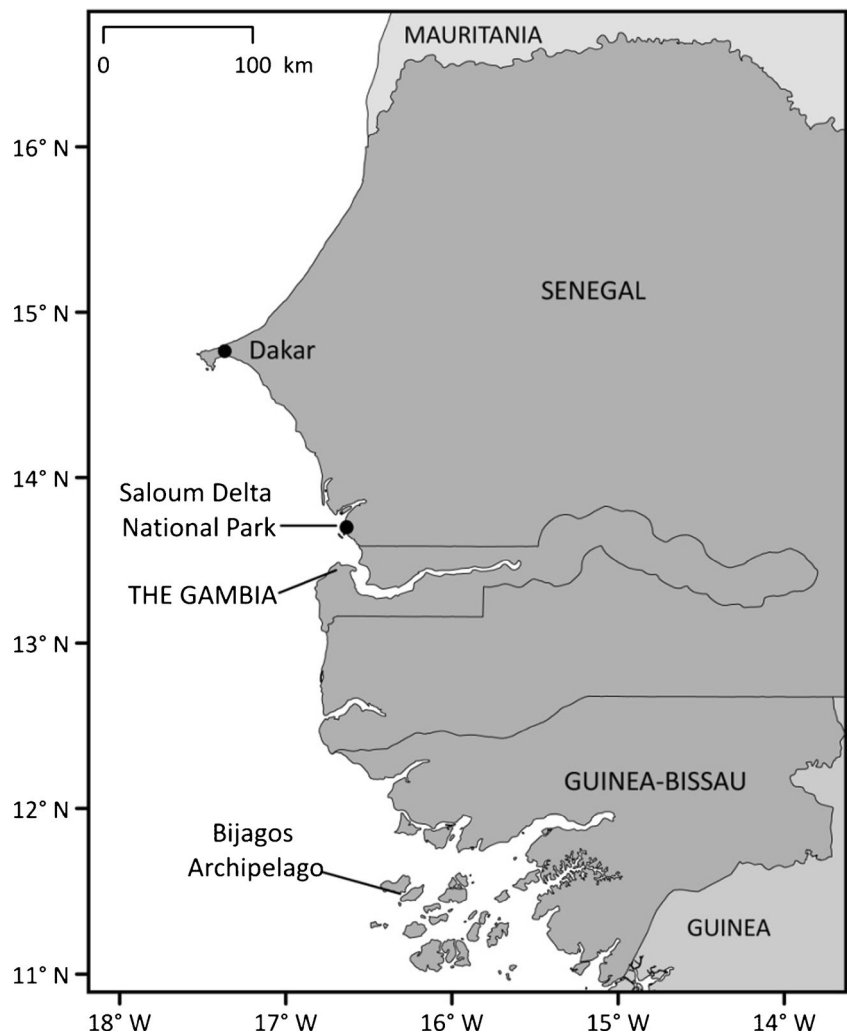
In order to assess whether deliberate and accidental catches of cetaceans are impacting populations, in countries where resources are limited and comprehensive surveys of cetacean stocks are not feasible, Robards and Reeves (2011) suggest focusing on 'understanding which groups of people are catching marine mammals, their motivations, and what species or stocks are being affected.' We used interviews with artisanal fishers to assess the frequency of bycatch of cetaceans, the fate of bycaught cetaceans and any cultural significance attached to whales or dolphins in the communities visited.

Methods

Interviews were carried out with artisanal fishers in villages and at landing sites in Senegal, The Gambia and Guinea-Bissau (Fig. 1). Artisanal fisheries are defined here as small-scale fisheries using relatively small fishing vessels (usually pirogues or canoes either with or without motors) or none at all, using relatively small amount of capital and energy, making short fishing trips, close to shore, for either subsistence or commercial purposes but mainly for local consumption (after FAO 2005–2013). In The Gambia and Senegal, interview data were collected as part of projects to train local staff in cetacean monitoring techniques. Interviews took place in September and November 2007 in The Gambia, and in June 2011 in Senegal. In Guinea-Bissau, data on cetaceans were collected after interviews focusing on sawfishes (Pristidae) in November 2012 (Leeney and Poncelet 2013).

LFK was collected using a questionnaire method (Huntington 2000), which ensured that interviewers covered all the required topics and that the interview could, if

Fig. 1 The three study areas: the Saloum Delta in central Senegal; The Gambia and Guinea-Bissau



necessary, be completed in a relatively short time period. For all three studies, local interviewers were used on the assumption that interviewees would be more comfortable and therefore open when speaking to someone known to them or their community. Fishers may fear consequences of responding to interviews, such as regulation of their activities (Silver and Campbell 2005), and are more likely to feel comfortable in the presence of a fellow fisher or someone from a neighbouring community (Leeney *pers. obs.*). In addition this allowed for interviews to be carried out primarily in the first local language of each fisher, rather than English, French and Portuguese (for The Gambia, Senegal and Guinea-Bissau, respectively) in which training was carried out and in which the questionnaires were worded.

In both The Gambia and Senegal, a single team of interviewers (12 and 13 individuals, respectively) were trained in basic interview techniques and an overview of the questionnaire, as part of longer training on cetacean identification, ecology and monitoring methods. In Guinea-Bissau, three separate teams of interviewers (25 in total)

were trained in different parts of the country: Cacheu (northern mainland Guinea-Bissau), Cacine (southern mainland) and on the island of Orango, in the Bijagos Archipelago. Cetaceans were not the primary focus of the programme conducted in Guinea-Bissau (questions on dolphins were asked after a series of questions relating to sawfishes) and the training session thus covered only a brief introduction to cetaceans, followed by a discussion of interview techniques and the questionnaire (Leeney and Poncelet 2013). All interviewers in The Gambia and Senegal were employees of the respective government departments responsible for national parks and wildlife and had previous experience carrying out our interview surveys or worked for a local NGO monitoring fish landings sites. In Guinea-Bissau, most interviewers had carried out previous monitoring of fisheries landings for a local NGO or had carried out manatee surveys with IBAP (Instituto da Biodiversidade e das Áreas Protegidas), but a small proportion were full-time fishermen with no prior experience in data

collection. All training was provided by the lead author (RHL).

During training sessions at all sites, the aims of the study were presented, interview techniques were discussed, the questionnaire was explained and discussed in detail, and modifications to the questionnaire were made either to clarify certain questions or based on advice from the interviewers on the sensitivities of the communities they would be working in. Interviewers in The Gambia then visited the main fish landings sites throughout the country over 8 days. In Senegal, an initial morning of interviews was followed by a feedback period, during which the data collected were checked over (by RHL) and any issues with clarity, legibility or missing answers were raised individually with interviewers to improve their performance on subsequent days. Interviewers then dispersed to landing sites throughout the Saloum Delta to carry out interviews over 6 days. The training provided in Guinea-Bissau was similarly structured except that the initial day of training was followed by 2 days where 'trial' interviews were conducted in the morning and feedback provided in the afternoon. In the first feedback session, interviews were checked by RHL and feedback provided both individually and as a group. In the second session interviewers checked each other's interview sheets in pairs to encourage identification and correction of mistakes their colleagues were making. Training on Orango was followed by 4 days of interviews in various villages on Orango and the neighbouring islands of Orangozinho, Menegue and Canogo, within the Orango National Park (ONP). Following the training courses in Cacheu and Cacine, each interviewer was provided with blank questionnaires and was requested to carry out a further 1 to 3 days of questionnaires in surrounding villages. One interviewer from Bissau joined the training course in Cacine and then returned to Bissau to carry out interviews there over 2 days.

Participant Sample

Interviews were conducted according to the availability of each fisher when approached by an interviewer and took place throughout the day, either in the respondent's residence or at landing sites and harbours. Interviewers began by introducing themselves, explaining the aim of the project and its affiliations: with the Department of Parks and Wildlife Management in The Gambia, with the Saloum Delta National Park authorities and the NGOs Wetlands International and WWF in Senegal, and for local NGO Noé Conservation, in association with IBAP, in Guinea-Bissau. The interviewers then explained that they were collecting information about important marine species in the region, assured the interviewee that the questionnaire was anonymous and likewise explained that the respondent was not obliged to answer any question s/he did not wish to.

The Questionnaire

A standard semi-structured questionnaire, containing both open and closed questions, was designed to collect basic background information from fishers, followed by questions relating to the incidence of bycatch by the individual and the community, the fate of any bycaught animals, traditional uses for, or stories or beliefs relating to dolphins, and any market value for dolphin meat (Appendix 1). Interviews were guided by this questionnaire and were conducted in an informal fashion. Interviewers were not encouraged to stray too far from the questionnaire, but were advised that they should re-phrase any question that was misunderstood by a respondent and should attempt to collect a response for each of the questions listed. Additional questions relating to the distribution of dolphin sightings and bycatch incidents were also included but the data collected were not used for this study. The questionnaire was provided in English to interviewers in The Gambia and in French to those in the Saloum Delta, and was translated into Portuguese by a local translator for interviewers in Guinea-Bissau.

Analysis

In The Gambia, 80 interviews were completed at nine harbours or landing sites; in Senegal, 136 interviews were completed at 12 sites; and in Guinea-Bissau, 295 interviews were carried out at 38 sites (27 on the mainland and 11 in the Bijagos Islands). In Guinea-Bissau, some data were excluded either because too many questions were left unanswered or due to the preponderance of irrelevant answers. A single interview was also carried out with a woman in The Gambia but she was not a fisher, and thus her responses were excluded from the final dataset. After excluding questionnaires of poor quality, 474 interviews remained for analysis; 79 from The Gambia, 136 from Senegal and 259 from Guinea-Bissau (Appendix 2). Data were analysed separately for each country, to facilitate comparison amongst regions. Differences in the stated incidence of bycatch by the interviewee and by other fishers were investigated using chi-square tests.

Results

The majority of respondents in each country were aged between 36 and 65 (Fig. 2). Whilst women do not traditionally go to sea in any of the areas where this study was conducted (RHL pers. obs.), they often collect molluscs at low tide on the mudflats in *bolongs*¹ and at the coast, and thus have experience in observing cetaceans close to the coast. In Guinea-

¹ *Bolong* is the name given in Senegal to the creeks which extend from the coast inland through mangroves and wetlands. These channels are important fishing grounds for artisanal fishers.

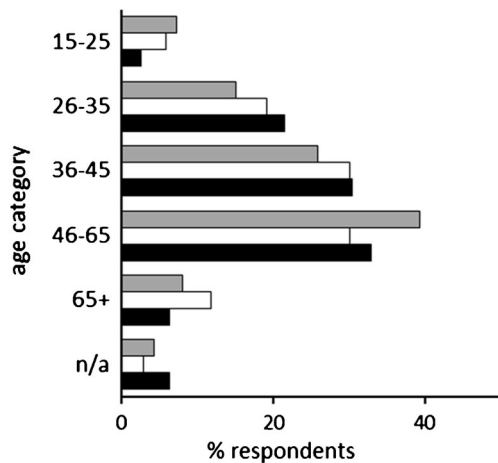


Fig. 2 Age distribution of interviewees in The Gambia (black, $n=79$), Senegal (white, $n=136$) and Guinea-Bissau (grey, $n=259$)

Bissau, the primary study focused on fishers who worked from boats and may have caught sawfishes and thus no women were interviewed. In The Gambia, interviewers chose to interview only male fishers, whilst in Senegal, 15 % of respondents (20 individuals) were women.

Bycatch

In all three areas, interviewees were more likely to state that other fishers accidentally catch dolphins than to affirm that they themselves had ever caught a dolphin (Fig. 3; Table 1). Between 48 and 67 % of respondents stated that other fishers accidentally caught dolphins, suggesting that this is a relatively common occurrence (Table 1). Chi-square tests revealed significantly different stated rates of bycatch among countries, with a higher proportion of interviewees in Guinea-Bissau (42 %) stating that they themselves had bycaught a dolphin at least once ($\chi^2=12.374$, d.f.=2, $P<0.01$), compared to The Gambia and Senegal (32 and 25 %, respectively). The 25 % of respondents in the Saloum Delta who stated that they had caught a dolphin at least once included several female interviewees. A significantly greater proportion (67 %) of interviewees in Guinea-Bissau stated that other fishers accidentally captured dolphins, compared to those in The Gambia (57 %) and Senegal (48 %; $\chi^2=13.7$, d.f.=2, $P<0.01$). Several fishers in Guinea-Bissau mentioned that they could be imprisoned for the possession of the carcass of an accidentally-caught dolphin.

In southern Guinea-Bissau, an interviewee had taken a photograph, with his mobile phone, of a dolphin he had bycaught several days before the interview. The bycaught animal was identified as a bottlenose dolphin (*Tursiops* sp.; Fig. 4). An interviewer from the Bijagos Islands suggested that *tubarão* (shark) and *bicuda* (barracuda) nets, with soak times of 2–3 days and 1 day, respectively, are the only net types likely to be involved in dolphin bycatch, since other

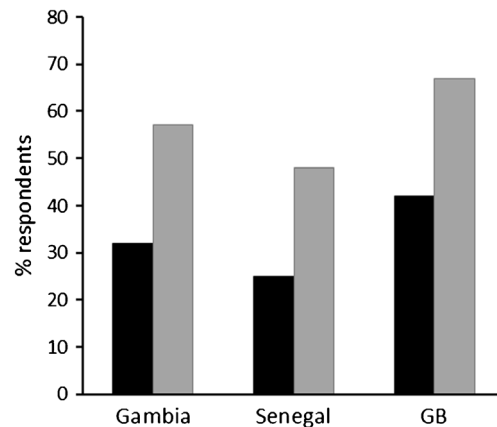


Fig. 3 Proportions of respondents who stated that they themselves had accidentally captured a dolphin (black) and that other fishers sometimes caught dolphins (grey)

net types used in that region are only cast when schools of fish are sighted.

In all study areas, the most common fate of a bycaught dolphin appears to be consumption by the local community (Fig. 5; Table 2). In many cases, interviewees stated that the meat was shared out with the entire village. Some respondents stated that bycatch would be released, if still alive, or abandoned at sea if dead; considerably more fishers in Guinea-Bissau than in Senegal or The Gambia stated that they would release a bycaught dolphin. Very few respondents in any of the study areas stated that dolphin meat would be sold. In The Gambia, seven respondents gave the usual price that dolphin meat might be sold for: 5–10 Dalasi/kg (6 respondents) or 400 D for an entire carcass (1 respondent). These prices equate to less than US\$0.50/kg or \$21 for a carcass.² In the Saloum Delta, two respondents provided an estimate of 1200 CFA/kg (US\$2.64³) for dolphin meat. In Guinea-Bissau, interviewees were not asked how much dolphin meat might sell for. One respondent noted “you don’t get much money for dolphin meat as people don’t like it much;” and another: “dolphins have good meat but if you take them to market, you don’t get a good price.” In 2014, during the collection (by RHL) of interview data on elasmobranchs in The Gambia, a fisherman eagerly showed the interview team a photograph on his mobile phone of a bottlenose dolphin he had caught in one of his nets the previous week. He stated that he butchered the dolphin, which “has a lot of meat so you can eat some and sell the rest,” and that he could sell the meat for around 1,000 CFA (~US\$2.10⁴) per kg.

When asked whether they had ever eaten dolphin meat, 59 % of interviewees in The Gambia, 40 % of respondents

² 1 Gambian Dalasi=US\$0.041 / €0.031, conversion rate for Nov 2007, <http://www.xe.com/currencytables/>

³ 1 CFA=US\$ 0.0022/ €0.0015; conversion rate for June 2011.

⁴ 1 CFA (Central West African Franc)=US\$ 0.0021/ €0.0015; conversion rate for April 2014.

Table 1 Incidence of bycatch

	Have you ever accidentally caught a dolphin?		Do other fishers accidentally catch dolphins?	
	Yes	No	Yes	No
Gambia	32 % (25)	68 % (54)	57 % (45)	43 % (34)
Senegal	25 % (33)	73 % (97) ^a	48 % (65)	43 % (58) ^b
Guinea-Bissau	42 % (108) ^c	55 % (143)	67 % (173)	27 % (70) ^d

^a Answer unclear/ not provided: $n=6$

^b Don't know: 5 %; n/a: 4 %

^c N/a: 3 %

^d Don't know: 3 %; n/a: 3 %

in the Saloum Delta and 37 % of respondents in Guinea-Bissau stated that they had eaten it at least once.

Cultural Significance and Uses of Dolphins

Interviewees were asked whether, apart from consuming bycatch, there were any other uses of, or beliefs or cultural significance relating to cetaceans in their region. Responses were markedly different at each site (Fig. 6). In The Gambia, 58 % of respondents referred to the ability of dolphins to save drowning fishers or guide lost boats back to shore. This was also mentioned by almost a quarter of respondents in the Saloum Delta, but by only 10 % of respondents in Guinea-Bissau. In contrast, in the Saloum Delta, 63 % of interviewees mentioned the importance of dolphins to certain families or ethnic groups in Senegal, especially the *Fata-fata*, a matrilineal subgroup of the Serer people who inhabit parts of Senegal and The Gambia. One interviewee, who was himself a Fata-



Fig. 4 Mobile phone image of a bycaught bottlenose dolphin, taken by one of the fishers interviewed in Cacine, southern Guinea-Bissau

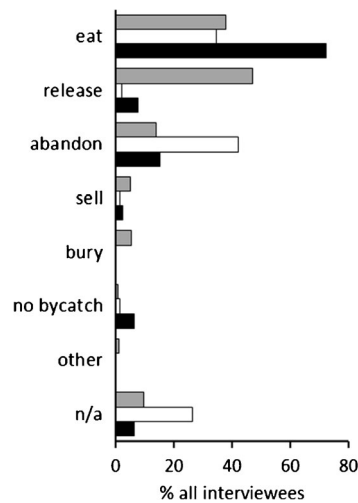


Fig. 5 Fate of bycatch in The Gambia (black, $n=87$), Senegal (white, $n=147$) and Guinea-Bissau (grey, $n=313$). Values are % of total number of interviewees in each country; in some cases interviewees provided >1 response. *Eat*—bycatch is consumed by the fisher/ community; *release*—if alive, the dolphin is released from the net; *abandon*—if dead, the bycaught animal is abandoned at sea; *sell*—meat is sold; *no bycatch*—bycatch does not occur/ was never observed by the interviewee; *n/a*—no answer or did not know

fata, stated that dolphins act as their guides and protect them against many things. Another Fata-fata respondent stated that his family would not eat dolphin meat, and would become ill if they did. Additional Serer fishers who were asked about the practices of the Fata-fata suggested that this group does not eat dolphin meat because doing so causes a skin rash. In Guinea-Bissau, two respondents noted that amongst the Felupe ethnic group (found in the northwest of the country) dolphins are thought to have a human soul. In The Gambia and Senegal, 11 and 6 % of respondents, respectively, suggested that dolphins act as 'indicators' for fishermen, showing them where they can find fish or sometimes indicating the way out of a bolong when the tide is low and sandbanks can block the

Table 2 The fate of bycatch, as a proportion (%) of the number of interviewees in each country. Some respondents provided more than one answer

Fate	Gambia	Senegal	Guinea-Bissau
Eat	72.2	34.6	37.8
Release	7.6	2.2	47.1
Abandon	15.2	41.9	13.9
Sell	2.5	1.5	5.0
Bury	0	0	5.4
There is no bycatch/ never seen bycatch	6.3	1.5	0.8
Other	0	0	1.2
Don't know/ no answer	6.3	26.5	9.7

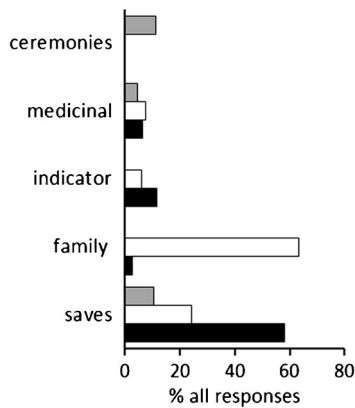


Fig. 6 Main uses (except as a food source) and cultural beliefs relating to dolphins, in The Gambia (black), Senegal (white) and Guinea-Bissau (grey). Number of responses as proportion of the number of interviewees in each country. *Saves*—dolphins rescue drowning fishers or guide lost vessels; *family*—certain families or ethnic groups do not catch or eat dolphins/ believe dolphins are their ancestors; *indicator*—dolphins indicate where fish are or can help fishers to navigate shallow waters; *medicinal*—various medicinal uses of dolphin products; *ceremonies*—use of dolphin meat in ceremonies (primarily of Bijagos Islands)

passage of a boat. In The Gambia, 14 % of interviewees also stated that dolphins were ‘friendly.’

In Guinea-Bissau, far fewer interviewees mentioned any uses for bycaught dolphins other than food. However, the use of dolphins in traditional ceremonies was mentioned by 29 respondents (all but one of whom were in the Bijagos Islands). Dolphins were mentioned in connection with the *grandesa* ceremony (marking the progression of individuals through the social ranks of the village) and other male ceremonies such as *fanado* (circumcision). Two interviewees mentioned that it has the same value as a cow in such ceremonies. Three individuals stated that if a dolphin is caught, it must be taken to the village elders or chief who conduct a ceremony before it is eaten.

The use of the oil, and occasionally the meat, of bycaught dolphins, for medicinal purposes was mentioned by between 5 and 7 % of respondents at all study sites. In The Gambia, the meat was said to cure polio and bone pains and the oil was used as a medicine for unspecified ailments. In the Saloum Delta, the oil or fat was used to treat rheumatism; and several respondents mentioned the extraction of oil from the head of a dolphin to use as a medication for *couli* (the Wolof name for a dermatological condition); the oil was consumed rather than applied topically. Dolphin meat was also mentioned as useful for treating illnesses. One interviewee in Senegal mentioned that dolphin bones could be burned and the resulting ash used as incense. In Guinea-Bissau, medicinal uses appeared to be restricted to the oil extracted from the head or skin of dolphins, which is used to heal broken bones throughout body (7 respondents), to treat stomach-ache (1 respondent), or is prepared as soup and eaten to treat *armorodia* - weakness and lack of energy (1 respondent).

In Senegal, several fishers mentioned the fact there used to be a targeted harpoon hunt for dolphins, but stated that this is no longer practiced. One respondent stated that this hunt ended in the 1960s. Two interviewees in The Gambia and two in Senegal mentioned the belief that dolphins are protected so that in the case of starvation or war, they would provide a reliable source of food.

Discussion

The capture, whether intentional or otherwise, and consumption of cetaceans continue to be contentious issues (e.g., Gales *et al.* 2005; Cunningham *et al.* 2012; Moore 2014). Addressing the impacts of bycatch and directed take on cetacean populations in developing countries not only requires an understanding of the level at which these activities occur, but should also consider the importance of cetaceans as a food source to the communities involved. This study has for the first time collected information on the uses for and cultural beliefs associated with cetaceans among numerous fishing communities in three West African nations. Given that there are at least 4,700 artisanal fishers in The Gambia, 59,500 in Senegal (figures for 2010; Diop and Dossa 2011), and 4,141 in Guinea-Bissau (data from 17 localities including the Bijagos Islands; CIPA 2011), this study sampled only a fraction of the extensive fishing community in the region. In addition, the spread of data collection over a 5-year period may have implications for the comparability of data among countries as environments can change considerably over such a time period. We did not attempt to qualify these changes, which are likely to be many and complex. The data presented nonetheless provide a valuable insight into the incidence of bycatch, the consumption, and other uses of cetaceans in a region where marine mammal bycatch is not monitored and where the conservation status of most cetacean populations is unknown.

Fishers were more likely to state that their colleagues sometimes accidentally caught dolphins than to admit to it themselves. This suggests that interviewees feared the repercussions of being personally implicated in the capture of a dolphin, and suggests that many of those who claimed not to have captured a dolphin may not have been truthful in their response. Nonetheless, these data provide evidence that bycatch continues to occur in artisanal fisheries in West Africa, as has been previously documented. It is possible that some respondents, particularly older fishers, may have provided information based on observations of bycatch made many years previously, but it proved difficult to collect associated data on timescales (see below). Historical accounts of bycaught and hunted cetaceans in the Eastern Tropical Atlantic have been summarised by Weir and Pierce (2013), and several reports have documented the bycatch and consumption of cetaceans in Senegal and The

Gambia in the 1990s (Murphy *et al.* 1997; Van Waerebeek *et al.* 2000, 2003), but few data exist for Guinea-Bissau. Maigret (1994) reported that 30–50 dolphins per year were landed in M'Bour in Senegal and were always eaten by fishermen. However, he believed that overall bycatch in the West Africa region was low, and noted that accidental captures of dolphins were not desirable as they caused the loss or damage of fishing nets and thus a financial loss for fishermen (Maigret 1994). A similar sentiment was expressed by several interviewees during this study, and the apparent lack of a market for dolphin meat may also make any 'intentional bycatch' less appealing.

It is useful to distinguish between accidental catches that are 'either unused or unmanaged' and usually discarded ('bycatch'; Davies *et al.* 2009) and those which are retained for consumption or sale ('non-target catch') (Hall 1996; Read 2008). In this study, accidentally-caught animals appeared to be treated as an opportunistic food source. The proportion of interviewees who stated that they would eat a bycaught dolphin was significantly higher in The Gambia than in the other two study regions. This may indicate a greater frequency of consumption of cetaceans in The Gambia, but may also have been a result of more truthful responses by Gambian fishers, who in some cases were very open about this topic. The proportion of interviewees who stated that they would abandon accidentally-caught dolphins was highest in Senegal, whilst the proportion stating that they would release an accidentally-caught dolphin was significantly higher in Guinea-Bissau than in The Gambia or Senegal. It is unclear whether this indicates that more dolphins are found alive by Bissau-Guinean fishers or is simply a misunderstanding of the term 'release' where the live state of the bycaught animal was not understood by interviewees. It is possible that the use of simpler, more traditional gears and hand-cast nets, particularly by subsistence fishers in the Bijagos Islands (Tvedten 1990), may result in lower rates of bycatch in this area. However, a considerable number of fishers from other West African nations also fish in Guinea-Bissau's waters and use motorised vessels which allow them to access deeper and more distant fishing grounds (Tvedten 1990). Future studies should also sample the experiences and attitudes of these fishers in order to gain a better understanding of the frequency with which bycatch occurs overall in Guinea-Bissau waters and the fate of bycaught cetaceans.

It does not appear to be common practice to sell bycaught dolphins. A slightly higher proportion of respondents in Guinea-Bissau stated that they would sell a bycaught dolphin. This may be due to the higher levels of poverty throughout Guinea-Bissau in comparison with its neighbours, or it may

simply be that in both The Gambia and the Saloum Delta, there are higher levels of awareness regarding laws for the protection of cetaceans,⁵ although the enforcement of fisheries and wildlife legislation is often poor in these regions. In most cases, however, the meat appears to be distributed among the community (Van Waerebeek *et al.* 2000). As long as this practice continues, it is less likely that a market for dolphin meat will develop. In no case did dolphin meat appear to be a highly-valued food source and some interviewees categorically stated that its taste was not particularly favoured. Similarly, an interview study in Nigeria found that both bycaught turtles and cetaceans were used by fishing communities, but did not appear to be important either as a food source or commercially (Lewison and Moore 2012).

Directed take of marine mammals is not uncommon in developing countries, though it is more poorly documented other than for certain controversial fisheries for large whales (Robards and Reeves 2011). Formerly discarded bycaught cetaceans are now retained for use as bait or food, and in some cases this transition has progressed to directed take. Weir and Pierce (2013) documented evidence of consumption of cetaceans, termed 'marine bushmeat' (Clapham and Van Waerebeek 2007), in 15 of the 21 countries bordering the eastern tropical Atlantic (Mauritania to Angola). Levels of small cetacean bycatch and directed take are often not well-understood and poorly documented because this activity is carried out in a clandestine manner. Although it was not possible in this study to determine the frequency with which various species are bycaught, it is likely that bottlenose dolphins and Atlantic humpback dolphins, both of which have a coastal distribution in the region (Van Waerebeek *et al.* 2003, 2004; Weir 2010; Weir *et al.* 2011), make up a considerable proportion of bycatch in artisanal fisheries. This is supported by photographs provided by fishers during this study, of bottlenose dolphins bycaught in southern Guinea-Bissau and The Gambia, and of a dead stranded humpback dolphin in the Saloum Delta. No population estimates exist for either species in this region and it is therefore of the utmost importance that future research in this region generates abundance estimates and investigates population connectivity throughout the region, as well as attempting to quantify rates of cetacean bycatch in artisanal and industrial fisheries.

The medicinal uses of dolphin oil and meat have not, to our knowledge, been documented in detail for the West Africa region. Numerous West African cultures are known to use a wide array of plants and animals as sources for medicinal products (e.g., Madge 1998; Huffman 2003; Alves *et al.* 2010; Alves and Alves 2011). In Togo, Segniagbeto and Van Waerebeek (2010) documented the use of oil derived from a stranded humpback whale for medicinal purposes. Worldwide, Alves *et al.* (2013) documented the use of at least 24 species of aquatic mammals in traditional medicine and Alves and Rosa (2008) documented the use of the body parts

⁵ Senegal: Ministry of Fisheries decree 97–1044, 18 Aug 1987. The Gambia: Fisheries Act, 1991 and the Biodiversity and Wildlife Act 2003. Guinea-Bissau: Regulation of Artisanal Fisheries of Guinea-Bissau, June 2011, Section II: Protected species.

of tucuxi dolphins (*Sotalia fluviatilis*) in northern Brazil for various magical and religious purposes - largely to attract sexual partners, make money or for good luck. The oil and fat of the tucuxi were also prescribed for the treatment of 12 diseases. Many areas where we conducted interviews, particularly the Bijagos Islands, are far from any clinics or medical supplies, which may cause communities to place greater reliance on 'traditional' cures. However, given that there does not appear to be a directed hunt to supply dolphins as a source of either food or medicines, this practice likely does not pose a significant threat to local cetacean populations. Wildlife may also be used for spiritual and magical purposes in some regions. In Brazil, Alves *et al.* (2012) documented the use of three species of river dolphin for magico-religious purposes, but such practices were not apparent in our West African study area. It was not possible to determine whether this might be because elements of Islam and Christianity have replaced older traditional belief systems, as has been observed elsewhere (e.g., McClanahan *et al.* 1997) or whether such practices simply involved other species. Mention amongst older interviewees of the uses of sawfish (*Pristis* sp.) rostra to protect households or to ward off evil spirits suggests that magical beliefs were certainly attributed to some aquatic species in the study area but are less familiar to younger generations (Leeney and Downing 2015). While some interviewees in the Bijagos Islands mentioned the use of dolphin flesh in certain traditional ceremonies, many different types of meat are used for such ceremonies including domestic cattle, hammerhead sharks (*Sphyrna* sp.) and (formerly) sawfishes (Leeney and Poncelet 2013). It seems therefore unlikely that dolphin meat holds a particular significance in this case.

Given that the ecological success of community-based conservation projects may be more likely when the project engages positively with cultural traditions (Brooks *et al.* 2012), it is important to document the cultural significance of species of conservation concern. In several West African cultures, certain animal species are totems for particular families or are of symbolic importance for an entire community (e.g., Birky 2013). Species such as crocodiles, sawfishes and hammerhead sharks form an integral part of the ceremonies of the Bijago people of Guinea-Bissau (Leeney and Poncelet 2013). This study found that, particularly in The Gambia and to a lesser extent in Senegal, the belief that dolphins can save fishers whose vessels have capsized and can guide lost boats back to shore is widespread (see Alves and Rosa 2008 for a similar case in Brazil). This is significant in as much as the persistence of this belief may prevent expansion of any directed take. One fisher in The Gambia stated that he did not eat dolphin meat in case he was ever in trouble at sea, because those who do so are not helped by dolphins. In The Gambia and Senegal the Fatafata were well known among interviewees for their respect for dolphins and their practice of not eating dolphin meat. Much in the same way as long-enduring customary practices, such as

taboos that limit resource use, are being merged with contemporary resource management (e.g., Drew 2005; Cinner and Aswani 2007; McClanahan *et al.* 1997), such knowledge of the cultural significance of and human attitudes towards particular species can strengthen community-based conservation efforts (Grigione 1996). Indeed, Alves and Rosa (2008) noted that the myths associated with dolphins in Amazonian folklore may have given dolphins some protection from humans. Likewise, high regard for marine mammals or religious beliefs of some coastal populations in West Africa may have prohibited their capture (Maigret 1994).

Negative responses of fishers to the data collection process may reflect a fear that their responses will result in tighter regulations or other implications, which in turn inhibits the data collection process (Silver and Campbell 2005). This study used local fishermen and parks staff as interviewers in order to minimise any distrust amongst interviewees and to encourage more open responses to topics that may be considered as sensitive. Some respondents were aware that dolphins are protected by law and consequently may have been reticent in their responses, limiting the findings of this study. Nonetheless, plenty of interviewees confirmed that either they themselves or other fishers occasionally caught dolphins accidentally, suggesting that the methodology employed was effective.

Numerous lessons relating to the design of questionnaires and training of interviewers in West Africa were learned during this study. It was important to abandon scientific and formal wording in favour of clear but informal language, both in the training sessions and within the questionnaires. Translation of interview questions from English, French or Portuguese into the local languages used in the study area proved challenging. Phrases such as 'cultural significance' usually had to be explained using examples during the training period, in order that the interviewers could formulate the question appropriately for their interviewees. Modifications to the language and order of questions on the questionnaire allowed the interview team to create a questionnaire that they were comfortable working with. For example, in Guinea-Bissau, interviewers mentioned that asking a village elder his age must be done with respect and this question would be better asked at the end of the interview. Images are more effective tools than language in many cases—for example, species such as dolphins may have different local names. In such cases, it may be impossible to begin discussing the species of interest until its local name has been established, and the easiest means of doing so with an image. In some cases, where several similar species are present or when collecting information on more than one species or group of species, it proved important to keep the image of the species of interest to hand and continue to refer to it throughout the interview, to ensure that the respondent did not become confused as to what the question referred to. Likewise, simple questions were most effective,

since the multiple translations of questions and corresponding answers resulted in numerous opportunities for misunderstandings and loss of information. Questions relating to time scales frequently proved troublesome, particularly in remote areas where interviewees often did not know their own age and where influences from the outside world, which may more clearly mark the passage of time, are few. During interviews in Guinea-Bissau, some interviewees tried to provide a rough time period for their observations by relating them to the start or end of the civil war. This highlighted that significant historical dates such as the end of colonial rule or periods of war are likely to be well-remembered by most interviewees and if noted in advance and integrated into the interview structure, may prove useful markers for estimating the timing of observations in future studies. A training period for interviewers proved essential in ensuring that high-quality data were collected. The format of the training provided during the final study, in Guinea-Bissau, was a result of integrating previous experiences in The Gambia and Senegal. Encouraging members of the interview team to correct each other's mistakes allowed for each individual to receive advice in their own language and from someone with similar experience and background. Using two feedback sessions greatly improved the quality of the data collected and would also prove an effective means of selecting the most skilled interviewers for unsupervised data collection.

Socio-cultural attitudes towards accidental capture of marine mammals are likely linked to a nation's dependency on marine resources for food (Alverson *et al.* 1994). Poverty is widespread in the three countries where this study took place, resulting in greater reliance on artisanal fisheries as the primary source of protein and income. This provides a major challenge when addressing bycatch and consumption of protected or endangered species. Our findings suggest that although marine bushmeat is not at present a major source of income for communities in Guinea-Bissau, The Gambia or the Saloum Delta, it does provide a supplementary source of food. Stocks of demersal and pelagic fish in West African waters are, in many cases, being fished at full capacity or are overfished (Christensen *et al.* 2004; Diop and Dossa 2011). As fish stocks continue to decline throughout the West Africa region due to pressure from industrial fishing fleets from Europe (Ramos and Grémillet 2013), China (estimated at 3 million t per year; Pauly *et al.* 2013) and elsewhere, ever-greater pressure is placed on the food security of coastal communities in West Africa and coastal cetaceans may become a more desirable target (Robards and Reeves 2011). In Ghana, periods when fish supply was low resulted in greater demand for bushmeat and thus higher levels of hunting in reserves (Brashares *et al.* 2004). The consumption of bycaught dolphins cannot easily be discouraged in a region where food is scarce and where,

understandably, conservation is not a priority for local communities.

These findings have provided evidence that bycatch by artisanal fishers continues to occur in these West African nations and that the consumption of cetacean meat by coastal communities is not uncommon. The meat and oil of bycaught cetaceans is also used in traditional medicines throughout the region. However, directed take of cetaceans does not appear to be prevalent, as dolphins can cause considerable damage to fishing nets while they are entangled. Marine mammal populations in West African waters are already considerably impacted through bycatch in industrial fisheries (e.g., Zeeberg *et al.* 2006). However, the vast majority of fishing activities worldwide is conducted by artisanal fishers and thus the knowledge gap regarding levels of bycatch in artisanal fisheries in West Africa presents a major challenge to the conservation of threatened marine species (Moore *et al.* 2010). Ultimately, the most effective means of minimising both bycatch and directed take of cetaceans in this region will be the management of fish stocks to prioritise the requirements of coastal communities in the region rather than international demand.

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Appendix 1

Questionnaire: The Gambia

1. Sex
2. Age
3. Home town
4. Have you ever accidentally caught a dolphin?
5. Do other fishermen accidentally catch dolphins?
6. What do other fishermen do with accidentally caught dolphins – discard/ keep to eat/ sell/ other (specify).
7. If you or someone you know catches a dolphin, do you sell any of it?
8. How much does dolphin meat sell for?
9. Have you ever eaten dolphin meat?
10. Have you noticed a change in the number of dolphins in Gambian waters? If yes, over what time scale?

11. Do you know of any cultural significance of dolphins in The Gambia, or any uses of dolphins?
12. Why do you think people are not allowed to catch and eat dolphins?

12. Há tradições ou crenças culturais relativas a golfinhos e baleias em sua aldeia? Se sim, quais são eles?

Appendix 2

Questionnaire: Senegal

1. Age
2. Vous habitez dans quelle ville ?
3. Est-ce que vous avez jamais attrapé accidentellement un dauphin ?
4. Attrapent les autres pêcheurs accidentellement les dauphins ?
5. Que font-ils les autres pêcheurs avec les dauphins attrapés ? abandonner/ manger / vendre / autre –
6. Combien est-ce qu'on peut gagner pour la vente d'un dauphin ?
7. Avez-vous jamais mangé de la viande de dauphin ?
8. Avez-vous remarqué un changement dans le numéro de dauphins dans cette région ? grand augmentation/ augmentation/ pas de change/ diminution/ grande diminution
 - Depuis quand ?
9. Est-ce qu'il y a des significations culturelles des dauphins au Sénégal ? Si oui, quoi exactement ?
10. Est-ce que c'est légal d'attraper et manger un dauphin au Sénégal ?

Questionnaire: Guinea-Bissau

1. Nome de aldeia
2. Idade
3. Nome de rede
4. Você vê golfinhos / baleias ao redor de sua aldeia?
5. Você já percebeu uma mudança no número de golfinhos na área, sobre sua vida? (Se sim, é um aumento ou uma diminuição, e em que período de tempo?) ? - O que você acha que é a causa desta mudança?
6. As pessoas às vezes capturar golfinhos acidentalmente em suas redes?
7. Se sim, quando foi a última vez que você viu isso acontecer?
8. Você já pegou um golfinho acidentalmente?
9. O que acontece com o golfinho se ele fica preso em uma rede? (É comido / liberada de volta para o mar / vendida como carne / abandonado / alguma outra coisa?)
10. Você já comeu carne de golfinho?
11. O que mais golfinho usado para nesta área?

Numbers of interviews completed at each harbour or landing site and used in final analyses

Country	Village	Number of interviews	
The Gambia	Albreda	5	
	Banjul	10	
	Barra	4	
	Brufut	10	
	Essau	5	
	Gunjur	15	
	Kartong	5	
	Sanyang	10	
	Tanji	15	
	Gambia total: 79		
	Senegal	Bakadadji	1
		Bassoule	1
		Betenty	23
		Bossinkang	11
		Cassindiane	3
Dassilame		5	
Djinack		18	
Missira		49	
Nema Bah		5	
Ngador		7	
Soukouta		8	
Senegal total: 136			
Guinea-Bissau	Northern mainland (n=78)		
	Bolol	4	
	Cacheu	26	
	Cobompor Mandjaco	3	
	Djifunco	4	
	Eosor	10	
	Morcunda	6	
	Porto Aribada/ Ribada	4	
	Sao Domingos	10	
	Susana	3	
	Varela	8	
	Central mainland (n=20)		
	Bissau	20	
	Southern mainland (n=92)		
	Cabasane	6	
	Cacine	44	
	Cadico	5	
Cambras	1		
Cameconde	5		

(continued)

Country	Village	Number of interviews
	Campeane	6
	Camsanha	1
	Canali Fula	2
	Cassibes	1
	Cassumba	1
	Catesse	6
	Gadmael Porto	6
	Ilha de Melo	1
	Iraque	2
	Pampaire	4
	Tribunal	1
	Bijagos Archipelago ($n=69$)	
	Abu	1
	Acanho	9
	Amupa	8
	Ancopado	2
	Ancaboca	1
	Canogo	7
	Eticoga	10
	Meneque	12
	Uite	10
	Uno	4
	Wassa	5
	Guinea-Bissau total: 259	

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