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Assessing The Presence of Nipa Palm in Qua Iboe River Estuary and Cross River Estuary: A Brackish Water Environment of Akwa Ibom State, South Nigeria

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Abstract:

The coastal brackish water environment of Akwa Ibom state is assessed of the presence of Nipa palm. The study areas were majorly the Cross River estuary and Qua Iboe river estuary and three sample points from both estuaries using 10m by 10m quadrat spaced at 100m interval. species diversity was determined using the Simpson's diversity index and the results were; 0.93, 0.91 and 0.89 for James Town, Douglas Creek and Stubbs Creek respectively. Margalef's index was used to calculate species richness and Lawson's subjective classification was used to classify it into rare, occasional and common. The result shows the dominance of Nipa palm alongside the indigenous Rhizophora racemosa indicating the positive nature of the invasiveness of the Nipa palm.

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1. Introduction

The Nipa Palm (*Nypa fruticans* Wurumb) is a brackish water plants that belongs to the family of palms. According to Udofia et. al. (2014), Ogbemudia et. al. (2013), Holzlohmer (2002) and Udoidiong and Ekwu (2011), they observed that *Aracaceae* family of which the Nipa Palm belongs is the dominant family of species in most of the coastal area of Akwa Ibom state. Hence and assessment of its presence especially its domineering presence in the brackish water environment of Akwa Ibom state is not insignificant. Nipa palm thrives in a temperature of between 20°C- 35°C it however thrives best in high temperature of between 32-35 and in areas that receives not more than 100 mm rainfall per month throughout the year. It is thus a tropical plant. Nipa palm thrives only in a brackish water environment. It is rarely seen directly on the seashore. Optimum conditions are when the base and the rhizome of the palm are regularly inundated by brackish water. The salt concentration is 1-9 per mil. Due to this, Nipa palm is present in estuarine tidal floodplains of rivers. Nipa palm swamp soils are however muddy and rich in alluvial silt, clay and humus.

Nypa Palm is not indigenous to Akwa Ibom state or any part of the Niger Delta but was introduced from Singapore Botanical Garden to check coastal erosion in the coastal region, Umoren (2001). However, the spread of nipa in the coastal zones of Nigeria threatens the mangrove vegetation of the zone by outcompeting and displacing the native mangrove species, due to its high level of invasiveness. This invasive characteristic of Nipa palm is facilitated by its dispersal mechanism. It is dispersed by the movement of water via ocean current and tide this has been responsible for its presence in the inland rivers and creek. It is also dispersed via humans carrying the fruits by hand to other places. The disturbing issue with the Nipa palm is that it prostrates and gregarious this gregarious characteristic implies that it grows in packs. This leads to an outright out competition of other indigenous

mangrove species and due to its spread mechanism it can be easily grown anywhere around the brackish environment.

Purpose of Study

Nipa palm as recorded by various scholars like Ogbemudia et. al. (2013) is the most dominant mangrove specie in the coastal mangrove environment of Akwa Ibom state, Nigeria. Although, it is not an original mangrove species, it dominates the mangrove ecosystem landscape of the study area. Thus, this study assesses the presence of Nipa palm in the mangrove ecosystem of Akwa Ibom state, in relation to other associated mangrove species in order to quantify its presence relative to its habitat.

Statement of Problem

The brackish water environment of Akwa Ibom State, Nigeria presents and ecosystem that supports a variety of Flora and Fauna species. However, a critical look at the composition of s of floral species across these two environments: Qua Iboe River Estuary and Cross River Estuary, shows skewness. This skewness is attributed to the observable domineering presence of a non-indigenous palm species- Nipa palm. This is a threat to the sustainability and preservation of this ecosystem original composition to avoid compromise in ecosystem function. However, there is dearth of data for planning process which is a preliminary for initiation of any management process.

Objectives of Study

The specific objectives of this study relative to the statement of problem are;

1. To assess the composition of floral species in the mangrove environment of Akwa Ibom state.
2. To identify the species with high dominance.
3. To specifically determine the presence index Nipa palm in the study area.
4. To represent the results on maps.

2. Materials and methods

The study uses data from field surveys carried out across the two environments. Line transects and quadrants were sets in the field and Sampling Techniques Line transects Twenty line transects were cut across the vegetation formations at two-kilometre-intervals along the coastline, starting from the Cross river estuary and terminating at Imo river estuary for rapid and extensive assessment of ecosystem types. This was done in all the sites in both study areas. A combination of sampling and study techniques was adopted for the extensive and intensive assessment of the vegetation types. These include line transects and Quadrats Olowokudejo et. al. (2016). All plant specimens encountered along the transects and within the quadrats were identified to species level either in the field or herbarium, using appropriate Floras, Manuals and Monographs Life form classification was carried out according to Kershaw (1973) and Raunkiaer (1934). In the study sites, Species were sampled in 10m x 10m quadrat, spaced at regular interval of 100m.

For the mapping of the two estuaries, the data was interpolated from the species richness calculations. This was done by alienating the dominant *Rhizophora racemose (*the indigenous mangrove plant) and *Nypa fruticans to* create an understandable classification culled from Holzlohner et. al (2002).

a. mixed *Nypa fruticans*, mangrove and trees
b. no *Nypa fruticans* no mangrove only trees
c. *Nypa* only
d. *Nypa fruticans*, little mangrove extended *Nypa fruticans*,
e. Only mangrove
f. Mangrove with fringing *Nypa fruticans*.

2.1 Study area

The study concentrated on the brackish water environment of Akwa Ibom covering the coast and the estuaries where the salt water fresh water interface occurs; this is shown in fig 1. The coastline is sandy, heavily incised by numerous creeks, shallow streams and rivers, and drained by a number of rivers including the Cross River, and the Qua Iboe River Olowokudejo et. al. (2016). The Cross River estuary study area focuses on the inner part and on the west coast of the outer part of the Cross River Estuary (Fig. 2). The study area in the Qua Iboe river estuary has a Longitude $7^{0}59'17"$ E and Latitude $4^{0}533'32"$ N. and covers the Qua Iboe estuary its disposal into to the ocean to far inland up past the Ubium creek.

2.2 Data analysis and presentation

The data was analysed using:

Shannon's species diversity $H=\Sigma(p_i) \parallel np_i \parallel$

Species richness (S) Margalef's index (di) was calculated using the formula (Ogbeibu, 2005) below to determine species richness: **di = (S -1)/ (log N)**

Where; S = Species variety or total number of species N = Total number of individuals in the sample According to Lawson et al., (2013), the occurrence of the species was described using a subjective acronym (COR): in which C stands for common; O for occasional or R for rare species. Species were considered Common, when a species occurred above 20 individuals; Occasional, when often below 20 individuals and Rare, when not found often usually less than 10 individuals.

Location	Description
Shoreline	Strand vegetation along the coastline characterised by loose soils dominated by i. *Ipomoea pes-caprae,* ii. *Ipomoea aquatic,* iii. *Dalbergia escastaphyllum,* iv. *Canavalia rosea,* v. *Rhizophora racemosa,* vi. *Cocos nucifera,* vii. *Laguncularia racemosa* viii. *Nypa fruticans* ix. *Sphagneticola trilobata* x. *Paspalum vaginatum* xi. *Hydrocotlye bonariensis*

Douglas Creek	Mangrove vegetation dominated by; i. *Rhizophora racemosa* ii. *Nypa Fruticans* iii. *Acrostichum aureum* iv. *Conocarpus erectus* v. *Laguncularia racemosa* vi. *Avicennia germinans* vii. *Phoenix reclinata*
Stubbs Creek	Mangrove vegetation dominated by; i. *Acrostichum aurem,* ii. *Nypa Fruticans* iii. *Conocarpus erectus* iv. *Laguncularia racemosa* v. *Avicennia germinans* vi. *Phoenix reclinata*
Edo Akoeti Creek	Mangrove vegetation dominated by; i. *Nypa Fruticans* ii. *Rhizophora racemosa* iii. *Conocarpus erectus* iv. *Laguncularia racemosa* v. *Avicennia germinans* vi. *Phoenix reclinata*
Ubium Creek	Mangrove vegetation dominated by; vii. *Nypa Fruticans* viii. *Rhizophora racemosa* ix. *Conocarpus erectus* x. *Laguncularia racemosa* xi. *Avicennia germinans* xii. *Phoenix reclinata*
Cross River Estuary	It includes areas with i. Mixed Nypa fruticans, Mangrove and Trees ii. No Nypa Fruticans, no mangrove only trees iii. Nypa only iv. Little Mangrove with extended Nypa Fruticans v. Only Mangrove vi. Mangrove with fringing Nypa Fruticans

Table 1: Presence of Nypa fruticans in Cross River Estuary and Qua Iboe River Estuary

The above table shows the flora species composition of various sites comprising the study area. This was done after a reconnaissance survey involving first identification of species present without any form of numerical computation. There was no segmentation into pure mangrove species or associated species it was just purely high population species found in the study sites. The table gives a preliminary description of the study area before reconciling it with empirical computation.

Species	James town	Douglas Creek	Stubbs Creek	Total

Ipomoea pes-carprae	4 (3.96)	3(3.33)	4(3.60)	11
Ipomoea acquatic	5 (4.95)	6(6.67)	8(7.21)	19
Dalbergia escastaphyllum	3(2.97)	2(2.22)	3(2.70)	8
Canavalia rosea	6 (5.94)	3(3.33)	5(4.50)	14
Rhizophora racemosa	16(15.84)	15(16.67)	11(9.91)	42
Cocos nucifera	6(5.94)	5(5.56)	2(1.80)	13
Laguncularia racemosa	2(1.98)	5(5.56)	4(3.60)	11
Nypa fruticans	19(18.81)	12(13.33)	29(26.14)	60
Sphagneticola trilobata	6(5.94)	2(2.22)	4(3.60)	12
Paspalum vaginatum	2(1.98)	4(4.44)	3(2.70)	9
Hydrocotlye bonariensis	4(3.96)	2(2.22)	6(5.41)	12
Acrostichum aureum	3(2.97)	3(3.33)	8(7.21)	14
Conocarpus erectus	3(2.97)	3(3.33)	6(5.41)	12
Avicennia germinans	5(4.95)	6(6.67)	1(0.90)	12
Phoenix reclinata	7(6.93)	10(11.11)	1(0.90)	18
Drepanocarpus lunatus	2(1.98)	3(3.33)	8(7.21)	13
Artocarpus altilis	6(5.94)	2(2.22)	4(3.60)	12
Lonchocarpus sericeus	2(1.98)	4(4.44)	4(3.60)	10
	101	90	111	302

Table 2; Number of individual species in the study area

Table 2 shows the population of individual species in the study area and their proportion of population. The table show that in all study sites, *Rhizophora racemosa* and *Nypa Fruticans* contains the highest population of individual species with a total value of 42 and 60 individual species in the study area respectively. However, *Dalbergia escastaphyllum* had the lowest value with 8 individual species. The table revealed that all the mangrove species documented in the study area are evenly spread across all study sites.

Species	Douglas Creek	**n(n-1)**
Ipomoea pes-carprae	3(3.33)	6
Ipomoea acquatic	6(6.67)	30
Dalbergia escastaphyllum	2(2.22)	2
Canavalia rosea	3(3.33)	6
Rhizophora racemosa	15(16.67)	210
Cocos nucifera	5(5.56)	20
Laguncularia racemosa	5(5.56)	20
Nypa fruticans	12(13.33)	132
Sphagneticola trilobata	2(2.22)	2
Paspalum vaginatum	4(4.44)	12
Hydrocotlye bonariensis	2(2.22)	2
Acrostichum aureum	3(3.33)	6
Conocarpus erectus	3(3.33)	6
Avicennia germinans	6(6.67)	30
Phoenix reclinata	10(11.11)	90
Drepanocarpus lunatus	3(3.33)	6

Artocarpus altilis	2(2.22)	2
Lonchocarpus sericeus	4(4.44)	12
	90	594

Table 3: Calculating Shannon's Diversity index for Douglas

The table 4 shows that Douglas creek has a total of 90 individual species. Relative to the other study sites, this is study site has the lowest presence index of species. However, *Rhizophora racemosa* outnumbers *Nypa fruticans*

Using the **Shannon's species diversity index, H=$\Sigma(p_i) \parallel np_i \parallel$** the diversity index is given as **Shannon's diversity index = 0.93**

Species	n(n-1)	StubbsCreek
Ipomoea pes-carprae	12	4(3.60)
Ipomoea acquatic	56	8(7.21)
Dalbergia escastaphyllum	6	3(2.70)
Canavalia rosea	20	5(4.50)
Rhizophora racemosa	110	11(9.91)
Cocos nucifera	2	2(1.80)
Laguncularia racemosa	12	4(3.60)
Nypa fruticans	812	29(26.14)
Sphagneticola trilobata	12	4(3.60)
Paspalum vaginatum	6	3(2.70)
Hydrocotlye bonariensis	30	6(5.41)
Acrostichum aureum	56	8(7.21)
Conocarpus erectus	30	6(5.41)
Avicennia germinans	0	1(0.90)
Phoenix reclinata	0	1(0.90)
Drepanocarpus lunatus	56	8(7.21)
Artocarpus altilis	12	4(3.60)
Lonchocarpus sericeus	12	4(3.60)
	1244	111

Table 4: Calculating Shannon's Diversity index for Stubbs Creek Forest Reserve

Table 4 shows the data for the calculation of the Diversity of Index of Stubbs creek Forest Reserve. Compared to the other study sites, this is the largest study sites in terms of land area coverage. The trend is replicated here as in Douglas Creek in Table 3 *Nypa fruticans* and *Rhizophora racemosa* contains the highest population of species. **Shannon's species diversity H=$\Sigma(p_i) \parallel np_i \parallel$**

Shannon's diversity index = 0.89

Species	James town	Douglas Creek	StubbsCreek	Total	Species richness
Ipomoea pes-carprae	4 (3.96)	3(3.33)	4(3.60)	11	occasional
Ipomoea acquatic	5 (4.95)	6(6.67)	8(7.21)	19	occasional

Dalbergia escastaphyllum	3(2.97)	2(2.22)	3(2.70)	8	rare
Canavalia rosea	6 (5.94)	3(3.33)	5(4.50)	14	occasional
Rhizophora racemosa	16(15.84)	15(16.67)	11(9.91)	42	common
Cocos nucifera	6(5.94)	5(5.56)	2(1.80)	13	occasional
Laguncularia racemose	2(1.98)	5(5.56)	4(3.60)	11	occasional
Nypa fruticans	19(18.81)	12(13.33)	29(26.14)	60	common
Sphagneticola trilobata	6(5.94)	2(2.22)	4(3.60)	12	occasional
Paspalum vaginatum	2(1.98)	4(4.44)	3(2.70)	9	rare
Hydrocotlye bonariensis	4(3.96)	2(2.22)	6(5.41)	12	occasional
Acrostichum aureum	3(2.97)	3(3.33)	8(7.21)	14	occasional
Conocarpus erectus	3(2.97)	3(3.33)	6(5.41)	12	occasional
Avicennia germinans	5(4.95)	6(6.67)	1(0.90)	12	occasional
Phoenix reclinata	7(6.93)	10(11.11)	1(0.90)	18	occasional
Drepanocarpus lunatus	2(1.98)	3(3.33)	8(7.21)	13	occasional
Artocarpus altilis	6(5.94)	2(2.22)	4(3.60)	12	occasional
Lonchocarpus					rare
Sericeus	2(1.98)	4(4.44)	4(3.60)	10	rare
	101	90	111	302	

Table 6: Species Richness

Using Lawson's method of subjective classification, the species were classified into common, rare and occasional as shown in Table 6. The table shows that most of the species in the study area were occasional that is they appear over the landscape occasional. Only 4 species where classified as rare that is wherever they appear they are low in population however, *Nypa fruticans* and *Rhizophora racemosa* were classified as common due to their domineering presence all over the landscape.

3. Result

The species diversity when collated from all sample points in the study area was given as 0.91. This indicates that the study area is rich in species composition. Individual sites presentation of diversity is given **0.93** for Douglas Creek, Stubbs creek is given as **0.89.** The indicate that across the study area, the species composition is rich in terms of diversity. The richness rate of the species is computed and using Lawson's subjective classification based on the relative value of presence of individual species population, the result was given as ratio 2:4:13 that is common, occasional and rare.

4. Discussion

The aim of this study was to assess to the presence of Nipa palm in the brackish water environment of Akwa Ibom State. Flora species diversity was firstly determined using the Simpson's diversity index and the following values were derived for James town in the . Cross River Estuary- 0.93, Douglas Creek in the Qua Iboe Estuary 0.91 and the Stubbs Creek in the Qua Iboe Estuary 0.89. This is a positive result that indicates a high level of species diversity. From the data in the three sampled area, the dominant species were *Rhizophora racemosa and Nypa fruticans* with cumulative individual species of 42 and 60 respectively out of the total of 302. This indicates the dominance of these two species. Also in the classification of the species richness according to Lawson et al., (2013), both species fall under the common species. Although it is natural to have a native species *Rhizophora racemosa* as a dominant species the Nipa palm however to be a dominant species also indicates a positive in its invasiveness and domineering influence in the brackish water environment of Akwa Ibom state.

5. Conclusions

With the objectives of the study in view, the study was able to compute the list of flora mangrove species associated with the study showing a total of the 19 different types of flora mangrove species. Computing the diversity and richness rate of species in the study area, this study shows that area is a thriving mangrove ecosystem with a wide range of diversity individual species type. However, in terms of population the study showed that Nipa palm and *Rhizophora racemosa* were the species that reoccurred in all study sites consistently bearing the highest number of individual species. Considering the primary aim of assessing specifically the presence of Nipa palm, the study reveals that Nipa palm is evenly spread in all study sites bearing the highest population.

After an assessment of the presence of Nipa palm in the study area, the following positions can be interpolated; that the Nipa palm a non-indigenous palm species is dominant in the study area alongside the indigenous *Rhizophora racemosa,* that the Nipa palm is a highly invasive species that threatens the integrity of the pristine mangrove integrity. The two estuaries were mapped showing the distribution of Nipa palm relative to the indigenous mangrove plants in both estuaries.

Implications of findings

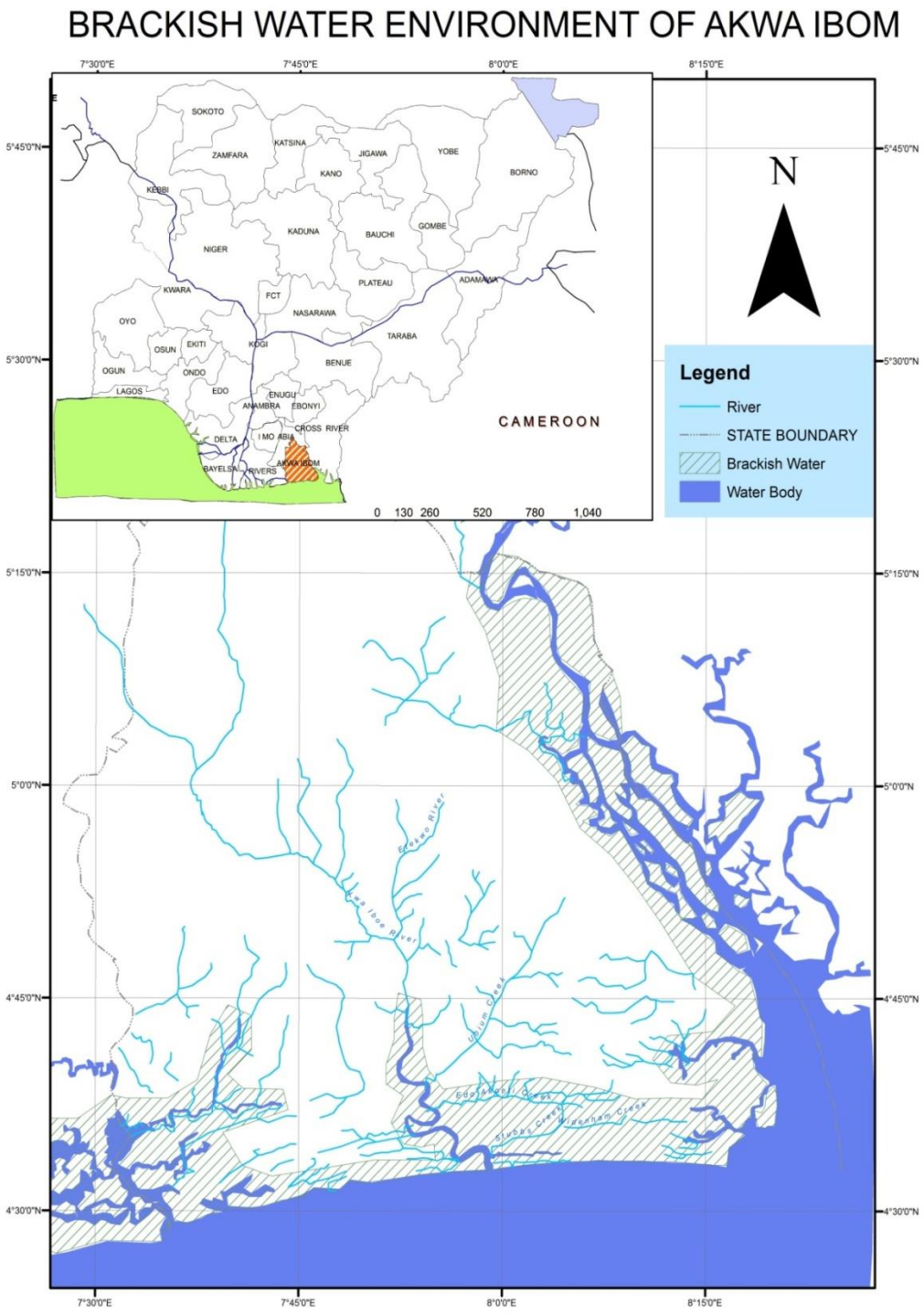

Fig 1: Akwa Ibom Showing Brackish Water Environment

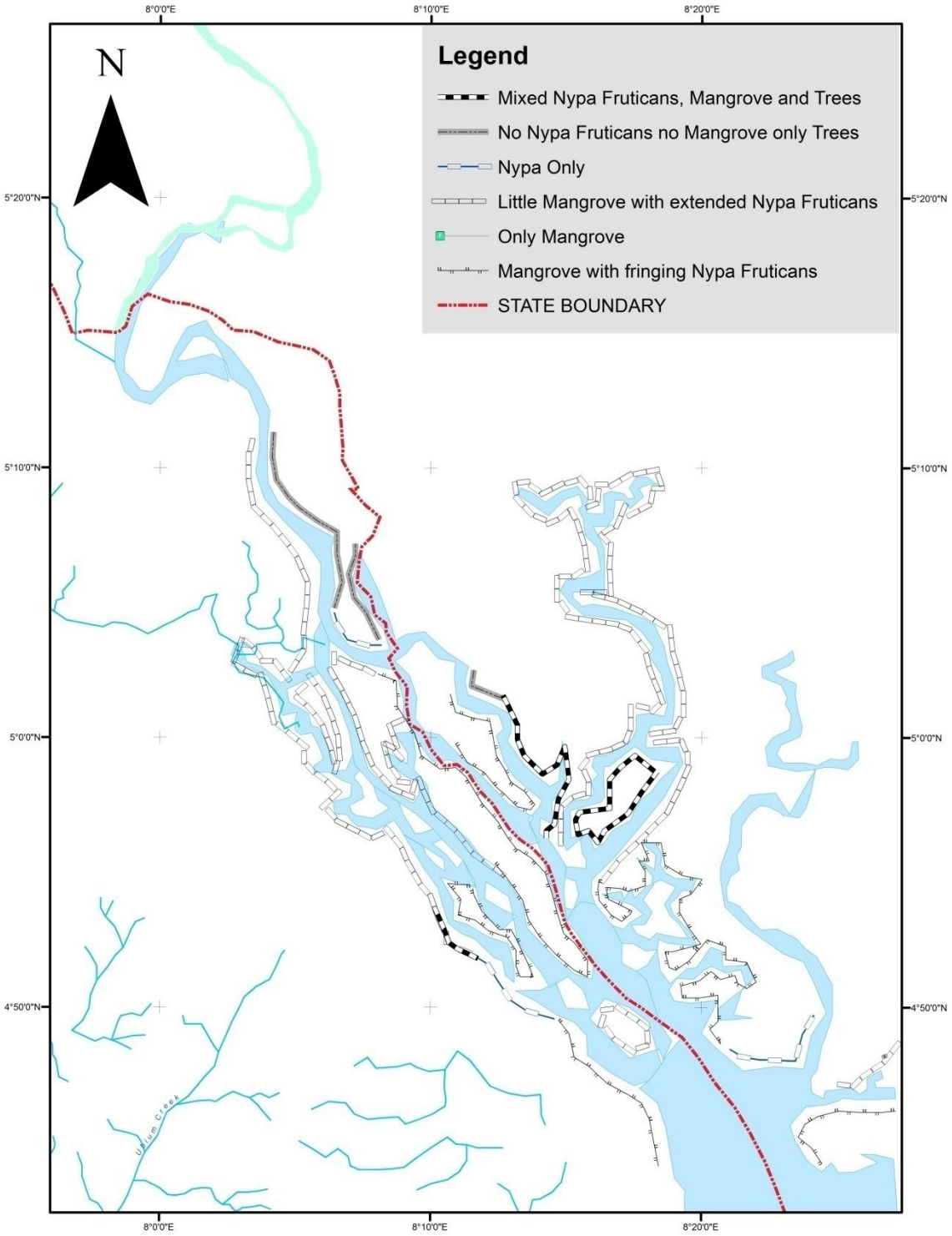

Fig 2: Distribution of Nypa Fruticans in CRS Estuary

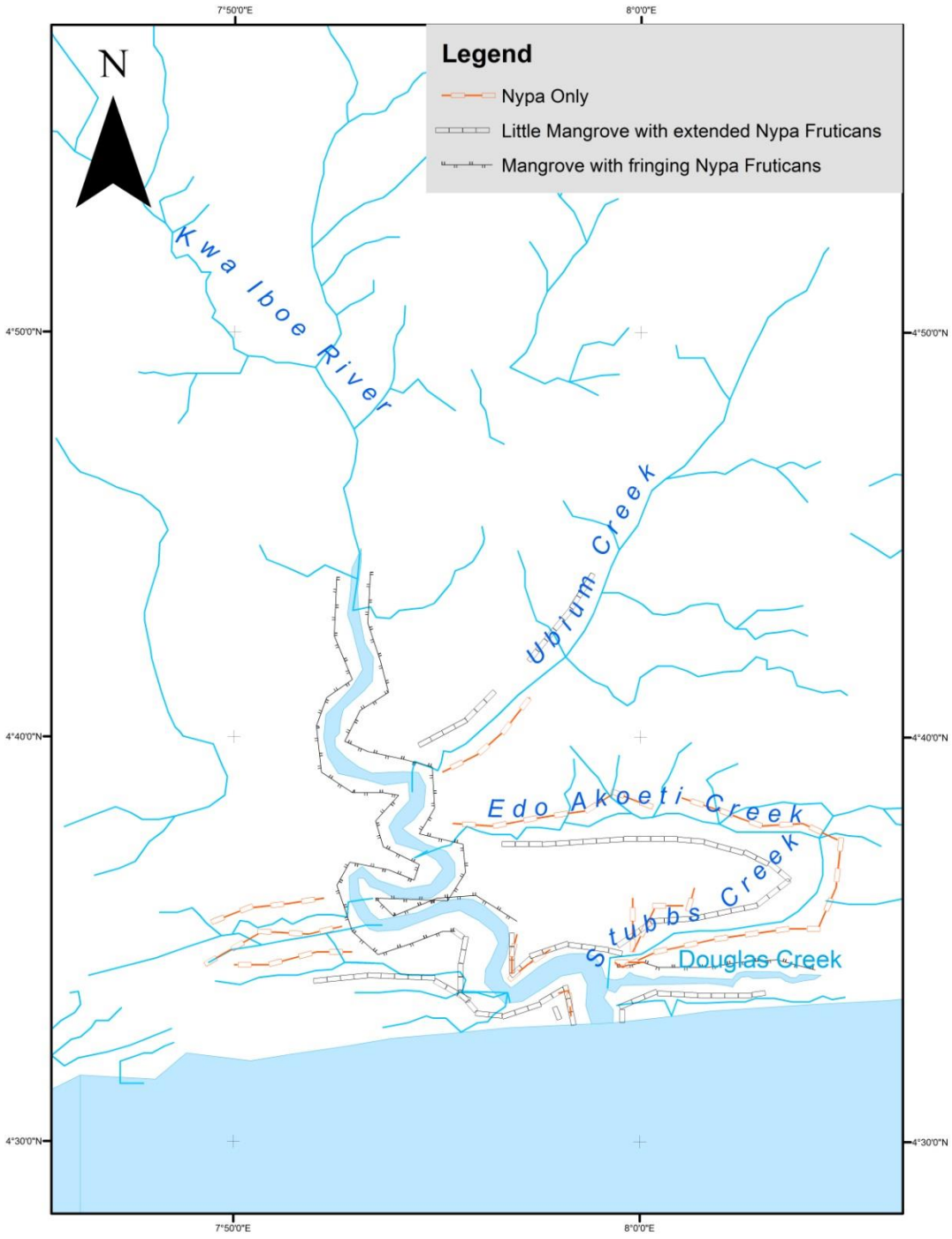

Fig 3: Distribution of Nypa Fruticanss in Qua Iboe River Estuary

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