FINAL REPORT

RAPID BIODIVERSITY ASSESSMENT

GALNEWA - PALAGALA - IPALOGAMA

GRAMA NILADARI DIVISIONS

Enhancing Biodiversity Conservation and Sustenance of Ecosystem Services in Environmentally Sensitive Areas (ESA) Project

BIODIVERSITY BASELINE SURVEY FOR THE ESA PROJECT

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ACKNOWLEDGEMENT

The Biodiversity Baseline Survey was conducted in 2019, as a component of the Environmentally Sensitive Area scheme proposed by UNDP, the Biodiversity Secretariat (BDS) and Ministry of Mahaweli Development and Environment. Members of the team are listed below and those who have contributed directly to the production of this document have been included under the respective taxonomic sections. It has been a pleasure to work with the staff of the Divisional Sectratariates in the Galnewa, Palagala and Ipalogama, Ministry of Mahaweli Development and Environment and UNDP. The team is grateful of the support received from the Development Officers, Grama Sevakas, Director Ms. Dhammika Wijayasinghe and Deputy Director Mrs. Nalini Kohowala. Ms. Sugandhi Samarasinge Technical Coordinator and Dr. Geethika Wijesundara of the ESA Project of UNDP and villagers of Galnewa, Palagala and Ipalogama are gratefully acknowledged for their continuous support throughout the project.

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1.0 INTRODUCTION TO THE PROJECT

The Project "Enhancing Biodiversity Conservation and Sustenance of Ecosystem services in Environmentally Sensitive Areas" is a GEF funded project, implemented by the Ministry of Mahaweli Development and Environment (MoMDE) and supported by UNDP. The Project would contribute to safeguarding globally significant biodiversity on production lands of high interest for conservation. Though Sri Lanka has instituted a national system of Protected Areas (PAs) to safeguard its biodiversity, many of the globally important ecosystems and habitats of globally significant species will continue to remain outside protected areas and will face accelerating threats.

This project will greatly strengthen the country's ability to safeguard biodiversity outside protected areas in special Environmentally Sensitive Areas (ESA), through a new land use governance framework. An ESA is to be broadly defined and understood as an area outside the Protected Area that is vital for the long-term maintenance of biodiversity and its evolutionary potential and/or the productivity of water, soil and other natural resources that provides ecological, environmental, economical and/or cultural benefits/services primarily to a local community which requires co-management as applicable. Project activities will provide a vehicle for safeguarding globally significant biodiversity on multiple-use lands of high conservation values.

The primary objective of this project is "**To operationalize Environment Sensitive Areas (ESA) as a mechanism for mainstreaming biodiversity management into development in areas of high conservation significance**". The project consists of two objectives.

1) National Enabling Framework strengthened to designate and manage Environmentally Sensitive areas (ESA).

2) Biodiversity-friendly ESA management for long term integrity and resilience ensured at two sites in the Kala Oya Region (KOR).

The KOR is in the North-Central and North Western area of the country and mostly falls within the Dry Zone of the country, with some parts of the area falling in the intermediate zone. This region had been identified as one of the five potential ESA bioregions in the initial project conceptualization phase. Detailed biodiversity baseline survey was conducted throughout KOR to identify important biodiversity and critical biodiversity habitats. But due to time limitations the transects has not sufficiently covered Galnewa and Palagala DS divisions in Anuradhapura district and indirect sources reports abundance of biodiversity in the said area and it is needed to conduct rapid biodiversity assessment in Galnewa-Palagala-Ipalogama DS divisions to Meet gaps in the former baseline survey.

This project, the Rapid Biodiversity Assessment of the Galnewa-Palagala and Ipalogama, provides results of a three months field survey on different taxonomic groups, specifically

Dragonflies and Damselflies, Butterflies, Freshwater Fish, Herpetofauna, Birds, Mammals and Flora (vascular plants) in their habitats which in turn illuminates the Galnewa-Palagala-Ipalogama value as an ESA, the importance of its management and the need for equilibrium between conservation efforts and development objectives. These include activities and mechanisms for land-use planning: protection of major habitat blocks and provision of structural and functional connectivity across the landscape during the course of development. The project evidences the indirect impacts of development and their necessity to be factored into decision making which will subsequently deliver benefits at local level -immediate river basin- and national level while improving the long-term conservation prospects of the Kala Oya basin.

1.1 Scope of the Study

The primary task of this study is to conduct a biodiversity inventory of the area, to assess the current baseline information on biodiversity population and distribution which provides information for defining and conserving the biodiversity to understand the potential effects and monitor the impacts of project interventions on globally important species that are considered as Point Endemic, Sri Lankan Endemic Species, nationally / globally Threatened or Endangered Species, restricted species, evolutionary distinct taxa, Overall richness of species and habitat that are Supports Critical Natural History Processes, Habitat that supports unique assemblages of species, Habitat that is critical for survival of threatened or endemic species, Habitat that is critical for survival of migratory species, Habitat that support large assemblages/ congregation species, Extent of Major Ecosystem as Percent Remaining at National Level , Dominant Variant Ecosystem, Indigenous livestock breed, Presence of land races/ Crop Wild Relatives and Ecosystem services.

1.2 Output of the Study

The expected deliverables/ outputs for this study, as per the Terms of Reference are;

1. A work plan for this assignment, methodology including sampling and data collecting methods, indicative outline of each deliverable and a delivery schedule.

2. Report and maps on ecosystem heterogeneity of the study area including terrestrial, coastal and aquatic ecosystems.

3. Report on the threats and conservation issues in the region that functions as barriers to enhancing the biodiversity quality.

4. Statistical Analysis of baseline biodiversity information of fauna and flora species in the ecosystems found in the area, to identify the endemism and the threaten status.

5. A database for continual updating and long term monitoring and a distribution map of critical habitats displaying the threats and conservation status.

2.0 GALNEWA –PALAGALA - IPALOGMA DIVISIONAL SECRETARIATS

2.1 Physical Features

Galnewa divisional secretariat is located in the southern boundary of the Anuradhapura district. Extent of this GNS area is 140.23 km^2 border to the Kala Oya in the North North eastern border, Kurunegala District in the South and Southwestern boarder, Kekirawa Divisional Sectratariate in the Southeastern boarder and Thambuttegama Divisional Secretariat in the North western border. Galnewa and Palagala consist of most distinctive landform like Kahallapallekele Sanctuary, Kahalla Kanda and Rocky hills punctured at different locations (Figure 2.1).

Figure 2.1. Location of the study area

Galnewa located in the second peneplain with 100m to 125m above the sea level. Main soil type is Red brown soil and this soil type is abundant in Central and South GN Divisions. Land in the north region varies to clay mixed sandy loam soil while clay deposits are found near Kala Oya lowland. Total land area of this area is 14450 ha and forest cover is 1870 ha. This is 13.5% of total area.

The main land use within the Galnewa includes forest (2,276 ha), Paddy (5,318 ha), Scrub area (621 ha),Home Gardens (3,150 ha), tanks (796 ha), Rocks (21 ha), Marshes (ha) and Abandoned lands (43 ha). The forests of this area consist of around 2,000 ha of Dry Mixed Evergreen

forests; Open forests (249 ha) and 27 ha of forest plantations (Galnewa Resource Profile, 2018). Tanks are scattered throughout the landscape and there are also natural water holes, which fill during the rainy season.

2.2 Climate and Rainfall

The mean annual rainfall varies from 1250mm to 1800mm and lowest rainfall received is during the months of May to late September. More than two-third of the rainfall is received during the Maha season (October to March). As the area lies within the dry zone of the country, the temperature varies between 30.4 –33.60C with an average monthly rainfall of 120 mm. The highest rainfall occurs from November to December (225 mm) while the driest periods are characterized by as little as 25 mm of rainfall per month.

There are 31 GN divisions present in this DS and 16 GN divisions belong to the Mahaweli H zone. Though these divisions receive Mahaweli water, Galnewa shows different climatic conditions when compared with dry climatic conditions in Anuradhapura District. This favourable weather conditions are provided via the flow of Kala Oya through this area. Tanks in the area play a major role in supplying water for the agricultural purposes.

2.3 Flora and Habitat

Terrestrial ecosystems include many dry zone vegetation types. They have many special physiological and floristic characteristics and their distribution is influenced by, soil, thermal hydrological and edaphic factors which induce more or less distinct assemblages: Vegetation types such as Dry mixed Evergreen Forest, Riparian forest, Scrub forest, Chena and abandoned Chena, Rocky out crops, Home Gardens, Forest Plantation, (Teak.) Dry mixed evergreen forests is the most abundant in the country, covering a majority of the dry zone (Figure 2.2). As Galnewa is located in the dry zone, it is characterized by tropical dry mixed evergreen forests. It is also characterized by a sparse canopy of about 20-25m in height, a sub-canopy of about 10-15 m and a well-developed shrub/ herb layer.

A total of 322 species of vascular plants have been recorded from the Kala Oya basin, with 262 indigenous species and 22 endemics. About 50 exotics have also been recorded among them. Flora found in this basin includes eight nationally endangered and 15 nationally vulnerable from the Kala Oya basin area (ESA, 2016). Galnewa also can be recorded similar plant species as in Kala Oyabasin.

Figure 2.2 Various types of vegetation found around Galnewa: (a) Riverine vegetation (b) Tank vegetation (c) Tropical dry mixed evergreen forest (d) Paddyfields within Galnewa

Fauna

According to the ESA report 2016 a total of 35 species of butterflies, 15 species of dragonflies, 29 species of fishes including 22 native, 8 amphibians, 23 reptiles, 120 species of birds (106 native, and 14 migrants), 10 endemics and 31 species of mammals, 28 native and 4 endemics have been recorded from the Kala Oya basin. Galnewa DS consists of variation of habitats which occupied by a broad range of species, extending to mammals, birds, herpetofauna, freshwater fish, as well as several groups of invertebrate fauna.

2.4 Water Resources

Aquatic ecosystems include paddy fields, marshes and fresh water holes, Tanks (seasonal and Perennial) Rivers and Streams (Figure 2.3). A large number of important wetlands including man-made and natural wetlands are situated in the Galnewa and Palagala Divisional Secretariat. These wetlands are vital for sustaining the livelihoods of the community in the area, as they have a major role in maintaining water quality, biodiversity, water quantity regulation, fisheries, recreational activities, tourism, etc.. These ecosystems have significant direct and indirect economic value. Unfortunately, they are also the most-threatened class of habitats in the world, mainly anthropogenic in origin. Filling (due to the competitive demand for land) is the leading threat to wetlands, where poverty compels some people to illegally encroach into wetlands.

Figure 2.3. Various types of wetlands found around the Galnewa and Palagala GNS; (a) Streams (b) Paddy fields (c) Seasonal water hole (d) Marshy lands

2.5 Land use Covered under Present Study within Galnewa , Palagala and Ipalogma GND

The landscape includes an area of at least 4922ha of biodiversity rich area and it covers 9 Grama Niladari Divisions (GND) which are 459, 461, 462, 465, 466, 467, 468, 473 and 476 GN divisions (Figure 2.4) . These Divisions cover land use type of 24% of buildup lands, 38% of agricultural lands, 24% of forest cover, 0.1% of wetlands, 0.3% rocky areas, 12 % water bodies and 0.11 % of bare lands. Further this site embodies of 4160 ha of agricultural fields, 673 ha of forest cover, 66 ha of wetlands and 22 ha of water bodies. Palagala covers 3 Grama Nildhari Divisions namely Balaluwewa II (488), Karawilagala (489) and Pahalagama (490). Table 2.1 shows the different GND covered during the survey.

Table 2.1. Grama Niladhari Division in Different Divisional Secretariats

No.	Grama Niladhari Division	Name of the village	Divisional Secretariat Division
1	Kandegama (459) (කන්දේගම)	Kandegama wewa (කන්දේගම වැව)	Galnewa
		Kuda wewa (කුඩා වැව)	
2	Werunkulama (461) (වේරුන්කුලම)	Werunkulama (වේරුන්කුලම)	Galnewa
		Niyangama (නියන්ගම)	

3	Negama (462) (නෑගම)	Negama (නෑගම)	Galnewa
4	Kandulugamuwa(464) (කඳුළුගමුව)	Ihala-Habarawatte (ඉහල-හබරවත්ත)	Galnewa
5	Kalanchiya(465) (කල්ලංචිය)	Palugolla (පලුගොල්ල)	Galnewa
		Kalanchiya (කල්ලංචිය)	
6	Medawachchiya(466) (මැදවච්චිය)	Medawachchiya (මැදවච්චිය)	Galnewa
		Maha Otthapahuwa (මහා ඔත්තපහුව)	
7	Kumbukwewa (467) (කුඹුක්වැව)	KumbukWewa (කුඹුක් වැව)	Galnewa
8	Siyambalawa (468) (සියඹලෑව)	Nelumpathgama (නෙළුම්පත්ගම)	Galnewa
		Siyambalawa (සියඹලෑව)	
		Mullannatuwa (මුලංනටුව)	
9	Musnawa(473) (මුස්නව)	Musnawa (මුස්නව)	Galnewa
		Galmediyawa (ගල්මැඩියාව)	
10	Hadungama(476) (හදුන්ගම)	Ihalagama (ඉහළගම)	Galnewa
11	Balaluwewa II (488) (බළලු වැව II)	Balaluwewa(බළලු වැව)	Palagala
12	Karawilagala(489) (කරවිලගල)	Peenawa (පිනව)	Palagala
		Nanwattegama (නාවත්තේගම)	
		Munhena (මුංහේන)	
		Karawilagala (කරවිලගල)	
13	Pahalagama(490) (පහළගම)	Pahalagama (පහළගම)	Palagala
14	Walawwegama (488) (වළව්වෙ ගම)	Kala oya (කලා ඔය)	Ipalogama
		Yodha Ela (යෝධඇළ)	Ipalogama
15	Ganthiriyagama (503) (ගන්තිරියාගම)	Ganthiriyagama (ගන්තිරියාගම)	Ipalogama
16	Hiripitiyagama (514) (හිරිපිටියාගම)	Hiripitiyagama (හිරිපිටියාගම)	Ipalogama
17	Kunchikulama (515) (කුන්චිකුලම)	Kunchikulama (කුන්චිකුලම)	Ipalogama

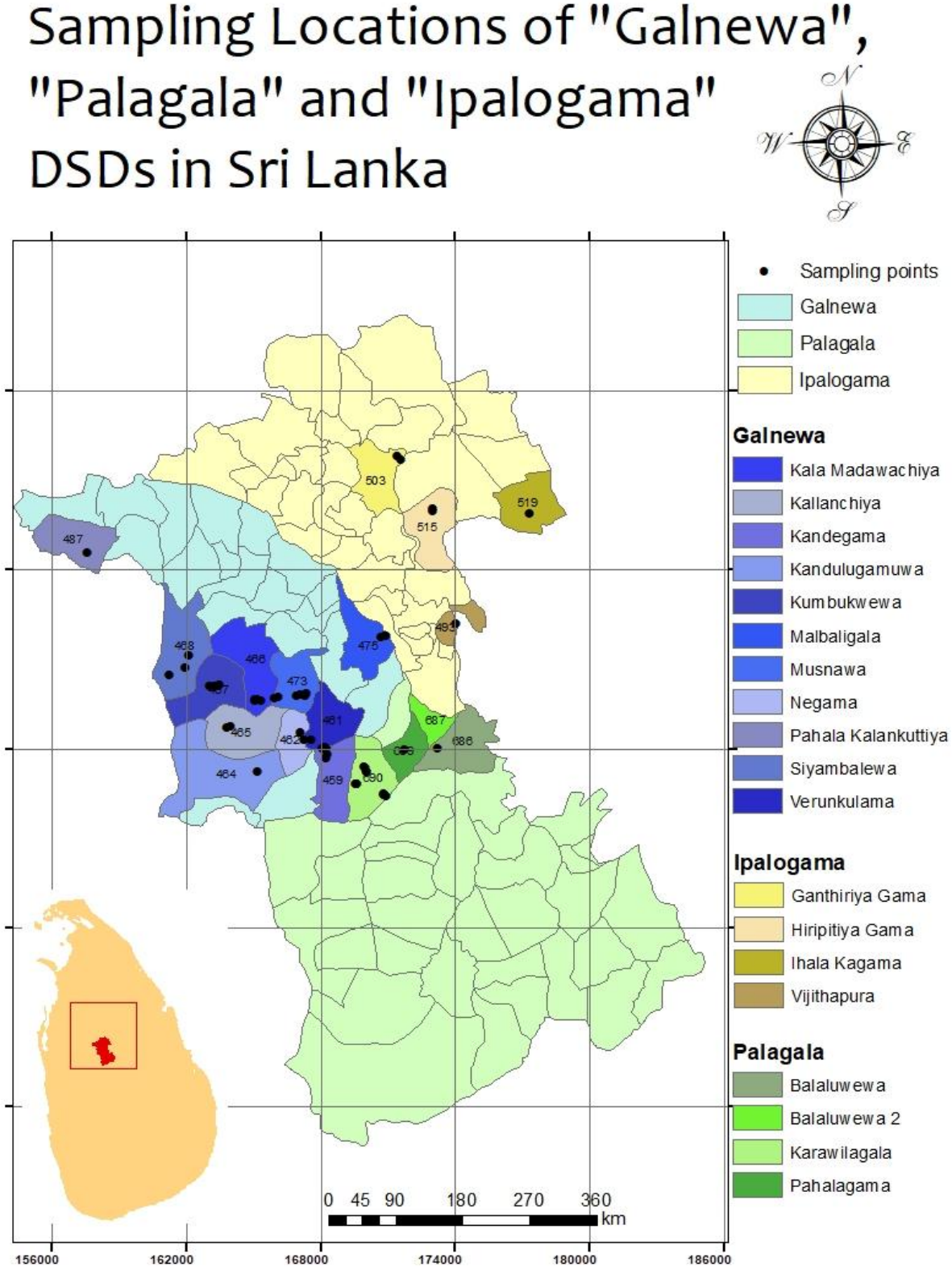

Figure 2.4. Detailed map of survey locations in three different divisional secretariats

3.0 SURVEY METHODOLOGY

The Biodiversity Baseline Survey covered terrestrial and aquatic habitats. Terrestrial habitats were sampled systematically for plants, amphibians, reptiles, birds and mammals using quadrats and transects. Opportunistic observations were also recorded along transects, between quadrats, and elsewhere within the Survey area. Freshwater habitats were treated as a single type, which was sampled systematically for fish diversity and opportunistically for other taxonomic groups.

3.1 Criteria for Sampling and Collection of Field Data

Site selection was done within the area as requested by the MoMDE. The number of sampling site in each land use type based on the availability of time and extent of the area. Each sampling point was geo referenced in order to ensure repeatability of the data in the future if necessary. The following criteria were adapted during the data collection for the survey.

- Sampling techniques used were not destructive to any habitat, population or individual.
- Same survey personnel were used throughout the Survey to minimize observer biases in species richness and abundance arising from differences in the competencies of field staff.
- Wherever possible, internationally recognized standard techniques were adhered to throughout the Biodiversity Baseline Survey.
- Sample sites (i.e. transects, quadrats and plots) were temporally marked on the ground using GPS coordinates.
- Vertebrate groups were surveyed in each of the selected habitats. Fish species were surveyed in all tanks.
- All animal specimens (alive) were photographed and had the standard set of international measurements recorded.
- All records of specimens and observations were geo-referenced and given a unique identifier.

Preliminary visit and survey of the diversity of the habitats of the site/s were done mid week of March 2019 to study floral and faunal component (natural, semi-natural and manmade, including home gardens). This was preliminarily to decide the size of sampling units, to assess the suitability/adequacy of selected methods to survey the flora and fauna and to decide the number of sampling units. Initially plan to survey vegetation (flora) was belt transect method (base line (50 m or 100 m length), belt (4 m or 5 m width)], plot and quadrate method, random sampling for checklist, aquatic and amphibious species (canals, *wewa*, marshes), epiphytic, epilithic or

parasitic species (zigzag, battlement)], and plot-less sampling (distance density). Faunal survey was plan to conduct along the transects, VCPs, Visual Encounter Methods and Trapping (DWC, 2008).

3.2 Deviations from the planned methodology

Initially planned methodology in the proposal was changed significantly and was mainly due to limited time, heterogeneity in habitats, extent in habitats, problems with boundaries and/or indistinct nature of land use types (merged in most cases) and some other valid unavoidable circumstances, such as wildlife activities and some previously unaccounted extrinsic difficulties faced with peripheral communities (after the Easter Sunday terrorist attack on April 21, 2019). Though there were deviations and/or alternations, appropriate methods were adopted for rapid assessment. Hypothetical belt transect along the banks of tank and other systems were used to record both fauna and flora and score method instead of Quadrate sampling, 0-5 was used for visual quantification. Here, 0 indicates the absence of a particular taxon in a given site and 1-5 are relative abundances of taxa in the same manner. Though somewhat subjective survey was conducted by a single person, *i.e.* by individual and with an assistant of the same group of trained field assistants, errors encountered were managed at minimal level. Final score given was drawn after the agreement of the whole group discussion. As if the score is 5 for any taxon, that means it is highly abundant in a given site and in most cases it is in its full carrying capacity, otherwise not.

Detailed of methodology for each taxa are described in each section separately. Table 3.1 summarizes the different methods used for the faunal survey.

Table 3.1. Different sampling methods used for encounter the animal taxa

Animal Group/Taxa	Observation	Sampling method
Fish	Direct and Indirect	Bank observation and counts, using nets, interviewing fishermen surrounding area
Amphibian	Direct	Visual encounter survey and pitfall traps during the day and night within the transect.
Reptiles	Direct and Indirect	Visual encounter survey and pitfall traps during the day and night within the transect. Interviewing villages in and around the area.
Avifauna	Direct and Indirect	Line Transects, point counts method, and opportunistic observations (Visual & Auditory)
Mammal	Direct and Indirect	Small mammals traps and indirect methods such as identification of dung and tracks and other signs
Butterflies and dragonflies	Direct	Visual encounter survey within the transect

3.3 Limitations in Data Collection

The time frame provided to study and survey and the extent of the area was a constraint and imposed limitations. Initially in the TOR mentioned to cover Galnewa and Ipologma GNDs. However, it was informed later that the team needs to cover 3 GN divisions including Palagala GND.

Some species counts were affected notably due to collection of data during the dry season and spending less time collecting during the after few rainy days. This caused a notable difference to the herpetofauna. Most of the snake species and burrowing frogs were not recorded in the dry season most probably due to their inactivity. Survey was started at the end of migratory period and most of the migratory bird species neither were not recorded.

In terms of survey techniques and their respective efficiencies, although opportunistic walks along forest ecotones using footpaths and wildlife trails generated the most information about species, the survey techniques used may have influenced the results of the distribution of organisms in the areas due to the lack of coverage of the geographic and environmental variations. Some taxonomic groups (herpetofauna) showed more promising results during night time in sampling plots. It was found that identification of conservation areas boundaries were difficult as there were no clear demarcations.

Also there were access issues in some sampling locations due to a lack of notable roads. In addition, several illegal trap guns along the foot pathways made an unsafe situation in visiting the sampling sites. There was also the risk of being attacked by wild elephants during sampling. In some cases problems arose due to the villagers not cooperating which made it frustrating in finding viable roads, especially which led to catchment areas of tanks.

Data collection on fauna was carried out for relatively short period and hence, our sampling may have underestimated the diversity of fauna in the region (Figure 3.1).

Figure 3.1. Research team observing the sampling sites

3.4 References

Biodiversity Baseline Survey (2008), Field Manual, Wildlife Department.

DWC (2008). Biodiversity Baseline Survey: Field Manual. Revised version. Consultancy Services, Report prepared by Green, M.J.B. (ed.), De Alwis, S.M.D.A.U., Dayawansa, P.N., How,R.,Padmalal, U.K.G.K., Singhakumara, B.M.P., Weerakoon, D., Wijesinghe, M.R. and Yapa, W.B. Infotechs IDEAS in association with GREENTECH Consultants. Sri Lanka Protected Areas Management and Wildlife Conservation Project (PAM&WCP/CONSULT/02/BDBS), Department of Wildlife Conservation, Ministry of Environment and Natural Resources, Colombo. 49 pp.

4.0 FLORAL DIVERSITY ANALYSIS

4.1 Introduction

Eleven Grama Nirladhari Divisions from Galnewa Secretariat Division and four Grama Nirladhari Divisions from Ipalogama Secretariat Division of Anuradhapura District in the Central Province were selected and assigned for the survey of flora by UNDP-Mahaweli Project. In the original UNDP-Mahaweli project proposal, some key tasks have been itemized to carry out. They are, identify species diversity and population densities of flora; estimation of population size of flora of the globally or nationally threatened species, critically endangered species, and endangered species; assess the conservation status of threatened flora; assess the conservation status of crop wild relatives (CWR) and agro-biodiversity; asses threats and conservation issues in the area that functions as barriers to enhancing the biodiversity quality; assess the threats for improving biodiversity quality in natural lands by terrestrial weeds and invasive terrestrial plants; and assess the threats, in small tanks and canals by aquatic weeds and invasive aquatic plants. Proposing conservation priorities for each identified system in the proposed area for sustainable management and to evaluate the suitability of the area to declare a sensitive area outside the conservation areas already declared adjacently is the main and overall objective of the survey.

4.2 Survey Methodology

Preliminary visits to the site/s have been done to familiar with the community (people). Diversity of the habitats was surveyed to study floral component (natural, semi-natural and manmade, including home gardens). This was initially to decide the number of sampling units, to decide the size of sampling units and to assess the suitability/adequacy of selected methods to survey the flora. Originally planned methods for surveying vegetation (flora) were belt transect method [base line (50 m or 100 m length), belt (4 m or 5 m width)], plot and quadrat method [macro plots (10 m x 10 m, 20 m x 20 m, …) and small plots (1 m x 1 m, 2 m x 2 m, …)], random

sampling for checklist [terrestrial species (roads, foot paths), aquatic and amphibious species (canals, *wewa*, marshes), epiphytic, epilithic or parasitic species (zigzag, battlement)], and plot-less sampling (distance density).

Deviations from the planned methodology

Preplanned methodology in the proposal had to be changed significantly and it was mainly due to the limited time frame, heterogeneity in habitats, extent in habitats, problems with boundaries and/or indistinct nature of land use types (merged in most cases) and some other valid unavoidable circumstances, such as wildlife activities and some unexpected and some extrinsic difficulties faced with peripheral communities, as it was after the Easter Sunday terrorist attack on April 21, 2019. Therefore, deviations and/or alternatives, but appropriate methods had to adopt in rapid assessment. Instead of quadrat sampling, hypothetical belt transect along the banks of wewa and other systems were used to record flora and score method, from 0-5 was used to visual quantification. Here, 0 indicates the absence of a particular taxon in a given site and 1-5 are relative abundances of taxa in the same manner. Though, this is somewhat subjective, due to the survey has been conducted by a single person, *i.e.* by myself, with the assistant of same group of trained field assistants, the possible errors encountered could be managed at minimal level. Final score given has always been drawn after the agreement of the whole group discussion. As if the score is 5 for any taxon, that means it is highly abundant in a given site and in most cases it is in its full carrying capacity, otherwise not. This is regardless of the taxon is a climatic climax species, native species, exotic species or even an Invasive Alien Species (IAS) of plant.

On-site identification was mainly practiced for identification of plant species (flora) under non-destructive or very rarely semi-destructive basis (uprooting), and sometimes using magnifiers to observe fine characters. Photographing (using camera and camera phones) was also done in most cases, for laboratory identification and as a promising method of recording field characters. Collection of samples (in to polythene bags) were also done, but very rarely under semi-destructive or rarely destructive (uprooting) manner. Identification of flora in the laboratory was done using photographs and samples.

Standard texts (and Floras), some guides, keys, checklists and other relevant publications, *viz*., Dassanayake and Fosberg (1980, 1981a, 1981b, 1983, 1985, 1988, 1991), Dassanayake, Fosberg and Clayton (1994), Dassanayake and Clayton (1995, 1996, 1997, 1998, 1999, 2000), Shaffer-Fehre (2006a, 2006b), Worthington (1959) and Senaratne (2001) were used to identify and confirm the species up to their species level. Names were checked and updated with the "Plant List, a working list of all plant species" (http://www.theplantlist.org) and the "International Plant Name Index (IPNI)" (https://www.ipni.org). Identification via herbarium techniques, preparation of herbarium vouchers and identification at National Herbarium were not done, as doubtful species were not encountered in the survey. Invasive species, medicinal species and CWR were

checked with Marambe, Silva, Wijesundara and Atapattu (2010), Jayaweera (1980, 1981a, 1981b, 1982a, 1982b), and Ganashan *et al*. (1995) respectively. The national conservation status (NCS) and the global conservation status (GCS) of plants were checked with National Red List 2012 of Sri Lanka (MOE, 2012).

Thirteen (fourteen) wewa ecosystems including adjacent terrestrial systems were surveyed during the study period from May–August 2019, *i.e.* 12 from Galnewa Divisional Secretariat (DS) Division, 3 from Ipalogama DS Division and 4 from Palagala DS Division, from Anuradhapura District (Table 4.1).

Table 4.1: Wewa systems surveyed during the study

No.	Grama Niladhari Division	Name of the village	Divisional Secretariat Division
1	Kandegama (459)	Kandegama wewa	Galnewa
		Kuda wewa	
2	Werunkulama (461)	Werunkulama (වේරුන්කුලම)	Galnewa
		Niyangama	
3	Negama (462)	Negama (නැගම)	Galnewa
4	Kandulugamuwa (464) (කඳුළුගමුව)	Ihala-Habarawatte (ඉහල-හබරවත්ත)	Galnewa
5	Kalanchiya (465) (කල්ලංචිය)	Palugolla (පලුගොල්ල)	Galnewa
		Kalanchiya (කල්ලංචිය)	
6	Medawachchiya මැදවච්චිය (466)	Medawachchiya (මැදවච්චිය)	Galnewa
		Maha Otthapahuwa (මහා ඔත්තපහුව)	
7	Kumbukwewa (467) කුඹුක්වැව	KumbukWewa (කුඹුක් වැව)	Galnewa
8	Siyambalawa (468) (සියඹලැව)	Nelumpathgama (නෙළුම්පත්ගම)	Galnewa
		Siyambalawa (සියඹලැව)	
		Mullannatuwa (මුලංනටුව)	
9	Musnawa(473) මුස්නව	Musnawa (මුස්නව)	Galnewa
		Galmediyawa (ගල්මැඩියාව)	
10	Hadungama(476) හඳුන්ගම	Ihalagama (ඉහළගම)	Galnewa
11	Balaluwewa II (488)	Balaluwewa	Palagala
12	Karawilagala(489) (කරවිලගල)	Peenawa (පීනව)	Palagala
		Nanwattegama (නාවත්තේගම)	
		Munhena (මුංහේන)	
		Karawilagala (කරවිලගල)	

13	Pahalagama(490) (පහළගම)	Pahalagama ^ පහළගම &	Palagala
14	Ganthiriyagama (503)	Ganthiriyagama (ගන්තිරියාගම)	Ipalogama
15	Hiripitiyagama (514)	Hiripitiyagama (හිරිපිටියාගම)	Ipalogama
16	Kunchikulama (515)	Kunchikulama (කුන්චිකුලම)	Ipalogama

4.3 Results and Discussion

4.3.1 Land-use and vegetation types

4.3.1.1 Land-use Types

Natural or semi-natural forest system was not surveyed for flora, as it was not an objective due to the occurrence of them within conservation areas under FD or DWLC. Findings of the survey are presented in three subsections, namely;

i. Wewa (tank) and adjacent habitats (Figure 4.1),

ii. Home gardens (Figure 4.2), and

iii. Disturbed forests (Figure 4.2).

However, the systems considered as disturbed forests are actually the extensions of large homegardens (private land) which are merging with terrestrial reservations of wewa ecosystems (the common land). Boundaries between them are not demarcated or not clearly visible. Remaining dry zone forests under the management of FD and DWLC are with demarcated boundaries or with electrical fences to control elephants and are clearly visible.

Figure 4.1: Wewa (Tank) and Adjacent Habitats
Aquatic/Amphibious Habitats (A1 and A2) and Adjacent Terrestrial Habitats (B1 and B2)

Figure 4.2: A homegarden (A), Disturbed forest patches (B1 and B2)
and Oththapahuwa quarry (C1) and disturbed vegetation adjacent to quarry (C2 and C3)

4.3.1.2 Wewa (tank) and adjacent habitats

Findings in these habitats are presented under the two categories as **aquatic/amphibious habitats** and **adjacent terrestrial habitats**(Figure 4.1).

4.3.1.2.1 Aquatic/amphibious habitats

Forty seven aquatic and amphibious plants were reported from aquatic and amphibious habitats surveyed in wewa and associated aquatic/amphibious system (Table 4.2).

Table 4.2: Aquatic/amphibious plant species reported from aquatic/amphibious habitats in the Wewa (tank) and adjacent systems (N=Noninvasive, IAS=Invasive Alien Species, NT=Near Threatened, VU=Vulnerable, LC=Least Concerned, NL=Not listed in National Red List).

No.	Name	Family	Invasive Status	NCS	Total Score	Frequency
1	*Acrostichum aureum*	Pteridaceae	N	LC	2	1
2	*Alternanthera pungens*	Amaranthaceae	N	NL	2	2
3	*Alternanthera sessilis*	Amaranthaceae	N	LC	4	5
4	*Aponogeton crispus*	Aponogetonaceae	N	VU	3	4
5	*Azolla pinnata*	Salviniaceae	N	NL	3	3
6	*Bacopa monnieri*	Plantaginaceae	N	LC	4	3
7	*Ceratophyllum demersum*	Ceratophyllaceae	IAS	LC	7	4
8	*Ceratopteris thalictroides*	Pteridaceae	N	NT	2	2
9	*Chamaecrista mimosoides*	Fabaceae	N	LC	1	1
10	*Corchorus olitorius*	Malvaceae	N	VU	1	1
11	Cyperaceae sp.(*Sclaria* type)	Cyperaceae	N	?	1	1
12	*Cyperus articulatus*	Cyperaceae	N	DD	2	1
13	*Cyperus corymbosus*	Cyperaceae	N	NT	1	1
14	*Cyperus* sp. 1	Cyperaceae	N	?	7	4
15	*Cyperus* sp. 2	Cyperaceae	N	?	2	1
16	*Cyperus* sp. 3	Cyperaceae	N	?	4	2
17	*Cyperus* sp. 4 (PHW)	Cyperaceae	N	?	2	1
18	*Echinodorus* sp.	Alismataceae	N	NL	2	3
19	*Eichhornia crassipes*	Pontederiaceae	IAS	NL	20	9
20	*Grangea maderaspatana*	Asteraceae	N	NT	1	1
21	Grass species (Dominant/PHW)	Poaceae	N	?	4	1
22	*Hydrilla verticillata*	Hydrocharitaceae	IAS	LC	1	1
23	*Hygrophila auriculata*	Acanthaceae	N	LC	9	5
24	*Hygroryza aristata*	Poaceae	N	NT	5	4

25	*Ipomoea aquatica*	Convolvulaceae	IAS	LC	8	5
26	*Lasia spinosa*	Araceae	N	LC	1	1
27	*Lemna perpusilla*	Araceae	N	LC	2	2
28	*Limnocharis flava*	Alismataceae	IAS	LC	1	1
29	*Limnophila* sp.	Scrophulariaceae	N	?	1	1
30	*Ludwigia hyssopifolia*	Onagraceae	N	LC	1	1
31	*Ludwigia perennis*	Onagraceae	N	LC	2	2
32	*Ludwigia adscendens*	Onagraceae	N	NL	6	6
33	*Marsilea minuta*	Marsileaceae	N	?	3	3
34	*Mollugo cerviana*	Molluginaceae	N	LC	1	1
35	*Najas minor*	Hydrocharitaceae	N	VU	1	1
36	*Nelumbo nucifera*	Nelumbonaceae	N	LC	6	3
37	*Neptunia oleracea*	Fabaceae	N	LC	3	3
38	*Nymphaea pubescens*	Nymphaeaceae	N	LC	10	10
39	*Nymphoides indica*	Menyanthaceae	N	NL	1	1
40	*Ottelia alismoides*	Hydrocharitaceae	N	LC	1	1
41	*Persicaria attenuata*	Polygonaceae	N	?	12	9
42	*Persicaria barbata*	Polygonaceae	N	LC	1	1
43	*Phyla nodiflora*	Verbenaceae	N	LC	1	1
44	*Pistia stratiotes*	Araceae	N	LC	2	2
45	*Salvinia adnata*(=*molesta*)	Salviniaceae	IAS	NL	16	10
46	*Typha angustifolia*	Typhaceae	IAS	LC	5	5
47	*Utricularia aurea*	Lentibulariaceae	N	LC	3	4

These habitats are mainly with Invasive Alien Species (IAS) of plants and their numbers were always higher (relative abundances) compare with native and/or naturally occurring species. This indicates the clear invasion of some species to a greater extent and the suppression of native species on the other hand is apparent. *Eichhornia crassipes* (Pontederiaceae), *Salvinia adnata* (Salviniaceae), *Ceratophyllum demersum* (Ceratophyllaceae), *Typha angustifolia* (Typhaceae), *Echinodorus* sp. (Alismataceae) and *Ipomoea aquatica* (Convolvulaceae) were reported as IAS of plants in the system. Highest total score and was recorded for *Eichhornia crassipes* (Pontederiaceae), followed by *Salvinia adnata* (Salviniaceae),*Persicaria attenuata*(Polygonaceae) (Figure 4.3) and *Nymphaea pubescens* (Nymphaeaceae), in their descending order of abundance (Figure 4.4).

Highest frequency was resulted for *Salvinia adnata* (Salviniaceae)and *Nymphaea pubescens* (Nymphaeaceae), followed by *Eichhornia crassipes* (Pontederiaceae) and then *Persicaria attenuata*(Polygonaceae). Indigenous species were not very common, *i.e.* low in numbers and seems locally threatened and almost extinct. The common indigenous species are a variety of *Cyperus*species in the Family Cyperaceae,*Aponogeton crispus* (Aponogetonaceae), *Nymphaea*

pubescens (Nymphaeaceae), and *Nelumbo nucifera* (Nelumbonaceae). However, red variety of lotus is not very common in the Wewa systems of study sites.

Figure 4.3: Some common aquatic/amphibious plant species in the Wewa (tank) systems: *Eichhornia crassipes* (A), *Salvinia adnata* (B), *Ceratophyllum demersum* (C), and *Persicaria attenuata* (D)

In addition to the above 47 aquatic/amphibious plant species reported from aquatic/amphibious habitats in the Wewa (tank) and adjacent systems, there were two other species, account to a total of 49 species. First species *Nymphaea nouchali* (Nymphaeaceae), the National Flower of Sri Lanka (erlier known as *Nymphaea stellata*, its synonym) reporterd only from Wetakoluwagama Wewa in the Galnewa DS Division, and the second species *Potamogeton nodosus* (Potamogetonaceae) reported only from Wetakoluwagama Wewa (වැටකොලුවාගම්වැව) and Naanwaththegama Wewa (නාන්වත්තේගම්වැව) in the Palagala DS Division. According to the National Red List, national conservation status (NCS) of *Nymphaea nouchali* (Nymphaeaceae) is vulnerable (VU). That is of *Potamogeton nodosus* (Potamogetonaceae) is least concerned (LC). Global conservation status (GCS) is also least (LC) concerned for *Potamogeton nodosus*. Though, it is an exotic species, not considered as a potential IAS yet (Figure 4.4 and Figure 4.5).

Figure 4.4: ***Nymphaea nouchali*** **(A1: Habit, A2: Flower) and** ***Nymphaea pubescens*** **(B1: Habit, B2: Flower)**

Figure 4.5: ***Potamogeton nodosus*** **(Potamogetonaceae)**

Among the 49 aquatic/amphibious plant species reported from aquatic/amphibious habitats in the Wewa (tank) and adjacent systems, there were four (4) near threatened (NT) species and three (3) vulnerable (VU) species (Table 4.3 and Figure 4.6).

Table 4.3: Near threatened (NT) and vulnerable (VU) aquatic/amphibious plant species reported from aquatic/amphibious habitats in the Wewa (tank) and adjacent systems

No.	Name	Family	NCS
1	*Ceratopteris thalictroides*	Pteridaceae	NT
2	*Cyperus corymbosus*	Cyperaceae	NT
3	*Grangea maderaspatana*	Asteraceae	NT
4	*Hygroryza aristata*	Poaceae	NT
5	*Aponogeton crispus*	Aponogetonaceae	VU
6	*Najas minor*	Hydrocharitaceae	VU
7	*Nymphaea nouchali*	Nymphaeaceae	VU

Figure 4.6: Some near threatened (NT) and vulnerable (VU) aquatic/amphibious plant species reported from aquatic/amphibious habitats in the Wewa (tank) and adjacent systems: *Ceratopteris thalictroides* (A), *Nymphaea nouchali* (B), *Hygroryza aristata* (C), *Grangea maderaspatana* (D)

4.3.1.2.2 Adjacent terrestrial habitats

Species in this system is presented in four main categories, *viz*. trees, tree-lets/shrubs, scandents and herbs, and other types (epiphytic, parasitic etc.). Dominant tree species, co-dominant tree species, relatively rare species and invasive species are among tree species.

Sixty one (61) tree species, *i.e.* individuals of mainly small and medium size and rarely large, sometimes saplings or seedlings of tree species (Table 4.4), thirty three (33) tree-let/shrub species (Table 4.5), twenty (20) scandent (liana/creeping)plant species(Table 4.6), thirty (30) herbaceous plant species (Table 4.7)and four (4) other plant species, *i.e.* epiphytic and parasitic (Table 3.8), altogether hundred and fifty two (152) species of terrestrial plants were recorded from the adjacent terrestrial habitats around the Wewa (tank) and adjacent habitats category.

Table 4.4: Tree species (woody perennial terrestrial plant species) reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems (LC = Least concern, VU = Vulnerable, NT = Near threatened, NL = Not listed in the National Red List).

No.	Name	Family	National Conservation Status	Total Score	Frequency (n=12)
1	*Acacia leucophloea*	Fabaceae	LC	8	3
2	*Albizia odoratissima*	Fabaceae	LC	1	1
3	*Albizia saman*	Fabaceae	NL	4	3
4	*Azadirachta indica*	Meliaceae	NL	12	5
5	*Barringtonia acutangula*	Lecythidaceae	LC	9	4
6	*Bauhinia racemosa*	Fabaceae	LC	9	5
7	*Berrya cordifolia*	Malvaceae	LC	1	1
8	*Borassus flabellifer*	Arecaceae	NL	5	5
9	*Bridelia retusa*	Phyllanthaceae	LC	4	4
10	*Canthium coromandelicum*	Rubiaceae	LC	1	1
11	*Caryota urens*	Arecaceae	LC	1	1
12	*Cassia fistula*	Fabaceae	NL	1	1
13	*Cassia* sp.	Fabaceae	?	1	1
14	*Cassine* sp. (saplings)	Celastraceae	LC	2	1
15	*Ceiba pentandra*	Malvaceae	LC	2	2
16	*Chloroxylon swietenia*	Rutaceae	VU	2	2
17	*Cordia dichotoma*	Boraginaceae	LC	2	2
18	*Crateva adansonii*	Capparaceae	LC	4	3
19	*Diospyros malabarica*	Ebenaceae	LC	2	1
20	*Diospyros ovalifolia*	Ebenaceae	LC	1	1
21	*Diplodiscus verrucosus*	Malvaceae	LC	1	1

22	*Drypetes sepiaria*	Putranjivaceae	LC	1	1
23	*Ficus callosa*	Moraceae	LC	1	1
24	*Ficus microcarpa*	Moraceae	LC	1	1
25	*Ficus racemosa*	Moraceae	LC	2	2
26	*Ficus religiosa*	Moraceae	NL	2	2
27	*Ficus tsjahela*	Moraceae	LC	1	1
28	*Ficus benghalensis*	Moraceae	LC	3	3
29	*Gliricidia sepium*	Fabaceae	NL	1	1
30	*Gmelina asiatica*	Lamiaceae	LC	1	1
31	*Grewia damine*	Malvaceae	LC	2	2
32	*Grewia orientalis*	Malvaceae	LC	2	2
33	*Gyrocarpus americanus*	Hernandiaceae	LC	1	1
34	*Haldina cordifolia*	Rubiaceae	LC	1	1
35	*Holoptelea grandis*	Ulmaceae	NT	2	2
36	*Khaya senegalensis*	Meliaceae	NL	1	1
37	*Leucaena leucocephala*	Fabaceae	NL	4	3
38	*Limonia acidissima*	Rutaceae	LC	6	3
39	*Madhuca longifolia*	Sapotaceae	NT	3	3
40	*Manilkara hexandra*	Sapotaceae	VU	5	5
41	*Mitragyna parvifolia*	Rubiaceae	LC	7	6
42	*Morinda coreia*	Rubiaceae	LC	3	3
43	*Nauclea orientalis*	Rubiaceae	LC	1	1
44	*Oroxylum indicum*	Bignoniaceae	LC	1	1
45	*Pongamia pinnata*	Fabaceae	LC	5	5
46	*Premna tomentosa*	Lamiaceae	LC	2	2
47	*Psidium guajava*	Myrtaceae	NL	1	1
48	*Sapindus emarginatus*	Sapindaceae	LC	2	2
49	*Schleichera oleosa*	Sapindaceae	LC	2	2
50	*Senna spectabilis*	Fabaceae	NL	1	1
51	*Sterculia foetida*	Malvaceae	LC	1	1
52	*Streblus asper*	Moraceae	LC	6	4
53	*Strychnos nux-vomica*	Loganiaceae	VU	4	2
54	*Syzygium cumini*	Myrtaceae	LC	11	5
55	*Tamarindus indica*	Fabaceae	NL	5	3
56	*Tectona grandis*	Lamiaceae	NL	2	1
57	*Terminalia arjuna*	Combretaceae	LC	7	6
58	*Thespesia populnea*	Malvaceae	LC	2	1
59	*Trema orientalis*	Ulmaceae	LC	4	2
60	*Vitex leucoxylon*	Lamiaceae	LC	19	7
61	*Walsura trifoliolata*	Meliaceae	LC	1	1

Out of 61 tree species(terrestrial plant species) reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems, there were only one endemic species, *i.e*. *Diplodiscusverrucosus* (Malvaceae). Though, it is listed as a least concerned species in National Red List, in the present study sites, it is not relatively a common species (*i.e*., rare). There were two near threatened (NT) tree species [*viz*., *Holoptelea grandis* (Ulmaceae) and *Madhuca longifolia* (Sapotaceae)] and three vulnerable (VU) tree species [*viz*. *Chloroxylon swietenia* (Rutaceae), *Manilkara hexandra* (Sapotaceae) and *Strychnos nux-vomica* (Loganiaceae)] among the 61 tree species reported. It is very essential to note, the relative abundance of all of these five species (except *Manilkara hexandra*) are also not high in the present study sites, like *Diplodiscus verrucosus* (Malvaceae).

Most of the *Manilkara hexandra* trees in the sites are not comparatively larger compared to the *Manilkara hexandra* trees visible in the conservation areas under the custody of FD and DWC. However, it is listed as a least concern species in the National Red List, abundance of *Drypetes sepiaria* (Putranjivaceae), an essential key species in the dry zone,is not in a satisfactory level. The two *Diospyros*sp. (Ebenaceae) reported, *viz*. *Diospyros malabarica* and *Diospyros ovalifolia* were also not commonly available in the study areas.

Prsence of some exotic species such as *Albizia saman* (Fabaceae), *Leucaena leucocephala* (Fabaceae)*, Tectona grandis* (Lamiaceae) and some other exotic tree species were also noticeable in the sites. Among the exotics, *Leucaena leucocephala* (Fabaceae) is considered one of the 100 worst invasive species by the Invasive Species Specialist Group (ISSG) of the IUCN Species Survival Commission (Global Invasive Species Database, 2019a).

It is worth to report that the present study sites housed six Keystone fig species, i.e. *Ficus* sp. (Moraceae), viz. *Ficus callosa*, *Ficus microcarpa*, *Ficus racemosa*, *Ficus religiosa*, *Ficus tsjahela* and *Ficus benghalensis*. These species provide an array of ecological services including food for frugivorous animals, especially avifauna (birds) and monkeys. Figs have coevolved and well established mutualistic symbiosis with their species specific fig-wasps. This particular plant-animal interaction is extremely environmental sensitive and the subsequent changes in fig/fig-wasp systems could be lead to the changes in the entire system, as they are promising producers in the system's food web. However, the number of individuals of all these fig species was at very low levels.

Vitex leucoxylon (Lamiaceae) was the most abundant (dominant) tree species (terrestrial plant species) reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems followed by *Azadirachta indica* (Meliaceae) and *Syzygium cumini* (Myrtaceae). Other tree species were *Barringtonia acutangula* (Lecythidaceae), *Bauhinia racemosa* (Fabaceae), *Acacia leucophloea* (Fabaceae), *Mitragyna parvifolia* (Rubiaceae), *Terminalia arjuna* (Combretaceae), *Limonia acidissima* (Rutaceae), *Streblus asper* (Moraceae), *Borassus flabellifer* (Arecaceae), *Manilkara hexandra* (Sapotaceae), *Pongamia pinnata* (Fabaceae), and *Tamarindus indica* (Fabaceae) in their descending order.

The tree species *Albizia odoratissima* (Fabaceae), *Berrya cordifolia* (Malvaceae), *Canthium coromandelicum* (Rubiaceae), *Caryota urens* (Arecaceae), *Cassia fistula* (Fabaceae), *Diospyros ovalifolia* (Ebenaceae), *Diplodiscus verrucosus* (Malvaceae), *Drypetes sepiaria* (Putranjivaceae), *Ficus callosa* (Moraceae), *Ficus microcarpa* (Moraceae), *Ficus tsjahela* (Moraceae), *Gmelina asiatica* (Lamiaceae), *Gyrocarpus americanus* (Hernandiaceae), *Haldina cordifolia* (Rubiaceae), *Nauclea orientalis* (Rubiaceae), *Oroxylum indicum* (Bignoniaceae), *Sterculia foetida* (Malvaceae) and *Walsura trifoliolata* (Meliaceae)were at the lowest abundancelevel(both total abundances and frequencies were equal to one) in the study area.Consequently, it is possible to consider them as the rare tree species in the study sites.

The palm species *Caryota urens* (Arecaceae), the fig species *Ficus callosa* (Moraceae) and *Ficus tsjahela* (Moraceae) are mostly found in the wet zone and also in the intermediate zone. Others are dry zone spcies. Among the lowest abundant (rare) tress species, *Albizia odoratissima* (Fabaceae), *Berrya cordifolia* (Malvaceae)and *Haldina cordifolia* (Rubiaceae) are timber species, and *Cassia fistula* (Fabaceae), *Gmelina asiatica* (Lamiaceae), *Nauclea orientalis* (Rubiaceae), *Oroxylum indicum* (Bignoniaceae) and *Sterculia foetida* (Malvaceae) are medicinal plants (Figure 4.7).

Table 4.5: Tree-let/shrub species (woody perennial terrestrial plant species) reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems (LC = Least concern, N=Not listed in the National Red List).

No.	Name	Family	National Conservation Status	Total Score	Frequency
1	*Atalantia ceylanica*	Rutaceae	LC	3	2
2	*Azima tetracantha*	Salvadoraceae	LC	4	2
3	*Bauhinia tomentosa*	Fabaceae	LC	1	1
4	*Breynia vitis-idaea*	Phyllanthaceae	LC	7	4
5	*Calotropis gigantea*	Apocynaceae	LC	7	5
6	*Carissa spinarum*	Apocynaceae	LC	2	2
7	*Catunaregam spinosa*	Rubiaceae	LC	1	1
8	*Chromolaena odorata*	Asteraceae	NL	5	4
9	*Clausena indica*	Rutaceae	LC	1	1
10	*Croton aromaticus*	Euphorbiaceae	LC	5	2
11	*Croton laccifer*	Euphorbiaceae	LC	7	3
12	*Dichrostachys cinerea*	Fabaceae	LC	1	1
13	*Euphorbia antiquorum*	Euphorbiaceae	LC	3	3
14	*Ficus hispida*	Moraceae	LC	3	3
15	*Flueggea leucopyrus*	Phyllanthaceae	LC	3	2
16	*Hibiscus tilliaceus*	Malvaceae	LC	2	1
17	*Ixora coccinea*	Rubiaceae	LC	4	3
18	*Jatropha gossypifolia*	Euphorbiaceae	NL	2	2
19	*Lantana camara*	Verbenaceae	NL	4	2

20	*Maba buxifolia*	Ebenaceae	LC	2	2
21	*Memecylon* sp. (umbellatum)?	Melastomataceae	?	1	1
22	*Memecylon umbellatum*	Melastomataceae	LC	4	1
23	*Murraya koenigii*	Rutaceae	LC	1	1
24	*Paramignya monophylla*	Rutaceae	LC	2	2
25	*Phoenix pusilla*	Aricaceae	LC	10	4
26	*Senna alata*	Fabaceae	LC	1	1
27	*Senna auriculata*	Fabaceae	LC	3	3
28	*Sesbania* sp.	Fabaceae	?	1	1
29	*Solanum torvum*	Solanaceae	LC	1	1
30	*Solanum insanum*	Solanaceae	NL	1	1
31	*Tarenna asiatica*	Rubiaceae	LC	1	1
32	*Volkameria inermis*	Lamiaceae	LC	1	1
33	*Ziziphus mauritiana*	Rhamnaceae	LC	1	1

The common native dry zone palm species *Phoenix pusilla* (Aricaceae) was the dominant tree-let/shrub species (terrestrial plant species) reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems. Codominant species were *Breynia vitis-idaea* (Phyllanthaceae), *Calotropis gigantea* (Apocynaceae) and *Croton laccifer* (Euphorbiaceae). All of them are medicially imprtnat species.

Other highly abundant tree-let/shrub species are *Croton aromaticus* (Euphorbiaceae), *Azima tetracantha* (Salvadoraceae), *Ixora coccinea* (Rubiaceae), *Memecylon umbellatum* (Melastomataceae), and two highly IAS of plants, *viz*., *Chromolaena odorata* (Asteraceae) and *Lantana camara* (Verbenaceae). *Lantana camara* (Verbenaceae)is also considered one of the 100 worst invasive species (Global Invasive Species Database, 2019b). Except two IAS of plants, others are medicinally important.

Next cluster of tree-let/shrub species are relatively less abundant than the above group and not the lowest. Except poisonous *Jatropha gossypifolia* (Euphorbiaceae), and *Maba buxifolia* (Ebenaceae), others are medicinal plants, *viz*. *Atalantia ceylanica* (Rutaceae), *Euphorbia antiquorum* (Euphorbiaceae), *Ficus hispida* (Moraceae), *Flueggea leucopyrus*(Phyllanthaceae), *Senna auriculata* (Fabaceae), *Carissa spinarum* (Apocynaceae), *Hibiscus tilliaceus* (Malvaceae) and *Paramignya monophylla* (Rutaceae).

Lowest abundant tree-let/shrub group of species is comprised of medicinally importanat *Catunaregam spinosa* (Rubiaceae),*Murraya koenigii* (Rutaceae), *Senna alata* (Fabaceae), *Solanum torvum* (Solanaceae), *Solanum insanum* (Solanaceae) and *Tarenna asiatica* (Rubiaceae); potential ornamentals *Bauhinia tomentosa* (Fabaceae),*Dichrostachys cinerea* (Fabaceae) and *Volkameria inermis* (Lamiaceae); and a crop wild reltive (CWR) *Ziziphus mauritiana* (Rhamnaceae) [*Ziziphus jujuba* is the cultivated species]. *Volkameria inermis* (Lamiaceae) is a mangrove associate plant and *Catunaregam spinosa* (Rubiaceae) and

Dichrostachys cinerea (Fabaceae) are typical dry zone scrubland plants and also perform well under arid or semi-arid conditions.

Figure 4.7: Some common wet zone plant species recorded from the adjacent terrestrial habitats in the Wewa (tank) and adjacent systems: *Caryota urens* (A), *Ficus callosa* (B), *Oroxylum indicum* (C)

Table 4.6: Scandent/liana/creeping plant species (woody and herbaceous terrestrial plant species) reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems (LC = Least concern, VU = Vulnerable, NT = Near threatened, NL = Not listed in the National Red List).

No.	Name	Family	National Conservation Status	Total Score	Frequency
1	*Argyreia osyrensis*	Convolvulaceae	LC	1	1
2	*Asparagus racemosus*	Asparagaceae	LC	1	1
3	*Cardiospermum halicacabum*	Sapindaceae	LC	3	3
4	*Cissus quadrangularis*	Vitaceae	LC	4	2
5	*Clitoria ternatea*	Fabaceae	LC	1	1
6	*Coccinia grandis*	Cucurbitaceae	LC	3	2
7	*Combretum ovalifolium*	Combretaceae	NT	12	5
8	*Derrisparviflora*	Fabaceae	LC	1	1
9	*Derris scandens*	Fabaceae	LC	8	4
10	*Dregea volubilis*	Apocynaceae	LC	1	1

11	*Gymnopetalum scabrum*	Cucurbitaceae	VU	1	1
12	*Ipomoea marginata*	Convolvulaceae	LC	1	1
13	*Ipomoea pes-tigridis*	Convolvulaceae	LC	1	1
14	*Merremia hederacea*	Convolvulaceae	LC	1	1
15	*Momordica charantia*	Cucurbitaceae	LC	1	1
16	*Mukia maderaspatana*	Cucurbitaceae	NT	2	2
17	*Oxystelma esculentum*	Apocynaceae	LC	1	1
18	*Passiflora foetida*	Passifloraceae	NL	6	4
19	*Ventilago madraspatana*	Rhamnaceae	LC	1	1
20	*Ziziphus oenopolia*	Rhamnaceae	LC	4	2

Near threatened (NT) *Combretum ovalifolium* (Combretaceae) is the dominant taxon among 20 species of scandent/liana/creeping (terrestrial plant species) reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems (Figure 3.8), followed by *Derris scandens* (Fabaceae) and *Passiflora foetida* (Passifloraceae). Both species are medicinally important.*Passiflora foetida* (Passifloraceae) is an underutilized wild fruit species and a CWR of cultivated *Passiflora edulis* (Passion fruit), and root extrcts of *Derris scandens* (Fabaceae) is used in indigenous fishery.

Cissus quadrangularis (Vitaceae), *Ziziphus oenopolia* (Rhamnaceae), *Cardiospermum halicacabum* (Sapindaceae), *Coccinia grandis* (Cucurbitaceae) and *Mukia maderaspatana* (Cucurbitaceae) form the next cluster, relatively less dominant to the above group. *Mukia maderaspatana* (Cucurbitaceae) is listed as a near threatened (NT) species in the National Red List 2012 of Sri Lanka (MOE, 2012) (Figure 3.8). All are medicinally important. Two Cucurbitaceae species, *Coccinia grandis* and *Mukia maderaspatana* are crop wild relatives (CWR).

Cluster of lowest abundant scandent/liana/creeping plants comprised of 12 species. Among them, *Asparagus racemosus* (Asparagaceae), *Clitoria ternatea* (Fabaceae), *Derris parviflora* (Fabaceae), *Dregea volubilis* (Apocynaceae), *Ipomoea marginata* (Convolvulaceae), *Ipomoea pes-tigridis* (Convolvulaceae) and*Momordica charantia* (Cucurbitaceae) are medicinally important plants. *Argyreia osyrensis* (Convolvulaceae), *Merremia hederacea* (Convolvulaceae), *Oxystelma esculentum* (Apocynaceae) are possess potential ornamental properties. *Gymnopetalum scabrum* (Cucurbitaceae) is a potential CWR for gourds and it is listed as a vulnerable (VU) species in the National Red List. *Ventilago madraspatana* (Rhamnaceae)is a high emergent liana, an underutilized plant source.

Table 4.7: Herbaceous plant species (upright terrestrial plant species) reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems (LC = Least concern, VU = Vulnerable, NT = Near threatened, NL = Not listed in the National Red List, M = Medicinal, WD = Weed, F = Fibre, IAS = Invasive Alien Species, CWR = Crop Wild Relative).

No.	Name	Family	National Conservation Status	Importance	Total Score	Frequency
1	*Abutilon indicum*	Malvaceae	LC	M	6	4
2	*Achyranthes aspera*	Amaranthaceae	LC	M	1	1
3	*Barleria prionitis*	Acanthaceae	LC	M	1	1
4	*Cassia occidentalis*	Fabaceae	LC	M	1	1
5	*Coldenia procumbens*	Boraginaceae	LC	WD	2	1
6	*Corchorus olitorius*	Malvaceae	VU	F	3	3
7	*Crinum latifolium*	Amaryllidaceae	VU	M	3	3
8	*Crotalaria* sp.	Fabaceae	?	F	1	1
9	*Croton bonplandianus*	Euphorbiaceae	NL	WD	5	3
10	*Cynodon dactylon*	Poaceae	LC	M	4	2
11	*Heliotropium indicum*	Boraginaceae	LC	M	1	1
12	*Hyptis suaveolens*	Lamiaceae	NL	WD	6	3
13	*Imperata cylindrica*	Poaceae	LC	IAS	2	1
14	*Ludwigia* sp.	Onagraceae	?	IAS	1	1
15	*Macroptilium lathyroides*	Fabaceae	NL	CWR	1	1
16	*Megathyrsus maximus*	Poaceae	NL	IAS	3	1
17	*Melochia corchorifolia*	Malvaceae	LC	CWR	1	1
18	*Ocimum americanum*	Lamiaceae	LC	M	1	1
19	*Panicum repens*	Poaceae	LC	M	2	1
20	*Pothos scandens*	Araceae	LC	M	1	1
21	*Sansevieria zeylanica*	Asparagaceae	NT	F	1	1
22	*Scoparia dulcis*	Plantaginaceae	NL	M	2	2
23	*Senna tora*	Fabaceae	LC	M	2	2
24	*Sesamum indicum*	Pedaliaceae	NL	M	1	1
25	*Sida acuta*	Malvaceae	LC	M	1	1
26	*Tephrosia purpurea*	Fabaceae	LC	M	4	3
27	*Tridax procumbens*	Asteraceae	NL	WD	1	1
28	*Urena lobata*	Malvaceae	LC	M	1	1

29	*Wissadula periplocifolia*	Malvaceae	NT	M	1	1
30	*Xanthium strumarium*	Asteraceae	LC	WD	3	2

Herbaceous plant species (terrestrial plant species) reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems dominated by *Abutilon indicum* (Malvaceae) and *Hyptis suaveolens* (Lamiaceae), followed by *Croton bonplandianus* (Euphorbiaceae). *Abutilon indicum* is a medicinal plant. *Hyptis suaveolens*is a gifted bee plant with small blue-purple flowers, which attracted 60 species of bees (Karunaratne*et al*., 2005). Considering therole of this plant in bee/pollinator conservation, it has been labeled as a prized-weed (Raju *et al*., 1997).This is an exotic plant in Sri Lanka, grown luxuriantly and thrive alsmot everywhere, but not considered it as an IAS yet.

Cynodon dactylon (Poaceae), *Tephrosia purpurea* (Fabaceae), *Corchorus olitorius* (Malvaceae), *Crinum latifolium* (Amaryllidaceae), *Megathyrsus maximus* (Poaceae), *Xanthium strumarium* (Asteraceae), *Coldenia procumbens* (Boraginaceae), *Imperata cylindrica* (Poaceae), *Panicum repens* (Poaceae), *Scoparia dulcis* (Plantaginaceae), *Senna tora* (Fabaceae) is cluster next in line as moderately abundant species, in their ascending order. Further details of these plants and other less abundant species (*i.e.* rare in the site) are given in the Table 4.7.

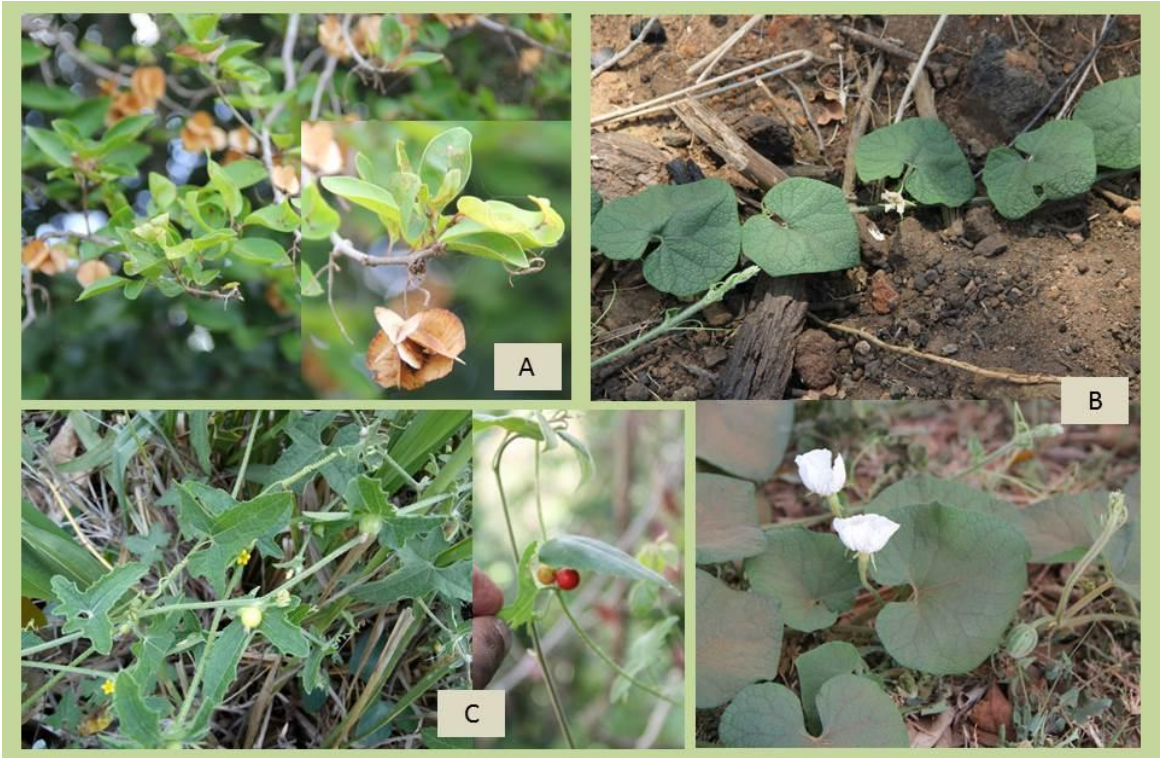

Figure 4.8: Some near threatened (NT) and vulnerable (VU) plant species reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems : *Combretum ovalifolium* (A), *Gymnopetalum scabrum* (B), Mukia maderaspatana (C)

Out of these 30 herbaceous plant species, 17 are medicinal, 5are weeds, 3 are IAS, 3 are fibre yielding plants, and 2 are CWR (Table 4.7).*Sansevieria zeylanica* (Asparagaceae) and *Wissadula periplocifolia* (Malvaceae) are listed as near threatened (NT); whereas, *Corchorus olitorius* (Malvaceae) and *Crinum latifolium* (Amaryllidaceae) are listed as vulnerable (VU) in the National Red List (Figure 4.9).

In addition to the above plant categories, 4 other plants (epiphytic/parasitic) were there in the sites (Table 4.8). Epiphytic orchid species *Vanda tessellata* (Orchidaceae) is abundant on the branches and also on the trunks of large trees in the sites. National Red List lists this species as vulnerable (VU) and this vulnerability may be due to the excessive collection of this taxon for commercial and ornamental purposes. There were two shoot hemiparasitic plant species grown on the twigs of large and medium sized trees [*viz*. *Dendrophthoe falcata* (Loranthaceae) and *Taxillu*s sp. (Loranthaceae)], and one shoot holoparasitic plant species grown on other herbaceous plant species [*Cuscuta chinensis* (Convolvulaceae)] in the study area (Figure 4.10).

Table 4.8: Other types of plant species (epiphytic/parasitic) reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems(LC = Least concern, VU = Vulnerable).

No	Name	Family	Habit	National Conservation Status	Total Score	Frequency
1	*Vanda tessellata*	Orchidaceae	Eepiphytic	VU	4	3
2	*Dendrophthoe falcata*	Loranthaceae	Hemiparasitic	LC	3	2
3	*Cuscuta chinensis*	Convolvulaceae	Holoparasitic	LC	3	3
4	*Taxillus* sp.	Loranthaceae	Hemiparasitic	?	1	1

Figure 4.9: Some near threatened (NT) plant species reported from adjacent terrestrial habitats in the Wewa (tank) and adjacent systems : *Sansevieria zeylanica* (A) and *Wissadula periplocifolia* (B)

Figure 4.10: Epiphytic and parasitic plants in the adjacent terrestrial habitats in the Wewa (tank) and adjacent systems: *Vanda tessellata* (A), *Dendrophthoe falcata* (B), *Taxillus sp.* (C)

4.3.1.2.3 Thicket of Parkinsonia at Medawachchiya Wewa System in Galnewa DS Division

Significant area of the adjacent terrestrial habitat of Medawachchiya Wewa system is occupied by *Parkinsonia aculeata* (Fabaceae)(Figure 4.11), a shrubby woody perennial plant species with tiny compound leaves and thorns. The luxuriant growth is dense and seems it is performing well. It is an introduced in Sri Lanka, probably as an ornamental plant or as a multipurpose tree species (Figure 4.12).

Figure 4.11: Thicket of *Parkinsonia aculeata* (Fabaceae) at Medawachchiya Wewa System (B) Location of Medawachchiya Wewa (A1 and A2) and Twigs of *Parkinsonia aculeata* (C)

Parkinsonia is well known as Jerusalem thorn (or jelly bean tree). It is native to tropical (semi-arid) America (some areas of southwestern United States, northern Mexico and the Galápagos Islands as well, native range has been expanded over the time). It has been introduced to other continents out of its native range and now it is widespread in Australia (Parkinsonia 2003 and Parkinsonia 2016). According to the Weed Management Guides for Parkinsonia (*Parkinsonia aculeata*) published by CRC for Australian Weed Management, the Commonwealth Department of the Environment and Heritage and the Queensland Department of Natural Resources and Mines, in Australia, it is a Weed of National Significance, and regarded as one of the worst weeds there due to its invasiveness, potential for spread, and economic and environmental

impacts caused consequently. This species threatens rangelands and wetlands around there, and if left untreated, it displaces native vegetation and lessens access to land and waterways, and further reduces of primary production of native flora, especially grasslands due to high competition. Accordingly, it is clear that the environmental impacts of this problematic plant are numerous (replacement of native plant species, leading to lower quality habita tfor animals etc.). Wetlands are particularly vulnerable due to many aspects' Threatened areas in Australia include national parks and other regions of high aesthetic, indigenous and tourist value(Parkinsonia 2003 and Parkinsonia 2016).

Figure 4.12: Dense Parkinsonia growth and regeneration at Medawachchiya Wewa System in Galnewa Divisional Secretariat Division

Figure 4.13: Dense Parkinsonia growth and regeneration at Medawachchiya Wewa System (B) Thorny twigs with tiny leaves and flowers (B) and a cluster of dried fruits/pods (C)

So far, *Parkinsonia aculeata* is not considered as an IAS of plant in Sri Lanka, or even as a noxious weed. However, it is a critical problem in some countries like Austrilia as described above. In the adjacent terrestrial habitat, rather the aquatic/terrestrial interface of the Medawachchiya Wewa ecosystem in Galnewa seems one of the favourable habitats of Parkinsonia (probably the best). Obviously, it is very clear that Parkinsonia spreading rapidly and outcompetes the local vegetation in the vicinity. Evidently, there are plenty of seeds (in mature dried pods), well established shade tolerant seedling bank under the relatively sparse thicket of mature Parkinsonia and mature thicket of treelets in their reproductive maturity. Seedbank may also be rich and rich enough for sustainable proliferation and concurrent regeneration (Cochard and Jackes, 2005 and van Klinken *et al*., 2008).

According to the Australian experiences (Parkinsonia, 2003 and Parkinsonia, 2016), Parkinsonia control is very expensive and prevention of spread is more cost-effective. Therefore, implementing suitable immediate actions to curb further spreading or eradication are highly recommended at this juncture. Different methods have been tested and applied to control Prakinsonia, however signifying that the control must be tailored to suit the landscape and also stressing that the follow-up will be required to control seedlings.

4.3.1.3 Home gardens

Home gardens are mainly with deliberately planted trees (timber, fruit, cash-crop, ornamental), shrub species (edible and ornamental), and herbaceous species (vegetable and ornamental). Naturally grown forest plant species (trees and shrubs) also in and around homegardens, especially in extended home gardens, as boundaries are not so clear. Occurrence of large forest tree species (both timber and non-timber) is relatively low in home gardens. Strangely, the home gardens are with abundant empty spaces and they are mainly lavish with IAS species of plants. Other naturally grown forest species are also available, but in weedy manner. They are not maintained healthy in most cases, *i.e.*, prospects for introducing more plant species into the system as garden plants as well as live fence species.

Chloroxylon swietenia (Rutaceae), *Tectona grandis* (Lamiaceae), *Haldina cordifolia* (Rubiaceae) and *Berrya cordifolia* (Malvaceae) are the common deliberately planted and/or unintentionally planted timber trees in the homegardens. *Mitragyna parvifolia* (Rubiaceae), *Bridelia retusa* (Phyllanthaceae), *Holoptelea grandis* (Ulmaceae),*Schleichera oleosa* (Sapindaceae), and *Bauhinia racemosa* (Fabaceae) are the other common tree species in the homegarden system. Mango (*Mangifera indica*: Anacardiaceae), Cashew (Anacardium occidentale: Anacardiaceae), Lime (*Citrus aurantiifolia*: Rutaceae), Pomegranate (*Punica granatum*: Lythraceae), Guava(Psidium guajava: Myrtaceae), and Bael-fruit (*Aegle marmelos*: Rutaceae)are the common fruit and cash-crop tree species in this system. Coconut (*Cocos nucifera*: Arecaceae) and Drumstick-tree (*Moringa oleifera*: Moringaceae) also highly available in these home gardens. *Moringa oleifera*is especially used as a common live fence species together with various exotic ornamental plants.

Live fences of the coastal home gardens are mostly comprised of indigenous species and remarkably the live fence species are in mid country highland home gardens are mostly introduced (exotic) plants (Wijetunga, 2007 and Wijetunga, 2008). Majority of live fence species around the home gardens in the present study sites are also exotics. Introduction of indigenous and endemic species to the live fences of the study areas is very important (highlighted and recommended), as it is a promising way of *ex situ* conservation and also a suitable way for additional income generation, if multipurpose species will be used.

4.3.1.4 Disturbed forests

Five (5) selected disturbed forest patches or rather extensions of large home gardens merging with existing reserves (3 from Galnewa DS Division, 1 from Ipalogama DS Division and 1 from Palagala DS Division) were surveyed for flora. In addition to the relatively dense already mentioned situation, the vegetation adjacent to an active quarry in Oththapahuwa also was surveyed to investigate and compare whether there is a difference in order to continuing disturbance due to the activities of massive quarry. Complete list of plant species of different

categories found in disturbed forest patches and vegetation adjacent to Oththapahuwa quarry is presented in Table 4.9; tree species (woody perennials) in Table 4.9a, tree-let/shrub species in Table 4.9b, scandent/liana/creeping plant species in Table 4.9c, herbaceous plant species in Table 4.9d,and other types of plant species Table 4.9e.

According to the observations, floristic component of these habitats (except the vegetation adjacent to Oththapahuwa quarry, though it has some unique features) are richer and diverse than the adjacent terrestrial habitats of "wewa (tank) and adjacent habitats" system. Rich with some typical dry zone forest species (also some timber trees, but very low in numbers). Medicinal plants and some crop wild relatives (CWR) are available in the system.

Vegetation rather dense with sparse scrublands, and also some partially utilized sites. Partially used sites are probably for chena cultivation (හේන්ගොවිතැන) or abandoned habitations after elephant damages. Regeneration can be seen, with erlay successional and/or pioneer dryzone plant species. Interestingly, the invasions (abundance of IAS of plants) are relatively low than the wewa (tank) and adjacent habitats system.

Table 4.9: Plant species reported from disturbed forest patches and the vegetation adjacent to Oththapahuwa quarry and their relative abundances (RA).

- x – not found in the site
- * – only found in disturbed forest system
- # – only found in vegetation adjacent to Oththapahuwa quarry
- ^ – also found in adjacent terrestrial habitats in the Wewa (tank) and adjacent systems
    - *# – found in disturbed forest system and vegetation adjacent to Oththapahuwa quarry, not in adjacent terrestrial habitats in the Wewa (tank) and adjacent systems

Table 4.9a: Tree species (woody perennials)				
No.	**Name**	**Family**	**Forest RA**	**Quarry RA**
1	*Acacia leucophloea* ^	Fabaceae	1	x
2	*Albizia odoratissima* ^	Fabaceae	1	1
3	*Azadirachta indica* ^	Meliaceae	2	1
4	*Bauhinia racemosa* ^	Fabaceae	2	x
5	*Berrya cordifolia* ^	Malvaceae	1	x
6	*Bridelia retusa* ^	Phyllanthaceae	1	1
7	*Cassia fistula* ^	Fabaceae	2	1
8	*Cassia roxburghii* *	Fabaceae	1	x
9	*Chloroxylon swietenia* ^	Rutaceae	1	x
10	*Cordia dichotoma* ^	Boraginaceae	1	x
11	*Crateva adansonii* ^	Capparaceae	1	x
12	*Dimorphocalyx glabellus* *	Euphorbiaceae	1	x

13	*Diospyros ebenum* *	Ebenaceae	1	x
14	*Diospyros malabarica* ^	Ebenaceae	1	x
15	*Diplodiscus verrucosus* ^	Malvaceae	2	x
16	*Drypetes sepiaria* ^	Putranjivaceae	x	1
17	*Gliricidia sepium* ^	Fabaceae	1	x
18	*Grewia damine* ^	Malvaceae	1	1
19	*Grewia helicterifolia* *	Malvaceae	1	x
20	*Grewia orientalis* ^	Malvaceae	2	1
21	*Haldina cordifolia* ^	Rubiaceae	x	1
22	*Holoptelea grandis* ^	Ulmaceae	1	1
23	*Ixora* sp.? *#	Rubiaceae	1	1
24	*Lannea coromandelica* *#	Anacardiaceae	1	1
25	*Leucaena leucocephala* ^	Fabaceae	1	x
26	*Limonia acidissima* ^	Rutaceae	2	x
27	*Manilkara hexandra* ^	Sapotaceae	1	x
28	*Mitragyna parvifolia* ^	Rubiaceae	2	1
29	*Morinda coreia* ^	Rubiaceae	2	1
30	*Pongamia pinnata* ^	Fabaceae	1	x
31	*Premna tomentosa* ^	Lamiaceae	x	1
32	*Psydrax dicoccos* *	Rubiaceae	1	x
33	*Sapindus emarginatus* ^	Sapindaceae	x	1
34	*Schleichera oleosa* ^	Sapindaceae	2	1
35	*Streblus asper* ^	Moraceae	x	1
36	*Strychnos nux-vomica* ^	Loganiaceae	1	1
37	*Syzygium cumini* ^	Myrtaceae	1	1
38	*Tamarindus indica* ^	Fabaceae	1	x
39	*Tectona grandis* #	Lamiaceae	x	1
40	*Trema orientalis* ^	Ulmaceae	x	2
41	*Vitex pinnata* *	Lamiaceae	1	x
42	*Walsura trifoliolata* ^	Meliaceae	1	x

Table 4.9b: Tree-let/shrub species (woody perennials)

No.	Name	Family	Forest RA	Quarry RA
1	*Allophylus cobbe* *#	Sapindaceae	1	1
2	*Atalantia ceylanica* ^	Rutaceae	2	1
3	*Breynia vitis-idaea* ^	Phyllanthaceae	1	x
4	*Calotropis gigantean* ^	Apocynaceae	x	1
5	*Carissa spinarum* ^	Apocynaceae	2	x
6	*Catunaregam spinosa* ^	Rubiaceae	2	x
7	*Chromolaena odorata* ^	Asteraceae	2	1
8	*Clausena indica* ^	Rutaceae	1	x

9	*Croton laccifer* ^	Euphorbiaceae	2	x
10	*Dichrostachys cinerea* ^	Fabaceae	2	1
11	*Flueggea leucopyrus* ^	Phyllanthaceae	2	1
12	*Jatropha gossypifolia* ^	Euphorbiaceae	1	x
13	*Lantana camara* ^	Verbenaceae	1	2
14	*Memecylon umbellatum* ^	Melastomataceae	1	1
15	*Murraya paniculata* #	Rutaceae	x	1
16	*Pamburus missionis* *	Rutaceae	1	x
17	*Phoenix pusilla* ^	Aricaceae	2	x
18	*Phyllanthus polyphyllus* *#	Phyllanthaceae	1	1
19	*Phyllanthus reticulatus* *	Phyllanthaceae	1	x
20	*Pleiospermium alatum* *	Rutaceae	1	x
21	*Senna auriculata* ^	Fabaceae	1	x
22	*Solanum insanum* ^	Solanaceae	1	1
23	*Tarenna asiatica* ^	Rubiaceae	2	x
24	*Ziziphus mauritiana* ^	Rhamnaceae	1	x
25	*Ziziphus oenopolia* ^	Rhamnaceae	2	1

Table 4.9c: Scandent/liana/creeping plant species (woody and herbaceous)

No.	Name	Family	Forest RA	Quarry RA
1	*Abrus precatorius* *	Fabaceae	1	x
2	*Acacia caesia* #	Fabaceae	x	1
3	*Argyreia osyrensis* ^	Convolvulaceae	1	x
4	*Argyreia osyrensis* ^	Convolvulaceae	1	x
5	*Asparagus racemosus* ^	Asparagaceae	1	x
6	*Cajanus scarabaeoides* *#	Fabaceae	1	1
7	*Cardiospermum halicacabum* ^	Sapindaceae	1	x
8	*Cissampelos pareira* *	Menispermaceae	1	x
9	*Clitoria ternatea* ^	Fabaceae	1	x
10	*Combretum ovalifolium* ^	Combretaceae	x	1
11	*Derris parviflora* ^	Fabaceae	1	1
12	*Derris scandens* ^	Fabaceae	1	x
13	*Dioscorea pentaphylla* *	Dioscoreaceae	1	x
14	*Dioscorea spicata* *	Dioscoreaceae	1	x
15	*Dregea volubilis* ^	Apocynaceae	1	1
16	*Hewittia malabarica* *	Convolvulaceae	1	x
17	*Ichnocarpus frutescens* *#	Apocynaceae	2	1
18	*Jasminum angustifolium* #	Oleaceae	x	1
19	*Mukia maderaspatana* ^	Cucurbitaceae	1	x
20	*Passiflora foetida* ^	Passifloraceae	1	x

21	*Salacia reticulata #*	Celastraceae	x	1
22	*Toddalia asiatica **	Rutaceae	1	x
23	*Vernonia zeylanica *#*	Asteraceae	1	1

Table 4.9d: Herbaceous plant species (upright)

No.	Name	Family	Forest RA	Quarry RA
1	*Aerva lanata **	Amaranthaceae	1	x
2	*Alysicarpus vaginalis **	Fabaceae	1	x
3	*Andrographis alata **	Acanthaceae	1	x
4	*Cleome viscosa **	Cleomaceae	1	x
5	*Crotalaria verrucosa #*	Fabaceae	x	1
6	*Croton hirtus **	Euphorbiaceae	2	x
7	*Desmodium triflorum **	Fabaceae	2	x
8	*Dipteracanthus prostratus **	Acanthaceae	1	x
9	*Euphorbia hirta ^*	Euphorbiaceae	1	x
10	*Evolvulus alsinoides **	Convolvulaceae	2	x
11	*Gomphrena celosioides **	Amaranthaceae	1	x
12	*Heliotropium indicum ^*	Boraginaceae	1	x
13	*Hemidesmus indicus *#*	Apocynaceae	1	1
14	*Hibiscus lobatus **	Malvaceae	1	x
15	*Hibiscus micranthus *#*	Malvaceae	1	1
16	*Hibiscus vitifolius **	Malvaceae	1	x
17	*Hyptis suaveolens ^*	Lamiaceae	2	2
18	*Megathyrsus maximus ^*	Poaceae	1	3
19	*Mollugo cerviana ^*	Molluginaceae	1	x
2	*Ocimum americanum ^*	Lamiaceae	1	x
21	*Oldenlandia corymbosa**	Rubiaceae	1	x
22	*Phyllanthus amarus **	Phyllanthaceae	1	x
23	*Rungia repens **	Acanthaceae	1	x
24	*Scoparia dulcis ^*	Plantaginaceae	1	1
25	*Senna tora ^*	Fabaceae	1	x
26	*Sesamum indicum ^*	Pedaliaceae	1	x
27	*Sida acuta ^*	Malvaceae	2	x
28	*Sida alnifolia **	Malvaceae	1	x
29	*Spermacoce articularis **	Rubiaceae	1	x
30	*Sporobolus coromandelianus **	Poaceae	1	x
31	*Stachytarpheta indica **	Verbenaceae	1	x
32	*Stachytarpheta jamaicensis **	Verbenaceae	1	x
33	*Tephrosia purpurea ^*	Fabaceae	2	2

34	*Tridax procumbens* ^	Asteraceae	1	x
35	*Urena lobata* ^	Malvaceae	1	x
36	*Waltheria indica* *	Malvaceae	1	x
37	*Wissadula periplocifolia* ^	Malvaceae	1	x

Table 4.9e: Other types of plant species

No.	Name	Family	Forest RA	Quarry RA
1	*Vanda tessellate* ^	Orchidaceae	1	x
2	*Dendrophthoe falcate* ^	Loranthaceae	x	1
3	*Riccia* sp. #	Ricciaceae (Bryoflora)	x	1

However, some common herbaceous plants found on road sides and highly disturbed sites are also available in the fringes and along footpaths in these habitats. This availability adds the sites additional attractiveness due to the tiny eye-catching flowers they possess and increasing the diversity in addition. Most of the weedy types are with C_4 photosynthesis and others are legumes. These legumes can fix atmospheric N_2 and can convert to the available forms of due to the presence of rhizobial root nodules. Generally the soils of disturbed fringes are nitrogen deficient. Number of Malvaceae family members is fascinatingly high in the fringes. Probably they are rich with mycorrhizae to sustenance and overcome the drastic conditions in these fringe habitats of the disturbed forest patches.

National Conservation Status (NCS) and importance of plants species reported only from disturbed forest patches and the vegetation adjacent to Oththapahuwa quarry (but not reported from adjacent terrestrial habitats in the Wewa/tank and adjacent systems) are presented in the Table 4.10. There were 9 tree species (woody perennials), 6 tree-let/shrub species (woody perennials), 12 scandent/liana/creeping plant species (woody and herbaceous), 24 herbaceous plant species (upright) and only 1 other type of plant species (a Bryoflora species), i.e. altogether 52 plant species.

Table 4.10: National Conservation Status (NCS) and importance of plant species reported from disturbed forest patches and the vegetation adjacent to Oththapahuwa quarry (LC = Least concern, EN = Endangered, VU = Vulnerable, NL = Not listed in the National Red List, Med = Medicinal, Wed = Weed, Fib = Fibre, Orn = Ornamental, Fst = Forest tree, Tim = Timber).

- + – found in the site
- x – not found in the site
- * – only found in disturbed forest system
- # – only found in vegetation adjacent to Oththapahuwa quarry
- *# – found in disturbed forest system and vegetation adjacent to Oththapahuwa quarry, not in adjacent terrestrial habitats in the Wewa (tank) and adjacent systems

No.	Name	Family	Forest	Quarry	NCS	Importance
Tree species (woody perennials)						
1	*Cassia roxburghii* *	Fabaceae	+	x	LC	Fst/Orn
2	*Dimorphocalyx glabellus* *	Euphorbiaceae	+	x	LC	Fst
3	*Diospyros ebenum* *	Ebenaceae	+	x	EN	Tim
4	*Grewia helicterifolia* *	Malvaceae	+	x	LC	Med/Fib
5	*Ixora* sp.? *#	Rubiaceae	+	+	LC	Fst
6	*Lannea coromandelica* *#	Anacardiaceae	+	+	LC	Tim
7	*Psydrax dicoccos* *	Rubiaceae	+	x	LC	Fst
8	*Tectona grandis* #	Lamiaceae	x	+	NL	Tim
9	*Vitex pinnata* *	Lamiaceae	+	x	NL	Tim
Tree-let/shrub species (woody perennials)						
1	*Allophylus cobbe* *#	Sapindaceae	+	+	LC	Med
2	*Murraya paniculata* #	Rutaceae	x	+	LC	Med/Orn
3	*Pamburus missionis* *	Rutaceae	+	x	LC	Med
4	*Phyllanthus polyphyllus* *#	Phyllanthaceae	+	+	LC	Fib
5	*Phyllanthus reticulatus* *	Phyllanthaceae	+	x	LC	Med
6	*Pleiospermium alatum* *	Rutaceae	+	x	LC	Med
Scandent/liana/creeping plant species (woody and herbaceous)						
1	*Abrus precatorius* *	Fabaceae	+	x	LC	Med
2	*Acacia caesia* #	Fabaceae	x	+	LC	Med
3	*Cajanus scarabaeoides* *#	Fabaceae	+	+	NL	Wed
4	*Cissampelos pareira* *	Menispermaceae	+	x	LC	Med
5	*Dioscorea pentaphylla* *	Dioscoreaceae	+	x	LC	Edible
6	*Dioscorea spicata* *	Dioscoreaceae	+	x	VU	Edible
7	*Hewittia malabarica* *	Convolvulaceae	+	x	LC	Med
8	*Ichnocarpus frutescens* *#	Apocynaceae	+	+	LC	Med
9	*Jasminum angustifolium* #	Oleaceae	x	+	LC	Med/Orn
10	*Salacia reticulata* #	Celastraceae	x	+	EN	Med
11	*Toddalia asiatica* *	Rutaceae	+	x	LC	Med
12	*Vernonia zeylanica* *#	Asteraceae	+	+	LC	Med/Orn
Herbaceous plant species (upright)						
1	*Aerva lanata* *	Amaranthaceae	+	x	LC	Med
2	*Alysicarpus vaginalis* *	Fabaceae	+	x	LC	Med
3	*Andrographis alata* *	Acanthaceae	+	x	LC	Med
4	*Cleome viscosa* *	Cleomaceae	+	x	LC	Med

5	*Crotalaria verrucosa #*	Fabaceae	x	+	LC	Med
6	*Croton hirtus **	Euphorbiaceae	+	x	LC	Wed
7	*Desmodium triflorum **	Fabaceae	+	x	LC	Med
8	*Dipteracanthus prostratus **	Acanthaceae	+	x	LC	Med
9	*Evolvulus alsinoides **	Convolvulaceae	+	x	LC	Med
10	*Gomphrena celosioides **	Amaranthaceae	+	x	NL	Wed
11	*Hemidesmus indicus *#*	Apocynaceae	+	+	LC	Med
12	*Hibiscus lobatus **	Malvaceae	+	x	LC	Wed/Orn
13	*Hibiscus micranthus *#*	Malvaceae	+	+	LC	Wed/Orn
14	*Hibiscus vitifolius **	Malvaceae	+	x	LC	Wed/Orn
15	*Oldenlandia corymbosa**	Rubiaceae	+	x	LC	Med
16	*Phyllanthus amarus **	Phyllanthaceae	+	x	LC	Med
17	*Rungia repens **	Acanthaceae	+	x	LC	Med
18	*Sida alnifolia **	Malvaceae	+	x	LC	Med
19	*Spermacoce articularis **	Rubiaceae	+	x	LC	Wed
20	*Sporobolus coromandelianus **	Poaceae	+	x	LC	Wed
21	*Stachytarpheta indica **	Verbenaceae	+	x	NL	Wed
22	*Stachytarpheta jamaicensis **	Verbenaceae	+	x	NL	Wed
23	*Waltheria indica **	Malvaceae	+	x	LC	Wed
Other types of plant species						
1	*Riccia* sp. #	Ricciaceae	x	+	NL	Bryoflora

Endangered (EN) *Diospyros ebenum* (Ebenaceae) was reported only from the disturbed forest patches, but very rarely, *i.e.* limited to a few small-sized individuals. Likewise, endangered (EN) *Salacia reticulata* (Celastraceae) was reported only from the vegetationadjacent to Oththapahuwa quarry, and limited a single individual. *Dioscorea spicata* (Dioscoreaceae), a vulnerable (VU) edible (yams) liana species was only reported fromthe disturbed forest patches and also limited to less number of individuals. *Vernonia zeylanica*(Asteraceae) was the only endemic plant species reported; however, from both disturbed forest patches and the vegetation adjacent to Oththapahuwa quarry. *Cassia roxburghii* (Fabaceae), a common ornamental dry zone tree species found only in the disturbed forest patches, but also relatively in low numbers.

Majority of the plant species reported either from the disturbed forest patches or the vegetation adjacent to Oththapahuwa quarry, or from both (but not reported from adjacent terrestrial habitats in the Wewa/tank and adjacent systems) are medicinal plants, account to 26 species. Ten (10) species of common weedy plants, 7 potential ornamental plant species, 4 timber tree species, 4 other forest tree species, 2 edible species, 1 fibre species and 1 bryoflora species were reported either from the disturbed forest patches or the vegetation adjacent to Oththapahuwa quarry, or from both. It is very interesting to report the occurrence of a Bryoflora species [Riccia

sp. (Ricciaceae) in the Division Marchantiophyta of Bryoflora] on the open rocks in the vegetation adjacent to Oththapahuwa quarry and also in the active quarry, even during the dry season.

Both edible plant species yield delicious edible yams and belonging to a common Genus Dioscorea of the Family Dioscoreaceae. *Dioscorea pentaphylla* and *Dioscorea spicata*are known in Sinhala as Katu-alaor Katuwala-ala and Gonala respectively (Jayasuriya, 1990; Dassanayake and Clayton, 1995 and Senaratna, 2001) (Figure 4.14).

Figure 4.14: Two edible wild yam species, *Dioscorea spicata* (A) *and Dioscorea pentaphylla* (B1 and B2) reported from disturbed forest patches

4.4 Conservation Priorities on Flora

Natural or semi-natural forest systems in the study area were not surveyed for flora, as it was not an objective of the rapid assessment of biodiversity, because they are within the conservation areas under FD or DWLC. Therefore, the findings of the floristic survey were presented in the three subsections (*viz*., wewa (tank) and adjacent habitats, Home gardens, and Disturbed forests) as mentioned in the section 4.3.2. As mentioned in the same section (4.3.2), the systems considered as disturbed forests are actually the extensions of large home gardens (private land) which are merging with terrestrial reservations of wewa ecosystems (the common land). Though, the boundaries between them are not demarcated or not clearly visible, remaining dry zone

forests under the management of FD and DWLC are boundary demarcated with fences or with electrical fences to control elephants.

4.4.1 Wewa (tank) and adjacent habitats

Two clear subsections, *i.e.* two habitat types could be identified in the Wewa (tank) and adjacent habitats, *viz*., aquatic/amphibious habitats (the Wewa) and adjacent/surrounding terrestrial habitats of the Wewa.

4.4.1.1 Aquatic/amphibious habitats

Abundance of native (indigenous) flora is comparatively very and instead the introduced species are highly available. Most of the exotic species are Invasive Alien Species (IAS) of plants. Therefore, the following points can be highlighted as conservation urgencies in these habitats.

- Aquatic IAS species of plants should be managed.
- Introduction of rare indigenous aquatic plants species should be promoted.
- On-site natural hybridization of exotic aquatic plants species with native species should be monitored.

4.4.1.2 Adjacent terrestrial habitats

Though there are some endemic and conservation prioritized species in the adjacent terrestrial habitats (of Wewa system), floristically they not so healthy to sustain the system for future ecological demands and the demands of the peripheral human community. Considering these realities, it is crucial to focus the following priorities for immediate action.

- Managing of crop wild relatives (CWR) and medicinal plants.
- Planting of indigenous and endemic climatic-climax non-timber tree species is recommended.
- Introduction of suitable indigenous and endemic plant species to obtain non-timber forest products (NTFP) and monitoring the utilization of NTFP by the peripheral community.
- Introduction of feeding plants for the animals (particularly for birds and monkeys, but not for elephants).

4.4.2 Home gardens

Plant (crop and wild) diversity and density in the home gardens of the study areas are relatively poor. They are very spacious and opportunities are available to introduce suitable crops and wild plants for the use of inhabitants particularly and as a source of additional income generation in general. Therefore, proper attention must be paid on the following recommendations.

- Indigenous, endemic and non-invasive exotic timber tree species and other non-timber forest species (NTFS) should be introduced to home gardens, with proper training.

- Live fences around the home gardens should be promoted with or without artificial material, again with proper training.
- Encourage the use of suitable multipurpose woody perennial (indigenous, endemic and non-invasive exotic) plant species for live fences; proper training is recommended.

In order to minimize illegal felling from adjacent conservation areas, planting of high demand timber trees in the own home gardens of inhabitants should be promoted, as trees outside the forest (TOF) is stressed in Forestry Sector Master Plan (FSMP) of Sri Lanka developed in 1995 and Forest Policy of Sri Lanka also formulated in 1995, with a special focus on home gardens. As FAO defines, TOF include trees in cities, on farms, along roads and in many other locations which are by definition not a forest (de Foresta *et al*., 2013).

4.4.3 Disturbed forests

As mentioned above, systems considered as disturbed forests in this survey are actually the extensions of large home gardens (private land) which are merging with terrestrial reservations of wewa ecosystems (the common land) and/or existing conservation areas under the management of FD and DWLC. Therefore, management of these reaming forest patches is essential, in order avoid over exploitation of NTFP and cease illegal felling of valuable timber trees. However, collection of renewable NTFP from the disturbed forests in a sustainable manner should be encouraged and monitored properly (*i.e*. routine management of NTFP). Other activities such as chena cultivation, constructions (particularly close to the boundaries of conservation areas) and cutting trees for fuel (fire) wood (especially *Drypetes sepiaria*).

According to the overall observations of the floristic survey in the GN Divisions selected from three DS Divisions (*viz*., Galnewa, Ipalogama and Palagala) in Anuradhapura District for the present rapid assessment of biodiversity, it can be considered these locations as sensitive areas outside the conservation areas and can be recommended for declaring as such.

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4.6. Annexures

Annexture 4.6 a

Checklist of the plants reported from the study sites [with their families, Sinhala vernacular names and their National Conservation Status (NCS)]

No.	Name	Family	Sinhala Vernacular Name	NCS
1	*Abrus precatorius*	Fabaceae	Olinda, Olinda-wel	LC
2	*Abutilon indicum*	Malvaceae	Anoda, Kokis-achchu-gas	LC
3	*Acacia caesia*	Fabaceae	Hinguru-vel	LC
4	*Acacia leucophloea*	Fabaceae	Keera, Keeria, Katu-andara, Maha-andara	LC
5	*Achyranthes aspera*	Amaranthaceae	Gas-karal-heba, Wel-karal-sebo	LC
6	*Acrostichum aureum*	Pteridaceae	Keren-koku	LC
7	*Aerva lanata*	Amaranthaceae	Pol-kudu-pala, Pol-pala	LC
8	*Albizia odoratissima*	Fabaceae	Huriyi, Suriya-mara, Huri-mara	LC
9	*Albizia saman*	Fabaceae	Mara, Pare-mara	NL
10	*Allophylus cobbe*	Sapindaceae	Bu-kobbe, Kobbe	LC
11	*Alternanthera pungens*	Amaranthaceae	-----	NL
12	*Alternanthera sessilis*	Amaranthaceae	Mukunu-wenna	LC
13	*Alysicarpus vaginalis*	Fabaceae	Aswenna	LC
14	*Andrographis alata*	Acanthaceae	-----	LC
15	*Aponogeton crispus*	Aponogetonaceae	Kekatiya	VU
16	*Argyreia osyrensis*	Convolvulaceae	Dumbada	LC
17	*Asparagus racemosus*	Asparagaceae	Hathawariya	LC
18	*Atalantia ceylanica*	Rutaceae	Yakinaran	LC
19	*Azadirachta indica*	Meliaceae	Kohomba	NL
20	*Azima tetracantha*	Salvadoraceae	-----	LC
21	*Azolla pinnata*	Salviniaceae	-----	NL
22	*Bacopa monnieri*	Plantaginaceae	Lunu-wila	LC
23	*Barleria prionitis*	Acanthaceae	Katu-karanda, Katu-karandu	LC
24	*Barringtonia acutangula*	Lecythidaceae	Ela-midella, Era-midella	LC

25	*Bauhinia racemosa*	Fabaceae	Maila, Mayila	LC
26	*Bauhinia tomentosa*	Fabaceae	Kaha-petan, Petan	LC
27	*Berrya cordifolia*	Malvaceae	Hal-milla	LC
28	*Borassus flabellifer*	Arecaceae	Thal	NL
29	*Breynia vitis-idaea*	Phyllanthaceae	Gas-kayila	LC
30	*Bridelia retusa*	Phyllanthaceae	Ketakala, Keta-kela	LC
31	*Cajanus scarabaeoides*	Fabaceae	-----	NL
32	*Calotropis gigantea*	Apocynaceae	Wara	LC
33	*Canthium coromandelicum*	Rubiaceae	Kara, Kara-kola	LC
34	*Cardiospermum halicacabum*	Sapindaceae	Penela-wel	LC
35	*Carissa spinarum*	Apocynaceae	Heen-karamba	LC
36	*Caryota urens*	Arecaceae	Kithul	LC
37	*Cassia fistula*	Fabaceae	Ahalla-gass, Ehela	NL
38	*Cassia occidentalis*	Fabaceae	Peni-tora	LC
39	*Cassia roxburghii*	Fabaceae	Ratu-wa	LC
40	*Cassia* sp.	Fabaceae	-----	?
41	*Cassine* sp. (saplings)	Celastraceae	Neralu?	LC
42	*Catunaregam spinosa*	Rubiaceae	Kukurman, Kukuruman	LC
43	*Ceiba pentandra*	Malvaceae	Pulun-imbul, Imbul, Kotta-pulun	LC
44	*Ceratophyllum demersum*	Ceratophyllaceae	-----	LC
45	*Ceratopteris thalictroides*	Pteridaceae	Kukul-messa?	NT
46	*Chamaecrista mimosoides*	Fabaceae	Bin-siyambala	LC
47	*Chloroxylon swietenia*	Rutaceae	Buruta	VU
48	*Chromolaena odorata*	Asteraceae	Podisingho-maranga, Danapathi-nattan	NL
49	*Cissampelos pareira*	Menispermaceae	Diya-mitta	LC
50	*Cissus quadrangularis*	Vitaceae	Hiressa, Sirassa	LC
51	*Clausena indica*	Rutaceae	Migon-karapincha	LC
52	*Cleome viscosa*	Cleomaceae	Wal-aba, Ran-manissa	LC
53	*Clitoria ternatea*	Fabaceae	Katarodu-wel, Nil-katarodu, Katarolu	LC
54	*Coccinia grandis*	Cucurbitaceae	Kowakka	LC
55	*Coldenia procumbens*	Boraginaceae	-----	LC

56	*Combretum ovalifolium*	Combretaceae	Kaduru-keti ya-wel (Geta-kaha?)	NT
57	*Corchorus olitorius*	Malvaceae	-----	VU
58	*Cordia dichotoma*	Boraginaceae	Lolu	LC
59	*Crateva adansonii*	Capparaceae	Lunu-warana	LC
60	*Crinum latifolium*	Amaryllidaceae	Goda-manel	VU
61	*Crotalaria* sp.	Fabaceae	-----	?
62	*Crotalaria verrucosa*	Fabaceae	Nil-andana-hiriya, Yak-bairiye	LC
63	*Croton aromaticus*	Euphorbiaceae	Wel-keppitiya	LC
64	*Croton bonplandianus*	Euphorbiaceae	-----	NL
65	*Croton hirtus*	Euphorbiaceae	Gan-veda, Val-tippili	LC
66	*Croton laccifer*	Euphorbiaceae	Gas-keppetiya, Keppetiya	LC
67	*Cuscuta chinensis*	Convolvulaceae	Aga-mula-neti-wel	LC
68	*Cynodon dactylon*	Poaceae	Ruha	LC
69	Cyperaceae sp. (*Sclaria* type)	Cyperaceae	-----	?
70	*Cyperus articulatus*	Cyperaceae	-----	DD
71	*Cyperus corymbosus*	Cyperaceae	Gal-ehi, Gallehe	NT
72	*Cyperus* sp. 1	Cyperaceae	-----	?
73	*Cyperus* sp. 2	Cyperaceae	-----	?
74	*Cyperus* sp. 3	Cyperaceae	-----	?
75	*Cyperus* sp. 4 (PHW)	Cyperaceae	-----	?
76	*Dendrophthoe falcata*	Loranthaceae	Pilila, Pilal	LC
77	*Derris parviflora*	Fabaceae	Kala-wel, Sudu-kala-wel	LC
78	*Derris scandens*	Fabaceae	Ala-vel, Bo-kala-vel, Kala-wel	LC
79	*Desmodium triflorum*	Fabaceae	Heen-undupiyali	LC
80	*Dichrostachys cinerea*	Fabaceae	Andara	LC
81	*Dimorphocalyx glabellus*	Euphorbiaceae	Weli-wenna	LC
82	*Dioscorea pentaphylla*	Dioscoreaceae	Katu-ala, Katuwala-ala	LC
83	*Dioscorea spicata*	Dioscoreaceae	Gonala	VU
84	*Diospyros ebenum*	Ebenaceae	Kaluwara	EN
85	*Diospyros malabarica*	Ebenaceae	Timbiri	LC
86	*Diospyros ovalifolia*	Ebenaceae	Habara, Kunumella	LC

87	*Diplodiscus verrucosus*	Malvaceae	Dik-andhe, Dik-wenna	LC
88	*Dipteracanthus prostratus*	Acanthaceae	Nil-puruk	LC
89	*Dregea volubilis*	Apocynaceae	Anguna, Anukkola, Tiththa-anguna	LC
90	*Drypetes sepiaria*	Putranjivaceae	Wira	LC
91	*Echinodorus* sp.	Alismataceae	-----	NL
92	*Eichhornia crassipes*	Pontederiaceae	Japan-jabara	NL
93	*Euphorbia antiquorum*	Euphorbiaceae	Daluk	LC
94	*Evolvulus alsinoides*	Convolvulaceae	Visnu-kranti	LC
95	*Ficus callosa*	Moraceae	Wal-gona	LC
96	*Ficus hispida*	Moraceae	Kota-dimbula	LC
97	*Ficus microcarpa*	Moraceae	-----	LC
98	*Ficus racemosa*	Moraceae	Attikka	LC
99	*Ficus religiosa*	Moraceae	Bo	NL
100	*Ficus tsjahela*	Moraceae	Kiri-pela, Kiripella	LC
101	*Ficus benghalensis*	Moraceae	Nuga, Maha-nuga	LC
102	*Flueggea leucopyrus*	Phyllanthaceae	Heen-katu-pila, Katu-pila	LC
103	*Gliricidia sepium*	Fabaceae	Kona, Weta-hira, Ladappa, Ginisiriya	NL
104	*Gmelina asiatica*	Lamiaceae	Demata, Gatta-demmata	LC
105	*Gomphrena celosioides*	Amaranthaceae	-----	NL
106	*Grangea maderaspatana*	Asteraceae	-----	NT
107	Grass species (Dominant/PHW)	Poaceae	-----	?
108	*Grewia damine*	Malvaceae	Daminiya, Damunu	LC
109	*Grewia helicterifolia*	Malvaceae	Bora-daminiya, Boru-daminiya	LC
110	*Grewia orientalis*	Malvaceae	Wel-keliya, Wel-mediya	LC
111	*Gymnopetalum scabrum*	Cucurbitaceae	-----	VU
112	*Gyrocarpus americanus*	Hernandiaceae	Diya-labu-gas, Hima	LC
113	*Haldina cordifolia*	Rubiaceae	Kolon	LC
114	*Heliotropium indicum*	Boraginaceae	Ddimi-biya, Et-honda, Et-setiya	LC
115	*Hemidesmus indicus*	Apocynaceae	Heen-iramusu, Iramusu	LC
116	*Hewittia malabarica*	Convolvulaceae	Wal-trastawalu	LC
117	*Hibiscus lobatus*	Malvaceae	-----	LC

118	*Hibiscus micranthus*	Malvaceae	Bebila	LC
119	*Hibiscus tilliaceus*	Malvaceae	Beli-patta, Wal-beli	LC
120	*Hibiscus vitifolius*	Malvaceae	Maha-epala	LC
121	*Holoptelea grandis*	Ulmaceae	Goda-kirilla	NT
122	*Hydrilla verticillata*	Hydrocharitaceae	Halpenni	LC
123	*Hygrophila auriculata*	Acanthaceae	Katu-ikiriya	LC
124	*Hygroryza aristata*	Poaceae	Go-jabba	NT
125	*Hyptis suaveolens*	Lamiaceae	-----	NL
126	*Ichnocarpus frutescens*	Apocynaceae	Gerandi-dul, Gerandi-wel, Gopi, Kiri-wel, Priyawarna	LC
127	*Imperata cylindrica*	Poaceae	Iluk	LC
128	*Ipomoea aquatica*	Convolvulaceae	Kankun	LC
129	*Ipomoea marginata*	Convolvulaceae	Rasa-tel-kola	LC
130	*Ipomoea pes-tigridis*	Convolvulaceae	Divi-adiya, Divi-pahura	LC
131	*Ixora* sp.?	Rubiaceae	-----	LC
132	*Ixora coccinea*	Rubiaceae	Ratambala, Rath-mal	LC
133	*Jasminum angustifolium*	Oleaceae	Wal-pichcha, We-kanda	LC
134	*Jatropha gossypifolia*	Euphorbiaceae	-----	NL
135	*Khaya senegalensis*	Meliaceae	Kaaya	NL
136	*Lannea coromandelica*	Anacardiaceae	Hik	LC
137	*Lantana camara*	Verbenaceae	Ganda-pana, Katu-hinguru, Rata-hinguru, Ton-kinna	NL
138	*Lasia spinosa*	Araceae	Engili-kohila, Kohila, Maha-kohila	LC
139	*Lemna perpusilla*	Araceae	Diya-panshi	LC
140	*Leucaena leucocephala*	Fabaceae	Ipil-ipil	NL
141	*Limnocharis flava*	Alismataceae	Diya-gowa	LC
142	*Limnophila* sp.	Scrophulariaceae	Wila?	?
143	*Limonia acidissima*	Rutaceae	Divul, Diwul	LC
144	*Ludwigia hyssopifolia*	Onagraceae	-----	LC
145	*Ludwigia perennis*	Onagraceae	-----	LC
146	*Ludwigia* sp.	Onagraceae	-----	?
147	*Ludwigia adscendens*	Onagraceae	Beru-diyanilla	NL
148	*Maba buxifolia*	Ebenaceae	-----	LC

149	*Macroptilium lathyroides*	Fabaceae	-----	NL
150	*Madhuca longifolia*	Sapotaceae	Mi, Mee	NT
151	*Manilkara hexandra*	Sapotaceae	Palu	VU
152	*Marsilea minuta*	Marsileaceae	Wel-ambilla	?
153	*Megathyrsus maximus*	Poaceae	Rata-tana	NL
154	*Melochia corchorifolia*	Malvaceae	Gal-kura	LC
155	*Memecylon* sp. (umbellatum)?	Melastomataceae	-----	?
156	*Memecylon umbellatum*	Melastomataceae	Kora-kaha	LC
157	*Merremia hederacea*	Convolvulaceae	Kaha-tel-kola	LC
158	*Mitragyna parvifolia*	Rubiaceae	Helamba	LC
159	*Mollugo cerviana*	Molluginaceae	Udetta	LC
160	*Momordica charantia*	Cucurbitaceae	Batu-karavila, Karavila	LC
161	*Morinda coreia*	Rubiaceae	Ahu	LC
162	*Mukia maderaspatana*	Cucurbitaceae	Gon-kekiri, Heen-kekiri, Lene-kekiri	NT
163	*Murraya koenigii*	Rutaceae	Karapincha	LC
164	*Murraya paniculata*	Rutaceae	Etteriya	LC
165	*Najas minor*	Hydrocharitaceae	-----	VU
166	*Nauclea orientalis*	Rubiaceae	Bakmi, Rata-bakmi	LC
167	*Nelumbo nucifera*	Nelumbonaceae	Nelum	LC
168	*Neptunia oleracea*	Fabaceae	Diya-nidikumba	LC
169	*Nymphaea nouchali*	Nymphaeaceae	Manel	VU
170	*Nymphaea pubescens*	Nymphaeaceae	Et-olu, Olu	LC
171	*Nymphoides indica*	Menyanthaceae	Maha-ambala	NL
172	*Ocimum americanum*	Lamiaceae	Heen-tala	LC
173	*Oldenlandia corymbosa*	Rubiaceae	Wal-patpadagam	LC
174	*Oroxylum indicum*	Bignoniaceae	Totila	LC
175	*Ottelia alismoides*	Hydrocharitaceae	-----	LC
176	*Oxystelma esculentum*	Apocynaceae	Usepale	LC
177	*Pamburus missionis*	Rutaceae	Pamburu	LC
178	*Panicum repens*	Poaceae	Etora, Etawara	LC
179	*Paramignya monophylla*	Rutaceae	Wellangiriya	LC

180	*Parkinsonia aculeata*	Fabaceae	-----	NL
181	*Passiflora foetida*	Passifloraceae	Del-honda	NL
182	*Persicaria attenuata*	Polygonaceae	Sudu-kimbul-wenna	?
183	*Persicaria barbata*	Polygonaceae	Ratu-kimbul-wenna	LC
184	*Phoenix pusilla*	Aricaceae	Indi	LC
185	*Phyla nodiflora*	Verbenaceae	Herimana-datta, Hiramana-datta	LC
186	*Phyllanthus amarus*	Euphorbiaceae	Pita-wakka	LC
187	*Phyllanthus polyphyllus*	Phyllanthaceae	Kooratiya, Kuratiya	LC
188	*Phyllanthus reticulatus*	Phyllanthaceae	Gas-dummella, Kaila, Wel-kayila	LC
189	*Pistia stratiotes*	Araceae	Diya-paradel	LC
190	*Pleiospermium alatum*	Rutaceae	Tumpat-kurundu, Tunpat-kurundu	LC
191	*Pongamia pinnata*	Fabaceae	Gal-karanda, Karanda, Magul-karanda	LC
192	*Potamogeton nodosus*	Potamogetonaceae	-----	LC
193	*Pothos scandens*	Araceae	Pota-wel	LC
194	*Premna tomentosa*	Lamiaceae	Boo-sairoo-gass, Boo-seru, Bu-seru	LC
195	*Psidium guajava*	Myrtaceae	Pera	NL
196	*Psydrax dicoccos*	Rubiaceae	Gal-karanda, Panakarawa, Panduru	LC
197	*Riccia* sp.	Ricciaceae	-----	NL
198	*Rungia repens*	Acanthaceae	Sulu-nayi	LC
199	*Salacia reticulata*	Celastraceae	Himbutu-wel, Kotala-himbutu	EN
200	*Salvinia adnata* (*S. molesta*)	Salviniaceae	Salweenia	NL
201	*Sansevieria zeylanica*	Asparagaceae	Niyanda	NT
202	*Sapindus emarginatus*	Sapindaceae	Penela, Gas-penela	LC
203	*Schleichera oleosa*	Sapindaceae	Kon, Koon	LC
204	*Scoparia dulcis*	Plantaginaceae	Wal-kottamalli	NL
205	*Senna alata*	Fabaceae	Rata-tora, Eth-thora	LC
206	*Senna spectabilis*	Fabaceae	Kaha-kona	NL
207	*Senna auriculata*	Fabaceae	Rana-wara	LC
208	*Senna tora*	Fabaceae	Peti-tora	LC
209	*Sesamum indicum*	Pedaliaceae	Tel-tala	NL
210	*Sesbania* sp.	Fabaceae	-----	?

211	*Sida acuta*	Malvaceae	Gas-bevila	LC
212	*Sida alnifolia*	Malvaceae	-----	LC
213	*Solanum torvum*	Solanaceae	Thibbatu	LC
214	*Solanum insanum*	Solanaceae	Ela-batu	NL
215	*Spermacoce articularis*	Rubiaceae	-----	LC
216	*Sporobolus coromandelianus*	Poaceae	-----	LC
217	*Stachytarpheta indica*	Verbenaceae	Nil-nakuta	NL
218	*Stachytarpheta jamaicensis*	Verbenaceae	Balu-nakuta, Rata-nil-nakuta	NL
219	*Sterculia foetida*	Malvaceae	Telambu, Telembu	LC
220	*Streblus asper*	Moraceae	Geta-netul, Geta-nithul	LC
221	*Strychnos nux-vomica*	Loganiaceae	Goda-kaduru	VU
222	*Syzygium cumini*	Myrtaceae	Madan, Maha-dan	LC
223	*Tamarindus indica*	Fabaceae	Maha-siyambala, Siyambala	NL
224	*Tarenna asiatica*	Rubiaceae	Tarana	LC
225	*Taxillus* sp.	Loranthaceae	Pilila, Pilal	?
226	*Tectona grandis*	Lamiaceae	Takku, Tekka, Thekka	NL
227	*Tephrosia purpurea*	Fabaceae	Gam-pila, Pila, Kathuru-pila	LC
228	*Terminalia arjuna*	Combretaceae	Kumbulu, Kumbuk	LC
229	*Thespesia populnea*	Malvaceae	Suriya, Gan-suriya	LC
230	*Toddalia asiatica*	Rutaceae	Kudu-miris	LC
231	*Trema orientalis*	Ulmaceae	Gadumba	LC
232	*Tridax procumbens*	Asteraceae	Kurunegala-daisy	NL
233	*Typha angustifolia*	Typhaceae	Hambu-pan	LC
234	*Urena lobata*	Malvaceae	Patta-epala	LC
235	*Utricularia aurea*	Lentibulariaceae	Diya-pasi	LC
236	*Vanda tessellata*	Orchidaceae	-----	VU
237	*Ventilago madraspatana*	Rhamnaceae	Yaccaka-wel, Yakkada-wel	LC
238	*Vernonia zeylanica*	Asteraceae	Papula, Pupula, Wail-pupula	LC
239	*Vitex leucoxylon*	Lamiaceae	Nabada, Nebedda, Ne-bedda	LC
240	*Vitex pinnata*	Lamiaceae	Kaha-milla, Milla, Miyan-milla, Niyan-milla	NL
241	*Volkameria inermis*	Lamiaceae	Boerende, Bu-renda, Gulinda, Wal-gurenda	LC

242	*Walsura trifoliolata*	Meliaceae	Kirikon, Mal-petta	LC
243	*Waltheria indica*	Malvaceae	-----	LC
244	*Wissadula periplocifolia*	Malvaceae	Kiri-kaju	NT
245	*Xanthium strumarium*	Asteraceae	Wal-rambutang, Uru-kossa, Agada	LC
246	*Ziziphus mauritiana*	Rhamnaceae	Dabara, Maha-debara, Masan	LC
247	*Ziziphus oenopolia*	Rhamnaceae	Heen-eraminiya	LC

Annexture 4.6 b

Photographic guide to the plants reported from study sites (not included in the main report)

***Nelumbo nucifera* (Nelumbonaceae)**

Memecylon umbellatum **(Melastomataceae)**

Coldenia procumbens **(Boraginaceae)**

Phoenix pusilla **(Aricaceae)**

Paramignya monophylla **(Rutaceae)**

Azima tetracantha **(Salvadoraceae)**

Oxystelma esculentum (Apocynaceae)

Neptunia oleracea (Fabaceae)

Phyla nodiflora (Verbenaceae)

Evolvulus alsinoides (Convolvulaceae)

Walsura trifoliolata (Meliaceae)

Barringtonia acutangula (Lecythidaceae)

Ficus racemosa (Moraceae)

Vitex leucoxylon (Lamiaceae)

Ixora coccinea (Rubiaceae)

Pamburus missionis (Rutaceae)


Passiflora foetida (Passifloraceae)
Crateva adansonii (Capparaceae)
Vernonia zeylanica (Asteraceae)
Hibiscus lobatus (Malvaceae)
Ottelia alismoides (Hydrocharitaceae)
Derris scandens (Fabaceae)
Xanthium strumarium (Asteraceae)

5.0 ICHTHYOFAUNA DIVERSITY ANALYSIS

5.1. Introduction

Sri Lanka has a rich biodiversity with higher percentage of endemism. It consists of 91 species of freshwater fish species including 50 endemic species (IUCN, 2012). Among the ichthyofauna, 24 exotic species which have been introduced to the natural water bodies of the country for the purpose of enhancing inland fisheries while been a few hav accidentally introduced through ornamental fish industry. There are four major ichthyological zones identified by Senanayake and Moyle (1982), namely Southwestern, Mahaweli, Dry and Transition zones. Of these zones Southwestern and Mahaweli zones are rich in freshwater fish diversity while dry zone species have a higher affinity with the freshwater fish in the Indian peninsula (Senanayake and Moyle, 1982).

5.2. Study site

Thirty tanks and two water canals in the Secretariat Divisions of Galnewa, Palagala and Ipalogama of Anuradhapura District in the North Central province were considered for the survey of ichthyofauna (Table 5.1). Although the Ipalogama Divisional Secretariet Division was not included inially in the survey, some tanks were considered during the survey. Of the thirty tanks, seven tanks were completely dried due to the heavy dry season during the period of survey. A total of twenty three tanks and two water canals were selected to conduct the survey (Total of 25 water bodies).

Table 5.1: Wewa (tanks), Grama Niladhari Divisions & number, Divisional Secretariat Division and status of the wewa during the survey

No	Name of the wewa (tank)	Grama Niladhari Division and Numer	Divisional Secretariat Division	Status during the survey
1	Galegoda Kumbuk wewa (ගලේගොඩ කුඹුක්වැව වැව)	Kandegama (459) (කන්දේගම)	Galnewa	Partially Dried
2	Kandegama wewa (කන්දේගම වැව)			Partially Dried
3	Kuda wewa (කුඩා වැව)			Partially Dried
4	Werunkulama wewa (වේරුන්කුලම වැව)	Werunkulama (461) (වේරුන්කුලම)	Galnewa	Partially Dried
5	Niyangama wewa (නියන්ගම වැව)			Dried
6	Negama wewa (නැගම වැව)	Negama (462) (නැගම)	Galnewa	Partially Dried

7	Ihala-habarawatte wewa (ඉහල-හබරවත්ත වැව)	Kandulugamuwa (464) (කඳුළුගමුව)	Galnewa	Partially Dried
8	Pahala-habarawaththe wewa (පහල-හබරවත්ත වැව)			2/3 Dried
9	Wetakoluwagama Wewa (වැටකොලුවාගම වැව)			2/3 Dried
10	Giranegama wewa (ගිරානේගම වැව)			2/3 Dried
11	Palugollawa wewa (පලුගොල්ල වැව)	Kalanchiya (465) (කල්ලංචිය)	Galnewa	Partially Dried
12	Kalanchiya wewa (කල්ලංචිය වැව)			Partially Dried
13	Madawchchiya wewa (මැදවච්චිය වැව)	Medawachchiya (466) (මැදවච්චිය)	Galnewa	Partially Dried
14	Maha oththapahuwa wewa (මහා ඔත්තපහුව වැව)			2/3 Dried
15	Mullannatuwa wewa (මුලංනටුව වැව)			Partially Dried
16	Kumbuk wewa (කුඹුක් වැව)	Kumbukwewa(467) (කුඹුක් වැව)	Galnewa	Partially Dried
17	Nelumpathgama wewa (නෙළුම්පත්ගම වැව)	Siyabalawa (468) (සියඹලෑව)	Galnewa	Dried
18	Siyabalawa wewa (සියඹලෑව වැව)			Partially Dried
19	Mee gas wewa (මීගස් වැව)			Partially Dried
20	Wal palugama wewa (වල් පළුගම වැව)			Dried
21	Musnawa wewa (මුස්නව වැව)	Musnawa(473)	Galnewa	Partially Dried
22	Galamadiyawa wewa (ගල්මැඩියාව වැව)			Partially Dried
23	Ihalagama wewa (ඉහළගම වැව)	Hadungama (476) හඳුන්ගම	Galnewa	Dried
24	Peenawa wewa (පීනෑව වැව)	Karawilagala (489) (කරවිලගල)	Palagala	Partially Dried
25	Nanwattegama wewa (නාන්වත්තගම වැව)			Partially Dried
26	Munhena wewa (මුන්හේන වැව)			Dried
27	Karawilagala wewa (කරවිලගල වැව)			Dried
28	Pahalagama wewa (පහළගම වැව)	Pahalagama (490) (පහළගම)	Palagala	Dried
29	Kunchikulama wewa	Kunchikulama (515)	Ipalogama	Not dried

	(කුන්චිකුලම වැව)	(කුන්චිකුලම)		
30	Ganthiriyagama wewa (ගන්තිරියාගම වැව)	Ganthiriyagama (503) (ගන්තිරියාගම)	Ipalogama	Not dried
31	Jaya ganga (ජයගඟ)	Walawwegama (488) **(**වළව්වෙ ගම**)**	Ipalogama	Not dried
32	Yoda ela (යෝධ ඇල)		Ipalogama	Not dried

5.3. Survey methodology

Since the survey was carried out during the dry season, most of the tanks were partially dried with low water level and were wadeable. Under water observations (bank observations) could not practiced in most of the tanks due to the low clarity of water and only practiced where the water was clear. Hence, scoop nets, gill nets, drag nets and cast nets were most frequently used to sample the fish diurnally according to the depth of water (Figure 5.1). Number of individuals and sampling efforts were recorded. Four random samples were taken at each sampling site. Collected fish samples were identified and released to same habitat. Fishing data also collected on the day of sampling from the fishermen.

Figure 5.1. Different Sampling gears used for fish catch (A) scoop net, (B) gill net, (C) cast net and (D) drag net

5.4. Results

5.4.1. Overall distribution of fish species

A total of 31 fish species were identified in the sampling sites including 5 endemic, 21 indigenous and 5 exotic fish species belonging to 14 families (Table 5.2). The common family was Cyprinidae which included 12 fish species. The five endemic fish species were *Mystus zeylanicus* (Yellow Catfish), *Clarias brachysoma* (Sri Lanka Walking Catfish), *Dawkinsia singhala* (Sri Lanka Filamented Barb) (Figure 5.2), *Pethiya melanomaculata* (Sri Lanka tic tac toe Barb) and *Esomus thermoicos*(Flying Barb) (Figure 5.3.). The invasive exotic fish species were *Hypostomus plecostomus*(Sucker Mouth Catfish) and *Trichogaster pectoralis* (Snake skin Gourami). The introduced exotic varieties for the purpose of fisheries were *Oreochromis niloticus* (Nile Tilapia), *Labeo rohita* (Rohu) and *Cyprinus carpio* (Common Carp).

Table 5.2. : Fish species identified during the survey

Scientific name	Common name		Distribution Status	IUCN Status
	English	Sinhala		
Family : Anguillidae				
Anguilla bicolor	Long Level-finned Eel	Kalu Aandha	Indigenous	National :LC Global :DD
Anguilla bengalensis	Long Finned Eel	Polmal Aandha	Indigenous	National :LC Global :DD
Family : Anabantidae				
Anabas testudineus	Climbing Perch	Kaavaiya	Indigenous	National :LC Global :DD
Family : Aplocheilidae				
Apolochelius parvus	Dwarf Panchax	Uda Handaya	Indigenous	National :LC Global :LC
Family : Bagridae				
Mystus zeylanicus	Yellow Catfish	Path Ankutta	Endemic	National :LC Global :NE
Mystus gulio	Long –whiskered Catfish	Maana Ankutta	Indigenous	National :LC Global :LC

Family : Belontidae				
Trichogaster pectoralis	Snake skin Gourami	Wel Gourami	Exotic	-
Family : Channidae				
Channa striata	Murrel	Spotted Snakehead	Indigenous	National :LC Global :LC
Channa kelrtii	Brown Snakehead	Paradal Kanaya	Indigenous	National :LC Global :NE
Family : Cichlidae				
Eutroplus suratensis	Green Chromide	Mal Koraliya	Indigenous	National :LC Global :LC
Pseudetroplus maculatus	Orange Chromide	Kaha Koraliya	Indigenous	National :LC Global :LC
Oreochromis niloticus	Nile Tilapia	Tilapia	Exotic	-
Family : Claridae				
Clarias brachysoma	Sri Lanka Walking Catfish	Magura	Endemic	National :NT Global :LC
Family : Cobitidae				
Lepidocephalichthys thermalis	Common Spiny Loach	Ahirava	Indigenous	National :LC Global :LC
Family : Cyprinidae				
Dawkinsia singhala	Sri Lanka Filamented Barb	Dankola Pethiya	Endemic	National: LC Global :LC
Pethiya melanomaculata	Sri Lanka tic tac toe Barb	Thith Pethiya	Endemic	National :VU Global : NE
Esomus thermoicos	Flying Barb	Revul dandiya	Endemic	National :LC Global : LC
Amblypharyngodon melattinus	Silver Carplet	Soraya	Indigenous	National :LC Global : DD
Puntius dorsalis	Long –snouted barb	Katu Titteya	Indigenous	National :LC Global : LC
Puntius vittatus	Silver barb	Bandi Titteya	Indigenous	National :LC

				Global : LC
Rasbora microcephalus	Caverii Rasbora	Caverii Dandiya	Indigenous	National :LC Global : LC
Rasbora dandia	Striped Rasbora	Dandiya	Indigenous	National :LC Global : LC
Devario malabaricus	Giant Danio	Damkola Saalaya	Indigenous	National :LC Global : LC
Systomus spilurus	Sri Lanka Olive Barb	Sri Lanka Mas Pethiya	Indigenous	National :DD Global : NE
Labeo rohita	Rohu	Rohu	Exotic	-
Cyprinus carpio	Common Carp	Carp	Exotic	-
Family : Gobiidae				
Awaous melanocephalus	Scribbled Goby	Bali Weligowwa	Indigenous	National :LC Global :DD
Glossogobius giuris	Bar-eyed Goby	Maha Weligowwa	Indigenous	National :LC Global :LC
Family : Heteropneustidae				
Heteropneustes fossilis	Stinging Catfish	Hunga	Indigenous	National :LC Global :LC
Family : Loricariidae				
Hypostomus plecostomus	Sucker Mouth Catfish	Tanki Sudda	Exotic	-
Family : Mastacembelidae				
Mastacembelus armatus	Marbled Spiny Eel	Gan Theliya	Indigenous	National: LC Global :NE

National(2012), Global (2014), Least Concern (LC), Not Evaluated (NE), Data Deficient (DD), Vulnerable (VU), Near Threatened (NT)

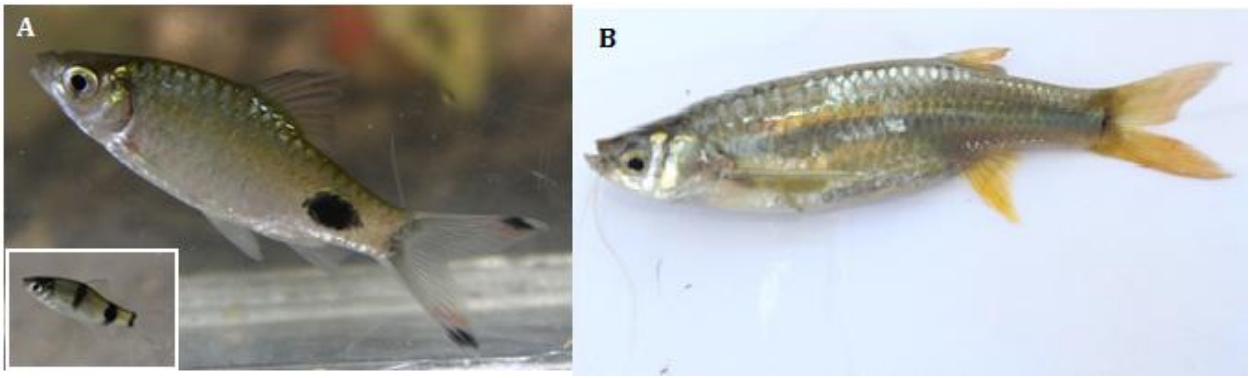

Figure 5.2 a. Endemic fish species recorded during the survey: (A) *Dawkinsia singhala* (Sri Lanka Filamented Barb) and (B) *Esomus thermoicos* (Flying Barb)

Figure 5.2b. Endemic fish species recorded during the survey: (C) *Mystus zeylanicus* (Yellow catfish) , (D) *Clarius brachysoma*(Sri Lankan walking catfish), (E) *Pethiya melanomaculata* (Sri Lanka tic tac toe barb)

5.4.2. Distribution of fish species in the tanks

Fisheries activities were not practiced in Palugollawa wewa. Number of fish species was also comparatively less in this tank and most of them were not used for human consumption. Although number of fish species were high in Kumbuk wewa, fisheries activities was prohibited in this tank. Tilapia and carp varieties were not found in this tank. There were many water pockets with high plankton count located close to the main tank. Population of *Hypostomus plecostomus*(Sucker Mouth Catfish) and *Trichogaster pectoralis* (Snake skin Gourami) were high in those water pockets as they can tolerate the low dissolved oxygen content in the habitat. Distribution of endemic fish *Pethiya melanomaculata* (conservation status : National: VU , Global: NE) was low and recorded only in 4 tanks Palugollawa wewa, Madawachchiya wewa, Kumbuk wewa and Musnowa wewa with comparatively very low number of specimens per sampling effort (Table 5.3.). *Esomus thermoicos* recorded only in Kumbukwewa which also showed a low abundance. According to the fishermen, population of *Hypostomus plecostomus* in Madavachchiya wewa, Musnowa wewa, Jaya ganga and Yoda ela have an impact on fisheries activity (Figure 5.3). There was a comparatively high population of *Trichogaster*

pectoralis and *Oreochromis niloticus* (Figure 5.4) recorded in Glamadiyawa wewa and there was no endemic fish encountered during the survey.

Figure 5.3. Invasive fish species *Hypostomus plecostomus* (Sucker mouth catfish)

Figure 5.4. Invasive species - *Trichogaster pectoralis* (Snake skin gourami)

Table 5.2. Diversity of fish in the tanks

No.	Fish species	Galegoda Kumbuk wewa	Kandegama wewa	Kuda wewa	Werunkulama wewa	Negama wewa	Ehala-habarawatta wewa	Pahala-habarawatta wewa	Wetakoluwagama wewa	Giranegama wewa	Palugollawa wewa	Kalanchiya wewa	Madawchchiya wewa	Maha oththapahuwa wewa
1	*Anguilla bicolor*												1	
2	*Anguilla bengalensis*												1	
3	*Anabas testudineus*		2	2		4	5			5			4	4
4	*Apolochelius parvus*	4	3	4		3					4	3	4	
5	*Mystus zeylanicus*													
6	*Mystus gulio*			2				1					2	
7	*Trichogaster pectoralis*				5	3				3				
8	*Channa striata*		3										4	
9	*Channa kelrtii*							2					2	
10	*Eutroplus suratensis*		4	4	5	4				3		4	4	
11	*Pseudetroplus maculatus*				5		5		5					2
12	*Oreochromis niloticus*		5	5	5		5			4			5	
13	*Clarias brachysoma*													
14	*Lepidocephalichthys thermalis*	4	4	4	4	4	4	4	4	3	4	3	4	4

15	*Dawkinsia singhala*			3	4								5	
16	*Pethiya melanomaculata*	1		1							2		1	
17	*Esomus thermoicos*													
18	*Amblypharyngodon melattinus*	4			3	3					5			
19	*Puntius dorsalis*			4									4	
20	*Puntius vittatus*	3	3				5	4	4	4	5	4		
21	*Rasbora microcephalus*	3	5	5	5	4	5				3		5	
22	*Rasbora dandia*													
23	*Devario malabaricus*													
24	*Systomus spilurus*			3									3	
25	*Labeo rohita*													
26	*Cyprinus carpio*													
27	*Awaous melanocephalus*			3									3	
28	*Glossogobius giuris*		4	4			4			3		2	4	
29	*Heteropneustes fossilis*			2									2	
30	*Hypostomus plecostomus*			4									4	
31	*Mastacembelus armatus*			1									1	
Total No. of fish sp.		06	04	18	09	07	07	04	03	06	06	05	18	03
No. of endemic fish sp.		01	00	02	01	00	00	00	00	00	01	00	02	00
Threatened fish sp. **National (N) ; Global (G)**		N; G 1 ; 0	-	N;G 1 ; 0	-	-	-	-	-	-	N; G 1 ; 0	-	N;G 1 ; 0	-

Abundance scale : low to high : 1 - 5

5.5. Threats to the ichthyofauna

The invasive aquatic plants, *Eichhornia crassipes*, *Salvinia adnata*, *Ceratophyllum demersum*, *Typha angustifolia*, and *Ipomoea aquatica* were high in the tanks. As most of the tanks dry during the dry seasons, the siltation and decaying aquatic plants are deposited on the bottom (Figure 5.5). This will cause reduction of water depth over the period. Therefore it will lead to an adverse effect on the distribution and abundance of fish species particularly on endemic fish varieties. Cleaning of aquatic plants should be practiced regularly to avoid this situation.

Figure 5.5.: Aquatic plants entangled in the drag net

Growth of algal blooms specially blue green algae was observed in partially dried tanks (Figure 5.6.) . The increase of algae population and siltation cause low dissolved oxygen level in the tanks. Hence the fish were on the water surface even at 13.00 hr. engulfing atmospheric air which will affect the survival of the fish during the dry season (Figure 5.7).

Figure 5.6. Algal blooms in the Nanwattegama tank

Figure 5.7. Tilapia fingerlings engulfing atmospheric air in Nanwattegama tank

Although the increase of *Trichogaster pectoralis* population is benefited by the inland fisheries sector, it could affect the native fish population in the face of predation on eggs and larval fish as well as competition.

Pethiya melanomaculata population was comparatively low which confirms the national conservation status, vulnerable. Apart from this *Esomus thermoicos* recorded only one tank with low number per unit of effort also ought to be pay attention on their conservation aspect.

Although abundance of *Dawkinsia singhala* and *Pseudetroplus maculatus* is comparatively high during the survey, they can be over exploited with the time as they have an ornamental value (Figure 5.8)

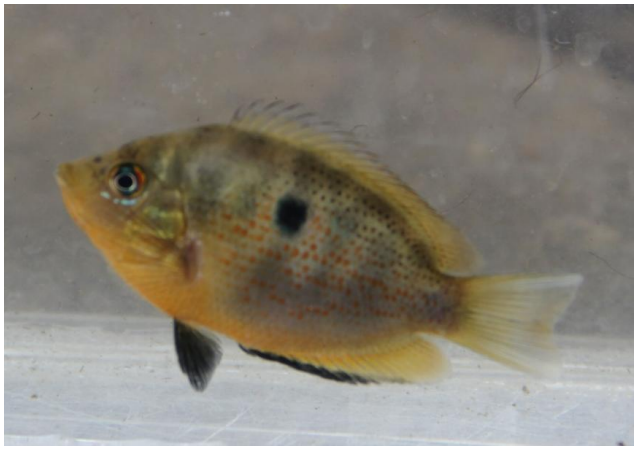

Figure 5.8. Ornamental fish species: *Pseudetroplus maculatus*

Fishermen reported that the population of eel varieties *Anguilla bicolor* and *Anguilla bengalensis*, and *Mastacembelus armatus* were becoming low because of over exploitation due to high demand. Illegal fishing gears such as tangos nets used by the villagers .to catch fish which cause impact on fisheries as well as environment.

The pollution with shampoo packets, bottles and polythene bags were common at the surrounding of tank. These plastic materials were also deposited on the bottom as well as littoral zone of the tanks. The pollution in the littoral zone affects the breeding grounds of native fish.

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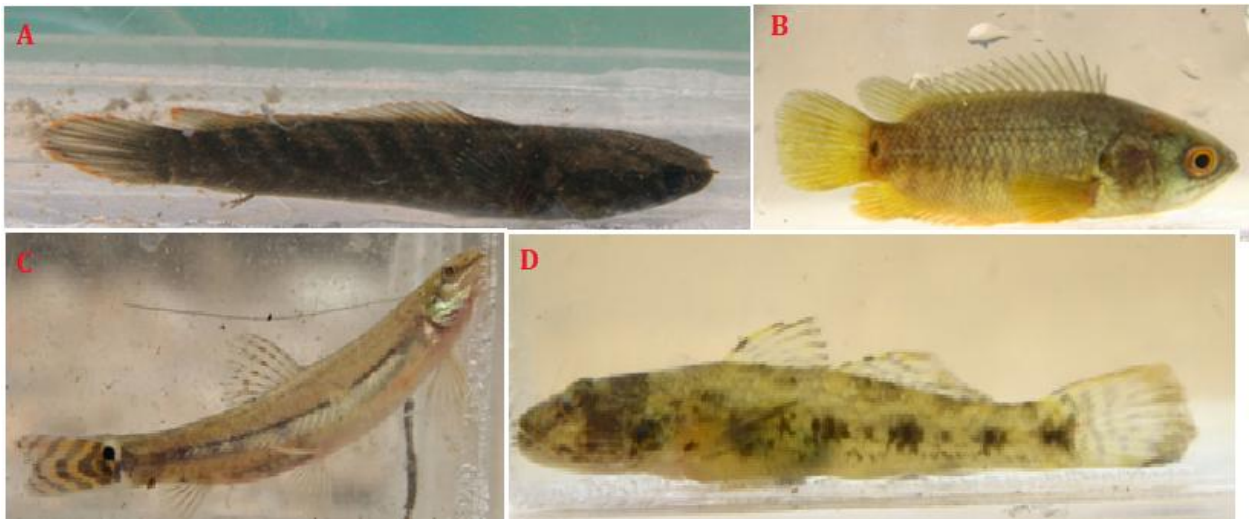
5.7. Annexures

Annexture 5.7a (A) *Channa striata* and (B) *Eutroplus suratensis* caught by fishermen

Annexure 5.7 b. ***Amlypharyngodon melattinus*** **(A),** ***Rasbora microcephalus*** **(B),** ***Devario malabaricus*** **(c) ,** ***Puntius vittatus*** **(D)**



Annexure 5.7c. ***Channa kelrtii*** **(A), Anabas testudineus (B),** ***Lepidocephalichthys thermalis*** **(C)*Glossobius giuris*** **(D)**

6.0 HERPETOFAUNA DIVERSITY ANALYSIS

6.1 Introduction

Sri Lanka is a globally recognized amphibian (Meegaskumbura *et al*., 2002) and reptile (Roll et al., 2017) diversity hotspot. Ampnog the amphibians, 120 species are known from the islands that are represented in two main orders: Anura and Gymnophiona (Ukuwela, 2010). The order Gymnophiona includes three species of limbless amphibians belonging to the family Icthyophiidae (Ukuwela, 2010). The order Anura includes the well-known frogs and toads (117 spp.) which is represented by the six families: Bufonidae, Dicroglossidae, Microhylidae, Ranidae, Rhacophoridae and Nyctibatrachidae (Ukuwela, 2010). 106 species of amphibians are endemic to Sri Lanka including the genera *Adenomus*, *Nannophrys*, *Lankanectes* and *Taruga* (Ukuwela, 2010). However, 78 (65%) species of amphibians are threatened with extinction (Manamendra-Aarachchi & Meegaskumbura, 2012) and 18 species have already become extinct (Pethiyagoda et al., 2006). The island is home to 227 species of reptiles (2 crocodiles, 8 turtles and tortoises, 112 lizards, 104 snakes) of which 135 are endemic to the island. However, 108 (65%) are considered threatened with extinction and five species are listed as data deficient in the National Red List (Wickramasinghe, 2012; de Silva & Ukuwela, 2017b). It has been highlighted that the biggest impediment for the conservation of the herpetofauna of Sri Lanka is the lack of accurate information on species identities, species limits (i.e. taxonomic issues), abundance and distribution (Wickramasinghe, 2012). Thus urgent studies are necessary to resolve taxonomic issues, assess distribution, abundance and evaluate the conservation status of these lizards to take the necessary steps for conservation. At the same time, assessing the presence of herpetofauna in places that are not usually sampled in regular surveys and understanding the occurrence of species outside protected areas is of immense importance to inform conservation strategies. Thus, the present survey reported here makes this important contribution towards the conservation of biodiversity in Sri Lanka.

6.2 Sampling Methodology

Pilot survey was carried out in May to select the study sites. Three main habitats were selected for the rapid biodiversity assessment upon initial observations and consultations from the villagers. Three study sites selected were home gardens, lakes and surrounding habitats and 'forest edge and secondary forest' habitats. Initially the study team experimented with both line transect method and Visual encounter method (Scott et al., 1994) to determine the appropriate method to determine the diversity. However, linet transect method turned out extremely low amounts of species or no species at certain instances compared to the Visual encounter method (VES). Hence, the visual encounter method was adopted to estimate the amphibian and reptile diversity in the study region. The VES method involved 3 hour nocturnal surveys within specific habitats by three personal at a time examining the leaf litter, under logs and boulders, on tree trunks and shrubs. The surveys were conducted from 19 00 hours 22 00 hours using torches and head lamps. A total of 45 man-hours were spent on field observations. Specimens were captured for closer examination to facilitate identification. Specimens were identified from the

identification guides Somaweera and Somaweera (2009), de Silva and Ukuwela (2017) and Dutta and Manamendra-aarchchi (1996). All captured specimens were released back to the same habitat after identification and photography. Apart from the direct observations made in the study, indirect evidence (photographs provided from the villages) for the presence of species in the region were also used. The presence of species in the study region were confirmed only when the species was positively identified from indirect evidence (i.e. photographs). Based on the number of observations, species were categorized into very common (>100), common (99-50), uncommon (49-20) and rare (19-9) and very rare (<8) species. Conservation status of species were quoted here from the national red list of Sri Lanka (MOE, 2012).

6.3 Results

6.3.1 Overall Herpetofauna Diversity within the GN Divisions in Galnewa

A total of 360 individuals of reptiles and amphibians belonging to 33 species were recorded from all three habitats (Annexure 6. 1). This included ten endemic species and 3 threatened species. Of the 33 species, 13 were amphibians while the rest (19) were reptiles (Table 6.1). 4.76% of the amphibians recorded in the study were endemic species while only 3.54% of the total reptiles recorded in the study were endemic to Sri Lanka (Table 6.1). Of the total diversity of amphibians in the study site, 1.85% was threatened species while 2.56% of the reptiles observed were threatened. The most abundant amphibian species observed in the study were *Minervarya syhadrensis* (120), *Euphlyctis hexadactylus* (28) and *Hydrophylax gracilis* (26) while the most abundant reptiles recorded in the study were *Lankascincus fallax* (36), *Hemidactylus parvimaculatus* (12) and *Hemidactylus frenatus* (11).

Table 6.1 Summary of the total species observed in the study

Group	No of Species	Endemic Species	Threatened Species
All sites	32	10	3
Amphibians	13 (10.83%)	5 (4.76%)	1 (1.85%)
Reptiles	19 (8.37%)	5 (3.54%)	2 (2.56%)

Values in parentheses shows the proportions in relation to the total number of species, total number of endemic species and the total number of threatened species in Sri Lanka.

Figure 6.1 Threatened species observed from the study site during the survey. A: *Pseudophilautus regius*, B: *Eutropis madaraszi* and C: *Cyrtodactylus yakhuna*.

Among the three sites surveyed, the highest diversity (10 species) of amphibians were observed in Lakes and surrounding habitats followed by home garden habitats (9 species) (Table 6.2). The lowest diversity was observed in the Secondary Forest & Forest Edge habitats. However, the highest number of endemic species was observed in home garden habitats while the lowest were observed in Secondary Forest & Forest Edge habitats. The lower diversity of amphibians in the Secondary Forest & Forest Edge habitats is most likely explained by the lack of aquatic habitats in this study site compared to Lakes and Surrounding habitats and Home gardens. Most abundant amphibian species in home gardens and Lakes and surrounding habitats was *Minervarya syhadrensis* while *Polypedates cruciger* was the most abundant species of amphibian in Secondary Forest & Forest Edge habitats.

Table 6.2. Comparison of amphibian diversity the three habitats surveyed

	Home garden	Tanks and Surrounding habitats	Secondary Forest & Forest Edge
Species richness	9 (7.5%)	10 (8.33%)	3 (2.50%)
Endemic Species	5 (4.76%)	3 (2.85%)	2 (1.90%)
Threatened Species	1 (1.28%)	0	0
Shannon Diversity Index	1.628	1.748	1.094
Shannon Evenness	0.741	0.759	0.996

Values in parentheses shows the proportions in relation to the total number of species, total number of endemic species and the total number of threatened species in Sri Lanka.

Of the three sites surveyed, the highest diversity (11 species) of reptiles were observed in the Secondary Forest and Forest Edge habitats. Both home gardens and Lakes and Surrounding habitats had 8 species each (Table 6.3). Similarly, the highest number of endemic species (3) were observed in Secondary Forest and Forest Edge habitats while the lowest were observed in Lakes and Surrounding habitats. *Lankascincus fallax* was the most abundant species of reptile in Home garden and Secondary Forest and Forest Edge habitats. No species were more abundant in Lakes and Surrounding habitats. This was further evidenced by the highest Shannon Evenness value (0.965) for this habitat.

Table 6.3. Comparison of reptile diversity the three habitats surveyed

	Home garden	Tanks and Surrounding habitats	Secondary& and Forest Edge
Species richness	8 (3.52%)	8 (3.52%)	11 (4.82%)
Endemic Species	2 (1.41%)	1 (0.71%)	3 (2.12%)
Threatened Species	1 (0.877%)	0	2 (1.75%)
Shannon Diversity Index	1.559	2.007	1.753
Shannon Evenness	0.750	0.965	0.731

Values in parentheses shows the proportions in relation to the total number of species, total number of endemic species and the total number of threatened species in Sri Lanka.

Figure 6.2. Common species of amphibians and reptiles observed in the study region, A: *Minervarya syhdrensis*, B: *Euphlyctis hexadactylus*, D: *Lankascincus fallax* and E: *Hemidactylus parvimaculatus*.

Overall the diversity of reptiles and amphibians observed in the study area was low. Typically, the diversity of herpetofauna is low in the dry zone of Sri Lanka compared to the wet zone of the country. Thus the diversity of reptiles and amphibians in the study area was also expected to be low as the study area mostly lies in the intermediate and dry climatic zones of Sri Lanka. This was further exacerbated by the prevailing dry conditions in the region as most species of reptiles and amphibians would be inactive and be estivating. The total diversity of amphibians in the dry zone of Sri Lanka is reported to be 17 species (Dutta & Manamendra-Arachchi, 1996). However, only 13 species were found during the survey from the study area. This is again most likely due to the prevailing dry conditions in the region. The diversity of snakes observed in the study region was also low (6 individuals of 4 species). The secretive nature of most snakes may explain their rarity during the study. The presence of endemic forest dwelling snake, *Trimersurus trignocephalus* is noteworthy (Annexure 6.1). Though this species was not directly observed by the survey team, its presence was confirmed by photographs provided by villagers of Habarawattha. The species was observed in a secondary forest habitat by the villagers during road extension work. Though this survey did not record a very high diversity of herpetofauna compared to certain sites in the dry zone (Somaweera et al., 2001; DWC, 2008), the diversity of Herpetofauna in the study region is more likely to be higher if more sampling is carried out especially during the rainy season.

6. 4 Recommendations for the conservation of Herpetofauna in the study area

- Vegetation cover in the home gardens and lakes and surrounding habitats should be maintained as they provide important moist habitats for survival of both reptiles and amphibians.

- Use of pesticides, weedicides and inorganic fertilizers should be discouraged in home garden habitats as they are toxic to all Herpetofauna and further as it reduces insect populations in the region.

- The residents of region should be informed not to burn decaying vegetation as they serve as major microhabitats in home gardens for many species of reptiles and amphibians.

- Awareness programs on the importance and conservation of Herpetofauna should be carried out to the residents of the study areas to reduce killing of especially snakes.

- The residents of the study areas should be educated on the identification of venomous snakes to reduce snake bites and as well as reduce the wanton killing of snakes both venomous as well as non-venomous.

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6.6.Annexures

Annexure 6.6 a. Checklist of the species of amphibians and reptiles observed in the survey

Family	Species	Native/ Endemic	Conservation Status	Abundance
Reptiles				
Crocodylidae	*Crocodylus palustris*	N	NT	**1**
Bataguridae	*Melanochelys trijuga*	N	LC	**1**
Agamidae	*Calotes calotes*	N	LC	**1**
Agamidae	*Calotes versicolor*	N	LC	**1**
Gekkonidae	*Cyrtodactylus yakhuna*	E	VU	**1**
Gekkonidae	*Hemidactylus deprassus*	E	LC	**1**
Gekkonidae	*Hemidactylus frenatus*	N	LC	**2**
Gekkonidae	*Hemidactylus parvimaculatus*	N	LC	**2**
Gekkonidae	*Hemidactylus triedrus*	N	LC	**1**
Lygosomidae	*Lygosoma punctata*	N	LC	**1**
Mabuyidae	*Eutropis carinatus*	N	LC	**1**
Mabuyidae	*Eutropis madarazsi*	E	VU	**1**
Ristellidae	*Lankascincus fallax*	E	LC	**3**
Varanidae	*Varanus salvator*	N	LC	**1**
Varanidae	*Varanus benghalensis*	N	LC	**1**
Colubridae	*Amphiesma stolatum*	N	LC	**1**

Colubridae	*Dendrelephis sp.*			**1**
Colubridae	*Xenochrophis piscator*	N	LC	**1**
Typhlopidae	*Indotyphlops sp.*			**1**
Viperidae	*Trimersurus trignocephalus**	E	LC	
Amphbians				
Bufonidae	*Duttaphrynus melanostictus*	N	LC	**1**
Dicroglossidae	*Euphlyctis cyanophlyctis*	N	LC	**2**
Dicroglossidae	*Euphlyctis hexadactylus*	N	LC	**3**
Dicroglossidae	*Hoplobatrachus crassus*	N	LC	**1**
Dicroglossidae	*Minervarya syhadrensis*	N	LC	**5**
Microhylidae	*Microhyla ornata*	N	LC	**2**
Microhylidae	*Microhyla mihintalei*	E	LC	**1**
Microhylidae	*Uperodon rohani*	E	LC	**1**
Microhylidae	*Uperodon taprobanicus*	N	LC	**3**
Rhacophoridae	*Polypedates cruciger*	E	LC	**3**
Rhacophoridae	*Polypedates maculatus*	N	LC	**3**
Rhacophoridae	*Pseudophilautus regius*	E	VU	**1**
Ranidae	*Hydrophylax gracilis*	E	LC	**3**

Score : 5- Very Common(more than 100), 3- Uncommon(49-20), 2 – Rare (19-9), 1- Very rare (less tan 8)

7.0 AVIFAUNA DIVERSITY ANALYSIS

7.1 Introduction

Sri Lanka's avifauna is one of the richest in the whole of Asia (Kotagama and Wijayasingha, 1998). Sri Lanka has a rich and diverse assemblage of avifauna that comprises a total of 508 species with 240 breeding residents and 213 purely migrants including 108 vagrants (Kotagama, 2019). Among Sri Lanka's residential breeders, 21 species are also represented by migrating populations (Weerakoon and Gunawardena 2012). The main reason for this high number of migratory species is due to Sri Lanka's geographical position and dimensions. It is 41.9% of the total number of birds. During the Migratory period from November to February, birds visit Sri Lanka. There are three main flyways, Eastern, Western and via Andaman islands. Sri Lanka is a major migratory bird point because it is the last landmass of the world. Of the breeding residents, 33 are endemic species. Largest migratory bird populations belong to waders, ducks and coastal birds.

At present, 67 species including 18 endemic species are categorized as "nationally threatened [Critically endangered (CR), Endangered (EN), and Vulnerable (VU)] according to the National Red List 2012 of Sri Lanka (MOE 2012). The distribution and habitat preference of the birds within the island of Sri Lanka is primarily governed by the vegetation and geo-climatic parameters such as temperature variability, precipitation, hydrology, and altitude (Harrison and Worfolk 2011; Kotagama et al 2006).

One in every five species of birds in Sri Lanka is currently facing the risk of becoming extinct in the wild according to the latest national Red list. Nearly one-third of all the resident birds in Sri Lanka are forest birds including all the endemic species. Therefore, main threats faced by the birds of Sri Lanka are the fragmentation of forests and loss of forest cover. Majority of the migrants and some of the local species depend on Wetlands, an important bird habitat in Sri Lanka. Many of these wetland habitats are adversely impacted due to conversion, changes in physical and chemical parameters of water due to discharges and the spread of invasive species. Consequently, species richness and the sustaining of many wetland habitats have declined rapidly.

7.2 Sampling Methodology

The main sampling method used to record terrestrial bird diversity within the Galnewa was the Variable Circular Plots (VCPs). A total of 72 VCPs were sampled within the transects in 3 terrestrial land uses within the region. Point counts method was adapted to record aquatic bird diversity within the 14 tanks in both Galnewa and Ipalogama divisional secretariat. Three point counts were used for each tank and total of 42 points were used for the data collection in tanks both in morning and evening hours. Any bird seen or heard outside the VCP, transect or point counts was record as outside and as opportunistic observations.

7. 3 Results

7.3.1 Overall Avifaunal Diversity within the GN Divisions in Galnewa

A total of 147 species of birds belonging to 55 families were recorded during the survey period. This included seven endemic species, 29 migrant species (of which in nine species breeding populations also has been observed in other parts of the country).

The eight endemics were *Gallus lafayetii* (Sri Lanka Jungle fowl), *Ocyceros gingalensis* (Sri Lanka Grey Hornbill), *Treron pompadora* (Sri Lanka Green pigeon), *Megalaima rubricapillus* (Sri Lanka Small Barbet), *Pellorneum fuscocapillum* (Sri Lanka Brown-capped Babbler) *Dinopium psarodes* (Sri Lanka Lesser Flameback), *Tephrodornis affinis* (Sri Lanka Wood shrike) and *Pycnonotus melanicterus* (Sri Lanka Black-capped Bulbul) (Annex 7.6b). Of the eight endemic species, *T. pompadora* had the largest presence within the Galnewa Division. Further details regarding the abundance observed as a complete list of species observed are available in Annex 7.6 a.

Of the total birds, 55 can be considered as wetland associated species (aquatic and semi aquatic). Among them, the most commonly occurring families are Ardeidae (09 species that includes herons and egrets); Ciconiidae (3 species including Open bills and storks); and Phalacrocoracidae (three species consisting of cormorants). 29 of the migrant species were found mainly associated with wetlands. Few commonly occurring aquatic birds are given in Figure 7.1

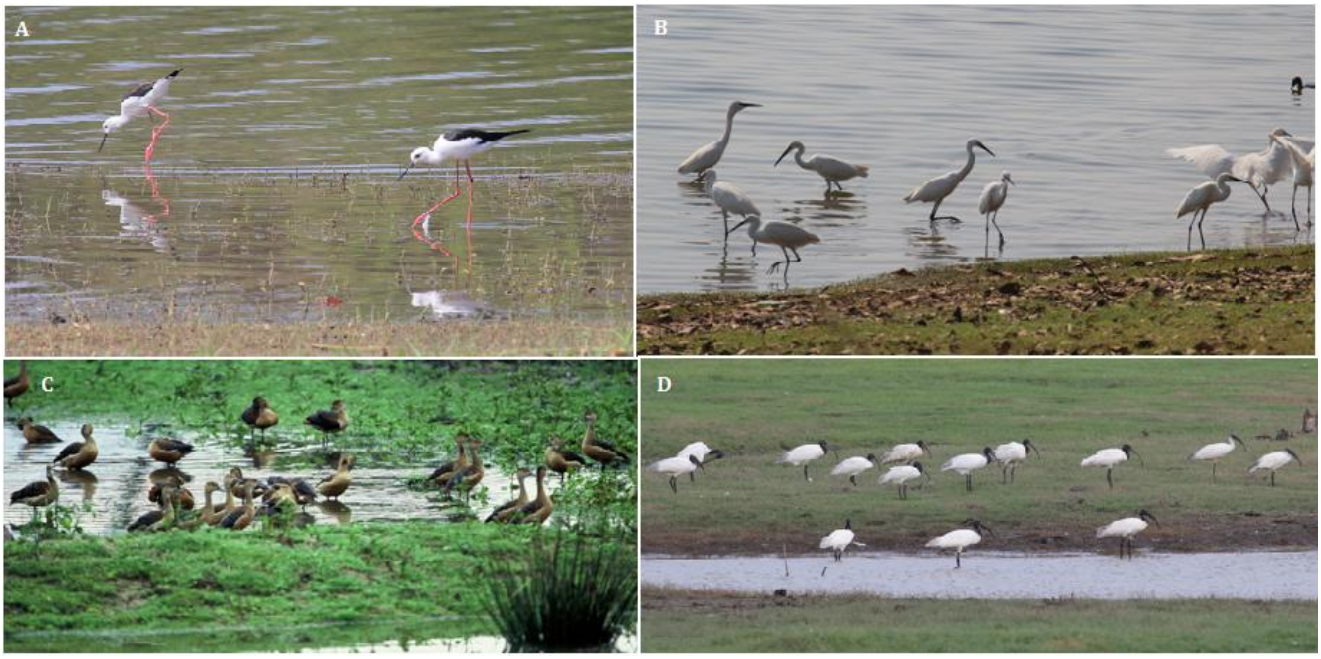

Figure 7.1 Black winged Stilt (A), Large Egret (B), Whitling Teals (C) and Black headed Ibis (D) recorded during the survey

Out of the 147 recorded species 16 and 8 species were recorded as nationally and globally threatened species respectively. Of the 14 species of nationally threatened species, four species fell into the category "vulnerable" such as Ruddy-breasted Crake (*Porzana fusca*), Little Tern (*Sternula albifrons*), White throated Munia (*Lonchura malabarica*) and Kentish Plover (*Charadrius alexandrines*) while Woolly-necked stork (*Ciconia episcopus*) was fell into the globally vulnerable category. Further one species fell into the category "Critical Endangered"; Salty-Legged Crake (*Rallina eurizonoides*) globally and Blue-Tailed Bee-Eater (*Merops philippinus*) nationally.

During the present survey, records *C. cepiscopus* was high with ten individuals being observed in an edge of the Siyambalawa tank, Mullannatuwa wewa, Kumbukwewa tank, Pahala Habarawatta tank and Palugollawa tank (Figure 7.2). Critically endangered *Rallina eurizonoides* was only recorded in two tanks.

7.3.2 Diversity within Habitats

Total of 136 species were recorded in the VCPs and point counts during the sampling time frame within the transects. Only 11 species were observed as opportunistic observations.

The highest species diversity was recorded tank associated habitat in Kumbukwewa, Medawachchiya, Siyambalawewa, Kadulugamuwa, Musnowa, Palugollawa, Galmediyawa, Hiripitiyagama, Ganthiriyagama, Kunchikulama and Mullannatuwa areas. The area bordered the water catchment areas and tank ecosystem. As a result a considerable number of forest birds, including the Grey hornbill were observed from this area. The most commonly found bird species with highest population within the tank associated area were Rose-Ringed Parakeet (*Psittacula kramerii*), White rumped Munia (*Lonchura striata*), Scaly-Breasted Munia (*Lonchura punctulata*), and Asian Palm-Swift (*Cypsiurus balasiensis*). Total of 93 species including 7 endemic species and seven nationally threatened species were recorded within this habitat. Presences of globally near threatened Great thick knee (*Esacus recurvirostris*), Wooly neck stork (*Ciconia episcopus*), Oriental Darter (*Anhinga melanogaster*), Grey-Headed Fish-Eagle (*Ichthyophaga ichthyaetus*) and Cotton Pigmy-Goose (*Nettapus coromandelianus*) were added to the importance of this ecosystem (Figure). Main threats included the heavy use of agrochemicals in the paddy fields, removal of trees for tank rehabilitation and siltation.

Figure 7.2 Globally near threatened (A) Oriental Darter (*Anhinga melanogaster*), (B) Wooly neck stork (*Ciconia episcopus*), (C) Grey-Headed Fish-Eagle (*Ichthyophaga ichthyaetus*), (D) Great thick knee (*Esacus recurvirostris*) and (E) Cotton Pigmy-Goose (*Nettapus coromandelianus*)

7.3.2.1 Tank Ecosystem

This ecosystem consists of both aquatic and semi aquatic habitats. Third highest species diversity was recorded from this habitat. The vegetation in this area dominated by the *Madhuca longifolia* , *Vitex leucoxylon*, *Manilkara hexandra* , *Terminalia arjuna* and *Syzygium cumini* which provided better habitats for most of the avifaunal species. Catchment area and the edges of the tanks provided resting and feeding grounds for the water birds (Figure 7.3)

Figure 7.3 Feeding ground for the Open Bills edges of the Mullannatuwa tank

Fifty five (55) bird species that included 8 nationally and 6 globally threatened species were recorded from this ecosystem during the study period. Most dominant species were varying tank to tank and showed in annex 7.I .Mullannatuwa tank was dominated by Open bill (*Anastomus oscitans*) and a colony of Little Cormorant (*Phalacrocorax niger*) was dominated in Kumbukwewa during the study. The globally near threatened Spot billed Pelican together with several migrant waders were observed in this tank and there was an indication that this bird species together with few other aquatic birds use the trees in this tank for roosting purposes (figure 7.4).

Figure 7.4 Roosting habitats for Spot billed Pelican at Kumbukkanwewa

Main threat to the ecosystem was the lack of water due to the dry weather conditions. Animal husbandry (cattle) was prominent in this area and the dung of the animals had led to eutrophication of the tank environment. Further, majorly of villagers use this tank for bathing purposes.

7.3.2.2 Disturbed Forest Patches

The vegetation in this area is highly fragmented and degraded, while extension of home gardens became disturbed forest as a result of long term succession (Figure 7.5). Yet the presence of scrublands secondary forests increased the areas potential to harbor 88 Bird species. Six endemic species, five nationally and one globally threatened (Alexandrine Parakeet - *Psittacula eupatria* (NT),was recorded from this ecosystem. White-browed Bulbul (*Pycnonotus luteolus*), Spotted Dove (*Stigmatopelia chinensis*), Red-vented Bulbul (*Pycnonotus cafer*), Purple-rumped Sunbird (*Nectarinia zeylonica*) and Common Iora (*Aegithina tiphia*) were the most dominant species in this land use area.

Figure 7.5 Disturbed Forest patches Karawilaga(A), Kalanchiya (B), Otthapahuwa (C) and Siyambalawa (D)

7.3.2.3 Home gardens

Homegardens are mainly with deliberately planted trees, shrub species, and herbaceous species. Naturally grown forest plant species (trees and shrubs) also in and around homegardens, especially in extended homegardens, as boundaries are not so clear. Occurrence of large forest tree species (both timber and non-timber) is relatively low in homegardens. Lowest diversity was recorded in home gardens. The least number of bird species (49) was encountered from this land use habitats and could be accounted to human interventions including cultivations (vegetables) and planted cash crops (Figure 7.6). Five endemic species represented the avifaunal assemblage of this land use habitat while two nationally and one globally threatened species were observed. Red Vented Bulbul (*Pycnonotus cafer*), Yellow billed Babbler (*Turdoides affinis*), Long billed Sunbird (*Nectarinia lotenia*) and White Browed Bulbul (*Pycnonotus luteolus*) were the most common bird species. Major threats include the highly fragmented nature of the habitat patches that were disappearing fast due to human interference such as clearing for cash crop cultivation and housing construction.

Figure 7.6 . Cultivated lands in Galnewa area : Palugollawa (A) and (B), Karawilagala (C) and Ottapahuwa (C)

Table 7.1. Avifaunal Diversity within the different land use habitats

Main Land use/ Ecosystem	Number of Species	Endemic species	Threatened Species		Shannon Wiener Diversity (H')
			National Status	Global Status	
Tank Ecosystem	58	0	10	6	1.5210
Tank Associate	93	7	7	4	1.7565
Home Garden	49	5	2	1	1.4697
Disturbed Forest	88	6	5	1	1.6939

7.4 Discussion

Galnewa and Ipalogama, divisional secretariats support a rich avifaunal assemblage. It is particularly important for migrant species, including some rare winter visitors, and also breeding residents. The survey revealed the presence of a rich avifaunal diversity within the two divisional secretariats including few nationally and globally threatened species. The tank

ecosystems that need priority in terms of conserving the bird diversity are Kumbukwewa, Mullannatuwa and Musnowa as well as Medawachchiya tank as it is important feeding ground for both local and migratory water birds. Attention should be given to minimize cattle grazing in inundation areas of tanks during the dry season and maintain adequate tree cover consisting of tree species required for feeding and nesting requirements.

Approximately 50% of birds recorded in this Survey are aquatic species or aquatic associates, indicating that this area remains one of the important sites for aquatic birds in Sri Lanka, especially winter visitors of which a number of species are rare, such as and Salty-Legged Crake (*Rallina eurizonoides*) and Orange Headed Thrush (*Geokichla citrine*)

Of Sri Lanka's 230 breeding resident species, 54% were recorded in the survey area, indicating the value of these two adjacent areas for long-term conservation of indigenous bird species.

The level of endemism is low compared with other protected areas in the dry Zone. The long term conservation value of this area, however, is threatened by several factors that include the following:

- Invasive plant species are rapidly spreading in many of the habitats in both the aquatic and terrestrial habitats. This will accelerate the success of the vegetation from aquatic to terrestrial types and thereby possibly reduce the carrying capacity for aquatic birds.

- Continued use of the tank ecosystem by villagers for grazing their cattle has several long-term ecological impacts including dispersal of seeds of the invasive plants by cattle; and eutrophication of water bodies, especially during the rainy season by dung from cattle. Such impacts will influence the avifaunal assemblages associated with these habitats. Adequacy and shortcomings of survey data this dataset provide a reliable, geo-referenced baseline for Galnewa Ipalogma Divisional secretariat which can be used to inform its management.

However, the data should be used judiciously, taking full account of the following limitations:

- Some habitats were not systematically sampled adequately due to time constrains. The sampling method was inherently biased towards terrestrial habitats and, therefore, the aquatic habitats were underrepresented in the Survey.
- The entire Survey was carried out during the dry and late period of migratory season that extended into the early -migratory but not the dry season. It is recommended that at least a selected number of transects be repeated during the wet season to enable seasonal changes in the diversity of avifaunal assemblages to be assessed.
- Main threats include forest clearing for Chena cultivation and use of high concentrations of agrochemicals that ended in the tank systems.

7.5. References

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7.6. Annexures

Annexure 7.6 a List of bird species recorded from the different land uses within the Galnewa-Palagala Ipalogma Divisional Secretariat.

	Family	Scientific Name Common Name	Status	NCS	GCS	T	HG	TA	DF
1	Accipitridae	*Haliastur Indus* Brahminy Kite	BR VC	LC	LC	5	0	3	0
2		*Spizaetus cirrhatus* Changeable Hawk-Eagle	BR C	LC	LC	0	1	3	1
3		*Spilornis cheela* Crested Serpent-Eagle	BR VC	LC	LC	0	3	3	3
4		*Ichthyophaga ichthyaetus* Grey-Headed Fish-Eagle	BR R	NT	NT	5	0	0	0
5		*Accipiter badius* Shikra	BR VC	LC	LC	0	5	5	5
6		*Haliaeetus leucogaster* White-Bellied Fish-Eagle	BR C	LC	LC	5	0	5	0
7		*Ictinaetus malayensis* Black Eagle	BR	NT	LC	0	0	1	0
8	Alcedinidae	*Alcedo atthis* Common Kingfisher	BR VC	LC	LC	5	0	5	0
9		*Pelargopsis capensis* Stork-Billed Kingfisher	BR C	LC	LC	2	0	2	0
10		*Halcyon smyrnensis* White-Throated Kingfisher	BR VC	LC	LC	5	3	5	2

11		*Ceryle rudis* Pied Kingfisher	BR	LC	LC	1	0	0	0
12	Alaudidae	*Alauda gulgula* Oriental Skylark	M	LC	LC	1	0	0	0
13		*Mirafra affinis* Jerdon's Bushlark	BR	LC	LC	2	0	0	0
14	Anatidae	*Dendrocygna javanica* Lesser Whistling Duck	BR & M	LC	LC	5	0	0	0
15		*Nettapus coromandelianus* Cotton Pigmy-Goose	BR	LC	NT	3	0	0	0
16	Anhingidae	*Anhinga melanogaster* Oriental Darter	BR C	LC	NT	5	0	0	0
17	Apodidae	*Apus affinis* Little Swift	BR C	LC	LC	5	0	5	0
18		*Cypsiurus balasiensis* Asian Palm-Swift	BR C	LC	LC	5	0	5	0
19	Ardeidae	*Bubulcus ibis* Cattle Egret	BR &M	LC	LC	0	2	5	3
20		*Casmerodius albus* Great Egret	BR C	LC	LC	5	0	0	0
21		*Ardea cinerea* Grey Heron	BR C	LC	LC	5	0	0	0
22		*Ardeola grayii* Indian Pond Heron	BR VC	LC	LC	5	0	3	0
23		*Mesophoyx intermedia* Intermediate Egret	BR VC	LC	LC	5	0	0	0
24		*Egretta garzetta* Little Egret	BR VC	LC	LC	5	0	3	0
25		*Ardea purpurea* Purple Heron	BR C	LC	LC	5	0	0	0
26		*Nycticorax nycticorax* Black Crowned Night Heron	BR C	LC	NT	3	0	0	0
27		*Butorides straitus* Striated Heron	BRR	LC	LC	1	0	0	0
28	Burhinidae	*Esacus recurvirostris* Great thick knee	BR	LC	NT	0	0	2	0
29	Bucerotidae	*Ocyceros gingalensis* Sri Lanka Grey Hornbill	BR VC E	NT	LC	0	3	2	3
30		*Anthracoceros coronatus* Malabar Pied Hornbill	BR C	NT	LC	0	3	3	3
31	Campephagidae	*Coracina melanoptera* Black-Headed Cuckoo-Shrike	BR R	LC	LC	0	0	1	1
32		*Coracina macei* Large Cuckoo-Shrike	BR C	LC	LC	0	0	1	1
33		*Pericrocotus cinnamomeus* Small Minivet	BR C	LC	LC	0	2	3	3

34		*Tephrodornis affinis* Sri LankanWoodshrike	BR E	LC	LC	0	4	0	4
35	Capitonidae	*Megalaima zeylanica* Brown-Headed Barbet	BR VC	LC	LC	0	5	5	5
36		*Megalaima haemacephala* Coppersmith Barbet	BR C	LC	LC	0	2	4	4
37		*Megalaima rubricapilla* Sri Lanka Small Barbet	BR VC E	LC	LC	0	2	2	2
38	Caprimulgidae	*Caprimulgus asiaticuseidos* Indian Nightjar	M	LC	LC	0	0	0	1
39		*Caprimulgus atripennis* Jerdon's Nightjar	BR	LC	LC	0	0	0	1
40	Charadiidae	*Vanellus indicus* Red-Wattled Lapwing	BR VC	LC	LC	5	0	5	0
41		*Charadrius dubius jerdoni* Little Ring Plover	BR & M	VU	LC	2	0	0	0
42		*Charadrius alexsandrinus seebohmi* Kentish Plover	BR & M	VU	LC	2	0	0	0
43	Ciconiidae	*Anastomus oscitans* Asian Open-Bill	BR C	LC	LC	5	0	5	0
44		*Mycteria leucocephala* Painted Stork	BR C	NT	LC	3	0	0	0
45		*Ciconia episcopus* Wooly-Necked Stork	BR R	VU	NT	2	0	3	0
46	Columbidae	*Chalcophaps indica* Emerald Dove	BR C	LC	LC	0	3	3	3
47		*Ducula aenea* Green Imperial-Pigeon	BR C	LC	LC	0	5	0	5
48		*Treron bicincta* Orange-Breasted Green-Pigeon	BR C	LC	LC	0	3	3	4
49		*Treron pompadora* Sri Lanka Green-Pigeon	BR C E	LC	LC	0	2	3	3
50		*Columba livia* Rock Pigeon	BR VC	CR	LC	0	0	2	2
51		*Streptopelia chinensis* Spotted Dove	BR VC	LC	LC	0	5	5	5
52	Coraciidae	*Coracias bengalensis* Indian Roller	BR C	LC	LC	0	0	1	1
53	Corvidae	*Corvus macrorhynchos* Large-Billed Crow	BR VC	LC	LC	0	0	2	0
54	Cuculidae	*Eudynamys scolopacea* Asian Koel	BR VC	LC	LC	0	3	2	3
55		*Oxylopus jacobinus* Pied Cuckoo	M	LC	LC	0	1	0	1

56		*Cuculus canorus* Common Cuckoo	M	LC	LC	0	0	0	1
57		*Phaenicophaeus viridirostris* Blue-Faced Malkoha	BR C	LC	LC	0	1	0	1
58		*Centropus sinensis* Greater Coucal	BR VC	LC	LC	0	3	0	2
59		*Cacomantis passerinus* Grey-Bellied Cuckoo	M C			0	0	1	1
60	Dicaeidae	*Dicaeum agile* Thick-Billed Flower Pecker	BR R	NT	LC	0	0	4	4
61		*Dicaeum erythrorhynchos* Pale- Billed Flower Pecker	BR VC	LC	LC	0	5	3	5
62	Dicruridae	*Dicrurus caerulescens* White-Bellied Drongo	BR VC	LC	LC	0	2	3	2
63	Estrildidae	*Lonchura malacca* Black-Headed Munia	BR VC	LC	LC	0	0	1	1
64		*Lonchura punctulata* Scaly-Breasted Munia	BR VC	LC	LC	0	4	3	2
65		*Lonchura striata* White-Rumped Munia	BR VC	LC	LC	0	0	2	2
66		*Lonchura Malacca* Tricoloured Munia	BR	LC	LC	1	0	0	0
67		*Lonchura kelaarti* Black Throated Munia	BR	VU	LC	1	0	0	0
68	Hemiprocnidae	*Hemiprocne coronata* Crested Tree-Swift	BR C	LC	LC	5	0	5	0
69	Hirundinidae	*Hirundo rustica* Barn Swallow	M VC	LC	NE	3	0	3	0
70		*Hirundo daurica erythropygia* Indian Red-Rumped Swallow	MBR C	LC	LC	3	0	3	0
71	Irenidae	*Aegithina tiphia* Common Iora	BR VC	LC	LC	0	5	5	5
72		*Chloropsis cochinchinensis* Blue-Winged Leaf Bird	BR C	LC	LC	0	0	3	3
73	Jacanidae	*Hydrophasianus chirurgus* Pheasant-Tailed Jacana	BR VC	LC	LC	5	0	0	0
74	Laniidae	*Lanius cristatus cristatus* Brown Shrike	M C	LC	NE	0	0	0	2
75	Laridae	*Chlidonias hybridus* Whiskered Tern	M VC	NE	LC	5	0	0	0
76		*Sterna albifrons* Little Tern	BR	VU	LC	4	0	0	0

77	Meropidae	*Merops philippinus* Blue-Tailed Bee-Eater	BR &M	CR	LC	0	0	1	1
78		*Merops leschenaulti* Chestnut-Headed Bee-Eater	BR C	LC	LC	0	0	1	1
79		*Merops orientalis* Little Green Bee-Eater	BR VC	LC	LC	0	0	5	5
80	Motacillidae	*Dendronanthus indicus* Forest Wagtail	M C	LC	NE	0	0	1	1
81		*Anthus rufulus* Paddy-Field Pipit	BR VC	LC	LC	2	0	2	0
82		*Anthus richardi* Richard's Pipit	M C	LC	NE	2	0	2	0
83	Muscicapidae	*Muscicapa dauurica* Asian Brown Flycatcher	M	NE	LC	0	3	3	3
84		*Cyornis tickelliae* Tickell's Blue-flycatcher	BR	LC	LC	0	0	2	0
85	Monarchidae	*Hypothymis azurea* Black-Naped Monarch	BR C	LC	LC	0	0	1	1
86		*Muscicapa paradise paradisi* Indian Paradise Flycatcher	BR & M C	LC	LC	0	2	2	2
87		*Terpsiphone paradisi ceylonensis* Sri Lanka Paradise Flycatcher	BR & M C	LC	LC	0	2	2	2
88	Nectariniidae	*Nectarinia lotenia* Long-Billed Sunbird	BR VC	LC	LC	0	5	5	5
89		*Nectarinia asiatica* Purple Sunbird	BR VC	LC	LC	0	5	5	5
90		*Nectarinia zeylonica* Purple-Rumped Sunbird	BR VC	LC	LC	0	5	5	5
91	Oriolidae	*Oriolus xanthornus* Black-Hooded Oriole	BR VC	LC	LC	0	3	2	3
92	Pelecanidae	*Pelecanus philippensis* Spot-Billed Pelican	BR VC	LC	NT	2	0	0	0
93	Phalacrocoracidae	*Phalacrocorax fuscicollis* Indian Cormorant	BR VC	LC	LC	5	0	0	0
94		*Phalacrocorax carbo* Great Cormorant	BR	NT	LC	5	0	0	0
95		*Phalacrocorax niger* Little Cormorant	BR VC	LC	LC	5	0	0	0
96	Phasianidae	*Coturnix chinensis* Blue breasted Quail	BR	LC	LC	0	0	0	1
97		*Gallus lafayetii* Sri Lanka Jungle Fowl	BR C E	LC	LC	0	0	5	5
98		*Pavo cristatus* Indian Peafowl	BR C	LC	LC	0	0	5	5

99	Picidae	*Dinopium benghalens psarodes* Golden backed Woodpecker	BR C	LC	LC	0	2	2	2
100		*Dinopium benghalens psarodes* Red backed Woodpecker	BR C	LC	LC	0	0	2	2
101	Pittidae	*Pitta brachyura* Indian Pitta	M C	LC	NE	0	2	0	1
102	Ploceidae	*Ploceus philippinus* Baya Weaver	BR VC	LC	LC	0	0	3	2
103		*Passer domesticus* House Sparrow	BR VC	LC	LC	0	4	0	0
104	Podargidae	*Batrachostomus monilieger* Frogmouth	BR R	LC	LC	0	0	1	1
105	Podicipedidae	*Tachybaptus ruficollis* Little Grebe	BR C	LC	LC	5	0	0	0
106	Psittacidae	*Psittacula krameri* Rose-Ringed Parakeet	BR VC	LC	LC	0	5	5	5
107		*Psittacula eupatria* Alexandrine Parakeet	BR	LC	NT	0	0	0	2
108	Pycnonotidae	*Pycnonotus melanicterus* Sri Lanka Black-capped Bulbul	BR CE	LC	?	0	0	0	2
109		*Pycnonotus cafer* Red-Vented Bulbul	BR VC	LC	LC	0	5	5	5
110		*Pycnonotus luteolus* White-Browed Bulbul	BR VC	LC	LC	0	5	5	5
111	Rallidae	*Rallina eurizonoides* Salty-Legged Crake	BR & M	LC	CR	1	0	1	0
112		*Porphyrio porphyrio* Purple Swamp hen	BR VC	LC	LC	5	0	0	0
113		*Amaurornis phoenicurus* White Breasted Water Hen	BR	LC	LC	5	0	5	0
114		*Porzana fusca* Ruddy breasted Crake	BR & M	LC	VU	1	0	0	0
115		Common Moorhen *Gallinula chloropus*	BR VC	LC	LC	2	0	2	0
116	Recurvirostridae	*Himantopus himantopus* Black winged Stilt	BR & M	LC	LC	5	0	0	0
117	Scolopacidae	*Tringa glareola* Wood Sandpiper	M VC	NE	LC	2	0	0	0
118		*Tringa stagnatilis* Marsh Sandpiper	M VC	NE	LC	2	0	0	0
119		*Actitis hypolecus* Common Sandpiper	M VC	NE	LC	2	0	0	0
120	Strigidae	*Ketupa zeylonensis* Brown Fish-Owl	BR C	LC	LC	0	0	1	1
121		*Ninox scutulata* Brown Hawk Owl	BR	LC	LC	0	0	1	1

122		*Bubo nipalensis blight* Spot bellied Eagle Owl	BR	NT	LC	0	0	1	0
123	Sturnidae	*Acridotheres tristis* Common Mynah	BR VC	LC	LC	0	5	5	5
124		*Pastor roseus* Rosy Starling	M	LC	NE	0	0	2	0
125	Sylviidae	*Cisticola juncidis* Zitting cisticola	BR	LC	LC	0	0	0	2
126		*Prinia inornata* Plain Prinia	BR VC	LC	LC	0	0	5	5
127		*Prinia socialis brevicauda* Ashy Prinia	BR	LC	LC	0	5	5	5
128		*Prinia hodgsonii* Grey-Breasted Prinia	BR C	LC	LC	4	0	4	3
129		*Orthotomus sutorius* Common Tailorbird	BR VC	LC	LC	0	5	5	5
130		*Phylloscopus nitidus* Green Warbler	M	LC	?	0	0	2	2
131		*Acrocephalus dumetorum* Blyth's Reed Warbler	M C	LC	NE	0	0	2	1
132	Threskiornithidae	*Threskiornis melanocephalus* Black Headed Ibis	BR VC	NT	LC	5	0	0	0
133	Timallidae	*Pellorneum fuscocapillum* Sri Lanka Brown Capped Babbler	BR	LC	LC	0	3	2	2
134		*Dumetia hyperythra* Tawny-Bellied Babbler	BR R	LC	LC	0	3	3	4
135		*Cyornis tickelliae* Tickell’s Blue Flycatcher	BR C	LC	LC	0	0	2	2
136		*Copsychus malabaricus* White-Rumped Shama	BR VC	LC	LC	0	0	0	5
137		*Turdoides affinis* Yellow-Billed Babbler	BR VC	LC	LC	0	5	5	5
138		*Chrysomma sinense* Yellow-Eyed Babbler	BR R	LC	LC	0	2	3	2
140	Turnicidae	*Turnix suscitator* Barred Button-Quail	BR C	LC	LC	0	0	1	1
141	Turdidae	*Copsychus saularis* Oriental Magpie Robin	BR VC	LC	LC	0	5	5	5
142		*Saxicoloides fulicata leucoptera* Indian Robin	BR VC	LC	LC	0	5	5	5
143		*Copsychus malabaricus leggei* White rumped Shama	BR VC	LC	LC	0	0	3	3
144		*Zoothera citrina* Orange-Headed Ground Thrush	M VR	NE	LC	0	0	1	1
145	Zosteropidae	*Zosterops palpebrosa* Oriental White-Eye	BR VC	LC	LC	0	4	2	4

146		*Glareola maldivarum* Oriental Pratincole	BR/M	NE	LC	0	0	1	0

BR: Breeding Resident VC- Very common VR- Very Rare C- Common R- Rare M- Migrant MBR- Migrant Breeding Resident

Annex 7.6 b Endemic species recorded during the syrvey

8.0 MAMMALIAN DIVERSITY ANALYSIS

8.1 Introduction

The pioneering work on the systematics of the mammals of Sri Lanka was carried out by Kelaart (1852). Subsequently, Phillips (1935) conducted an extensive review of the mammals of Sri Lanka and the resulting manual is still the standard refrence for the mammals of Sri Lanka. Subsequently, a number of additional taxon specific reviews have been conducted. A total of 144 species and subspecies of Sri Lankan mammals have been described at various times. Of the 9 land living orders of mammals of Sri Lanka there are 91 species belomging to 53 genera of which, 22 are endemic (Dittus, 2017).

8.2 Survey Methodology

Thirteen localities within the area of interest were visited between April and July 2019. Three basic habitat types were identified, secondary dry zone forest, home gardens and water bodies and canals. Three approaches were used to assess the diversity and relative abundance of mammals.

8.2.1 Recce transect method

Although a wide range of wildlife census techniques have been developed (Leica *et al*., 2013), opinions are deeply polarized on method selection for estimating animal densities (Marshall *et al*., 2008). The most accurate density estimates are obtained from complete counts (Davenport *et al*., 2007; McNeilage *et al*., 2001) or focal group studies of home range (Chapman *et al*., 2000; Fashing & Cords, 2000; Marshall *et al*., 2008). Line transect methods have also been recommended (Plumptre, 2000). However, these methods require sampling effort that is often impractical, especially over large areas. In addition, establishing transects cause habitat disturbances and hence, may be problematic to establish within protected areas. Furthermore, unhabituated monkeys may violate the mathematical assumptions of transect methods, as they tend to flee from the transect when traversed by observers.

Hence, in our survey we used the recce transect method to estimate the relative abundance mammals (Sussman & Phillps-Conroy, 1995; Walsh & White, 1999; Vandercone, 2011). The method is also relatively quick and results in minimal habitat disturbances. Sampling was conducted from 07:00- 10.00 AM to and to 15.00 to 17:00 PM. Natural trails within the area were traversed slowly at about 0.5 km/h by two observers, stopping at regular intervals (15 min) to scan surroundings. We stopped whenever we saw or heard mammals and recorded the location using a handheld GPS receiver (Magellan triton 2000) and the number of individuals and age and sex categories when possible.

8.2.2 Baited traps

Baited traps were used to estimate the diversity of small mammals (Motro et al., 2019). A trap line of 100 m was established with 10 traps placed at intervals of 10 m along the trap line (Figure 8.1). The traps were baited with roasted coconut and dry fish. The traps were set at dusk and examined the following morning.

8.2.3 Ethnobiological approach

A total of 121 residents/households were interviewed using a structured questionnaire and a pictorial catalogue of mammals found in the north central dry zone of Sri Lanka (Fleck & Harder, 2000). Respondents were asked to identify species they had seen and approximately when they were seen last. Attitudes towards conservation were also assessed (Figure 8.1)

Figure 8.1 Different techniques used for data collection

8.3 Results

8.3.1 Overall Mammalian Diversity within the GN Divisions in Galnewa and Palagala

8.3.1.1 Recce transects

Only one species of mammal, *Herpestes edwarsii was* recorded through direct observation. *Sus scrofa*, *Manis crassicaudata* and *Semnopithecus priam* were identified either through signs such as burrowing activity, tracks or feces.

8.3.1.2 Baited traps

No mammals were captured in the baited traps.

8.3.1.3 Ethnobiological approach

A total of 23 species of mammals had been observed by respondents. Charismatic species such as the Asian elephant *(Elephas maximus),* Sri Lanka leopard (*Panthera purdus)* and sloth bear

(*Melursus ursinus)* and globally endangered species such as the purple faced langur (*Semnopithecus vetulus)* and the Indian pangolin (*Manis crassicaudata)* had also been observed in the region (Figure 8.2). The toque macaque was the most commonly observed mammal, while the sloth bear was the least common.

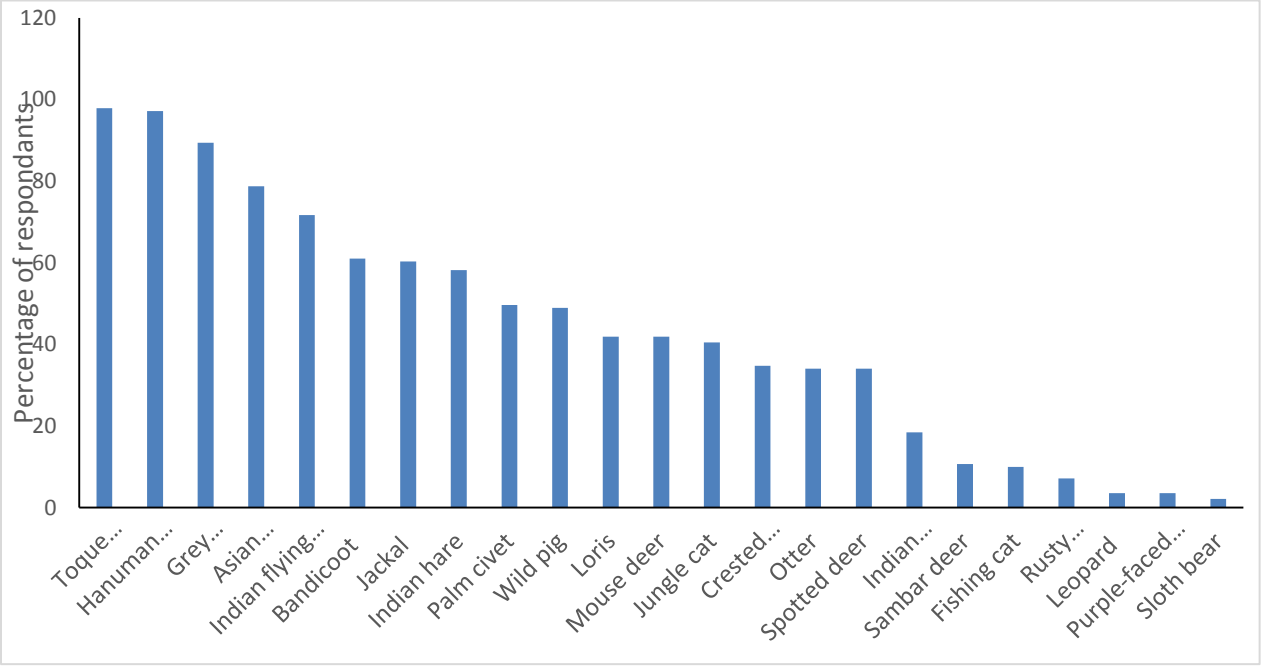

Figure 8.2 . Mammalian diversity and relative abundance based on ethnobiological approach

70% of the mammal species had been observed within the last 6 months, suggesting that the majority of these species were frequently encountered by residents (Figure 8.3).

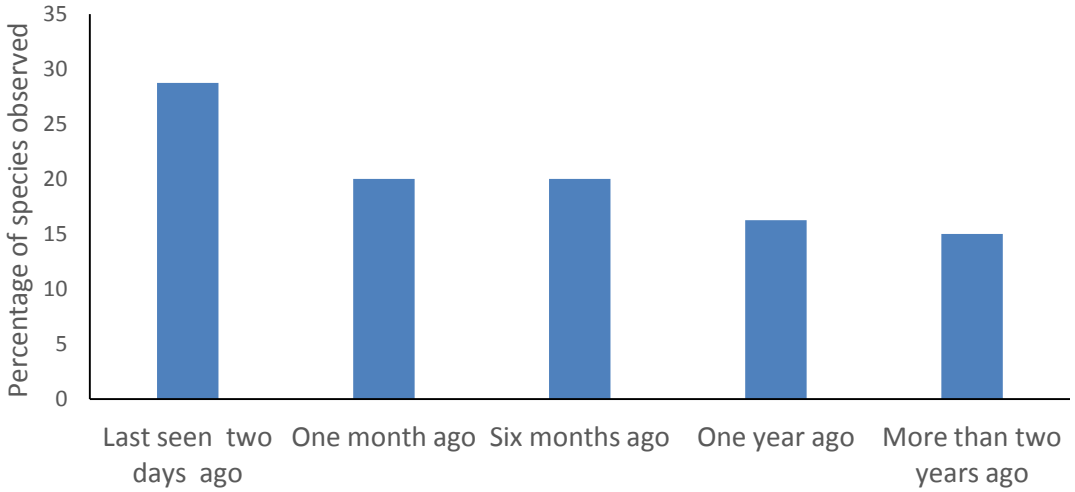

Figure 8.3. Time of last encounter

8.3.1. 4 Habitat wise comparison

More than 40% of the species had been observed in home gardens. This suggests that human-wildlife interaction in the region is common. Furthermore, home gardens could be the last refuge for many species in the face of deforestation. The low diversity of mammals reported in forest habitats could be because forest habitats are not frequently visited by residents (Figure 8.4).

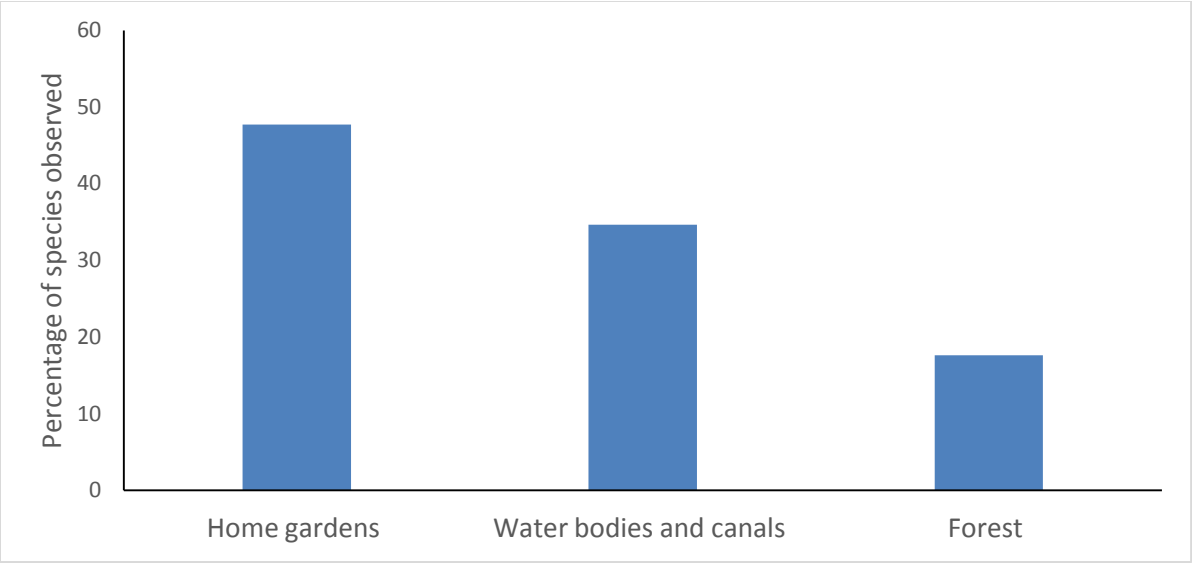

Figure 8.4. Mammalian diversity and in relation to habitat types

Table 8.1 . Relative abundance of mammals in the three different habitat types

Family	Species	National Conservation Status	Habitat type		
			Home gardens	Tank and Associate habitats	Disturbed forest
Cercopithecidae	*Macaca sinica* (Toque monkey)	LC	5	4	0
	Semnopithecus entellus (Hanuman langur)	LC	3	3	0
	Semnopithecus vetulus (Purple-faced lagur)	EN	0	0	1
Canidae	*Canis aureus* (Golden jackal)	LC	2	3	0
Cervidae	*Axis axis* (Spotted deer)	LC	0	3	0
	Rusa unicolor (Sambar deer)	NT	0	1	0
Elephantidae	*Elephas maximus* (Asian elephant)	EN	4	4	0

Herpestidae	*Herpestes edwarsii* (Grey mangoose)	LC	3	0	0
Felidae	*Felis chaus* (Jungle cat)	NT	0	1	0
	Prionailurus viverrinus (Fishing cat)	EN	0	0	1
	Prionailurus rubiginosus (Rusty spotted cat)	EN	0	0	1
	Panthera pardus (Leopard)	EN	0	0	1
Leporidae	*Lapus nigricollis* (Black naped hare)	LC	3	0	0
Lorisidae	*Loris lydekkerianus* (Slender loris)	NT	0	1	0
Muridae	*Bandicota indica* (Inidan bandicoot)	LC	4	0	0
Manidae	*Manis crassicaudata* (Pangolin)	NT	0	0	1
Pteropodidae	*Pteropus giganteus* (Indian flying fox)	LC	4	0	0
Suidae	*Sus scrofa* (Wild pig)	LC	4	0	0
Sciuridae	*Ratufa macroura* (Giant squirrel)	LC	4	1	0
Tragulidae	*Moschiola meminna* (Mouse deer)	LC	2	0	0
Ursidae	*Melursus ursinus* (Sloth bear)	EN	0	0	1
Viverridae	*Paradoxurus hermaphroditus* (Palm civet)	LC	3	0	0

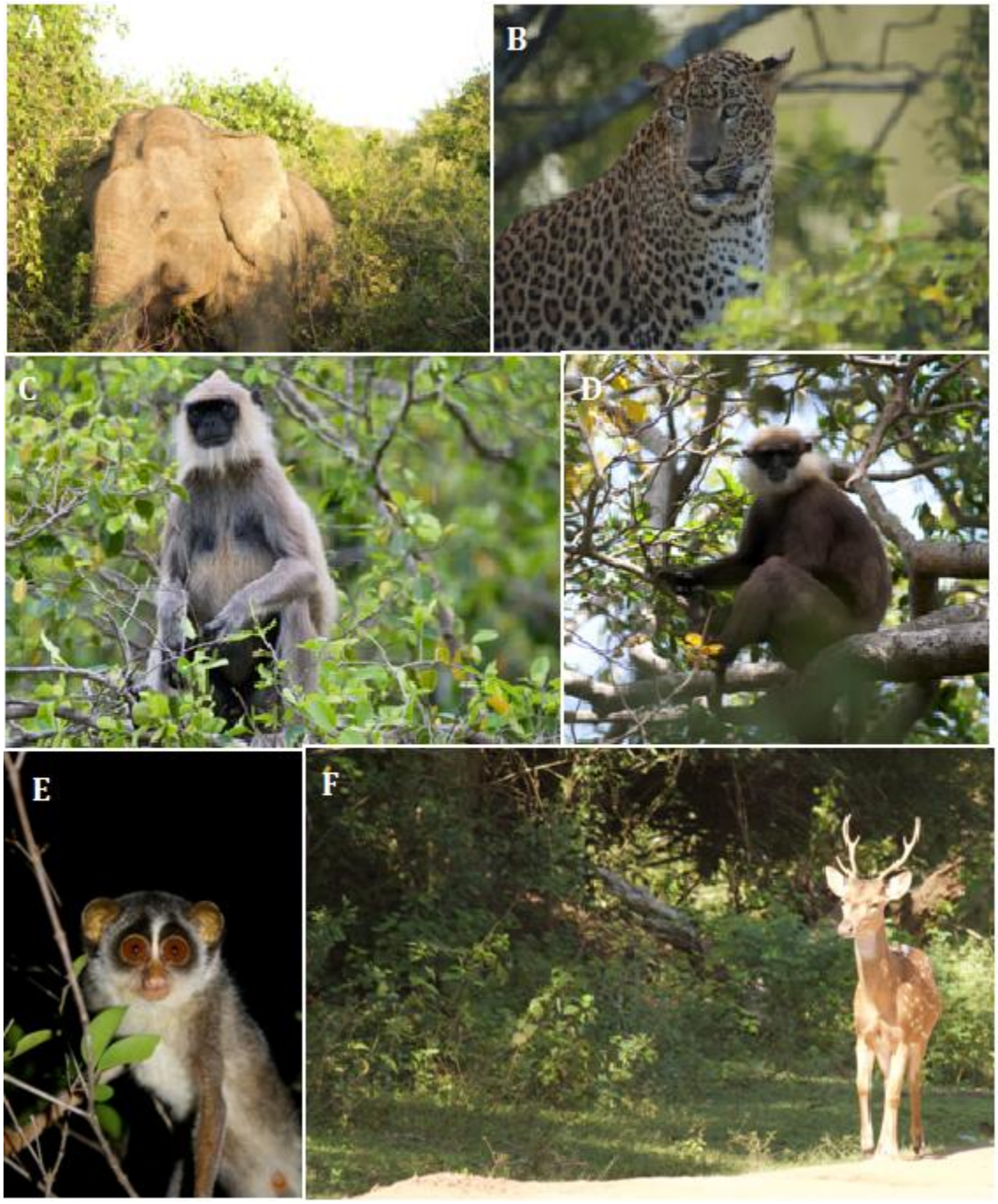

Figure 8.5. Some mammals recorded during the survey. A) Asian elephant, B) Leopard, C) Hanuman langur, D) Purple-faced langur, E) Slender loris and F) Spotted deer.

8.3.1.5 Attitudes towards conservation

A significant proportion of respondents were not aware of the need for conservation. Human-wildlife conflict was also common and a significant proportion of respondents were of the view that problem animals should be removed (Figure 8.6).

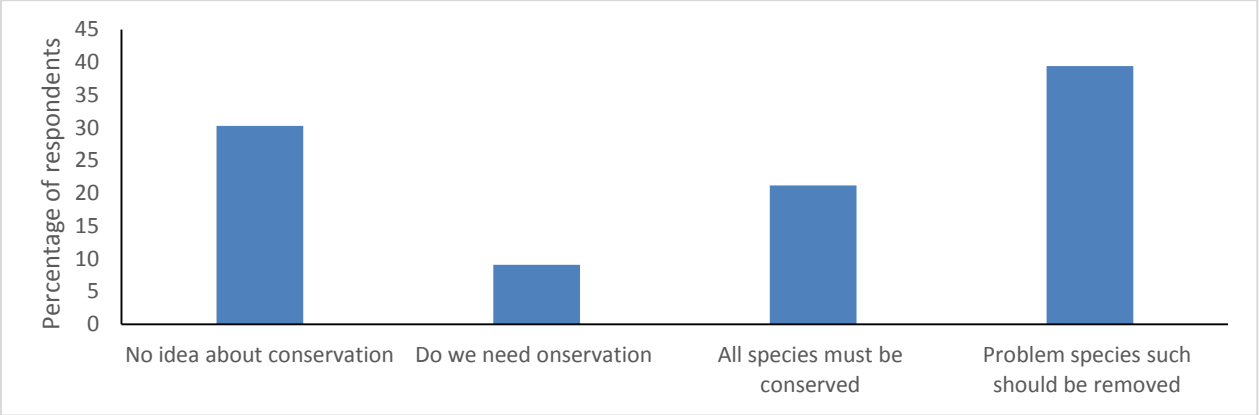

Figure 8.6. Attitudes towards conservation

8.4 Discussion

According to the observations, 3 species (*Macaca sinica*, *Semnopithecus vetulus*, *Moschiola meminna*) are endemic. Considering National conservation status of Sri Lankan mammals, surveying area consisted of 6 species of Endangered and 4 species of Near Threatened. *Ratufa macroura* (Grizzled giant squirrel) were recorded in home gardens and tank associated habitats. Most of the water bodies/streams within the selected localities at Galnewa –Palagala divisions were totally dry, therefore otter or its scats were not recorded. Except the Inidan bandicoot other species were not trapped during the survey.

8.4 References

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9.0 BUTTERFLY DIVERSITY ANALYSIS

9.1 Introduction

Butterflies and their larvae play important roles in ecosystem functioning, including nutrient cycling and pollination (Janzen, 1987; Schowalter, 2006). Determining of butterflies distribution and abundance mainly depend on the food plants (Kunte, 2000). Availability of larval food plants is of prime importance for having a breeding population in a given habitat (VaneWright, 1978) which mainly consist with secondary growths consisting of shrubs, herbs, creepers and saplings (Nimbalkar et al., 2010). Most adult butterflies found in tropical and subtropical regions are feed on nectar, ripe fruits, rotting fruits, exuded tree sap, mud carrion, and dung (Boggs and Jackson 1991; Krenn 2008).

Butterflies are one of the best studied groups of insects and they are highly sensitive to habitat or climatic changes. They plays an important role in ecosystems and their occurrence and diversity are considered as good indicators of health of the terrestrial biota (Kunte, 2000; Koh and Sodhi 2004) and offer a number of logistical advantages over other potential indicative taxa such as unlike other insect groups, many butterfly species can be easily identified in the field using field guides (Basset et al., 2011). Determination of butterfly populations is vital for the consistency in environmental conditions (Murphy and Weiss 1988).

In Sri Lanka, 247 species belong to 6 families of butterflies have been recorded of which 31 species are endemic and 84 are endemic subspecies (van der Poorten and van der Poorten 2016). Out of the recorded species, 99 species (including 22 endemics) are considered as threatened of which 21 species (including 5 endemics) are critically endangered, 38 species (including 10 endemics) are endangered and 40 species (including 7 endemics) are vulnerable (van der Poorten, 2012). According to van der Poorten (2012), in Sri Lanka, the distribution of butterfly fauna is determined by the climate, topography and the geology of the particular area and many butterfly species are generalists and occur in a range of climatic zones while few species display a restricted distribution.

9.2 Sampling Methodology

A visual encounter survey was used for data collection on butterfly in terrestrial ecosystems and waterholes and other aquatic habitats were surveyed using circular plot methods. Any other additional species encountered elsewhere within the area/habitats were also recorded. Nets were used for catch some butterflies and release them in to the same habitats after the identification. Butterfly associate plants were identified together with flora identification team.

9.3 Results

9.3.1 Overall Butterfly Diversity within the GN Divisions in Galnewa and Palagala

There were 57 species of butterflies belonging to five families and thirty nine genera have been recorded during the survey (Table 9.1). Nymphalidae showed the maximum species richness, comprising of 22 species (39%), followed by Pieridae (12 species, 21%), Papilionidae (10 species, 17%) and Lycaenidae (8 species, 14%) and Hesperiidae (5 species, 9%,). Out of them 14 were endemic sub species while the Red Helen (*Papilio helenus*), the Common caster (*Ariadne merione*) and the Banded Peacock (*Papilio crino*) were vulnerable species. And also Sri Lanka Lesser Albatross (*Appias*

Figure 9.1 Lesser Albatross

9.3.2 Butterfly diversity in different ecosystems

Out of the four ecosystems chosen the highest species richness of butterflies was recorded in tank associated ecosystems (53 species 93 %) while the least was recorded in home gardens (42 species, 74%). As for the Sri Lanka Lesser Albatross, Common Grass Yellow (*Eurema hecabe*), Plain Tiger (*Danaus chrysippus*), Common Tiger (*Danaus genutia*), Common Indian Crow (*Euplea core*), Mottled Emigrant (*Catopsilia pyranthe*), Forget-me-not (*Catochrysops Strabo*) and White four ring (*Ypthima ceylonica*), they were recorded as very common in all the habitats (Figure 9.2).

Figure 9.2 Tank ecosystem(A), Tank Associated (B), Home Garden (C), Disturbed forest (D)

9.3.3 Tank and Tank Associated Ecosystems

It was also found out that the population distribution of most of the butterflies was seen in the tanks and the tank associated areas was very high. Amongst the visited tanks a higher abundance of butterflies were recorded in Siyambalawa, Kumbukwava, Madhavachchiya and Mullannatuva tanks. In these tanks, Common Sailor (*Neptis hylas*), Tiny Grass Blue (*Zizula hylax*), Common Cerulean (*Jamides celeno*), Peocock Pansy (*Junonia almata*), Lemon Pansy (*Junonia lemonias*), Three Spot Grass Yellow (*Eurema blanda*), Small Salmon Arab (*Colotis amata*), and Leopard (*Phalauta phalauta*) were found in higher abundance while the other species were relatively low. In these ecosystems *Stachytarpheta jamaicensis*, *Lantana camara*, *Chromolaena odorata*, *Hibiscus lobatus* and *Tridax procumbens* were dominant plant species attract highest number of butterflies (Figure 9.3).

Furthermore, Red Helen (*Papilio helenus*) was only recorded in Peenawa tank while Grey Pansy (*Junonia atlites*) was recorded only in Nanwaththegama and Siyambalawa tanks and their associates. As for the Common Evening Brown (*Melanitis leda*) and Gladeye Bush Brown (*Mycalesis patina*), they were only recorded in (Figure 9.4) Siyambalawa, Kunchikulama and Pahalahabaravaththa tanks and associated respectively.

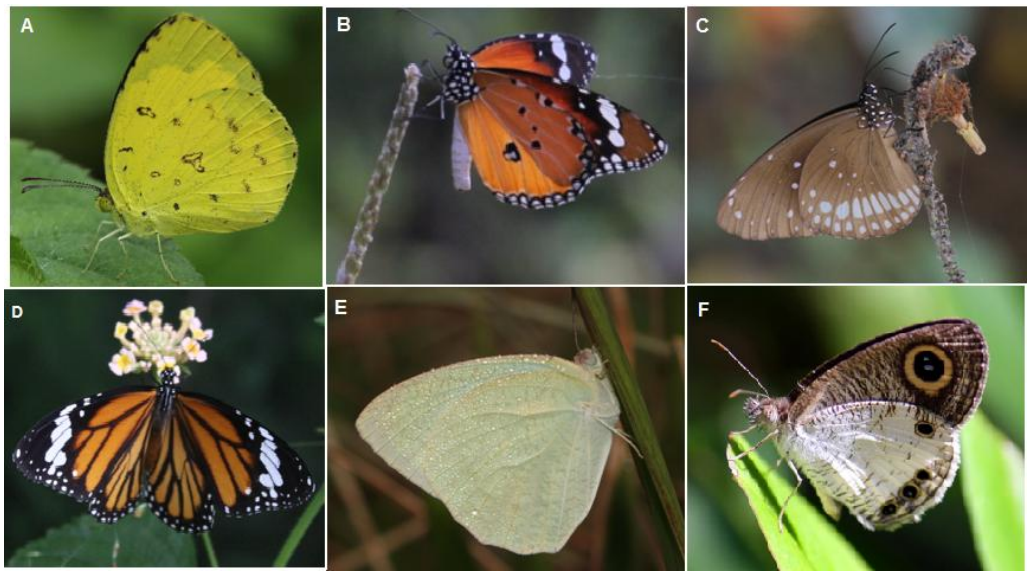

Figure 9.3 Butterfly species recorded in all ecosystems A: Common Grass Yellow (*Eurema hecabe*), B: Plain Tiger (*Danaus chrysippus*), C: Common Indian Crow (*Euplea core*), D: Common Tiger (*Danaus genutia*), E: Mottled Emigrant (*Catopsilia pyranthe*), F: White four ring (*Ypthima ceylonica*)

Figure 9.4. *Stachytarpheta jamaicensis* (Verbenaceae) (A), *Heliotropium indicum* (Boraginaceae) (B) *Tridax procumbens* (Asteraceae)(C), *Hibiscus micranthus* (Malvaceae) (D), *Lantana camara* (Verbenaceae) (E), *Chromolaena odorata* (Asteraceae) (F), *Calotropis gigantea* (Apocynaceae) (G) *Sida acuta* (Malvaceae) (H)

Vulnerable Banded Peacock (*Papilio crino*) was recorded in Kumbuk wewa, Musnowa ,Medawachchiya and Nanwaththegama tanks and associated only. The preference of butterflies for particular habitats is associated with the availability of larval host plants and adult nectar plants. The floras in tank ecosystems were mixed type with herbs and shrubs dominating the vegetation in the tropical climate. The study areas were dominated by plant species belonging to families Apocynaceae, Araceae, Asteraceae, Boraginaceae, Convolvulaceae, Euphorbiaceae, Fabaceae, Malvaceae, Rubiaceae, Verbenaceae, and grasses (Annex 9.7) which provide diverse habitat, food and breeding sites for butterflies. More than 50% of these species were invasive species.

Figure 9.5 Tiny Grass Blue (*Zizula hylax*) (A), Common Sailor (*Neptis hylas*) (B), Common Cerulean (*Jamides celeno*) (C), Peocock Pansy (*Junonia almata*)(D), Lemon Pansy (*Junonia lemonias*)(E), Three Spot Grass Yellow (*Eurema blanda*) (F), Small Salmon Arab (*Colotis amata*)(G), and Leopard (*Phalauta phalauta*)(H)

According to the survey conducted it is clear that Golden Angle (*Caprona ransonnettii*) Common Grass Dart (*Taractrocera maevius*) and Tropic Dart (*Potanthus confucine*) who belong to the family Hesperiidae were only recorded in Siyambalawa and kumbukwava tank associated areas (Figure 9.6)

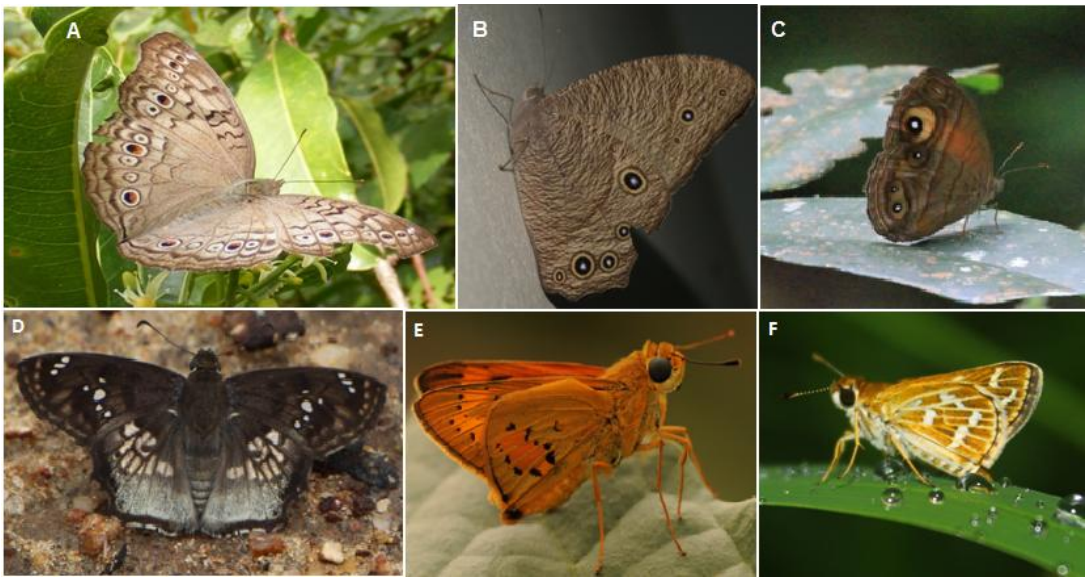

Figure 9.6 Grey Pansy (*Junonia atlites*)(A), Common Evening Brown (*Melanitis leda*) (B), Gladeye Bush Brown (*Mycalesis patina*) (C), Golden Angle (*Caprona ransonnettii*) (D), Tropic Dart (*Potanthus confucine*) (E), Common Grass Dart (*Taractrocera maevius*) (F).

9.3. 4 Home Gardens

When studying the data of the survey it has been identified that the species richness in home gardens were relatively low compared to the tanks, their associated areas and disturbed forest, but according to the data it is clear that the abundance of Jezebel (*Delias eucharis*) was relatively higher than the other species while the Common Sailor (*Neptis hylas*), the Lesser Grass Blue (*Zizula otis*), the Dark Grass Blue (*Zizula hylax*), the Tiny Grass Blue (*Zizula hylax*) and the Lime Blue (*Chilades lajus*) abundance were high compare to the other species. Even though the abundance of Jezebel (*Delias eucharis*) is in a such manner, the abundance of Blue Tiger (*Tirumala limniace*), Crimson Rose (*Pachliopta hector*), Striped Albatross (*Appias libythea*) and Common Gull (*Cepora nerissa*), was relatively low. The Chestnut Bob (*Lambrix salsala*) was only recorded in home garden while the Tropic Dart also recorded in these habitats (Figure 9.7). Most of the flowering plants (*Ixora* spp, *Murraya koenigii*, *Barleria prionitis* etc*)*, small shrubs and herbs (*Heliotropium indicum*, *Stachytarpheta jamaicensis,* were providing suitable habitats for breeding and feeding.

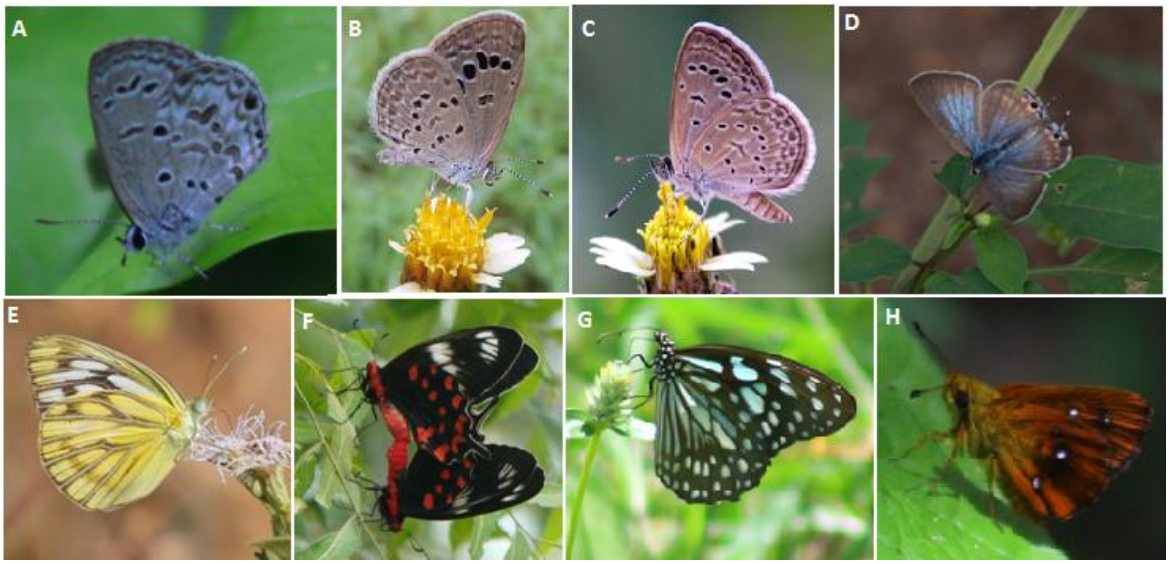

Figure 9.7 Lime Blue (*Chilades lajus*) (A), Lesser Grass Blue (*Zizula otis*) (B), Dark Grass Blue (*Zizula hylax*) (C), Forget -me-not (*Catochrysops Strabo*) (D), Common Gull (*Cepora nerissa*) (E), Crimson Rose (*Pachliopta hector*) (B), Blue Tiger (*Tirumala limniace*) (G) and Chestnut Bob (*Lambrix salsala*) (H)

9.3.5 Disturbed forests

Third highest species richness was recorded in this ecosystem. Except the most common species in four ecosystems Common Pierrot (*Castalius rosimon*), Red Pierrot (*Talicada nyseus*), Jezebel (*Delias eucharis*) and Common Sailor (*Neptis hylas*) were recorded as high abundance species. Different types of herbs such as *Tridax procumbens*, *Stachytarpheta indica*, *Hibiscus micranthus* and many grasses, shrubs like *Lantana camara*, *Chromolaena odorata*, *Ixora coccinea* etc and herbs such as *Croton hirtus*, *Heliotropium indicum*, *Stachytarpheta jamaicensis* etc. White Orange Tip (*Ixias Marianne*) and Psyche (*Leptosia nina*) were only recorded in this ecosystem (Figure 9.8) and vulnerable Common caster (*Ariadne merione*) also recorded.

Figure 9.8 Common Pierrot (*Castalius rosimon*), Red Pierrot (*Talicada nyseus*), Jezebel (*Delias eucharis*), Psyche (*Leptosia nina*), White Orange Tip (*Ixias Marianne*) and Common caster (*Ariadne merione*)

Table 9.1 List of Butterfly species recorded from the different ecosystems and their status and frequency

No	Family	Common Name and Scientific Name	Status	Red List Status	Frequency			
					T	TA	HG	DF
01	**Papilionidae**	*Graphium doson* Common Jay	Endemic subspecies	LC	2	2	0	0
02		*Graphium Agamemnon* Tailed Jay	Indigenous	LC	2	2	0	0
03		*Pachliopta aristolachiae* Common Rose	Endemic subspecies	LC	2	2	2	2
04		*Pachliopta hector* Crimson Rose	Indigenous	LC	2	2	1	1
05		*Papilio clyta* *Mime*	Indigenous	LC	2	2	0	0
06		*Papilio crino* Banded Peacock	Indigenous	VU	2	2	0	0
07		*Papilio demoleus* Lime Butterfly	Indigenous	LC	3	2	2	2
08		*Papilio helenus* Red Helen	Endemic subspecies	VU	1	1	0	0
09		*Papilio polymnestor* Blue Mormon	Endemic subspecies	LC	2	2	2	2
10		*Papilio polytes* Commom Mormon	Indigenous	LC	2	2	2	1
11	**Pieridae**	*Appias libythea* Striped Albatross	Indigenous	LC	2	2	1	1
12		*Appias galene* Sri Lanka Lesser Albatross	Endemic	LC	5	5	5	5
13		*Belenois aurota* Pioneer	Endemic subspecies	LC	2	2	2	1
14		*Catopsilia Pomona* Lemon Emigrant	Indigenous	LC	3	4	2	2
15		*Catopsilia pyranthe* Mottled Emigrant	Indigenous	LC	5	5	5	5
16		*Cepora nerissa* Common Gull	Indigenous	LC	0	1	1	1
17		*Colotis amata* Small Salmon Arab	Indigenous	LC	4	4	2	2
18		*Delias eucharis* Common Jezebel	Indigenous	LC	3	3	5	4

19		*Eurema hecabe* Common Grass Yellow	Indigenous	LC	5	5	5	5
20		*Eurema blanda* Three Spot Grass Yellow	Endemic subspecies	LC	4	5	5	3
21		*Leptosia nina* Psyche	Indigenous	LC	3	3	0	1
22		*Ixias Marianne* White Orange Tip	Indigenous	LC	0	0	0	1
23	**Nymphalidae**	*Acraea violae* Tawny Coster	Indigenous	LC	3	3	2	2
24		*Ariadne merione taprobana* Common caster	Endemic subspecies	VU	1	1	0	1
25		*Cethosia nietneri* Ceylon Lace Wing	Endemic	LC	2	2	0	1
26		*Danaus genutia* Common Tiger	Indigenous	LC	5	5	5	5
27		*Danaus chrysippus* Plain Tiger	Indigenous	LC	5	5	5	5
28		*Dophla evelina* Red Spot Duke	Endemic subspecies	LC	0	1	0	0
29		*Elymnias hipermnestra* Common Palmfly	Indigenous	LC	0	0	1	0
30		*Euplea core* Common Indian Crow	Endemic subspecies	LC	5	5	5	5
31		*Hypolimnas misppus* Danaid Eggfly	Indigenous	LC	0	2	2	2
32		*Junonia lemonias* Lemon Pansy	Endemic subspecies	LC	4	4	2	2
33		*Junonia atlites* Grey Pansy	Indigenous	LC	1	1	0	0
34		*Junonia iphita* Chocolate Soldier	Indigenous	LC	1	1	0	0
35		*Junonia almata* Peocock Pansy	Indigenous	LC	4	3	2	2
36		*Melanitis leda* Common Evening Brown	Indigenous	LC	1	1	0	0
37		*Mycalesis perseus* Common Bush Brown	Indigenous	LC	3	3	3	3
38		*Mycalesis patnia* Gladeye Bush Brown	Endemic subspecies	LC	1	3	2	1
39		*Neptis hylas* Common Sailor	Indigenous	LC	5	5	4	4
40		*Orsotriaena medus* Medus Brown	Indigenous	LC	3	3	3	1
41		*Parantica aglea*	Indigenous	LC	3	3	2	2

		Glassy Tiger						
42		*Phalauta phalauta* Leopard	Indigenous	LC	4	4	2	2
43		*Tirumala limniace* Blue Tiger	Indigenous	LC	2	2	1	1
44		*Ypthima ceylonica* White four ring	Indigenous	LC	5	5	5	5
45	**Lycaenidae**	*Castalius rosimon* Common Pierrot	Indigenous	LC	3	5	3	4
46		*Catochrysops Strabo* Forget-me-not	Indigenous	LC	5	5	5	5
47		*Chilades lajus* Lime Blue	Indigenous	LC	0	3	4	2
48		*Talicada nyseus* Red Pierrot	Indigenous	LC	1	1	3	4
49		*Zizula hylax* Tiny Grass Blue	Indigenous	LC	5	5	4	3
50		*Jamides celeno* Common cerulean	Endemic subspecies	LC	5	5	4	3
51		*Zizula hylax* Dark Grass Blue	Indigenous	LC	3	3	3	3
52		*Zizula otis* Lesser Grass Blue	Indigenous	LC	3	4	4	3
53	**Hesperiidae**	*Caprona ransonnettii* Golden Angle	Endemic subspecies	LC	0	1	0	0
54		*Lambrix salsala* Chestnut Bob	Indigenous	LC	0	0	1	0
55		*Potanthus confucine* Tropic Dart	Possibly Endemic	LC	0	1	1	0
56		*Taractrocera maevius* Common Grass Dart	Indigenous	LC	0	1	0	2
57		*Udaspes folus* Grass Demon	Indigenous	LC	0	0	1	0
Species Richness					44	53	42	43

9. 4 Discussion

Habitat destruction is perhaps the most important process that threatens butterflies as for most other biota. In the dry zone the most serious impact of illicit felling of some valuable timber plants which were dominant butterfly larval food plant. Another recent trend that seems to be taking hold in the dry zones is the lopping of branches of *Syzygium cumini* and *Drypetes sepiaria* (also *Manilkara hexandra* though not a butterfly related plant) for easy harvesting of their fruit. *Syzygium cumini* is an important larval food plant for several species of lycaenids; *Drypetes sepiaria* is used exclusively in the dry zone by the endemic Lesser Albatross.

Introduced invasive plants competitively displace native flora and are a major threat to all biota. *Lantana camara* is an excellent nectar source for many species of butterflies, it aggressively displaces the native vegetation in many areas diminishing the supply of many larval food plants and nectar sources, particularly those of meadow species (e.g. *Lesser grass blue Zizina otis, Dark grass blue Zizeeria karsandra,* and Tiny grass blue - *Zizula hylax*). *Chromolaena odorata* s a good source of nectar for butterflies, it displaces the native vegetation such as *Dipteracanthus prostrates* and, which are used as larval food plants. The impact of domesticated grazing herbivores is two-fold: 1) light grazing often improves habitats for meadow species by keeping more aggressive vegetation in check by removing competition for light and nutrients and allowing the vegetation on which the butterflies depend to survive and flourish; 2) however, over-grazing and the excessive trampling of vegetation by domesticated animals such as cattle and buffalo are very destructive to butterfly habitats since it completely eliminate or diminishes all sources of larval food and adult nectar sources to an extent that makes butterfly populations non-sustainable.

9.5. Conservation Priorities

Apart from being one of the most prominent biodiversity indicators butterflies also act as our native gardener for their dependence on indigenous plants for completion of the life cycle. Therefore, an abundance of butterflies usually indicates a healthier ecosystem

It is important to specify conservation measures at the subspecies level as well as at the species level because of the high level of endemicity in the butterfly fauna.

Use of pesticides and weedicides. Education and awareness programs through extension workers in the Department of Agriculture

Grazing. Free grazing must be disallowed by law if the environment is to be maintained at a reasonable level of biodiversity, particularly in areas that are considered ecologically sensitive (Tank associated habitats)

Implement site-specific conservation action plans for butterfly sensitive areas including conservation of plants used as larval food plants

Encourage the development and maintenance of butterfly friendly gardens in schools, homes, hotels, public spaces, hospitals and parks. Site specific butterfly posters can prepare by encouraging students and these posters can be used for the awareness programs.

9.6 References

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9.7 Annex

Feeding plants of Butterflies

No.	Name	Family	Sinhala Vernacular Name
1	*Calotropis gigantea*	Apocynaceae	Wara
2	*Chromolaena odorata*	Asteraceae	Podisingho-maranga, Danapathi-nattan
3	*Crotalaria verrucosa*	Fabaceae	Nil-andana-hiriya, Yak-bairiye
4	*Croton bonplandianus*	Euphorbiaceae	-----
5	*Croton hirtus*	Euphorbiaceae	Gan-veda, Val-tippili
6	*Evolvulus alsinoides*	Convolvulaceae	Visnu-kranti
7	*Heliotropium indicum*	Boraginaceae	Ddimi-biya, Et-honda, Et-setiya
8	*Hibiscus lobatus*	Malvaceae	-----
9	*Hibiscus micranthus*	Malvaceae	Bebila
10	*Hibiscus vitifolius*	Malvaceae	Maha-epala
11	*Ixora coccinea*	Rubiaceae	Ratambala, Rath-mal
12	*Lantana camara*	Verbenaceae	Ganda-pana, Katu-hinguru, Rata-hinguru, Ton-kinna
13	*Lasia spinosa*	Araceae	Engili-kohila, Kohila, Maha-kohila
14	*Stachytarpheta indica*	Verbenaceae	Nil-nakuta
15	*Stachytarpheta jamaicensis*	Verbenaceae	Balu-nakuta, Rata-nil-nakuta
16	*Tridax procumbens*	Asteraceae	Kurunegala-daisy

10.0 DRAGONFLY DIVERSITY ANALYSIS

10.1 Introduction

Dragonflies and damselflies are among the most attractive creatures on earth belonging to the most popular insect order-Odonata. These are observed near the ponds, lakes, rivers, ditches and all over the marshy places. Dragonflies (suborder-Anisoptera) have broad head with confluent separated eyes. Wings are dissimilar; hind wings are broadly dilated at base and differ in venation from fore-limbs.

Order Odonata is comprised of three distinct suborders: Anisozygoptera, Zygoptera and Anisoptera. Anisozygoptera holds only the extant genus *Epiophlebia* which is distributed in Japan, China and the Himalayan region. The other two suborders are far more diverse and have worldwide distribution. Suborder Anisoptera is consisting of the members of damselflies whose bodies are much delicate and smaller in size.

True dragonflies belong to the suborder Anisoptera who are generally larger; robustly build and their compound eyes cover almost the entire head (Bedjanic. *et al*, 2014). Dragonflies are among the most significant organisms in the systems that are under threat, and are therefore important focal organisms in contemporary conservation biology. Their role is as top predator for other invertebrates, as well being food themselves for vertebrates (Samways, 2008). Many species of odonates that inhabit agro ecosystems play a crucial role in controlling pest populations and can be considered as pollution indicators.

Currently, 120 Odonate species have been identified in Sri Lanka of which 55 are Zygopterans belonging to 8 families and 65 are Anisopterans belonging to 4 families (MOU, 2012, IUCN, 2007). This contains 57 endemic, 13 critically endangered, 5 endangered and 2 vulnerable species (IUCN, 2010) making the Odonate fauna in Sri Lanka a very threatened insect group (Bedjanic, 2004).

10.2 Sampling Methodology

The sample areas were mainly confined to habitats associated with aquatic environments because a major part of odonate's lifecycle is spent in aquatic habitats. Visual encounter survey methods were used associating with general area surveys, line transects and opportunistic observations. All captured specimens were examined carefully and recorded before being released at their capture site without injury.

10.3 Results

10.3.1 Overall Dragonfly Diversity within the GN Divisions in Galnewa, Ipalogama and Palagala

A total of 738 individual dragonflies and damselflies belonging to 5 families 26 genera and 33 species were observed during the period of the survey. Majority of species belong to the family Libellulidae (26 species) and one species each recorded from families Chlorocyphidae, Platycnemididae and Gomphidae while four species recorded from family Coenagrionidae. Among recorded species, Sri Lanka Orange faced Sprite (*Pseudagrion rubiceps*), Sri Lanka Adams Gem (*Libellaga adami*) and Sri Lanka Stripe headed Threadtail (*Prodasineura sita*) ((Figure 10.1) were endemic to Sri Lanka. Sri Lanka Adams Gem and Sri Lanka Stripe headed Threadtail were only recorded in Kala Oya riparian habitat. Among the recorded species, 24 species were in the category of Least Concern (LC), 6 in the Near Threatened (NT) and 3 species in the Vulnerable (VU) category (IUCN 2012).

Figure 10.1 Recorded endemic species during the survey ; Sri Lanka Orange faced Sprite (*Pseudagrion rubiceps*) female(A), Sri Lanka Adams Gem (*Libellaga adami*)(B), Sri Lanka Stripe headed Threadtail (*Prodasineura sita*) (C)

Species richness was high in three tanks in Galnewa area while the lowest was in Palagala due to lack of water in several tanks. In Siyambalawa and Medawachchiya tanks recorded highest abundance of dragonflies. Asian Slim and Asian Groundling were the most dominant in these tanks.

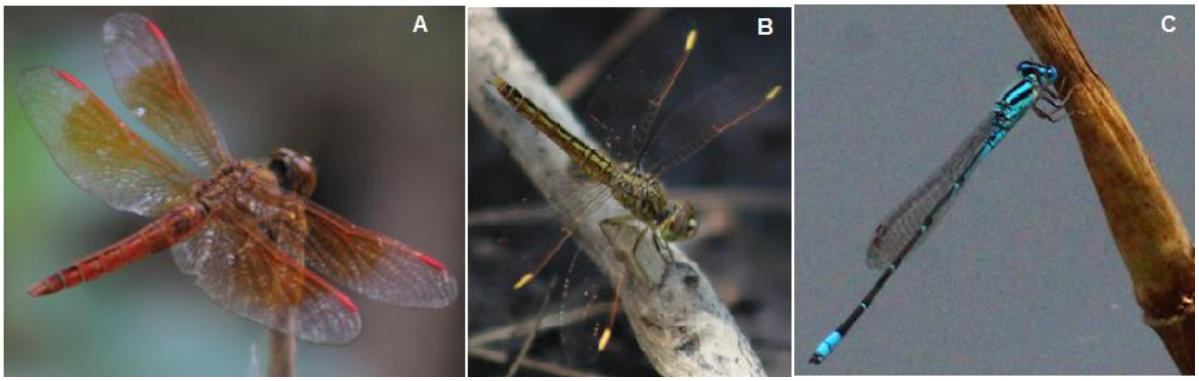

Figure 10.2 Most dominant dragonflies in Siyambalagamuwa wewa and Medawachchiya wewa. Asian Groundling Male (A) Asian Groundling Female (B), Asian Slim(C)

A total of 185 individuals from 25 species were recorded from Medawachchiya tank. Asian Slim was the most abundant species while Keyhole Glider and Foggy wing Twister were recorded rarely. Second highest dragonflies that are 136 individuals were recorded from Siyambalagamuwa tank. Most abundant species was Asian Pintail. Light tipped Demon was the lease recorded species in this tank. Amber winged Glider (*Hydrobasileus croceus*) and Keyhole Glider (*Tramea basilaris burmeisteri*) were recorded only in Medawachchiya tank while Black tipped Percher (*Diplacodes nebulosa*) was recorded only in Kumbuk wewa and Medawachchiya tank only. The Wandering Glider (*Pantala flavescens*) was recorded only Palugollawa and Kunchikulama tanks. All these species were recorded rarely (Table 10.1).

The Elusive Adjutant (*Aethriamanta brevipennis brevipennis*), Blue Sprite (*Pseudagrion microcephalum*), Blue Percher (*Diplacodes triviallis*), Light tipped Demon (*Indothemis carnatica*), Restless Demon (*Indothemis limbata sita*), Pruinosed Bloodtail (*Lathrecista asiatica*), Asian Skimmer (*Orthetrum glaucum*), Green Skimmer (*Orthetrum Sabina*), Foggy winged Twister (*Tholymis tillarga*), Sociable Glider (*Tramea limbata*) and Scarlet Basker (*Urothemis signata signata*) were the rare species found in tank ecosystem (Table 10.1).

Figure 10.3 Scarlet Basker (*Urothemis signata signata*)(A: male and B: female), Blue Sprite (*Pseudagrion microcephalum*)(C: male and D:female), Elusive Adjutant (*Aethriamanta brevipennis brevipennis*)(E), Blue Percher (*Diplacodes triviallis*) (F: male and G: female), Asian Skimmer (*Orthetrum glaucum*)(H), Green Skimmer (*Orthetrum Sabina*) (I), Pruinosed Bloodtail (*Lathrecista asiatica*) (J), Light tipped Demon (*Indothemis carnatica*)(K), Dancing Dropwng (*Trithemis pallidinervis*)(L),Restless Demon (*Indothemis limbata sita*) (M), Foggy winged Twister (*Tholymis tillarga*)(N), Sociable Glider (*Tramea limbata*)(O) and Crimson Dropwing (*Trithemis aurora*)(P).

Dragonflies are one of the salient and a relic group of insects whose fossil records dates back to the Permian era 230-280 million years ago (Bedganic , *et al*., 2014). These ancient fliers have ability to be successfully thrived in a vast range of habitats because of their striking adaptations. Due to their high diversity and behavioral patterns, they have drawn the attention, especially in the prospects of ecology.

10.4 Discussion

Majority of dragonflies were observed in sub littoral zones of the tanks. Asian groundlings were the most abundance species in this ecosystem. Some species only restricted to some habitats such as Sri Lanka Adams Gem (*Libellaga adami*) and Stripe-headed Threadtail (*Prodasineura sita*) recorded only in Kala Oya and rocky areas inhabited by the territorial species like Sociable glider (*Trameam limbata*). Species richness was reduced with the vegetation and environmental condition. Abundance of Blue Sprite, endemic Sri Lanka Orange faced Sprite, Elusive Adjutant, Blue Percher, Black tipped Percher, Asian and green Skimmers were very low and recorded in very few tanks due to destruction of the habitats around the tanks. Variegated Flutterer, Oriental Scarlet and Paddy field Parasol were recorded paddy fields as well. The following table displays areas with high species richness from all tanks surveyed.

10.5 References

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Table 10.1. List of Dragonfly species recorded from the different ecosystems and their status and frequency

Family	Species Name	Conservation status	Individual numbers	Frequency
Coenagrionidae	*Aciagrion occidentale* Asian Slim	VU	102	5
	Pseudagrion microcephalum Blue Sprite	LC	7	1
	Pseudagrion rubiceps Sri Lanka Orange faced Sprite*	LC	5	1
	Ceriagrion coromandelianum Yellow Waxtail	LC	16	2
Chlorocyphidae	*Libellaga adami* Sri Lanka Adams Gem*	VU	2	
Platycnemididae	*Prodasineura sita* Sri Lanka Stripe headed Threadtail*	LC	2	
Gomphidae	*Ictinogomphus rapax* *Rapacious* Flangetail	LC	42	4
Libellulidae	*Acisoma panorpoides* Asian Pintail	LC	56	4
	Aethriamanta brevipennis brevipennis Elusive Adjutant	LC	8	1
	Brachythemis contaminate Asian Groundling	LC	108	5
	Bradinopyga geminate Indian Rockdweller	LC	28	3
	Brachythemis sobrina Sombre Lieutenant	LC	28	3
	Crocothemis servilla servilla Oriental Scarlet	LC	62	4
	Diplacodes triviallis Blue Percher	LC	10	1
	Diplacodes nebulosa Black tipped Percher	LC	4	1
	Hydrobasileus croceus Amber winged Glider	NT	2	1
	Indothemis carnatica	NT	5	1

	Light tipped Demon			
	Indothemis limbata sita Restless Demon	NT	9	1
	Lathrecista asiatica Pruinosed Bloodtail	NT	11	1
	Neurothemis intermedia intermedia Paddy field Parasol	LC	33	3
	Neurothemis tulia tulia Pied Parasol	LC	26	3
	Orthetrum glaucum Asian Skimmer	LC	7	1
	Orthetrum Sabina Green Skimmer	LC	8	1
	Pantala flavescens Wandering Glider	LC	2	1
	Potamarcha congener Blue Persuer	LC	10	1
	Rhodothemis rufa Spine legged Redbolt	NT	32	3
	Rhyothemis variegata variegate Variegated Flutterer	LC	49	4
	Trithemis aurora Crimson Dropwing	LC	15	2
	Tramea basilaris burmeisteri Keyhole Glider	VU	1	1
	Tholymis tillarga Foggy winged Twister	LC	9	1
	Tramea limbata Sociable Glider	LC	10	1
	Trithemis pallidinervis Dancing Dropwing	NT	23	3
	Urothemis signata signata Scarlet Basker	LC	10	1
Total Number of individuals in all tanks			738	
Species Richness in all tanks			33	

11.0 CONCLUSIONS AND RECOMMENDATIONS

This biodiversity baseline survey focuses on pockets of unprotected areas that do in fact require protection through proper legislation.The purpose of conservation is to provide the appropriate habitat and resources to maintain stable populations into the future. Conservation is an active process that requires an integrated approach. Most of the time conservation targets basically focus only the flora and fauna and ignore the social aspects of community who lives in the vicinity of the important ecological zones.

11. 1 Conservation Issues &Threats for each Taxonomic Group Surveyed

Excessive usage of agro-chemicals and fertilizer

Many households and farmers indicated that they used agrochemicals as fertilizer, weedicides and pesticides in their cultivations and homegardens. Application of agrochemicals that are toxic to Herpetofauna and their' prey may be a major threat to these amphibians and reptiles living anthropogenic habitats of the region. Further destroy the feeding plants of butterflies and egg laying substratums.

Siltation of water ways and wetlands

According to the socio economic survey conducted in these region villagers stated that 90% of paddy fields cannot be ploughed due to lack of water. Most of the tanks filled with silt and reduce there capacity. Reason was illegal cultivation in uppercatchemnt areas of the tanks.

Flora

Invasive Species

Invasive Alien Species (IAS) of plants recorded from the survey sites account to 14. They can be characterized into three groups, *viz.* aquatic and amphibious, terrestrial herbaceous and shrubs, and woody perennial trees or treelets as listed in the Table 111. For further details, refer the Chapter 3.

Table 11.1: Invasive Alien Species (IAS) of plants recorded during the survey

No.	Name	Family	Common English Name
Aquatic and amphibious plants			
1	*Ceratophyllum demersum*	Ceratophyllaceae	Hornwort, Coontail
2	*Eichhornia crassipes*	Pontederiaceae	Common Water Hyacinth
3	*Hydrilla verticillata*	Hydrocharitacea e	Water-thyme
4	*Ipomoea aquatica*	Convolvulaceae	Kangkong
5	*Limnocharis flava*	Alismataceae	Yellow-velvetleaf

6	*Ludwigia* spp.	Onagraceae	Water-primrose
7	*Salvinia adnata* (=*Salviniamolesta*)	Salviniaceae	Giant salvinia
8	*Typha angustifolia*	Typhaceae	Lsser-bulrush
Herbaceous plants and shrubs (terrestrial)			
9	*Chromolaena odorata*	Asteraceae	Siam weed, Devil weed
10	*Imperata cylindrica*	Poaceae	Cogon grass, Kunai grass
11	*Lantana camara*	Verbenaceae	Common Lantana
12	*Megathyrsus maximus* (=*Panicum maximum*)	Poaceae	Guinea grass
Woody perennial trees or treelets			
13	*Leucaena leucocephala*	Fabaceae	Ipil-Ipil, White-leadtree
14	*Parkinsonia aculeata*	Fabaceae	Parkinsonia

Invasion of alien plant species (IAS) in the aquatic ecosystems can be highlighted as a major conservation issue for the survival of indigenous and endemic macrophytes. Other than that, isolated local invasions of herbaceous and shrubby plants and woody perennial trees/treelets in some areas are also worth to highlight. However, most of the cases are at initial stages and can be control further spreading with minimal management practices, except Parkinsonia invasion. It is at a critical phase. Over exploitation of flora is at moderate level, as it not very noticeable. However, removal of relatively large woody perennials from adjacent disturbed forest patches for temporary constructions was evidenced during the survey.

Conservation priorities on flora have been discussed in details in the Section 4.4. In addition to them, the plantation of woody perennials [especially *Terminalia arjuna* (Kumbuk), *Madhuca longifolia* (Mee), *Manilkara hexandra* (Palu), *Drypetes sepiaria* (Weera), Diospyros ebenum (Kaluwara) and other *Diospyros* spp. of the region] in the suitable locations is recommended and the priority is emphasized, with immediate effect.

Fish

Although the fish tend to survive during the peak dry seasons in North Central province, the pollution due to anthropogenic activities significantly affect the survival of fish in the tanks. (Threats to ichthyofauna discussed in Chpater 5) Use of illegal fishing gears such as small mesh size, tangos nets should be prohibited through organized farmer socities. Dumping of shampoo packets, soap wrappers etc. should be prevented by educating the community of the village particularly residents surrounding the tanks.

Herpatofauna

Though the anthropogenic habitats surveyd in this study indicated a high diversity of Herpetofauna, only three species observed in survey were threatened with extinction. Similarly,

only a very few significant threats to the herpetofauna were observed from the survey area. As evident by the results of the survey, certain plantations (i.e. Banana) and densely vegetated home gardens can serve as important secondary habitats for Herpetofauna. However, certain practices can be harmfull for most of these species in secondary habitats. Clearing of vegetation in home gardens was a major threat to most species of Herpetofauna. Densely planted home gradens provide humid environments for many species of Herpetofauna especially amphibians. Clearing of vegetation removes the canopy exposing the Herpetofauna to the sun, which leads to desiccation and predation. Leaf litter accumulated in most home gardens and plantations are ieal refugia for many species of litter dwelling Herpetofauna. Clearing the vegetation may also remove the leaf litter layer in these habitats putting the Herpetofauna at risk of drying and predation. At the same time, most villagers burn the decaying leaf litter in home gardens killing the Herpetofauna unknowingly. Simillarly, application of agrochemicals that are toxic to Herpetofauna and their' prey may be a major threat to these amphibians and reptiles living anthropogenic habitats of the region. Many households and farmers indicated that they used agrochemicals as fertilizer, weedicides and pesticides in their cultivations and homegardens. Road kills may pose a significant threat to many species of Herpetofauna as we observed several road kills especially after rains. Poacing of certain species such as land monitors (*Varanus bengalensis*) and terrapins (i.e. *Lissemys ceylonensis*, *Melanochelys trijuga*) and crocodiles (*Crocodylus palustris*) for meat could be a problem. However, we did not observe any of the above. Another, major issue is killing snakes due to fear. Certain species of amphibians especially tree frogs (Polypedates spp.) face the same issue, as many villagers believe that the urine of these frogs can cause skin diseases. Thus, most of these threats can be minimzed by awareness programmes that educate the residents of the area on the importance of Herpetofauna and conservation and to irradicate misconceptions about them.

Avifauna

Prolonged droughts leading to reduction in most of the waterbirds in the tank ecosystem. Siltation of the tanks leads to reduction of water holding capacity and diving birds surrounded to big tanks due to lack of food in small tanks. Some tanks in Palagala division totally dried and inhabit by other animals rather than birds. For safe operation of tanks with siltation free tank bed it is required to keep spillway channels free of debris and bund free of trees and brushes. Some tanks fully covered with Reed plants and provided better habitats for some grain eaters. Example Peenawa tank in Palagala division covered with many *Cypreracea* species which dominated by Munias (Figure 11.1 A and B). Some tanks utilized by cattles (C) and some covered with invasive species (D) and lack of habitats for water birds.

The survey reveals the presence of a rich avifaunal diversity within the Galnewa-Palagala DS including fewnationally and globally threatened species. However, their survival is threatened by many anthropogenic as well as climate change related issues. Espescially, in Galnewa DS rich with both aquatic and terrestrial birds. Therefore inclusion of these sites as IBAs is recommended and also continuous monitoring of the bird populations should be undertaken. Attention should be given to maintain adequate tree cover consisting of tree species required

for feeding and nesting requirements, while when allocating water, the importance of wetlands for maintaining the rich biological resources should kept in mind. Main threats include forest clearing for Chena cultivation and use of high concentrations of agrochemicals that ended in the tank systems.

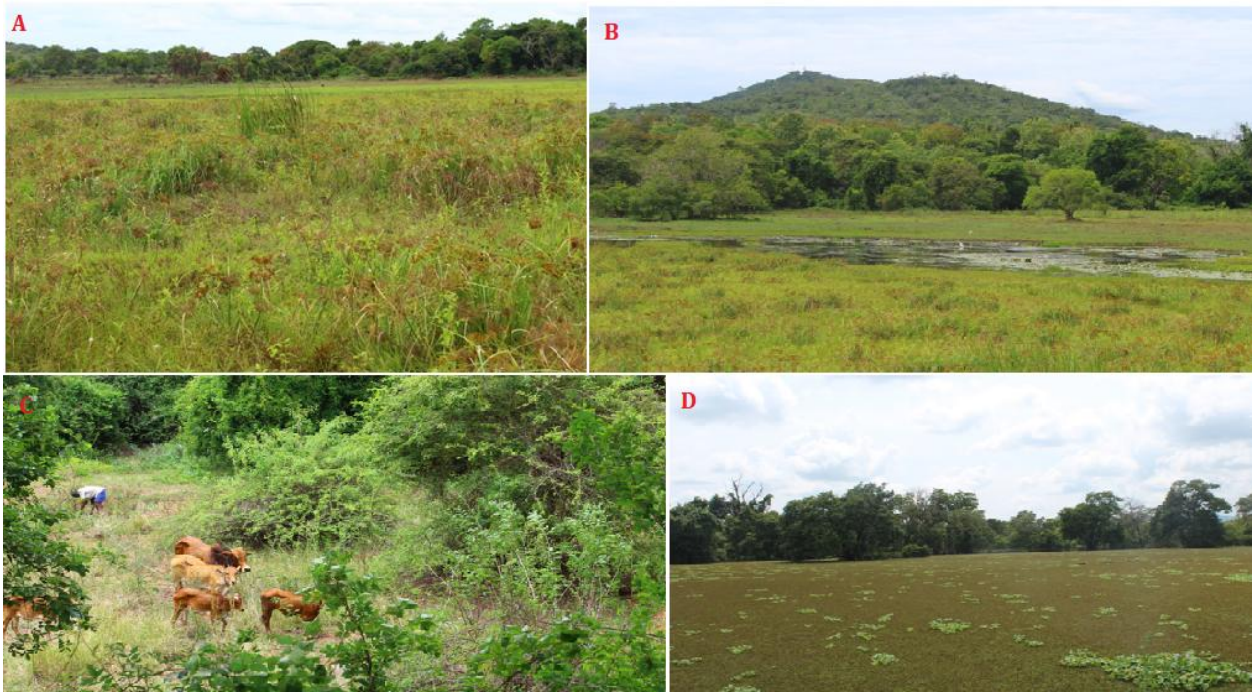

Figure 11.1 Peenawa tanks dominated by Cyperacea species (A and B), Munhena tank provided grazing ground for the cattels (C) and Mee gas wewa cover with invasive species (D)

Mammals

Attempts should be made to educate residents of the importance and the benefits of conservation that could accrue to their communities. In addition, efforts should be made to minimize-human wildlife conflict through consultation with all stakeholders (Local residents, DWC, agriculture officers and local and regional planners). Furthermore, efforts should be made to ensure that compensation mechanism in place to alleviate losses from human-wildlife conflict operate efficiently.

Butterflies

Habitat destruction and fragmentation is one of the primary threats to butterflies, resulting in the removal of critical species resource bases and changes in the climate required for the survival of butterfly populations, creating pressure on habitats. These also include illegal logging of trees for firewood, timber and other uses that threaten their food and breeding sites. Spread of invasive plant species that displace native flora and pose a major threat to all biota.

However, establishment of monocrop agricultural plantations including the use of pesticides and weedicides has direct and indirect impacts by killing whole species populations or destroying larval host plants resulting in larval death. Indirect impacts on populations of butterflies include Soil depletion affecting larval food plants and the production of nectar plants. The problem of over-grazing and excessive vegetation trampling by domesticated animals such as cattle and buffalo is very damaging to butterfly ecosystems as it destroys or diminishes all food sources of larva and adults.

Dragonflies

Eutrophication of water bodies that serve as breeding grounds for dragonflies and as a habitat for larvae to grow have negative impacts on the development of Odonata larval stages. Other weather phenomena that have stemmed from climate change such as flooding also destroys larval stages and habitats. The growth of invasive plant species such as *Eichhornia* spp. also alters habitat requirements, with indirect impacts on the dragonfly lifecycle. Odonates have been used as biological indicators of water quality and environmental quality for conservation work due to their sensitivity towards environmental changes. Salvinia and Pistia alter habitats which in turn affect their requirements. Addition of agrochemicals and insecticides to water bodies inhabited which affect Odonata larvae and freshwater fauna consumed by the larvae.

Critical Species

Critical Species can be defined as any species that is, (i) Critically Endangered or Endangered (ii) Endemic and (iii) or a restricted range species. The table below provides a summary of critical species found in the Galnewa-Palagala DS. By the given definition, the table indicates the importance of different clusters in terms of taxonomic and conservation considerations. Refer ,Table 4.3. , Table 5.3, Annexture 6.1, Annexure 7.1, Table 9.1, Table 10.1.

Constraints of the field survey

A field survey was carried during the drought period which made it difficult to monitor animal activity which ended in low counts in species diversity and abundance while a three-month period also wasn't sufficient to cover the entire area and consequentially adequate sampling could not be done.

Also there were access issues in some sampling locations due to a lack of notable roads. In addition, several illegal trap guns along the foot pathways made an unsafe situation in visiting the sampling sites. There was also the risk of being attacked by wild elephants during sampling. In some cases problems arose due to the villagers not cooperating which made it frustrating in finding viable roads, especially which led to catchment areas of tanks.