Status of Large Marine Flagship Faunal Diversity Within Cameroon Estuaries of Central African Coast

Isidore Ayissi, Gordon N. Ajonina, and Hyacinthe Angoni

Abstract

An assessment of the status of large marine flagship faunal species along Cameroon estuaries within the Central African coast was carried out through several surveys, interviews, literature reviews and experience to compile species checklists, causes of their presence (migration, reproduction, feeding, etc.), the conservation status and different threats to species. Results showed that four species of sea turtles were identified and common along Cameroon estuaries: *Dermochelys coriacea*, *Lepidochelys olivacea*, *Chelonia mydas* and *Eretmochelys imbricata* for nesting and feeding activities. Eight cetaceans (*Sousa teuszii, Delphinus capensis, Delphinus sp,. Tursiops truncatus, Stenella attenuata* or *S. frontalis, S. coeruleoalba, Megaptera novaeangliae, Physeter macrocephalus)* and one sirenian species (*Trichechus senegalensis*) were found to be common, seasonal or rare. We recorded up to 61 waterbird species represented by 17 families from monthly counts within 20 km of the Sanaga River estuary and associated rivers and lakes in the Douala-Edea Wildlife Reserve between March 1999 and December 2012. The families of Ardeidae, Scolopacidae, Charadriidae and Alcedinidae were top with 12, 10, 8 and 7 species, respectively. Twenty-two (36.1 %) of the 61 species appeared to be resident, while 21(34.4 %) and 16(29.5 %) were seasonal and occasional visitors, respectively. Of particular significance is the high abundance of African Skimmers, Grey Pranticoles, Open-billed Storks and Common green shanks with monthly numbers of up to 811, 583, 336 and 189, respectively. In spite of the existing laws and conservation policies on these threatened species in Cameroon, most are

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facing many threats. By-catches in gillnets and other fishing gears and the potential for increasing direct takes may be the most severe threats and causes of significant mortality rates. Other threats of varying magnitude of concern include the following: habitat encroachment through coastal development (e.g. port and road construction), over-fishing, chemical and acoustic pollution, ship collisions and ghost nets. The almost complete lack of scientific data on the biology, distribution, stock structure and abundance of sea turtles and cetaceans in Cameroon waters makes it difficult to properly assess the impact of these threats, let alone addressed them. An acceleration of research is urged with the involvement of national Universities and Research Institutes. More faunal surveys are needed to unveil the potentials of the area and the need for the establishment of important relationships between species abundance, site temporal conditions (sandbank dynamics) and socio-economic activities with a view to identifying sustainable wetlands ecosystem utilization options.

Keywords
Cameroon estuaries • Cetaceans • Flagships • Marine mammals • Sea turtles • Waterbirds

Introduction

In international literature, an estuary is defined as a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with freshwater derived from land (Cameron and Pritchard 1963; Pritchard 1967). Estuaries is a partially enclosed permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper limit of tidal action or salinity penetration. During floods, an estuary can become a river mouth with no seawater entering the formerly estuarine area or when there is little or no fluvial input an estuary can be isolated from the sea by a sandbar and become a lagoon which may become fresh or hyper-saline.

Estuaries constitute one of most heavily utilized and productive zones on our planet. Their integration processes weave a web of complexity far out of proportion to their occupation of less than 1 % of the planet's surface area Welsh (1984). Estuary management is a complex task, for it deals with the use and care of the interface between the land, rivers and the sea (UNEP/MAP/PAP 1999).

Rapid industrialization and burgeoning population have caused a related increase in the demand for freshwater and a resultant alteration in the flow regime of many of Cameroon's rivers. Estuaries are also at the receiving end of poor catchment practices, such as pollution, erosion, excessive water abstraction and impoundments. Poorly regulated activities have led to the destruction of Cameroon estuaries habitats by physical development such as land reclamation, pollution, deforestation, agriculture, urbanization of Douala and correlated towns, all of these affect the rich and important bio-diversity in this area.

The Cameroon section of the Central Africa coastline hosts an important marine biodiversity, especially sea turtles, marine mammals and water birds. Yet, very little is known about the importance and status of these species. Certain information has been documented on the status of these species along the Cameroon estuary from limited surveys. Atangana (1996) presents the biogeography of these ecosystems in general aspects; Fretey (1998a, b, c, 2001) present the different species of sea turtles occur in this zone and the need of their conservation; Angoni (2005) and Angoni et al. (2010) present the ecology of sea turtles related to their habitats; Ayissi (2000), and Ayissi et al. (2006a, b, 2007, 2013) present also these species but insisting on the need of their conservation by developing alternative sources of income through ecotourism; Ajonina et al. (2002, 2003, 2007), Ajonina and Ayissi (2012) present avifaunal diversity in this area with the aim of the wetlands management. This also includes those undertaken recently under some conservation-based institutions working within the zone including Specialized Research Center of Marine Ecosystems (CERECOMA), Cameroon Marine Biology Association (CMBA), Cameroon Wildlife Conservation Society (CWCS), WWF and other partners who have also carried out some rapid assessments of the status of large marine flagship faunal diversity along the Cameroon coastline.

However, these studies have often been scattered without any clear consolidation to build up any baseline information on these flagship species, especially the evaluation of different impacts necessary for any conservation measures needed for long-term management of these species and their habitats. The present study sets to achieve this aim and drive recommendations in future for sustainable management of Cameroon's estuary.

Methods

Cameroon Coastal Profile and Study Sites

The coastal zone of Cameroon stretches over 402 km (Sayer et al. 1992), from the Nigerian border in the north (Akwayafe River, latitude 4°40′N) to the Equatorial Guinean border in the South (Campo River, latitude 2°20′N), falling between longitude 8°15′E and 9°30′E).

The vegetation of this region belongs to the large set of massive dense humid forest of Cameroon in low and medium altitudes in the coastal forest group, consisting of dense vegetation moist evergreen lowland to *Sagoglottis gabonensis* and *Lophira alata*, biafran subtype; this primitive forest is similar to South American affinities with the humid Amazon rainforest (Letouzey 1968).

Cameroon Continental Shelf

The continental shelf of Cameroon occupies an area of about 10,600 km^2 and gradually descends through 30, 50 and 100 m depths (Bye et al. 1974; Zogning 1986; Morin and Kuete 1989). The northern part has a width of about 25 nautical miles on average, while the southern portion is narrow (15 nautical miles on average). Its relief shows two distinct zones separated by a parallel which passes through the mouth of the Lokoundje River. In the north, the slope is gentle, with a drop in altitude of 130 m. This zone is rocky, with intermittent occurrence of sandbanks. Meanwhile, two major faults have been identified: a reef north of the mouth of the Sanaga River and a series of outliners in the neighbourhood of Macias Nguema Island (Bioko-Equatorial Guinea). This area is favourable for trawling (industrial fishing) (Crosnier 1964). South of this parallel, the relief of the continental shelf is more disjointed; there are many reefs and sandbanks. The interruption of the slope occurs quite early (e.g. at 50 m depth between Campo and Kribi). This area is not suitable for trawling, but is favourable for small-scale fishing. Many corals can be found at 150 m depth.

Coastal Landscape and Hydrology

According to Kramkimel and Bousquet (1987), four characteristics areas can be distinguished within the Cameroon coastal landscape:

- From Campo to the River Nyong mouth

The coast is high and shows an alternation of rocky outcrops and sandy mud. The main rivers are Ntem, Lobe, Kienke, Lokoundje and Nyong. Their discharges are low, and they transport little alluvium towards the sea. Mangroves are slightly represented; when present, they are in the form of patches on a rocky substrate; this is comparable to the situation described by Villiers (1973) along the Gabonese coast. On the continent, the vegetation is made up of low-altitude Atlantic forest, preceded on the seaward side by patches of a few species of grass which grow on the beaches.

- From River Nyong to Limbe

The coast is low and is characterized by the presence of estuary and riverine mangroves, separated from the Atlantic forest by a marshy complex of brackish waters. The rivers here are Dibamba, Wouri, Mungo and Sanaga. These waterways have high discharges and transport huge quantities of sediments towards the sea. The Mungo enters the sea through a delta, while other rivers enter together through the estuary (Dibamba, Wouri and Sanaga). The creation of the Douala-Edea Wildlife Reserve has been justified by the great fauna diversity in the area.

- From Limbe to Idenau

The coast is volcanic and is overhung by Mount Cameroon which has a peak of 4,095 m at the level of Fako. The vegetation is made up of low-altitude mountain forest rich in endemic species. It is characterized by lava flows and the industrial plantations of the Cameroon Development Corporation (CDC). These plantations currently cover more than 90,000 ha. The Mabeta-Moliwe reserve is found here.

- From Idenau to the Nigerian border

The coast is once more low and marshy; this part of the coast is watered by the mouths of rivers Akwayafe, Ndian, Lokete and Meme which together enter the sea through the Rio-Del-Rey estuary. The vegetation consists of mangroves and swampy species. In the hinterland, the Atlantic forest includes the Korup rainforest and national park.

Geological Characteristics

Sedimentary Basin

The Cameroon coast includes three sedimentary basins of different dimensions. These are the Campo–Kribi basin, the Douala basin and the Rio-del-Ray basin. The Campo–Kribi basin covers an area of 45 km^2 (1–3 km wide and 25 km long). It is situated north of the River Ntem, and its fossils give it great paleogeographic importance. The increase varies between 30 and 100 m. The slope variations measured at sea are a reflection of the situation obtained on land. This can be explained by the existence of many recent faults parallel to the coast and rising several metres above the base. These faults are associated with the formation of the Congo basin, the Lobe waterfall and the Ntem and Bongola rapids. The Douala Rio-del-Rey basin stretches from latitudes 20° to 50° North. It is made up of two sub-basins: the Douala basin in the east (7,000 km^2) and the Rio-Del-Rey basin in the west (2,500 km^2). From south to north, one passes successively through symmetrical geomorphologic settings on both sides of Mount Cameroon: the

Sanaga delta; the "Bouches du Cameroun"; the volcanic horst proper the Rio-del-Rey; and the Niger delta.

The Douala–Rio-del-Rey basin takes the shape of an isosceles triangle with its peak at Yabassi and its side measuring 150 km. The height of the triangle corresponds to the maximum width of the basin (50–60 km). The relief has preserved traces of destructive tectonic activities which calved out the base into steps. The 200 m isobath Douala is at the same distance from the coast (40 km), it is off Kribi–Campo. On the other hand, within the Rio-del-Rey basin, this isobath lies up to 80 km from the beach. The continental shelf in this area is twice as broad as it is in the South-East of Mount Cameroon.

Sediment Dynamics

Sediments deposition leads to the creation of sandy offshore bars whose origin is either marine (effect of the Benguela and Gulf of Guinea currents) or volcanic (Mount Cameroon). The progression of offshore bars and sandy spits parallel to the coast (Souelaba Point), and of various points between Idenau and Bamusso, is caused by: the predominance of the Benguela current over that of the Gulf of Guinea which flows from the west; the low amplitude of tides (2 m on the average); the low charge of coarse detritus material in rivers which flows through a woody hinterland; the build-up of these coastal structures tends to regularize the coastal profile.

Erosion is significant along the volcanic coast of Cameroon. A displacement of the coastline towards the continent has been observed in the South West province. The estuaries and mangroves are characterised by high turbidity which extends right up to 30 km into the sea from Bakassi. This phenomenon is also noticed in the estuaries of "Bouches du Cameroon". The entire eastern part of Rio-Del-Rey basin is blocked by accumulation of mud and fine sand advancing southwards the River Meme. The evolution of the coast will also depend on the quantity and rate of deposition of alluvial material. Between River Akwayafe and Limbe, the offshore currents can reverse direction. This phenomenon can either lead to enlargement of the beaches or otherwise cause erosion as in the case of Bamusso. The portion of the coast between Kribi and Campo consists of crystalline rocks which appear sometimes as isolated out crops in the sea. This rocky portion is characterized by the absence of significant deposits of sand and mud.

Climate and Oceanographic Conditions

The coastal climate in Cameroon, just as in the rest of the Gulf of Guinea, is influenced by the meteorological equator, which is the meeting point between the anticyclone of Azores (North Atlantic) and that of Saint Helen (South Atlantic). This climate results from the combined effect of convergence of the tropical low-pressure zone and the inter-tropical front within the continent. Along the coast, rainfall intensity increases from south to north. Recorded values show average annual rainfall of 3,000 mm in Kribi, 4,000 mm in Douala and more than 11,000 mm in Debundscha. There are two distinct seasons: a long rainy season of more than 8 months and a dry season which generally stretches from November to February. Air temperature is high throughout the year (above 25 °C).The coastal climate is also characterized by monsoon winds of the Guinean type, predominantly south-westerly. These winds cause humidity values to be most always at saturation point. Winds speeds attain exceptional values of 18 m/s (April 1993). In general, average wind speeds recorded over a period of 10 years (1983–1993) vary between 0.5 and 2 m/s.

Cameroon coastal surface waters are warm throughout the year, unlike the coastal waters of other West African countries (Côte d'Ivoire, Ghana, Togo, Benin, etc.) which are characterized by seasonal upwelling. Water temperatures remain always above 24 °C. This warm water layer has a thickness of 20–30 m (Crosnier 1964) depending on the location and the season. It overlies a less warm water layer whose temperature varies between 18 and 20 °C. There is a thermocline between the two water layers which plays an important role in the dynamics of living organisms. Cameroon's coastal waters are generally characterized by low salinity due to high rainfall and a dense river network which supplies freshwater. Lafond (1965) recorded peak salinity values of 20 ‰ at 15 km from Douala port in the dry season and less than 12 ‰ in the rainy season. Tides on the Cameroon coast are of the semi-diurnal type. In general, the amplitude varies between 0.3 and 3 m depending on the location. Their effects are felt in the estuarine complexes. The propagation of the waves and ebb tides are enormous, but poorly known. Olivry (1986), Morin and Kuete (1989) estimate them at 10^6 m^3 for the River Dibamba and 50×10^6 for the River Wouri, in nature are tidal currents which are sometimes violent: 1–1.5 m/s for the flux and up to 2.6 m/s for the reflux. The river flow disturbs this already unstable system by submerging the estuarine complexes. According to observations made by Chaubert and Garraud (1977), sea swells are from the south to south-west sector and of distant origin. Their peculiarity results from the double obstacle constituted by Bioko Island and the widening of the continental shelf at the level of Rio-Del-Rey.

Data Collection Methods

Sea Turtles

From several monitoring of sea turtles species population in the area, we made identification and description of nesting sites and species according to standard KUDU-Program protocols and the different nesting beaches patrolled by

teams of eco-watchers according to tidal conditions to observe and identify females laying eggs on the beaches. Biometric data were also collected on sea turtles (curved carapace length and curved carapace width) during patrols and those caught incidentally in nets and observed during the return of fishermen from sea recorded on cards pre-established according to the KUDU-Program standard protocols. We also noted all ringed live turtles with MONEL ECO tags used in the Gulf of Guinea.

The data were also collected in the morning on the tracks and prints of turtles on the beaches; different turtle's nests with some eggs transplanted in hatcheries. Evaluation of human impacts was carried out by surveys through fishermen capture questionnaires and search for carapaces in homes and museums.

Marine Mammals

Beach surveys coverage on foot totalled 784 min and 30.52 km. At least one observer walked along the high waterline so as to maximize distant view, while simultaneously allowing close inspection for cetacean skeletal material among flotsam. Every few minutes, the sea was scanned with 8 × 40 mm binoculars. Prior knowledge of the small-scale geography of coastal stretches is essential for effective beach surveying. Cameroon's beaches are widely interspersed with rocky formations as well as with small and larger freshwater outflows which are often difficult, or time-consuming, to cross or circumvent. At high tide, dense vegetation at the high waterline can obstruct passage.

Five small-boat outings were implemented using both indigenous wooden canoes and a small open fibreglass boat. Duration of visual survey effort was 1,008 min, with 259.1 km distance covered. Traditional canoes are ubiquitous in Cameroon and the most economical way to get onto the water. The main drawbacks are poor stability and velocity, low height above sea level (especially the smaller canoes) allowing adequate view only under optimal sea conditions. A fibre glass boat, equipped with a 40 hp outboard motor, was found to be the most functional and safest platform for inshore work.

Some 18 ports and smaller fish landing sites were visited and checked for evidence of cetacean catches and landings. When direct evidence (carcasses, bones) was lacking, fishermen were interviewed about the presence of cetaceans and by-catches.

Waterbirds

Waterbird census were done monthly (first Thursday and Friday of each month starting at 6.30 a.m) within 20 km of R. Sanaga length starting some 6 km from its mouth, 2 distributaries and a lake (Lake Tissongo) by CWCS Project staff using a 15 hp motorised canoe, binoculars, telescopes, measuring tapes, GPS and identification manuals (Serle et al. 1977; Maclean 1988; Sinclair et al. 1993; Girard 1998). Prior to the beginning of the census in March 1999, the river was divided into five sections following the settlement villages with all sandbanks and vegetated islands mapped and allocated identification numbers including an estimate of their areas. These sites were then monitored (100 % counts) monthly following standard bird census techniques (Bibby et al. 1992; Dodman et al. 1997; Girard 1998). Monthly data collected include the following: species data (waterbird species, other bird species and animals); meteorological data (temperature and rainfall) from CWCS weather station near the river; sandbank status data, i.e. disappearance (area monitoring); and human activity data (wetland use).

Data Analysis

Data were compiled, analysed and presented using simple descriptive statistics, especially frequencies of species and abundance and threat status.

Results and Discussions

Species Status and Indices of Abundance

Sea Turtles

From our surveys, four species of sea turtles were identified and common along Cameroon coastline: *Dermochelys coriacea*, *Lepidochelys olivacea*, *Chelonia mydas* and *Eretmochelys imbricata*. If the first two species are there for nesting activities, the last two are present in this area for feeding activities although *Chelonia mydas* rarely nest (Ayissi et al. 2006c).

Marine Mammals

(1) *Cameroon dolphin*

The Atlantic humpback dolphin *Sousa teuszii* was observed in Cameroon despite the 119 years since the species' discovery. The definition of the "Cameroon Estuary stock" (Van Waerebeek 2003), derived from the species' type location, implied such a premise. This specie was confirmed on 17 May 2011: at 11:05 a.m. we sighted and photographed a small group of about 10 (min. 8–max. 12) Atlantic humpback dolphins near Bouandjo, at N02°28.708′, E09°48.661′. Some individuals showed a strongly developed dorsal hump, while others, thought to be juveniles, had only a faint indication of a hump.

(2) *Humpback whales*

Humpback whales *Megaptera novaeangliae* are seasonally present for calving and breeding in waters of several coastal nations in the Gulf of Guinea, ranging west from

(at least) Côte d'Ivoire east to western Nigeria (Van Waerebeek et al. 2001, 2009; Van Waerebeek 2003). Further south, the species occurs also off Gabon and the Republic of Congo (Harmer 1928; Rosenbaum et al. 2004). Until the present survey, no substantiated records of humpback whales existed for Cameroon. Two calves captured incidentally by artisanal fishers were landed and butchered for food. Several other unidentified whales may also have been humpback whales. The presence of calves suggests Cameroon waters may also be part of the calving ground in the northern Gulf of Guinea. Freshly stranded or by-caught whales are flensed and consumed mostly at the community level. Reports from fishers, who (confusingly) call humpback whales "cachalots", suggest that their seasonality coincides with those known from other coastal nations in the northern Gulf of Guinea (Van Waerebeek et al. 2001, 2009). While this will require testing, presumably the same or a closely related Southern Hemisphere humpback whale population is involved.

(3) *Sperm whales*

An entangled sperm whale *Physeter macrocephalus* was stranded at Bakingili (N04°04′17″, E09°02′27″), Southwest Region, in May 2005. It was flensed in situ and served as food for many people from Limbe and Idenau. A second, very large animal was stranded near Kribi in 2009; the weathered skull of a third sperm whale, which was stranded in 1990, was examined at Mpollongue.

(4) *Other marine mammalian species*

Over a distance of 30.52 km and 784 min duration, beach combing effort was implemented on foot. Flotsam at the high waterline was searched but no cetacean skeletal specimens were found. However, after interviews with fishermen, at times, we were shown miscellaneous cetacean bones (primarily vertebrae and ribs) which were documented photographically. Cameroonians often utilize whale bones, especially vertebrae, as ornaments at home. Enquiries resulted in cetacean bones of some 10 specimens. Single whale vertebrae, out of context, are difficult to identify to species because many morphological features overlap among species.

A fisherman who collected teeth from a small whale, referred to as "cachalot", provided the teeth for study. The teeth's pronounced curvedness and their relatively small size (height 49.70–57.80 mm; max breadth 15.05–23.95 mm; max thickness 13.30–16.30 mm) were initially assumed to be from a juvenile *P. macrocephalus.* The pulp cavities were filled to about half tooth length. However, the shape, small size and lack of osteodentine (common in sperm whale, see Boschma 1938) would also concur with a killer whale *Orcinus orca.* A detailed morphological comparison with reference specimens is awaited. Earlier fieldwork yielded photographic evidence for two further species of Delphinidae, both dead due to fisheries interactions: a long-snouted common dolphin *Delphinus capensis* and a common bottlenose dolphin *Tursiops truncatus.* Interviews repeatedly suggested the occurrence of at least one species of spotted dolphin (*Stenella attenuata* or *Stenella frontalis*). On two occasions (one across the border in Equatorial Guinea), a chunk of a freshly butchered dolphin had called the attention of interlocutors due to its spotted skin. Both spotted dolphin species have been documented from by-catches in Ghana (Van Waerebeek et al. 2007; Debrah et al. 2010) and are likely to occur also in Cameroon. A striped dolphin was observed stranded on a beach, the body has been severed by the time it was photographed but colouration pattern positive identifies it as a striped (*Stenella coeruleoalba*), a new species record for both Cameroon and the Gulf of Guinea (Perrin and Van Waerebeek 2007 in Ayissi et al. 2011a, b). No striped dolphins have been found during extensive dolphin by-catch monitoring in Ghana (Ofori Danson et al. 2003; Van Waerebeek et al. 2009; Debrah et al. 2010). Weir (2009) and Weir et al. (2011) did not sight *S. coeruleoalba* in the Gulf of Guinea, whereas it was fairly frequent offshore Angola.

A larger dolphin locally known as "iowa" may be identifiable with *T. truncatus* or *O. orca.* It is said to exhibit an assertive, fearless behaviour towards people, vessels and fishing gear. Francophone fishermen in Cameroon typically refer to humpback whales as "cachalots", an obvious source of confusion as the true "cachalot" (= sperm whale) also appears to be a frequent visitor of Cameroonian waters. Several fishermen independently mentioned a "Dauphin blanc" (white dolphin), possibly identifiable with a common dolphin (*Delphinus* sp.). "Dauphin blanc" seen to be distinguished from dolphins with darker flank patterns, presumably bottlenose and humpback dolphins.

Waterbirds

Sixty-one (61) waterbird species represented in 17 families have so far been recorded. The families Ardeidae, Scolopacidae, Charadriidae and Alcedinidae have the highest with 12, 10, 8 and 7 species, respectively. The migratory status is also presented

Of the 61 species, 22 (36.1 %) appeared to be resident while 21 (34.4 %) and 16 (29.5 %) were seasonal and occasional visitors, respectively. Of particular significance is the high abundance of African Skimmers, Grey Pranticoles, Open-billed Storks and Common Green Shank with monthly numbers of up to 811, 583, 336 and 189, respectively, close to Glazebrook et al. (1998) counts of 833, 318, 414 and 77, respectively, for River Sanaga during their coastal waterbirds survey of Cameroon Coast in February 1998. According to them, River Sanaga holds nationally significant numbers of Grey Pranticole and African

Skimmer. The seasonal visit of Open-billed Stork coincides with the bivalve extraction activities in the dry season where the birds share in the harvest.

Current and Potential Threats

Sea Turtles

In spite of existing laws and conservation policy on these threatened species, sea turtles are facing several threats such as human predation for local consumption, meat and eggs, selling of carapaces to tourists and gathering of fat for medicinal uses.

The evaluation of impacts of by-catch on sea turtles revealed around 1,241 individuals per year for 13 leatherback and others were green, hawksbill and olive species (Ayissi 2008). Turtle meat is common in the feeding habits of coastal people in Cameroon, but the majority of their catch is not intentional. However, in certain cases, those reptiles are caught intentionally as in Sandje where results include 400 individuals per year by traditional fishermen.

- *Cetacean by-catches*

Nigerian and Ghanaian fishermen occupy a dominant niche among many fisher communities in Cameroon, and customs transfer such as fishing and processing techniques and diet habits, including the consumption of cetacean products, should be expected. Although interviewees frequently denied the occurrence of cetacean by-catches at first, apparently because they feared it was illegal, when the issue was revisited after reinforcing trust with the interviewer, most fishers finally admitted that cetacean by-catches occur with some regularity. Fresh carcasses obtained from such catches and from strandings are utilized in the villages, primarily as food item. Such use of "marine bush meat" is in line with findings for several coastal nations in western Africa, e.g. Ghana, Togo, Nigeria and Guinea (e.g. Clapham and Van Waerebeek 2007; Bamy et al. 2010; Uwagbae and Van Waerebeek 2010; Debrah et al. 2010; Segniagbeto et al. in preparation; Jeff et al. 2010). While there is a lack of material evidence, this can be explained. In other regions where cetacean carcasses are utilized by fishermen (e.g. in Peru), significant quantities of cetacean remains are retrieved from beaches, especially around fishing ports and landing sites. In Ghana, bones of cetaceans are cleaved with machetes and sold attached to the meat. The smoking process of such chunks burns and destroys the bony structures, and little or no recognizable skeletal parts remain after consumption (Debrah et al. 2010), explaining the scarcity of skeletal specimens.

Dolphin meat is consumed freshly cooked or smoked. Stranded or by-caught whales are also flensed and eaten. One case of a sperm whale stranded in Kribi was widely remembered by independent sources who indicated that several people suffered acute gastro-intestinal problems after ingestion, and some were even hospitalized. As elsewhere, teeth of sperm whales are eagerly collected as ivory.

The potential utilization of cetacean carcasses as bait in long-line fisheries, mainly for shark, as reported from Ghana (Ofori-Danson et al. 2003; Debrah et al. 2010), was rarely mentioned by interviewees in Cameroon, and perhaps this practice is indeed uncommon. However, no overhasty conclusions can be drawn as such (illegal) uses, if they occur, are typically shrouded in silence and very hard to ascertain.

- *Direct takes*

One of us (Ayissi) surveyed Japoma and Mbongo (Littoral Region) from 1 to 4 June 2011. Reports from locals indicated that a group of about 12 dolphins were spotted in the Dibamba River with rising tide, near Japoma (N4.0365°, E 9.8196°) and Mbongo (N4.4620°, E8.9840°) in May 2010. Dolphin sightings were suggested to be unusual in the Dibamba River. A few days later one dolphin was found stranded among mangrove roots and was killed by Nigerian fishermen. When additional dolphins became stranded, they suffered the same fate. The village chief mentioned (pers.-comm. to Ayissi, I. 2 June 2011) that two dolphins were butchered in his presence and the meat was distributed among the villagers for personal consumption. The species of dolphin has not yet been identified but *T. truncatus* is considered possible. Some skeletal material that was collected awaits examination.

We recognize the danger in the possible repetition of a global trend documented in a number of developing nations in South America, Africa and Southeast Asia (e.g. Clapham and Van Waerebeek 2007). The consumption of cetacean products initiated with the opportunistic but regular utilization of by-catches can give rise to a larger market demand and ultimately may turn commercial, leading to directed takes of mainly delphinids, especially in situations where important fish stocks are depleted following over-exploitation. The relatively low prices cited by two fishers as typically paid per dolphin suggest the current local market for dolphins is still immature. However, as seen in Ghana, this market can be developed in few years.

- *Over-fishing*

Both humans and marine mammals act as top marine predators and inevitably compete for fish resources. The coasts of Cameroon are characterized by intense fishing effort (Folack and Njifondjou 1995; Ayissi 2008). Besides nationals, thousands of fishermen from Nigeria, being long-term residents, were found to operate from Cameroon, as well as smaller numbers from Togo, Benin and Ghana. A wide variety of fishing arts are practiced by the small-scale fishers, including drift and set gillnets long-lines, purse-seine nets and beach seines. Both multifilament and monofilament nets are widely used, depending on target

species and size. In the course of the past few years Ayissi, I. (personal observations) noted an increase in the presence of Asian trawlers (from China, Korea, Japan) off Cameroon's coast, vessels with the reputation of often unsatisfactory adherence to fisheries regulations. Between 1999 and 2009 Chinese pair-trawlers "chalut-boeuf" were deployed on Cameroon's continental shelf. Pair-trawling is well known for its devastating effects on benthic fauna and flora (Liggins and Kennelly 1996).

Little or no recent data are published on catch statistics and the status of fish stocks in Cameroon, but circumstantial evidence suggest that these follow the general trend of fisheries in the Eastern Central Atlantic (FAO area 34), i.e. increasingly overexploited stocks (FAO 2011).

- *Chemical pollution*

Only the lower 20 km of the Sanaga River are navigable, up to Edea, home to the second largest hydropower plant in the country (265 MW). The ALUCAM aluminium smelter in Edea is dependent on the Sanaga for process water and is the single biggest energy consumer in Cameroon (Van der Waarde 2007). The lower reaches of the Sanaga, including its estuary, are sparsely populated (<20/km^2) with the local population engaged in benthic bivalve harvesting from the river and fishing. The coastline is mostly inhabited by foreign fishermen from Nigeria, Benin, Ghana and Togo fishing along the coast in larger fishing boats. The aluminium smelting industry produces 500,000 tonnes/year of material in suspension in the Sanaga River (Atangana 1996). The impact on the river's ecology and on its estuary near Mouanko (N 03.58867°, E009.6489°) is unclear. "Red mud", the waste product from the extraction of aluminium from bauxite, is highly contaminating for the environment since it consists of a highly alkaline fine particulate containing heavy metals and other pollutants (White et al. 1997; Pascucci et al. 2009). The question arises about heavy metal toxicity among the fisher communities who subsist on bivalves and other locally extracted sea food. Similarly, the health of top-level marine predators such as small cetaceans, which are known to accumulate contaminants, may be at risk. The coastal beaches are also important breeding grounds for various species of sea turtles (Ayissi 2000; Ayissi et al. 2006a, b).

Cameroon is considered to have abundant offshore natural gas resources. The country's petroleum reserves are located offshore in the Rio-del-Rey basin, offshore and onshore in the Douala and Kribi–Campo basins, and onshore in the Logone-Birni basin in the northern part of the country. Cameroon's only refinery, which is located in the port city of Limbe, had a capacity to produce 45,000 barrels per day (Newman 2006). Tankers, tugboats and other supporting vessels contribute to the heavy vessel traffic around Limbe. Evidence of the hydrocarbon exploration and production industry are ubiquitous. Near Bolondo, on the southern shores of the Cameroon Delta, we found considerable quantities of a tar-like substance (a heavy hydrocarbon fraction) that contaminates the sandy beaches, apparently related to Cameroon's single most important shipping lane which leads to the port of Douala. Locals indicated that the fisher's community of Bolondo had shrunk over the past decade as fishers moved out, blaming declining fish catches. An earlier gravel road that connected Bolondo with Mouanko, no longer maintained, has been reclaimed by the forest. Hence, access to Bolondo is by sea or motorbikes which drive along the beach at low tide. North of the Ntem estuary (Campo), hydrocarbon pollution was seen dispersed through the upper sand layers at several sites along the shore. However, locals claimed pollution had improved from the 1990–2000 period when major timber exploitation along the river transported logs by tugboats down the Ntem River and out to cargo ships anchored in deeper water. The river and estuary was then highly degraded by hydrocarbons but, allegedly since timber has been transported by road, water quality had improved. No documentation was found on this subject.

- *Discarded nets*

On open shores and around ports, we encountered important quantities of various types of abandoned, lost or discarded nets, both monofilament and multifilament. Long after, fishing gear is lost or abandoned at sea by fishers, it continues to ensnare fishes (so-called ghost fishing) and thus harms the marine environment. The drifting gear also causes entanglements of sea turtles and marine mammals (Mac Fadyen et al. 2009). A nationwide awareness campaign might help reduce abandoning of damaged nets and urge fishers to dispose of them on land and/or incinerate them. Alternative uses, disposal methods or recycling should be explored. Nets also pose a hazard to propellers of vessels, especially smaller ones. When visiting Youme I village and spotting discarded nets, our team offered a constructive recommendation in that sense, surprisingly well received, to 12 fishermen including their chief. Several readily acknowledged the problem while the chief announced that they would address it. This spontaneous reaction suggests that with a carefully planned and implemented nationwide educational effort, perhaps with some incentives, this serious environmental problem may not be as intractable as it seems.

- *Shipping and port construction*

Heavy shipping traffic to and from the Gulf of Guinea enters the Cameroon delta via deep-water shipping lanes that lead to the major industrial port of Douala. Concerns are that this waterway may be linked to hydrocarbon pollution and, inevitably, underwater acoustic pollution. Vessel collisions are also expected to constitute a significant risk to the coastal-dwelling population of humpback whales, a threat that has been documented near several West African ports, e.g. in Senegal, Guinea, Côte d'Ivoire, Ghana and

Togo (Félix and Van Waerebeek 2007; Van Waerebeek et al. 2007; Bamy et al. 2010). Near Lolabe, in the South Region, coastal forest clearance, reportedly for new port construction and access roads, was blatantly evident. Of obvious immediate concern is the Cameroon dolphin, our only sighting of which was registered in the South Region. Sediment and detritus run-off may significantly alter and degrade the coastal habitat with a negative impact on littoral biodiversity. Impacts of a fully operational new port evidently could be major. If neritic fish populations decline, and with increased disturbance, near shore-living cetaceans, in particular Cameroon dolphins and (inshore-ecotype) common bottlenose dolphins, are going to be affected. It is worth remembering that no sightings of Atlantic humpback dolphin have ever been reported near a major port in its entire range (Van Waerebeek et al. 2003).

Waterbirds

Apart from the mentioned threats to marine faunal diversity directly or indirectly faced by waterbirds, they are subjected to additional risk of coastal wetlands loss from upland and catchment deforestation, water diversion, encroachment into protected areas and non-protected areas (due to population expansion) (Ajonina and Ayissi 2012).

Addressing the Threats and Future Directions

The almost complete lack of scientific data on the biology, distribution, stock structure and abundance of sea turtles and cetaceans in Cameroon waters makes it difficult to properly assess the impact of these threats, let alone addressed them. An acceleration of research is urged with the involvement of national Universities and Research Centres. More faunal surveys are needed to unveil the potentials of the area and the need for the establishment of important relationships between species abundance, site temporal conditions (sandbank dynamics) and socio-economic activities with the view to identifying sustainable wetland ecosystem utilization options.

In order to achieve management of Cameroon's estuaries with important flagship species encountered, strategies could be set up to deal with the key threats that prevent the achievement of the vision of conservation. It is urgent to develop programmes according national and international laws and policies by action plan with the following goals:

- Identify key threats;
- Action to address key threats;
- Tools and methods required for these programmes;
- Also it is urgent to involve all stakeholders in this area.

Conclusion

Cameroon estuaries hold important marine fauna (birds, mammals and sea turtles); most of them are listed under important conventions and laws. Although this legislation, they are facing many threats from human activities along the area. In the future, many actions involving all stakeholders need to be taken.

This area does not operate in isolation but is connected ecologically with human needs. As a result, certain decisions need to be made at a higher level to ensure overall sustainability (taking into account social equity, economical growth and ecological integrity). It should be better to set up conservation programmes according main strategic objectives and goals need to be achieved for the vision with key actions.

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