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Articles

Devils in disguise: Exotic Ornamental aquatics in the wet zone of Sri Lanka

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Introduction

Ornamental aquatic plants are popularly used in landscaping to break the monotony of the land. These are used in small containers to large scale ponds. Apart from the landscape industry these are also an essential component in aquaria. There is an increasing demand for these plants as people prefer to use novel plant species, varieties or cultivars. At present, the ornamental aquatic plant industry is emerging as a potential foreign exchange generating avenue in Sri Lanka where people import exotics, propagate them locally and either export or release them to the local market. A good example is Anubia species which is an exotic plant popularly used as a submerged plant in the aquarium industry which has a good demand in the export as well as in local markets. According to recent studies (Yakandawala, *et al.,* unpublished), 386 plant species are traded as ornamental aquatic plants in the country of which 76% were exotics. Therefore exotic plants play an important role in this industry.

Once escaped from aquatic landscapes, aquaria or plant propagation units, some of these exotic aquatic plants have the potential to establish themselves and spread in natural aquatic ecosystems, causing irreversible damage to biodiversity, agriculture and recreation. Many such events have occurred globally and such plants are listed under the category of invasive alien plants. According to the Global Compendium of Weeds (Randall, 2012), 32% of the plants traded in Sri Lanka as ornamental aquatic plants are recognized for their invasive behaviour elsewhere in the world (Yakandawala, 2012).

Sri Lanka, a biodiversity hot spot harbors over 370 aquatic or wetland plant species. Among them 12% are considered to be endemic to the country. They are taxonomically

placed under 64 plant families. Out of this 41% percent of the aquatic flora are now threatened and listed under different categories during the last process of assessing threatened plants and animals for the Red List of Sri Lanka (Yakandawala, 2012).

One notable threat to the biodiversity of wetland ecosystems is the spread of the exotic ornamental aquatic plants. Many ornamental aquatic invasive species have been encountered in the country's wetlands in the past, out of which Water hyacinth or 'Japan Jabara' *(Eichhornia crassipes)* and Salvinia *(Salvinia molesta)* are dominating wetlands all over the country. Apart from these, other ornamental aquatics such as Water lettuce/water cabbage or 'Diya-paradel' *(Pistia stratiotes)* and Hydrilla *(Hydrilla verticillata)* have also received considerable attention in the recent past as problematic plants in water bodies

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Figure 1: Water hyacinth dominates a water body creating a spectacular view. However it does not allow any other plant to survive, causing an irreversible damage to the biodiversity of the wetland

Apart from these well known invasive exotics, recently concluded studies by the authors reported three other ornamental aquatics *Ludwigia sedioides, Mayaca fluviatilis.* and Echinodorus spp. as naturally occurring in water bodies in the Gampaha district of the

Western Province of Sri Lanka (Yakandawala and Yakandawala, 2007). At the time of detection of these species as potential invasives in 2006, they showed only a limited spread in isolated locations. However, continuous monitoring during the past 8 years has revealed a notable increase in their populations (Yakandawala et al., 2014). *Especially Mayaca fluviatilis* and *Ludwigia sedioides* have gradually extended their spread and the ornamental aquatic plant industry could be responsible for the introduction of these species as these plants are traded (Yakandawala, *et al.,* unpublished).

Stream bog moss *(Mayaca fluviatilis)*

Mayaca fluviatilis belongs to the monocot family Mayacaceae. The family Mayacaceae is represented only by this genus and is native to Central and South America, the Caribbean and the United States. It is a perennial herbaceous plant which is well established as a submerged background plant in the aquaria all over the world. This plant has not being previously recorded as naturally occurring in Sri Lanka. *Mayaca fluviatilis* was initially detected in a single water body in 2006 and subsequent monitoring has revealed its spread into other water bodies in its vicinity. In 2013 this plant was detected in 15 water bodies (Yakandawala *et al.,* 2014). Caution has been raised in some countries over the spread of this popular aquarium plant whereas certain countries have recognized it as a quarantine weed (European & Mediterranean Plant Protection Organization, 2007), as a problematic weed in Florida Lakes in USA (Hanlon *et al.,* 2000), weed with high risk in Queensland, Australia and as a pest within the parts of its native range, particularly in Puerto Rico, Florida and North Carolina (Anon, 2010).

During dry conditions the plant is capable of growing as a dense mat on the surface of wet soils. The reproduction of *Mayaca* is through vegetative means or by seeds. However, in nature they are mostly carried away by vegetative means. Since the plant is capable of reproducing vegetatively, mechanical control in extensively spread areas has been dismissed due to the reason that fragmented vegetative parts of even 2 cm in length are capable of developing into a new plant and potentially leading to further spread downstream (Yakandawala and Dissanayake 2010). Hence herbicide screening trials have been

undertaken in Queensland, Australia to evaluate the possibility of controlling this plant (Madigan and Vitelli 2012).

Figure 2: Water body in the Gampaha District completely covered with *Mayaca fluviatilis*

Figure 3: *Mayaca fluviatilis* growing in a water body and also on the adjacent wet soils of the bank

Mosaic flower (Ludwigia sedioides)

Ludwigia sedioides belongs to the family Onagraceae and is native to Brazil and Venezuela. It is a perennial herbaceous plant established as a floating aquatic especially for ponds in outdoor landscaping. The plant has not been previously recorded as naturally occurring in Sri Lanka. *Ludwigia sedioides* was initially detected in two water bodies in 2006 and continuous monitoring by the authors in 2013 has revealed its spread into 36 other water bodies in its vicinity and. it has also been detected in three other different locations in the western and Northwestern provinces. Though it is recorded to have a fast growth rate, the plant has not been identified as problematic elsewhere in the world. However, some species of the same genus are identified as invasive in certain other countries (Randall, 2012).

Ludwigia sedioides produces small diamond-shaped leaves arranged in neat rosettes, giving an attractive appearance to the plant. Their reddish coloured stalks and the lower surface of the leaf together with yellow flowers give a contrast to the greenish leaves. The habitual propagation is via snipping off a rosette with a section of the stem attached. However, studies conducted by Debarawatte and Yakandawala (2009) revealed that propagation is possible even through other stem sections excluding the rosette. According to our observations made in the wet habitats in the Western Province, the plant forms dense mats on dry soil during the dry season and is capable of surviving on completely dry soil.

Figure 4: A small water body completely dominated by *Ludwigia sedioides*

Figure 5 : A large stream completely blocked by fast spreading *Ludwigia sedioides*

Amazon sword plant *(Echinodorus sp.)*

Echinodorus belongs to the family Alismataceae and are distributed in the Western Hemisphere from the Central United States to Argentina. *Echinodorus* are by nature marshy plants and are capable of growing submerged. They are popular as specimen plants in aquaria and also in aquatic landscapes. Out of the 11 *Echinodorus* species recorded to be traded in Sri Lanka, 9 species are recorded as invasive weeds elsewhere in the world (Yakandawala *et al.,* unpublished). This was detected in a single water body in 2006. However, by 2013 it was detected in 10 different locations in the Western and Northwestern provinces. The plant produces a long inflorescence with 1-18 whorls of florets which are eye catching. Each floret is capable of developing into a plantlet while still attached to the mother plant, facilitating it to spread successfully. Since the inflorescence reaches beyond the mother plant, these plantlets establish quite easily.

Figure 6 : A dried out water body encroached with *Echinodorous* species and *Ludwigia sedioides*

What needs to be done against new exotic plant invasions?

At present, ornamental exotic plants are continuously being introduced into the aquatic plant sector in Sri Lanka. Out of these, only a few species are recorded as escapes that have got established in nature. Although the majority of exotic species are not considered to be harmful to the environment and thereby is not expected to have negative economic impacts, a small percentage of them could cause harmful effects and need to be detected and managed as soon as possible. Once these plants are detected for the first time in a new environment, they can be successfully controlled if their management is initiated soon as possible after their first report (Kaiser and Burnett, 2010). Such a successful story was revealed in Switzerland by Wittenberg (2005), where the first population of *Ludwigia grandiflora* was successfully eradicated by hand-picking for two years after its first record. Accordingly, a number of projects have recently been initiated in Germany to increase public awareness and to reduce the delay between first reports and management of aquatic alien species. This report shows the importance of taking urgent action on newly introduced invasive plant species, that remain unnoticed yet, but are likely to be problems in the future. Therefore in Sri Lanka too, after the first detection/report, a rapid eradiation strategies followed by a monitoring programme should be adopted. However, at present all the resources are focused towards the management of established invasive plants. Hence, the efforts of nipping off the aquatic plant invasions in the bud will not become a reality unless authorities give priority for newly established species.

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Panama Lagoon : A unique mangrove ecosystem in the east coast of Sri Lanka

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Introduction

Mangroves constitute a characteristic coastal ecosystem of evergreen woody plants in the tropical and subtropical areas of the world (De Silva and de Silva, 1998). In Sri Lanka, mangroves are found scattered mainly along the north-western, northeastern and eastern coasts bordering lagoons and river estuaries. Mangroves in Sri Lanka are not extensive and are often limited to narrow strips of vegetation, sometimes only a few trees deep. The area covered by mangroves today is estimated to be 120 km2in extent which is about 0.12% of the total land area of the country.At present, mangrovesare present in patches in association with the estuaries and lagoons (Ransaraet al., 2012).

Twenty one true-mangrove species (Jayatissa, 2012) and 23 mangrove associate species have been recorded in Sri Lanka (IUCN, 2009). Of these the common true mangrove species are *Rhizophoramucronata, Avicennia marina, Excoecariaagallocha, Acanthus ilicifolius, Lumnitzeraracemosa, Sonneratiacaseolaris, Bruguieragymnorhiza* and *Aegicerascorniculatum* (De Silva and De Silva, 1998). Since the submerged parts of the trees and the prop and knee-roots offer a substratum for attachment, and a place for hiding and protection, and the leaf litter offers protection and a source of food, aquatic fauna occurs in greater abundance in a mangrove-associated estuary or lagoon (Karunathilake, 2003). Furthermore, lagoons and estuaries are important as nursery grounds for a number of species of fin fish and crustaceans (Jayawickrema, 1992). As they provide nursery grounds for many marine species, estuarine systems are essential to the renewal of fisheries resources of a country as well (Able, 2005).

Although mangroves are present in association with most of the estuaries, the west coast mangroves have been more thoroughly studied than the others. Information on mangroves in most parts of the North and the East is not available and the availableinformation appears to be in need of being updated (Ranawana, 2012).

Panama Lagoon

Panama Lagoon (6º45'-6º46' N; 81º48'-81º49' E) is a shallow estuarine lagoon situated in the Ampara District in the East coast of Sri Lanka. It covers an approximate total water surface area of 0.73 km² (73ha) with an average depth of 1.48m (4.86 ft). A maximum depth of 4.26m

(14ft) has been recorded. The salinity ranges from an average of 4.5 ppt to 26.6 pptand shows monthly variations. The Panama lagoon is situated in the dry semi-arid climatic zone of Sri Lanka receiving a mean annual rainfall of 500-775mm, much of it being received during the North East Monsoon from December to February. The dry period of the lagoon area ranges from March to August whereas the wet period ranges from September to mid-February. According to meteorological data, maximum day time temperature cango up to 34 ºC and it can decrease to 21 ºC during the night. The lagoon mouth opens to the sea from the eastern part of the lagoon as a narrow channel which is about 52 m wide. The lagoon mouth closes during September to mid-November and it remains open during the rest of the year from December to August. Artificial breaching of the lagoon mouth is done at certain times of the year in order to facilitate transportation of boats from the ocean to the lagoon and also to protect upstream agricultural lands from flooding. The main freshwater input comes to the lagoon through WilaOya, a tributary of the HedaOya which enters the lagoon from the western region of the lagoon (Figure 1). Fisheries are an important primary activity in the lagoon

Figure 1: Location map of the Panama lagoon (Source: https://www.google.com/earth/)

Methodology

A study was conducted from May 2011 to April 2012 in order to assess the composition of mangrove species andtheir relative density as well as the fishery in the Panama lagoon. The floral compositionand zonation were studied in 5 m wide belt transects running at right angle from water's edge to the land ward margin of the mangrove. Geographical Positioning

System (GPS) coordinates were obtained from the margins of each mangrove patch. These data were incorporated into a digitized map of the lagoon area.

Data collection on fish species of the lagoon was carried out monthly. Cast nets were used on line transects at the lagoon mouth, mid region and upstream region toobtain primarydata for this study. The two regular fish landing sites in the lagoon were visited early in the morning during the field visits to gather information from the fishermen. Daily yields,the species caught, number of fish collected from each species and their total weights were recorded. Fish identification guides (Pethiyagoda 1991, Deraniyagala, 1952, Munro, 1955 and De Brulne*t al*., 1994) and colored photographs were used in fish identification.

Results

Mangroves occupy approximately 83 ha of land bordering the lagoon and were observed to grow luxuriantly along the fringes of the Panama lagoon (Appendix I).

The field survey yielded eight true mangrove species and 14 mangrove associate species from the Panama lagoon (Appendix II). Among them four mangrove species namely, *Avicennia marina, Lumnitzeraracemosa,Exoecariaagallocha* and *Rhizophoramucronata* are the most common mangroves species (Figure 02). The relative density of *Avicennia marina, Lumnitzeraracemosa, Exoecariaagallocha* and *Rhizophoramucronata*ishigher in comparison to other true mangrove species recorded (Figure 03). The density of plants increased towards the upstream region of the lagoon where the salinity is lower. A few individuals of rare mangrove species *Pemphisacidula*were recorded near the lagoon mouth

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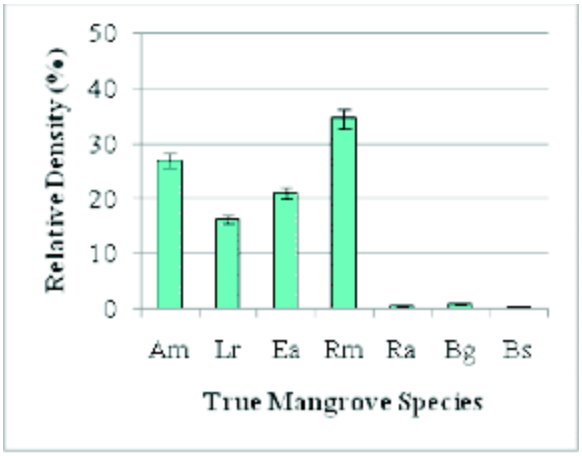

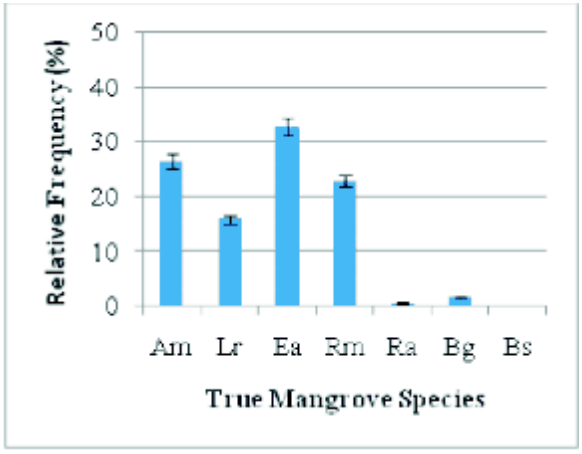

Figure 2: Relative density of true mangrove Figure 3: Relative frequency of true mangrove species in the Panama lagoonspecies in the Panama lagoon

Am – *Avicennia marina*
Lr – *Lumnitzeraracemosa*
Ea – *Exoecariaagallocha*
Rm – *Rhizophoramucronata*
Ra – *Rhizophoraapiculata*
Bg – *Bruguieragymnorhiza*
Bs – *Bruguierasexangula*

True mangrove species were arranged into two distinct zones. A zone of *Rhizophora* at the waterfront, followed by a mixed mangrove community of other true mangrove species such as *Avicennia marina, Lumnitzeraracemosaand Exoecariaagallocha* could be seen. *Avicennia marina* is found in the mixed zone, usually towards the inland margin, but sometimes extending to edge of water as well. Species such as *Bruguierasexangula, B.gymnorhiza* and *Rhizophoraapiculata* occurred in a small patch near the lagoon mouth on the right bank of the lagoon while species such as *Acanthus illicifolius, Avicennia marina, Lumnitzeraracemosa, Exoecariaagallocha and Rhizophoramucronata* were more frequent on the right bank of the lagoon while Avicennia marinawas the most dominant species in the left bank of the lagoon.

The fish species harvestedincluded freshwater forms, brackish water forms, fresh-brackish water forms and marine-brackish migratory species. The typical freshwater species were observed mostly in the uppermost reaches of lagoon where water salinity is comparatively lower, due to the inflow of freshwater from streams. A total of 47 species of fish belonging to 34 families were recorded from the Panama lagoon during the survey (Appendix III).

About one third (17 species) of the fish species in Panama lagoon consist of typical brackish water forms. The migratory species included many “anadromous” species which are marine species that move into brackish/freshwater for spawning or to spend their juvenile period. From the lagoon mouth area, Twenty one fish species belonging to 19 families were recorded from the lagoon mouth while 23 fish species belonging to 19 families were recorded from the mid region of the lagoon. A total of 15 species belonging to 14 families were recorded in the upstream region. The abundance of fish was somewhat equal throughout the lagoon where it showed patterns of distribution according to salinity changes.

About 35 species of food fish (belonging to 26 families) are harvested from the lagoon. However, only five species of fish namely *Siganaslineatus, Oreochromisniloticus, Mugilcephalus, Gerresargyreus and Mystusguilio* contribute to the bulk of the catch (Figure 4). These species occur regularly in the fishermens catch. The total production of this lagoon was estimated at 74.05kg/ha/yr. The productivity is high in the lagoon and it has seasonal fluctuations due to environmental changes. *Siganaslineatus* and *Mugilcephalus* are the most preferred food fishes in the Panama village community and thus sold for a comparatively higher price than all the other species (Figure 4).

Apart from fish, crab cages are used seasonally to capture mangrove crab (Scylla serrata,Family Portunidae.). Small hand nets are used to capture shrimps hiding among roots of mangroves during the shrimp season in April. Four species of shrimps namely *Pinnaeusindicus, Pinnaeusmonodon, Pinnaeussemisulcatus* and *Pinnaeusmarguiensis* are harvested from the lagoon.

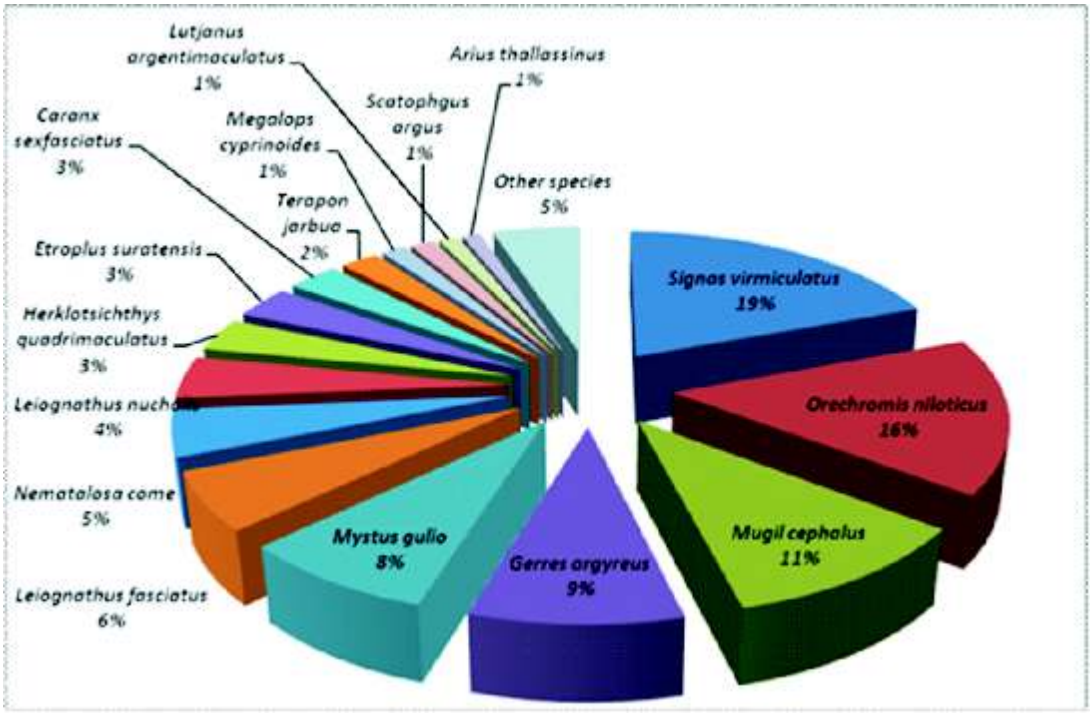

Figure 04.Composition of fishermen catch in Panama lagoon

Discussion

Undisturbed mangrove forests are rare and most of the mangrove areas in Sri Lanka have been subjected to human interference for a long time (Katupotha, 2002). However, Panama lagoon is a unique mangrove ecosystem with fewer disturbances and human interferences. Even during the Tsunami of 2004 it has been subjected to less damage due to the protection provided by the sand dunes covering the seaward area of the lagoon.

Among the 21 species of true-mangrove species in Sri Lanka, eight were recorded from the Panama lagoon while 14 out of 23 mangrove associate species havealso been recorded from it. Therefore, the diversity of mangrove species is higher in the Panama lagoonin comparison to that of the other lagoons in the same region (Weerakoon *et al.,* 2014). Of the five common mangrove species (Jayatissa, 2012)two were present in the Panama lagoon while five others were of conservation importance (Appendix II). Continuous mangrove patch all along the shoreline, richness and diversity of the mangrove species together with the lagoon fishery resources makes Panama mangrove a unique ecosystem in the east coast of Sri Lanka. De Silva and De Silva (1998) noted that difference in floristic composition of mangrove species in the dry zone and the wet zone reflected differences in salinity tolerance of species. It may be applicable for these species as well.

Since the salinity varies throughout the year and it fluctuates between freshwater to sea water, species such as *Avicennia marina*, *Lumnitzeraracemosa,* and *Rhizophoramucronata*

which can tolerate wide ranges of salinity occur in higher frequencies and densities in the Panama lagoon. Since prevalence of lower salinity levels is restricted only to a shorter time period of the year in the Panama lagoon, species that prefer low saline conditions such as *Bruguierasexangula, B.sexangulaand Rhizophoraapiculata* occur at lower densities.

The Panama lagoon is highly influenced by the abiotic variations and the thick mangrove vegetation surrounding the lagoon, which affects the occurrence, distribution and the survival of the fish species (Ellepola*et al.,* 2013). A study conducted in 2012 showed that salinity influenced the fish fauna of the lagoon both during the dry season and the rainy season recording higher numbers of fish species of marine origin during the dry season (Ellepola *Unpublished)*. The results of this study showed that the species areevenly distributed spatiallyin the dry season than in the wet season. However, the occurrence of some species throughout the lagoon such as *Caranxsexfasciatus, Gerresargyreus, Leiognathusfasciatus* and *Mugilcephalus,* suggests that they are highly tolerant of variable salinity levels.

Fishery is an important activity of the lagoon. Majority of the people living in the surrounding areas of the lagoon depend on the lagoon and they catch fish to sell as well as for their own consumption. Generally fishing is seasonal in the lagoon with high fishing frequencies during the dry season, low fishing frequencies during the wet season with shifts from fish harvesting to shrimp harvesting during a certain period of the year. It has been estimated that the average natural production of Sri Lankan lagoons are around 20 kg/ha/yr (BOBLME, 2011)) and the productivity of the Panama lagoon (74.05 kg/ha/yr) is well above the average productivity of a lagoon in Sri Lanka which gives an indication that Panama lagoon is rich in fishery resources.

However, during the past few years there has been a visible degradation in the Panama lagoon ecosystem due to human activities of which, agricultural runoff has been a major concern. The rice fields adjacent to the lagoon and leakage of pesticides used could be a major threat to the lagoon health in the near future(Ellepola, 2012).

Conclusion

Although no detailed studies on the biodiversity of Panama lagoon have been carried out previously, the importance of this wetland in terms of its high ecological and biological significance has been identified through this paper. Therefore, this will provide a platform for further research to be carried out and managers to come up with necessary management plans to ensure its sustainability.

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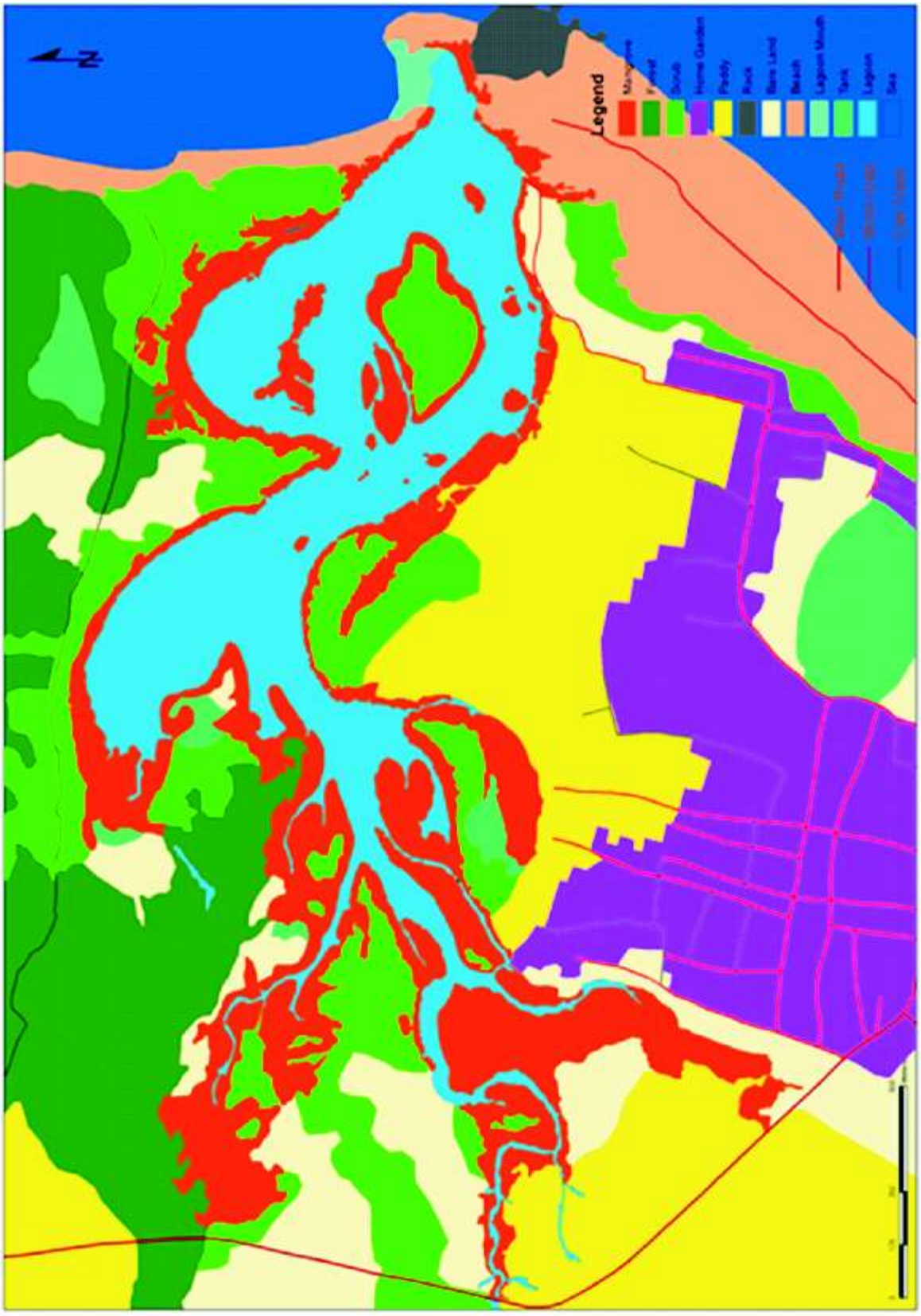

Appendix I: Map showing the distribution of mangrove vegetation in Panama lagoon (Source: Ranawana, 2012)

Appendix II: List of true mangrove species and mangrove associate species recorded from the Panama lagoon

Family	Species	Conservation Status[1]
True mangrove species		
Avicenniaceae	*Avicennia marina*	LC
Combretaceae	*Lumnitzeraracemosa*	NT
Euphorbiaceae	*Exoecariaagallocha*	LC
Rhizophoraceae	*Rhizophoramucronata*	LC
	Rhizophoraapiculata	NT
	Bruguieragymnorhiza	VU
	Bruguierasexangula	VU
Lythraceae	*Pemphisacidula*	NT
Mangrove associate species		
Acanthaceae	*Acanthus illicifolius*	Common
Apocynaceae	*Cerberaodollam*	
Asclepiadaceae	*Calotropisgigantea*	
Bignoniaceae	*Dolichandronespathacea*	
Clusiaceae	*Calophylluminophyllum*	
Combretaceae	*Terminaliaarjuna*	
	Thespesiapopulnea	Common
Fabaceae	*Derris scandens*	
Leguminosae	*Desmodiumumbellatum*	
	Cassia auriculata	
Malvaceae	*Hibiscus tiliaceus*	Common
Palmae	*Phoenix zeylanica*	
Verbenaceae	*Clerodendroninerme*	Common
	Premnafoetida	

(1follows Jayatissa, 2012)

Appendix III: List of fish species recorded from the Panama lagoon

Family	Sspecies	Common Name	
		Sinhala	English
Acanthuridae	*Acanthurusnigrofuscus*		Brown Surgeonfish
Adrianichthyidae	*Oryziasmelastigma*	Diya pita handheya	Estuarine Top-Minnow
Apogonidae	*Apogonlateralis*	Katilla	Cardinal fish
Ariidae	*Arius thallassinus*	Thoraanguluva	Giant catfish
Bagridae	*Mystusgulio*	MadaAnguluwa	Long Whiskers cat Fish
Carangidae	*Caranxsexfasciatus*	Inguruparava	Bigeye trevally
	Scomberoidescommersonianus	Kattawa	Talangqueenfish
Cyprinidae	*Catlacatla*	Catla	Catla
	Cirrhinusmrigala	Mrigal	Mrigal
Chanidae	*Chanoschanos*	Vaikkaya	Milkfish
Cichlidae	*Etroplusmaculatus*	Ran koraliya	Spotted Etroplus
	Etroplussuratensis	Koraliya	Banded Etroplus
	Orechromisniloticus	Thilapia	Tilapia
Clupeidae	*Herklotsichthysquadrimaculatus*	Kolamuruwa	Bluestripe herring
	Nematalosa come		
Dasyatidae	*Himanturauarnak*	Valimaduva	Banded Whip-tail Sting Ray
Gobiidae	*Glossogobiusguiris*	Weligowwa	Bar-Eyed Goby
	Ctenogobiusmalabaricus		
	Oligolepisacutipennis		Pointed-finned Goby
Gerreidae	*Gerresargyreus*	Olaya	
Haemulidae	*Plectorhinchusgibbosus*		Harry hotlips
Hemiramphidae	*Zenarchropterusdispar*	Murungawa	Viviparous Half Beak
Leiognathidae	*Leiognathusfasciatus*		Banded Ponyfish
	Leiognathusnuchalis	Panna	
Lutjanidae	*Lutjanusargentimaculatus*	Thambalaya	Mangrove red snapper
	Lutjanuseherengergii		Ehrenberg's snapper
Megalopidae	*Megalopscyprinoides*	Illeya, Mareva	Indo-Pacific tarpon
Monodactylidae	*Monodactylusargenteus*	Kapuhandha	Silver moony
Mugilidae	*Mugilcephalus*	Thelgodeya	Flathead mullet
Pristigasteridae	*Ilishastriatula*		Banded ilisha
Platycephalidae	*Platycephalusendrachtensis*		
Scatophagidae	*Scatophagusargus*	Aanaliththi	Spotted scat
Siganidae	*Siganasvermiculatus*	Otti	Vermiculated spinefoot
Sparidae	*Acanthopagrusberda*	Thiraliya	Picnic seabream
Sillaginidae	*Sillagosihama*	Kalanda	Silver sillago
Sphyraenidae	*Sphyraenaobtusata*	Theliya, Ulava	Obtuse barracuda
Syngnathidae	*Microphisocellatus*		
Terapontidae	*Teraponjarbua*	Iribateya	Jarbuaterapon
	Teraponputa	Gonkili, Vairankili	Small scaled terapon
	Tetraodonfluviatilis	Peththaya	

How green are crops? The linkage between wetlands and agriculture

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Water is life. Wetlands are life supporting ecosystems. Sri Lanka being a tropical country with 103 major rivers supports a variety of wetlands distributed island wide. Wetlands are close to human life in many ways. They play a pivotal role in hydrological functions by providing surface water and replenishing ground water resources as well as sediment retention and flood risk attenuation. Urban wetlands are nationally significant habitat in terms of biodiversity conservation since they shelter one-third of Sri Lanka's faunal species including thousands of the endemics. Many of these plants and animals are unique and rare. Although unnoticed, these ecosystems play at least two critical roles in mitigating the effects of climate change: management of greenhouse gases by absorbing carbon dioxide through wetland plants and physically buffering climate change impacts. Economically, wetlands play a major role in supporting tourist industry and leisure activities. A large fishing community relies on this habitat for their livelihood.

One of the most important services of wetlands is its support to agricultural activities in the area by providing water. Since the beginning of human civilization, man has been cultivating land for food production. Initially, human settlements primarily occurred in fertile areas along rivers. Several centuries ago , i.e. 6000 years , the cradle of human civilization occurred in the floodplains of Mesopotamia. Even in Sri Lanka, King Pandukbhaya built the first planned city and settlement near *Malwathu oya*. Ancient kings of Sri Lanka, understanding the importance of water storage for agriculture commenced irrigation work. The earliest such work was in 300 BC, in the reign of King Pandukabhaya. This island had the most complex irrigation systems of the ancient world. The Sinhalese were among the first to build completely artificial reservoirs to store water.

From the beginning of agricultural activities, wetlands have been identified as valuable land areas for crop production, because they are rich in fertile soils as a result of regular sediment deposition during flood events. Another benefit was easy access to waterways for transport which was a major additional advantage. When human populations grew gradually over the course of history, wetlands have been reclaimed for agriculture in many parts of the world.
In addition to supply of water, wetlands play a key role to support agriculture by mitigating extreme weather events, such as abatement of the impacts of floods and storms. On the other hand they replenish ground water resources and store flood water, releasing it slowly during droughts.

Despite all the services they provide wetlands worldwide continue to face many pressures from agriculture, and Sri Lanka is no exception. In 2009 Ramsar Convention (www.ramsar.org) officially announced that wetland protection is a priority for the 159 nations that have ratified the convention. Yet wetlands continue to be under threat of being drained and reclaimed for agriculture.

Rice fields are in a way converted wetlands. The world's rice fields (1·5 million km^2) are a very important in feeding global community. In South-East Asian countries including Sri Lanka, rice has been cultivated more than six millennia. Rice fields can therefore be classified as 'agronomically managed temporary wetland ecosystems'.

One major impact of agriculture is the outright conversion of wetlands to agricultural use which is evident in all districts in the country. This situation has aggravated due the population pressure and ever increasing demand for land. Agriculture continues to have significant impact on remaining wetlands. The health and ecological functions of wetlands located near agricultural areas can be threatened in many ways. Indirect loss of wetland areas can be attributed to over extraction of water often from rivers and streams for irrigation.. Water withdrawals for irrigation in certain areas can act to exacerbate the effects of other stressors on wetlands.

Pollution has been one of the major threats to water resources any where. Although wetlands can improve watershed water quality, their can exceed their capacity to process pollutants without becoming degraded.. Many wetlands are suffering functional degradation, where evaluation of the magnitude of the degradation has become difficult. A severe threat arises from the agricultural runoff with pesticides, other types of agrochemicals and fertilizer which are generated and reach wetlands as non point sources of pollution. Enrichment by fertilizer and animal waste provides nitrates and phosphates to wetlands which facilitate algal growth leading to algal blooms. This will ultimately lead to oxygen depletion, death of organisms, foul smell etc. The adverse impacts of pesticides are well documented and are still accelerating. According to the Stockholm Convention on Persistent Organic Pollutants, 9 of the 12 most dangerous and persistent organic chemicals are organochlorine pesticides. Especially bio accumulation and impacts on on non target species have been a major risk of these chemicals.

Loss of wetland function due to salinization, sediment deposition and erosion could arise as a result of unsustainable agricultural practices in thesurrounding watershed. For instance, some major Mahaweli reservoirs have now depleted their storage capacity due to

accumulation of sediments. Salinization also results from agricultural practices that leaves excess water on the ground surface where salt of the soil get dissolved and when water gets evaporated those will remain in the soil.

Wetlands possess certain hydrologic conditions which cause the water table to saturate or inundate the soil throughout the year or at least for a certain amount of time each year. Agricultural and related activities that include drainage, dredging, stream channelization, deposition of fill material, stream diversion, ground water withdrawal definitely contribute to altering wetland characteristics. Alterations which change the amount of water naturally entering a wetland or the period of saturation and inundation can affect wetland functioning.

In Sri Lanka, especially in the Dry Zone, cattle grazing is frequently observed around wetlands. Grazing livestock can degrade wetlands that they use as a food and water source. Deposition of cow dung can result in high nutrient inputs. Cattle movements may cause changes in the topography at least in the banks. Overgrazing by livestock reduces streamside vegetation, preventing runoff filtration, and reduces food and cover for aquatic wildlife. As vegetation is reduced, banks can be destroyed by sloughing and erosion. Destabilization of banks and erosion then causes sedimentation and reducing capacity of wetlands.

Finally, everything has a price. Agriculture and wetlands should be managed in harmony in order to ensure long term sustenance of this vital ecosystems and support the livelihoods of millions of people. Wetland conservation can only be achieved through a cooperative approach involving all the concerned people and organizations, including the local agricultural communities.

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Photo : Wetland and paddy fields

Photo: spraying pesticides in paddy cultivation

Restoring our coral reefs; an experience from Passikudah, Sri Lanka

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Introduction

Passikudah bay is situated about 28 km north of Batticaloain the in the Eastern Province of Sri Lanka along its coast. The bay is renowned for its wide, shallow, calm sandy beach extending to about 200 m from the beach and the coral reef inhabiting it. This attracts local and foreign visitors in large numbers during the non-monsoonal periods from April to November (Green Tech Consultants, 2009). Passikudah reef is a part of a series of discontinuous fringing reef systems along the east coast from Kalmunai to Trincomalee (Rajasuriya, 2002). The bay is occupied by hard coral species dominated by *Acropora spp* and other species such as *Pocillapora* spp*, Goniastrea* spp, *Favites* spp, *Montipora* spp, *Potites rus, Psammacora contigua, Montipora aequituberculata, Porites lutea, Psammocora digitata, Goniopora lobata, Platygyra lamellina, Acropora microphthalm* and *Echinopora lamellose* (Green Tech Consultants, 2009). The overall live coral cover in the area was estimated as 64.31% by Ellepola and Ranawana, (2014) but in the shallow areas about 60% of the reef is dead. Fish life is of moderate diversity with 113 species recorded (Green Tech Consultants, 2009) of which Damselfishes (Pomacentridae), Surgeonfishes (Acanthuridae), Parrotfishes (Scaridae) and Wrasses (Labridae) were more abundant (Ellepola et al., 2014).

The study area was occupied by a large number of reefs until mid-70s. However, today the reefs are being destroyed due to many reasons. Although the average live coral cover is about 64%, large areas of the reefs have been degraded by coral mining, destructive fishing methods, invasion by algal species and large scale tourism (Green Tech Consultants, 2009). However, degraded reefs could recover through natural dispersal of larvae if favorable environmental conditions were restored and pressure from human activities is reduced. The time required for recovery would depend on the scale of disturbance and level of stress on the reef system and might be as little as five years, but it could also take centuries (Harriot and Fisk, 1988).

By identifying the importance of these coral reefs in Passikudah and considering its slow pace natural colonization, a local NGO Wildlife Research and Conservation Trust of Sri Lanka has initiated a coral transplantation project. It is a known fact that the recovery of a coral reef can

be stimulated through artificial methods (Clark and Edwards, 1995). One such method is transplantation of corals which is a viable method of expediting the recovery of degraded coral reefs (Rinkevich, 1995) which is being used in this project.

Materials and Methods

Lack of suitable substrate for coral settlement was identified as the major problem in the reef which limited the recovery pace. Therefore, a novel low-tech approach known as the 'reef ball method' was introduced in reef restoration. These are concrete boulders made out of waste concrete. The artificial structure s served a dual purpose- to enhance the fish assemblage and as a substrate for coral transplantation. Each concrete boulder consisted of 4-5 holes and coral nubbins maintained in a nursery are planted on these boulders using a mixture of cements. By September 2014, two hundred and fourteen concrete boulders were deployed at a depth ranging from 4m-10m supporting a total of 1070 nubbins over an area of 168m2. On each boulder 4-5 nubbins of corals are transplanted and growth and survival data is collected.

Results

The coral nursery remains healthy giving new nubbins to be planted and it is been well looked after by the WRCT staff (Figure 01). It has added approximately 168m^2 of sea surface area and an extra of 672^2 of total surface area of new substrate for the growth of corals. Two hundred and fourteen reef balls were planted with 1070 new nubbins by the end of September 2014. The planted corals were seen well established on reef balls two days after planting (Figure 02) and no mortalities were recorded. Some have shown signs of branching and some have grown in few millimeters in height. Reef fish also have shown signs of succession by attracting towards the newly planted reefs. There should be a list of the reef fish that have been attracted to these reef balls. Not sufficient to say they are only attracted

Figure 01. Well looked after coral nursey surface and well established corals

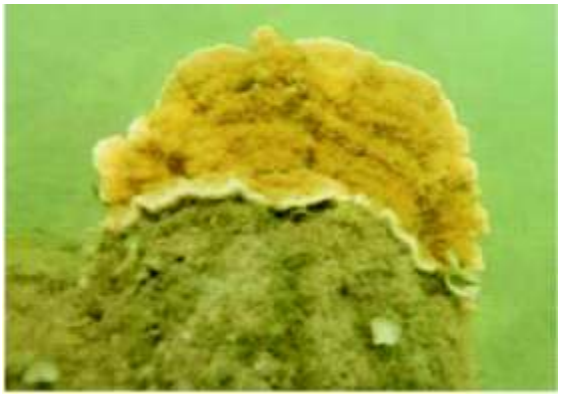

Figure 02. Spreading over the attachment in the deeper area of the bay

The species planted includes *Porites* spp, *Psammacora* spp, *Montipora* spp and *Acropora* spp of which *Acropora* is the most commonly planted type of species. A full list of replanted species is needed. Which species grow best and which did not should be included. Mere descriptions are good for newspaper articles but not in a publication on wetalnds published by the CEA.

However, the growth requires a significant amount of time to show a distinct growth. Figures 03 (A &B) shows coral nubbins which are about 10 months old. A newly planted coral is shown in Figure 04. As shown in the Figures 05 and 06, with time a lot of algae species grow around corals covering them on certain boulders in the shallow area. Therefore, regular cleaning is necessary to help them grow and it is done regularly by the WRCT staff (Figure 07)

A **B**

Figure 03 (A & B). Transplanted corals

Figure 04. A newly planted coral nubbin

Figure 05. Algae competing with corals

Figure 06 Algae covering the corals.

Figure 07. Cleaning algae grown over corals

Discussion

The Passikudah bay has had a healthier coral reef in the past and its remnants are still visible towards the deeper areas of the bay but the vast majority of the reef is dead.The results of preliminary survey suggested that the Passikudah reefs are showing signs of slow recovery (Ellepola and Ranawana, 2014) but lack of a substrate for the corals to grow has become a major issue limiting their growth. The percent live coral cover has increased by 48% within a ten year time period and it is a significant natural recovery. However, the shallow reefs towards the near shore area have not shown signs of recovery and it should be noted. Therefore, replanting the corals in near shore areas is a possible solution in this regard. The cover of sea grass and algae such as *Halimedaand Caulerpa* towards the shallow area is higher and it could be a possible competitor and a threat to the regenerating corals. Therefore removal of algae would give a support to the regenerating corals in this area. Further, high turbidity may be a possible reason which limits the growth of the corals towards the near shore area. In regard of fish still the numbers of fish species are increasing in numbers and diversity towards the newly replanted areas. These claims should be supported by data on fish species diversity.

Coral transplantation by the fragmentation method using concrete boulders is a relatively labor intensive method. However, transplantation on concrete boulders helps to protect the nubbins from sedimentation (Edward *et al*., 2002). Thus, this method for restoring damaged coral patches is a viable way to rehabilitate a damaged coral reef and restore the marine life if done in large scale.

The involvement of the local community in the reef restoration work how many local NGOs were involved and what did they do? has created awareness among the fisher folk of the need for conserving corals and associated resources in the area. This participatory involvement of resource management is considered vital for the protection and conservation of corals by the fisher folks themselves.

Acknowledgments

The authors would like to thank Mr. Chandra Wickramasinghe, Chairman of Malu Malu Hotels and Spas for having the idea of this conservation project and inviting WRCT to initiate the project in Passikudah. The staff of Malu Malu Hotels and Spas and WRCT members are acknowledged for the immense support provided. Tokyo Cement Cooperation is acknowledged for providing the reef balls at their own cost and providing funds for further reef research in the area. UNDP/GEF-Small Grants Program of Sri Lanka is acknowledged for funding this project.

All references should be included in the main text

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Ten Species of True Mangroves at Extinction Risk in Sri Lanka

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The term mangrove is broadly used to describe awide variety of unrelated tree species which share a common ecosystem in the intertidal zone. It is historically used to introduce a group of plants which are in muddy wet soil in tropical tidal waters or the inter tidal area(Tomlinson, 1994). Sri Lanka has mangroves that are scattered distributed along its coastal zone as indicated by Figure 1.

According to Tomlinson (1994), globally there are more than 50 true mangrove species belonging to 16 different families. Generally, the mangrove species have many adaptations to survive extreme habitat which exclude other land plants. Mangrove species show a distinct zonation from low to high water based on frequency of inundation and salinity gradient. The mangrove ecosystem provides many ecological and economically important services to adjacent ecosystems as well as to human wellbeing.The coastal zone makes up only 10% of the ocean environment, but is home to over 90% of all marine species. For example, of the 13,200 known species of marine fish, almost 80% are coastal (Perera, et al, 2013)

A typical mangrove ecosystem (Pambala Lagoon, Sri Lanka,2013) /Pic ByM.G.M.Prasanna

Mangrove ecosystems provide many ecological as well as economical services such as, it helps to protect the land from erosion, it acts as a buffer zone between the land and sea, it plays a major role as nature's shield against cyclones, tsunami and other natural disasters and as protector of shorelines, it provides protection to breeding and nursery grounds for a variety of brackish and marine fauna, it acts as a gene bank for cultivating salt tolerant species of crops which could be our future resource. It also harbors a wide variety of fauna like invertebrates, fish, amphibians, reptiles, birds and even mammals, it helps to purify the water by absorbing impurities and harmful heavy metals, and it provides a potential source for recreation and eco-tourism. In comparison to other terrestrial plants or any other ecosystem, the mangrove ecosystem has a special ability tosequestrate comparatively more carbon resulting in an efficient system to reduce global warming impacts (Mangkay, et al., 2013).

This dominated vegetative habitat is found at the interface between sea and land in the same area. The global mangrove area amounts to around 180 000 km2. Since 1980, 20% of the world's mangroves have been destroyed for land reclamation, shrimp aquaculture, and wood for fire and building materials (FAO, 2008, Mangkay, et al., 2013).In spite of these important functions, more than 50% of the global mangrove forests have been destroyed over the last 100 years, mainly caused by human development (FAO, 2008). According to the FAO's statistics, mangroves are being lost now at the rate of around 1% per year. That means nearly 150,000 ha of mangroves are still being lost each year (FAO, 2008). Mangrove ecosystem ranks among the most threatened coastal habitats, especially for developing countries in the tropical region.

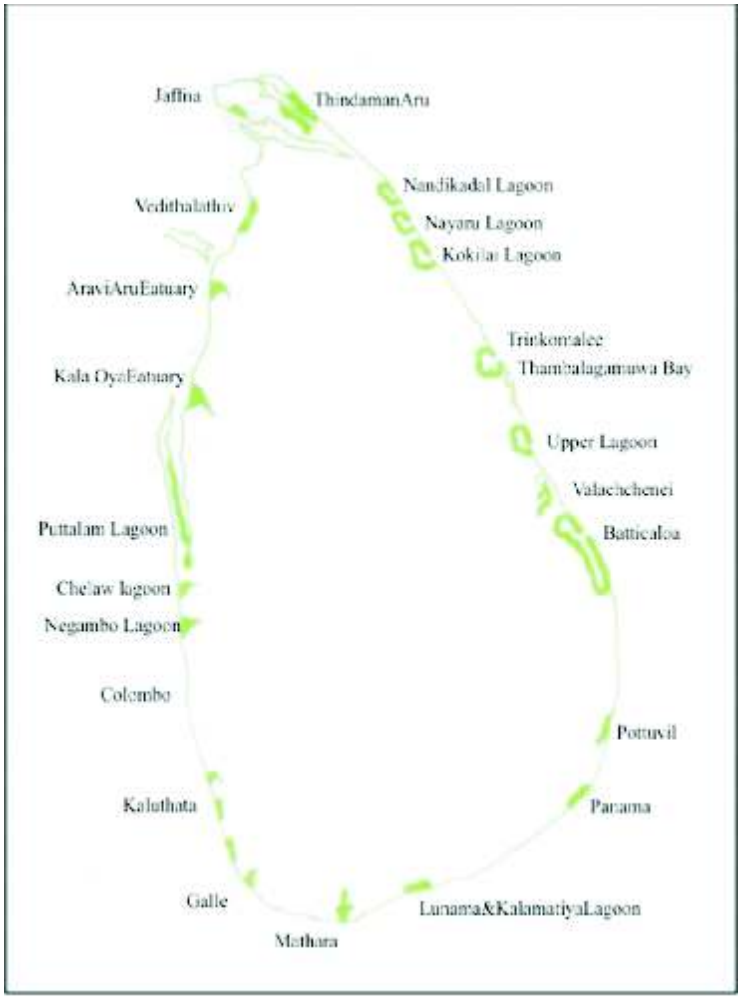

Figure 1 – Distribution of Mangroves in Sri Lanka (Source CCD, 1982))

Lumnitzeralittorea(S-Rathamilla) *Ceriposdecandra*(S-Punkanda)

Critical Endangered (CR) Mangrove Species in Sri Lanka

Bruguieracylindrica(Mal Kadol)*Sonneratia alba* (Yak Kirala)

Endangered (EN) Mangrove Species in Sri Lanka

The mangrove species such as *Rhizophoramucronata, Avicennia marina, Excoecariaagallocha, Lumnitzeraracemosa* are the most abundant mangrove species while *Xylocarpusgranatum, Bruguieracylindrica, Pemphisacidula, Ceriopstagal, Excocear*iaindica *and Scyphiphorahydrophyllacea* are rarely distributed. Lumnitzeralittoreaoccurs only in the Maduganga estuary, *Nypafruticansoc* curs only in the south to north East coast of the country From Rakawa Lagoon to Gin Oya at Ykkala. *Ceriposdecandra* was recently re-discovered by Prof. L.P Jayathissa 2012 and puplished the data through the National Red List 2012 and the other of this article recorded this species from Thambalagamuwafrom Trincomalee.

Twenty one true mangrove species which belong to twelve families have been recorded in Sri Lanka. In according to the 2012 National Red List of Sri Lanka 48%of mangrove species arethreatened. Out of these, two are listed as Critically Endangered, three asbeing Endangered and five species are listed as Vulnerable. Other than that another six species have been listed in a Near Threatened category. In 2007 National Red List *Scyphiphorahydrophyllacea* was listed as Critically Endangered but in 2012 it was downgraded as Vulnerable due toavailability of new distribution data. True mangrove species of Sri Lanka and their threatened status have been listed in Table 1.The extent of mangrove and their species diversity are degrading at an alarming rate day by day (National Reddlist, 2012) Therefore very urgent action is needed to conserve the mangrove ecosystem in the country.

Action TakenThe Biodiversity Secretariat, Ministry of Environment &Renewable Energy To Conserve Mangroves

Start a rehabilitation programe of degraded mangrove ecosystem with the Forest Department,

Held Awarenessprogrammes and training programmes for general public, school students, teachers and other government offices regarding the importance of mangrove conservation,

Prepare and distribution publications about mangrove ecosystem.

Establishment and strengthen existing field centers to collect information, ecotourism activities and researches on mangrove Ecosystem

Started to develop

Innitial steps have been taken to develop National Data Base on Mangrove and National policy on Mangrove Conservation and Sustainable usedistribution of Sri Lanka

Table 1 List of true mangrove species and their conservation status

Fmily	Species	Vernicular Name	Status
Myrsinaceae	*Aegicerascorniculatum*	yk lfvd,	LC
Avicenniaceae	*Avicenniamarina*	uKv	LC
Avicenniaceae	*Avicenniaofficinalis*	uKv	NT
Rhizophoraceae	*Bruguieracylindrica*	u, lfvd,	EN
Rhizophoraceae	*Bruguieragymnorrhiza*	u, lfvd,	VU
Rhizophoraceae	*Bruguierasexangula*	u, lfvd,	VU
Rhizophoraceae	*Ceriopstagal*	mxlKv	NT
Rhizophoraceae	*Ceriopsdecandra*	mxlKv	CR
Euphorbiaceae	*Excoecariaagallocha*	f;,$f;, lrh	LC
Sterculiaceae	*Heritieralittoralis*	wegk	NT
Combretaceae	*Lumnitzeralittorea*	r;ñ,,	CR
Combretaceae	*Lumnitzeraracemosa*	nErh	NT
Arecaceae	*Nypafruticans*	.xfmd,	VU
Lythraceae	*Pemphisacidula*	uyÿ jrd	NT
Rhizophoraceae	*Rhizophoraapiculata*	uy lfvd,	NT
Rhizophoraceae	*Rhizophoramucronata*	uy lfvd,	LC
Euphorbiaceae	*Excoecariaindica*	uyÿ lc	VU
Sonneratiaceae	*Sonneratiaalba*	hl lr,	EN
Sonneratiaceae	*Sonneratiacaseolaris*	lr,	LC
Meliaceae	*Xylocarpusgranatum*	uÜá lfvd,	EN
Rubiaceae	*Scyphiphorahydrophyllacea*	l¿ lfvd,	VU

late 1: True mangrove species of Sri Lanka and their status

Rhizophoramucronata(LC) uy lfvd,

Rhizophoraapiculata(NT) uy lfvd,

Bruguieragymnorrhiza(VU) u, lfvd,

Bruguierasexangula(VU) u, lfvd,

Avicennia marina
uKv

Avicenniaofficinalis
uKv

Sonneratiacaseolaris
lr,

Lumnitzeraracemosa
nErh

Ceriopstagal(NT)
mxlKv

Nypafruticans(VU)
.xfmd,

Scyphiphorahydrophyllacea(VU)
l¿ lfvd,

Xylocarpusgranatum(EN)
uÜá lfvd,

Excoecariaagallocha(LC)
f;,$f;, lrh

Excoecariaindica(VU)
uyÿ lc

Aegicerascorniculatum(LC)
yk lfvd,

Heritieralittoralis(LC)
wegk

Similar to the previous set of photos, the photos here also must be labeled clearly to enable the reader to identify which is which.

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Socio - EcologicalConsequences of Illegal Cattle rearing and its eradication in Bundala National Park, Sri Lanka.

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INTRODUCTION

The Bundala National Park (08' N- 60 14'N and 810 08' E- 810 18' E), 6216 ha in extent, is located between the coast and the Hambanthota – Thissamaharama road via Veligattha and Bundala, in Hambanthota District. The park falls within the Southeastern Arid Zone of Sri Lanka, with a general climate that can be classified as hot and dry. Three streams: MalalaOya, Embilikala and KirindiOya discharge in to the park and adjacent areas. In addition a group of ancient small cascading tanks and several small, often temporary, water bodies are present, especially in the wet season which, are rainfed.The shallow brackish water lagoons located within the park – Koholankanla (390ha), Malala (650ha), Embilikala (430ha) and Bundala (520ha) and outside the park Mahalevaya (260ha), occupying total area of 2,250ha(Bambaradeniyaet. al., 2002) form a complex wetland system. Bundala National Park (BNP), an international RAMSAR site, and adjoining area is unique in environmental and cultural values. BNP is one of the destinations of international bird migratory routes in South Asia. Some activities such as fishing are allowed inside BNP considering traditional and cultural aspects.

Water level of these lagoons and other wetlands are highest when the rainfall peaks during the second inter monsoonal period, from October to November. Unless the sandbar break naturally, excess water is released to sea by breaking of the sandbar of the mouth of Malala lagoon in order to prevent inundation of houses and cultivations.The lagoons and other wetlands which are surrounded mainly by forest, scrub jungle and grasslands serve ideal habitats to a variety of fauna including wild mammals

In addition to wild mammals, introduction of livestock in to the park has been identified as a threat which to be addressed. Sending livestock in to the park is treated as an illegal activity by wildlife authorities. But still community around the park send their animals to graze in the park. Despite the available legal coverage, no successfulsolution has been found against this activity sofar.

When intense grazing occurs at riparian areas, overland flow (runoff) from cattle-grazed pastures adds nutrients mainly nitrate and phosphate to water bodies. Runoff from agricultural land through irrigation systems is another major means of nutrient influx to water bodies. There is a growing concern that lagoon system of Bundala National Park is under threat of eutrophication(De Silva et.al., 1998). In this article we discuss nutrient addition and other related implications of cattle rearing inside BNP.

MATERIALS AND METHODS

Present study aimed to identify the issues related to cattle grazing inside the park in order to propose some remedial measures. The main aim of the study was to investigate the nutrient addition to the park by dung and urine of cattle and domestic buffalos. The nutrient influx over irrigation systems to park water bodies was also calculated. Furthermore, findings from other studies were reviewed and briefed here.

An initial reconnaissance survey of the study area to identify different habitats which, cattle and domestic buffalos associated with them was carried out. From June 2005 to November 2006 over a period of nineteen months, observations wereconducted at monthly intervals. Survey was carried out from Veligattha junction to Bundala alone Hambanthota – Thissamaharama road via Bundala and then inside the park at lagoons and selected inland water bodies from 6.30 am to 5.30pm, where cattle and buffalos were recorded as sample head counts. Other park - livestock interactions were also observed. Questionnaire survey was conducted in surrounding villages and 163 families were interviewed. [Shorten]
Nitrate, phosphate and potassium in lagoon and inlet water were analysed over fifteen months. Amount of nutrients add to the park was calculated based on the head counts and nutrient information based on farm cattle and buffalos.

IMPLICATIONS AND RECOMMENDATIONS

Several threats have been identified.

- § Greater competition for wild grazers from cattle and domestic buffalos
- § Exceeding of the carrying capacity of Park by Large number of livestock living in the park.
- § Overgrazing leading to unproductive regions and Habitats destruction.
- § Soil compacting and erosion
- § Spread of diseases and invasive plants.
- § Nutrient inflow with dung and urine.

Competition for wild grazers

Wiled grazers such as Wild buffalo (Babalusarnee), Spotted deer (Axis axis), Samber (Cervus unicolor) have a direct competition for grazing resources with comparatively larger number of cattle and buffalo. Other herbivore and omnivore mammals in the park, Asian elephant (Elephasmaximus), Wild boar (Sus scrofa), Black-napped hare (Lepusnigricollis) also face indirect competition produced by cattle and buffalo. Grazing or foraging time of wild animals may differ from that of cattle and buffalo (C&B), but they share common feeding grounds. These C&B are not just enter to the park in the morning and leave at evening. They are residing in the park for long time, several months, forage, breed and head back to owners.

Overgrazing and Exceeding of the carrying capacity

C&B increase the competition among the grazing herbivores and exceeds the carrying capacity of the park. Carrying capacity here means the number of animals certain area can support without environment degradation. It has been found that certain studied areas of BNP has damaged due to over grazing, means carrying capacity has been exceeded in such areas. Calculation of Grazing pressure in two sites, Weiligattha and Bundala, has reviled that it causes heavy damaged to ground herbage cover (Bopitiyaet al, 1998).

Table. 01 Overgrazing, Herbage damage and Soil compacting at Weligattaand Bundala (Sourse: Bopitiyaet al 1998)

Site	Average number of livesock	Grazing pressure	Percentage ground herbage	Degree of overgrazing	Degree of soil compacting
Weligatta	1274	0.92	33.3	Heavy	Heavy
Bundala		0.73	88.1	Moderate	Low

* Grazing pressure=Rate of intake/Rate of herbage production

Soil Compacting and Erosion

Overgrazing heavily reduce herbage cover and make soil open. Continuous damage to the top layer of soil results dust and wash away with rain increasing soil erosion. In some places, especially near lagoons, increase soil compacting reducing micro habitat diversity.When hundreds of C&B walk on bare earth soil compact, crevices, small tunnels, mounds and other micro habitats are damaged and reduce soil aeration.

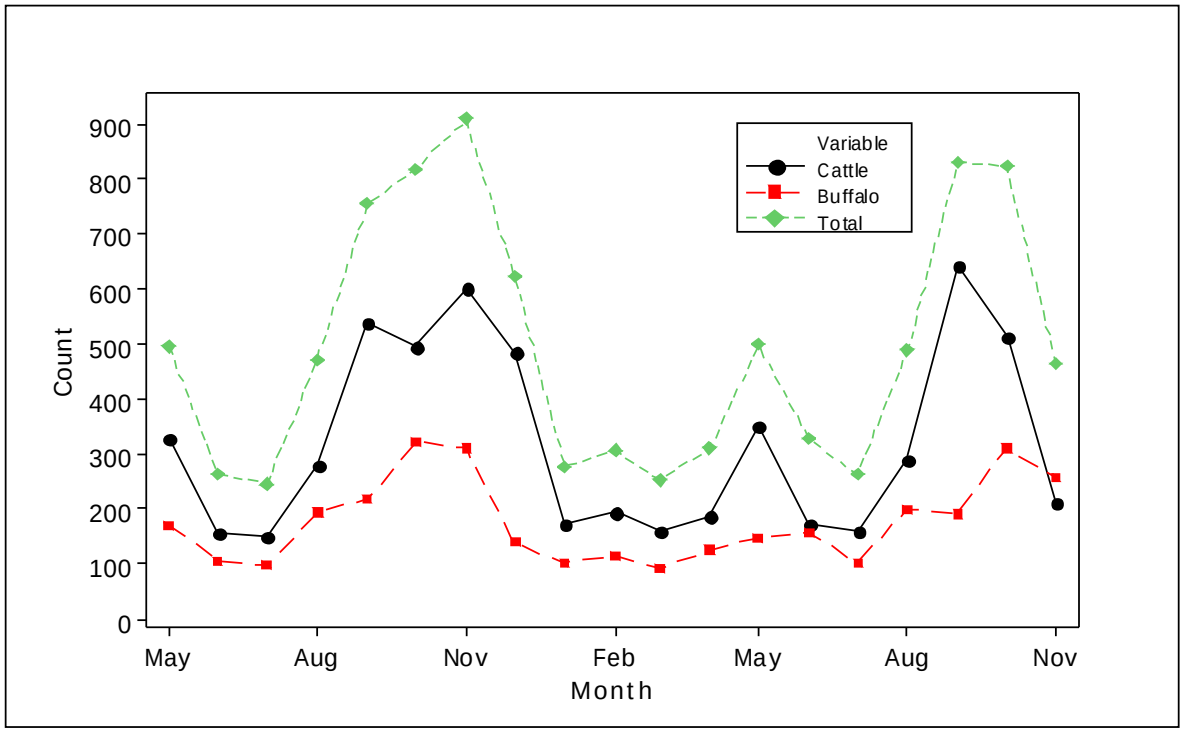

Figure 01. Dynamics of number of Cattle and Buffalo observed in the BNP.

Spread of diseases and invasive plants

There are 383 plant species documented in BNP with four endemics and three nationally threatened species. These also include fifteen invasive plant species (Bambaradeniyaet. al.2002). Roaming C&B are seed disperser, carry soil with seeds in their hooves, also feed on invasive plants such as Panicumpaximum and spread their seeds through dung. Also opotunistic feeders of prosophisjuliflorawich produce the hieghs threat to habitats in BNP. Dropping of dung on open grasslands and scrublands give opportunity for invasive plant species to spread fast in such suitable habitats. Furthermore C&B carry many diseases of mammals especially

Cattle and buffalo spread seeds of invasive plant species. Such animals potentially could introduce and spread infections into wild animals. Despite the distinction between wild and domestics buffaloes is not very clear (REFF),interbreeding between domestic and wild buffalo can causes bio-pollution.

Nutrient addition and Eutrophication

During the study period, daily cattle and buffalo counts varied between 148-601 and 91-321, respectively. Higher number of cattle and buffalos were encountered in November to January in each year.

Nitrate concentrations of Malala and Embilikala lagoons showed a strong positive correlation with nitrate in inlet water ($p<0.01$ and $p<0.05$) respectively. The maximum, minimum and average nitrate levels in ppm were(8.20, 1.10, 3.96), (3.3, 0.34, 1.30), (2.32, 0.32, 1.34) and (3.3, 0.33, 1.3) in inlets, Malala, Embilikala and Bundala lagoons respectively. The highest concentrations occur in waterinlets which is about three times of mean lagoon nitrate concentration, which evidenced that the high nutrient influx to lagoons. The total number of cattle and buffalo did not correlate with nitrate concentration of each month in lagoon water. But the long term accumulation of nutrients from urine and dung of C&Bincreases nutrient (NO-13, PO-34, NH+4) levels in water bodies favouring eutrophication.

Eradication and social impact

Only 13 respondents of 163 families (8%) indicated that they rear animals. None of the respondents rear pigs, nine indicated that they own cattle and 4 respondents own buffaloes. Cattle and buffaloes are used for curd production, and to get milk for domestic use. The total numbers all respondents indicated that they own were 314 cattle and 55 buffaloes. Eight of them have indicated that their animals get into the park for grazing. Most cattle owners were from Weligatta village,while one owner indicated that his animals live within the park for months. Majority of cattle owners also stated that their animals breed in an uncontrolled manner and they had no decent idea on the current numbers.

Bopitiyaet al (1998) reported that about 4000 cattle and 2000 buffaloes enter the park while Bambaradeniyaet al (2002) estimated about 5000 – 6000 buffaloes and 3000 – 4000 cattle, based on the information ofwildlife officers and villagers.Despite the maximum daily count in present survey is about 1000, our estimate of total C&Benter the park would not exceed that of Bopitiyaet al (1998). If both early estimates are reliable, number of C&B entering to the park has been increased during four years of time from 1998 to 2002.

Interview revealed that these large numbers of animals are owned by few people. Thus the eradication of cattle and domestic buffalos from BNP will not produce any social issue. In helping the parks to function with minimum such disturbances, the establishment of Grazing Grounds in State Lands (GGSL) and allowing farmers to rear cattle in GGSL under after licensing, and imposing heavy fines can be recommended.

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Aftermath of a silent invader: 'Dam manel'

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Water lilies:

Water lilies or 'Nymphaeas' are one of the most noticeable and eye catching plant groups inhabiting large water bodies in the lowlands of Sri Lanka together with *Nelumbo* ('Lotus', 'Nelum'). The genus *Nymphaea* belongs to the family Nymphaeaceae and is represented in Sri Lanka by *N. nouchali* ('Nil manel' or 'Manel') and *N. pubescens* ('Olu'). A recent study has identified and described the 'Rathu-Olu', a larger red-flowered Nymphaea species, that occurs in water bodies as N. rubra (Guruge et al., 2014). In addition to these native water lilies, few ornamental *Nymphaea species* have also been introduced in the past. Of these a violet-flowered *Nymphaea* ('Dam manel'), that has been erroneously identified as N. nouchali, the native water lily, in literature both locally and internationally (Yakandawala and Yakandawala, 2011), has got extensively established in natural water bodies. Interestingly, this is the flower that is often used to depict the national flower of Sri Lanka, *N. nouchali*, ('Nil Manel'). This violet flowered *Nymphaea* is a hybrid involving *N. capensis/N. caerulea* and N. micrantha during their parentage history.

This hybrid *Nymphaea* species with violet flowers was introduced to Sri Lanka for ornamental purposes and has escaped from the controlled environments to become naturalized. Although there are no records, its initial introduction would have been at least over 50 years ago. It is possible that several successive introductions had occurred. According to literature, many of the species that turned out to be successful in a new environment have done so either following an unusually long lag time after initial arrival, or after multiple introductions (Tiebre et al., 2007; Ellstrand and Schierenbeck, 2006). The violet-flowered *Nymphaea* may have had multiple introductions and it is also possible that all these introductions were not of the same hybrid but could have introgressed into a new hybrid. Natural hybridization often occurs whenever two or more species of *Nymphaea* occur together in the same water body. Hybrids that establish in this manner can be very successful invaders (Ellstrand and Schierenbeck, 2006). The fact that this plant has silently invaded water bodies of most parts of the low country at present exemplifies the phenomenon.

Native and the exotic in competition for habitats

The native *N. nouchali* is found in water bodies and wetlands in the lowlands, especially in the dry and intermediate zone, and it occurs towards the periphery of larger pools and tanks. This could be due to its shorter petiolated leaves and flowers (than the violet-flowered *Nymphaea*) which in turn limit the depth of the water that it could survive. The plant populations completely die-off after a growing season especially towards the dry season and new plants emerge with the onset of rainy season either from the rhizome or seeds. In contrast, the violet-flowered *Nymphaea* populations continue to grow without hindrance and also occupy a deeper territory in the water body compared to native N. nouchali. The most notable feature is its mode of reproduction which takes place via epiphyllous plantlets. Since the plant is a hybrid it does not produce viable seeds. Almost all mature leaves are capable of producing new plantlets. The term 'vivipary' has also been adopted to refer to the phenomenon (Wiersema 1987). A spongy textured nub that is initiated at the node where the leaf stalk joins the stem signals the initiation of epiphyllous plantlets. After 3-4 days, it becomes gelatinous, covered with mucilage, and soon shows signs of developing leaves. As the leaf lamina of the mother plant becomes older, the plantlets develop further. Once detached from the deteriorated lamina, it is a miniature of the parent and is capable of floating away and establishing as an independent plant on mud. Our observations indicated that early detachment from the mother plant speeds up the growth of the plantlets. These miniature plants are capable of blooming while attached to the mother plant. Compared to the native *N. nouchali*, the violet-flowered *Nymphaea* with longer petioles occupies a larger growing area and, due to this reason the new plantlets get established extending the territory away from the mother plant. While growing in waters with slow currents these are easily carried away to a new destination. This has led the violet-flowered *Nymphaea* to successfully expand its territory in local water bodies as a 'silent invader'.

Hybridization, another threat posed by the alien

Apart from competing for the habitat, this exotic water lily possess a threat to the native species by hybridization. Both *N. nouchali* and the violet-flowered *Nymphaea* species are day bloomers while *N. pubescens* and *N. rubra* are night bloomers. Both *N. nouchali* and the violet-flowered *Nymphaea* species bloom with the sunset and the flower closes towards the early afternoon enabling hybridization between the two species while in the same water body. This has led to the establishment of hybrid populations in many parts of the country. According to the literature, hybridization of natives with exotics is likely to displace the native and would even lead to the extinction of the native (Huxel, 1999; Ellstrand, 1992; Yakandawala and Yakandawala, 2011). Hybridization between the two water lilies might have been taking place over a long period in nature, producing hybrid populations with

mixed characters encountered locally. This has been over looked due to the incorrect identification of the alien violet flowered *Nymphaea* species as the native *N. nouchali* ('Nil manel') and subsequently its position as the national flower of Sri Lanka.

`Dam manel' acquiring `Nil manel' legacy

Native `Nil manel' (N. nouchali) has been admirably described in ancient Sanskrit, Pali and Sinhalese literature, under different names such as, 'Nilupul', 'Nilothpala' 'Kuvalaya' and 'Induwara' which have also been an inspiration in naming goddess and princess. The flower is graciously compared to the female eye in its beauty (Yakandawala and Yakandawala 2014 and references there in).

Buddhists lore claims that two floral symbols of `Nil Manel' appear among the 108 auspicious signs found on Prince Siddhartha's foot print. The flower is therefore considered as a symbol of virtue, discipline and purity.

Nymphaea nouchali has also been cultivated for food, as rhizomes are full of starch and quite tasty when boiled, roasted or cooked as curry (de Soyza 1936; Dassanayake 1996). The flower stalks are eaten as a vegetable. Rhizomes and seeds are also reputed for their medicinal value (Jayaweera 1982; Dassanayake 1996).

However, the establishment of alien and invasive `Dam manel' in the `Nil manel' territory and people's mind as the country's national flower, inevitably lead to `Dam manel' acquiring values and the legacy of `Nil manel', changing the perception of the society (Yakandawala and Yakandawala 2014).

Past and present scenario

According to the *Revised Handbook to the Flora of Ceylon* (Dassanayake, 1996), N. nouchali occurs particularly in ponds and tanks of the low country dry region and is often cultivated. During our long journey looking into the distribution of *N. nouchali,* we were able to record the 'pure' *N. nouchali* plant populations from all three major climatic zones of the country where hybrid populations were also encountered. Further, it was noted that they mostly occur in shallow pools, swamps or ditches and towards the shallow periphery of large tanks. Few populations were encountered in the dry zone where plants occurred towards the interior of the large water-bodies, and in such instances they produced comparatively large flowers. Even though Dassanayake (1996) stated that often populations are encountered in cultivation, it was interesting we did not encounter any *N. nouchali* plants in large-scale

cultivation during the present study but *Nymphaea species*, being the violet flowered species, was the one that was cultivated. According to Soyza (1936), with the launching of the 'Grow more food crops campaign' in the Kegalle range, *N. nouchali* (then known by the synonym, *N. stellata*) was planted in paddy fields that were left uncultivated. The flowers being the historically famed choice of floral offering that could be made at a Buddhist shrine, a fresh flower could be easily sold for one cent, often reaching five cents on festival days (Soyza, 1936). However, after more than 75 years, the situation has completely changed where the small, delicate native flowers of *N. nouchali* have been completely replaced by the exotic Nymphaea species with violet flowers, introduced into local landscaping. At present, an exotic violet-flowered *Nymphaea* is priced between 5-10 rupees depending on the demand and, during the off-season of the other flowers, it could even rise to 25 rupees, which is a considerably higher price. A recent study has indicated that the violet-flowered *Nymphaea* is the type of flower that is second-in demand in major Buddhist religious places in the country, next to the white-flowered Nelumbo nucifera ('Sudu nelum'). As the flowers are available throughout the year, the violet-flowered *Nymphaea* has a very good demand in the market during the off-season of other species offered. According to the study, majority (72.1%) of the vendors, were aware of the identity of true 'Nil manel' (Subashini et al., 2014). Another reason for its popularity is the hardiness of the flowers with minimum post-harvest loss (Subashini et al., 2014).

The violet-flowered *Nymphaea* is distributed in almost all climatic zones of the country, in the lowlands occupying preferred habitats/territories of the native. The hybrid populations are also expanding at the expense of the native where the 'pure' native *N. nouchali* populations are faced with a threat for survival.

False identification has allowed the violet-flowered *Nymphaea* to thrive in the prestigious position as the national flower of Sri Lanka. This has also gradually changed people's perception of the national flower and the violet-flowered *Nymphae*a continues to occupy a prominent place in cultural, official, social and religious events of the country. It has also established itself as an ornamental plant over the native *N. nouchali.* The present scenario will continue unless the native *N. nouchali* is revoked back to its position as the national flower of this country. However, there is only a little progress made, after almost four years since a nationwide call was made to rectify this mistake by concerned University-Botanists.

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'Dam-manel': The violet-flowered *Nymphaea* species which is the wrong flower **that is often used to depict the national flower of Sri Lanka, *N. nouchali*, ('Nil manel').**

***The native Nymphaea nouchali* ('Nil manel') the correct national flower of Sri Lanka**

'Dam-manel' with an epiphyllous plantlet, a very effective mode of reproduction

'Dam-manel' populations extending its territory in local water bodies with their very effective mode of reproduction via epiphyllous plants. Note the blooming of these miniature plants while attached to the mother plant. Marked with a red arrow are plantlets developed on mature leaves.

The hybrid populations between the native N. nouchali and 'Dam-manel' are also expanding at the expense of the native where the 'pure native N. nouchali' populations are faced with a threat for survival.

Assessment of Selected Classes of Fauna at Thalangama Wetland

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Study Area

The study area of the bio diversity assessment is a wet land area, known as the Thalangama wetlands consisting of a man built irrigation tank (reservoir), a few canalas, paddy fields and some marshlands. This study area is within 15km zone from Colombo city and is a one out of the two remaining irrigation tanks controlled by the Colombo divisional office of Irrigation Department. It's located between 6°53'16.99"N Latitude and 79°56'50.10"E Longitude. The nearest major city is Battaramulla.

The tank is called the Thalangama Tank.It was believed to be built during the era of King Parakramabahu VI (1551-1547 AD) for paddy cultivation and is situated close to the ancient city of Kotte.It is an important habitat for water birds, functioning as an urban biodiversity refuge, as it is surrounded by densely populated human settlements of the Colombo District.The tank is in the Madiwela catchment area within the Kelani river basin, which includes the Colombo flood detention area.The gross capacity of the tank is 50 Ac.Ft.The area consists of an irrigation area of 95 acres and non-irrigable area of 111 acres and provides water for more than 200 acres of nearby paddies.

Figure 1- The Study Area

Objectives of the study

Thalangama wetlands provide a diversity of habitats for both floral and faunal species yet it is not fully assessed for its total diversity. The faunal and floral species in manywetlands in and around Colombo are threatened due to various development projects andwetland conversions as well as by various environment pollutants. It can be assumed that thesechanges in and around this wetland area will adversely affect and threaten its bio-diversity.Hence a full survey to find out the remaining floral and faunal diversity of the area was a timelyneed. This study, covering the diversity of several classes of fauna is intended to fill this gap even though it is limited in time.

Time Period

The survey was carried out over a period of 14 months from 3rd February 2013 to 23rd March 2014 and covered all the seasons and weather conditions of the study area.The research team visited the area at least once a week and they have completed 63 day visits and 3 night visits during this period of time. Data collections in day visits were done during 0600hrs to 1800hrs and night visits were done during 2000hrs to 0100hrs.

Methods and Methodology

Butterflies and Dragonflies

Random transects directed throughout the site has been used to identify the species and to count their abundance.A separate study was made to find out the butterfly feedingplants and the larval feeding plants and their early stages were recorded to confirm the breeding in the area, and information on species biology.

Herpetofauna

Visual Encounter Surveys (VES) and Quadrate Cleaning Technique (QCT) were used to identifythe herpetofauna species and their abundance.Quadrates measuring 10 x 10 m sized were randomlydistributed throughout the study area and then all the amphibian and reptile species within quadrates were identified using field guide.

Birds

The Variable Circular Plot (VCP) method was used in the present survey.The birds seen or heard within the VCP were used to calculate the diversity and abundance of species.The team

madeobservations from the naked eye and binoculars as well as used Digital SLR cameras to photograph birds, for keeping records and to confirm identifications when necessary.

Mammals

Direct observations and indirect methods(scats,pellets,droppings,tracks) were used to identify mammals.Abundance of each species was carried out by direct observations.

Status criterion for the species of the study area

The conservation status of each species that was recorded in the study area wascategorized by referring to the National Red List of 2012.Final counts of the abundance of each species were made after analyzing the collected data and then by dividing each one of the species into one of the three separate categories.

I . Very Rare – (VR)
II . Rare – (R)
III .Common – (C)

VERY RARE

If theabundance was less than 10 individuals or / and if a species was found in one specific and limited habitat or / and If the species was categorized as endangered / critically endangered or vulnerable in National Red List 2012, then the species is categorized as Very Rare.

RARE

When the individual count is between 11- 40, the species is categorized as Rare.

COMMON

If the individual count is more than 40 or / and if the species was found from various habitatsthen they were categorized as Common.

Results

Butterflies

The Checklist of Butterflies recorded in the Thalangama Wetlands

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
	Family- Papilionidae			
1	*Graphium agamemnon*	Tailed Jay	C	LC
2	*Pachliopta aristolochiae*	Common Rose	C	LC
3	*Pachliopta hector*	Crimson Rose	C	LC
4	*Papilio clytia*	Mime	C	LC
5	*Papilio demoleus*	Lime Butterfly	C	LC
6	*Papilio polymnestor*	Blue Mormon	R	LC
	Family- Pieridae			
7	*Appias galene*	Sri Lanka Lesser Albatross	VR	LC
8	*Catopsilia pomona*	Orange Migrant	C	LC
9	*Catopsilia pyranthe*	Mottled Emigrant	C	LC
10	*Catopsilia scylla*	Orange Migrant	R	LC
11	*Delias eucharis*	Jezebel	C	LC
12	*Leptosia nina*	Psyche	C	LC
	Family- Nymphalidae			
14	*Acraea violae*	Tawny Coster	C	LC
15	*Ariadne ariadne*	Angled Castor	R	LC/M
16	*Danaus chrysippus*	Plain Tiger	C	LC/ M
17	*Danaus genutia*	Common Tiger	C	LC/M
18	*Elymniashyp ermnestra*	Common Palmfly	C	LC
19	*Euploea core*	Common Indian Crow	C	LC
20	*Euploea phaenareta*	King Crow	C	LC
21	*Hypolimnas bolina*	Great Eggfly	C	LC
22	*Hypolimnas misippus*	DanaidEggfly	R	LC/M
23	*Ideopsis similis*	Blue Glassy Tiger	C	VU

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
24	*Junonia atlites*	Grey Pansy	C	LC
25	*Junonia iphita*	Chocolate Soldier	C	LC
26	*Junonia almana*	Peacock Pansy	C	LC
27	*Melanitis leda*	Common Evening Brown	C	LC
28	*Mycalesis mineus*	Dark-Brand Bushbrown	C	LC
29	*Mycalesis perseus*	Common Bushbrown	C	LC
30	*Neptis hylas*	Common Sailor	C	LC
31	*Neptis jumbah*	Chestnut-streaked Sailor	C	LC
32	*Orsotriaen amedus*	Medus Brown	C	LC
33	*Parantica aglea*	Glassy Tiger	C	LC
34	*Phalanta phalantha*	Leopard	C	LC
35	*Tirumala limniace*	Blue Tiger	C	LC
36	*Ypthima ceylonica*	White Four-ring	VR	LC
	Family- Lycaenidae			
37	*Anthene lycaenina*	Pointed Ciliate Blue	R	LC
38	*Arhopa laamantes*	Large Oakblue	C	LC
39	*Chilades lajus*	Lime Blue	C	LC
40	*Chilades pandava*	Plains Cupid	C	LC
41	*Curetis thetis*	Indian Sunbeam	VR	LC/M
42	*Deudorix epijarbas*	Cornelian	R	VU
43	*Euchrysops cnejus*	Gram Blue	C	LC/M
44	*Everesl acturnus*	Indian Cupid	C	LC
45	*Jamide sbochus*	Dark Cerulean	C	LC
46	*Jamides celeno*	Common Cerulean	C	LC
47	*Prosotas dubiosa*	Tailless Lineblue	C	LC
48	*Rathinda amor*	Monkey-puzzle	C	LC
49	*Spalgis epeus*	Apefly	C	LC
50	*Tajuria cippus*	Peacock Royal	C	LC

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
51	*Talicada nyseus*	Red Pierrot	C	LC
52	*Zesiuschrysomallus Hübner*	Redspot	R	LC
53	*Zizeeriakarsandra*	Dark Grass Blue	C	LC
54	*Zizinaotis Fabricius*	Lesser Grass Blue	C	LC
55	*Zizula hylax*	Tiny Grass Blue	C	LC
56	*Rapala varuna*	Indigo Flash	VR	VU
57	*Iraota timoleon*	Silverstreak Blue	VR	NT
	Family- Hesperiidae			
58	*Ampittia dioscorides*	Bush Hopper	C	LC
59	*Borbo cinnara*	Wallace's Swift	C	LC
60	*Caprona ransonnettii*	Golden Angle	C	LC
61	*Hasora chromus*	Common Banded Awl	R	LC/M
62	*Iambrix salsala*	Chestnut Bob	C	LC
63	*Matapa aria*	Common Redeye	C	LC
64	*Oriens goloides*	Common Dartlet	C	NT
65	*Parnara bada*	Smallest Swift	C	NT
66	*Pelopidas agna*	Little Branded Swift	C	NT
67	*Potanthus confuscius*	Tropic Dart	C	LC
68	*Suastus gremius*	Indian Palm Bob	C	LC
69	*Tagiades japetus*	Ceylon Snow Flat	C	LC
70	*Taractroce ramaevius*	Common Grass Dart	C	LC
71	*Telicota bambusae*	Dark Palmdart	C	VU
72	*Udaspes folus*	Grass Demon	C	LC
	Family- Riodinidae			
73	*Abisara echerius*	Plum Judy	R	LC

C-Common; R-Rare; VR-Very Rare; *Bold-Endemic; M-Migrant; EN-Endangered; VU-Vulnerable; NT-Near Threatened LC-Least Concern

Damselflies and Dragonflies

The Checklist of Damselflies and Dragonflies recorded in the Thalangama Wetlands

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
	Family - Chlorocyphidae			
* 1	*Libellago adami*	Sri Lanka Adam's Gem	R	VU
	Family- Lestidae			
2	*Lestes elatus*	White Tipped Spreadwing	R	LC
	Family - Coenagrionidae			
3	*Agriocnemis pygmaea*	Wandering Wisp	C	LC
4	*Onychargia atrocyana*	Marsh Dancer	R	VU
5	*Paracercion malayanum*	Malay Lilysquatter	C	LC
6	*Ischnura senegalensis*	Common Bluetail, Marsh Bluetail	C	LC
7	*Ceriagrion cerinorubellum*	Painted Waxtail	C	VU
8	*Ceriagrion coromandelianum*	Yellow Waxtail	C	LC
9	*Pseudagrion malabaricum*	Malabar Sprite	C	LC
10	*Pseudagrion microcephalum*	Blue Sprite	C	LC
11	*Pseudagrion rubriceps*	Sri Lanka Orange-faced Sprite	C	LC
	Family- Platycnemididae			
12	*Copera marginipes*	Yellow Featherleg	C	LC
	Family - Protoneuridae			
* 13	*Prodasineura sita*	Sri Lanka Stripe-headed Threadtail	R	LC
	Family - Gomphidae			
* 14	*Macrogomphus lankanensis*	Sri Lanka Forktail	VR	EN
15	*Ictinogomphus rapax*	Rapacious Flangetail	C	LC
	Family - Aeshnidae			
16	*Gynacantha dravida*	Indian Duskhawker	R	NT
	Family - Libellulidae			
17	*Brachydiplax sobrina*	Sombre Lieutenant	R	LC
18	*Lathrecista asiatica*	PruinosedBloodtail	R	NT

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
19	*Orthetrum chrysis*	Spine-tufted Skimmer	C	VU
20	*Orthetrum luzonicum*	Marsh Skimmer	C	NT
21	*Orthetrum pruinosum*	Pink Skimmer	C	NT
22	*Orthetrum sabina*	Green Skimmer	C	LC
23	*Acisoma panorpoides*	Asian Pintail	C	LC
24	*Brachythemis contaminata*	Asian Groundling	C	LC
25	*Bradinopyga geminata*	Indian Rockdweller	R	LC
26	*Crocothemis servilia*	Oriental Scarlet	C	LC
27	*Diplacodes nebulosa*	Black-tipped Percher	C	NT
28	*Diplacodes trivialis*	Blue Percher	C	LC
29	*Neurothemis tullia*	Pied Parasol	C	LC
30	*Rhodothemis rufa*	Spine-legged Redbolt	R	NT
31	*Trithemis aurora*	Crimson Dropwing	C	LC
32	*Trithemis pallidinervis*	Dancing Dropwing	R	NT
33	*Onychothemis tonkinensis*	Aggressive Riverhawk	VR	EN
34	*Rhyothemis triangularis*	Sapphire Flutterer	VR	VU
35	*Rhyothemis variegata*	Variegate Flutterer	C	LC
36	*Pantala flavescens*	Globe Skimmer/ Wandering Glider	C	LC/M
37	*Tramea limbata*	Sociable Glider	C	LC
38	*Tholymis tillarga*	Foggy-winged Twister	R	LC
39	*Zyxomma petiolatum*	Dingy Duskflyer	R	NT
40	*Aethriamanta brevipennis*	Elusive Adjutant	R	LC
41	*Urothemis signata*	Scarlet Basker	C	LC

C-Common; R-Rare; VR-Very Rare; *Bold-Endemic; M-Migrant; EN-Endangered; VU-Vulnerable; NT-Near Threatened LC-Least Concern

Amphibians

The Checklist of Amphibians recorded in the Thalangama Wetlands.

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
	Family - Bufonidae			
1	*Duttaphrynus melanostictus*	Common house toad	C	LC
	Family -Ranidae			
2	*Euphlyctis cyanophlyctis*	Skipper frog	C	LC
3	*Euphlyctis hexadactylus*	Six toe green frog	C	LC
4	*Fejervarya limnocharis*	Common paddy field frog	C	LC
5	*Hylarana aurantiaca*	Golden frog	R	EN
* 6	*Hylarana gracilis*	Sri Lanka wood frog	C	LC
	Family -Microhylidae			
7	*Kaloula taprobanica*	Sri Lankan bullfrog	C	LC
* 8	*Pseudophilautus popularis*	Common shrub frog	R	NT
9	*Polypedates cruciger*	Common hourglass tree frog	C	LC
10	*Polypedates maculatus*	Spotted tree frog	C	LC

C-Common; R-Rare; VR-Very Rare; *Bold-Endemic; EN-Endangered; VU-Vulnerable;
NT-Near Threatened LC-Least Concern;

Reptiles

The Checklist of Reptiles recorded in the Thalangama Wetlands.

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
	Family - Bataguridae			
1	*Melanochelys trijuga*	Black turtle	R	LC
	Family - Trionychidae			
* 2	*Lissemys ceylonensis*		R	LC
	Family - Agamidae			
3	*Calotes calotes*	Green garden lizard	C	LC
4	*Calotes versicolor*	Home garden lizard	C	LC
	Family - Gekkonidae			
5	*Hemidactylus frenatus*	Common house-gecko	C	LC
6	*Hemidactylus parvimaculatus*	Spotted housegecko	C	LC
7	*Gehyra mutilata*	Four-claw gecko	C	LC
	Family - Scincidae			
* 8	*Lankascincus fallax*	Common lankaskink	C	LC
9	*Lygosoma punctatus*	Dotted skink	R	LC
10	*Eutropis carinata*	Common skink	C	LC
	Family - Varanidae			
11	*Varanus bengalensis*	Land monitor	C	LC
12	*Varanus salvator*	Water monitor	C	LC
	Family - Cylindrophidae			
* 13	*Cylindrophis maculate*	Pipe snake	VR	NT
	Family - Colubridae			
14	*Ahaetulla nasuta*	Green vine snake	R	LC
15	*Coeloganthus helena*	Trinket snake	VR	LC
* 16	*Dendrelaphis schokari*	Common bronze back	C	LC
17	*Lycodon aulicus*	Wolf snake, house snake	C	LC
* 18	*Lycodon osmanhilli*	Flowery wolf snake	C	LC

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
19	*Oligodon arnensis*	Common kukri snake	VR	LC
* 20	*Oligodonsublineatus*	Dumerul'skuki snake	VR	LC
21	*Ptyas mucosa*	Rat snake	C	LC
	Family -Natricidae			
22	*Amphiesma stolatum*	Buff striped keelback	R	LC
* 23	*Xenochrophis asperrimus*	The checkered keelback	C	LC
24	*Xenochrophis piscator*	Checkered Keelback	C	LC
	Family – Elapidae			
25	*Naja naja*	Indian cobra	C	LC
	Family - Typhlopidae			
26	*Ramphotyphlops braminus*	Common blind snake	VR	LC
	Family -Viperidae			
27	*Daboia russelii*	Russell's viper	VR	LC
* 28	*Hypnale hypnale*	The Merrem's Hump nose	R	LC

C-Common; R-Rare; VR-Very Rare; *Bold-Endemic; M-Migrant; EN-Endangered; VU-Vulnerable; NT-Near Threatened LC-Least Concern

Birds

The Checklist of Birds recorded in the Thalangama Wetlands.

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
	Family – Anatidae			
1	*Dendrocygna javanica*	Lesser Whistling-duck	C	LC
	Family - Pelecanidae			
2	*Pelecanus philippensis*	Spot-billed pelican	C	LC
	Family –Picidae			
3	*Dendrocopos nanus*	Brown-capped Woodpecker	R	LC
4	*Dinopium benghalense*	Black-rumped Flameback	C	LC
	Family- Ramphastidae			
5	*Megalaima zeylanica*	Brown-headed Barbet	C	LC
* 6	***Megalaima rubricapillus***	Crimson-fronted Barbet	C	LC
	Family- Alcedinidae			
7	*Alcedo atthis*	Common Kingfisher	C	LC
8	*Pelargopsis capensis*	Stork-billed Kingfisher	R	LC
9	*Halcyon smyrnensis*	White-Throated	C	LC
10	*Ceryle rudis*	Pied Kingfisher	C	LC
	Family-Meropidae			
11	*Merops philippinus*	Blue-tailed Bee-eater	C	M
12	*Merops leschenaulti*	Chestnut-headed Bee-eater	R	LC
	Family- Cuculidae			
13	*Clamator jacobinus*	Pied Cuckoo	C	LC
14	*Cuculus micropterus*	Indian Cuckoo	VR	M
15	*Clamator caramandus*	Chesntut-winged Cuckoo	VR	M
16	*Cuculus varius*	Common Hawk-cuckoo	R	EN
17	*Eudynamys scolopaceus*	Asian Koel	C	LC
18	*Centropus sinensis*	Greater Coucal	C	LC

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
	Family-Psittacidae			
* 19	***Loriculusberyllinus***	**Sri Lanka HangingParrot**	C	LC
20	*Psittacula krameri*	Rose-ringed Parakeet	C	LC
	Family- Apodidae			
21	*Collocalia unicolor*	Indian Swiftlet	C	LC
22	*Cypsiurus balasiensis*	Asian Palm-swift	C	LC
23	*Apusa ffinis*	Little Swift	C	LC
	Family- Tytonidae			
24	*Otus bakkamoena*	Collared Scops-owl	C	LC
25	*Ketupa zeylonensis*	Brown Fish-owl	VR	LC
26	*Ninox scutulata*	Brown Hawk-owl	R	LC
	Family-Columbidae			
27	*Stigmatope liachinensis*	Spotted Dove	C	LC
28	*Ducula aenea*	Green Imperial-Pigeon	C	LC
	Family- Rallidae			
29	*Amaurornis phoenicurus*	White-breastedWaterhen	C	LC
30	*Gallirallus triatus*	Slaty-breasted Rail	VR	VU
31	*Gallicrex cinerea*	Watercock	VR	NT
32	*Porphyrio porphyrio*	Purple Swamphen	C	LC
33	*Gallinula chloropus*	Common Moorhen	R	LC
34	*Rostratula benghalensis*	Greater Painted-Snipe	R	VU
	Family- Jacanidae			
35	*Hydrophasia nuschirurgus*	Pheasant-Tailed Jacana	C	LC
	Family- Recurvirostridae			
36	*Himantopush imantopus*	Black-Winged Stilt	C	LC
	Family-Charadriidae			
37	*Charadrius dubius*	Little Ringed Plover	C	M
38	*Charadrius alexandrinus*	Kentish Plover	R	M

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
39	*Vanellus indicus*	Red-Wattled Lapwing	C	LC
	Family: Laridae			
40	*Chlidonia shybridus*	Whiskered Tern	C	M
	Family- Accipitridae			
41	*Pernispti lorhyncus*	Oriental HoneyBuzzard	VR	NT
42	*Halia sturindus*	Brahminy Kite	C	LC
43	*Haliaeetus leucogaster*	White-Bellied Seaeagle	C	LC
44	*Spilornis cheela*	Crested Serpent-eagle	C	LC
45	*Accipiter badius*	Shikra	C	LC
46	*Accipiter virgatus*	Besra	R	VU
47	*Spizaetus cirrhatus*	Changeable Hawkeagle	R	LC
	Family- Podicipedidae			
48	*Tachybaptus ruficollis*	Little Grebe	C	LC
	Family-Anhingidae			
49	*Anhinga melanogaster*	Oriental Darter	R	LC
	Family-Phalacrocoracidae			
50	*Phalacrocorax carbo*	Great Cormorant	R	NT
51	*Phalacrocorax niger*	Little Cormorant	C	LC
52	*Phalacrocorax fuscicollis*	Indian Cormorant	C	LC
	Family-Ardeidae			
53	*Egretta garzetta*	Little Egret	C	LC
54	*Ardea cinerea*	Grey Heron	C	LC
55	*Ardea purpurea*	Purple Heron	C	LC
56	*Casmerodiusalbus*	Great Egret	C	LC
57	*Mesophoyx intermedia*	Intermediate Egret	C	LC
58	*Bubulcus ibis*	Cattle Egret	C	LC
59	*Ardeo lagrayii*	Indian Pond-heron	C	LC
60	*Butorides striata*	Striated Heron	VR	LC

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
61	*Nycticorax nycticorax*	Black-Crowned Nightheron	R	NT
62	*Ixobrychus sinensis*	Yellow Bittern	C	NT
63	*Ixobrychus cinnamomeus*	Cinnamon Bittern	VR	NT
64	*Ixobrychus flavicollis*	Black Bittern	R	LC
	Family- Threskiornithidae			
65	*Plegadis falcinellus*	Glossy Ibis	VR	M
66	*Threskiornismel anocephalus*	Black-headed Ibis	C	LC
	Family- Ciconiidae			
67	Mycterial eucocephala	Painted Stork	C	LC
68	Anastom usoscitans	Asian Openbill	C	LC
	Family - Laniidae			
69	*Lanius cristatus*	Brown shrike	C	M
	Family-Laniidae			
70	*Corvus splendens*	House Crow	C	LC
71	Corvus levaillantii	Jungle Crow	C	LC
	Family-Artamidae			
72	*Artamus fuscus*	Ashy Woodswallow	C	LC
	Family-Oriolidae			
73	*Oriolus xanthornus*	Black Hooded Oriole	C	LC
	Family- Campephagidae			
74	*Pericrocotus cinnamomeus*	Small Minivet	C	LC
	Family- Dicruridae			
75	*Dicrurus caerulescens*	White Bellied Drongo	C	LC
	Family- Monarchiidae			
76	*Terpsiphone paradisi*	Asian ParadiseFlycatcher	C	LC
	Family- Aegithinidae			
77	*Aegithina tiphia*	Common Iora	C	LC

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
	Family-Muscicapidae			
78	*Copsychus saularis*	Oriental Magpie Robin	C	LC
79	*Saxicoloides fulicatus*	Indian Robin	C	LC
	Family- Sturnidae			
80	*Acridotheres tristis*	Common Myna	C	LC
	Family- Hirundinidae			
81	*Hirundo rustica*	Barn swallow	C	M
* 82	*Hirundo hyperythra*	Red rumped swallow	C	LC
	Family- Pycnonotidae			
83	*Pycnono tusluteolus*	White Browed Bulbul	C	LC
84	Pycnono tuscafer	Red Vented Bulbul	C	LC
	Family-Cisticolidae			
85	*Cisticola juncidis*	ZittingCisticola	C	LC
86	*Prinia inornata*	Plain Prinia	C	LC
	Family-Muscicapidae			
87	*Muscicapa dauurica*	Asian brown flycatcher	C	M
	Family- Zosteropidae			
88	*Zosterops palpebrosus*	Oriental White Eye	C	LC
	Family-Sylviidae			
89	*Acrocephalus stentoreus*	Clamorous ReedWarbler	R	NT
90	*Orthotomus sutorius*	Common Tailorbird	C	LC
	Family-Timaliidae			
91	*Rhopocichla atriceps*	Dark-fronted babbler	VR	LC
92	*Turdoides affinis*	Yellow Billed Babbler	C	LC
	Family-Dicaeidae			
93	*Dicaeumery throrhynchos*	Pale BilledFlowerpecker	C	LC
	Family- Nectariniidae			
94	*Nectarinia zeylonica*	Purple Rumped Sunbird	C	LC

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
95	*Nectarinia lotenia*	Long Billed Sunbird	C	LC
	Family- Passeridae			
96	*Passer domesticus*	House Sparrow	C	LC
	Family-Motacillidae			
97	*Dendronanthus indicus*	Forest wagtail	C	M
98	*Motacilla cinerea*	Grey wagtail	C	M
99	*Anthus rufulus*	Paddyfield Pipit	C	LC
	Family- Estrildidae			
100	*Lonchura striata*	White RumpedMunia	C	LC
101	Lonchura punctulata	Scaly BreastedMunia	C	LC
	Family - Pittidae			
102	Pitta brachyuran	Indian pitta	R	M

C-Common; R-Rare; VR-Very Rare; *Bold-Endemic; M-Migrant; EN-Endangered; VU-Vulnerable; NT-Near Threatened LC-Least Concern

Mammals

The Checklist of Mammals recorded in the Thalangama Wetlands.

No.	Sceintific Name	Common Name	Status in the Thalangama wetlands	Red List Status
	Family - Pteropodidae			
1	*Pteropus giganteus*	Flying fox	C	LC
	Family : Felidae			
* 2	*Prionailuru srubiginosus*	Rusty-spotted Cat	VR	EN
	Family - Vespertillionidae			
3	*Pipistrellus tenuis*	Pigmy pipistrel	C	LC
4	*Kerivoula picta*	Painted bat	CC	LC
	Family - Cercopithecidae			
* 5	*Semnopithecus vetulus nestor*	Sri Lanka Purple-faced Langur	VR	CR
	Family - Herpestidae			
6	*Herpestes brachyurus*	Brown mongoose	C	LC
	Family : Mustelidae			
7	*Lutra lutra*	Otter	VR	VU
	Family - Viverridae			
8	*Paradoxurus hermaphoditus*	Palm cat	R	LC
9	*Viverricula indica*	Ring-tailed civet	R	LC
	Family - Hystricidae			
10	*Hystrix indica*	Porcupine	R	LC
	Family - Muridae			
11	*Bandicota bengalensis*	Mole rat	R	LC
12	*Bandicota indica*	Malabar bandicoot	R	LC
13	*Rattus rattus*	Common rat	C	LC
	Family - Sciuridae			
14	*Funambulus palmarum*	Palm squirrel	C	LC
	Family - Soricidae			
15	*Suncus murinus*	Common musk shrew	C	LC

C-Common; R-Rare; VR-Very Rare; *Bold-Endemic; M-Migrant; EN-Endangered; VU-Vulnerable; NT-Near Threatened LC-Least Concern

Figures &Diagrams

Figure 02
The Grey pansy
Photo: EeshadhariUdadini

Figure 03
TheCornalean
Photo: D.Randula

Figure 04
TheMonkey-puzzle
Photo: D.Randula

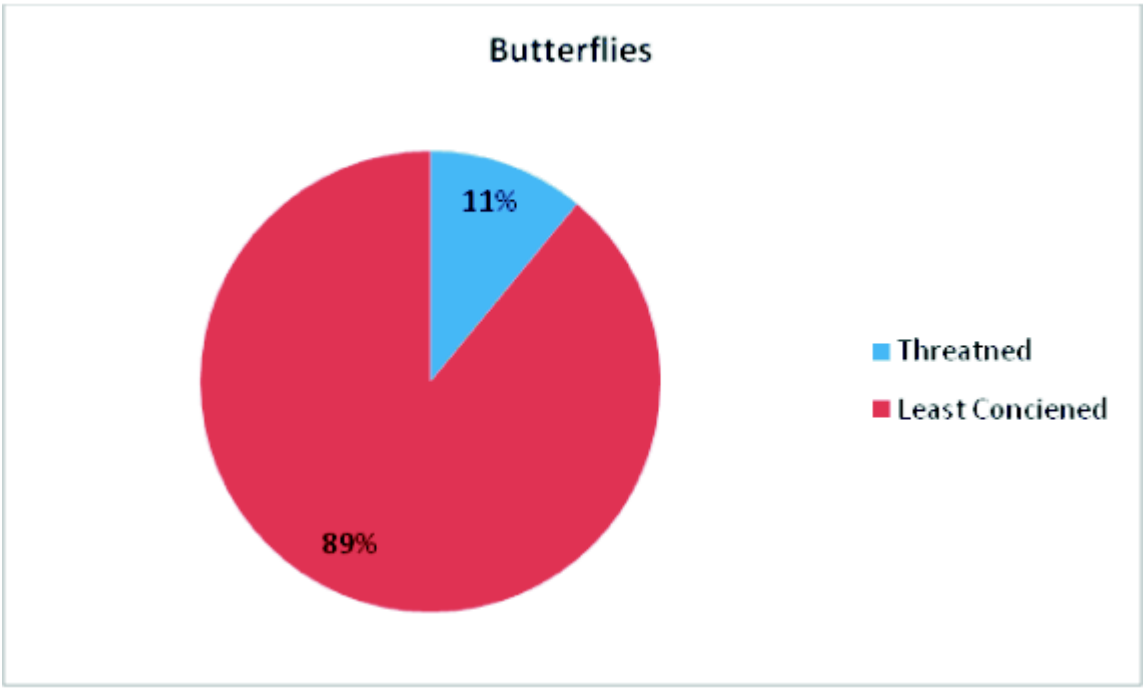

Diagram 01
Threatened species level

A total of 73 species of butterflies were recorded during the study period. This comprises a total of 08 species (11%) that are included in the threatened categories of the red data list.

Figure 05
The endangered Sri Lanka Forktail
Photo: D.Randula

Figure 06
Adams' Gem
Photo: D.Randula

Figure 07
Stripe-headed Threadtail
Photo: KasuniAnuththara

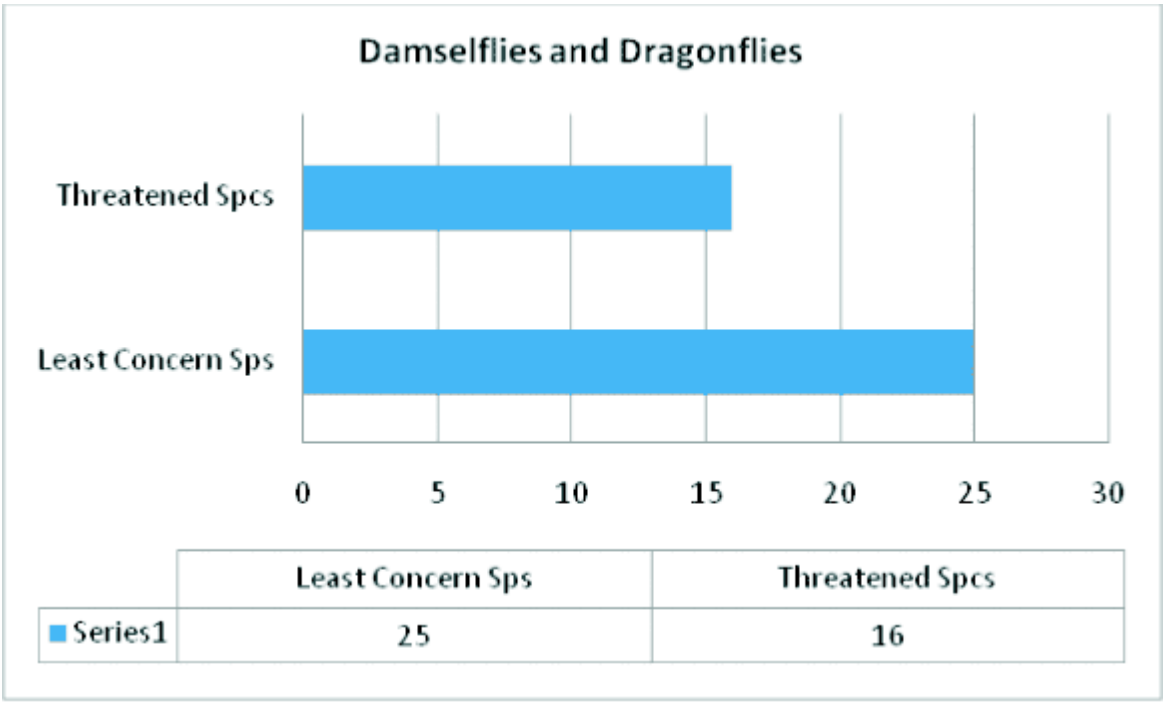

Diagram 02
Threatened species level of recorded Odonates.

A total of 41 species of Damselflies and Dragonflies were recorded from the study area which included 16 threatened species and 25 least concern species.

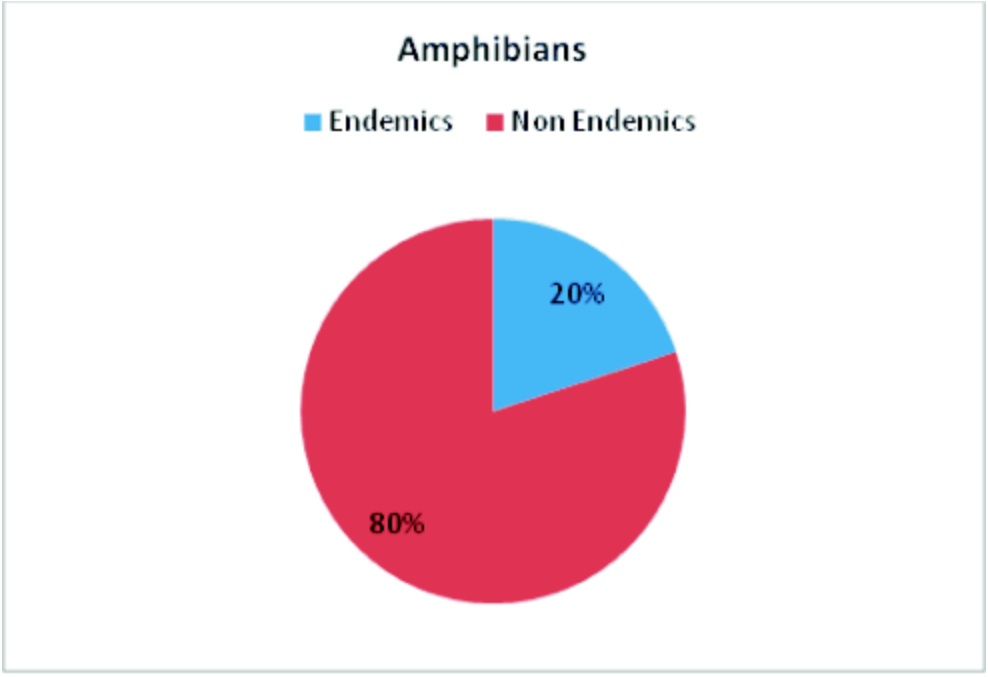

Diagram 03

Percentages of Endemicsand Non-endemics of recorded amphibians

A total of 10 species of Amphibians including 20% endemics and 80% non endemics werefound.

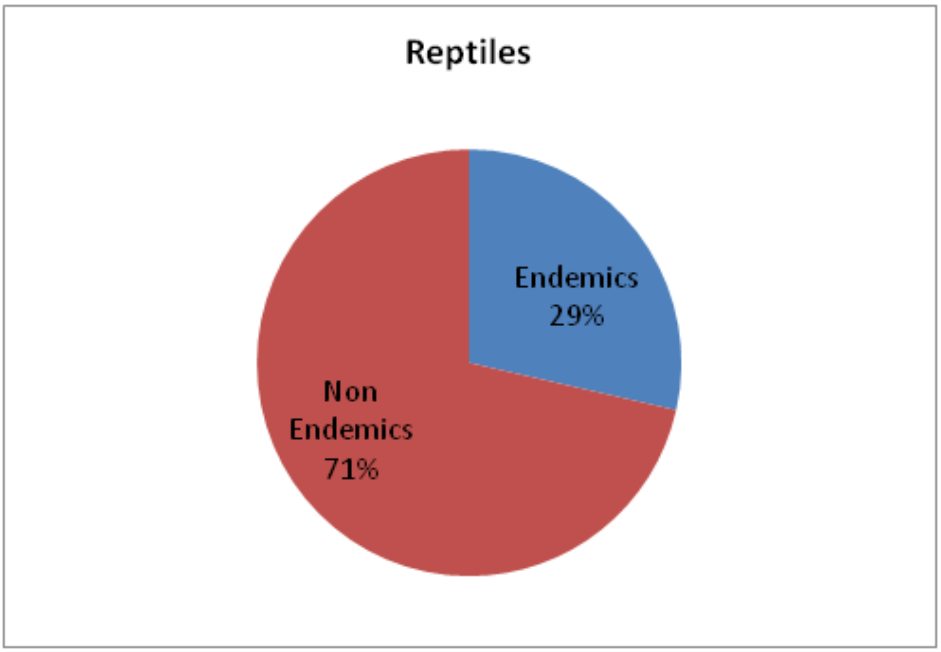

Diagram 04

Percentages of Endemics and Non-endemics of recorded reptiles

A total of 28 species of reptiles including 29% endemics while 71% non endemics.

Figure 02
Glossy Ibis
at Thalangama Wetland
Photo: SujeevaGunasena

Figure 03
Purple Coot
at Thalangama Wetland
Photo: DivankaRandula

Figure 04
Painted Stork
at Thalangama Wetland
Photo: DivankaRandula

Figure 05
Lesser-whistling Ducks
at Thalangama Wetland
Photo: UdariPeiris

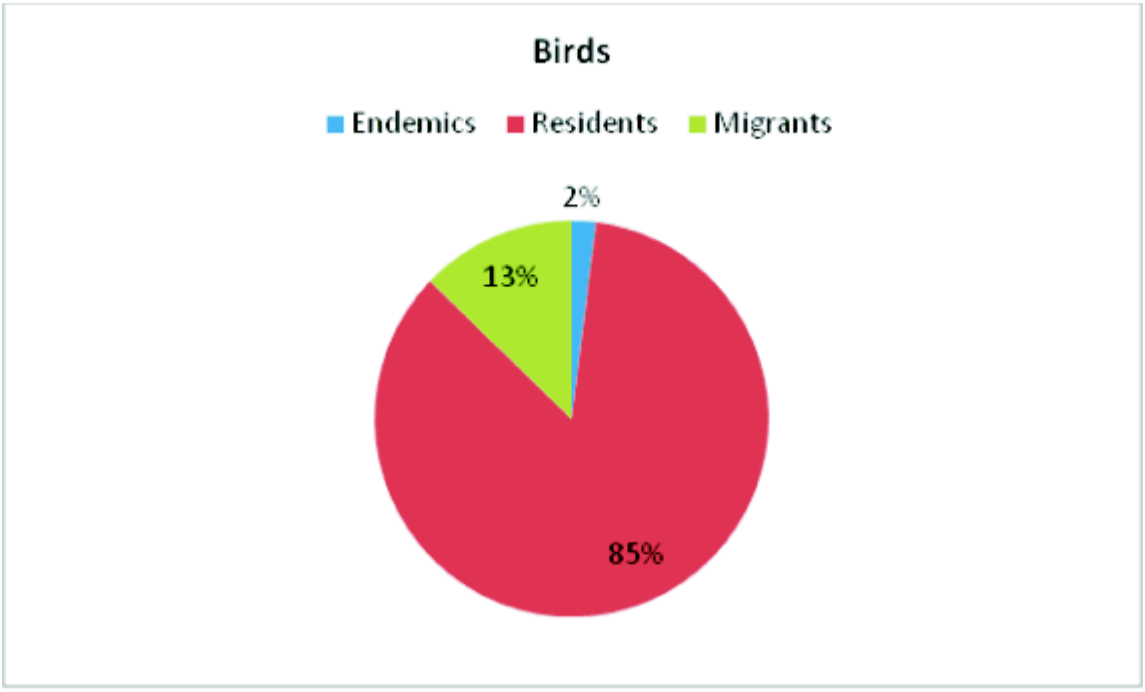

Diagram 05
Percentage Chart of Total recorded avifauna

A total of 102 species of birds including 2% endemics, 13% migrants and 85% residents were recorded.

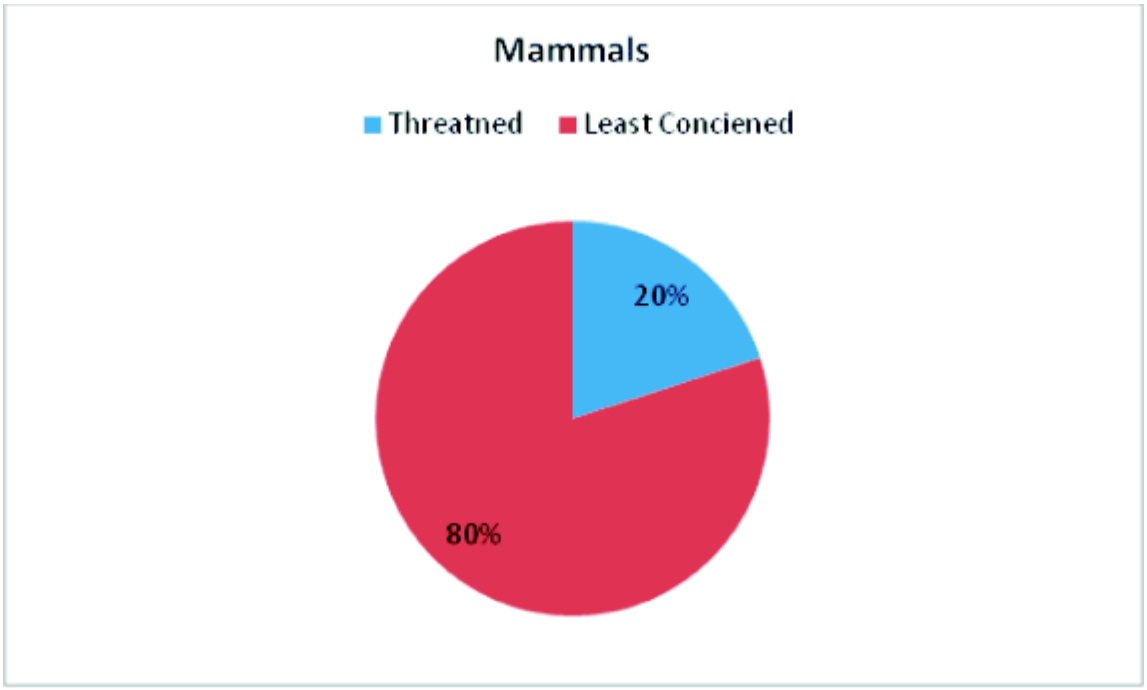

Diagram 06
Threatened species level of recorded mammal species

A total of 16 species of mammals including 03 threatened species (20%)were recorded.

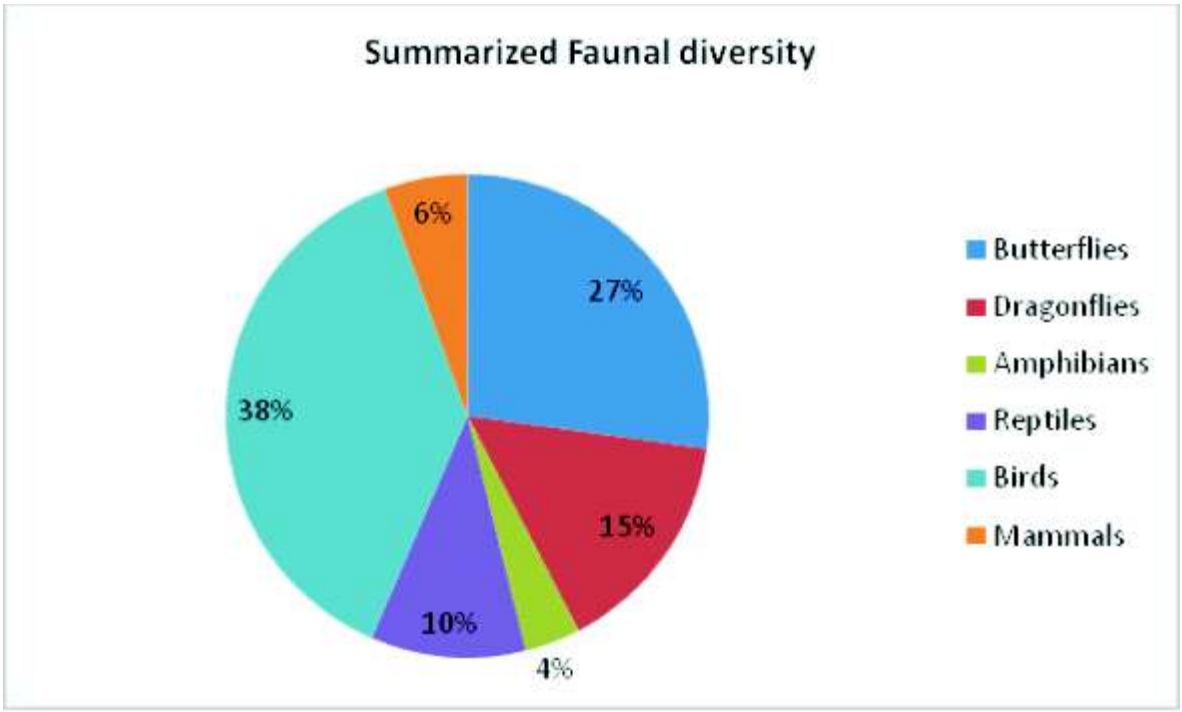

Diagram 07
Faunal diversity in Thalangama.

Highest number of diversty shows in birds while the least number of diversity shows in amphibians. Butterflies and dragonflies are among the most abundant groups of diversity and the rest of the faunal diversity is in minute values.

Discussion

A total of 102 species of birds including 02 endemics were recorded during the study period.This includes a total of 11 species that are included in the threatened categories of the red data list.

Of the total, 90 species were residents and 13 species were winter migrants to the country.It was observed that four species;the Black-winged Stilt, Indian Pond Heron, Cattle Egret, and Lesser Whistling Teal show a great increasment in their numbers during the winter months and a corresponding increase in numbers was observed in adjoining areas such as Thalawathugoda paddy fields, Thalapathpitiya marshes, Sri Jayawardhanapura wetland sanctuary.It is presumed that this increase may be due to winter migrating birds arriving in this area during the migratory season.

The occurrence of the Glossy ibis (2 individuals in non breeding plumage) is a significant observation as this species was considered to be extinct forms Sri Lanka during the first half of the 20thcentury (Henry 1971 and 1998).This bird was first recorded in the wet zone in December 1973 from Nedimala and in the Sri JayawardhanapuraKotte Marshes in late 1986 (By SamanLaksiri in Octomber 1986 Pers.Corres.) This bird though a breeding resident in the dry zone during the late 19th century (Legge, 1880), is now considered to be a rare winter migrant to the wet and dry zone of Sri Lanka.Further observations are needed to ascertain whether this bird is to be seen in the upcoming migratory seasons.

This place is an important breeding habitat for aquatic birds such as Black-crowned Night heron, Little Grebe, Pheasant-tailed Jacana.Various disturbances like intensive wetland conversions and clearance of the green cover are causing harm to the breeding resident populations inhabiting the area.The Dark-fronted Babbler, which was a fairly common bird in the area in the 1980's, and 1990's, is rare at present, with only one or two groups of them been rarely seen.

A total of 73 species of butterflies were recorded during the study period.This includes a total of 08 species that are included in the threatened categories of the red data list.Sri Lanka Lesser Albatross is the only endemic that has been recorded in the study area.The Angled Castor, Plain Tiger, Common Tiger, DanaidEggfly, Indian Sunbeam, Gram Blue and Common Banded Awl are seems to be seasonal migrants from the other parts of the country.

Except those 07 inter migrant species all other (66) species were recorded as residents of the area.Total of 58 species of plants and trees were recorded as their host plants. As all the resident species of butterflies are depends on their host plants while some of the plants were

immensely declining their populations and being threaten to the survival of those species.The host plant of the King Crow, "GonKaduru" *(Cerberaodollam)* is an example for a threatened plant of the area.

There are no significant threats facing the existence of the butterflies of the study area and hence can be recommended as a suitable location for observations and study of butterflies and a refuge for the species to breed and feed as the surrounding areas are all built up and cannot support the larval feeding plants which are critical for the maintenance of populations of these species. Therefore it is recommended that the diversity of the existing habitats should be maintained and preserved in order to maintain and preserve the diversity of butterflies in the area.

The introduced and invasive Lantana camera is an important feeding plant for the adult stages of many butterflies. Since this species is having a detrimental effect on the native flora it is proposed to plant other suitable species of flora that serve the same purpose and remove the lantana from the study area. Since the Tailed jay has a wide Varity of larval species plant the removal of the invasive alien *Annonaglabra* will not have any adverse effect on the population of this species.

A total of 41 species of Odonates consisting of 13 Damselflies (Zygoptera) and 27 Dragonflies (Anisoptera) were recorded during the study period.Among them 03 species were endemics and 16 species that were included in the threatened categories of the red data list.The Wandering Glider is considered being a migrant to the country and was recorded very commonly in October and November months.

The early stages of odonates spend inside the water;hence the quality of the water directly affects their populations and survival.The vegetation cover of the banks is another crucial factor for their existence.The high diversity of odonates attests to the quality of the water sources and vegetation along the banks is still in good conditions. However, the endangered Sri Lanka Forktail was found only in a very specific, limited range of habitat and it is one of the highly threatened species that would vanish for ever from the area if the habitats are degraded and destroyed and environment pollution continues.Therefore, it is vital to maintain the habitats and to reduce and eliminate the pollution of water bodies for the maintenance of the diversity of Odonates.

All species of odonates are protected under section 31B of the fauna and flora protection ordinance and therefore cannot be killed harmed or collected (weather live or dead) for any purpose.Thus, they do not face a direct threat to their survival.

It was observed that some people of the area have directed their waste water outlets from their houses to the wetland or to the canal.It pollutes the water and habitats and will cause many species of fauna and flora to decrease and disappear.This is specially a high threat to the aquatic larvae of the Odonates.Actions should be taken as soon as possible to prevent such water polluting occurrences and people of the area should have to educate about such things.
A total of 28 species of reptiles including 08 endemics were recorded during the study period.There are 5 highly venomous reptiles of the country and 02 of them were recorded in the study area (Russell's viper and Indian Cobra).The Russell's viper is very rarely recorded but the cobra is much common.Nevertheless there are no recorded snake bites from the study area.

A total of 10 species of amphibians including 02 endemics were recorded during the study period.This includes a total of 02 species that are included in the threatened categories of the red data list.

A total of 16 species of mammals were recorded during the study period.This includes 03 species that areincluded in the threatened categories of the red data list. Only the sub species of Purple-faced Langur, known as the Western purple-faced Langur was recorded as an endemic mammal species.

This endemic old world monkey was once highly prevalent even in the former capitalcity of Colombo.But at present, the western sub species was considered as a criticallyendangered species as the distribution of the subspeciesislimitedto the wet zone inwestern Sri Lanka around the former capital city of Colombo.The population of thewestern subspecies has declined by 80% over the previous 36 years, and if the rate ofpopulation decrease continues then the extinction of the species is inexorable (IUCN).In 2010, the subspecies was included in the list of "The world's 25 most endangeredprimates "(IUCN).As the study area is one of thevery limited habitats for the furthersurvival of the species, it is highly recommended that the existing trees and habitatsaround the area should have protect and maintain effectively.
The Rusty-spotted Cat and Otter are the other threatened species recorded from the area.A further study is required to identify the specific habitats of both species. The protecting and conserving of these habitats needed to be given priority.

Acknowledgement

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