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Threats and Conservation Strategies of Pygmy Hippopotamus (*Choeropsis liberiensis*) in Tiwai Island, Sierra Leone

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ABSTRACT: The pygmy hippopotamus (*Choeropsis liberiensis*) is one of the rarest animals to be found in and around Tiwai Island in Sierra Leone. An assessment of species' threats and causes is important to establish a robust baseline for future conservation efforts. There is insufficient information on the threats to *C. liberiensis*in and around Tiwai island, hence, this study. The study was conducted at Tiwai Island edge communities, South-Eastern Sierra Leone; seven communities (Mapoma, Segbema, Geima, Kabama, Jenneh, Nyanahun, and Booma) on both sides of the island were purposively sampled based on the objectives of the study. The data were obtained using a structured questionnaire, oral interview, and reconnaissance surveys. The level of impact of poaching, habitat loss and fragmentation, climate change, and illegal wildlife trade was high, human-wildlife conflict was moderate and natural predator was low. Urbanization, poverty, agricultural expansion, lack of adequate legislation to prohibit illegal trading, greed, lack of proper funding, diverse demand and usage, were all identified to be the causes of the threats in and around the study area. Additionally, habitat loss and fragmentation were identified to be the primary threats to the quality, extent and continuity of habitat in pygmy hippopotamus range in and around Tiwai Island. Likewise, some of the food items consumed by the species are been competitive with human utilizations. Thus, conservation education programs about *C. liberiensis* and other remarkable wildlife species should be carried out in communities in and around Tiwai Island. Furthermore, community farmers should be warned from clearing of water catchment areas, forests, plantations, and swamps edges as these are areas plants are wildly grown that served as food preferences for pygmy hippos.

Keywords: *C. liberiensis,* Endangered Species, Tiwai Island, Wildlife threats, Wildlife conservation

INTRODUCTION

The pygmy hippopotamus (*Choeropsisliberiensis*) is considerably smaller than the common hippopotamus (*Hippopotamus amphibius*), weighing 180–270 kg and with a shoulder height of 70–80 cm. Also, it has proportionately longer limbs and neck and a smaller head (Eltringham, 1999). The species is less aquatic than the common hippo and has maintained some terrestrial patterns of locomotion (Eltringham 1999; Fisher *et al.,* 2007). Largely elusive and nocturnal, it is one of only two extant species in the family: Hippopotamidae. The other is its much larger cousin the common hippopotamus; a distinct subspecies in Nigeria, *Choeropsis liberiensis heslopi*, is thought to be already extinct (Mallon *et al*., 2011). The *C. liberiensis* displays many terrestrial adaptations, but like its larger cousin, it is semi-aquatic and relies on proximity to water to keep its skin moisturized and its body temperature cool. Behaviors such as mating and giving birth may occur in water or on land with one calf, rarely twins. Mothers give birth in shallow water pools and they visit their offspring only a

few times per day for suckling (https://en.wikipedia.org/wiki/Portal:Guinea/Featured_article/1). The *C. liberiensis*is herbivorous although there are previous records of them eating fish from traps in Sierra Leone. In the wild, pygmy hippopotamuses are said to feed on ferns, leaves, grasses, herbs, stems, and fallen fruits and crops such as cassava and shoots of young rice (Robinson, 1970; Eltringham, 1999). The estimate from the 2010 workshop was roughly 150 individuals in the Gola Forest and the Moa river islands, including Tiwai (Mallon *et al*., 2011). *C. liberiensis*is listed as 'Endangered' on the IUCN Red List of Threatened Species (www.iucnredlist.org 2012). The wild pygmy hippopotamus has a restricted range in the Upper Guinea forest region of West Africa, where it is found in only four countries - Liberia, Côte d'Ivoire, Guinea, and Sierra Leone (Figure 1).

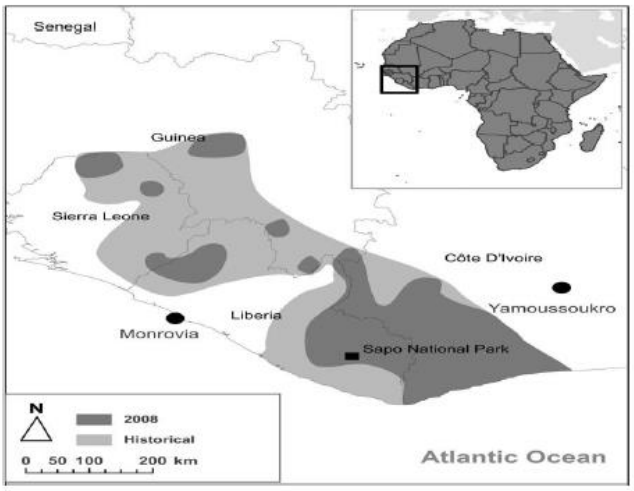

Figure 1: Map showing range of pygmy hippopotamus in West Africa. Adapted from Collen *et al.,* (2011).

In Sierra Leone, its presence is confirmed in the Gola Rainforest National Park, Tiwai Island Wildlife Sanctuary the base of Loma Mountain National Park and along the Moa River almost 50km from Tolubu in the north to Tossor in the south on islands with unconfirmed reports as far south as Mambo village only 20 km from the coast. Pygmy hippos are primarily threatened by habitat loss, as forests are logged and converted to farm land, and are also vulnerable to poaching, hunting for bushmeat, natural predators, and war. An assessment of species' threats is important to establish a robust baseline for future conservation efforts. There is insufficient information on the threats of the species, hence, this study. Therefore, this study assessed the threats and conservation measures of *C. liberiensis* with a view of proper planning and management techniques for protecting the species.

MATERIALS AND METHODS

Study area

Tiwai Island is located in the Upper Guinea Tropical Rainforest in south-eastern Sierra Leone, about 300 km from the capital city, Freetown, 15 km from Potoru, and 30 km from the Liberian border (Figure 2). Tiwai Island is an inland rainforest island in the Moa River, approximately 12 km² (1200 hectares) in size, located between latitude 7° 30' and 7° 34' N and longitude 11° 20' and 11° 21' W (Tiwai Island Wilglife Sanctuary, 2007). It is nationally the first community conservation program managed by the Tiwai Island Administrative Committee (TIAC), which represents both communities, government, universities, and conservation organizations. The Guinean Forests Biodiversity Hotspot designated by Conservation International (CI), is home to around 9000 vascular plant species, 785 bird species, 320 mammal species, 425 herptiles, and 510 freshwater fish. Of these species, very large percentages are endemic, ranging from 20 percent of plants to 35 percent of freshwater fishes. Tiwai is a humid tropical lowland ecosystem where rainfall can exceed 4000 mm per year in some places. It is an inland river island in the Moa River, which flows from the highlands of Guinea southwest into the Southern Province of Sierra Leone (Gamett, 2012).

Figure 2: Map of Sierra Leone showing the study area, adapted from Collen *et al.* (2011).

METHOD

Seven communities (Mapoma, Segbema, Geima, Kabama, Jenneh, Nyanahun, and Booma) on both sides

of the island were purposively selected based on the objectives of the study. A structured questionnaire, oral interview, and reconnaissance surveys were used to obtain the data; the methodology was adapted from that developed by ZSL and Njala 2010, for surveys of hippos in Loma. Structured questionnaires based on the objectives of the study were issued in (7) communities on both sides of the island (Figure 3).

Figure 3: A map showing locations of respondents. adapted from Collen *et al.* (2011).

Three of the communities; Mapoma, Segbema, and Geima are in Baoma Koya chiefdom in Kenema District, Eastern Province of the country, and four of the communities; Kabama, Jenneh, Nyanahun, and Booma in Barrie Chiefdom, Pujehun District, Southern Province of Sierra Leone. In each community, respondents were randomly selected; (Mapoma = 30; Segbema = 28; Geima = 25; Kabama = 45; Jenneh = 26 Nyanahun = 30 and Booma = 20) making a total of two hundred and four (204) completed interviewees. The interviewees were comprised of farmers, fishermen, and past hunters. At each village, the name of the village, GPS location, date, and time of administering the questionnaires were recorded. Reconnaissance surveys were also conducted along suspected pygmy hippopotamus trails, rivers, and streams searching for and recording pygmy hippopotamus signs including dung, footprints, and feeding sites. Furthermore, any plant observed to be fed on by pygmy hippopotamus was photographed, identified, and GPS coordinates were taken. In cases where it was not possible to identify the correct name of the plant specimens, they were collected and taken to the National Herbarium at Njala Campus for later identification. The data were summarized using descriptive statistics.

RESULTS AND DISCUSSION

Several anthropogenic and natural factors such as poaching, human-wildlife conflict, habitat loss and fragmentation, climate change, illegal wildlife trade and natural predators were identified to be threats to *C. liberiensis.* The level of impact of poaching, habitat loss and fragmentation, climate change, and illegal wildlife trade was high, human-wildlife conflict was moderate and natural predator was low (Table 1).

During this study, ten different plant species were reported to be frequently consumed by Pygmy Hippos in this area. Two of these plants belong to one family (*Ipomoea alba and Ipomoea batatas).* The remaining eight species (*Theobroma cacao, Pteriduimaquilinum, Cucurbita pepo, Urena sp., Digitaria eriantha, Hibiscus esculentus, Corchorus olitoruis, and Geophila obvallata)* belong to different families. Five of these plants are cultivated plants (*Corchorus olitoruis, Hibiscus esculentus, Cucurbita pepo, Ipomoea batatas,* and *Theobroma cacao)* while the other five are wildly grown *(Geophila obvallata, Pteriduim aquilinum, Urena sp. Digitaria eriantha,* and *Ipomoea alba)* (Table 2).

Ten (10) plant species were identified by respondents as being consumed by hippos (Table 2), among which humans are also competing in utilization as food. No further species were identified in reconnaissance walks although there may be many other plant species that are consumed in areas that are not readily accessible to humans. There was no reference to the pygmy hippos consuming any cereal crop (rice, maize, millet, or sorghum) and only one wild grass was noted as being consumed. None of the species consumed have either strong chemical or strong physical defenses. The majority of the species are edible including those that are not cultivated. Many of the species are mucilaginous (slimy) but whether this is a coincidence or a requirement of the hippo is unknown; the local explanation is that hippos eat “mud” and require the slime to help them digest it. It is possible that “eating mud” is a behavior associated with “salt licks” and minerals. Except for cocoa, the plants eaten are low-growing plants that rely on either man-made or natural breaks in the forest canopy. Many plants are found on the river banks or in swamps where there is a year-round supply of both water and light (and presumably soils that are enriched by regular flooding). Most of the wild plants noted as being consumed are available throughout the year. Out of the cultivated plants, krin-krin, sweet potato, and okra are cultivated year-round in gardens (although they are most abundant in the wet season).

Threats to the pygmy hippopotamus

Table 1 highlighted the major threats and causes to *C. liberiensis* in and around Tiwai island.

Table 1: Major threats and causes to *C. liberiensis*in around Tiwai Island.

Threat	Causes of threats	Level of impact of threat
Poaching	Poverty, hunger and ignorance	High
Human-wildlife conflict	Agricultural expansion, human settlement, deforestation, poaching, overgrazing by animals, illegal grass collection	Moderate
Inadequate protected area network	Lack of proper funding	High
Habitat loss and fragmentation	Urbanization, agriculture, infrastructural development	High
Climate change	Deforestation, ozone layer depletion, emission of greenhouse gases	
Illegal Wild Animal Trade	Lack of adequate legislation to prohibit illegal trading, greed, diverse demand and usage.	High
Predators	Food source to Carnivores	Low

Table 2: Plants reported as being eaten by pygmy hippos and in competition with humans.

Mende Name	English / Krio Name	Scientific Name	Cultivated or Wild	Edible to people
Ndogboyolaa	Moonflower	*Ipomoea alba*	Wild	No
Njolaa	Sweet potato	*Ipomoea batatas*	Cultivated	Yes
Cacaowii	Cocoa	*Theobroma cacao*	Cultivated	Yes
Gbuhuin	Bracken	*Pteriduim aquilinum*	Wild	Yes
Towae	Pumpkin	*Cucurbita pepo*	Cultivated	Yes
Kpɔlorhun	Caesar weed	*Urena sp.*	Wild	Yes
Kpetee	Pangola grass	*Digitaria eriantha*	Wild	No
Bondea	Okra	*Hibiscus esculentus*	Cultivated	Yes
Ngegee	Krainkrain	*Corchorus olitoruis*	Cultivated	Yes
Kwaawolie	Monkey –tail	*Geophila obvallata*	Wild	No

Poaching

Bushment hunting for subsistence and income generation has been in practices from time immemorial all over the world. Bushmeat is an important source of protein and a significant part of local economies across West Africa. Pygmy hippopotamus is poached predominantly for their meat and unlike the common hippopotamus, their teeth have little trade value, but many of their body parts, including the skull, may be used in rituals or folk medicine (Robinson, 1970; Hentschel, 1990). The pygmy hippopotamus cryptic nature provides a degree of protection against hunting and in most areas pygmy hippopotamus is unlikely to be the main target of subsistence hunting but are killed opportunistically, while some communities avoid hunting them altogether. In some areas, commercial poachers target the species, along with other large mammals such as elephant, forest buffalo and chimpanzee. A study of the bush meat market in Lola, Guinea, showed that the species was poached for commercial purposes (Brugière and Kormos, 2009). Another study at south of Sapo National Park, Liberia, found that a single commercial poaching camp had obtained 4 pygmy hippos in one month (Green grass in prep). Pygmy hippos have full legal protection in all countries, but lack of enforcement of existing laws is a chronic problem. There has been little work carried out on the impact of hunting on pygmy hippopotamus or to quantify the amount of pygmy hippopotamus meat consumed or available in the market. However, it is believed that this pressure is increasing. For example, in Cote d'Ivore, pygmy hippopotamus meat was confiscated in only 5 out of 632 official poaching reports from 1975−1983 in the south western districts (Hoppe-Dominik, 1999), but more recent monitoring in the Tai forest area has shown that this species is also under severe poaching pressure in the eastern part of the Tai National Park (Roth *et al*., 2004).

Human-wildlife conflict

Although seldom reported as an agricultural nuisance, some cases of damage by pygmy hippopotamus to rice and cassava fields have been reported (Roth *et al*., 2004). This is so far only a local problem but the potential for conflict is likely to increase, as swamps are converted to rice fields, riparian forests are cleared and crops are planted closer to the forest edge (Table 1). There is a possibility that damage caused by other species such as red river hog *Potamochoerus porcus* may be blamed on pygmy hippopotamus. Localized conflicts with fishermen

(e.g. through damage to nets) in Sierra Leone were reported during the workshop (Mallon *et al.* 2011). In Loma mountain, similar report about crop raiding and fish eating on traps were recorded by Saidu in 2014 (Unpublished)

Inadequate protected area network

Most, but not all the known pygmy hippopotamus populations occur within sites that have some form of protection. These range in status from full protected Areas to national forests or classified forests that are not primarily designed to protect wildlife. Many Protected Areas in which pygmy hippopotamus occur do not have effective protection and a comprehensive program to increase management effectiveness, build capacity, train staff and increase resources, equipment and staffing levels are needed across the region.

Habitat loss and fragmentation

Deforestation represents the main threat to the quality, extent and continuity of habitat in pygmy hippopotamus range. It has been estimated that roughly 10 million ha of forest in West Africa may have been lost in the 20th century and around 80% of the original forest area is now an agriculture-forest mosaic. The remaining forest blocks are fragmented, leaving pygmy hippopotamus populations isolated, with demographic consequences and the increased susceptibility of small populations to local extinction. Fragmentation has made the forests more accessible for hunters and there is now very little, if any, undisturbed forest in the region safe for wildlife causing the pygmy hippo to retreat into the diminishing fragmented parcels of forest (Lewison and Oliver, 2008). Two hundred years ago, roughly 65% of Sierra Leone was covered with moist closed forest; it now covers less than 4%. In Côte d'Ivoire, less than 10% of the original forest remained at the end of the 20th century. In Guinea, Ziama and Diécké represent the last two large blocks of closed canopy forest and most classified forests are severely degraded (Brugière and Kormos, 2009). In comparison, Liberia's deforestation rates have been relatively low; from 1986 to 2000 the average deforestation rate was 0.2% per year but this has increased in the last 10 years and is likely to continue to increase as security has returned to the country and most of the remaining forest is readily accessible. The main causes of deforestation are traditional slash-and-burn cultivation, agricultural expansion by small holders, commercial logging, and commercial plantations of rubber, coffee, cocoa and oil palm. Draining swamps to create rice fields also destroys pygmy hippo habitat. Conversion of forest to agriculture is expected to increase along with the growing human population. Mining of iron ore, diamonds and many other mineral resources is widespread in the region. This results in more forest clearance, pollution and increased sedimentation of water courses. A further negative effect is the potential reliance of miners and their families on bush meat. Road construction for mining and logging operations also opens up new areas to hunters.

Climate change

It was agreed by the International Union for the Conservation of Nature (IUCN), Species Survival and Commission (SSC) and Zoological Society of London (ZSL) in a Pygmy Hippo strategy workshop, in Monrovia, Liberia in November 2010, that global climate change potentially represents a threat to wildlife which pygmy hippopotamus is no exception. However, at present there is an absence of detailed, quantitative data on regional impacts and how these may affect pygmy hippopotamus, making it difficult to identify or to prioritize actions (Mallon *et al*., 2011). Deforestation, ozone layer depletion, and excess emission of greenhouse gases have contributed immensely to climate change (Table 1).

Illegal wild animal trade

Much of the information on pygmy hippos from the first half of the century is from European collectors who report capturing them at a number of sites. Anstey (1991) stated that many were exported from Liberia and the value of a live pygmy hippo in 1971 was around $350 and in 1975 that overseas resale value of these animals was around $2,000. Since this time, this trade had been massively reduced primarily due to the success of captive breeding programs and restrictions on animals captured from wild for captive collection (Anstey, 1991).

Predators

The effects of natural predators on the pygmy hippopotamuses are unknown, but the principal carnivore capable of attacking an animal of this size is the leopard, *Pantherapardus* (Robinson, 1981), but leopards are getting very rare in this region. Hentschel (1990) obtained a photograph of a juvenile hippo that had been killed by a leopard. Aside from leopards, crocodiles and pythons could possibly kill a pygmy hippopotamus (Hentschel, 1990, Roth *et al*., 2004). Pythons are quite abundant in swampy areas and are capable of swallowing new born animals. Very small juveniles and new born calves are

said to be at risk from golden cat, *Felisaurata and* the African palm civet, *Nandiniabinotata* (Eltringham, 1999).

Conservation measures

In spite formal protection since 1933, pygmy hippos have declined drastically (Kingdon, 1997, Mallon *et al*., 2011). Conservation of the species is hampered by a lack of basic biological knowledge, including details of food preferences. Observational records of the species are scant because of its cryptic nature but the most acute period of range decline (inferred from habitat loss) has been over the past 3 decades (Lewison and Oliver, 2008). The largest fragment of the species' former range is the contiguous Upper Guinea forest in Liberia and Cote d'Ivoire and this area probably harbor the majority of the remaining population (IUCN Hippo Specialist Group, 2008). Priorities for the conservation of the pygmy hippopotamus include establishing a reliable method for assessing the sizes of the various populations and monitoring the species in protected areas using census techniques (Lewison and Oliver 2008). The main threats to the species include habitat fragmentation, land conversion, and hunting (Roth *et al.,* 2004). Its threatened status, long independent evolutionary heritage, and ongoing threats make the pygmy hippopotamus a candidate for priority conservation attention (Isaac *et al.,* 2007). To address this concern, several pygmy hippo conservations related initiatives have been adopted. A Regional Conservation Strategy Workshop in 2009 was attended by representatives of several NGOs involved in pygmy hippo conservation, including the Zoological Society of London (ZSL), Fauna and Flora International (FFI), Institute for Breeding of Rare and Endangered African Mammals (IBREAM), IUCN, and the Royal Society for the Protection of Birds (RSPB) resulted in the establishment of the Pygmy Hippo Sub-group of the IUCN SSC Pigs, Peccaries, and Hippos Specialist Group., with Monique Paris (IBREAM) and Chris Ransom (ZSL) as its Co-chairs. The workshop aimed to bring together all stakeholders to review current knowledge, create a collaborative network and develop a government-endorsed, regional conservation strategy to guide conservation, education, and research across the entire range of the pygmy hippo. Some other notable conservation initiatives include the Liberia-Sierra Leone transboundary pygmy hippo conservation project, the University of Georgia Pygmy Hippo Project on Tiwai Island, Njala University-Zoological Society of London Pygmy Hippo Conservation Project in Loma Mountain National Park, the ZSL-FFI-FDA Pygmy Hippo Project in Sapo National Park and the Tai Hippo Project in Cote d'Ivoire (Mallon *et al.,* 2011). Captive breeding programs are also undertaken for the conservation of captive pygmy hippo populations. Until 2009, there were 332 (133 males, 196 females, and 3 individuals of unknown sex) pygmy hippos in 134 public zoos and private collections (Mallon *et al*., 2011).

Conclusion

In conclusion, different anthropogenic and natural factors such as poaching, human-wildlife conflict, habitat loss and fragmentation, climate change, illegal wildlife trade and natural predators were identified to be threats to *C. liberiensis.* Additionally, ten different plant species were identified to be consumed by *C. liberiensis.*

Recommendations

The following recommendations are of essence based on the findings of this study.

- Conservation education programs about pygmy hippos and other notable wildlife species should be undertaken in communities around Tiwai Island.
- Minds of community farmers should be turned away from the clearing of water catchment areas, forests, plantations, and swamps edges as these are areas plants are wildly grown that are of Hippo food preferences.
- Farmers should not intercrop foods that hippos prefer with rice (for example, pumpkin or okra) especially in fields closer than 500m from the river.
- During restoration in mined-out areas, especially artisanal mining areas, plantlike*Ipoma alba, Pteridiumaquilinum*ete should be planted not only trees like acacia sp.
- A long-term study on pygmy hippos should be conducted on Tiwai Island and sub- Islands to establish a quantitative baseline and fully understand their population dynamics and whether the availability of suitable food is a limiting factor.
- A camera trapping technique in combination with reconnaissance surveys should be developed for further information on population trends in the study area.
- Consolidative agreement between community stakeholders (BaomaKoya and Barri chiefdoms) EFA and other conservation agencies for the maintenance and general protection of biodiversity.
- Stakeholders involved should reduce human settlements around the island, expansion of farmland and cattle grazing in and around Tiwai island.
- It is better to encourage the local people to plant trees for their various types of utilization to reduce their dependency in and around Tiwai island.

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