CHAPTER 21

Conservation and Restoration of Pasir Ris Park Mangroves

Mohamad Yusoff

Introduction

In 1820, mangrove swamps covered about 13% of Singapore's fringe coastal areas (Ng & Sivasothi, 1999). By 2010, these ecosystems occupied less than 0.5% of Singapore's total land area. The existing mangroves are mostly concentrated in the northern and northeastern coast of Singapore, as well as offshore islands. Mangroves in Singapore is under pressure for more than 200 years due to development and rapid urbanisation. It is crucial to intensify efforts to conserve the remaining mangroves and restore the mangrove ecosystem as they protect the coastal areas, ameliorate effects of rising sea-levels, serve as homes to native flora and fauna, and provide numerous essential ecosystem services.

Objectives

This chapter documents the conservation and restoration works conducted at Pasir Ris Park which is the first urban park to feature the restoration of the natural mangrove ecosystem, through:

1) Improving the hydrology by bringing brackish water to the middle and back of mangrove zone,
2) Creating a mangrove nursery by propagating local stocks, and
3) Removing invasive terrestrial plants and replacing them with mangrove species using local stocks.

Materials and methods

Improve the hydrology

During land reclamation at Pasir Ris between 1978 and 1979, a 5-hectare patch of mangroves was carefully conserved by maintaining the tidal inundation. Over the years, it was observed that the middle and back mangrove received less brackish water from the sea and more freshwater from the overland flow from adjacent park land. These factors caused the soil salinity at the middle and back mangrove to decrease. A large area was occupied by hardy terrestrial plants.

It was essential to modify the hydrology of the mangrove by increasing the flow of seawater to the middle and back mangrove before the introduction of more mangrove species to the area. To improve the hydrology, tidal influence and substrate profile had to be studied.

Tidal influence

The analysis of these factors was largely based on visual survey and research materials. Studies were carried out over several days to record the correlation between different tidal height levels and inundation levels. It was observed that the back mangrove would only be inundated when the tides were 2.9 metres or higher. As a tide level of this height did not occur regularly, the back mangrove was often left drier. The source of water for the back mangrove came from the overland flow from abutting park land. As such, hardy freshwater plants species such as *Andira inermis*, *Acacia auriculiformis*, *Syzygium grande*, *Hibiscus tiliaceum*, *Cerbera odollam*, *Terminalia catappa*, *Pittosporum tobira*, and other creepers were observed to be taking over these spaces.

Substrate profile

Substrate profile was categorised according to sediment size and colour of the soil. Light coloured porous soil profile with bigger sediments was categorised as sandy, while dark coloured soil profile with finer silky sediments was categorised as muddy. The sandy soil was suspected to have been washed down from upstream, causing the downstream ground level to be raised over the years. This impeded the flow of brackish water to the back mangrove area. It was also observed that the trenches or rivulets that were created many years ago were now covered and filled with thick silt, which obstructed the flow of brackish water to the back mangrove.

To improve the hydrology at the back mangrove, soil was unearthed at several sites to investigate the feasibility of creating new trench lines to bring in water from the river to the back mangrove. The extent of tidal influence for each site was studied through observing the water trail marks on bakau (*Rhizophora* species) poles that were installed on the ground. Water trail marks on the bakau poles indicated the presence of heavy downpour or high tide. Once suitable sites for the new trenches were identified, 15 to 20 pieces of 1.5-metre-long bakau poles were used to mark out the new trench lines at each site (Fig. 1–3). Excavation was carried out to create new trench lines along the pole peg line from the river to the back mangrove. For the existing trench lines and rivulets, desilting was carried out to deepen the trenches and allow higher volume of brackish water to reach the drier area of the back mangrove.

The locations of the existing and newly created trench lines were recorded using GPS. These GPS points were transferred onto Google Earth for a comprehensive overview of the network of trench lines within the mangrove (Fig. 4). GPS plotting of the trench lines was essential in the study and management of the brackish water inundation within the mangrove. This would help to project the manpower requirements and funds needed for the desilting work on a year-to-year basis.

Fig. 1. Preparing for the surveying and marking of new trench lines with bakau poles at suitable sites.

Fig. 2. Surveying and marking new trench lines at suitable sites.

Fig. 3. Checking the new trench lines at suitable sites.

Fig. 4. Map of trench lines using GPS. (Image credit: Google Earth)

Other than creating trenches to bring in brackish water, regrading of the profile covering over 2,584 square metres was also carried out to ensure natural inundation of brackish water.

Creation of a mangrove nursery to propagate local stocks

During the site survey, it was observed that there were mangrove saplings overcrowding below the parent plants. Some of these plants would not be able to reach their potential growth as they would be deprived of full sunlight. These plants were also observed to be exhibiting signs of drying up such as turning brown and having dead terminal foliage.

The cluttered sites were marked and the overcrowded propagules and saplings below their mother plants were identified for salvaging (Fig. 5). The plants were salvaged for the replacement planting. A corer was used for the salvaging exercises as it was more efficient compared to doing manual trenching using a *cangkul* (i.e., a hoe) (Fig. 6). More than 1,000 mangrove saplings were salvaged from the exercises (Table 1). A mangrove nursery was created for the salvaged saplings to adapt and acclimatise before being reintroduced to the new planting site (Fig. 7–8). The site of the nursery location was carefully selected based on the natural soil profile where it was naturally inundated by sea water.

Fig. 5. Selective thinning was carried out on bigger *Bruguiera parviflora* saplings in a crowded site.

Fig. 6. Corer used to take out plants from the forest floor to mangrove nursery for acclimatisation.

Table 1. Breakdown of the species and number of saplings salvaged.

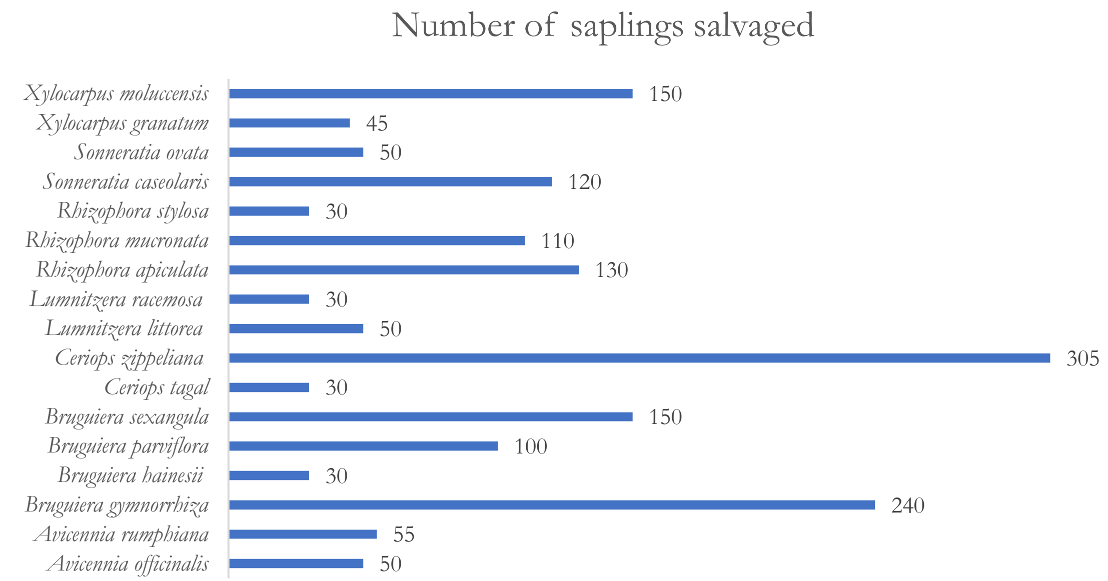

Fig. 7. Mangrove nursery in Pasir Ris Park.

Figs. 8. (A) Mangroves growing in plastic bags; (B) Mangroves planted on the ground before being transplanted back on site.

Removal of terrestrial plants and replacement with mangrove species

As terrestrial plants were observed to have taken over the back mangroves area, clearing of the existing vegetation was necessary to prevent competition with the slower growing mangroves plants. Over 400 square metres of terrestrial plants were removed (Fig. 10) and replaced with mangrove plant species that were salvaged (Fig. 11).

Fig. 10. Before the clearing of the terrestrial plants.

Fig. 11. Cleared area planted with salvaged and mangrove saplings grown in the nursery.

Results

After the new trenches were created, existing trenches were desilted, and the soil profile was regraded, it was observed that high volume of brackish water reached the drier area of the back mangrove (Fig. 12 & 13). This resulted in the creation of a favourable condition for mangrove species to colonise the area.

Fig. 12. Existing trench line before desilting.

Fig. 13. Existing trench line after desilting.

With the favourable mangrove site condition, saplings that were salvaged and nursed were reintroduced back to Pasir Ris Park mangrove following the clearance of terrestrial plants.

Monitoring of the growth and health of new plantings was carried out every fortnight. Observations revealed that the fatality of the new plants was very low and there was no visible negative impact to the surroundings. As the area was fairly bare after terrestrial plants were cleared, dried palms fronds from the park were used to cover the tree bases to reduce evaporation and transpiration. This operation helped speed up the growth of many mangrove tree species (Fig. 14).

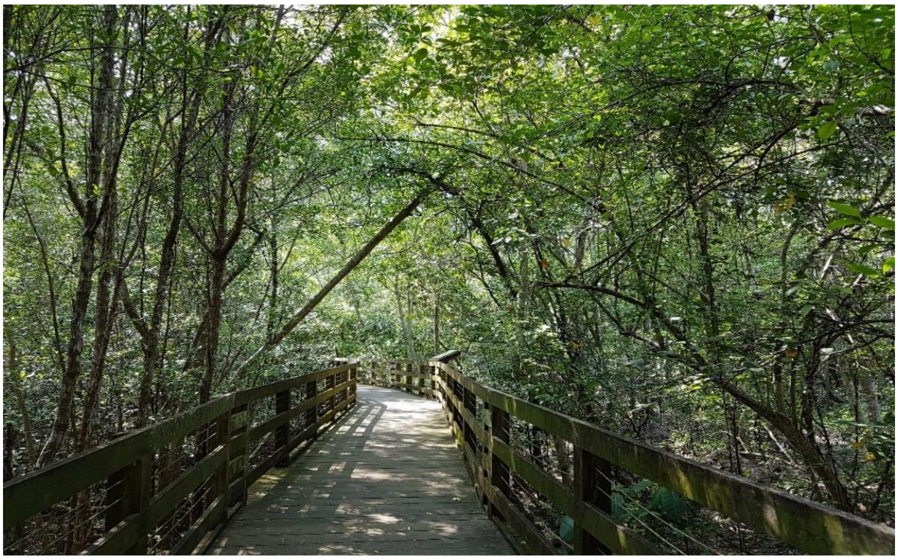

Fig. 14. Healthy thriving mangroves in Pasir Ris Park after restoration efforts.

Conclusion

Tidal reclamation and development disturbed the natural mangrove ecosystem at Pasir Ris, resulting in a change in soil profile, increase in terrestrial plants, and reduction of mangrove plants. With appropriate human intervention that improved the hydrology, removal of terrestrial species, and re-introduction of native back mangrove species, the health and integrity of the mangrove ecosystem were restored. This set of restorative method could serve as a model to be replicated at other parks that need to carry out mangrove enhancement planting under a similar environment and conditions.

References

Ng PKL & Sivasothi N (1999) A guide to the mangroves of Singapore. Singapore: Singapore Science Centre.