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Local awareness of and attitudes toward pygmy hippopotamus conservation in the Moa River Island Complex, Sierra Leone.

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Local awareness of and attitudes towards the pygmy hippopotamus *Choeropsis liberiensis* in the Moa River Island Complex, Sierra Leone

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Abstract The pygmy hippopotamus *Choeropsis liberiensis* is an Endangered species found only in the Upper Guinea rainforests of West Africa. Using a two-phase approach, with initial semi-structured interviews followed by more extensive questionnaires, we examined local residents' awareness of and attitudes towards the pygmy hippopotamus along the Moa River near Tiwai Island Wildlife Sanctuary in Sierra Leone. The interviews and questionnaires addressed human–hippopotamus interactions, local knowledge and awareness of pygmy hippopotamus ecology and behaviour, and public attitudes towards hippopotamus conservation. Overall, 22% of questionnaire respondents acknowledged benefits related to hippopotamus conservation; factors affecting the perception of benefits included age, livestock ownership, distance from Tiwai Island and exposure to conservation programmes. The results of this study could be used to inform the conservation of the pygmy hippopotamus and highlight the critical role of local support in the management of threatened species in biodiversity hotspots.

Keywords *Choeropsis liberiensis*, community attitudes, community-based conservation, Endangered species, protected areas, pygmy hippopotamus, Sierra Leone

This paper contains supplementary material that can be found online at http://journals.cambridge.org

Introduction

Declines in biodiversity as a result of anthropogenic factors are a major concern in conservation hotspots (Pimm et al., 1995). Human populations whose survival depends directly on local resource use and consumption often pose a threat to endemic species (Brockington et al., 2006). In this context the dynamic relationship between land and people creates a complex management environment where protection of threatened species is inextricably linked to human values and behaviour (Hackel, 1999). Conservation organizations working in biodiversity hotspots are increasingly challenged to balance biodiversity conservation with human development goals (Brockington et al., 2006). Input from local people at the outset can help conservation practitioners and land managers to adapt conservation programmes to benefit humans, wildlife and the unique ecosystems in which they reside. Conversely, limited participation in wildlife management by local communities may lead to negative perceptions of conservation and wildlife (Gillingham & Lee, 1999). More research is needed to reveal the importance of a socially inclusive approach to the conservation of threatened species (Brewer, 2002), particularly those existing near protected areas in Africa (Hartter, 2010).

The Upper Guinea forests are a mosaic of tropical forests in West Africa identified as a biodiversity hotspot (Myers et al., 2000). The pygmy hippopotamus *Choeropsis liberiensis* (hereafter pygmy hippo) is native to these forests and current estimates indicate that 2,000–3,000 individuals remain in the wild (Lewison & Oliver, 2012). The Zoological Society of London ranked the pygmy hippo 28th of 100 mammals that have received limited conservation attention, are evolutionarily unique and are in urgent need of conservation action (Isaac et al., 2007). Habitat loss and fragmentation, poaching, and human–wildlife conflict are considered the major factors contributing to the decline of the pygmy hippo (Mallon et al., 2011).

Little is known about this species, including the specific ecosystem functions it provides. Few people encounter pygmy hippos and local residents rarely see them (Eltringham, 1999; Hillers & Muana, 2011). The species is admired for spiritual and aesthetic reasons and is part of the folklore of West African culture (Robinson, 1996; Hillers & Muana, 2011). Like the common hippopotamus *Hippopotamus amphibius*, pygmy hippos may affect natural ecosystems at multiple spatial scales by seeking higher-quality vegetation (Lewison & Carter, 2004) and functioning as seed dispersers and nutrient recyclers by spreading dung (Eltringham, 1999). Furthermore, funds associated

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with research and tourism revenues generated by pygmy hippo conservation have the potential to stimulate economic growth, promoting support for conservation initiatives in surrounding communities (Gössling, 1999).

Human–wildlife conflict can hinder conservation efforts, especially in developing countries (Gadd, 2005). Larger herbivores such as the common hippopotamus and the African elephant *Loxodonta africana* are among the most problematic species because of their ability to cause crop damage and because of the physical threat they pose to humans. For example, farmers in Malawi have negative attitudes towards common hippos because of crop raiding (Mkanda & Kumchedwa, 1997) and respondents in Tanzania believed that elephants were dangerous and offered no benefits to local people (Hill, 1998). Given the potential for similar conflicts with pygmy hippos it is imperative to characterize and account for local perceptions.

We investigated the awareness and attitudes of local residents towards pygmy hippos and their conservation in south-eastern Sierra Leone. Focusing on villages adjacent to pygmy hippo habitat in the vicinity of Tiwai Island Wildlife Sanctuary we aimed to (1) assess the nature and extent of human–hippo interactions, including local knowledge of pygmy hippo ecology and behaviour, and (2) characterize public attitudes towards hippo-related benefits and identify demographic and contextual factors influencing perceived benefits.

Study area

Tiwai Island (12 km^2) lies in the Moa River, adjacent to the Gola Rainforest National Park (Fig. 1). Land cover on the island comprises bush fallow, palm swamps and secondary forest (Dasilva, 1992). Near Tiwai Island the river splits into channels as a result of geographical faulting, giving rise to hundreds of islands (Eichenlaub et al., 1989). The surrounding mainland is a mosaic of secondary forests, upland bush fallow, lowland swamps and cultivated fields.

Tiwai Island was designated a Wildlife Sanctuary in 1987 and is jointly owned by eight host communities in Barri and Koya Chiefdoms, who share annual tourism revenues from the island (Oates, 1999). After a decade-long civil war ended in 2002 the Environmental Foundation for Africa established management of Tiwai Island by funding a visitor centre and research station and initiated several outreach programmes targeting the eight communities (EFA, 2011).

Residents in this region are primarily farmers who rely heavily on subsistence rice farming but also derive supplementary income from palm oil, cocoa and kola nut cash crops (Leach, 1994). Fish is a major component of the diet but bushmeat is also an important source of protein (Davies & Richards, 1991).

Methods

Our study involved two phases over a 2-year time span: semi-structured interviews and questionnaires. Following a pilot test in Kambama village in early January 2009, semi-structured interviews were conducted in the eight host villages during January–June 2009. In the first phase we interviewed 33 people, using a snowball sampling approach, which allowed respondents to recruit further subjects (Biernacki & Waldorf, 1981). Interviews were conducted by the lead researcher (ALC) and a local research assistant, who translated questions into Mende. Conversations took place in private in people's homes during the early morning or late evening, and typically lasted 20–40 minutes. Interviews (2–9 per village; Table 1) focused on people who were at least moderately familiar with pygmy hippos, and were open-ended, focusing on number and location of encounters with pygmy hippos, knowledge of pygmy hippo ecology, and perceived benefits associated with Tiwai Island and pygmy hippos (Supplementary Material 1). Basic demographic information for interview respondents was recorded. Interviews were used to identify key concepts that informed the development of the broader questionnaire in phase two.

Following interviews, an outreach programme was delivered in the eight host communities during January–April 2009. The programme complemented the environmental education programmes of the Environmental Foundation for Africa. During the programme we gave a presentation that outlined preliminary results of ongoing research on the pygmy hippo, with the objective of raising awareness of threatened species in the area. In subsequent discussions respondents had an opportunity to ask questions about the research programme and pygmy hippo conservation.

Phase two of the study, in the following year, involved a questionnaire administered across a broader geographical area, extending 32 km from Tiwai Island. Villages further than this along the Moa River did not report the presence of pygmy hippos and logistical constraints made further exploration inappropriate. During this phase we selected 27 villages, including the communities surveyed in phase 1, to participate in face-to-face intercept questionnaires. Villages were selected based on a reconnaissance survey that ranked villages according to willingness to participate and logistical suitability. Respondents were chosen opportunistically, whether or not they were familiar with pygmy hippos, as the research team moved through the village. We visited villages closer to Tiwai Island between late August and early October 2010 and villages > 10 km away between late October and December 2010. Questions about encounters with pygmy hippos, crop damage, and bushmeat consumption included both dichotomous and open-ended items (Supplementary Material 2). Respondents were

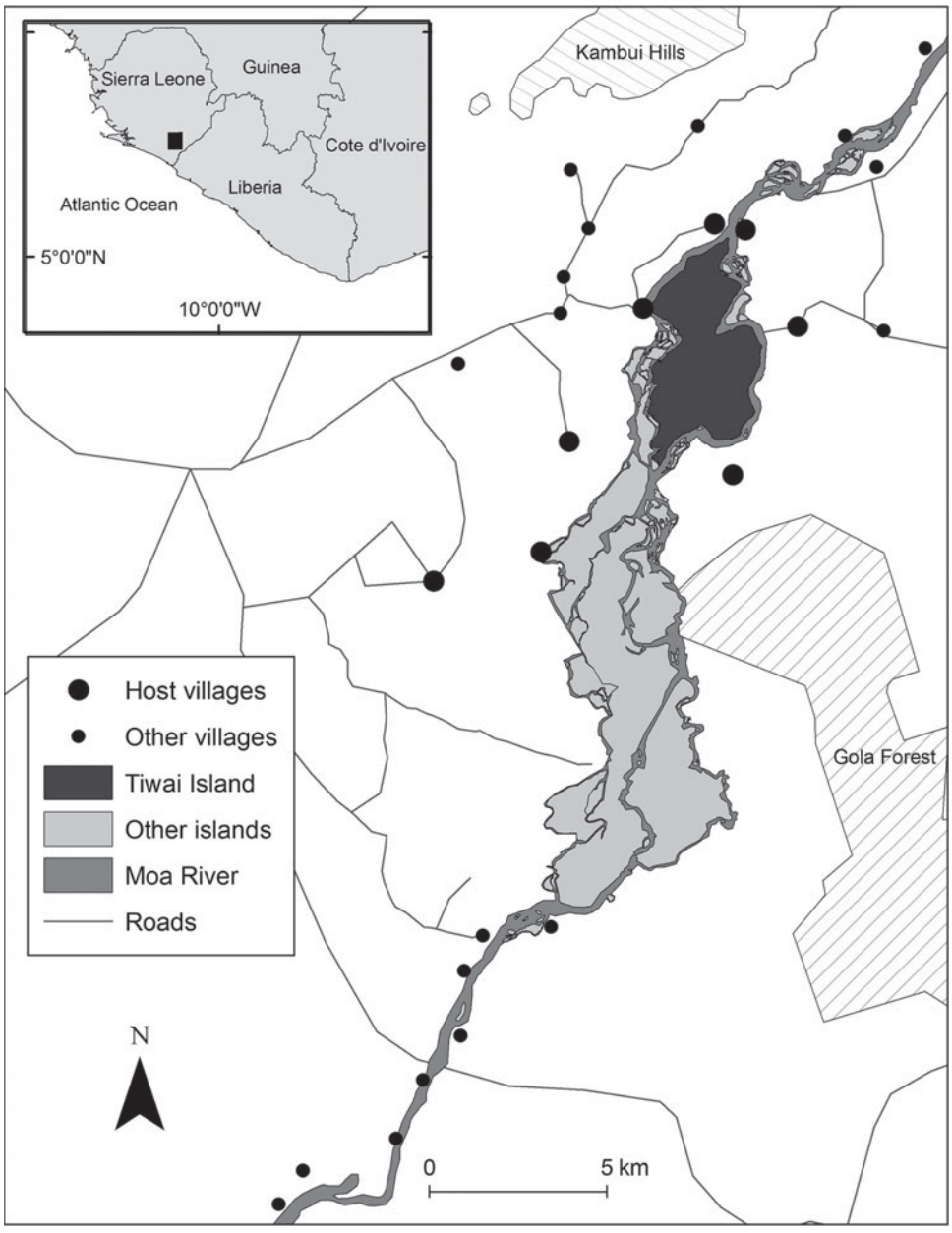

FIG. 1 Locations of communities along the Moa River, in the vicinity of Tiwai Island, Sierra Leone, where interviews and questionnaires were administered from January 2009 to December 2010. The rectangle on the inset shows the location of the main map in Sierra Leone.

allowed to give multiple answers to questions about the benefits of pygmy hippos. Items assessing attitudes towards pygmy hippos and hippo conservation were measured on a three-point scale: −1, disagree; 0, unsure; 1, agree. We recorded demographic characteristics, including age, gender, level of education, and resident status.

There were 522 respondents to the phase-two questionnaire. Participation rates were comparable across all sites (12–30 respondents per village), with c. 5% of the estimated population chosen to obtain adequate representation for statistical inferences (Vaske, 2008). Given the lack of official census data, village authorities were asked to provide estimates of village populations. Questionnaires were administered in Mende by three local residents trained in the administration process, each of whom collected c. one-third of the questionnaires.

Data analyses

Responses to semi-structured interview questions were not statistically analysed beyond descriptive frequency results because of the small sample size and the qualitative nature of the data. However, basic descriptive information, including demographics, hippo sightings and general themes of hippo–human interactions that emerged were used to inform the design of the phase-two questionnaire.

We analysed the phase-two data, using *SPSS v. 19.0* (SPSS, Chicago, USA). Using χ^2 tests of independence we examined

TABLE 1 Demographic characteristics of respondents in semi-structured interviews (January–June, 2009, n = 33) and questionnaire respondents (August–December, 2010, n = 522) in villages around the Tiwai Island Wildlife Sanctuary, Sierra Leone (Fig. 1).

Variable	Semi-structured interview (%)	Questionnaire (%)
Gender		
Female	6.1	43.6
Male	93.9	56.4
Age (years)		
18–29	18.8	13.4
30–39	25.0	29.2
40–49	31.3	24.4
50–59	3.1	11.5
60+	21.9	21.5
Occupation		
Farmer	69.7	89.8
Tiwai staff	12.1	0.0
Fisherman	9.1	0.4
Miner	3.0	0.6
Merchant	0	4.2
Other	3.0	4.4
Education		
None		41.7
Arabic madrassa/ Primary[1]		48.2
Secondary		10.1
Resident status[2]		
Native	87.9	88.4
Immigrant	12.1	11.6
Distance from Tiwai (km)		
0–2.0	63.6	14.8
2.01–5.0	24.2	42.3
5.01–15.0	12.1	23.4
> 15.01	0	19.5

[1]Local people referred to Qur'anic schools or madrassa as Arabic school. We grouped them with primary school because in Sierra Leone the duration of education at both types of school is approximately the same.
[2]A native was defined as someone who was born in the surveyed village or in a tributary village; an immigrant was defined as someone born outside these villages (Davies & Richards, 1991).

differences among individuals in the 27 villages, based on their demographic characteristics. We developed a binary logistic regression model to evaluate the relative influence of multiple predictors, including demographic variables, distance from Tiwai Island and exposure to conservation education programmes, on respondents' recognition of benefits associated with the conservation of pygmy hippos around Tiwai Island. The outcome variable was a discrete choice between two response options: respondents either recognized benefits associated with pygmy hippos (n = 112) or expressed uncertainty or scepticism regarding hippo-related benefits (n = 406). Cases with missing values on at least one item for the predictors of interest (3.8%) were excluded from the analysis. The question of whether pygmy hippos damage crops was asked using two different methods for cross-validation purposes. Odds ratios were used to compare the probabilities of the respondents' perceptions based on demographic factors.

Results

Demographic overview

Semi-structured interviews in phase one were primarily conducted with males (94%); when we approached females they were often reluctant to speak, stating they knew nothing of the topic or were unavailable. The mean age of respondents was 41.8 ± SE 13.5 years. In phase two there was a more even distribution between the genders and the mean age was 44.8 ± SE 16.4 years. The level of education was generally low; only 10.1% of respondents had received secondary schooling. Most respondents owned livestock, including sheep, goats and chickens. Mean household size was 7.60 ± SE 4.37 individuals. Demographic ratios within the sample did not differ significantly as distance from Tiwai Island increased and, based on anecdotal evidence from the area, sample characteristics seemed to reflect accurately the population throughout the region.

Pygmy hippo ecology and human–hippo interactions

In semi-structured interviews all respondents reported seeing at least one pygmy hippo in their lifetime, although one respondent saw only a dead hippo. Few (27.2%) had seen a pygmy hippo within the previous year and two had not seen a hippo since the civil war ended in 2002. Of the most recent encounters, most (68.8%) occurred on the mainland, with only 6.3% on Tiwai Island and 15.6% on the smaller islands south of Tiwai Island. Three respondents (9.4%) could not recall where they had seen the hippos.

In response to the questionnaire 35.1% of respondents claimed to have seen at least one pygmy hippo since the previous rainy season, in May 2009, with a mean of 2 ± SE 1.3 hippo sightings per person. Sightings were more commonly reported by respondents within 2.0 km of Tiwai Island than by respondents who were > 15 km away ($\chi^2 = 3.4$, df = 1, P = 0.06; Fig. 2). However, distance from the Moa River had no significant influence on the number of sightings of pygmy hippo. Gender was the only significant demographic variable, with males more likely than females to have seen a pygmy hippo since the previous rainy season ($\chi^2 = 30.8$, df = 1, P < 0.001).

Respondents in semi-structured interviews provided insight into the foraging behaviour of pygmy hippos. The majority of respondents (93.9%) believed that pygmy hippos consumed crops. Several respondents stated that although pygmy hippos did not often eat crops, their movement

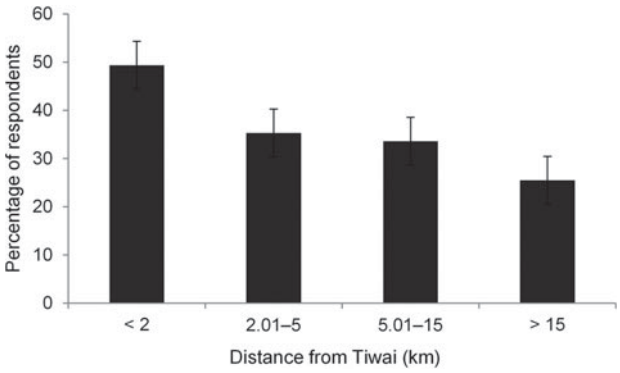

FIG. 2 Percentage of questionnaire respondents (n = 522) who reported sightings of pygmy hippopotamus *Choeropsis liberiensis* since the previous rainy season (September 2009), depending on distance from Tiwai Island Wildlife Sanctuary. Questionnaires were administered during August–December 2010. Error bars indicate standard errors.

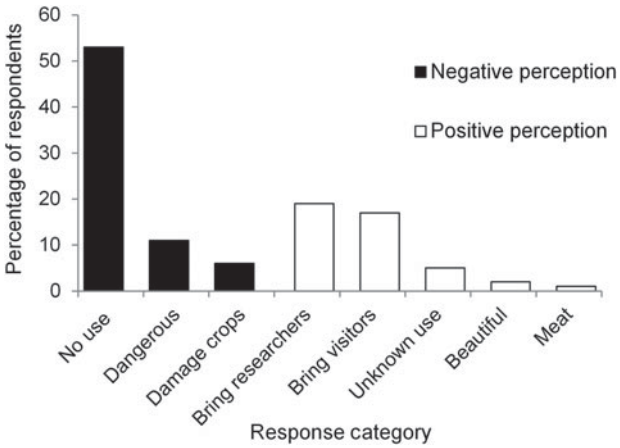

FIG. 3 Percentage of questionnaire respondents (n = 518) in 27 villages surrounding Tiwai Island Wildlife Sanctuary with positive or negative perceptions of the pygmy hippopotamus. Questionnaires were administered during August–December 2010.

through a field in search of okra or sweet potato damaged rice crops. When asked whether it was possible to prevent a pygmy hippo from entering the farm, six respondents believed that building a fence could help but several believed that pygmy hippos could break most fences.

Although the majority of respondents in semi-structured interviews reported that pygmy hippos consumed crops, only 27.8% of the questionnaire respondents believed that pygmy hippos caused crop damage and 7.3% were unsure. Ten people believed pygmy hippos were the most destructive crop pest, far fewer than those implicating cane rats *Thryonomys swinderianus* and red river hogs *Potamochoerus porcus*. Reports of hippo-related crop damage differed significantly with distance from Tiwai Island, with crop damage reported more often among villagers further from Tiwai Island ($\chi^2 = 8.5$, df = 2, P = 0.01). However, reports of hippo-related crop damage decreased significantly as distance from the Moa River increased ($\chi^2 = 22.5$, df = 6, P < 0.01). Males were significantly more likely to report hippo-related crop damage than females ($\chi^2 = 9.8$, df = 2, P = 0.007).

When respondents in semi-structured interviews were asked about consumption of hippo meat 14 people (42%) responded they had tried pygmy hippo meat at least once in their lifetime, and respondents acknowledged the sweetness or deliciousness of the meat. However, of 518 questionnaire respondents who answered the question 'Which wild meat do people catch most often in traps?' none reported pygmy hippo, and only two people listed pygmy hippo as a preferred source of meat.

Local perceptions of the benefits of pygmy hippo conservation

Many of the respondents in semi-structured interviews (69.7%) believed pygmy hippos offered benefits, including attracting researchers and visitors to the area (30.3%). Four respondents replied that pygmy hippos were valuable for aesthetic purposes as they had physical characteristics, such as smooth skin and neck rolls, similar to human babies and beautiful women. Another respondent believed pygmy hippos brought good luck and two farmers believed that the presence of pygmy hippos could deter agricultural pests such as the cane rat. Several respondents were unsure of direct benefits, but one stated '[Pygmy hippos] bring many people like the BBC. If pygmy hippos have no benefit, why would people come from London to search for them?' Three respondents mentioned that pygmy hippo faeces could be used as fertilizer for their gardens. However, 21.2% of respondents believed that meat was the primary benefit provided by hippos. As one respondent noted: 'I never get benefit from the pygmy hippo unless…I kill it.'

Overall, only 21.6% of questionnaire respondents recognized benefits to local communities and 9.1% were unsure. In villages near Tiwai Island (n = 368) the most commonly cited benefit was that the pygmy hippos attracted researchers and tourists to the area (Fig. 3). Further from Tiwai Island the only respondent who recognized any benefit from hippos valued only the meat. The most common reasons cited for why pygmy hippos were not beneficial included their relative inutility, the potential danger they posed and the damage they caused to crops.

The logistic regression model revealed multiple variables predicting the likelihood of respondents' recognition of benefits associated with pygmy hippos (Nagelkerke $r^2 = 0.50$), and the relative influence of multiple predictors on respondents' recognition of benefits related to pygmy hippos (Table 2). Parameter estimates (β) and odds ratios showed that the distance of the respondent from Tiwai Island and exposure to conservation education were the

TABLE 2 Parameter estimates and odds ratios of the binary logistic regression model for the influence of nine independent variables on the awareness of questionnaire respondents (n = 518) of pygmy hippo-related benefits near Tiwai Island Wildlife Sanctuary (Fig. 1). Tests for multicollinearity among independent predictor variables indicated appropriateness for analysis (tolerance ≥ 0.71, VIF ≤ 1.46). Full model, $\chi^2 = 201.1$, df = 9, $P < 0.001$. A Hosmer and Lemeshow goodness-of-fit test indicated that the observed and predicted group assignments did not differ, $\chi^2 = 5.8$, df = 8, P = 0.70.

Variable	B[1]	Wald	Odds ratio[2]	Predicted probability
Constant	−1.55 ± SE 0.80*	3.78		
Gender (male)	0.23 ± SE 0.33	0.45	1.25	0.56
Age	0.23 ± SE 0.11*	4.21	1.26	0.56
Household size	−0.05 ± SE 0.03	2.21	0.95	0.49
Resident status (native)	0.10 ± SE 0.46	0.04	1.10	0.52
School (some education)	0.10 ± SE 0.34	0.09	1.11	0.53
Occupation (farmer)	−0.79 ± SE 0.46	2.93	0.45	0.31
Livestock ownership	0.83 ± SE 0.42*	3.95	2.28	0.70
Distance from Tiwai	−0.89 ± SE 0.19**	21.32	0.41	0.29
Conservation education	2.36 ± SE 0.33**	51.44	10.57	0.91

[1]*P < 0.05, **P < 0.01
[2]A measure of association between the dependent variable and each independent variable; Cox & Snell $r^2 = 0.32$; Nagelkerke $r^2 = 0.50$

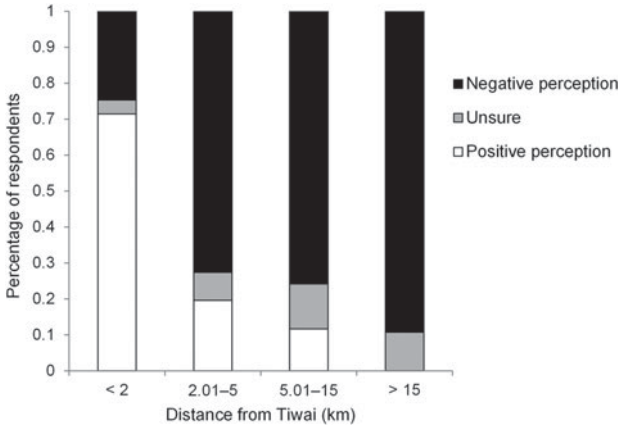

FIG. 4 Percentage of questionnaire respondents (n = 518) in 27 villages with positive or negative perceptions of the pygmy hippopotamus, according to distance from Tiwai Island Wildlife Sanctuary. Questionnaires were administered during August–December 2010.

strongest predictors of awareness of hippo-related benefits. Respondents in villages far from Tiwai Island were less likely to recognize benefits associated with hippo conservation than those who lived closer to the island (β = -0.89, df = 1, $P < 0.001$; Fig. 4). Respondents in villages exposed to conservation education programmes were > 10 times more likely to recognize benefits associated with hippo conservation (β = 2.36, df = 1, $P < 0.001$). For example, 65.3% of respondents from villages involved in outreach efforts by the Environmental Foundation for Africa and our research team thought that pygmy hippos were beneficial to local communities, compared to 7.9% of respondents in other villages ($\chi^2 = 183.7$, df = 1, $P < 0.001$). Older residents were 1.3 times more likely (β = 0.23, df = 1, P = 0.04) and livestock owners were twice as likely (β = 0.83, df = 1, P = 0.04) to recognize benefits associated with pygmy hippo conservation.

Discussion

Pygmy hippo ecology and human–hippo interactions

Our results suggest that local people are an important source of information regarding pygmy hippo ecology and behaviour. The frequency of sightings of pygmy hippos was inversely related to the distance of respondents from Tiwai Island, which may be attributable to the animal's dependence on the availability of water because of its highly vascular skin, which is prone to dehydration (Eltringham, 1999). The primary source of water near Tiwai Island is the Moa River and pygmy hippos use many of the smaller islands as refuge (A. Conway, unpubl. data). Therefore pygmy hippos may be more abundant in villages closer to the river, resulting in more frequent sightings. More male respondents encountered pygmy hippos than females, which may be a result of societal activities; men spend more time fishing in the river at dawn and dusk, when pygmy hippos are most active, whereas women fish in social groups in streams and swamps in the middle of the day (Leach, 1994).

Although hippos were not viewed as crop pests by local residents, as also found by Hillers & Muana (2011), the affinity of pygmy hippos for vegetation in agricultural fields has the potential to result in human–wildlife conflict (Mallon et al., 2011). Crop damage caused by pygmy hippos appeared to be most prevalent closer to the Moa River, which mirrors findings for the common hippopotamus, which is more likely to raid farms near rivers and hippo access points (Kendall, 2011). Negative attitudes towards

hippos are often associated with crop damage. For example, farmers in Malawi were intolerant of crop grazing by common hippos and killed or wounded 600 hippos in 4 years (Mkanda & Kumchedwa, 1997). However, lethal control was not an effective preventative method for common hippos (Mkanda, 1994) and it is an even less acceptable management strategy for pygmy hippos in Sierra Leone, given the species' Endangered status. However, as forests and swamps are converted to farmland and pygmy hippo habitat is destroyed, human–hippo conflicts may intensify (Norris et al., 2010).

In Sierra Leone wild-caught meat is an important source of income and protein as well as a means of reducing crop damage (Davies & Brown, 2007). Koster et al. (2010) found that hunters target animals with rich flavour, high fat content and large body mass, characteristics that would predispose pygmy hippos to hunting pressure. Although few respondents claimed to have eaten pygmy hippo meat, there was agreement among all those who had that the meat was delicious. Our surveys may have underestimated the intensity of hunting of the pygmy hippo as respondents may have been hesitant to admit to illegal activities. During our preliminary visits to villages, three of the 27 villages reported recent hunting of the pygmy hippopotamus. The Wildlife Conservation Law of 1972 prohibits hunting of threatened species but does not offer adequate support for implementation and enforcement (USAID, 2007). Although there have been reports of pygmy hippo meat for sale in markets in range countries, the extent of poaching is still unclear (Mallon et al., 2011). Therefore hunting of hippos across all range countries should continue to be monitored.

Local perceptions of the benefits of pygmy hippo conservation

Most study respondents, and particularly those living further from Tiwai Island, did not recognize benefits associated with pygmy hippos. This finding represents a major barrier to pygmy hippo conservation efforts. When residents do not place a positive value on wildlife, perceptions of negative interactions such as crop damage can be exaggerated (Gillingham & Lee, 2003). That respondents further away from Tiwai Island were also more likely to report hippos as crop pests could be a reflection of negative attitudes. Nevertheless, we identified certain factors that may increase the likelihood of local support. Livestock owners were generally more positive and were twice as likely to perceive benefits associated with pygmy hippos. Gadd (2005) reported similar results in a study of elephants in Kenya, noting that pastoralists were more tolerant of large herbivores than farmers whose livelihoods depended solely on agriculture. In the Tiwai area livestock owners generally have supplemental income, which improves their livelihoods, and this could influence their tolerance of wildlife such as hippos (Davies & Richards, 1991; Randolph et al., 2007).

Older residents were more likely to recognize hippo-related benefits, perhaps because they remember the era before the civil war, when numerous foreign researchers were involved in large, multi-year research projects and they experienced a positive association between conservation and foreign investment. These differences highlight the effects of changes in political stability over time on ecotourism and wildlife conservation. For example, nearly twice as many tourists visited Sierra Leone in 1986 compared to 2009 (Shakya, 2009). With fewer visitors reaching Tiwai Island the younger generation has not experienced the economic benefits of conservation. However, anecdotal evidence suggests that recent tourists are attracted by the possibility of seeing pygmy hippos and guidebooks promote the island as a valuable refuge for threatened species (Manson & Knight, 2012).

Ecotourism has been shown to have a positive effect on the attitudes of local people towards conservation in countries such as India (Sekhar, 2003) and Kenya (Gadd, 2005). These effects are often enhanced by concerted efforts to focus on umbrella species of ecological and socio-economic significance (Walpole & Leader-Williams, 2002). Pygmy hippos have international appeal, cultural value and charismatic appearance, which would allow them to function in this capacity, but Sierra Leone's infrastructural limitations are a major barrier to ecotourism. For instance, annual returns from research and tourism at Tiwai Island are c. USD 4,000, which is barely enough to cover basic maintenance costs (EFA, 2011). Although opportunity for improvement exists, research in other areas suggests that people may revert to previous consumptive behaviours when potential economic gains are not realized (Pretty & Smith, 2004). Reports by community members also indicate that poaching and diamond mining on Tiwai Island are increasing. With little law enforcement and minimal conservation revenue, these activities may escalate and continue to threaten the sustainability of Tiwai Island as a protected area.

Our results indicate that conservation education programmes by the Environmental Foundation for Africa during 2006–2010 and the additional programmes provided by our team generated support for conservation of pygmy hippos around Tiwai Island. Formal education is uncommon in the study area and, when it does occur, little attention is given to the environment (Skuce, 2002). Alternative delivery mechanisms should therefore be considered, particularly those with a core message that resonates with local stakeholders, such as an ecosystem benefits approach (Mertz et al., 2007). Furthermore, because pygmy hippo habitat extends well beyond the boundaries of Tiwai Island, support for conservation efforts from

stakeholders outside the sanctuary is critical. Pygmy hippos would probably benefit from a collaborative initiative by conservation and governmental organizations in Sierra Leone to expand management objectives and outreach efforts further away from protected areas, integrating socio-cultural considerations and human dimensions into landscape-level conservation practices (Mallon et al., 2011).

Implications

The results from our study are being disseminated to stakeholders in Sierra Leone and across pygmy hippo range countries via newsletters, peer-reviewed articles and conferences. The Environmental Foundation for Africa received funding for environmental education outreach focused on pygmy hippos in the Tiwai Island area and ongoing research and education-oriented programmes in other range countries are also contributing to the growing knowledge base (e.g. Gola Forest Programme in Sierra Leone, the Zoological Society of London and Fauna & Flora International in Liberia, Sylvatrop in Guinea and IBREAM in Côte d'Ivoire). At a meeting for the creation of the IUCN Conservation Strategy for the Pygmy Hippopotamus in 2010, stakeholders, conservation organizations, researchers and government officials assembled to determine the threats to the pygmy hippo and the conservation actions required (Mallon et al., 2011). Since this multinational meeting researchers from several organizations have collaborated on the first national pygmy hippopotamus conservation strategy in Liberia, which details the conservation status, current threats and activities to address these issues (Hodgkinson et al., 2013). On-going research programmes are being conducted by these organizations in Sapo National Park in Liberia, Tai National Park in Côte d'Ivoire, and Gola Rainforest National Park in Sierra Leone to further assess conservation needs and population status. Building on our research on the pygmy hippopotamus in Sierra Leone, future research should continue to explore the dynamic ways engagement with local people can enhance or detract from the conservation of threatened species in biodiversity hotpots.

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