

CURRENT POPULATION STRUCTURE OF MANGROVES FROM MLALAZI TO MTAMVUNA ESTUARIES IN KWA-ZULU NATAL, SOUTH AFRICA

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Abstract

Mangroves are considered to be among the rarest and most threatened of forest types in South Africa. South Africa has 0.05% of Africa's total mangrove area. Mangrove forests are also one of the world's most threatened biome types due to utilization of mangrove wood by communities living along coastlines and the conversion of mangroves forests to other land uses such as agriculture. Potential threats to mangroves in South Africa include altered water flow patterns together with altered salinity profiles, water level rise (prolonged inundation) and unsustainable utilization. South Africa has five species of mangroves and two associate mangrove species. The most recent estimate of mangrove cover in South Africa in 2000 was 663 ha, this decreased from 673 ha in 1997. The aim of this study was to determine the current population and community structure of mangroves and to determine the change in area cover for each mangrove forest. This was investigated for the mangroves of Kwa-Zulu Natal estuaries. Mangroves have been lost from ten estuaries between 1982 and 1999 and forests have been lost from two estuaries since 1999. *Rhizophora mucronata* has been lost from Mkomazi and potentially Mlalazi where Ward and Steinke (1982) previously recorded this species. Most mangrove forests sampled showed reverse J shaped curves as well as fairly high adult to seedling ratios (1:2 – 1:23 for *Bruguiera*, 1:7 – 1:19 for *Avicennia* and 3:1 – 1:8 for *Rhizophora*) implying that regeneration is taking place. None of the forests showed signs of pole harvesting, but it seems that altered water flow patterns and land use change (wetlands to sugar-cane plantations) have negatively affected forests that were smaller than 0.5 ha and these have since been lost.

1. Introduction

The most recent estimate of cover for mangroves along the coastline of Africa is 3 350 813 ha (Wilkie and Fortuna, 2003). South Africa has 0.05% of Africa's total mangrove area. South Africa has five species of mangroves and two associate mangrove species. Kosi Bay situated in northern Kwa-Zulu Natal (KZN) is the only area where all seven species were previously found. These species are *Avicennia marina* (Forssk.) Vierh., *Bruguiera gymnorhiza* (L.) Lam, *Ceriops tagal* Perr. C.B.Robinson, *Lumnitzera racemosa* Willd., and *Rhizophora mucronata* Lam (Colloty, 2000; Steinke, 1999 and Ward & Steinke, 1982). *Acrostichum aureum* L., and *Hibiscus tiliaceus* are mangrove associates, which are found sporadically from KZN to the Eastern Cape (Colloty, 2000 and Steinke, 1999).

Avicennia marina is the most common mangrove species in South Africa. It occurs from Kosi Bay in KZN to the Nahoon Estuary in the Eastern Cape in 24 estuaries. It is considered a pioneer species and occurs on both sand and mud (Steinke, 1999). *Bruguiera gymnorhiza* is also fairly common throughout the east coast of South Africa and occurs in 33 estuaries. *Rhizophora mucronata* is found sporadically along the coast. It is found in five of the Eastern Cape estuaries and seven of the KZN estuaries. The distribution of *Acrostichum aureum* was not documented but it is thought to occur as far south as the Eastern Cape (Steinke, 1999). Colloty (2000) only recorded this species in Mkozi Estuary in the Eastern Cape. *Bruguiera gymnorhiza*, *Ceriops tagal*, *Lumnitzera racemosa*, and *Rhizophora mucronata* were listed on the Protected Tree List of 2004 issued by the Department of Water Affairs and Forestry. The purpose of this study was to determine the state of mangroves in Kwa-Zulu Natal by assessing the current population structure in relation to associated anthropogenic disturbances. This was achieved by answering the following questions:

- What is the status of mangrove forests in estuaries where Ward and Steinke (1982) recorded area cover to be 0.5 ha or less?
- Are all height and diameter at breast height size classes present in undisturbed mangrove forests?

2. Study site

The Kwa-Zulu Natal (KZN) coastline stretches from Kosi Bay in the north to Mtamvuna (Port Edward) in the south (Figure 1). All estuaries in KZN occur in the Sub-Tropical region. KZN has the largest mangrove forests in South Africa that occur in the Mhlathuze (652 ha) and St Lucia (571 ha) estuaries (Riddin, 1999). In 1982, Ward and Steinke recorded mangrove cover in 22 estuaries in KZN, but more recently the "Classification of Indigenous South African Forest" report indicated that mangroves were only present in 12 KZN estuaries (Steinke and Mucina, 2003). Scientists have recorded changes in the community structure of mangrove forests in KZN due to changing water levels, flow and salinity (Begg, 1984; Riddin, 1999). Table 1 summarises the state of the estuaries from Mlalazi to Mtamvuna in terms of the type of estuary, ichthyofauna, water quality and aesthetics (Harrison *et al.*, 2000). The type or classification of each estuary describes the dominant mouth status (open, closed). Ichthyofaunal data were collected to determine the state of fish communities in estuaries and these were then classified into categories (good, moderate, poor, very poor) according to the Biological Health Index. An Estuarine Water Quality Index was used to classify estuaries in relation to water quality indicators (e.g. dissolved oxygen, pH, faecal coliforms). An Aesthetic Health Index was used to classify estuaries in terms of the appearance of the estuary which contributes to its perceived environmental health. Some of the following were taken into account; floodplain use, bridges, odour, algal growth, and exotic vegetation.

Table 1. State of estuaries from Mlalazi to Mtamvuna (Harrison *et al.* 2000). Durban Bay, Msimbazi, Mgababa and Ngane were not sampled

System/Estuary	Classification	Ichthyofauna	Water quality	Aesthetics
Mlalazi	Open	Good	Undefined	Good
Mhlanga	Closed	Good	Very poor	Good
Mgeni	Open	Good	Poor	Moderate
Sipingo	Closed	Good	Very Poor	Poor
Little Manzimtoti	Closed	Good	Very poor	Moderate
Lovu	Open	Moderate	Poor	Moderate
Mkomazi	Open	Good	Good	Moderate
Mahlongwa	Closed	Good	Fair	Moderate
Kongweni	Closed	Good	Fair	Moderate
Bilanhlo	Closed	Good	Poor	Good
Mhlangankulu	Closed	Good	Poor	Good
Khandandlovu	Closed	Moderate	Fair	Good
Mtamvuna	Open	Good	Fair	Moderate

Avicennia marina, *Bruguiera gymnorrhiza* and *Rhizophora mucronata* covered an area of 30 ha in the Mlalazi estuary (Ward and Steinke, 1982). It was previously classified as a temporarily open/closed estuary. The mangroves first became established here between 1940 and 1950. The mangrove cover has increased from 10 ha (Begg, 1978) to 30 ha (Ward & Steinke, 1982). Prior to 1952 the mouth would close for long periods of time. Since then, it has become a permanently open system, linked to the artificial control of the water levels in the estuary. There were two possible reasons proposed for the subsequent spread of the mangroves. An increase in siltation during the 1950's provided a thick muddy substrate suitable for mangrove colonisation (Macnae, 1963), however it has been argued that the muddy substrate was present since 1910. The change in mouth status from a temporarily open/closed to permanently open state was ultimately the reason for the spread of the mangrove trees.

Ward and Steinke (1982) recorded a mangrove area cover of <0.5 ha in the Mhlanga Lagoon. Begg (1984) did not record mangroves only coastal forests and lagoon or freshwater trees. One would not expect mangroves to be present due to the nature of the mouth. This is a temporarily open closed estuary due to sand deposition at the mouth and mouth closure during low freshwater inflow conditions. During the closed phases mean salinities were never higher than 5ppt. During open phases salinities would rise to 35 ppt and stratification occurred.

In 1982 mangroves at the Mgeni Estuary covered an area of 44 ha (Ward & Steinke 1982, Steinke & Charles, 1986). *Avicennia marina* covered an area of 11.6 ha and *Bruguiera gymnorrhiza* covered an area of 10.6 ha. The remaining area consisted of both mangrove species and some *Rhizophora mucronata* individuals (21.8 ha) (Steinke & Charles, 1986). The main area of mangroves at Mgeni was at the Beachwood Reserve. It is situated near the mouth of the estuary. Propagule dispersion from this area has resulted in the spread of mangroves upstream (~4.5 km from Beachwood) (Begg 1984). Dredging in the

1980's introduced large quantities of silt into the estuary. Silt deposits have subsequently been colonised by mangroves and have become consolidated. The mangroves have been both positively and negatively managed. On the one hand the City Council wanted to facilitate the spread of mangroves by planting young trees in areas where bank erosion was occurring, translocation of Australian species was carried out and excavations to increase tidal exchange within the Beachwood creek were undertaken. Boardwalks were also constructed so that the public could appreciate the mangroves and use the site as an educational venue. Steinke and Charles (1986) measured mangrove litter production at the Beachwood Reserve. The 44 ha of mangroves produced 334.2 tons of litter per year of which 60% was made up of leaves.

The Durban Bayhead mangrove community, which consists of *Avicennia*, *Bruguiera* and *Rhizophora*, occupy an area ~ 1 km long on the eastern shoreline opposite the Maydon Wharf Channel, and the width of the community ranges from 30 to 250 m (Begg, 1984). Durban Bay was once known for its extensive mangrove forests. However in 1979 the Durban harbour was built and this led to the destruction of almost 156 ha of mangroves through physical removal, infilling and reclamation. Only 15 ha remains of the once 200 ha forest (Ward & Steinke, 1982).

According to Ward and Steinke (1982) the area of mangroves at Sipingo was 12.5 ha. *Avicennia*, *Bruguiera* and *Rhizophora* were present. The Sipingo system has had a long history of pollution and mismanagement. Industries in the Prospecton area have added to the poor state of estuarine health, as have surrounding homeowners and the general public. Pollution issues ranged from water contamination (lead, zinc and lithium), litter in the canal and surrounding area as well as effluent from the Umlazi Sewage Works. The Sipingo Lagoon has two limbs, southern and northern. Mangroves were present at both limbs. The development of a township resulted in the removal of part of the mangrove community on the southern bank and with the stagnation of the water conditions became unsuitable for mangroves. Some trees survived in the lower reaches on the northern bank and some regeneration was taking place. Mangrove harvesting also took place by members of the public to build shelters on the beach area. Dumping of litter had also negatively affected the mangrove community (Begg, 1984).

Lovu and Mkomazi estuaries were reported to have approximately 2 ha of mangroves each (Ward & Steinke, 1982). *Avicennia* and *Bruguiera* were found in both estuaries and *Rhizophora* was present in the Mkomazi system. Begg (1984) did not refer to the presence of mangroves in the botanical review of the Lovu system, but does refer to the dense fringe of lagoon *Hibiscus* on the steep southern bank of the estuary. Sugar cane plantations in the floodplain areas negatively impacted the banks of the Mkomazi estuary. Peripheral vegetation was recorded as being better preserved in the lower reaches. There was also a dense fringe of lagoon *Hibiscus* on the southern bank of the Mkomazi estuary, which is said to be just in front of a relict mangrove community. The poor state of the mangrove community was probably due to impeded drainage and inadequate tidal exchange (Begg, 1984).

Ward and Steinke (1982) recorded one hectare of mangroves at Mahlongwa Estuary with only the *Bruguiera* species present. Begg (1984) made no reference to the mangroves but did map mangrove distribution. Four hectares of wetland were lost due to sugarcane planting on both banks of the system. Begg noted a healthy patch of *Bruguiera* on the north bank of the system growing amongst the clumps of palm trees. On the south bank only the occasional mangrove was found.

Msimbazi, Mgababa, Ngane and Bilanhlolo estuaries were estimated to have approximately 0.5 ha of mangroves. *Bruguiera* was present in all systems and *Avicennia* was present in the Msimbazi area (Ward and Steinke, 1982). Begg (1984) noted the absence of the mangroves at Msimbazi. No mention of the mangroves was made for Mgababa, while a few dying black mangroves were found at Ngane Estuary. The geomorphology of the estuary restricts the growth of plants at the water's edge and disruption of the wetland occurred when the freeway was extended into the area. At Bilanhlolo Estuary the best-developed plant communities were the reeds and lagoonal *Hibiscus* on the southern bank. Coastal forests occurred in parts and extended to the waters edge.

Little Manzimtoti, Kongweni, Mhlangankulu and Khandandlovu estuaries had less than 0.5 ha of mangroves (Ward and Steinke 1982). All four systems had only *Bruguiera* present. Begg (1984) did not mention mangroves at Little Manzimtoti, Kongweni or Khandandlovu. At Mhlangankulu some black mangroves were still present (Begg, 1984).

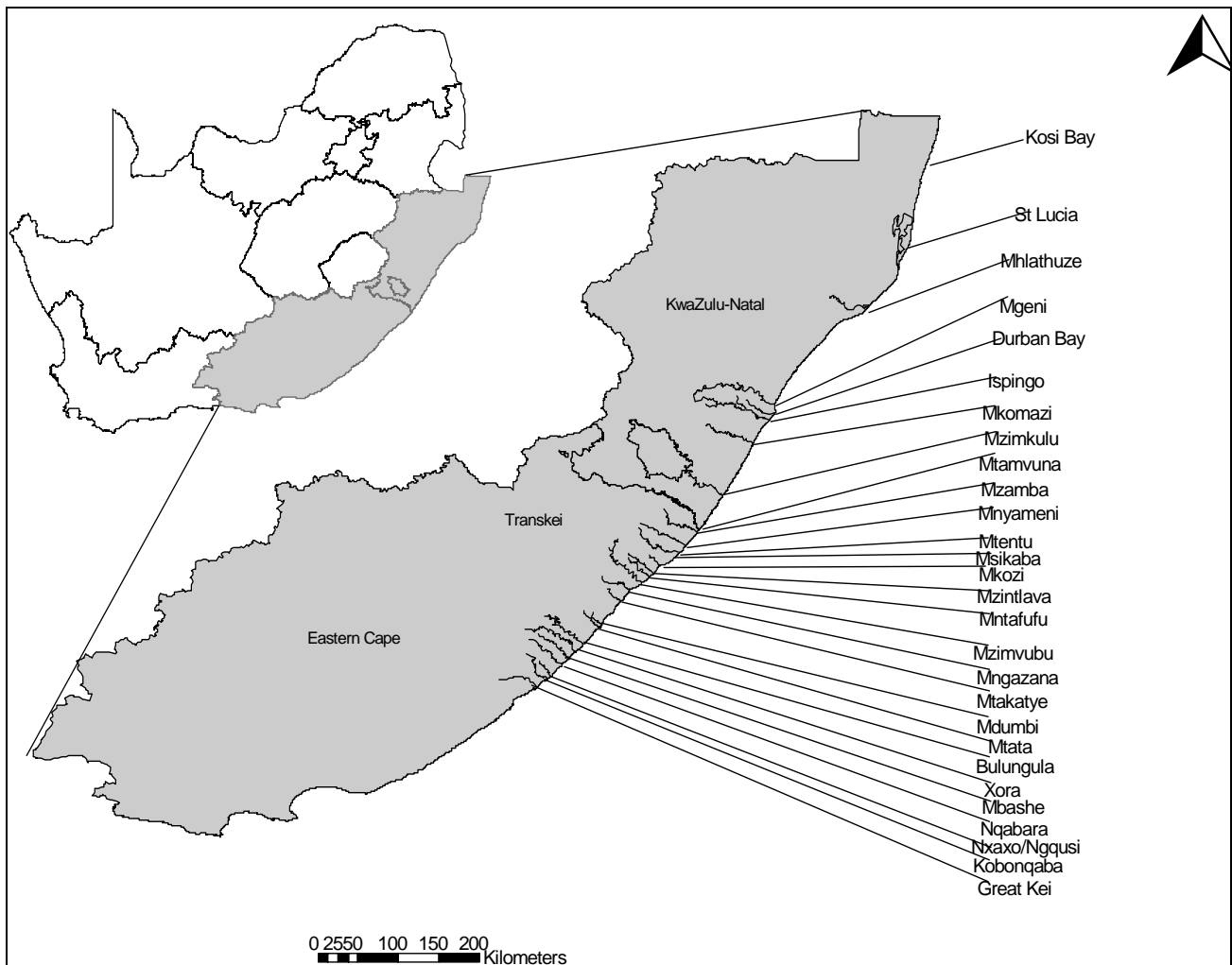


Figure 1. Distribution of mangroves in South Africa (from Adams et al., 2002).

3. Materials and methods

Seedlings, juveniles or saplings and adults for all mangrove species were identified, measured and counted in 25 m² quadrats within the mangrove forests in Mlalazi, Mgeni, Durban Bay and Sipingo. Height and diameter at breast height (DBH = 1.3 m) were measured. Three replicate quadrats were sampled in each site. The phenology of the adult trees was also noted (not presented here) and observations made regarding anthropogenic disturbances and utilization patterns. Measurements using quadrats were not possible at Mkomazi and Mtamvuna estuaries due to the sporadic distribution of the mangroves; so all individuals that were encountered were measured. During the survey a note was made of mouth condition and water column salinity was measured using a refractometer.

Results from this field survey in 2006 in terms of presence and absence of mangroves was compared with data from Ward and Steinke (1982) and Steinke and Mucina (2003). This was to identify the areas where mangroves were present previously but have subsequently disappeared.

4. Results

Table 2 shows the estuaries where Ward and Steinke recorded mangroves in 1982 compared to 1999 and April 2006. Mangroves have been lost from ten estuaries between 1982 and 1999 and two forests have been lost since 1999. Durban Bay was not mentioned in the list of mangrove forests in Steinke and Mucina (2003). Most of the estuaries that had mangrove forests less than 0.5 ha in size have been lost. *Rhizophora* has been potentially lost from two estuaries i.e. Mlalazi and Mkomazi. No individuals were encountered here. This may be due to the low salinities that were measured in these estuaries.

Table 2. Historical and present distribution of mangroves from Mlalazi to Mtamvuna estuaries in KZN

Name of Estuary	Area covered by mangroves (Ward and Steinke 1982)	Mouth status (Harrison et al. 2000)	Steinke 1999	Present 2006
Mlalazi	30	Open	Y	Y
Mhlanga	<0.5	Closed	N	N
Mgeni	44	Open	Y	Y
Durban Bay	15	Undefined	N	Y
Sipingo	12.5	Closed	Y	Y
Little Manzimtoti	<0.5	Closed	N	N
Lovu	2	Open	Y	N
Msimbazi	0.5	Undefined	N	N
Mgababa	0.5	Undefined	N	N
Ngane	0.5	Undefined	N	N
Mkomazi	2	Open	Y	Y
Mahlongwa	1	Closed	Y	N
Kongweni	<0.5	Closed	N	N
Bilanhlo	0.5	Closed	N	N
Mhlangankulu	<0.5	Closed	N	N
Khandandlovu	<0.5	Closed	N	N
Mtamvuna	1	Open	Y	Y

Table 3 describes some of the physical conditions of the estuaries where mangroves were found and the species present at the time of the survey.

The tree density, adult tree to seedling ratio, average height of seedlings and the tree diameter at breast height for each mangrove forest sampled is summarised in Table 4. The highest adult to seedling ratios were found at Mgeni Estuary for *Bruguiera*, Isipingo Estuary for *Rhizophora* and Durban Bay for *Avicennia*. At Mgeni Estuary, there were more than three times as many adult trees than seedlings for *Rhizophora*. Highest tree densities occurred at Mlalazi and Mgeni estuaries. At Mkomazi Estuary, *Avicennia* was only recorded in one 25 m² quadrat which accounts for the high density at this estuary.

Figures 2 and 3 show the height and DBH size class distribution for *Avicennia* and *Bruguiera* at Mlalazi. *Avicennia* showed a reversed J shaped distribution with more seedlings than adults encountered, this trend was also present but less pronounced for *Bruguiera*. Most adult individuals were in the 1.0-2.0 cm DBH class for both species.

Table 3. Present conditions of estuaries with mangroves

Name of Estuary	Mouth Conditions	Salinity (PSU)	Species present (2006)	Species present (1982)
Mlalazi	Open	5-15	<i>Bruguiera and Avicennia</i>	<i>Rhizophora, Bruguiera and Avicennia</i>
Mgeni	Open	1-10	<i>Rhizophora, Bruguiera and Avicennia</i>	<i>Rhizophora, Bruguiera and Avicennia</i>
Durban Bay	Open	25	<i>Rhizophora, Bruguiera and Avicennia</i>	<i>Rhizophora, Bruguiera and Avicennia</i>
Sipingo	Open	5-20	<i>Rhizophora, Bruguiera and Avicennia</i>	<i>Rhizophora, Bruguiera and Avicennia</i>
Mkomazi	Open	0	<i>Bruguiera and Avicennia</i>	<i>Rhizophora, Bruguiera and Avicennia</i>
Mtamvuna	Open	7	<i>Bruguiera</i>	<i>Bruguiera</i>

Table 4. Summary of community structure of each mangrove forest

Estuaries	Species	Density (m ⁻²)	Adult seedling to ratios	Average height of seedlings (cm ± SE)	Average DBH of adults (cm± SE)
Mlalazi	<i>Bruguiera</i>	9	1:2	54.8 ± 1.7	1.6 ± 0.2
	<i>Avicennia</i>	8	1:10	14.8 ± 3.8	1.9 ± 0.4
Mgeni	<i>Bruguiera</i>	8.6	1:23	38.4 ± 3.3	8.6 ± 0.7
	<i>Avicennia</i>	6.7	1:19	25.0 ± 9.3	1.6 ± 0.3
	<i>Rhizophora</i>	undetermined	3:1	44.7 ± 2.4	5.5 ± 0.5
Durban Bay	<i>Bruguiera</i>	2.5	1:4	49.8 ± 0.1	1.3 ± 0.4
	<i>Avicennia</i>	2.8	1:22	23.0 ± 0.6	18.1 ± 1.4
	<i>Rhizophora</i>	1	1:2	52.5 ± 0.01	1.4 ± 0.7
Isipingo	<i>Bruguiera</i>	5	1:3	47.8 ± 1.2	3.6 ± 0.6
	<i>Avicennia</i>	8	1:7	27.0 ± 19.5	4.4 ± 1.2
	<i>Rhizophora</i>	4	1:8	49.5 ± 1.1	0.3 ± 1.0
Mkomazi	<i>Bruguiera</i>	1	1:3	35.8 ± 2.6	8.7 ± 1.2
	<i>Avicennia</i>	11.8	1:12	33.7 ± 2.0	0.3 ± 0.02
Mtamvuna	<i>Bruguiera</i>	3	1:3	35.3 ± 2.9	2.7 ± 0.5

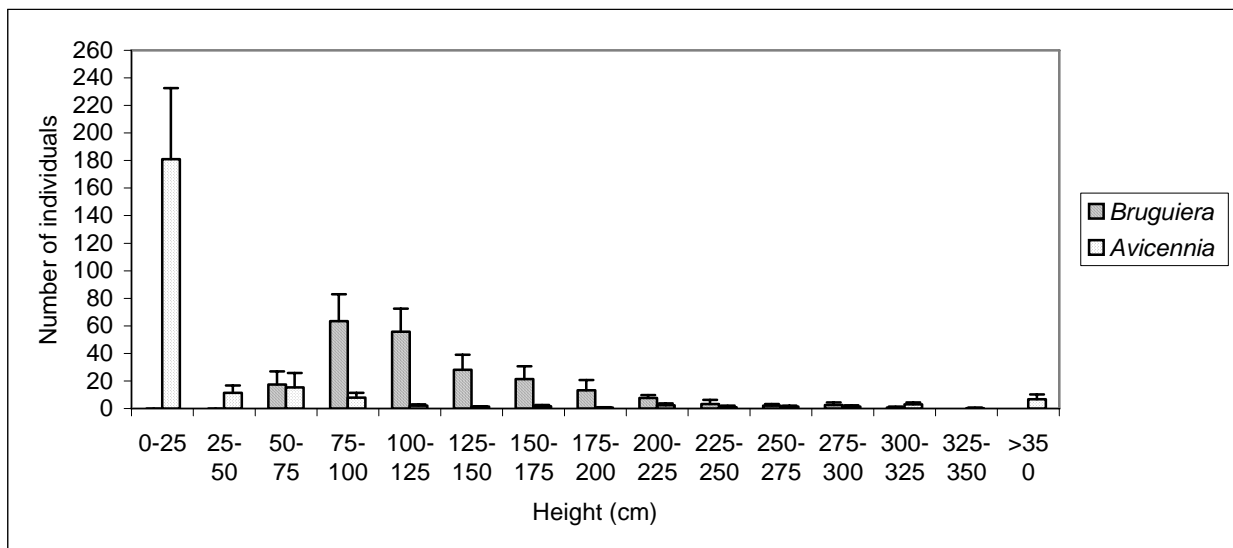


Figure 2. Mangrove tree height size classes for Mlalazi Estuary.

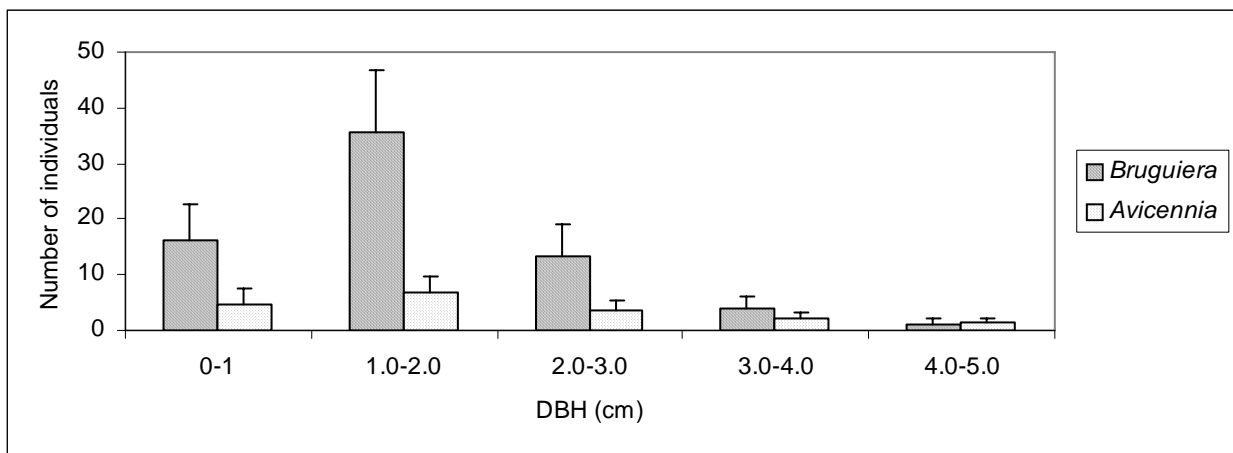


Figure 3. Adult tree DBH size class for Mlalazi Estuary.

Figures 4 and 5 show the height and DBH size class distribution for *Avicennia* and *Bruguiera* at Mgeni Estuary. Both species showed a reversed J shaped distribution with more seedlings than adults encountered. Most adult individuals were in the 0-1.0 DBH classes for *Avicennia* and >11cm for *Bruguiera*. The average DBH for *Rhizophora* was 5.5 ± 0.5 cm.

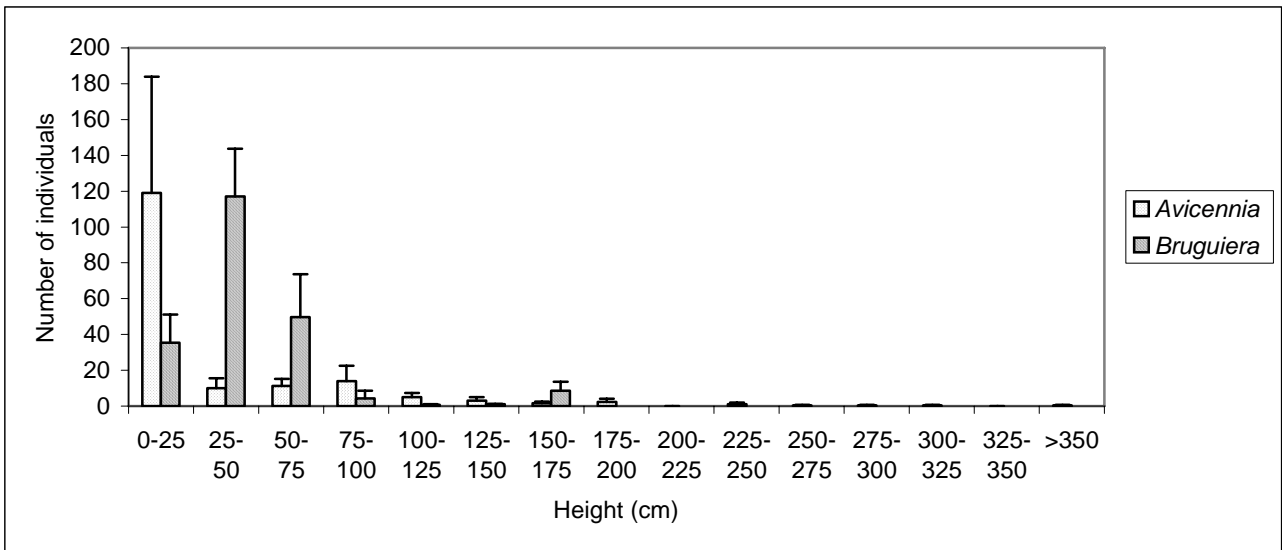


Figure 4. Mangrove tree height size classes for Mgeni Estuary.

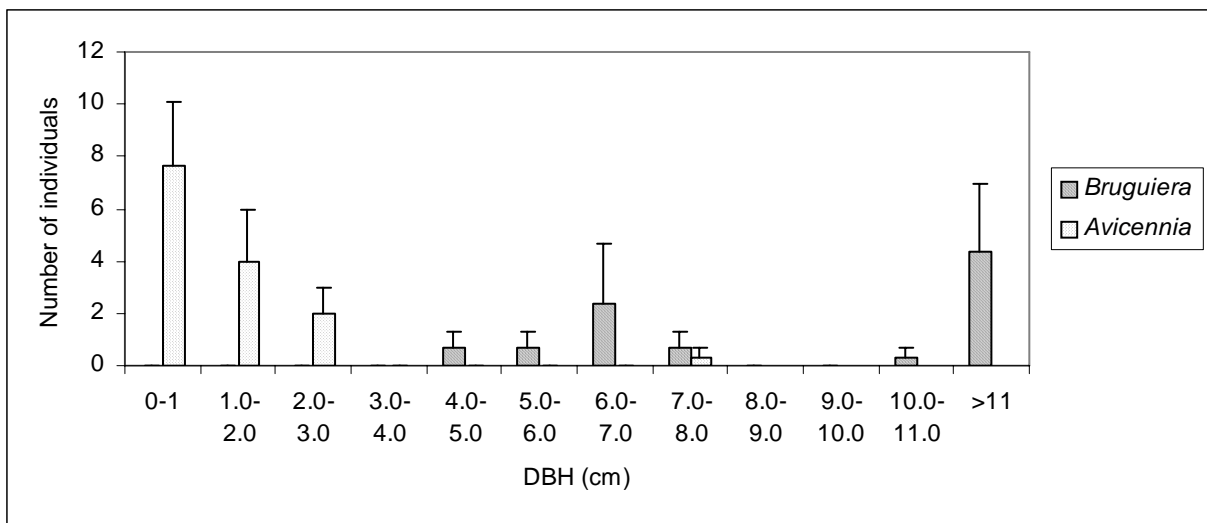


Figure 5. Adult tree DBH size classes for Mgeni Estuary.

Figures 6 and 7 show the height and DBH size class distribution for *Avicennia*, *Bruguiera* and *Rhizophora* at Durban Bay. *Avicennia* showed a reversed J shaped distribution with more seedlings than adults encountered while the other two species showed more medium sized saplings and adults than seedlings. Most adult individuals were in the 0-1.0 DBH classes for *Rhizophora* and *Bruguiera* and >10cm for *Avicennia*.

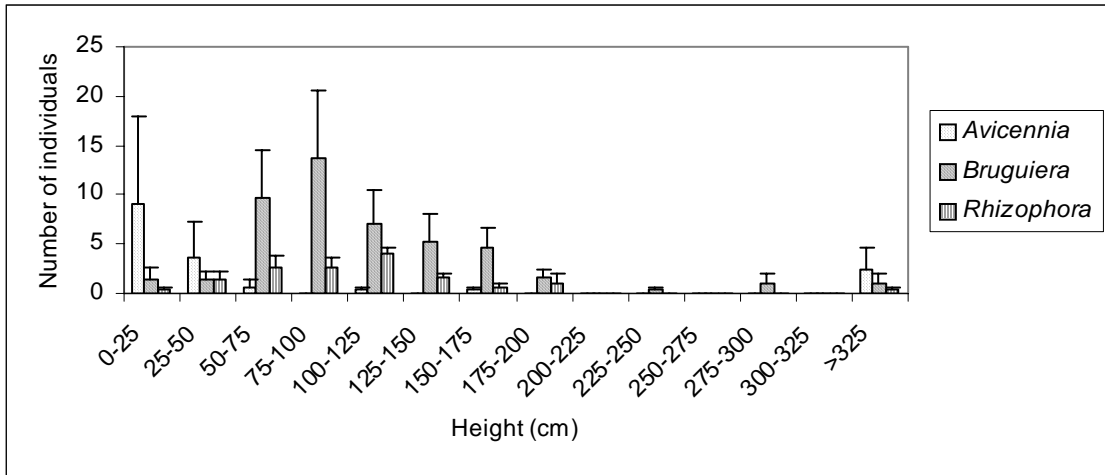


Figure 6. Mangrove tree height size classes for Durban Bay.

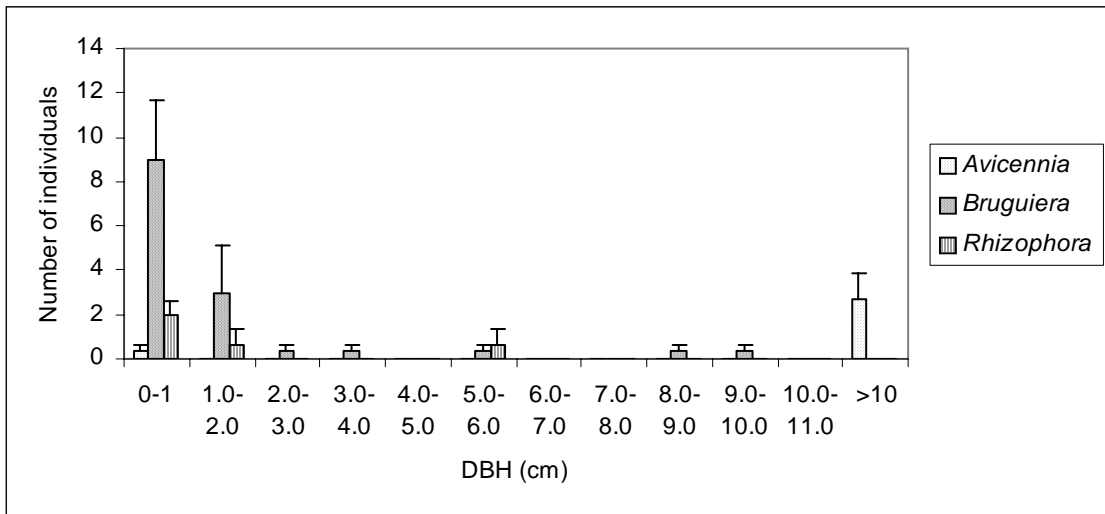


Figure 7. Adult tree DBH size classes for Durban Bay.

Figures 8 and 9 show the height and DBH size class distribution for *Avicennia*, *Bruguiera* and *Rhizophora* at Sipingo. *Avicennia* showed a reversed J shaped distribution with more seedlings than adults encountered while the other two species showed very few seedlings and more saplings between 50-70 cm. Most adult individuals were in the 0-1.0 cm DBH classes for *Rhizophora* 5.0-6.0 cm for *Bruguiera* and 1.0-3.0 cm for *Avicennia*.

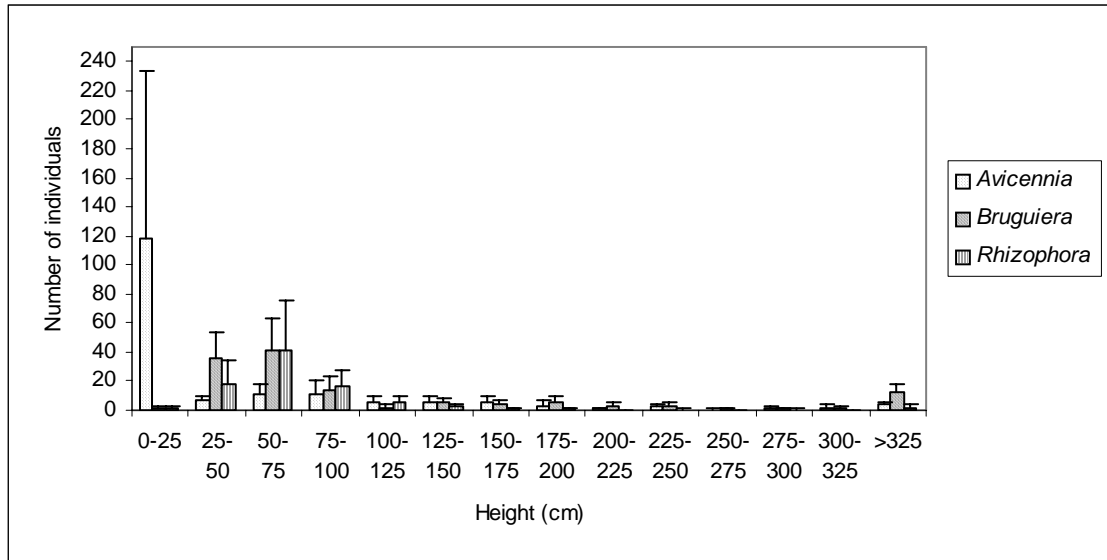


Figure 8. Mangrove tree height size classes for population found at Sipingo Estuary.

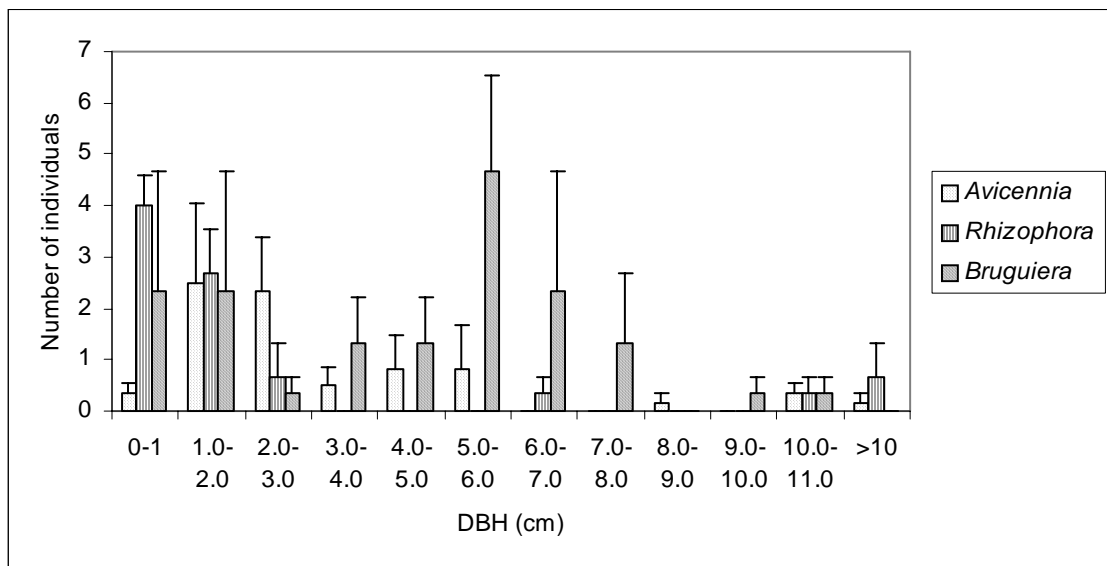


Figure 9. Adult tree DBH size classes found for Sipingo Estuary.

Most of the *Avicennia* individuals encountered at Mkomazi Estuary were between 100-125 cm (Figure 10). All the adults were in the DBH size class of 0-1 cm (Figure 11). *Bruguiera* individuals ranged from very big to very small with little in between. Only 58 *Bruguiera* individuals were encountered.

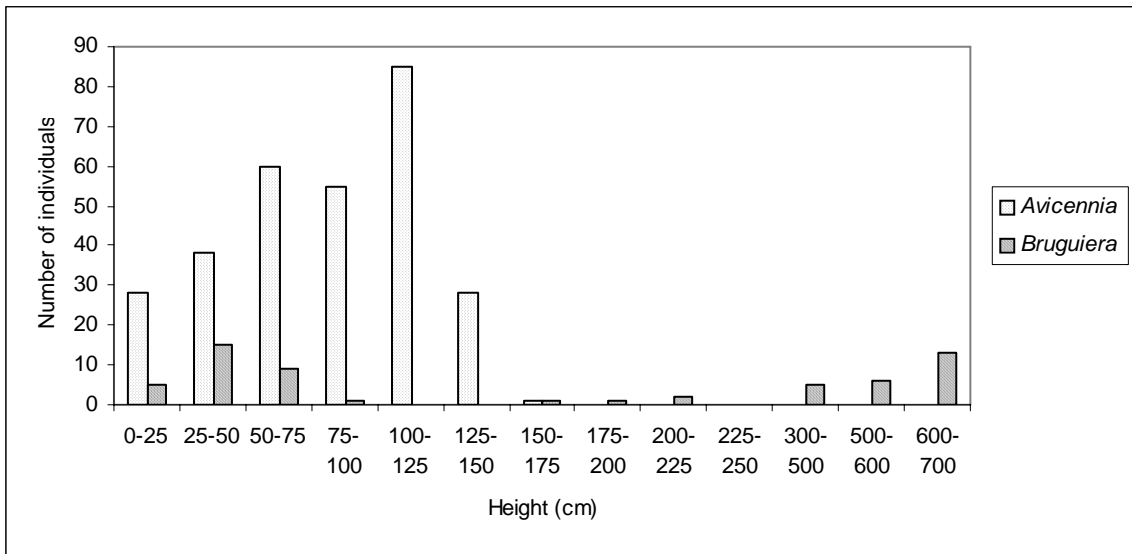


Figure 10. Mangrove tree height size classes found at Mkomazi Estuary.

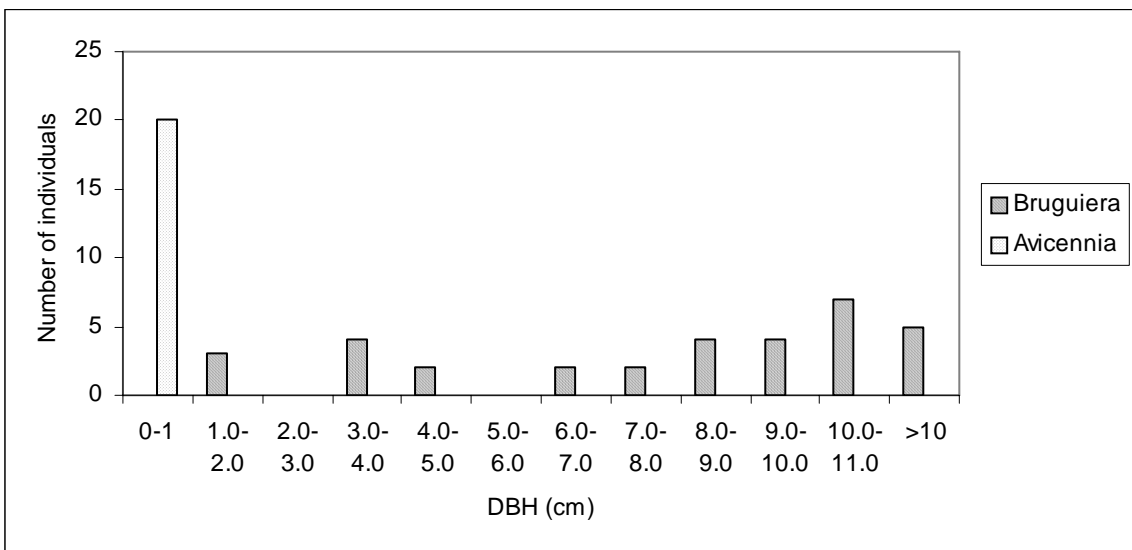


Figure 11. Adult tree DBH size classes found at Mkomazi Estuary.

Only *Bruguiera* was found at Mtamvuna Estuary. Individuals were present in all size classes with most of the individuals found in the 50-75 cm range (Figure 12). Most of the adults were in the 1.0-2.0 cm size class (Figure 13).

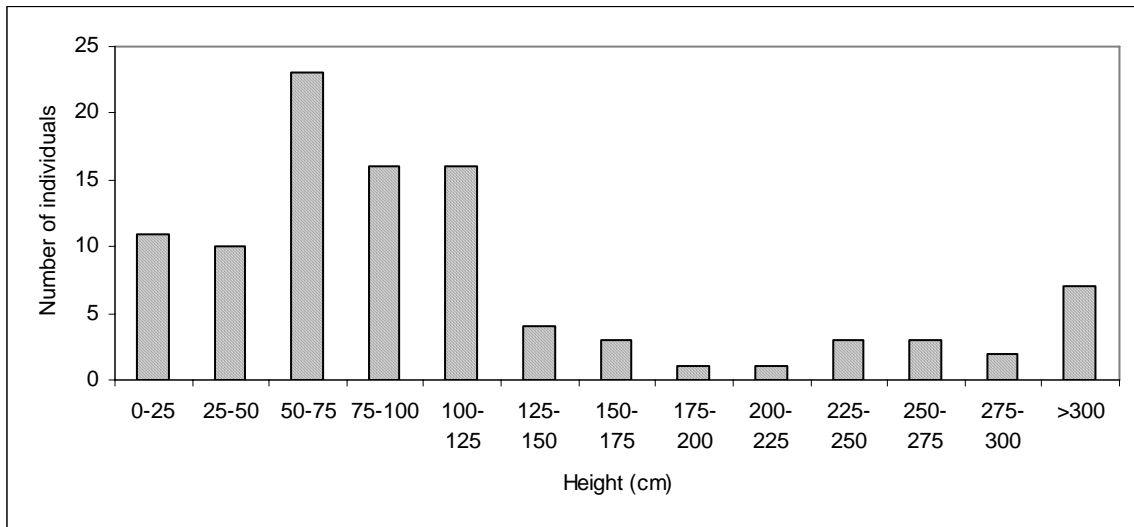


Figure 12. Mangrove tree height size classes for *Bruguiera* at Mtamvuna Estuary.

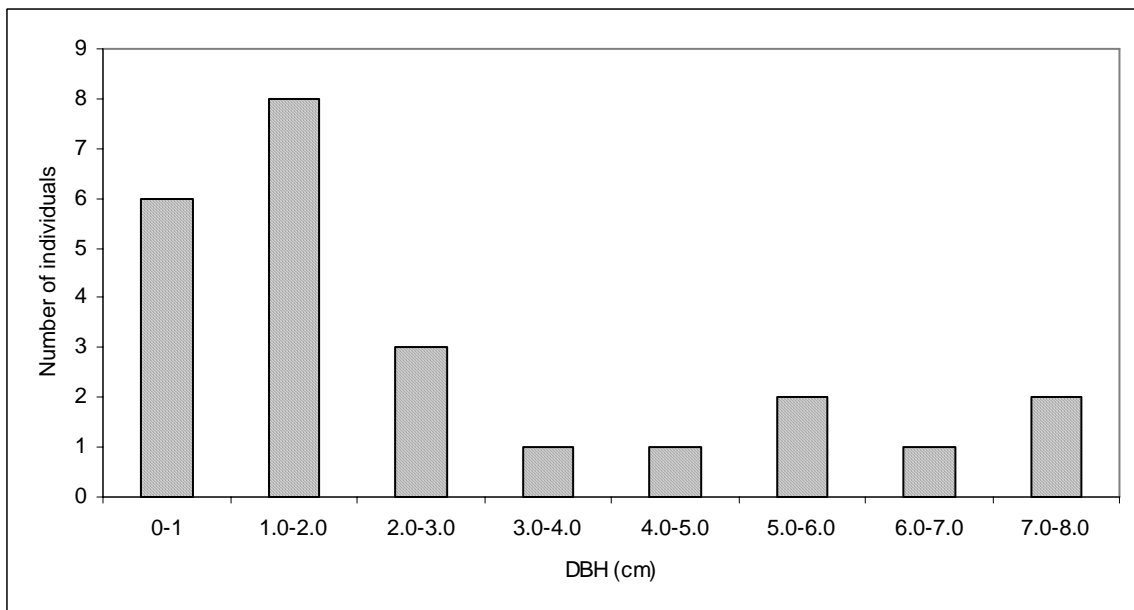


Figure 13. Adult tree DBH size classes for *Bruguiera* at Mtamvuna Estuary.

5. Discussion and conclusion

In 1982 Ward and Steinke recorded mangrove cover and distribution of species from Kosi Bay to Nahoon Estuary in the Eastern Cape. Steinke reviewed this in 1999. Between 1982 and 1999 ten estuaries recorded losses in total mangrove area. These estuaries were Mhlanga, Little Manzimtoti, Msimbazi, Mgababa, Ngane, Kongweni, Bilanhlo, Mhlangankulu and Khandandlovu. Between 1999 and 2006 a further two mangrove forests were lost from the Lovu and Mahlongwa estuaries. Harrison *et al.* (2000) classified all these estuaries as closed (temporarily open/closed estuaries). The temporarily closed state would have caused long term inundation of the mangrove forests, and as shown in other estuaries (Begg, 1978), mangroves are intolerant of long term inundation. This may be one of the main reasons that mangrove forests were completely lost from estuaries with an area cover of approximately 0.5 ha, the abstraction of freshwater for human use and an increase in agriculture in the floodplain may have resulted in an increase in mouth closure of formally permanently open estuaries (e.g. Mhlanga and Little Manzimtoti). Begg (1978) also noted that the loss of mangroves from the Lovu, Mkomazi, Mahlongwa, Msimbazi and Mgababa estuaries was due to the conversion of wetland area to sugarcane plantations. Some of these mangrove areas were also negatively impacted by the construction of the freeway.

It was also noted that *Rhizophora mucronata*, previously found at Mlalazi and Mkomazi estuaries (Ward & Steinke, 1982) were not encountered during the present study. The salinity tolerance range of *Rhizophora* is close to that of seawater (~35 PSU). At Mkomazi Estuary between 1979 and 1981 surface and bottom water salinities ranged from 0-35 PSU implying a stratified system, during this time *Rhizophora* was present. During the present study the surface salinity never exceeded 0 PSU along the river even though there seemed to be a strong tidal influence at the mouth of the river. Most of the mangroves have been replaced by *Hibiscus tiliaceus* and *Rhizophora* was not found.

Most forests showed a reverse J shaped curve for the distribution of individuals in relation to height. This implies that these forests are regenerating by producing many propagules and subsequently seedlings. *Bruguiera* seedlings at Mlalazi Estuary were very few and most of the young individuals were 50-70 cm in height. At Mgeni Estuary seedlings of *Bruguiera* were only found in canopy gaps. Most of the seedlings were found near a freshwater stream under very large, dead *Bruguiera* adults. No seedlings were found under intact stands. In these systems *Avicennia* seedlings were abundant on the seaward edge of the banks away from the shade of the parents. At Durban Bay all three species were found together compared to Mlalazi and Mgeni estuaries where separate stands for each species were found. *Rhizophora* had the lowest density of approximately 1 m² and *Avicennia* had the highest. This seems to be one of the healthiest stands of mangroves compared to other forests that were sampled in KZN even though it is located in a harbour. Sipingo Estuary seems to be the unhealthiest due to the lack of tidal influence, large areas of black sludge and is a dumping ground for waste materials and other pollutants. Some mangrove adults had white spots on the main stems, which could imply a reaction to pollutants. Mangroves are sporadically distributed around Mkomazi Estuary with very few seedlings of both species present. *Avicennia* was only found in one area (25 m²) in size. Adams *et al.* (2002) recorded no seedlings at Mtamvuna Estuary for *Bruguiera* but during the present study a number of seedlings were measured and the population seems to be increasing. However the presence of *Hibiscus tiliaceus* may negatively influence the population in a similar way to that found at Mkomazi Estuary.

All the forests seem to be regenerating but the potential for regeneration may be limited if the mouth conditions of the estuaries were to change. If there are further losses of mangroves along the KZN coast we stand to lose biodiversity in the form of associated estuarine habitat and mangrove associated fauna. Therefore the remaining mangroves need to be maintained to conserve the remaining species and the unique habitat.

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