

**Pollinator Conservation Action Plan for Sri Lanka**  
**Prepared for the**  
**Biodiversity Secretariat of the Ministry of Environment.**  
**(Draft - only for discussion)**

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Respectfully submitted for discussions and comments,

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**Summary:** The subject of pollination ecology has been recognized by some of the forefathers of modern biology. However, up until recent times it received very little attention. Now (since 1992 UN Earth Summit, Rio de Janeiro) it is recognized as an integral part of natural environment, environment conservation and ecosystem health. Even though there is a shortage of modern empirical data on the importance of “pollination and pollinators”, the traditional knowledge and practices of people who were totally dependent on natural biological resources of their environment clearly suggest their dependency on flower visiting insects for their survival. The “Pollinator Conservation Action Plan” (PCAP) is for the conservation and perhaps for the utilization of pollinators in our natural environment for the posterity of this nation. Here an attempt is made to direct the state policy towards the conservation and utilization of these pollinating animals who do a yeoman service to mankind and for the maintenance of natural environment where both humans and pollinators live together in harmony.

## 1. Introduction

In tropics the diversity of plants are at its peak and in Sri Lanka in particular we have over 4300 species of flowering plants. Naturally or otherwise there exist a great abundance of plants as highly mixed plant populations where very commonly the neighbouring plants happen to be of different species. This simply means that each plant is surrounded by other plants of different species. Therefore passive or unprompted pollination mechanisms such as “wind pollination” may not be effective enough to transfer pollen to the stigma of another flower of the same species to achieve effective pollination and fertilization for viable seed production to ensure continuation of the existence and survival of the plant species in question. Then the most effective mechanism to overcome the barrier for pollen transfer or transport is to utilize animals that are highly mobile. Here comes the importance of animal or active pollen carriers in maintaining our ecosystem.

Therefore the pollinators provide an essential ecosystem service that result in the out-crossing and sexual reproduction of many plants. This process of pollen transfer benefit the society by increasing food security and improving livelihoods by the role that they play in conserving biological diversity in agricultural and natural ecosystems. Reduced agricultural yields and deformed fruits often result from insufficient pollination rather than from a deficiency of other agricultural inputs or agronomic practices. The visual clues of insufficient pollination are more subtle than in agriculture, but the consequences can be as severe as the local extinction of a plant species, a noticeable decline in fruit and seed eating animals, the loss of vegetation cover and ultimately, if keystone species are involved, the demise of healthy ecosystems and their services.

The Action Plan on Sri Lankan Pollinators (Pollinator Conservation Action Plan- PCAP) the document which promote the conservation and utilization of pollinators in faunal groups of insects, birds and mammals. Many fruits and vegetable crops are dependent on insect pollination of which bees are the most prominent group. Bees specifically evolved for the pollination of flowering plants soon after the advent of flowering plants about 40million years ago. Among bees, honey bees play even a more effective role as they being large colonies of pollinators concentrated at a location to provide the pollination service to flowering plants that exist within their foraging range. Based on floral visits, pollen carriage and special behaviour at flowers, 148 bee species in 38 genera and 4 families has being recorded from Sri Lanka. The floral hosts of the documented bees comprise 167 species in 115 genera and 44 plant families in the island, which may be far below the actual numbers. Further, this list will greatly expand if one considers the four species of honeybees in Sri Lanka, as they are being generalized and opportunistic flower visitors. Other than the bees, butterflies like flag species, ants, beetles, wasps, moths, flies, midges, bats, sun birds, flower peckers, snakes (possible), civets (possible) act as the pollinators. However the many species on pollination has not been adequately documented due to limited research emphasis and incentives for conservation and sustainable use of pollinators.

In the mid 1990s, scientists and agriculturists around the world were concerned that a worldwide decline of pollinator diversity was occurring. By this time there were enough literature available on the importance of biodiversity conservation and importance of pollination ecology (Faegri & Pijl 1979, Futuyama 1979, Wilson & Peter 1988). The development of the **Convention on Biological Diversity (CBD)** work program approved by Decision III/11 on the “Conservation and Sustainable use of Agricultural Biological Diversity” which identified pollinators as one of the initial priorities. In 2000, the 5<sup>th</sup> meeting of the **Conference of Parties (COP)** of the CBD to establish an international initiative for the Conservation and Sustainable use of Pollinators referred to as the **International Pollinators Initiative (IPI)**. COP-V/5 requested the development of a Plan of Action for the IPI which built on recommendations from the Sao Paulo Declaration on Pollinators was adopted at COP-6 in 2002.

Various state acts or legalization of environments issues, particularly with reference to “Pollinators” are finally crystallized in “**Mahinda Chinthanaya / Haritha Lanka**” program. In the Sri Lankan perspective, the vision of the Executive President is given in “*Mahinda Chinthanaya*” where there is a chapter on “**Green Lanka for a sustainable future**” which states that the “*Haritha Lanka*” programme will be launched from 2010-2020 under the leadership of the His Excellency with the objective of creating a base for sustainable development. This intervention includes activities such as the introduction of innovative methods for agriculture; prepare the country for environmental change etc stating that, “**an Action Plan**” will be implemented from 2010 to seek solutions to the problems emerging out environmental changes such as extinction of species, threats to food cultivation etc. Among them, the most important is the National Action Plan (NCS 2009) for Haritha Lanka programme under **Mission 2: Saving the Fauna, Flora and Ecosystems Section 3.7 “Conservation of pollinators and their habitats”** as an action in the Conservation and sustainable use of flora and fauna outside the protected area network strategy. Therefore, this document is an elaborate on the “**Action Plan**” for the “**Conservation of pollinators and their habitats**”

The Biodiversity Conservation Action Plan and the addendum is a generalized document that identified the limited knowledge on conservation and sustainable use of pollinators as a gap of conservation issues of both in natural and agro biodiversity.

The formulation of PCAP is expected to get specific information need to be protected and sustainable management for the pollination service and incorporate the conservation of pollinators and their sustainable use for agriculture. Furthermore specific conservation action is useful in properly designed research studies on pollinators and plant-pollinator relationships in future.

To be edited later. (after considering comments the comments for the final draft)

This document has been prepared with ..... knowledge from..... and accepted as an AP of national importance. A preliminary working document was discussed at a workshop of selected experts..... On the ..... at the Ministry of Environment which enabled to obtain valuable comments and suggestion to prepare the PCAP. The draft PCAP was reviewed by a group of technical experts.

## 2. Guiding Principles

- i) Pollinators are essential in agro ecosystems of which widely recognized for the crop production.
- ii) Recognizing the wild pollinators in agricultural landscapes can provide important pollination services.
- iii) Natural ecosystems and many agricultural ecosystems depend on pollinator diversity to maintain overall biological diversity.
- iv) Recognizing bees are the efficient pollinators in crops and other plants.
- v) Rapid development and current agricultural practices are harmful to pollinator biodiversity, and instead, developments and current agricultural practices can be promoted with environment friendly manner to sustain pollinator biodiversity in both natural and agro ecosystems.
- vi) Habit protection as an important criterion in pollinator protection.

## 3. Aims & Objectives

The aims of the PCAP are to identify information gaps related to pollinators in Sri Lanka and to formulate constructive and practical recommendations towards their conservation.

**Goal:** To achieve conservation and sustainable use of pollinators in Sri Lanka

**The major objectives of the AP are:**

- Species identifications of principal pollinators and review their conservation status
- Monitor the numbers and diversity of pollinators target crop systems and landscapes
- Determine the pollination requirements of crops and their effective pollinators
- Identification specific cause of pollinator decline
- Monitoring the loss of pollinators

- Identification the conservation practice to maintain pollinators and restoration strategies
- Estimation of the economic cost associated with reduced pollination of crops
- Review current research and management programmers and recommend priorities for future action
- Provide a list of Pollinator Specialist group who will work with the Ministry to advise on issues pertaining to pollinator conservation and who will oversee management activities
- Manage conservation information and stimulate public awareness of the role of pollinators in their lives

Taking in to account the above facts the following summarized major topics are taken in to consideration in developing National PCAP. They are;

1. Nationwide understanding of the role of pollinators.
2. Assessment of the pollinators and pollination conservation. This will form the theoretical base and the justification of the National PCAP.
3. Conservation of pollinators in natural sites.
4. Protection of pollinators in disturbed sites.
5. Development planning and pollinator conservation.
6. Pollinator utilization.

## **4. An overview of pollinator diversity and conservation in Sri Lanka**

### **4.1 History Pollinators & Pollination related studies in Sri Lanka**

Pollinators and pollination services have long history in the world (Darwin 1876, Knuth 1895). Insect pollination and wind pollination are the commonest ways in plant pollination. Among those insect pollinators, bees are considered the most efficient pollinator group in the world. The arrival of plants which took place about 100 million years ago led to evolution of flowering plants. To bring about effective transportation of pollen of a particular flower to the stigma of another flower of the same species, specialized insect groups called bees were evolved about 40 million years ago.

Anthropologically, the first record of the importance of pollination comes from Assyria about 1000 years BC. Old Mayan screen fold books (eg the Madrid Codes) indicate that the ancient Mayan kept stingless bees to manage and propagate captive colonies in log hives (A Resource book on Policy and practice on Pollinators and Pollination)

Sri Lanka is a biodiversity hotspot has over 4300 species of flowering plants. Without pollinators this great biodiversity cannot exist and among them honey bees play a key role. Considering the history of Sri Lanka our indigenous people “Veddas” livelihood highly depend on the honey from *Apis dorsata* or Bambara and *Apis cerana* or Mee Bee, honey combs (Seligmann & Seligmann 1910, Spittle 1945). Further the importance of pollinators was recorded in the folklore (Dep 1956). Presently several Sri Lankan scientists are engaged in detailed studies on insect pollinators of crop and other plants (See separate annexure on pollinator studies conducted in Sri Lanka).

There have been several publications including books and research papers dealing with the pollinators and pollination service in the world. Surprisingly even the identities of major and minor pollinators for many major crops plants worldwide remain unknown. Some of important publications are the “**Pollination directory of world crops**” (Crane & Walker 1984) described more than 25,000 species of bees in worldwide and many of them are efficient pollinators of crops. According to Buchmann & Nabhan (1996) in their book “**The Forgotten Pollinators**” estimated that two-thirds of the worlds 3000 species of agricultural crops require animals for pollination. Thousands of species of animals are responsible for this service comprising bees, ants, birds, wasps, beetles, butterflies, moths and flies.

Taxonomic impediments and taxonomic deficits are major drawbacks for the pollinator studies. Also the science of pollination ecology has not advanced adequately. Therefore scientific data on pollinators and the pollination services are inadequate in Sri Lanka. The beekeeping for honey production and pollinator related book on “Bee keeping for honey production in Sri Lanka” published by Punchihewa (1994) made a brief introduction to

pollination ecology. There were number of research studies carried out on pollinators and pollination service in Sri Lanka. (Annexure 1)

#### 4.2 Taxonomy of Pollinators of Sri Lanka

Most of the pollinators are group of invertebrates comprising bees, wasps, ants, beetles, butterflies, moths and flies. There are some vertebrates also contribute to the pollination service such as bats, birds. In Sri Lanka there is a taxonomic impediment and taxonomy deficit as well as the lack of research studies on pollinators and pollination service. According to the prevailing data the classification is as follows:

##### Classification of the Pollinator in Sri Lanka (to be edited later)

Common name	Order	Sub order	Super Family	Family / Sub Family
<b>Bees</b>	Hymenoptera	Apocrita	Apoidea	Apidae
				Anthophoridae
				Halictidae
				Megachilidae
				Collitidae
<b>Wasp</b>	Hymenoptera		Agaonidae	Agaoninae
<b>Ants</b>	Hymenoptera			Formicidae, Dolichoderinae
<b>Flies</b>	Diptera			Calliphoridae
<b>Beetles</b>	Coleoptera			Curculionidae
				Nitidulidae
				Elateridae
<b>Butterflies</b>	Lepidoptera			all families
Moths	Lepidoptera			various
<b>Birds</b>	Passeriformes			Nectaridae
				Dicaeidae
<b>Bats</b>	Chiroptera		Mega chiroptera	Pteropodidae

### 4.3 Diversity of the Pollinator species in Sri Lanka

#### Species Richness and Conservation Status of Pollinators\*

Common name of pollinator	Family	Number of species	Threatened species
<b>Bees</b>	Apidae	04	
	Anthophoridae	53	
	Halictidae	53	
	Megachilidae	35	
	Collitidae	02	
<b>Wasp</b>	Agaonidae		
<b>Ants</b>	Formicidae	181	
<b>Beetles</b>	Curculionidae		
	Nitidulidae		
	Elateridae		
<b>Flies</b>	Calliphoridae		
<b>Butterflies</b>	All families		
<b>Moths</b>	various		
<b>Birds</b>	Nectariniidae (Sunbirds)	3	
	Psittacidae (Hanging Parrot)	1	LC 1
	Zosteropidae (White-eyes)	2	NT 1
	Dicaeidae (Flowerpeckers)	3	NT 1
<b>Bats</b>	Pteropodidae	30	12

LC Least concerned NT Near Threatened

Source : The Fauna of Sri Lanka(2006)

\*to be update and or modified.

#### 4.4 Distribution of Pollinators in Sri Lanka: the role of Honeybee or Social Bees (Hymenoptera: Apidae)

The roles of honeybees or social bees as the most efficient “generalized<sup>1</sup>” pollinators are unique as they act as a large pollinator force or a population concentrated in a single location or their colony as oppose to solitary bees. The four species those are indigenous such as *Apis dorsata* (**Bambara or Giant honeybee**), *Apis cerana* (**Mee or Hive honeybee**), *Apis florea* (**Danduvel or little honeybee**) and *Trigona iridipennis* (**Kanaiya or Dammar bee**) share the same ecosystem depending on resource availability, foraging ranges and migratory behavior. Frisch (1967), Lindauer (1956 & 1957), Koeniger et al (1982), Koeniger *et al* (2010), Punchihewa (1994), Punchihewa *et al* (1984) etc have elaborated many of these biological, behavioural and ecological aspects of this uniqueness on the work done in Ceylon or Sri Lanka itself. Koeniger & Vorwohl (1979) reveal the basic facts on competition for food among these sympatric Apini in Sri Lanka.

- *Apis dorsata* makes a long range annual migration from the tops of central mountains (cloud forest) to the sea coast annually pollinating many species of plants covering all ecosystems on their migratory path. During this annual migration they have temporary nesting sites where they may stay for several weeks to months depending on the food availability or flowering of the plants. From the nest, they have a foraging radii of several kilometers covering several hundreds of square kilometers of land. Therefore, *A dorsata* should be considered the major pollinator and they have a island wide distribution. Plants benefitted by them still unknown but may be in the range of 1,000s. However, these bees are not manageable<sup>2</sup> thus causing a wide spread believe that this is a dangerous stinging insect; essentially due to the undue interference with them by humans. Major threat seems habitat destruction especially with regard to nesting sites. A

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<sup>1</sup> - As oppose to specialized pollinators who visit only a specific family or genus of plants for the purpose of pollination. Eg Orchid bees, Pollination of Durian by bats, sunbirds for flowers with long corolla tube, hawk moths (Sphingidae) pollinating curcubits, etc. Honeybees are essentially “opportunistic” flower visitors and by this they effectively pollinate even exotic flowers.

<sup>2</sup> Depending on whether they could be managed easily like the honeybee of commerce, the *Apis cerana* or the **Mee Bee**.

- nest contains about 60,000 bees and they have a unique ability to forage in the moon light as well (Dyer 1985).
- *Apis cerana* pollinate many plants within their foraging range which is within a radius of about 750 meters from its nest and is non-migratory. Therefore *A. cerana* should be considered the 2<sup>nd</sup> important pollinator and have an island wide distribution. Also this is the species utilized in commercial beekeeping and as such this species is manageable (Punchihewa 1994). A nest contains about 20,000 bees
  - *Apis florea* pollinate many plants within a foraging range less than 500 meters and make short range migrations depending on the food availability. Unmanageable and distribution limited in higher elevations and completely devoid in elevations above 1250 meters. A nest contains about 2,500 bees. However more common in Arid zones of the island. Major threat seems the over and misuse of insecticidal chemicals.
  - *Trigona irridipennis* manageable short range pollinator with a foraging range of about 250 meters. An ideal species for pollination in home gardens and a very resilient species. A nest contains about 2,000 bees. Major threat seems the over and misuse of insecticidal chemicals.

Therefore, all four species of honey bees need conservation and particularly *Apis dorsata* needs urgent conservation measures. Further the honeybees could be considered as “Keystone Species<sup>3</sup>” (Cunningham *et al* 2005) to determine not only the pollinator status but as an indicator for total ecosystem health or wellbeing.

#### **4.5 Legal and Institutional aspects related conservation of Pollinators of Sri Lanka**

From the point of view of implementation, two important aspects are considered. Firstly the conservation of existing pollinators in the island. Secondly the protection of existing pollinators from the intervention of exotic species through unscrupulous importations. With regard to both these aspects The Dept of Agriculture could be

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<sup>3</sup> Keystone Species – is a species or a group of species whose feeding activity has an inordinate influence on the structure of its community.

considered the major agency in implementing two-pronged approach to pollinator conservation and protection.

#### **4.5.1 Conservation of existing pollinators.**

Existing pollinator conservation is a well accepted fact (NCSD 2009) that does not require any further elaboration. The scientific basis for the existing pollinator conservation is well illustrated and justified by Black *et al* (2012), Buchmann & Nabam (1996) and Price (1997).

In Sri Lanka the different laws in force to environmental protection and many of which directly or indirectly related to the conservation of species and ecosystems. Most related acts and ordinance are Forest Ordinance, Fauna and Flora protection ordinance, National Environmental Act, National Heritage Wilderness Areas Act, Felling of Trees Act and Plant Protection Ordinance etc. But in certain situations these laws are overlapping and sometimes in conflict. Habitats of the animals and plants protected by Forest Ordinance and Fauna and Flora protection ordinance in Protected Areas, Nature Reserves, National Parks, Natural Reserves etc. As per the amendment of Fauna and Flora Protection Act No. 22 of 2009 protected all butterfly species including moths (schedule VII). Import and export of plants and animal species protect by Custom Ordinance.

Effective implementation of the action plan depends on the capabilities of relevant institutions. The Departments of Agriculture, Forests, Wild life Conservation, Central Environment Authority, Mahaweli Authority etc and the Universities have to play vital role in pollinator conservation and their sustainable utilization.

The beekeeping promotional work done Department of Agriculture, Ministry of Economic Development, Ministry of Irrigation and Water Management which includes the former Mahaweli Authority does a great indirect service by generating family income along with pollinator and plant conservation.

#### **4.5.1.1 Registrar of Pesticides (RoP) functioning under the Dept of Agriculture (DoA)**

As far as pollinator conservation and protection is concerned, the sphere of influence of the RoP, is far beyond the *modus operandi* of the Dept of Agriculture (DoA). It is a world renowned fact that chemical pesticides alone had caused so much destruction to the biota<sup>4</sup> of the world as documented by the classical work of Rachel Carson and others later (Carson 1962, Perkins van den Bosch 1978, Perkins 1982). Pollinator protection had not been considered an important issue in environment protection (McEven & Stephenson, 1979). However, insect pollinators which consist mostly bees (Superfamily Apoidea) in particular faced devastating direct and indirect ill effects and precautionary measures were suggested (McGregor 1976, Johansen & Mayer 1990).

Therefore, the RoP should make available, the relevant sections of the **Test Reports**<sup>5</sup> to the Ministry of the Environment. Ministry of Environment in turn should seek the views and comments of experts appointed for the purpose of environmental impact assessment evaluation. **The approval for the use of a pesticide should only be allowed after receiving clearance from the Ministry of Environment.**

#### **4.5.1.2 Appointment of a Panel of Experts to advise the Ministry of Environment (MoE).**

Ministry of Environment should therefore appoint a panel of experts to evaluate the “**Environment Impact Assessment**” of each and every pesticide already in use and to be approved and used in future. The experts should be provided with facilities to conduct the needed investigations by the MoE. The RoP should therefore be in regular liaison with the MoE.

#### **4.5.2 The protection of existing pollinators from the intervention of exotic species.**

Sri Lanka Custom’s Division of Biodiversity Protection has a very special role in implementing the laws governing the imports and exports of Flora and Fauna to and from

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<sup>4</sup> The total complement of animals and plants in a particular area.

<sup>5</sup> Usually a test report of a particular chemical consist of about 100,000pages which include the environment impact assessment.

Sri Lanka. Considering the well known problems that occurred worldwide such as the “Brazilian Africanized Honeybee Problem” in the American continent and the “Asian Honeybee Parasitic Mite Problem” that is affecting the billion dollars honey industry Small Island based nations like Sri Lanka need to be extra careful (Needham *et al* 1988), . It should be recorded, reiterated and remembered that due to the swift and timely action of the Division of Biodiversity Protection of the Sri Lanka Custom, this country was able to avert a major disaster that could have occurred due to the importation of exotic “Bumble Bees” quite officially with the permission of the Dept of Agriculture to pollinate green house strawberries, in 1999 December.

#### **4.5.2.1 National Plant Quarantine Service (NPQS) functioning under the Dept of Agriculture.**

The very basis of having a national Plant Quarantine Service for the protection of the agro-ecosystems from intruding or invasive biota (Seneviratne 1983 & 2012 and Jeyanandarajah 2012). It is time now to include pollinators as an essential part of all agro-ecosystems and take protective actions accordingly. Therefore in this respect NPQS should work very closely with the Biodiversity Protection Division of the Sri Lanka Customs in protection our agro-ecosystems.

Plant quarantine act is a legislative provision for implementing scientifically determined measures to prevent the introduction of exotic pests, pathogens, planting materials, microbes and invertebrates harmful to cultivated crops, forest species and the natural vegetation.

Although quarantine regulations exist in Sri Lanka, it is certain that the general public is ignorant of the importance it plays in the national economy and conservation of biodiversity. Thus an important aspect in the strengthening of plant quarantine services should be to create an awareness and sense of responsibility in the public of the importance of phytosanitary certificate and import permits over the movement of plants, planting material, beneficial organisms for soil fertility and pollination.

An analysis of risk should be made of the living organisms imported. Risk analysis is a thought process whereby the entry of plants, plant products, cargo, baggage, mail, etc. is based on the calculated risks inadvertently introducing hazardous pests, pathogens and menacing organisms on these items as moved by man.

To reiterate and stress the point of view again, for plant quarantine to be fully effective, team work is essential. Very close co-operation must be established between custom officials and plant quarantine staff at various places.

#### **4.5.3 Legislation on Pollinator Protection.**

The legislation currently implemented on the safe use of pesticides should be modified to accommodate the importance of pollinators and their protection, particularly the bees. Level of hazard to pollinators and the “**Pollinator Safety Use**” should be included in the labels of all pesticides (**The Label is the Law**). It is suggested that pesticides be divided into three groups as far as toxicity to pollinators are concerned, such as;

- Highly toxic and dangerous
- Moderately Toxic and moderately dangerous
- Non-toxic or non- dangerous

#### **4.6 Conservation Issues**

There is a need to address pollinators and their conservation issues in existing acts and regulations. In a practical conservation process the identification of threats are important factors. In PCAP the allocation for conservation status and therefore understanding the definition and assessment of threat are important areas. There were several specific identification of threats for the pollinators in the workshop on International Pollinators Initiative in Brazil 1998. At this workshop the experts recommended document of “ The frame work for action” submitted to COP-V for the recommendation. This is an important general document has been made for the Pollinator Conservation and sustainable use. It is also important to realize the crucial role that can be played by the Sri Lanka Customs “**Biodiversity Protection Unit**” in the conservation of pollinators.

**4.6.1 Global warming and climate change:** The Global climate change appears to be contributing to a mismatch between pollinators and plants. Distribution and phenology of many plants and animals are biased in the directions from global warming. The flowering time for plants which is likely to change in response to regional and global climate change. The plants and pollinators are responding differently to climate change, potentially resulting in reduced reproductive success for both groups and possible extinctions. The timing of flowering has become earlier, the abundance of some flowers has changed, and the synchrony of plants and pollinators may be changing. It may be assumed that the abundance and distribution of plants and pollinators in response to climate warming is taking place. However, it stands to reason that no adjustments can be made without proper understanding of the deviated processes. Plant-pollinator assemblage shows the overall structure of pollination networks probably robust against perturbations caused by climate warming, though debatable without proper data.

**4.6.2 Habitat fragmentation :** Habitat dramatically change by the human activities. Illicit felling, damage by the forest fire, urbanization, developments, *chena* (shifting) cultivation are the process cause by the habitat destruction common in Sri Lanka. Habitat fragmentation is directly affects the nesting sites of the pollinators and declines the nectar producing flowers. Other than this some pollinators exhibited specific plant-pollinator attraction the habitat fragmentation is severely affected. Wetland filling is also a major issue in the Western Province. Forest fires annihilate honeybee colonies (social bees) and other solitary bees in total.

**4.6.3 Agricultural practices:** Mono culture farming systems destroy habitats many natural pollinators on one hand and then deplete the food resources available for pollinators after the growing season of single crop. Irrigation systems have been seen to a negative effect on bees that burrow or nest underground.

**4.6.4 Pesticide pollution and Industrial chemicals:** Chemical misuse is just one of the most potent factors causing pollinator disappearances. At present use of pesticides worldwide for cultivation vegetables, fruits and cereals have increased considerably.

Now farmers got used to using diverse pesticides in Sri Lanka even above the recommended dosages. Impact of insecticide application on pollination services and the crop yields depends on the kind of pesticide, dosage, formulation and timing of application. Herbicides are not usually directly toxic to bees and other pollinators, but can have important impacts through eliminating larval host plants (weeds) for Lepidoptera or reducing nectar and pollen for bees. Pesticides cause severe insects mortality also removing the natural vegetation.

**4.6.5 Honey hunting:** Honey an important non-timber forest product of tropical Asia has been obtained through hunting as an ancient art but it has to be done in a sustainable manner (Beer & McDermott 1996, Knox 1681, Seligman & Seligman 1910). It can become sustainable only if they follow the traditional methods, which are less harmful to the bees. However, honey-hunting need not be practiced now as there are so many new methods in producing honey sustainably.

**4.6.6 Parasites and diseases:** This is an important area where Sri Lanka Custom's Bio Diversity Protection Unit can play an important role as already they have done several times in the past. (see section 4.5.2.1)

**4.6.7 Alien invasive species:** Alien invasive species affected the native pollinators and resulted food resources competition. (see also section (vi) above)

**4.6.8 Taxonomic impediment:** Accurate genus and species identifications are essential for understanding pollination. Identification of principal pollinators are severely hampered by a shortage, in all countries of taxonomists. Taxonomic impediment is greater for invertebrate animals than for vertebrates because of their greater diversity, abundance and small size.

#### **4.7 Constraints for Conservation of Pollinators in Sri Lanka**

This has been discussed in detailed before, however for the convenience of the reader, this aspect can be broadly divided in to two areas.

**4.7.1 Lack of public awareness:** Similar to all other environmental issues unawareness seems the major cause among the general public in ignoring the importance of pollinators. This need to be rectified at the very early stage and initially the public should be made aware of the importance of pollinators, similar to the way in which several other environmental problems were settled; such as prevention of burning of strew, prevention of stagnant water collection, etc.

**4.7.2 Non-inclusion in the school curricula:** An important aspect in promoting public awareness is through including the “issue” and at this instance the “importance of pollinators” in school biology curriculum at a suitable stage. This be done at several stages with the consultation of the educational experts, at primary stage as “nature watching” and at GCE (OL) and GCE(AL) stages as essential part of plant reproductive biology.

**4.7.3 Lack of funding for research studies:** State scientific research funding agencies such as National Science Foundation (NSF), National Research Council (NRC), Council for Agricultural Research Policy (CARP) etc should include “pollinator or pollination studies” among the research priorities taking into account the national importance of the issue. The scientific community should give thought to some crucial issues such as, breaking down of the “Passion Fruit Industry”, “Gherkin Cucumber Cultivation” which were direct foreign exchange earners and employment generators from economic point of view. Then from the nature conservation point of view, the current “Bambara or Giant Honeybee Problem” is an obvious case in hand. All these need serious scientific investigation, rather than casual routine remedies which were mostly pesticide related, which were/are disastrous in the long run.

#### **4.8 Recommendations for the Conservation of Pollinators in Sri Lanka**

In this respect the initiative taken by the Ministry of Environment (MoE) is highly commendable. Now it is up to all of us in the scientific community to carry out and help in the initiative taken by the Ministry of Environment. As the initial step MoE should liaise with other Ministries such as Agriculture & Lands, Irrigation & Water Management, Forestry, Wild Life, Botanical Gardens etc which are directly involved

with policies and actions involving land and plants to have demonstrated concerns on the conservation of pollinators.

Final Draft PCAP only for discussion

## 5. Action Plan

The action plan is based on the relationships of pollinators to sustainable livelihood because of their direct links to food production and ecosystem regeneration through plant reproduction. Pollination followed by fruit set and seed set are integrally linked to biodiversity conservation because many plants have unique pollinators. The general lack of awareness about ecosystem services and their value and why pollination is important both to conservation and sustainable agriculture needs to be conveyed more effectively by scientists to broader audiences in the policy arena and public. Further, pollinators are small animals that rarely appear on the policy maker's agendas. Yet the challenge to protect them and to ensure stable and lasting pollinator-plant relationships are important to the survival of human beings and the ecosystems on which we depend.

### 5.1 National Awareness Campaign.

We reiterate the point, the education of the public as the most important and potent tool in solving all national issues of all magnitudes, including "Pollinator Conservation" program. The following are suggested for immediate implementation.

#### 5.1.1 Through media

Three aspects are suggested for immediate implementation.

**5.1.1.1 Involvement of Private Sector.** Media should be encouraged to highlight processes (and perhaps problems) pertinent to pollination. One effective way may be by offering "Tax Reliefs" to private sector organization who would undertake to perform mass media campaigns promoting "Pollinator Conservation", either through electronic or conventional means.

**5.1.1.2 Publication of a poster** on the importance of Pollinator Conservation for country wide publicity.

**5.1.1.3 Publication of a Booklet** on the importance of "Pollinators and their Conservation"

#### 5.1.2 Through the educational process

See section 4.7.2 above. The educational process should start at primary educational and going up to University and beyond. This is nothing new, when we take a simple issue like plant or animal biology (Raven & Johnson 1992, Taylor *et al* 2005). However, the subject of "Pollination Ecology" be included at appropriate level to trigger the interest of

initially young students at primary level developing up to secondary level and beyond. Thus the MoE should also liaise with Ministry of Education with regard to including pollination ecology in school curricula at this very early stage of policy development. The Poster and Booklet suggested in section 5.1.1.2 & 5.1.1.3 if becomes reality be distributed in all schools in the country.

## 5.2 Pollinator Conservation<sup>6</sup>

At present there exists only a broad concept of what is needed for pollinator conservation. Obviously, additional research is needed to understand the specific details and to bring pollination awareness and management into agricultural development and land management practices. The following are suggested for immediate implementation.

5.2.1 Conservation and restoring natural habitats.

5.2.2 Encouragement of growing flowering plants preferred by pollinators.

5.2.3 Promoting mixed farming systems.

5.2.4 Establishing nectar corridors for migratory pollinators.

5.2.5 Providing habitats alongside crop land for pollinator nests and food.

5.2.6 Encouraging integrated pest management.

5.2.7 Discouraging misuse of agrochemicals.

(Justification for these topics are discussed before in this document)

## 5.3 State commitment

State commitment can only be seen through the willingness of the state to fund professional positions in relevant state departments and sufficient funding for these professionals to function effectively and efficiently. As the initial step a specific officer (**Pollinator Conservation Officer**<sup>7</sup>) concerning all affairs in “Pollinator Conservation” be appointed at the Ministry of Environment. One of the important functions of this officer will be to keep a check on the incidences of “Pollinator Destruction and Pollinator

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<sup>6</sup> Bambara (*Apis dorsata*) and Mee Bees (*Apis cerana*) are ideal common example for conservation. Earlier suggestion to consider them as “**Flagship species**” is fully justified, under the circumstances of lack of empirical data.

<sup>7</sup> This is nothing new. For an instance there are “Soil Conservation Officers” in the public service.

Habitat Destruction<sup>8</sup>” taking place countrywide. This officer will also liaise with other relevant ministries (Agriculture, Irrigation, Education, Science, Econ Development etc) in fostering the programs of those ministries towards pollinator conservation.

### **5.3.1 Funding Research Programs**

The Ministry of Environment should liaise with the Ministry of Finance to secure enough funding each year for programs related to pollinator issues. Later these funds be disbursed to maintain MoE relevant staff and pollinator related programs elsewhere within the state machinery.

### **5.3.2 Involvement of Relevant State Agencies**

The state Ministries such as Agriculture & Lands, Irrigation & Water Management, Economic Development, Forestry etc should include a statement announcing their commitment to the conservation of pollinators in all their development programs. May this be in the use of chemical pesticides, land fragmentation, habitat destruction, and infrastructure or physical development the concerns for pollinator and their habitat protection should be a mandatory.

### **5.3.3 Protected Area Network**

Already we have Departments of Wild Life Conservation, Botanical Gardens and Forests. Pollinator Conservation be included in the programs of these state departments as a mandatory requirement

## **5.4 National Pollination Ecology (Palynological) Inventory**

It is suggested that Ministry of Environment consider establishing “National Palynological Inventory” and the following is suggested for consideration.

### **5.4.1 Floral Inventory**

Perhaps the best possible way to build this is to work with the “National Herbarium” which comes under the Dept of National Botanical Gardens. There are two major topics that should be covered under this. Such as the Pollen Inventor and Plant inventory (see below for details).

#### **5.4.1.1 Pollen Inventory**

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<sup>8</sup> Monitoring the incidences of Bambara attacks on public and attempts of destruction of Bambara colonies and their nesting sites in the island. As an example the “Sigiriya” is a common topic in this respect.

A proper palynological facility should be installed at the “National Herbarium” with proper funding for equipment and staffing<sup>9</sup>. Similar to national herbarium collection there should be the parallel collection of “voucher specimens” of all pollen types of the Sri Lankas’ fauna. Then in future any one will be able to use it as the reference point. More over now “Pollinator Conservation” has become a national issue, “Palynological Facility” is mandatory for the conservation of pollinators.

#### **5.4.1.2 Plant Inventory**

It is an encouraging coincident that when Mr HF Macmillan, perhaps one of the greatest superintendents of the Royal Botanical Gardens, Peradeniya published its first edition in 1910, he included a section of flower visiting insects and honeybees (Macmillan, 1943). Over a century ago, this visionary realized the importance of pollinators and up to us now to take it to the proper place in Science and National Policy in a Sri Lankan context. With the establishment of “Palynological Facility” and with the data generated from this facility; it is suggested to include the information in the future editions of the “Flora of Ceylon” (Dasanayake & Forsberg 1976-2002). As an ad hoc measure “Anthophilous Faunal Data” are constantly up dated with the available information for anyone to make reference or to use. The “Pollinator Conservation Officer” (see Section 5.3), if appointed by the Ministry of Environment be made responsible for up-dating the information with the consultation of the group members.

#### **5.4.2 Faunal Inventory**

Faunal Inventory be made in consultation with the “National Museum” fauna collection. Already our national collection is available with “The National Museum” and it is up to us in the pollinator conservation group to make references to the Insects, Birds, Bats etc in the “National Collection”. The “Pollinator Conservation Officer” should liaise with the National Museum for up-dating the information.

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<sup>9</sup> A rudimentary “Palynological Facility” is already established at the National Herbarium with the collaboration of Dr DSA Wijesundara, Director General of the National Botanical Gardens with equipment borrowed from University of Ruhuna (Faculty of Agriculture) and a Microbiologist/Microscopical Expert Dr P Jeyanadarajah, agreeing to work on a voluntary basis. These *ad hoc* measures may not be sufficient and effective in the long run.

## 6. Indicators for regular monitoring

Pollination ecology in spite of being an old science, however lack any empirical evidence for proper monitoring of the “health” of the existing pollinators. Monitoring of pollinators through conventional techniques of insect capture such as “Malaise Trap” may be ineffective and or too cumbersome. However, as the initial step, monitoring and demarcation of “Bambara Trees” and other “Bambara Nesting Sites” are suggested as a simple and a practical measure. Similarly the nesting sites of “Nectar Feeding Bats” should also be demarcated and protected. Trap nesting (Krombein 1967), a rather simple technique for solitary and semi-social bees be encouraged in all agro-ecosystems as a routine measure. Similarly food plant cultivation for Lepidopteron pollinators should also be encouraged where some of the food plants are in fact used in indigenous medicine.

Particularly, the Departments coming under the Ministry of Agriculture should encourage the “Nesting Site Provision” for other two species of home garden pollinators, Mee Bee (*Apis cerana*) and Kanaiya Bees (*Trigona irridipenis*). Here again, it is reiterated that various scientists be given the opportunity through research grants/projects to close these wide gaps in our understanding of pollinators where we will be able to develop more reliable and empirical measuring and or monitoring techniques.

**“Long live pollinators and humans in harmony”**

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