SC/MAY19/AAWW/06

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INTERNATIONAL
WHALING COMMISSION

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ABSTRACT

A minimum of twenty-four cetacean species occur in Senegal. Documentation of cetaceans killed by fisheries bycatch or direct take by illegal hunting has been opportunistically recorded since the 1940's. Van Waerebeek and colleagues conducted surveys from the mid-1990's to the early 2000's and greatly increased knowledge of species present in Senegal as well as documenting carcasses killed as a result of bycatch or direct take during their surveys. In 2015, the Senegal Stranding Network (SSN) began quarterly surveys along Senegal's north coast from Dakar to St. Louis, and also implemented a network of local reporters in coastal villages from St. Louis to Toubacaouta. Fifteen quarterly surveys have been conducted and 17 reports have been received outside of surveys. Two hundred forty-six cetacean strandings of 13 species have been documented, as well as unidentified whale and dolphin carcasses that genetics analyses will be used to determine the species. Recorded strandings include 33 cases of bycatch of four species, as well as 43 cases of butchering in six species. A total of 32% of the carcasses documented by this study had indications of either bycatch or butchering, or both. The Senegal Stranding Network is now working with Fisheries, Water and Forestry, and National Parks Ministries to identify which fisheries are causing bycatch, as well as Peace Corps volunteers throughout Senegal to report cetacean sightings, bycatch and illegal hunting. SSN is also leading education programs in 16 schools per year to raise awareness about protecting cetaceans.

INTRODUCTION

Senegal has a rich diversity of marine mammal fauna, including at least 24 species of cetaceans and the African manatee (Dupuy and Maigret 1976, 1978, 1979, 1980, 1982, Maigret 1990a, Van Waerebeek *et al*. 2000, Perrin and Van Waerebeek 2012, Van Waerebeek *et al*. 2013, Djiba *et al*. 2015, Keith Diagne 2015). All of these species fall under the U.S. Marine Mammal Protection Act and/or the Endangered Species Act. The Convention of Migratory species Memorandum of Understanding concerning the Conservation of the Manatee and Small Cetaceans of Western Africa and Macaronesia was ratified on October 3, 2008. Senegal became a signatory prior to 2012 (https://www.cms.int/aquatic-mammals/en/documents/agreement-text). Additionally, all marine mammals are protected species under Senegalese national laws. In the past, intermittent and opportunistic surveys have been conducted since the 1940's (Cadenat 1949, Cadenat 1959). Interactions between marine mammals and fisheries were also documented by Maigret (1990b, 1994), Van Waerebeek *et al*. 1997, and Van Waerebeek *et al*. 2003. The non-governmental non-profit organization Conservation and Research of West African Aquatic Mammals (COREWAM) was founded in Senegal in 1997 by K. Van Waerebeek, M. Diallo, A. Djiba, and E. Ndiaye and was periodically active doing surveys on different sections of the coast until 2001.

In June 2014, hundreds of stranded sea turtles and cetaceans were found along the Atlantic coast of Mauritania on a routine sampling survey conducted by the Program Biodiversity, Oil and Gas (BGP) which has been monitoring the coast there since 2012. High marine mammal and sea turtle mortality due to fisheries bycatch has previously been documented in Mauritania (Zeeburg *et al*. 2006). To investigate whether the mortality found in Mauritania continued south into Senegal, a survey was organized in late July 2014 by W. Mullié to survey the northwest coast of Senegal between St. Louis and Dakar, a total distance of 184 km. The survey was supported by the Senegal office of IUCN. The purpose of this trip was to document and inventory all stranded marine mammal and sea turtle carcasses, collect GPS locations of strandings, biological samples for genetics, and bones/skulls for taxonomy and other future studies. The result of this preliminary survey was the discovery and collection of 26 dead cetaceans and 34 sea turtles in three days of field effort. Carcasses were found in all stages of decomposition, from fresh to old skeletal remains, and four dolphins had indications of human interaction, including fisheries bycatch and slaughter for human consumption (*Stenella* sp. and *Delphinus* sp. that had been dismembered and will require genetics to identify the species). However, badly decomposed carcasses were not able to be adequately evaluated for signs of fisheries or human interaction, and it is possible others were also dead as a result of these causes. Genetic samples were collected from all carcasses, and skeletal remains (primarily skulls) were collected from select carcasses that were fresh or moderately decomposed. Cetacean skeletal material was placed in the collection of the Institute Fondemental d'Afrique Noire (IFAN, Dakar, Senegal).

CURRENT RESEARCH

After the July 2014 survey, the need was recognized for more regular monitoring of Senegal's coastline to determine the numbers and causes of mortality of stranded marine mammals and turtles, to conduct necropsies to determine causes of death, and to collect valuable samples for scientific study of these species. In March 2015, the Senegal Stranding Network (SSN) was initiated by W. Mullié, L. Keith-Diagne, T. Diagne and A. Djiba. The goals of SSN are to document numbers and species of stranded marine mammals and sea turtles along Senegal's Atlantic coastline, to determine causes of death, and to collect samples for studies including genetics, physiology, taxonomy, and baseline health. Additionally, we use the compiled data to advocate and work with Senegal's fisheries and wildlife law enforcement authorities for the reduction of marine mammal and sea turtle bycatch and direct take in Senegalese waters.

Quarterly surveys began in 2015 along 184 km of Senegal's north coast between Dakar and St. Louis. We divided this coast into 15 transects varying in length between 6.7 and 15.7 km for surveys. We also tried surveys from Dakar south to Delta Saloum in 2016, but much of that coast is not drivable due to development, rocky areas and mangrove channels. Therefore, we decided to develop and train a coastal network of local people working in and around the ocean to report marine mammal and sea turtle sightings and strandings throughout the year, so that the mortality of protected species can be accurately documented, and samples can be collected more quickly and effectively when animals strand. Four training workshops for local partners were held in Senegal during 2016-2017. Three workshops were held in central Senegal at Joal, Fadiouth, and Palmarin, and a fourth was held at Langue de Barbarie National Park south of St. Louis. A total of 44 participants attended these workshops and included representatives from local fishermen's organizations, women's shellfish cooperatives, Ministries of Fisheries, Water and Forestry, national parks, and marine protected areas. Together, the participants represented over 3000 people working in fisheries.

During surveys and responses to stranding reports outside of surveys, genetics samples were collected for all unidentified species, as well as from most carcasses that were identified. In addition, all specimens were photographed, and standard measurements and GPS coordinates were collected. Other data collected from selected specimens included stomach samples, skulls and other bones. For documentation purposes, bycatch was defined as carcasses that had fins, flippers or tails cut off, and butchering was defined as carcasses that had clear cuts that could only have been made by a knife. Measurements were not taken if the carcass was so decomposed that it would not provide any useful information about the size of the animal, or if only a skull or other single bone was found. Most carcasses were moderately to severely decomposed. Genetics samples collected from 2014-2017 are being analysed by the University of Western Brittany in France. In 2018, the network began a partnership with C. Potter and M. McGowen of The Smithsonian Museum of Natural History for genetics analyses and taxonomy studies.

As of April 2019, SSN has conducted 15 quarterly surveys and has received 17 reports of cetacean strandings outside of surveys. Two hundred forty-six cetacean strandings of 13 species have been documented, as well as unidentified whale and dolphin carcasses that will need genetics analyses to determine the species. A preliminary analysis of the data collected so far indicates that sixty-six percent of marine mammal carcasses were recovered during the months of June and July. This time frame coincides with high levels of both artisanal and industrial fishing in northern Senegal and southern Mauritania, possibly causing higher incidences of bycatch.

The two most frequently documented cetaceans were *Delphinus delphis* and *Phocoena phocoena.* A preliminary analysis of north coast survey data from 2014-2017 indicated that cetacean carcass densities peaked near the three largest fishing villages of Kayar, Lompoul and St. Louis, which may indicate increased artisanal bycatch in these villages. Similarly, when *Phocoena phocoena* carcasses for the same time period were analysed, the data showed that carcasses were only found north of Kayar, with peaks at Lompoul and St. Louis. For large whales, we found no trends by location of time of year. However, we documented five whales stranded on the north coast in one month in April 2016.

Recorded strandings include 33 cases of bycatch of four species (*Balaenoptera acutorostrata*, *Delphinus delphis*, *Grampus griseus*, *Phocoena phocoena,* and three dolphins yet to be identified), as well as 43 cases of butchering in six species (*Delphinus delphis*, *Grampus griseus*, *Megaptera novaeangliae*, *Phocoena phocoena*, *Sousa teuszii*, *Stenella longirostris*, plus two unidentified whales and six unidentified dolphins). A total of 32% of the carcasses documented by this study had indications of either bycatch or butchering, or both. For *Delphinus delphis*, 18% of carcasses had signs of bycatch and 20% had signs of being butchered (three carcasses had signs of both bycatch and butchering). For *Phocoena phocoena*, a minimum of 15% of recovered carcasses were bycaught and another 15% were butchered. In cases of butchering, it is often unclear if carcasses were butchered before or after they stranded on the beach, but in at least two cases (one *Megaptera novaeangliae* and one juvenile *Delphinus delphis*) the animals were in the process of being butchered on the beach as our team arrived. In both

cases, the people butchering the carcasses said they needed the meat for food. The unfortunate humpback whale was a juvenile that stranded and was butchered alive. The juvenile dolphin was targeted because the fishermen said it was swimming around their boat and they don't like dolphins taking their fish, so they decided to kill and eat it. Unless caught in the act, it is extremely difficult to get fishermen to discuss either bycatch or direct take of marine mammals, even when interviews are conducted by Senegalese Wolof speakers. However, when discussed at all, fishermen only speak of cetaceans being taken for human consumption, and there has been no mention of their use as fishing bait during the past five years of surveys.

The Senegal Stranding Network maintains a database of all marine mammal and sea turtle strandings recorded since 2014 including the following information: date and time stranding was recorded, whether the stranding was in or out of a survey, GPS coordinates of all stranding locations, species identification, total length and other measurements, sex, age class, state of decomposition, samples collected, presence of indications of bycatch or butchering, where specimens are stored, and any additional notes. SSN also maintains a photographic database of carcasses. Marine mammal specimens (skulls and other bones) are inventoried at Senegalese institutions including IFAN and the African Aquatic Conservation Fund, as well as the Smithsonian Museum of Natural History in Washington, D.C. All specimens are available to scholars for study.

NEXT STEPS

We expect to publish the first five years of data collected by the Senegal Stranding Network in the scientific literature in 2020.

We have started working with Senegal's Fisheries Ministry and others to determine the extent to which each type of fishery (artisanal, local commercial, and foreign industrial) are causing cetacean bycatch mortality. We would also like to be able to better determine drowning as a cause of death, because cetaceans killed as a result of drowning in trawls or other gear are not able to be detected by our current methodology of documenting cut flippers and tails. Further hampering this are badly decomposed carcasses from which drowning cannot be determined. In order to accurately understand the full impact of bycatch on Senegal's cetaceans, we will need more frequent surveys and training from north American colleagues who have recently developed methods to determine drowning in fresh carcasses (Moore *et al.* 2013).

In winter 2019 the MAVA Foundation and Birdlife International began a fisheries observer program together for industrial fishing boats in Senegal and six other countries (Cabo Verde, The Gambia, Guinea, Guinea Bissau, Mauritania, and Sierra Leone) to document sea turtle and seabird bycatch. This seems an excellent opportunity for these observers to also be trained to document cetacean bycatch, but additional funds would likely be needed to join this work. More information about this program can be found at: http://mava-foundation.org/oaps/reducing-bycatch-of-seabirds-and-sea-turtles/

In order to combat direct killing of marine mammals for human consumption, both awareness of the protected status of cetaceans and increased enforcement would need to occur. We believe it will also take 15 or more years of education programs in schools throughout Senegal to change attitudes and build respect for wildlife in younger generations. To that end, we are now in our third year leading marine wildlife education programs in 16 schools per year in Senegal's central coast, and we continue to expand these programs as funds are raised. We have recently begun working with the Peace Corps in Senegal to develop programs that their volunteers can teach in villages across the country.

To date 6% of SSN cetacean stranding reports have reached us from our network or the public, but last month we initiated a new stranding hotline number which we will promote with our local network along the coast as well as to the public in order to increase reports. We are also in discussions with several organizations who have developed phone applications for citizen science marine animal reporting in Africa, and once we choose the best platform we will promote reporting through apps as well.

It has taken a huge amount of work to raise funds to keep the Senegal Stranding Network running. L. Keith-Diagne and T. Diagne have raised all funds for cetacean and sea turtle research, respectively, and continue to try to do so, but SSN is a "second job" on top of other fulltime research and conservation projects for African manatees and African freshwater turtles and tortoises in Senegal and seven other African countries. Therefore, we continually seek new funding opportunities and partnerships to make SSN sustainable for the long-term. The project has grown to include two other Senegalese staff, several volunteers and graduate students. SSN is grateful to our funders and for our partnerships with the Smithsonian Museum of Natural History, Senegal's Direction of Marine Protected Areas, Ministries of Water and Forestry and National Parks, and the Ecology and Aquatic Ecosystem Management Department at the University Cheikh Anta Diop in Dakar.

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