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Population Status and Anthropogenic Threats to the African dwarf crocodile (*Osteolaemus tetraspis*) in the Niger Delta, Nigeria

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Abstract: The African dwarf crocodile (*Osteolaemus tetraspis*), classified as Vulnerable by the IUCN, faces significant threats across its range, yet specific data from many regions, including parts of the Niger Delta, remain scarce. This study aimed to assess the population status, habitat conditions, and anthropogenic pressures impacting *O. tetraspis* in Omuihechi Community, Aluu, Nigeria. Systematic sampling, involving visual encounter surveys along six established transects, habitat assessments, structured questionnaires, and interviews with local hunters/fishermen (n = 7), was employed. Relative abundance was derived from survey counts, while anthropogenic activities were quantified by frequency of occurrence. The interview data provided valuable insights into hunting pressures and local perceptions. Descriptive statistics were used for data analysis. Farming (19) and logging (7) were the most frequent habitat disturbances. Hunting, primarily for sale (85.71%), has a significant impact on the species, with juveniles being the most targeted size class (57.14%). Relative abundance averaged 102 individuals across surveys, with notable variation between transects (Transect 2 highest: avg. 31; Transect 4 lowest: avg. 9.5). Most hunters (71.43%) caught crocodiles opportunistically, predominantly using wire traps (85.71%) during the dry season (100%). Most respondents (57.14%) perceived a decline in crocodile numbers. *O. tetraspis* in the Omuihechi Community is under considerable pressure from habitat alteration (primarily farming and logging) and unsustainable hunting practices targeting juveniles. Urgent conservation actions are needed. It is recommended to implement community-based conservation programs focusing on awareness campaigns about the ecological role of crocodiles and the negative impacts of current hunting levels, alongside the development and promotion of alternative livelihood options to reduce reliance on hunting. Enforcement of existing wildlife laws and continued population monitoring are also crucial for the species' long-term survival in the region.

Keywords: *African dwarf crocodile, Anthropogenic pressures, Relative abundance, Conservation, Nigeria*

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1. Introduction

The *Reptilia* class consists of four orders (27 *Crocodilians*, 366 *Turtles*, 1 *Rhynchocephalian*, 203 *Amphisbaenia* and 12,108 *Squamata*) and approximately 12,502 species (Uetz et al., 2024). Among the crocodilians (Table 1), African dwarf crocodile (*Osteolaemus tetraspis*) is notable for their small size, secretive behaviour, and vulnerability to anthropogenic pressures. Found predominantly in woodland streams and marshes or swamps where sunlight is scarce in Western Africa (Shirley et al., 2009; Eaton, 2010), these crocodiles are crucial to local ecosystems but face severe population declines due to habitat destruction and hunting (Eaton et al., 2009). Despite its vital role in maintaining the balance of freshwater ecosystems, the African dwarf crocodile remains poorly understood due to its elusive nature, fragmented habitats, and limited research attention, particularly regarding localised population status and specific threats within diverse regions like the Niger Delta (Shirley et al., 2016, 2009).

In the Niger Delta's Omuihechi community, where oil exploration activities prevail, African dwarf crocodiles inhabit a biodiverse yet understudied landscape. Previous research in the area has primarily focused on oil-related

impacts rather than the ecological dynamics of native species, such as the African dwarf crocodile (Efenakpo et al., 2022). The African dwarf crocodile is a keystone species, contributing to ecosystem health through nutrient recycling, prey population regulation, and habitat maintenance. In freshwater ecosystems, *O. tetraspis* preys on small aquatic and terrestrial animals, helping to control population dynamics and maintain biodiversity (Luiselli et al., 2012). Additionally, its nesting behaviour can enhance soil fertility, supporting the growth of vegetation and other wildlife. Its presence is an indicator of ecosystem integrity, emphasising the need for monitoring its population trends in Nigeria's aquatic habitats. Despite its ecological importance, research on *O. tetraspis* in Nigeria is sparse, especially at the community level within the Niger Delta. Most studies focus on general biodiversity assessments rather than targeted investigations into the species' population size, genetic diversity, and behavioural ecology in specific localities facing unique anthropogenic pressures. This lack of localised data impedes the development of effective, context-specific conservation strategies. Furthermore, the crocodile's cryptic and nocturnal nature makes it challenging to study, requiring innovative methodologies such as environmental DNA (eDNA) analysis and camera trapping (Ficetola et al., 2019).

Globally, *O. tetraspis* is classified as Vulnerable on the International Union for Conservation of Nature (IUCN) Red List, with populations steadily declining (IUCN, 2021). In Nigeria, precise relative abundance are scarce, but anecdotal evidence suggests significant declines in areas once considered strongholds. The species is also threatened by hunting for bushmeat and the use of its parts in traditional medicine, both of which are prevalent in rural communities (Akani et al., 2014). These pressures, combined with weak enforcement of wildlife protection laws, highlight the urgency of assessing and conserving this species. Therefore, this study addresses the research gap by providing essential baseline data on relative abundance, habitat conditions, and specific anthropogenic pressures affecting African dwarf crocodiles in the Omuihechi Community of the Niger Delta. The primary objectives were: (1) To estimate the population size and distribution of *O. tetraspis* within the study area; (2) To identify and rank the major anthropogenic activities impacting the crocodile's habitat; (3) To assess hunting pressure, including methods, seasonality, purpose, and local perceptions of population trends; and (4) To provide evidence-based recommendations for conservation strategies. By elucidating their population status and the threats they face locally, this research aims to guide targeted conservation actions to ensure the long-term survival of this vulnerable species in this part of Nigeria.

Table 1: Extant crocodilian genera and species

	Family	**Species**	**Author**	**Common Name**
1	Crocodylidae (Crocodylia, crocodiles)	*Crocodylus acutus*	Cuvier (1807)	American crocodile
2		*Crocodylus halli*	Murray *et al.* (2019)	Hall's New Guinea Crocodile
3		*Crocodylus intermedius*	Graves (1819)	Orinoco crocodile
4		*Crocodylus johnstoni*	Krefft (1873)	Johnstone River/Freshwater Crocodile
5		*Crocodylus mindorensis*	Schmidt (1935)	Philippine crocodile
6		*Crocodylus moreletii*	Duméril and Bibron (1851)	Morelet's Crocodile
7		*Crocodylus niloticus*	Laurenti (1768)	Nile crocodile
8		*Crocodylus novaeguineae*	Schmidt (1928)	New Guinea crocodile
9		*Crocodylus palustris*	Lesson (1831)	Mugger/Swamp/Marsh crocodile

10		*Crocodylus porosus*	Schneider (1801)	Saltwater crocodile
11		*Crocodylus rhombifer*	Cuvier (1807)	Cuban crocodile
12		*Crocodylus siamensis*	Schneider (1801)	Siamese crocodile
13		*Crocodylus suchus*	Geoffroy Saint-Hilaire (1807)	West African crocodile
14		*Osteolaemus tetraspis*	Cope (1861)	West African dwarf
15		*Osteolaemus osborni*	(Schmidt, 1919)	Osborn's Dwarf crocodile
16		*Mecistops cataphractus*	Cuvier (1825)	African slender-snouted crocodile
17		*Mecistops leptorhynchus*	Bennett 1835)	Central African slender-snouted
18		*Tomistoma schlegelii*	Müller (1838)	False Gharial, Sunda Gavial
19	Alligatoridae, Crocodylia, crocodiles (alligators)	*Alligator mississippiensis*	Daudin (1801)	Alligator, Gator, American/Florida/ Mississippi/Louisiana alligator.
20		*Alligator sinensis*	Fauvel (1879)	Chinese alligator
21		*Caiman crocodilus*	Linnaeus (1758)	Common/Spectacled caiman
22		*Caiman latirostris*	Daudin (1801)	Broad-snouted caiman
23		*Caiman yacare*	Daudin (1801)	Yacare caiman
24		*Melanosuchus niger*	Spix (1825)	Black caiman
25		*Paleosuchus palpebrosus*	Cuvier (1807)	Dwarf /Cuvier's smooth-fronted caiman
26		*Paleosuchus trigonatus*	Schneider (1801)	Schneider's smooth-fronted caiman
27	Gavialidae, Crocodylia, (crocodiles)	*Gavialis gangeticus*	Gmelin (1789)	Gharial

Source: Uetz et al., (2024)

2. Materials and methods

2.1 Study Area

The study was carried out in the Omuihechi Community of Aluu, in the Ikwerre Local Government Area of Rivers State. It is predominantly a village settlement with a large expanse of tropical forest that cuts across the New Kalabar River. It is situated close to the villages of Omuoko and Isoba communities, still in Aluu, Rivers State. The University of Port Harcourt is located nearby, and most of the staff and students reside there. Though it is a rural area but is rapidly developing into a semi-urban area. The Omuihechi Community is located within latitude 4.91278º and 4º54'46" N and Longitude 6.89944º and 6º52'58" E with an elevation of 11 meters (36 feet) above sea level (Figure 1).

The area has a tropical monsoon climate along the coasts, with peak rainfall in September and October, and a prevailing tropical maritime air mass that is almost periodic, with little variation in wind directions. (Olaniran, 1986). It has a humid tropical equatorial climate with the rainy season lasting from April to November and the dry season lasting from December to March. The annual mean total rainfall of the region is approximately 2,500mm and has a monthly temperature range of 24-25ºC during the rainy season in August to 27-29ºC during the end of the dry season in March/April (Dami et al., 2014). The region experiences high wind speeds during the dry season, particularly during periods of heavy rainfall and thunderstorms (Dami et al., 2014).

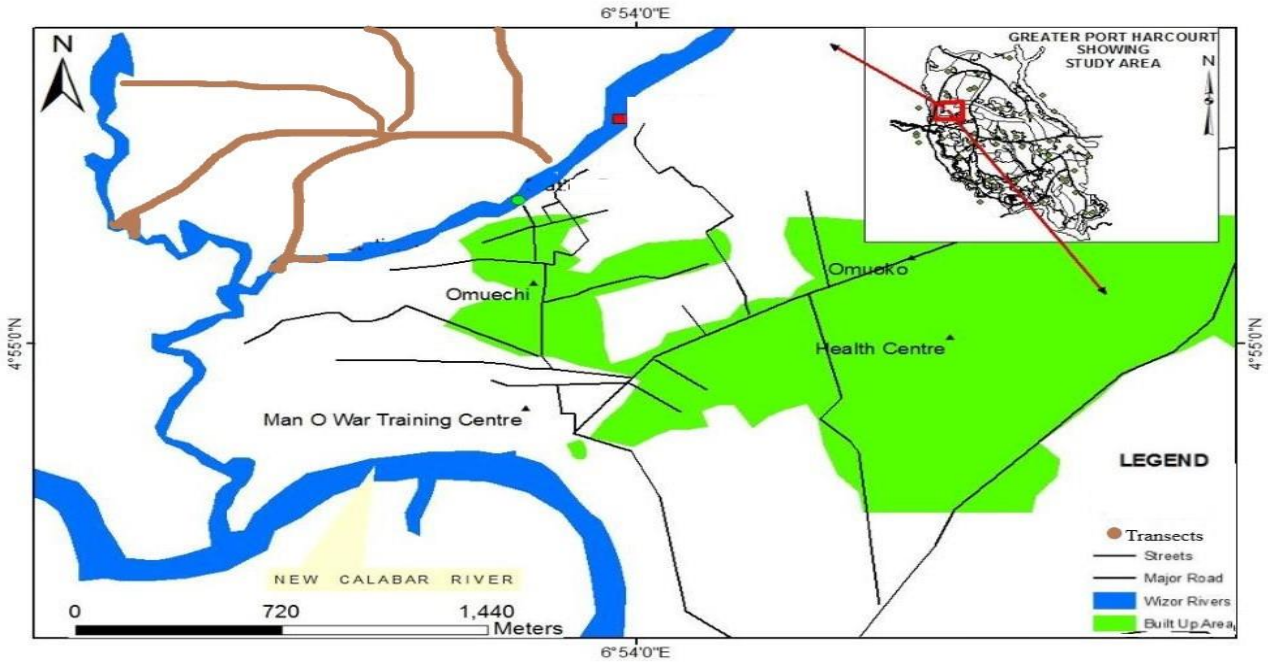

Figure 1: Map of Omuihechi Community of Aluu and the area segmented into Transect

2.2 Sampling and Data Collection

A systematic sampling technique was used for the survey. Data for this study was obtained through habitat assessments, visual encounter surveys (VES), pre-tested semi-structured questionnaires, and interviews.

Habitat Assessment & Transects: The study area was segmented into six (6) transects. Line transects (specific length of 200m were established within the study area, placed semi-randomly using handheld GPS units to ensure representative coverage of the primary habitat types (riparian zones and swamp forests) frequented by *O. tetraspis*. Direct observation along these transects was used to determine the frequencies of selected anthropogenic activities (Farming, housing, oil pipeline, logging, and firewood collection) within each transect.

Population Estimation: Visual encounter surveys, involving systematic searching along established transects during daylight hours, were used to estimate the relative abundance and distribution of African dwarf crocodiles. Counts of observed individuals were recorded for each transect during two distinct survey periods.

Hunting Pressure and Perceptions: A set of pre-tested, semi-structured questionnaires was administered to 7 known local Hunters/Fishermen to gather information on their knowledge, attitudes, and perceptions regarding African dwarf crocodiles, as well as data on hunting pressure (methods, seasonality, purpose, size classes targeted, and perceived population trends). Personal interviews were conducted to supplement the questionnaire data and facilitate clarification. The questionnaires were written in English, and interviews were conducted with the assistance of a local field guide to overcome potential language barriers.

Trapping Methodology (Hunter-Reported): Information regarding trapping methods (e.g., use of baits such as snails, dead lizards, and fish; trap types including wire traps and nets) was obtained solely through interviews with hunters describing their own practices, not through trapping conducted by the research team.

Ethical Considerations: Visual encounter surveys were conducted in a manner designed to minimise disturbance to crocodiles and other wildlife. No animals were captured or handled by the research team during the population assessment phase. Interviews with local hunters were conducted after obtaining informed consent.

2.3 Data Analysis

The data collected were analysed using descriptive statistics. Qualitative data from hunter interviews regarding practices and perceptions were analysed using thematic categorisation of responses. Quantitative data (population counts, frequencies of anthropogenic activities, questionnaire responses) were summarised using frequencies, percentages, and averages. Results are presented using descriptive statistical tools, namely charts and tables. Data was organised and analysed using Microsoft Excel 2018.

3. Results

3.1 Relative abundance of African dwarf crocodiles

The results of Table 2 provide relative abundance for African dwarf crocodiles across six transects during two survey periods. The first survey recorded a total of 102 individuals, with Transect 2 showing the highest count (29) and Transect 4 the lowest (7). Similarly, the second survey yielded 101 individuals, with Transect 2 again having the highest count (33). Average estimates across both surveys revealed that Transect 2 consistently had the largest population (31), while Transect 4 remained the lowest (9.5). These results highlight variability in population distribution across transects.

Table 2: Relative abundance of African dwarf crocodiles in the study area

Period of Survey	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Tran sect 6	Total
1st survey	25	29	11	7	16	14	102
2nd survey	27	33	6	12	13	10	101
Average	26	31	8.5	9.5	14.5	12	102

Source: Field Survey, 2022

3.2 Anthropogenic Activities in the Study Area

Table 3 shows key anthropogenic activities affecting the study area, with rankings based on their frequency and severity. Farming emerged as the most significant activity, with 19 occurrences (Rank 1), predominantly in swamp forests (13 occurrences). Logging ranked second, with 7 incidents, primarily in riparian areas. Bush burning and firewood collection followed, with frequencies of 4 and 6, ranked third and fourth, respectively. Illegal oil exploration and hunting were the least frequent, ranking fifth and sixth. The table shows the varying impacts of human activities on different habitats, emphasising the need for targeted conservation strategies. Figure 2 shows wire traps (85.7%) as the method mostly used to catch the African dwarf crocodile

Table 3: Selected Anthropogenic Activities and their Ranking in the study area

Anthropogenic Activities	Riparian Area	Swamp Forest	Frequency	Ranked severity
Illegal oil exploration	1	0	1	6
Farming	6	13	19	1
Logging	5	2	7	2
Bush Burning	1	3	4	3
Hunting	1	1	2	5
Firewood Collections	1	5	6	4

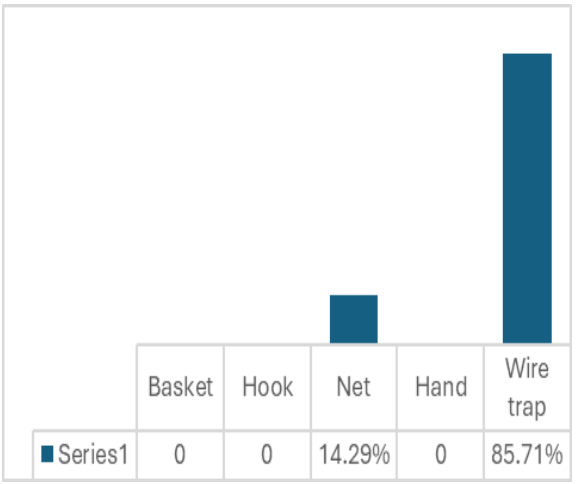

Figure 2: Bar Chart showing the method mostly used to catch the African dwarf crocodile
Source: Field Survey, 2022

3.3 Hunting Pressure on African dwarf crocodiles in the Study Area

Table 4 presents data on hunting practices and perceptions regarding African dwarf crocodiles in the study area. A majority (71.43%) of respondents reported catching crocodiles by chance, while 28.57% purposefully set traps. Juveniles were the most frequently caught size (57.14%), followed by medium-sized individuals (28.57%), with no reports of large crocodiles being caught. The primary reason for hunting was for sale (85.71%), with food accounting for 14.29%. Hunting occurred exclusively during the dry season (100%), and all sales were to natives (100%). Over half (57.14%) of respondents believed crocodile populations are decreasing, highlighting conservation concerns. Among the tools used for trapping African dwarf crocodiles, the Wire trap (85.71%) was the most used, followed by nets (14.29%).

Table 4: Hunting practices and perception of African dwarf crocodiles

Parameter	Variable	N	%
Do you [purposely set trap for them] or [catch them by chance]	[Set a trap for them]	2	28.57
	[Catch them by chance]	5	71.43
What size do you catch most?	[Juvenile]	4	57.14
	[Medium]	2	28.57
	[Large]	0	0.00
Why do you mostly kill African dwarf crocodiles?	[Food]	1	14.29
	[Sale]	6	85.71
	[Sport]	0	0.00
	[Non]	0	0.00
Which season do you catch most?	[Rainy Season]	0	0.00
	[Dry Season]	7	100.00
	[Harmattan]	0	0.00
What categories of people do you sell to?	[Natives]	7	100.00
	[Non-Native]	0	0.00
	[Both]	0	0.00
	[Non]	0	0.00
Do you think the numbers are reducing in the bush/rivers?	[Yes]	4	57.14
	[No]	2	28.57
	[Not sure]	1	14.29

Source: Field Survey (2022)

4. Discussion

Relative abundance of African dwarf crocodiles in the study area

The relative abundance of African dwarf crocodiles reveal notable variations across transects, suggesting habitat heterogeneity or differential anthropogenic pressure within the study area. Transect 2 consistently showed the highest counts, potentially indicating more suitable habitat conditions (e.g., denser vegetation cover, less disturbance, higher prey availability) compared to Transect 4, which had the lowest counts (Gardner et al., 2016; Cox et al., 2022). While a direct comparison of density is difficult without precise transect lengths and widths, the overall estimate suggests a potentially significant local population, although its long-term viability is threatened by the identified pressures. The variability highlights areas potentially crucial for conservation focus within the community landscape. Further research correlating specific microhabitat features with crocodile abundance could clarify these patterns (Taylor et al., 2021).

Anthropogenic Activities that affect the African dwarf crocodiles in the Study Area

Agricultural expansion was identified as the primary form of habitat disturbance (Table 3), consistent with trends across Nigeria where forest conversion for farming is widespread (Nelson et al., 2019; Jacob et al., 2015). This finding aligns with reports from other regions where habitat loss due to agriculture and logging poses significant threats to *O. tetraspis* (Palm Oil Detectives, 2023; Eaton, 2010). Logging, ranked second, further fragments and degrades essential riparian and swamp forest habitats. The impact of farming and logging is likely to reduce available cover, increase human-crocodile encounters, and alter hydrological conditions crucial for the species.

Hunting was identified as a direct threat through interviews and observed signs. While opportunistic hunting was more commonly reported, the fact that crocodiles are primarily killed for sale indicates commercial pressure, not just subsistence use. This shift from subsistence to commercial exploitation mirrors trends observed for other bushmeat species driven by economic hardship and market demand (Alves et al., 2018; Jacob et al., 2018; Ceríaco et al., 2018; Zoer, 2012). This commercialisation, also noted by Eaton (2006) and Zoer (2012) for *O. tetraspis* due to its transportability, poses a severe threat, potentially driving unsustainable harvest levels, especially when combined with habitat degradation. The perception by most hunters that numbers are declining further supports the need for intervention. Similar findings on habitat loss and hunting impacting reptile populations have been reported elsewhere (e.g., Kideghesho, 2009, on monitor lizards).

Hunting Pressure on African dwarf crocodiles in the study area

The results of the hunting pressure obtained in this study agree with Zoer (2012), who reported that the African dwarf crocodile, *O. tetraspis,* is by far the most heavily hunted of all the crocodile species. This preference is influenced by its small size and relatively non-aggressive nature, which facilitates easy capture, and further, it stays alive while being transported to markets. However, this study revealed a dangerous path that, if not controlled with immediate measures, will lead to species local extinction as was the case in The Gambia, Senegal, and Uganda, as reported by Eaton (2010). The targeting of juvenile and medium-sized crocodiles, with no large individuals reported caught, is a critical issue. This selective hunting pattern, potentially driven by ease of capture or market preference, poses a particularly severe threat to the long-

term sustainability of the population. Removing younger age classes before they reach reproductive maturity drastically reduces recruitment and the potential for population recovery, a concern echoed in studies of other harvested wildlife populations. This pattern contrasts with some crocodile harvesting programmes elsewhere that focus on larger individuals or eggs/hatchlings under controlled conditions, highlighting the unsustainable nature of the practices observed here. The concentration of hunting effort in the dry season likely corresponds to periods of lower water levels, making crocodiles more accessible or concentrated in remaining pools.

The reliance on wire traps suggests a common and potentially indiscriminate capture method. The fact that sales are exclusively to natives (100%) might indicate a localised market, but the scale suggested by previous reports (Zoer, 2012; Eaton, 2006) implies these animals may enter larger trade networks. The reasons cited for hunting (primarily sale) align with economic drivers but also reflect complex socio-cultural factors surrounding bushmeat (Alves et al., 2018; Pooley, 2016). Compared to other West African regions, the specific combination and intensity of threats (high agricultural pressure, targeted juvenile hunting for local sale) may vary, but the overall vulnerability of *O. tetraspis* to habitat loss and overharvesting is a consistent theme (Nelson et al., 2019; Alves et al., 2018; Jacob et al., 2018; Jacob et al., 2015). Therefore, addressing the hunting pressure requires understanding these local economic and social contexts, potentially through alternative livelihood programs and community engagement, as suggested by Rueness et al. (2024), Ashepet et al. (2024), Naabeh et al. (2023), Pooley et al. (2021) and Pooley (2016).

The Nile crocodile has already experienced a nearly similar collapse in the same Rivers State waterways: in just three years (2008–2010), 70 fishermen removed 3,206 individuals (mostly juveniles), causing the species to become functionally extinct in these communities (Ijeomah & Efenakpo, 2011). This shows how quickly uncontrolled juvenile harvesting can wipe out a crocodile population in the Niger Delta.

5. Conclusion

The African dwarf crocodile (*Osteolaemus tetraspis*) in the Omuihechi Community faces significant threats from anthropogenic activities, primarily habitat degradation driven by farming and logging, as well as direct hunting pressure. This study revealed an average population estimate of 102 individuals across six transects, with considerable spatial variation. A major concern is the hunting focus on juvenile and medium-sized crocodiles, primarily for commercial sale, which severely compromises population recruitment and long-term viability. Hunting primarily occurs during the dry season, utilising wire traps. The perception among local hunters of declining crocodile numbers underscores the urgency for conservation action.

To address these challenges, the following recommendations are made:

i. Initiate programmes involving local stakeholders to raise awareness about the ecological importance of *O. tetraspis*, the current conservation status, and the detrimental impacts of unsustainable hunting, particularly of juveniles.

ii. Explore and promote viable alternative income sources (e.g., sustainable agriculture practices, aquaculture, non-timber forest product enterprises, potential for localised ecotourism if feasible) to reduce economic dependence on crocodile hunting and habitat conversion.

iii. Work with the community to identify and potentially designate critical crocodile habitats for protection, and encourage habitat restoration activities, particularly in degraded riparian zones.

iv. Advocate for improved monitoring and enforcement of existing state and national wildlife protection laws about hunting and trade of protected species like *O. tetraspis.*

v. Implement a long-term monitoring program to track population trends and the effectiveness of conservation interventions.

Moreover, collaborative efforts involving the Omuihechi community, local government authorities, conservation NGOs, and research institutions are essential for the successful implementation of these recommendations and ensuring the future of the African dwarf crocodile in this part of the Niger Delta.

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